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AQUATOX

MODELING ENVIRONMENTAL FATE AND ECOLOGICAL EFFECTS IN AQUATIC ECOSYSTEMS

Sensitivity Analysis of AQUATOX

Contents

Introduction

This report reflects the results of a comprehensive sensitivity analysis of AQUATOX EPA Release 3. The approach was two-pronged. First, a nominal-range sensitivity analysis was used to provide a comprehensive screening of various endpoints and relevant parameters and loadings using calibrated studies. Second, parameters of particular interest were analyzed more closely using statistical sensitivity analysis with user-defined probability distributions. This analysis is intended both as an examination of the structural integrity and robustness of the AQUATOX model–-i.e. "is the model behaving appropriately?"—and also as a guide for users calibrating and analyzing the AQUATOX model for other sites.

The model runs presented here were performed with AQUATOX Release 3, and not Release 3.1. However, AQUATOX Release 3.1 is generally backwardly compatible with Release 3.0. Two model updates that may change results are a minor change to the denitrification code and a change in the manner that BOD is converted to organic matter. Neither of these updates should have an appreciable effect on the results and conclusions presented herein. However AQUATOX Release 3.1 also has many new options and capabilities that were not tested as part of this analysis (e.g. diagenesis steady-state mode, floating cyanobacteria, and updates to the perfluoroalkylated surfactants model).[1]

The studies chosen from the list of AQUATOX Release 3 distributed studies were intended to span a wide range of water-body types, with a wide spectrum of nutrient and chemical contamination issues:

- **Lake Onondaga NY:** stratified eutrophic lake
- **Lake Onondaga NY, with Diagenesis:** implementation of sediment diagenesis model
- **Cahaba River, AL:** shallow, nutrient-enriched, wadeable stream
- **Duluth, MN Pond with Chlorpyrifos**: toxicant in mesocosm
- **Ohio Stream with Chlorpyrifos**: toxicant effects in stream
- **Galveston Bay, TX:** estuary with PCB contamination

Simulations were not altered from the simulations that are distributed with AQUATOX Release 3, with the possible exception of the simulation time periods.

NOMINAL-RANGE SENSITIVITY ANALYSIS

Depending on the complexity of each model setup and the goals of the sensitivity analysis, between 45 and 890 parameters were tested for each site. Results in this document reflect a total of over 1000 hours of CPU time. A complete list of the parameters tested may be found in Appendix C of this analysis.

[1] In addition, one model construct was changed as a part of the sensitivity-analysis process. Based on the nominal sensitivity results, the "selective sorting" construct was modified so that it was desensitized. This model change is reflected in the statistical sensitivity analysis included in this report and is also included as part of AQUATOX Releases 3 and 3.1.

Table 1. Overview of analyses.

Site name:	15 % Test	33% test	Parameters Tested	Ave. Runtime	Tot. CPU time
Lake Onondaga NY	done	done	173	0.6 min	6.5 hours
Lake Onondaga NY, with Diagenesis	done		50	1.33 hrs	133 hours
Cahaba River, AL	done		627	21.3 min	444 hours
Duluth, MN Pond with Chlorpyrifos	done	done	419	1 min	3 hours
Ohio Stream with Chlorpyrifos	done	done	274	8.3 min	100 hours
Galveston Bay, TX		done	890	10.5 min	308 hours

The nominal-range sensitivity analysis was run both to assess near-range sensitivity (adding and subtracting 15% to each parameter's value) and also occasionally run with larger differences (adding and subtracting 33%). Due to computer-time limitations, both tests were not run for every site listed. For two sites, both near-range and far-range simulations were utilized to examine the linearity of model response to parameter changes. Care must be taken when interpreting far-range sensitivity results as an addition of or subtraction of 33% from a parameter's value may bring that value outside the range of plausibility. For example, if all measured values for a parameter fall within plus or minus 10% running the model with a 33% change may be inappropriate. Furthermore, some parameters, such as Log *Kow*, have units measured on a logarithmic scale. In this case, a 33% change is much more significant than a 33% change to a parameter with non-logarithmic units.

Parameters in the feeding-preferences matrix were not modified as part of this test, due to direct dependencies of other feeding-preference parameters in the matrix. Tests outside of this analysis suggest that the model is sensitive to food-web setup, however.

For all simulations tested, a few endpoints of particular interest were examined. However, results were also generally produced for all nutrient, organic matter, and biota concentrations as well. Increasing the number of parameters tested has a direct effect on how much time a sensitivity analysis will take, but increasing the number of endpoints (for which results are saved) does not. However, reporting all of these results was generally outside of the scope of this report. Select results of interest are presented in Appendix B.

INTERPRETING MODEL RESULTS

When interpreting results of a nominal-range uncertainty analysis, a *sensitivity* statistic may be calculated such that when a 10% change in the parameter results in a 10% change in the model result, the *sensitivity* is calculated as 100%:

$$Sensitivity = \frac{|Result_{Pos} - Result_{Baseline}| + |Result_{Neg} - Result_{Baseline}|}{2 \cdot |Result_{Baseline}|} \cdot \frac{100}{PctChanged}$$

where:

Sensitivity = normalized sensitivity statistic (%);

$Result_{Scenario}$	=	averaged AQUATOX result for a given endpoint given a positive change in the input parameter, a negative change in the input parameter or no change in the input parameter (baseline)
PctChanged	=	percent that the input parameter is modified in the positive and negative directions.

The averaging period for sensitivity results is generally the entire period of the simulation. For each output variable tracked, model parameters may be sorted on the average sensitivity (for the positive and negative tests) and plotted on a bar chart. The end result is referred to as a "Tornado Diagram" as shown throughout this document. When interpreting a tornado diagram, the vertical line at the middle of the diagram represents the deterministic model result. Red lines represent model results when the given parameter is reduced by the user-input percentage while blue lines represent a positive change in the parameter. Within this report the top 14 most sensitive variables out of all variables tested in a simulation are shown in each tornado diagram. When interpreting sensitivity results, it is important to consider the endpoint being evaluated and the system being modeled. For example, a 15% change in oxygen results in a system on the verge of hypoxia could be very important. On the other hand, a 15% change in oxygen in a high oxygen system may have little biological effect. It is also important to consider the uncertainty in the input parameter being evaluated. Some parameters are constrained to a fairly narrow range due to extensive study (e.g. Log *Kow* for many parameters). Other parameters may be variable up to several orders of magnitude, either because of lack of scientific knowledge or actual variability (e.g. "critical force" or *FCrit* for periphyton). Finally keep in mind that the sensitivity is relative to the percentage change in the parameter. In other words 100% sensitivity means that a 15% change in the parameter results in a 15% change in the endpoint.

OVERALL CONCLUSIONS FROM RESULTS

In the course of working through all the results from these sensitivity analyses, several conclusions become clear:

- AQUATOX biotic state variables are sensitive to temperature parameters
    - These parameters include "optimal temperature," "maximum temperature," and "temperature response slope."
    - Changes to the temperature of water, itself, often produce sensitive results. This would indicate the importance of obtaining accurate temperature data, site-specific, if possible.
    - Careful attention should be paid to these variables by anyone calibrating biotic state variables; this conclusion was true for every type of site tested in this analysis.
- Consumption and respiration parameters are also particularly sensitive, especially when allometric formulations are used for fish.
- Algae are sensitive to their maximum photosynthesis rate (*PMAX*).
    - This relationship is especially straightforward for phytoplankton biomass.
    - Periphyton biomass are be predicted to have a similar response but rapid buildup of biomass may be offset by sloughing of periphyton mats, so average results often show less of an effect.
- Simpler food-web models are more sensitive to effects from food-web interactions.
    - For example a food web with five zoobenthos categories is less sensitive to perturbations in a single zoobenthos parameter than a food web in which all zoobenthos are represented by a single category.

- Some biotic state variables are subject to rapid growth and dieback processes and these variables tend to be more sensitive to changes in parameters.
  - For example, cryptomonad and periphyton biomass tend to be more sensitive endpoints than the "slow-and-steady" moss compartments.
  - Similarly, invertebrates tend to be more sensitive than fish.
- "Percent lost in slough event" is a sensitive parameter for periphyton biomass.
- "Sorting: selective feeding," a relatively new parameter that affects the ability of an organism to avoid sediment dilution effects, is also a fairly sensitive parameter for many animals. Based on the initial analyses, it was reformulated to be less sensitive. This updated reformulation is present in both EPA Release 3.0 and 3.1.
- Predictably, Log *Kow* is a highly sensitive parameter for toxicant fate and effect.
- Many AQUATOX parameters show an essentially linear response when extrapolating a 15% change out to a 33% change. (In other words, one could use a line drawn from the baseline model result, with 0% perturbation, through the perturbed model result with 15% parameter change, to fairly successfully predict what the model result would be with a 33% perturbation.)
  - This indicates that many of these sensitivity results *may* be extrapolated to a wider range than tested. For example, consider a calibration procedure in which predicted chlorophyll *a* needs to be increased by 25% in order to match observed chlorophyll *a* and the sensitivity analysis suggests that a parameter has 100% sensitivity to chlorophyll *a.* In this case, increasing the tested parameter by 25% might help bring the endpoint into line with observed data. (This assumes that increasing the given parameter by 25% is biologically defensible.)
- Usually it's fairly easy to understand why other parameters are non-linear, e.g. they are logarithmic or exponential parameters by nature.

When examining the full set of results, the nominal-range sensitivity analysis generally produced results supportive of the validity of model construction. None of the examined effects on model endpoints proved to be unexplainable. In this manner, this sensitivity analysis has provided somewhat of a stress-test of the model. Thousands of alternative model parameterizations have been tested without producing results that are unreasonable or outside of physical plausibility.

In some cases, additional investigation may be required to determine why a particular parameter causes a particular effect. A useful exercise can be to run the unchanged baseline simulation as a "control" simulation and then run the model with the parameter change as the "perturbed" simulation. This exercise can be performed with derivative "rates output" turned on and a daily averaging period. Then the precise nature of model feedbacks that led to the unexpected result can generally be tracked down. This was done to determine why there was a discrepancy between nominal-range sensitivity analysis and statistical sensitivity analysis of chlorpyrifos in the Duluth MN pond (Appendix A). For the most part, though, model results were straightforward enough to render such an exercise unnecessary.

Two model parameterizations did reduce the model's time-step to nearly zero due to stiff equations but neither appears to be a cause of great concern:

- For the diagenesis model of Lake Onondaga, increasing the exponential temperature dependence of pore water diffusion by 15% caused the model to freeze up. This parameter is exponential in nature and an increase by 15% is likely outside the reasonable range for this parameter.

- For the Cahaba River, increasing “selective feeding” for *Corbicula* to 1.15 caused the simulation to freeze. The default parameter for this variable is 1.0 meaning that selective feeding is perfect and sediment dilution has no effect on feeding for this organism. In fact, the value of 1.15 is outside the allowable range for this parameter which ranges from 0 to 1.0.

LAKE ONONDAGA, NY

As a test of which parameters are most sensitive within a highly impacted stratified lake, Lake Onondaga New York was chosen as a case study. Summary:

- A two-year simulation was performed on this highly-impacted eutrophic lake; results are averaged over two years
- Parameters tested include all phytoplankton parameters and all nutrient and organic matter loadings (see Appendix C for a complete list)
- Sediment diagenesis parameters were tested separately; this model run was performed without the sediment diagenesis model included
- Model was run with both 15% and 33% parameter tests
- The two endpoints that were examined particularly closely were chlorophyll *a*, and percent blue-greens (recently renamed “percent cyanobacteria”).

CHLOROPHYLL *A*

Not surprisingly, chlorophyll *a* for this site was most sensitive to algal parameters, particularly those for cryptomonad, which appears to be the algal compartment most subject to variability in this simulation. (In the baseline simulation, cryptomonad comprises 30% of the predicted biomass) The results also indicate that if the blue-green optimal temperature were to be lowered, a blue-green bloom would occur creating a significant increase in the predicted chlorophyll *a.* Parameters that caused the most effects on this output variable were maximum photosynthesis rates and also temperature variables (temperature response slope and optimal temperatures). Interestingly, increasing the inflow of organic matter to the system resulted in a decrease in chlorophyll *a* concentrations, likely due to the effect on predicted turbidity (See Figure B-1 in Appendix B).

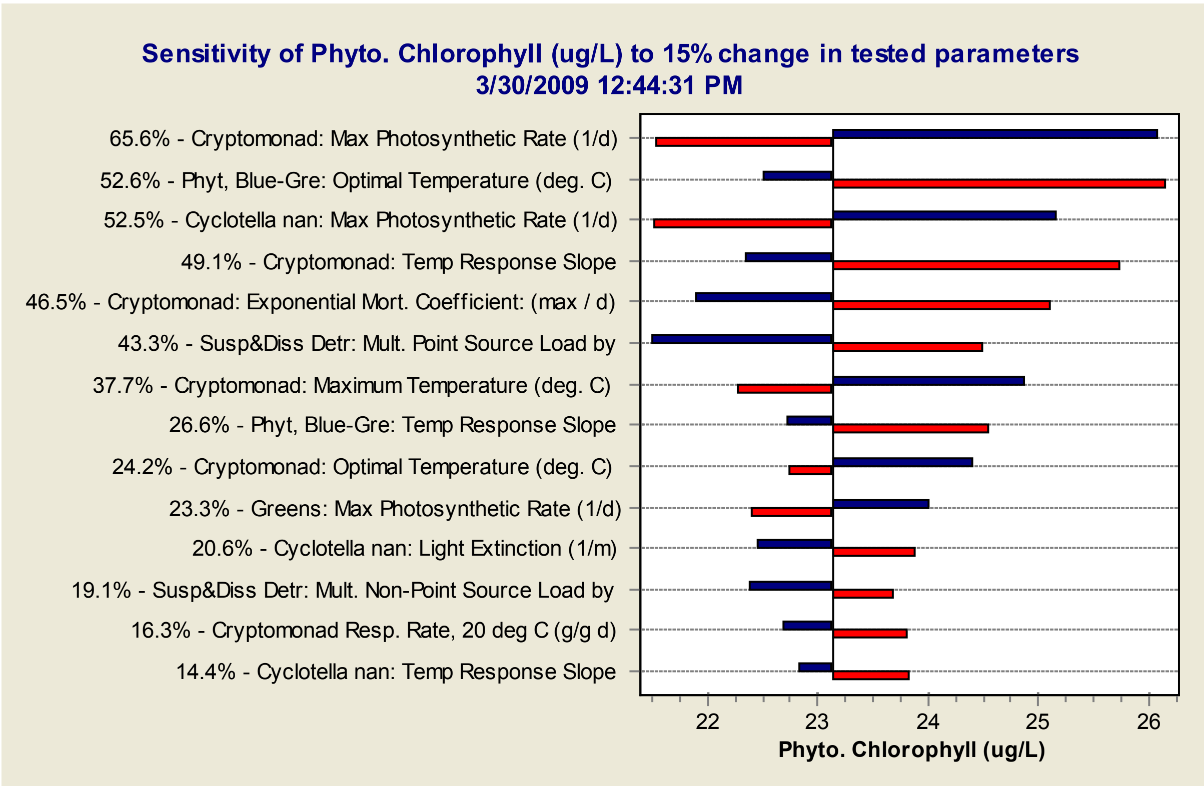

Figure 1. Sensitivity of Phytoplanktonic Chlorophyll a in Lake Onondaga NY.

Comparing the 33% parameter-change results (See Figure B-2 in Appendix B) with the 15% results, blue-green temperature parameters stand out as being the most non-linear. Reducing blue-green temperature parameters so that they can thrive in cooler water will cause dramatic blue-green blooms in this simulation; however, 33% may be outside the range of plausibility for some of these parameters. Other parameters tested are predicted to have a much more linear response. For the most part, changing a parameter by 33% roughly doubled the response that was predicted by the 15% change. One exception to this linearity is the loading of organic matter. The relationship between organic matter and chlorophyll *a* weakens as the signal to that parameter intensifies. In other words, there are limits to the extent of predicted chlorophyll *a* responses given a change in organic matter.

PERCENT BLUE-GREENS

As of AQUATOX Release 3.0, this AQUATOX output has been renamed “percent cyanobacteria.” As mentioned above, the blue-greens (cyanobacteria) are subject to dramatic blooms if the temperature parameters are lowered to allow this variable to thrive in cooler water temperatures. This may not be a reasonable model parameterization, however, as a 33% decrease in this parameter may not be biologically feasible. Other blue-green parameters that significantly affect the percentage of blue-greens include the maximum photosynthetic rate, respiration rate, and saturating light parameters. Increasing the photosynthetic rate of *Cyclotella nana* (a diatom) would reduce the overall percentage blue-greens. (This is because the “percent blue-greens” metric is calculated based on the percentage of blue-green biomass relative to all algal biomass. In other words, a diatom bloom will cause a decrease in percent blue-greens even if the blue-greens biomass stays constant.)

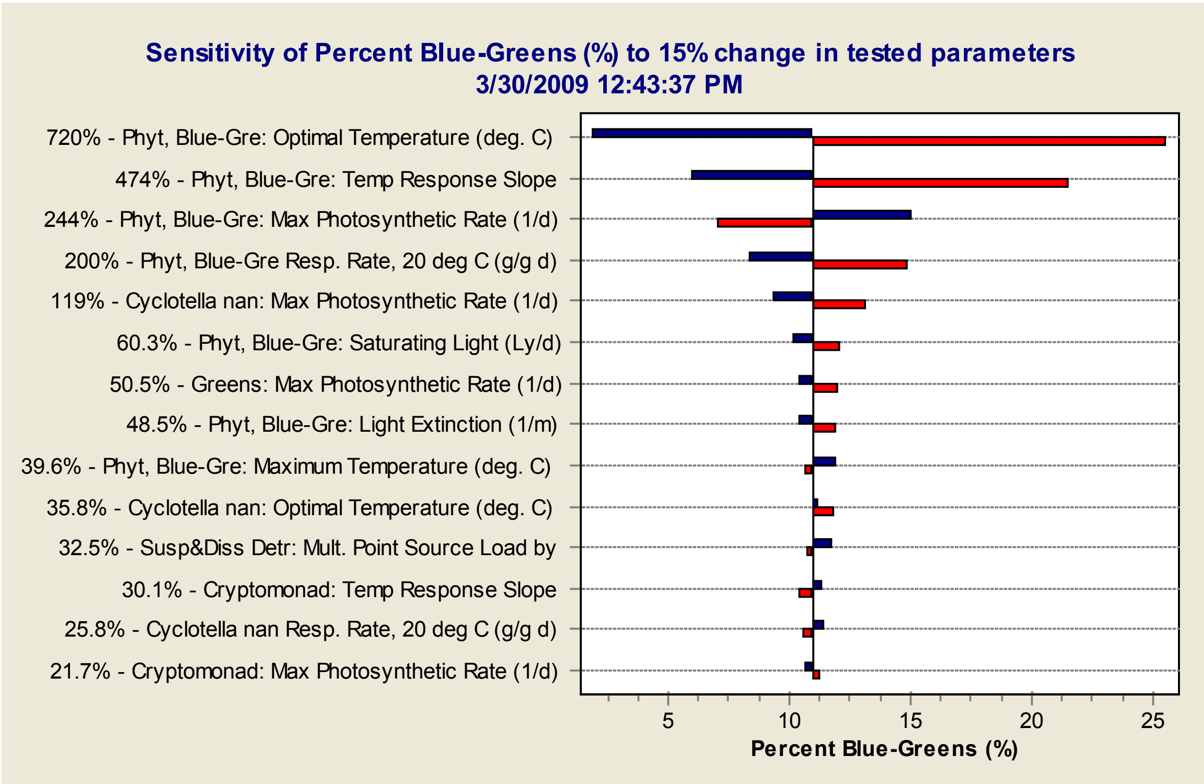

Figure 2. Sensitivity of Percent Blue-Greens in Lake Onondaga NY.

Examining the 33% test (Figure B-3), as noted above, blue-green temperature parameters are the most non-linear. For example, decreasing the blue-greens “maximum temperature” parameter by 33% results in a “percent blue-greens” of 70 as opposed to the baseline of 11. Non-temperature related parameters are approximately linear within this range of parameter testing, however. Results for blue-green biomass, shown below, are very similar to the results for the percentage blue-greens category.

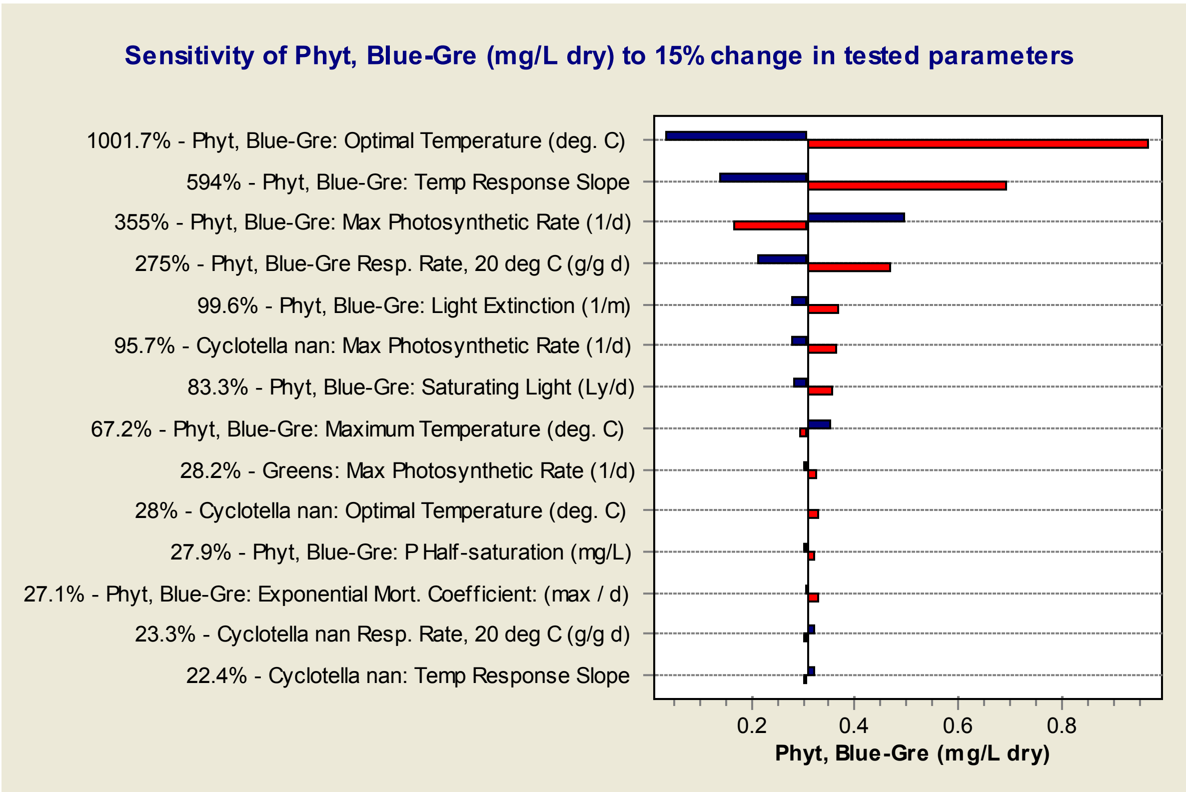

Figure 3. Sensitivity of Phytoplanktonic Blue-Greens in Lake Onondaga NY.

OTHER ENDPOINTS

Other endpoints examined within this sensitivity analysis are summarized below:

- Hypolimnetic Oxygen: this output is sensitive to those parameters that increase chlorophyll *a* concentrations such as cryptomonad parameters and BOD loadings. See Figure B-4.
- Largemouth Bass Concentrations, Adult: this output is sensitive to primary producers' effects on the food-web and therefore *Cyclotella* and cryptomonad maximum photosynthesis rates. See Figure B-5. However, these are all indirect effects as largemouth bass parameters themselves were not tested as part of this study.
- Results were produced for all nutrient, organic matter, and biota concentrations in both segments and are available upon request.

LAKE ONONDAGA, NY – DIAGENESIS MODEL

As a test of which parameters are most sensitive within an implementation of the AQUATOX sediment diagenesis model, the diagenesis implementation of Lake Onondaga was chosen. Summary:

- A one-year simulation was performed and results were averaged over that year
- Parameters tested include all sediment diagenesis parameters
- Model was run with a 15% change in tested parameters

The three endpoints that were examined particularly closely were hypolimnion SOD, hypolimnion oxygen, and hypolimnion Total Phosphate (TP).

HYPOLIMNETIC SEDIMENT OXYGEN DEMAND

Sediment oxygen demand (SOD) results were most sensitive to the "exponential dependence of decomposition to temperature" for G class 2 particulate organic carbon (Theta for G class 2). Class G2 corresponds with sedimented refractory detritus. The reaction velocity for methane oxidation also produces significant SOD changes (kappa CH4). Other sensitive parameters relate to the speed at which organic matter decomposes, methane oxidizes or denitrification occurs.

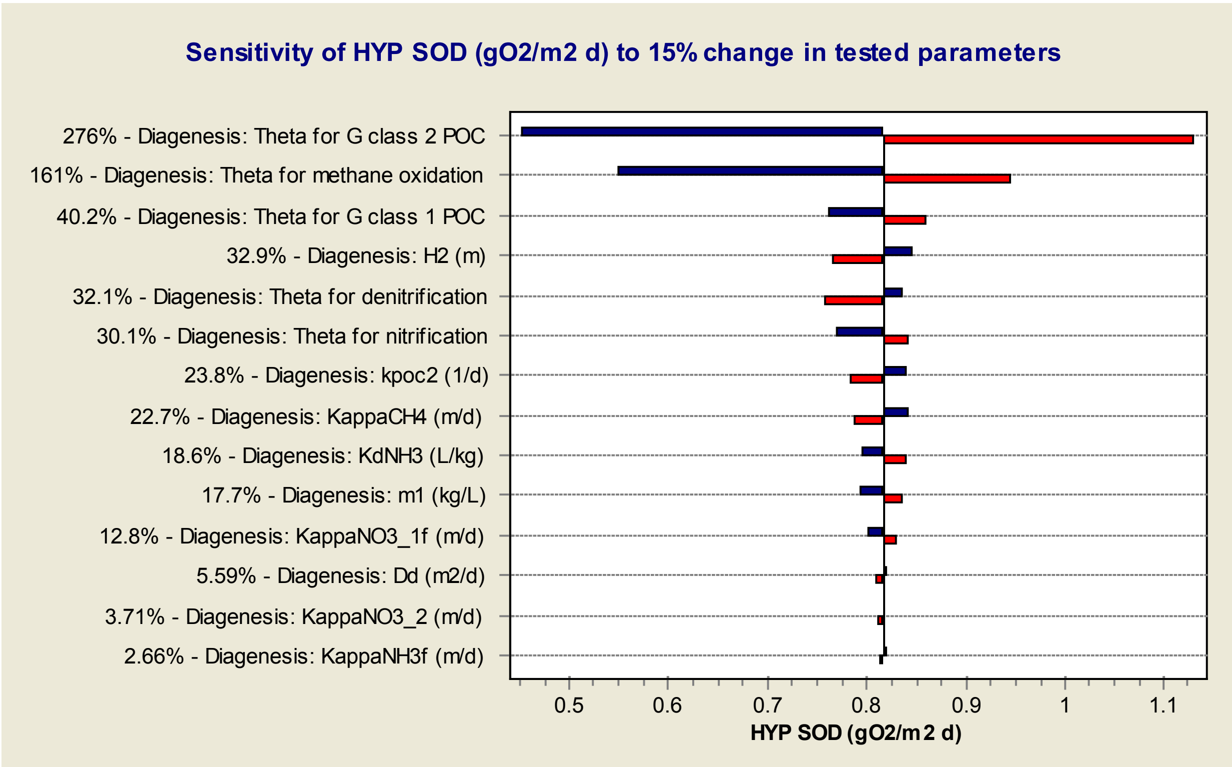

Figure 4. Sensitivity of Hypolimnetic SOD in Lake Onondaga NY.

HYPOLIMNION OXYGEN

Not surprisingly, the concentration of oxygen in the hypolimnion is directly related to the SOD parameters tested above. Any parameter that increases SOD in the hypolimnion decreases oxygen in that same layer. Calculated *sensitivity* statistics for oxygen concentration in water are generally lower, however, as that concentration is a function of many factors only one of which is the SOD flux.

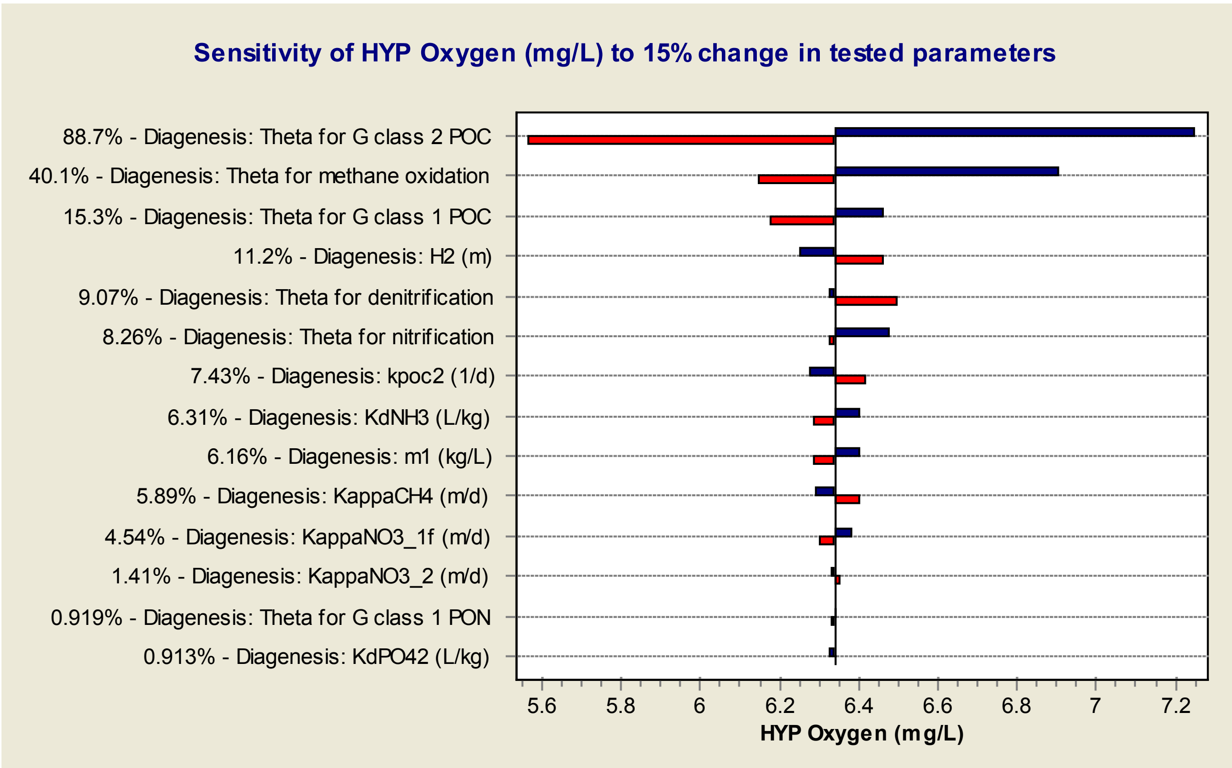

Figure 5. Sensitivity of Hypolimnetic Oxygen in Lake Onondaga NY.

HYPOLIMNION TOTAL PHOSPHORUS

Phosphorus concentrations in the hypolimnion were most strongly related to the partitioning of phosphate between dissolved and particulate forms in the anaerobic layer. The most sensitive parameters were the partition coefficient for phosphate in layer 2 (KDPO42), and the solids concentration in that layer (m2). The diffusion coefficient for pore water was also important (Dd). Because the diffusive surface mass transfer is related to predicted sediment oxygen demand, the rate at which organic carbon decomposes (theta for POC) also affects the rate at which phosphorus diffuses into the water column.

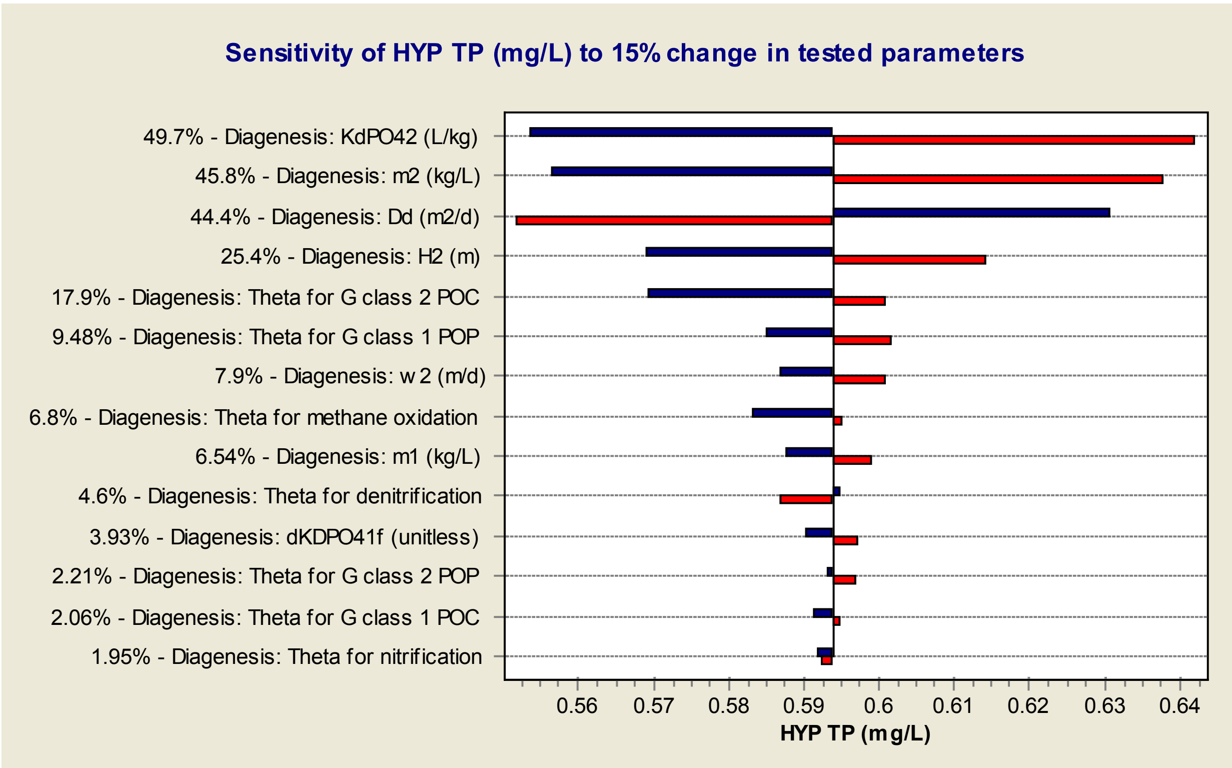

Figure 6. Sensitivity of Hypolimnetic TP in Lake Onondaga NY.

OTHER ENDPOINTS

Other endpoints examined within this sensitivity analysis are summarized below:

- Ammonia and nitrate concentrations are most sensitive to nitrification parameters and the rate of decomposition of POC and PON. (Figures B-6 and B-7)
- Interestingly, the depth of the active layer (h1) did not appear in the top 14 most sensitive parameters for any of the endpoints that we examined. Increasing the size of the active layer can significantly reduce model run-times when the model is not run in steady-state mode.
- Increasing the exponential temperature dependence of pore water diffusion (theta for pore water diffusion) by 15% caused the model to freeze. For this reason, this parameter was not included in these results, but nutrient release from the sediment bed can be assumed to be quite sensitive to small changes in this parameter.
- Results were produced for all nutrient, organic matter, and biota concentrations as well as diagenesis fluxes and nutrient and organic matter compartments within the sediment bed. These results are too numerous for this report but are available upon request.

Cahaba River, Alabama

As a test of which parameters are most sensitive within a nutrient-enriched wadeable stream, Cahaba River, Alabama was chosen as a case study. Summary:

- A one-year simulation was performed on this flashy river; results are averaged over the entire year

- Parameters tested include all periphyton and moss parameters, all fish parameters, and all nutrient and organic matter loadings (see Appendix B for a complete list)
- The model was run with a 15% change in parameters
- The over 20-minute runtime and extensive list of parameters tested meant that nearly 450 hours of computer time were required for this analysis.
- When periphyton and phytoplankton species were linked, parameters tested in one species were simultaneously changed in the linked species. These parameter changes are designated as “Linked” in the variable lists.

Endpoints that were examined particularly closely were periphytic chlorophyll a, moss biomass, zoobenthos biomass, and fish biomass.

PERIPHYTIC CHLOROPHYLL A

Periphyton biomass is quite sensitive to sloughing during high flow events, especially when biomass has built up to an unstable degree. The percentage of biomass that is lost in a sloughing event affects the amount of periphyton left behind to rebuild from. Not surprisingly, the two most sensitive parameters for this endpoint are “percent lost in slough event” for the two most important periphyton groups. Other sensitive parameters for this category are dominated by temperature effects. Sensitive parameters include, “optimal temperatures” for periphyton, “temperature response slopes,” and the multiplication factor for water temperature itself.

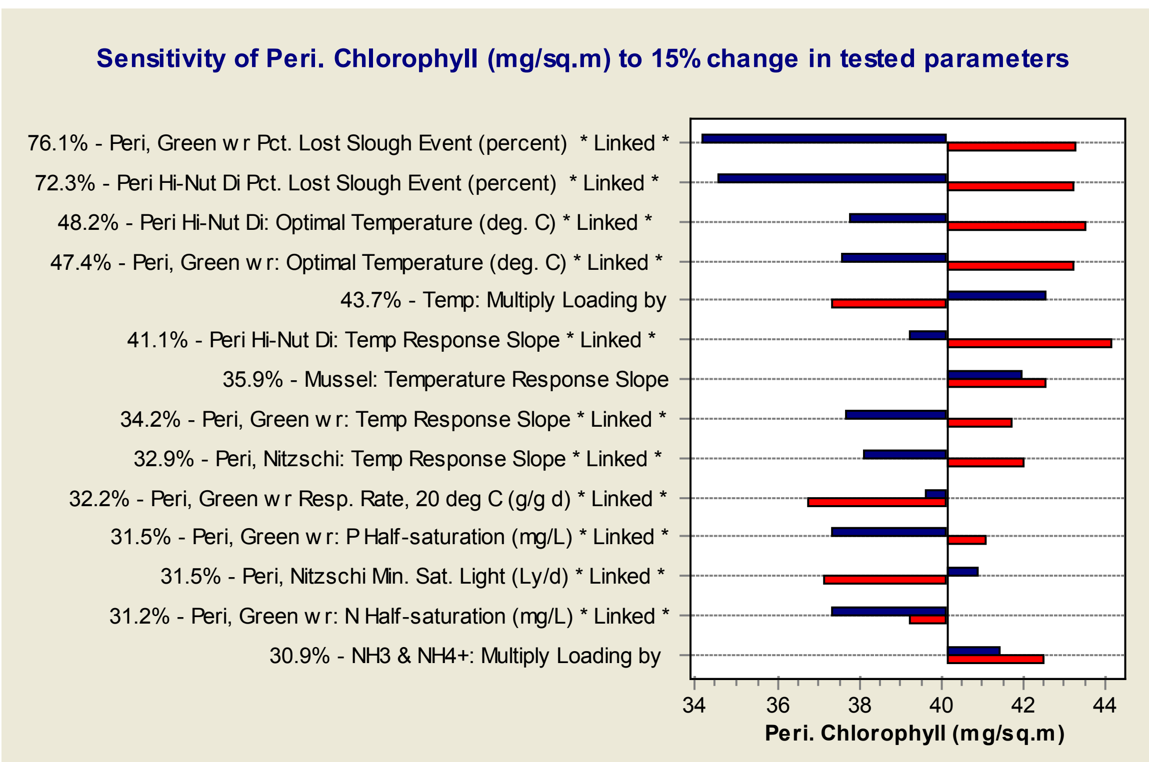

Figure 7. Sensitivity of Periphytic Chlorophyll a in Cahaba River AL.

MOSS BIOMASS

Moss biomass within this simulation is represented by the "*Fontinalis*" state variable, so *Fontinalis* parameters dominate. *Fontinalis* is sensitive to temperature effects so the water temperature itself, the "temperature response slope," and the "maximum temperature" for this state variable are all within the top five most sensitive variables. This "slow and steady" moss compartment is also affected by its initial condition more than other state variables in this simulation. *Fontinalis* is subject to shading by periphyton and is therefore inversely sensitive to many of the same parameters that affect periphyton chlorophyll *a*.

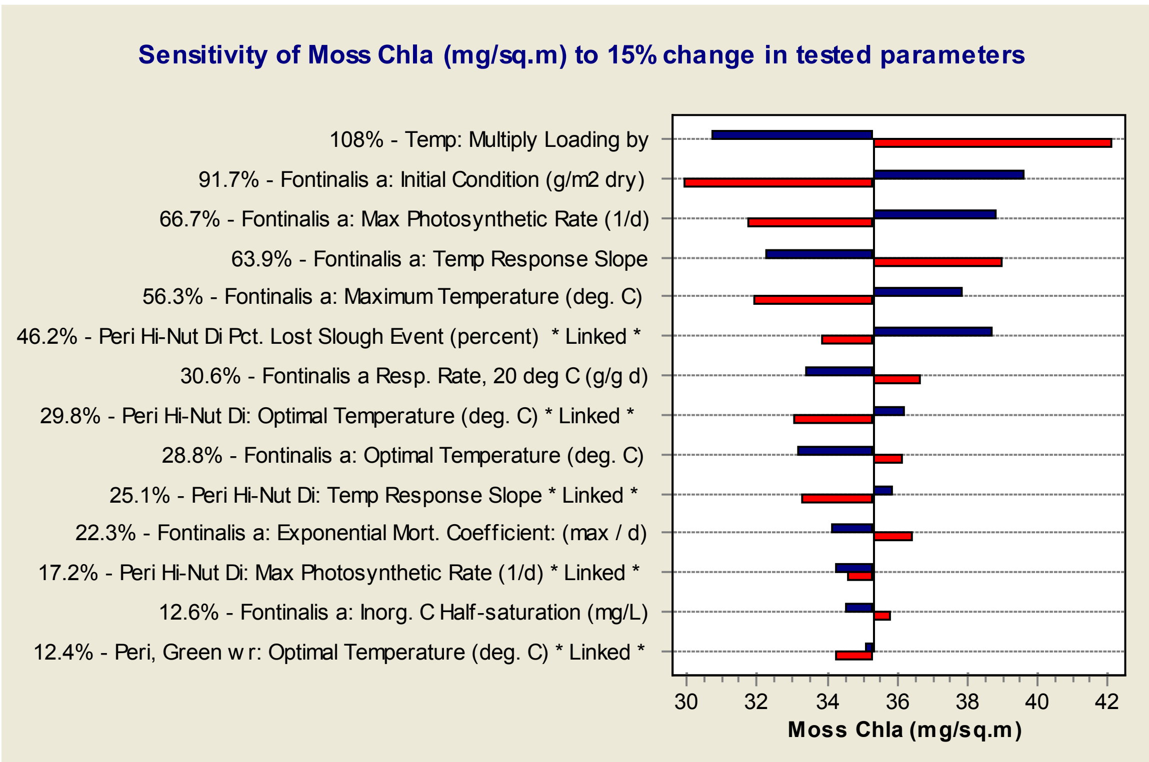

Figure 8. Sensitivity of Moss Chlorophyll a in Cahaba River AL.

ZOOBENTHOS BIOMASS

There are several zoobenthos compartments within this simulation. For this report, we focus on chironomid results as an example of testing and modifying sediment effects. Other zoobenthos sensitivity results for this site may be found in Appendix B (Figures B-8 to B-11). Chironomid results were most sensitive to sorting capability (degree to which there is selective feeding, relevant to all invertebrates). The default parameter for this variable is 1.0 meaning that selective feeding is perfect and sediment dilution has no effect on feeding for this organism. Increasing this parameter by 15% results in a parameter value that is outside the natural zero to one domain for this parameter, so this result should be ignored. Decreasing the parameter to 0.85, however, results in a significant loss of predicted biomass (to an average value that is less than one third of the baseline biomass). Based in part on this sensitivity, the selective sorting construct was modified so that it was desensitized, meaning this simulation result is no longer relevant for EPA Release 3.0 or 3.1. Chironomids are secondarily most sensitive to shiner parameters. Shiners are predators for chironomids so those parameters that increase the viability of shiners decrease the predicted biomass for chironomids. This relationship illustrates the importance of food-chain interactions when calibrating the AQUATOX model.

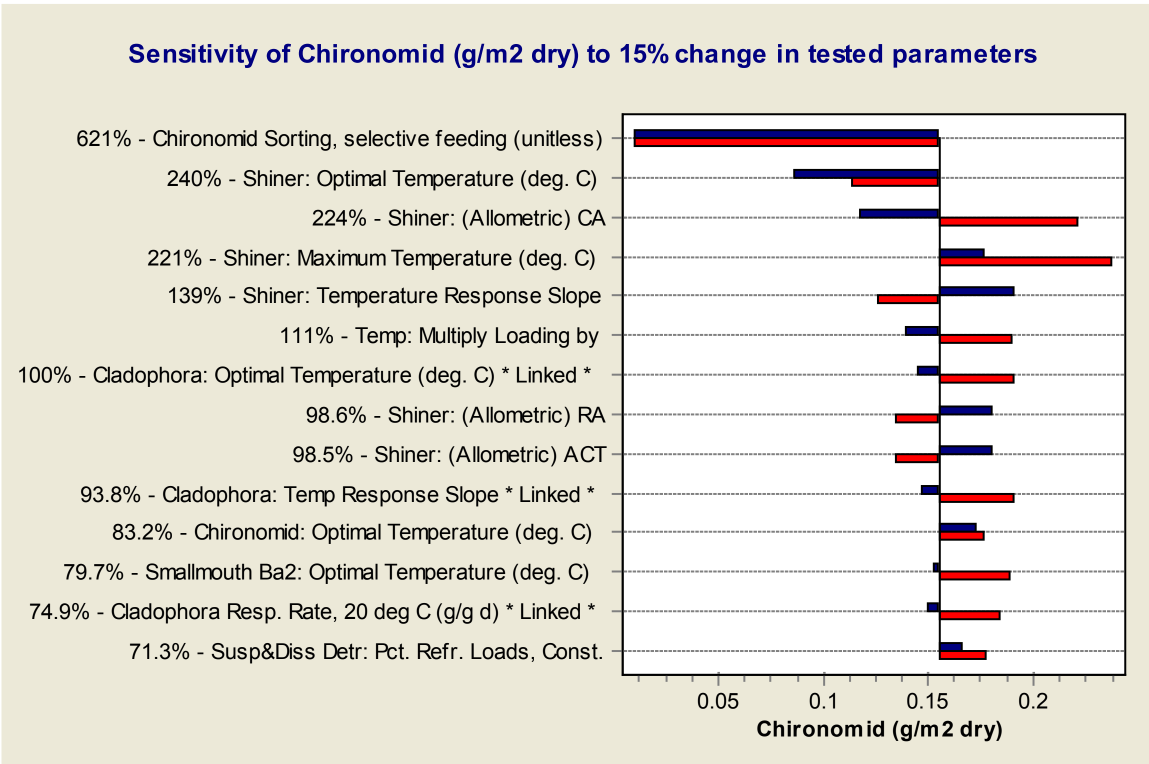

Figure 9. Sensitivity of Chironomid in Cahaba River AL.

FISH BIOMASS

There are five fish species modeled within this simulation. This section will focus on the adult gamefish in this simulation. This state variable can be considered an “integrator of the food chain” given its position at the top. Graphs for the other four fish species in this simulation may be found in Appendix B (Figures B-12 to B-15). Adult smallmouth bass are sensitive to bass parameters, especially “optimal temperature,” allometric consumption parameter “CA,” “Mortality coefficient,” and its own “temperature response slope.” Parameters further down the food-chain create high sensitivity as well. The chironomid “selective feeding” and shiner “maximum temperature” parameters both have significant effects on the availability of food for the bass state variable. (Note that, based on the trophic interaction matrix for this simulation, both chironomids and shiners are directly preyed upon by smallmouth bass.)

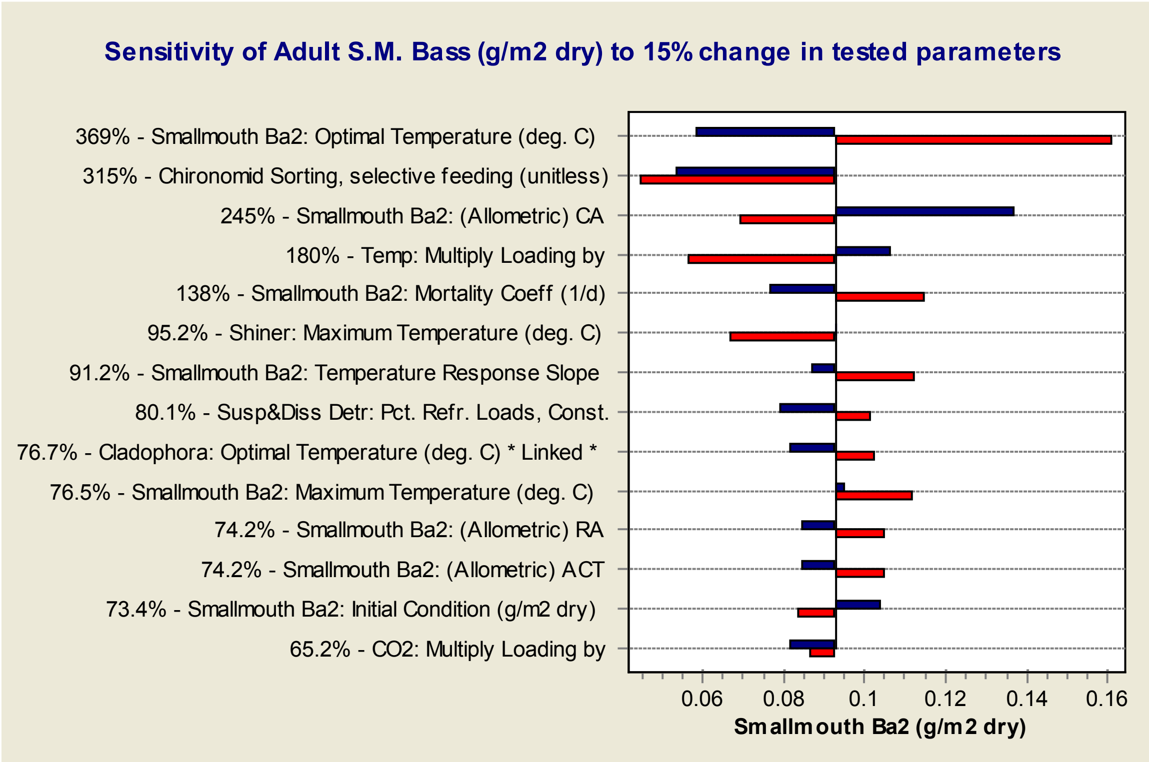

Figure 10. Sensitivity of Adult Smallmouth Bass in Cahaba River AL.

OTHER ENDPOINTS

Results were produced for all nutrient, organic matter, and biota concentrations within this simulation. Graphs of these results are too numerous for this report but are available upon request.

DULUTH POND, MN

As a test of toxicant fate and effects in mesocosm, chlorpyrifos in an experimental enclosure in Duluth Pond, MN was chosen as a case study. Summary:

- Three-month simulation with an initial chlorpyrifos concentration of 6.3 ug/L. Results are averaged over the three months.
- Parameters tested included zoobenthos parameters, fish parameters, fate parameters, animal LC50s, and the toxicant initial condition (see Appendix C for a complete list)
- The model was run with both a 15% and 33% change in parameters

The endpoints that were examined particularly closely were zoobenthos biomass, fish biomass, and the chlorpyrifos concentration in water.

CHLORPYRIFOS IN WATER

Chlorpyrifos concentrations in water are by far most sensitive to the Log *Kow* parameter which affects the partitioning between organic matter and water for this chemical. As this is a logarithmic parameter, the extent of this relationship is not surprising, and this high sensitivity will turn up throughout the sensitivity analysis. The initial condition in water is the next most sensitive parameter for this endpoint followed by the "Henry's law constant" which affects volatilization and the rate of aerobic microbial degradation. Although the sensitivity is only 20%, the "elimination rate constant" of chemicals within diatoms is an interesting addition as it shows how biotic processes can affect the concentration of a chemical within a water body.

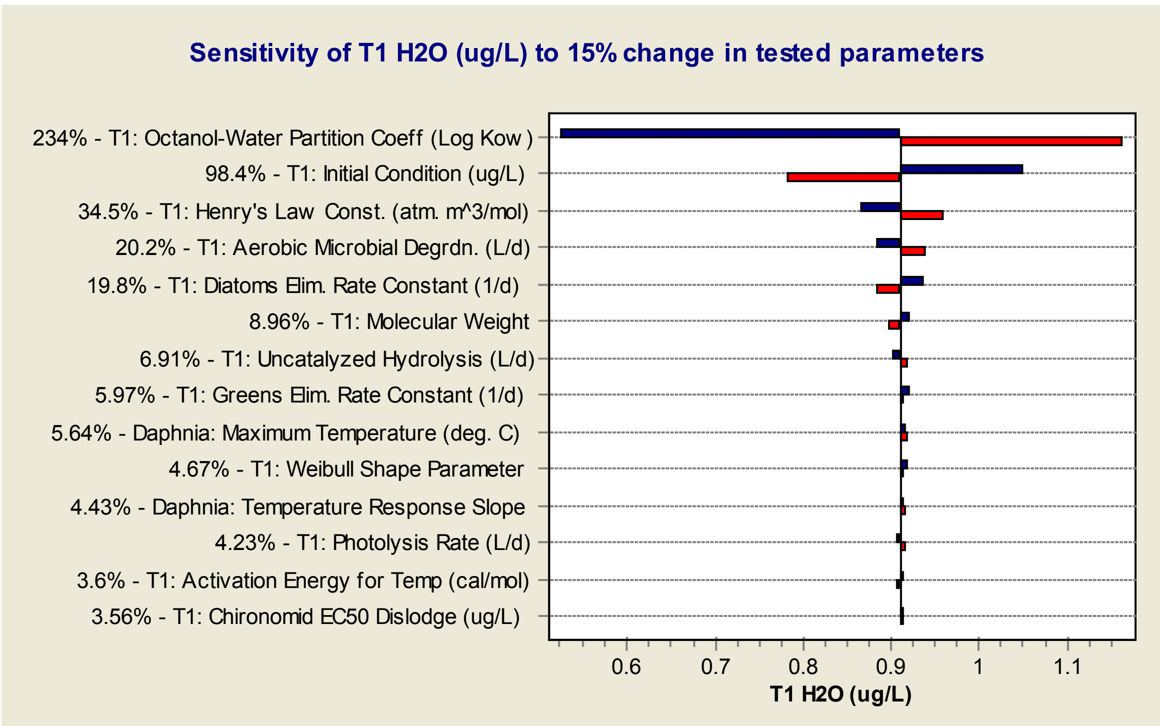

Figure 11. Sensitivity of Chlorpyrifos in Water in Duluth Pond MN.

Examining the 33% changes in parameters produces a remarkably similar list of sensitive variables with very similar *sensitivity* statistics (Figure B-16 in Appendix B). This means, for this simulation, the parameters that affect toxicant concentrations in water exhibit a linear response in the 15% to 33% range.

ZOOBENTHOS BIOMASS

Zoobenthos in this simulation are represented by the chironomid state variable. This endpoint is, by far, most sensitive to the change in the Log *Kow* variable. Interestingly, a decrease in Log *Kow* which increases tissue concentrations (Figure B-17) results in far greater biomass. This is apparently due to a reduction in grazing pressure from shiners, a predator that loses biomass when Log Kow goes down. Moving beyond Log *Kow*, because predicted biomass is so low, chironomid biomass is somewhat sensitive to the "seed" loading that is added to the system each day. Chironomid parameters including optimal temperature, *LC50* and *EC50s* are also somewhat sensitive.

Examining results given a 33% change indicates that these parameter effects are more or less linear with the exception of Log *Kow* which is significantly more sensitive to a negative change. (A 33% reduction in Log *Kow* results in a ten-fold increase in chironomid biomass.)

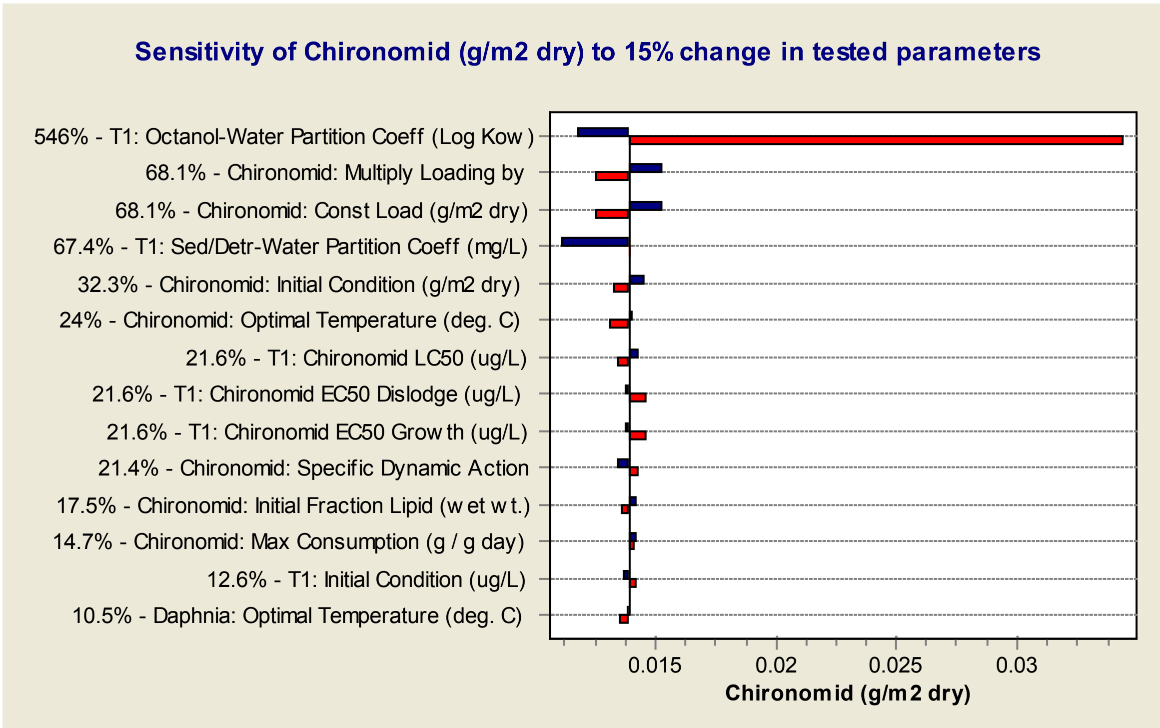

Figure 12. Sensitivity of Chironomids in Duluth Pond MN.

FISH BIOMASS

Food-chain effects again dominate sunfish biomass results. While the concentration of chlorpyrifos increases within sunfish when Log Kow decreases, the abundance of the chironomid food source increases overall sunfish biomass. Increasing the Kow by 15% results in lower predicted body burdens and lower toxic effects, also increasing biomass.

Non-toxicant parameters that affect predicted sunfish biomass include optimal temperature, and allometric consumption and respiration parameters.

The chemical partition coefficients (Log *Kow* and Sed/Detr partition coefficients) show non-linear responses to a 33% test, but the biotic parameters are quite linear (i.e. calculated *sensitivity* percentages are nearly the same, Figure B-18).

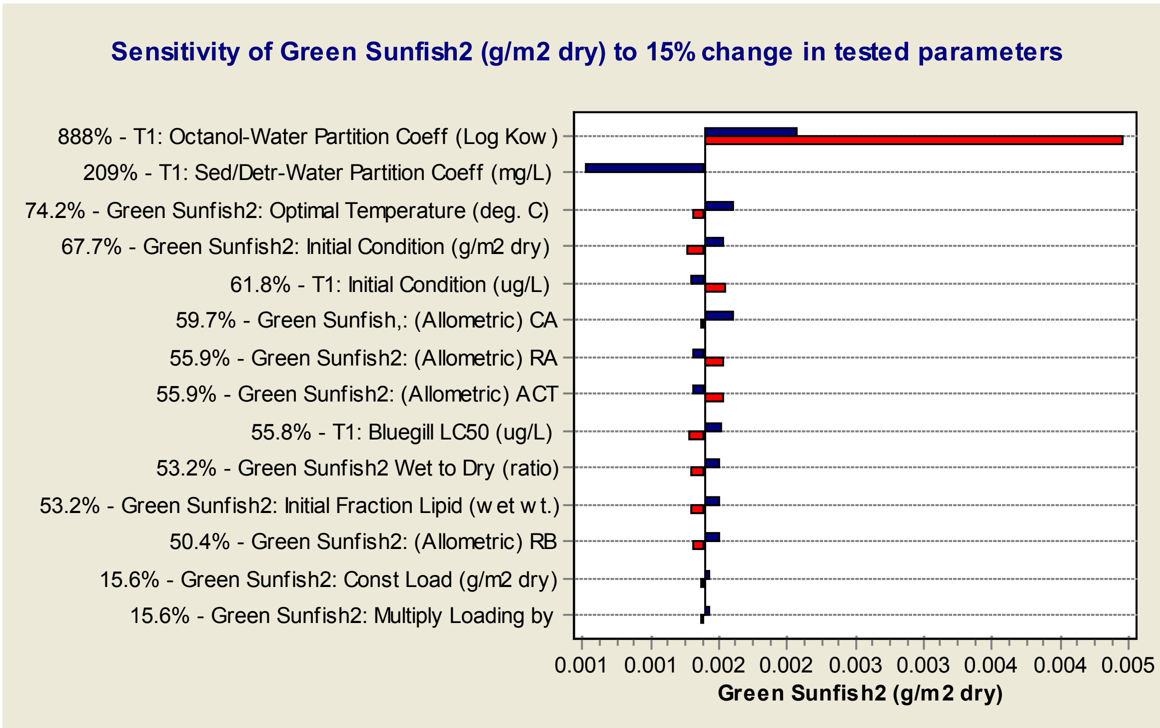

Figure 13. Sensitivity of Green Sunfish in Duluth Pond MN.

Shiner biomass is sensitive to Log *Kow* and initial condition, mortality coefficient, temperature parameters, and allometric respiration parameters.

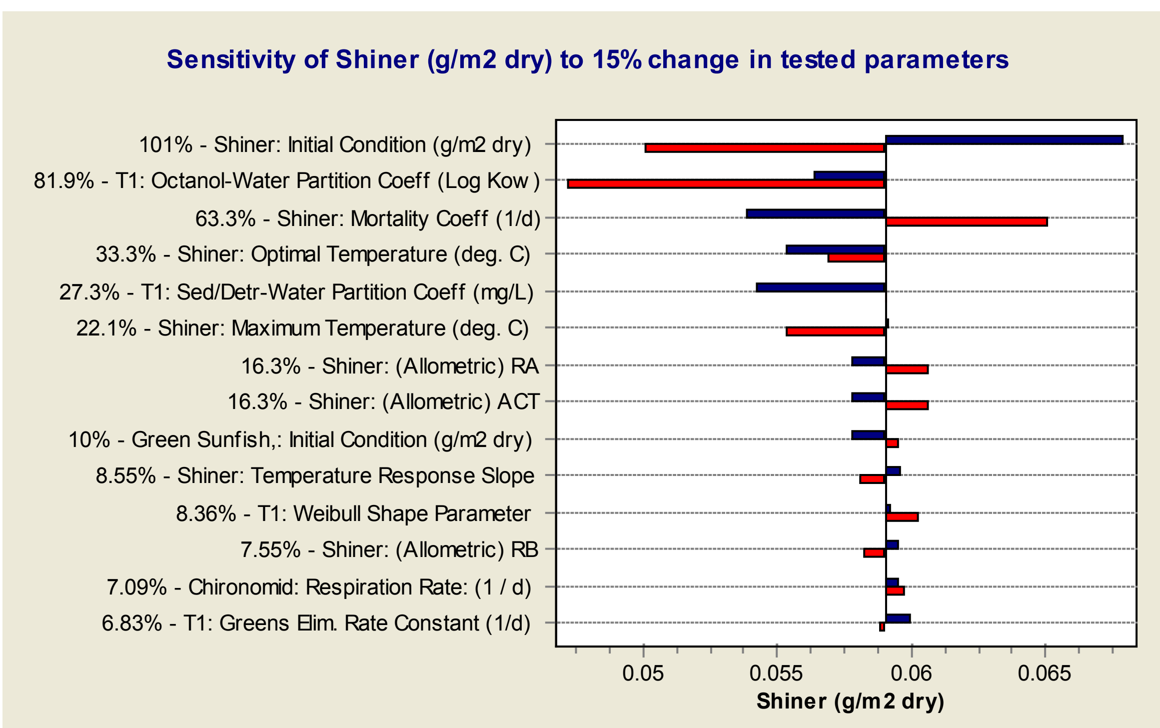

Figure 14. Sensitivity of Shiner in Duluth Pond MN.

OTHER ENDPOINTS

As is the case for all of these analyses, results for all nutrients, plants, and animals are available upon request as well as toxicant concentrations in tissues. In this simulation, for several of the algal state variables, the tornado diagrams reflect a unidirectional response to several parameters (see Figure B-19 for example). In some cases, when many parameters push a system into the same alternative state, this can indicate that the ecosystem has two possible "equilibrium" states. In other cases, a unidirectional response may suggest that the baseline parameter is an optimal value for the parameters in question.

OHIO STREAM WITH CHLORPYRIFOS

To examine model sensitivities to toxicant loadings within an AQUATOX river segment, and factors affecting periphyton fate in particular, the simulation of a generic 2nd- and 3rd-order stream (based in part on Honey Creek, Ohio) was utilized. Summary:

- One-year simulation with several 0.4 ug/L pulses of chlorpyrifos representing the effects of pesticide runoff during summer storms.
- Parameters tested included periphyton parameters, animal *LC50s* and *EC50s*, and chlorpyrifos parameters (see Appendix C for a complete list)
- Model was run with 10% changes in parameters to examine close-range sensitivities

Endpoints most closely considered for this system were periphytic chlorophyll *a* and select biomass results.

PERIPHYTIC CHLOROPHYLL *A*

Periphyton in this system are not sensitive to the toxicant concentration being simulated (an insecticide). Toxicant variables do not show up in the top 30 most-sensitive variables for this endpoint.

Similar to the Cahaba River implementation, periphyton are most sensitive to the "percent lost in slough event" parameters. Other sensitive parameters for this category are dominated by temperature effects, including "temperature response slopes" for periphyton, and "optimal temperatures."

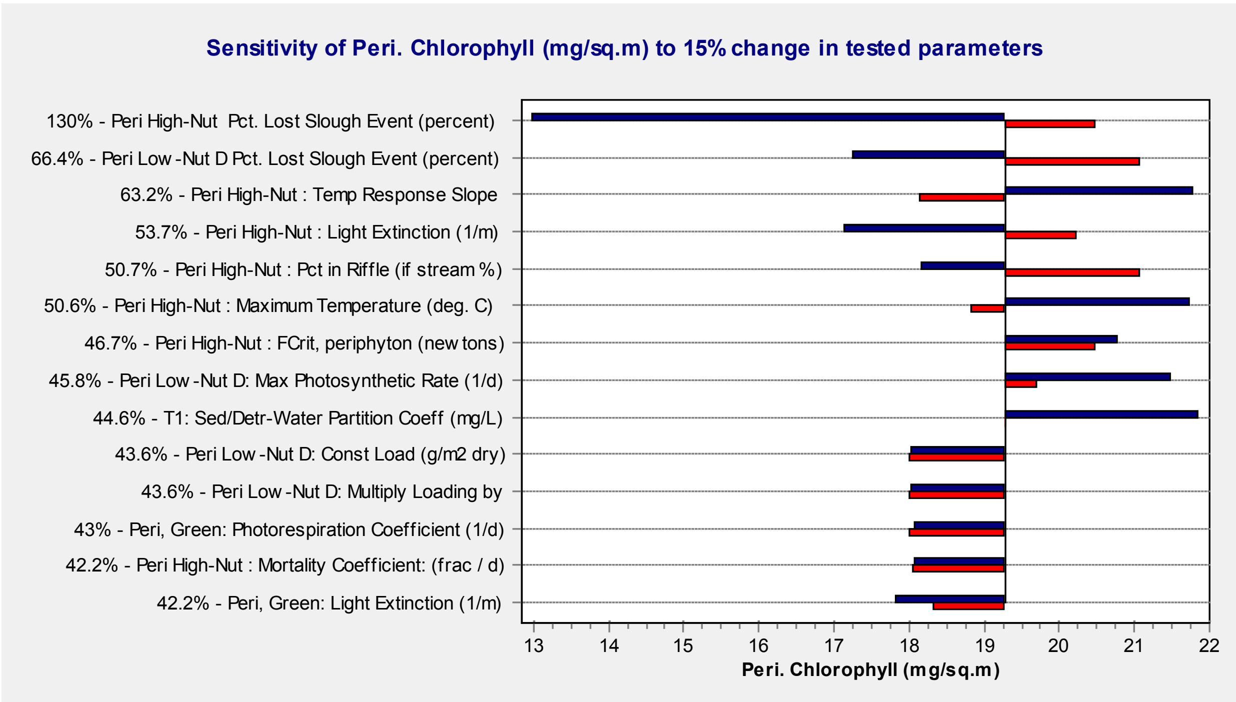

Figure 15. Sensitivity of Periphytic Chlorophyll a in Ohio Stream.

Interestingly, when the range of tested parameters extends to 33%, sensitivities are reduced. This indicates that the range of periphyton biomass results is limited in extent but can be highly variable within that range given even small changes in model parameters.

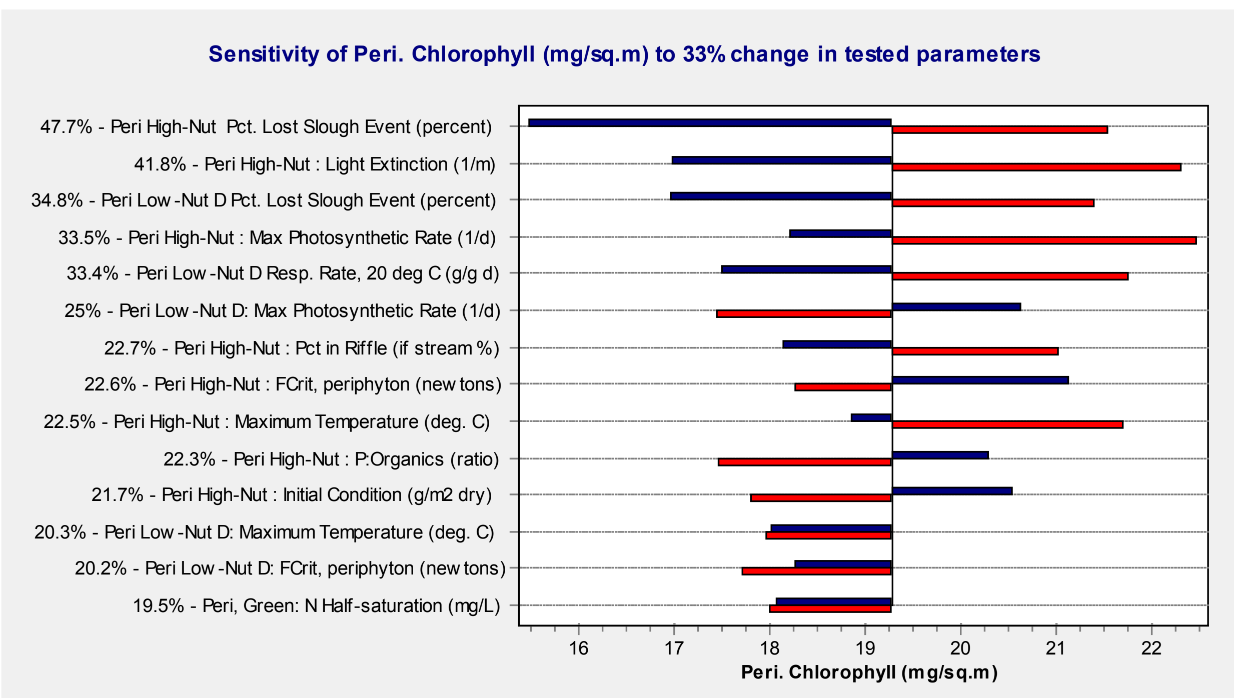

Figure 16. Sensitivity of Periphytic Chlorophyll a in Ohio Stream.

SELECT BIOMASS RESULTS

Of all the parameters tested, smallmouth bass biomass is by far most sensitive to the sediment-to-detritus partition coefficient for the toxicant in water. This variable still only has a 48.5% *sensitivity* meaning a 10% change in the parameter results in a roughly 5% change in biomass. As the *LC50* for this organism (12.4 ug/L) is well above the dose of the toxicant used in this study (0.4 ug/L), this result is certainly due to food-web effects. Caddisfly populations are sensitive to toxic effects of chlorpyrifos (Figure B-20) and this echoes up the food-web.

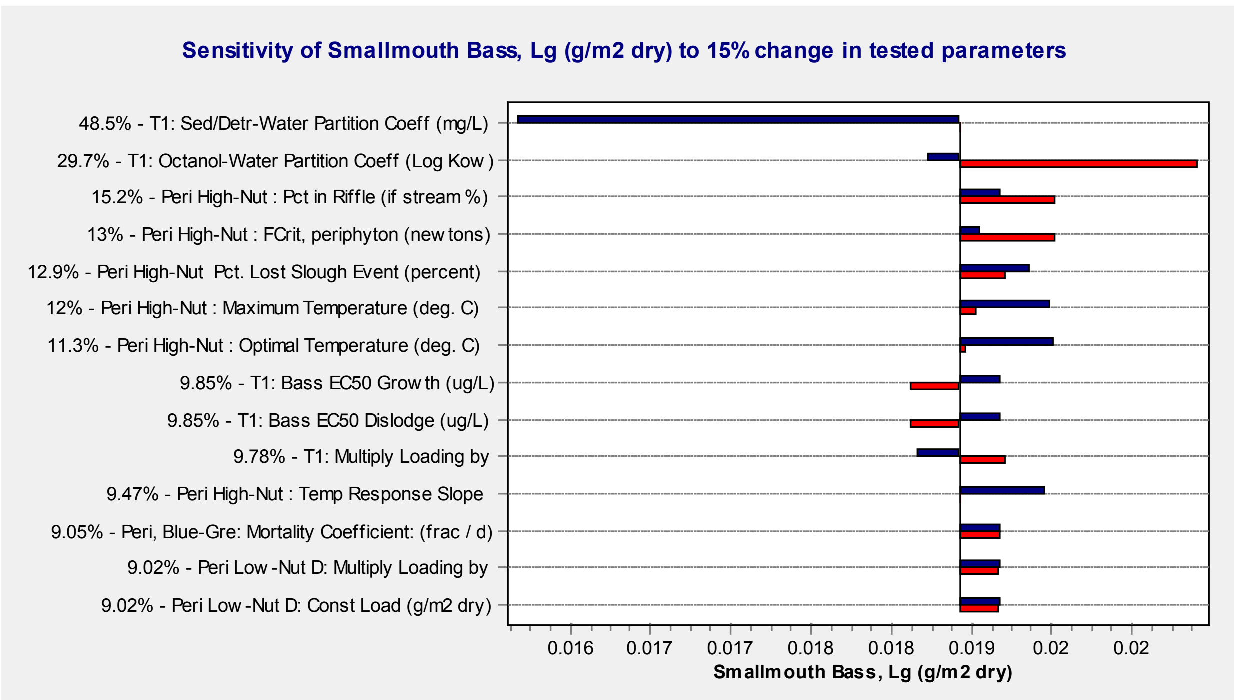

Figure 17. Sensitivity of Smallmouth Bass in Ohio Stream.

Alternatively, white suckers have neither direct nor indirect effects of toxicant at this dosage and, in fact, have very little sensitivity to any of the parameters tested. The maximum sensitivity is below 5% indicating that a 10% change an all of these variables resulted in less than one half of a percent effect on average sucker biomass. White suckers are parameterized as omnivores, and that evidently buffers them against food-web perturbations.

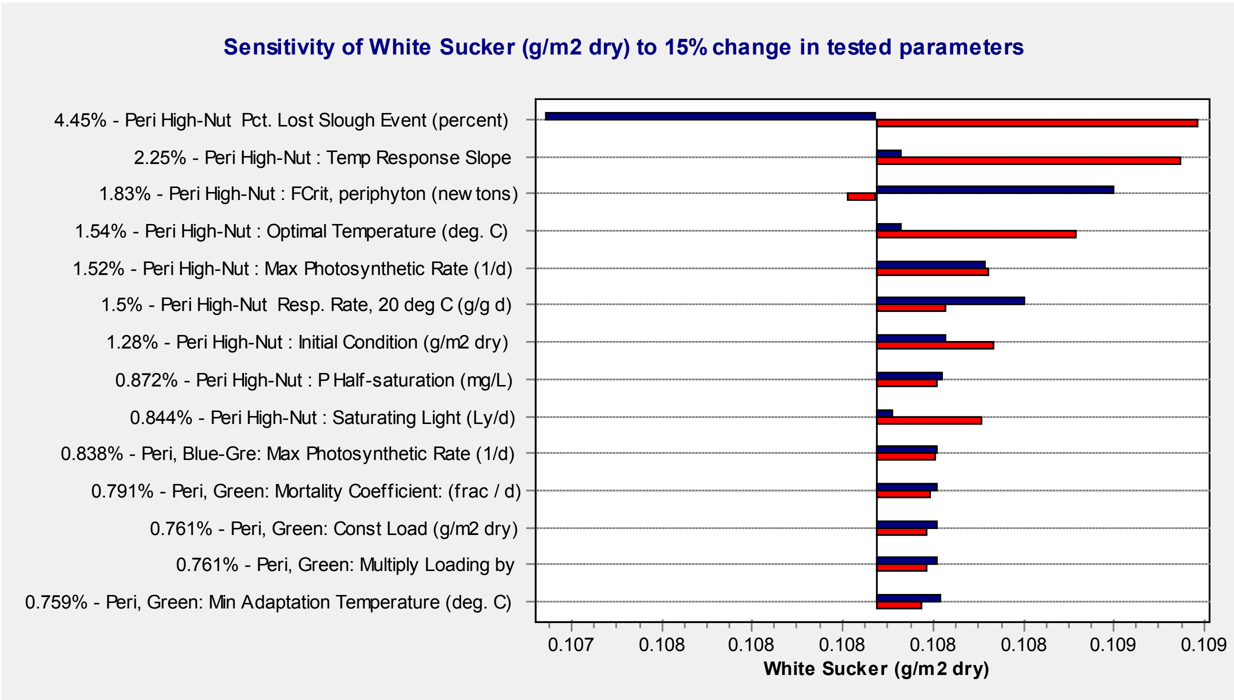

Figure 18. Sensitivity of White Sucker in Ohio Stream.

For all of these case studies a complete set of results based on all parameter tests performed are available upon request.

GALVESTON BAY, TX

To examine model sensitivities within the AQUATOX estuary implementation and factors affecting PCB bioaccumulation, the simulation of Galveston Bay Texas was utilized. Summary:

- One-year simulation with PCB 1254 contamination in sediments.
- Parameters tested included zoobenthos parameters, fish parameters, fate parameters, and PCB initial conditions in sediments (see Appendix C for a complete list)
- Model was run with 33% changes in parameters. The long run-time (over 300 CPU hours for all parameters) precluded an additional 15% run for this report.

The endpoints that are reported on here are PCB burdens in animals; biomass results are also available (e.g. Figures B-22 to B-24).

PCB BURDENS IN ANIMALS

PCB concentrations in sea bass (*Cynoscion*), at the top of the food web, are quite sensitive to temperature parameters for *Cynoscion* but also to these parameters for shrimp and mullet. It is possible that these temperature parameters are outside of their reasonable range given a 33% change in value. Interestingly, parameters for organisms further down the food-chain produce considerable sensitivity for PCB concentrations in *Cynoscion*. This illustrates the importance of bioaccumulative multipliers for PCB burdens at the top of the food web.

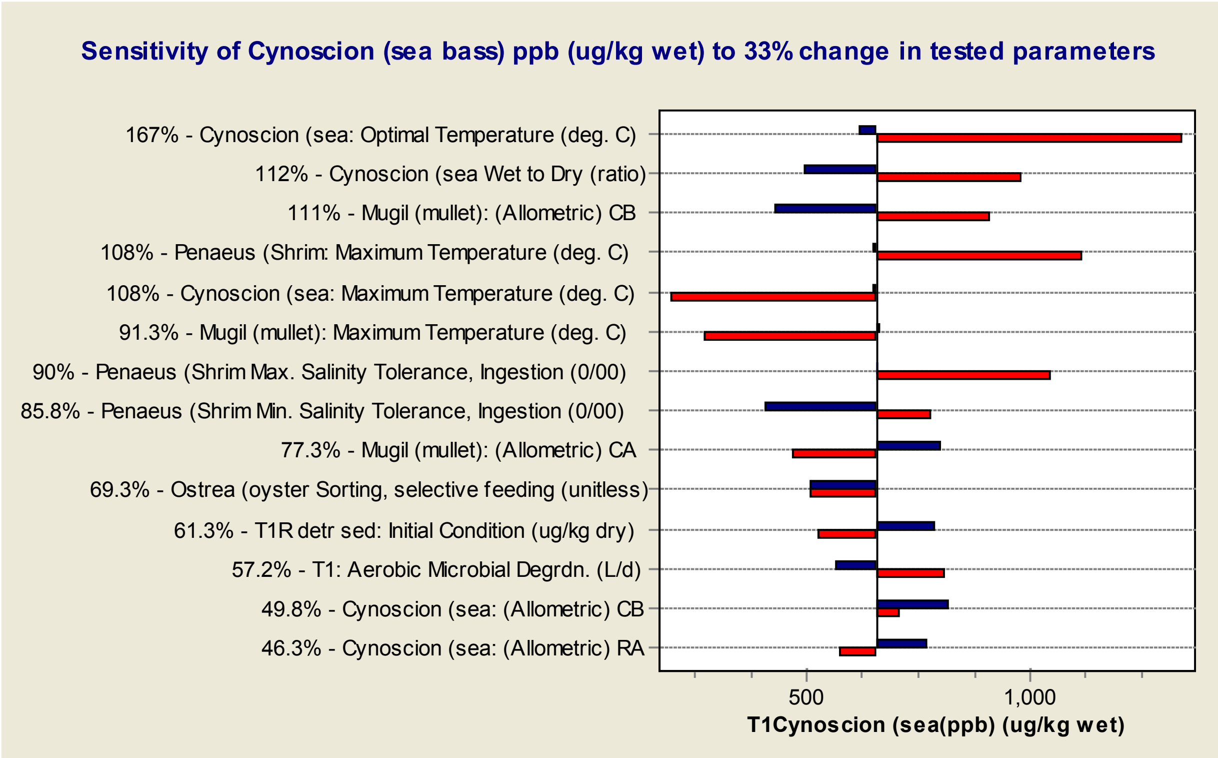

Figure 19. Sensitivity of Sea Bass in Galveston Bay TX.

Results for tissue concentrations of PCBs in catfish are also sensitive to temperature parameters and allometric consumption and respiration parameters. Interestingly, increasing the rate of aerobic microbial degradation of sediments decreases burdens in catfish as there is less labile detritus available for the organism to consume. Unlike sea bass, catfish are almost exclusively sensitive to their own parameters. Effects from prey parameters do not make the list of most-sensitive parameters.

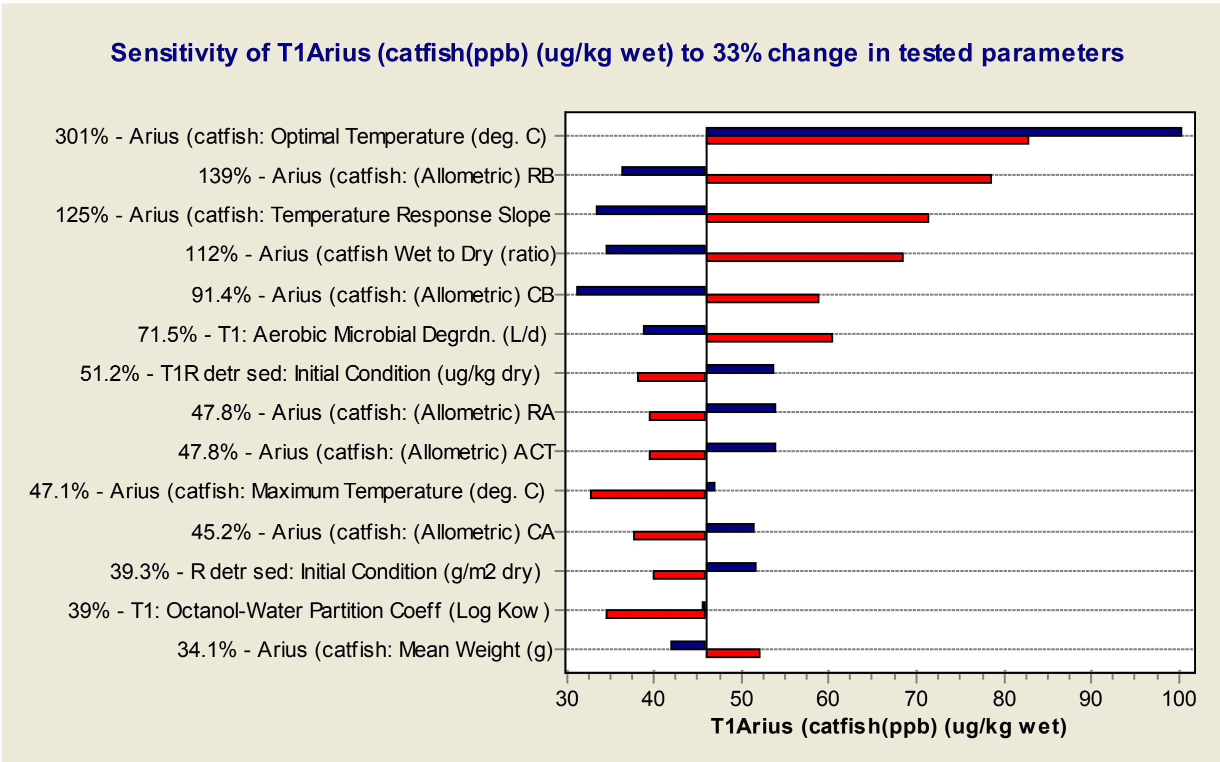

Figure 20. Sensitivity of PCBs in Catfish in Galveston Bay TX.

Shrimp results are most sensitive to the assumed wet-to-dry ratio for shrimp. This wet-to-dry ratio, which appears in many of the PCB sensitive-parameter lists, affects the calculated wet-weight PPB when calculating this quantity from the dry-weight units native to the model. Like catfish, the rate of microbial degradation is an important parameter for shrimp as is the toxicant initial condition in sediments. Finally, shrimp PCB burdens are sensitive to the organism's own consumption rates as governed by the maximum consumption parameter, the salinity tolerance for ingestion parameters, and the selective feeding parameter.

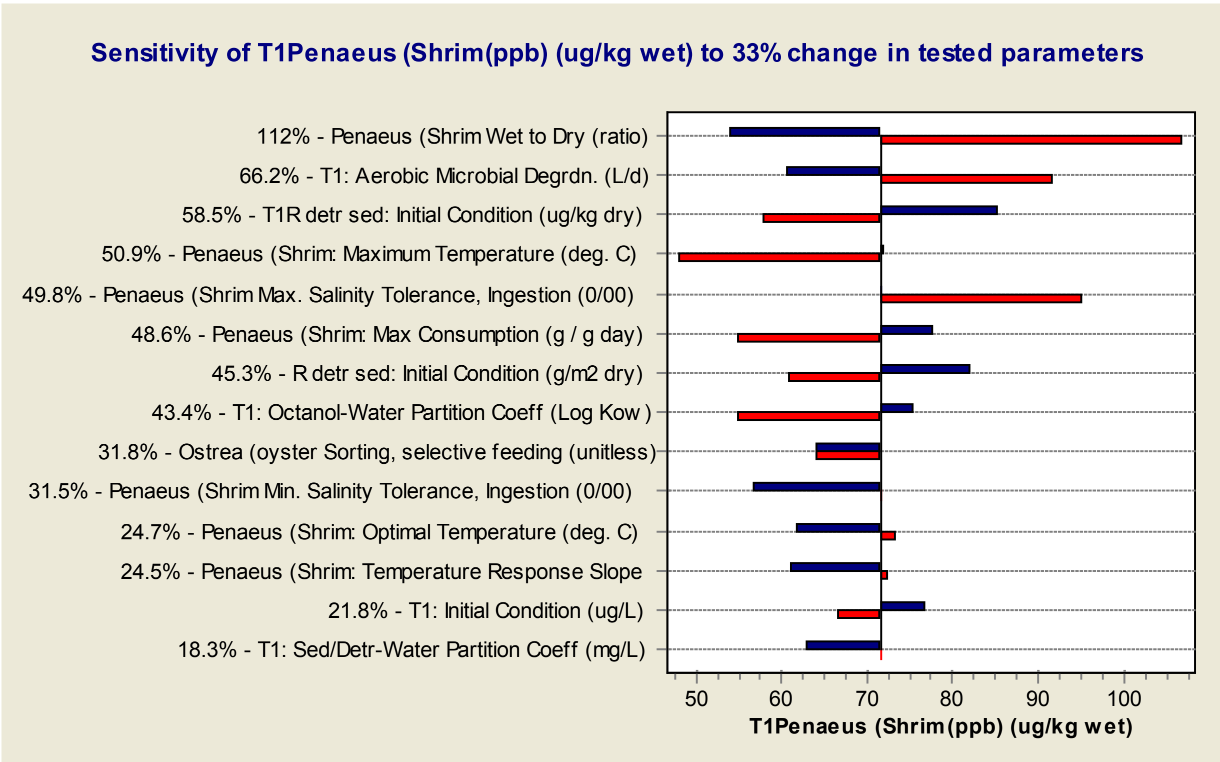

Figure 21. Sensitivity of PCBs in Shrimp in Galveston Bay TX.

OTHER ENDPOINTS

Biomass results for this estuary simulation were strongly influenced by changes in temperature parameters (optimal and maximum temperature), salinity tolerance ranges, and also allometric parameters for consumption and respiration. The complexity of the food-web in this system caused the biomass of most species to be most sensitive to their own parameters as opposed to the parameters of a predator or prey state variable. (Multiple food sources mean a predator is less dependent on a single prey item; Figures B-22 to B-24). Results for all nutrients, biomasses, and PCB burdens in both vertical segments are available upon request.

STATISTICAL SENSITIVITY ANALYSIS

Nominal-range sensitivity analysis is suitable as a screening method to identify the parameters and drivers most important to the simulation results. However, by taking an arbitrary, uniform percentage without regard to units and underlying distributions, and looking only at results averaged over the entire simulation, it can distort the true sensitivity of a particular parameter. Therefore, as a second step, we applied statistical sensitivity analysis based on distributions derived from literature parameter values. For this analysis, we chose parameters that were highly sensitive during the nominal-range sensitivity analysis. In some cases, we chose parameters where adequate data were available to create a distribution that represents their range (for example, the maximum photosynthesis rates for algae). In other cases, we used this analysis to help understand sensitivity to a parameter that is not easily measured (for example, the percentage of periphyton lost in a “sloughing event”). Analyses were performed using the uncertainty analysis option in AQUATOX with one parameter at a time. With sufficient data approaching normality, the normal distribution can be used. In the examples that follow the *Analyse-it* add-on to the Excel spreadsheet was used to visually evaluate normality by comparison of a normal plot with the frequency diagram, and by comparison of a plot of the observations of the sample against the expected normal quantile. As stated by the *Analyse-it* Help file: "The expected quantile is the number of SDs [standard deviations] from the mean where such an observation would be expected to lie in normal distribution with the sample mean and standard deviation. When the sample is normally distributed the points will form a straight-line. Deviation from the line indicates non-normality."

Where data are insufficient or normality is not indicated, uniform and triangular distributions were used. In a uniform distribution every value across the specified range has an equal likelihood of co-occurrence; it is used when only the range is known. A triangular distribution is used when a central tendency also is known; it is defined by three points: a most likely value, and by minimum and maximum values, which have zero probability of occurring.

In addition to plotting the minimum, maximum, and mean +- one standard deviation for a given endpoint, the time-varying coefficient of variation (CV) can be calculated and plotted in an Excel file using the ratio of the standard deviations to the means for a particular endpoint. The CV is dimensionless so it is useful for comparing the responses of dissimilar endpoints.

ONONDAGA LAKE, NY

BLUE-GREEN MAXIMUM PHOTOSYNTHETIC RATE

We obtained *PMax* parameter values from Collins and Wlosinski (1983). Several values were considered to be outliers but were kept in the distribution. The reported data in Collins and Wlosinski exhibit a normal distribution (Figure 22, Figure 23), which was well represented by the distribution used in the analysis (Figure 24). Percent blue-greens is very sensitive to the *PMax* (Figure 25, Figure 26), and chlorophyll a is less sensitive (Figure 27); however, the latter was chosen because there are chlorophyll data from the lake to provide a reality check.

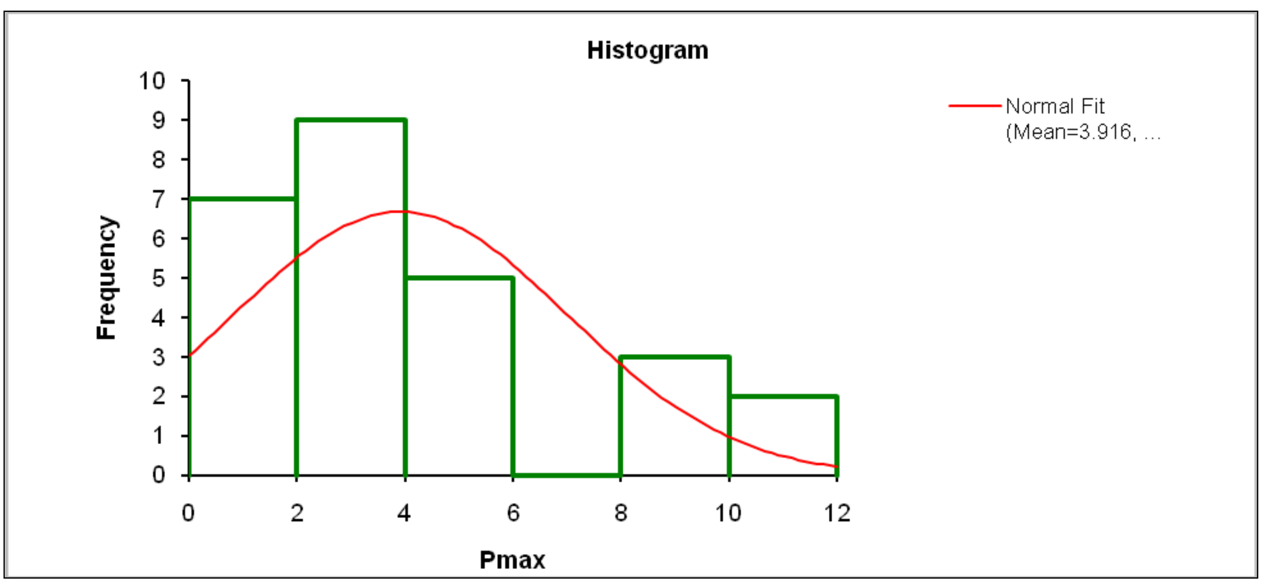

Figure 22. Histogram of observed Blue-Green *PMax* values from Collins and Wlosinski (1983).

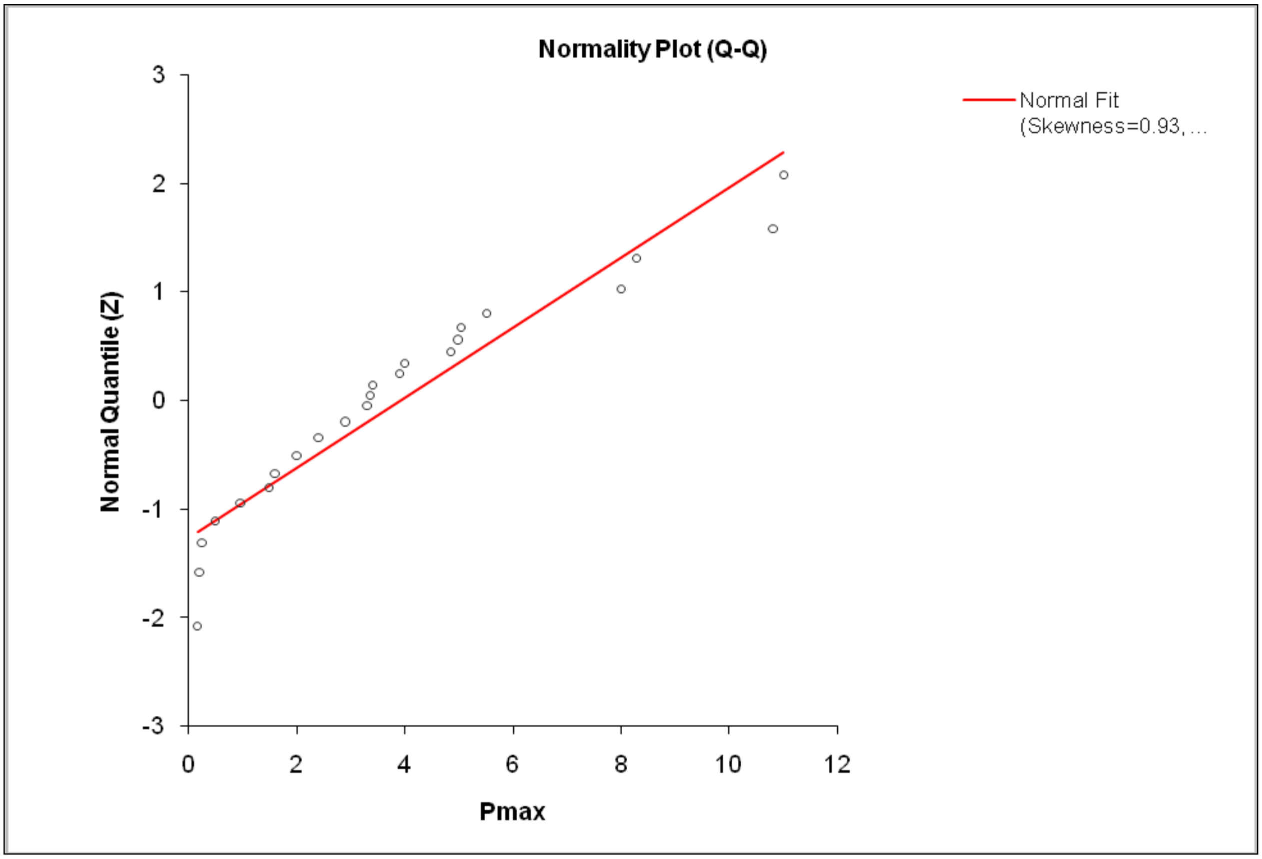

Figure 23. Normality of observed blue-green *PMax* values from Collins and Wlosinski (1983).

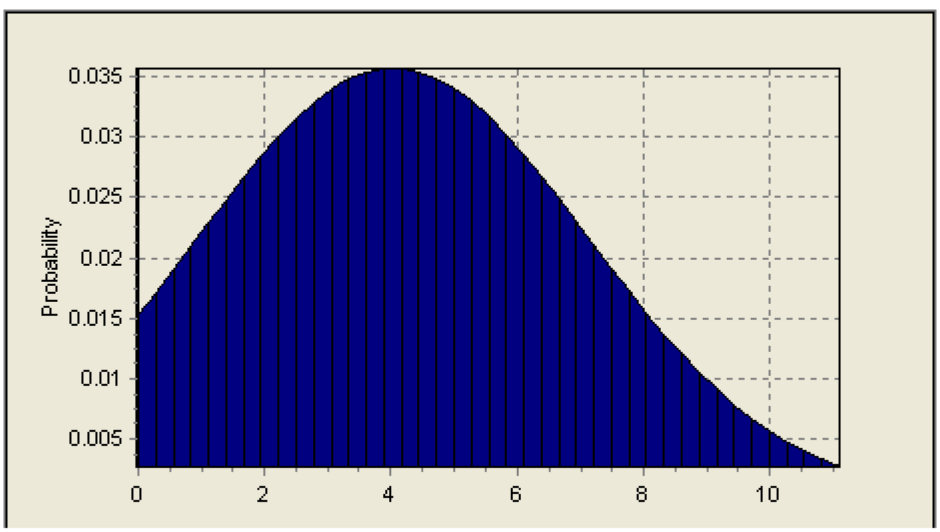

Figure 24. Distribution of blue-green *PMax* values used in analysis.

Table 2. Statistics for observed blue-green PMax values.

n	26	
Mean	3.916	
95% CI	2.661	to 5.171
SE	0.6094	
Variance	9.655	
SD	3.107	
95% CI	2.437	to 4.289
CV	79.4%	
Skewness	0.93	
Kurtosis	0.19	
Shapiro-Wilk W	0.91	
p	0.021	

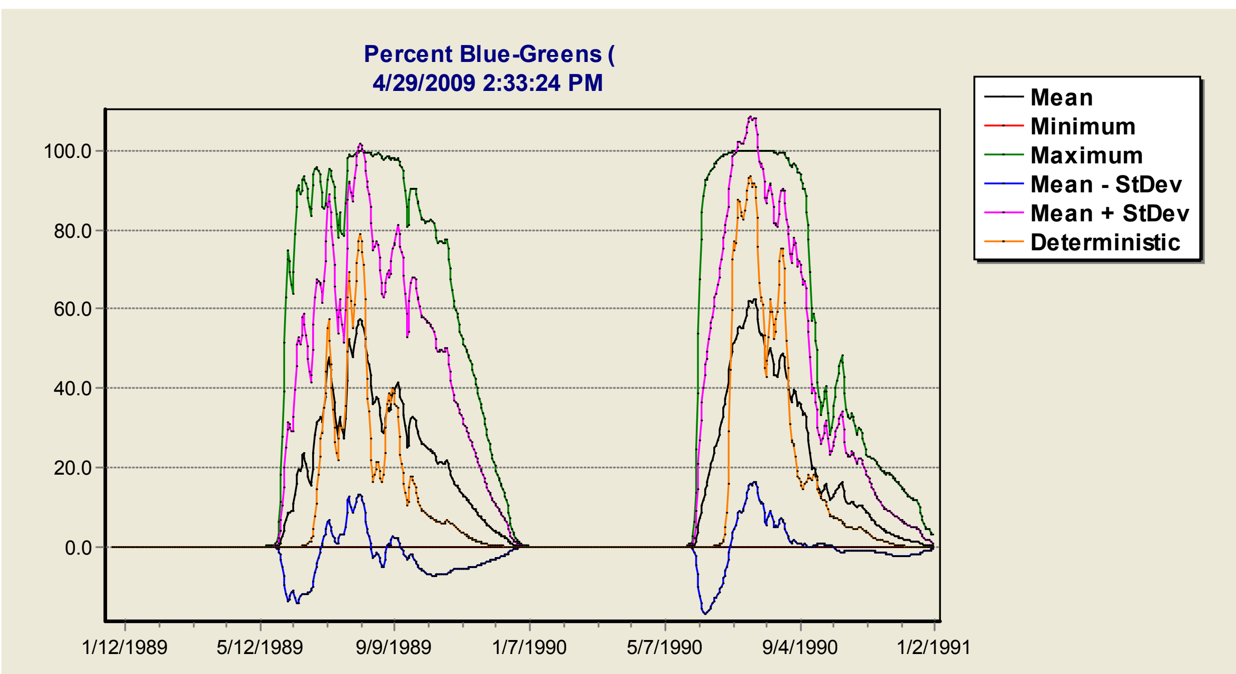

Figure 25. Sensitivity of percent blue-greens to blue-green *PMax* in Onondaga Lake NY.

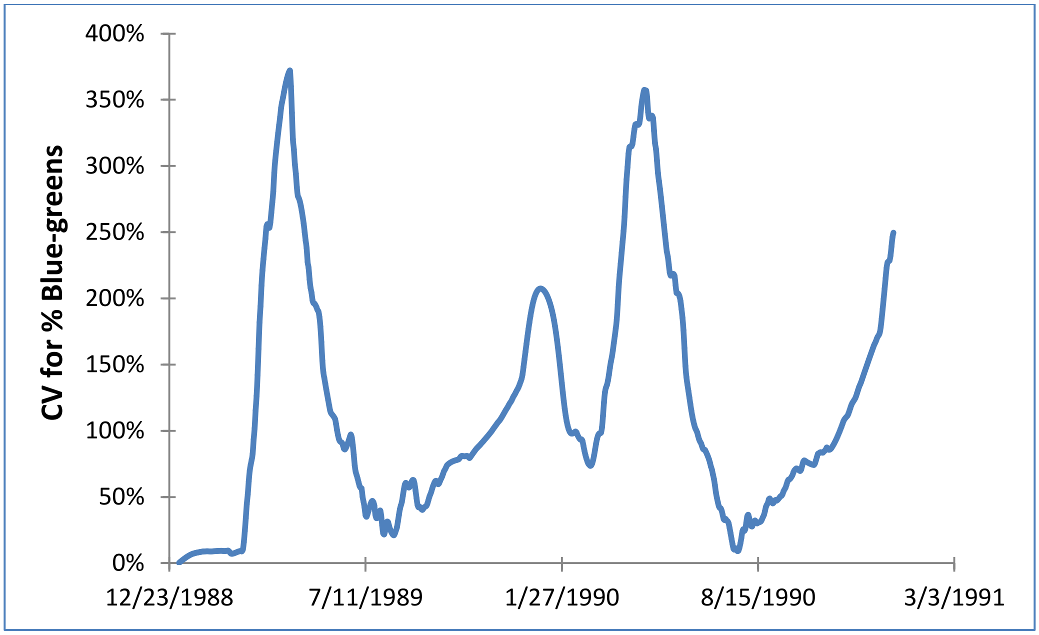

Figure 26. Coefficient of variation for percent blue-greens based on sensitivity analysis of blue-green *PMax* in Onondaga Lake NY.

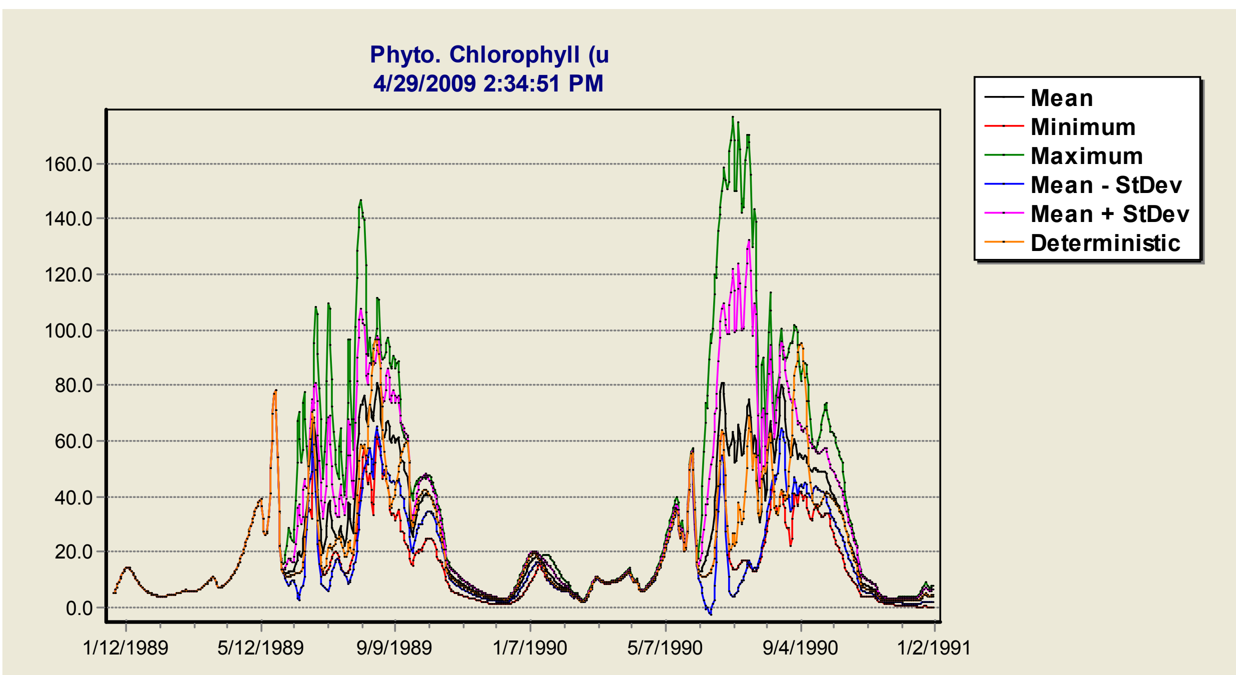

Figure 27. Sensitivity of chlorophyll a to blue-green *PMax* in Onondaga Lake NY.

BLUE-GREEN TOPT

The same dataset used for *PMax* was used for *TOpt*, assuming that the *PMax* values were measured at the optimum temperatures. The distribution did not exhibit normality (Figure 28).

Based on visual inspection, the closest distribution is a uniform distribution (Figure 29), which in this case is defined by the 25th and 75th percentiles, similar to the box plot based on observed values (Figure 30, Table 3). As with *Pmax*, percent blue-greens is very sensitive to *TOpt* (Figure 31), and chlorophyll *a* is less so (Figure 32).

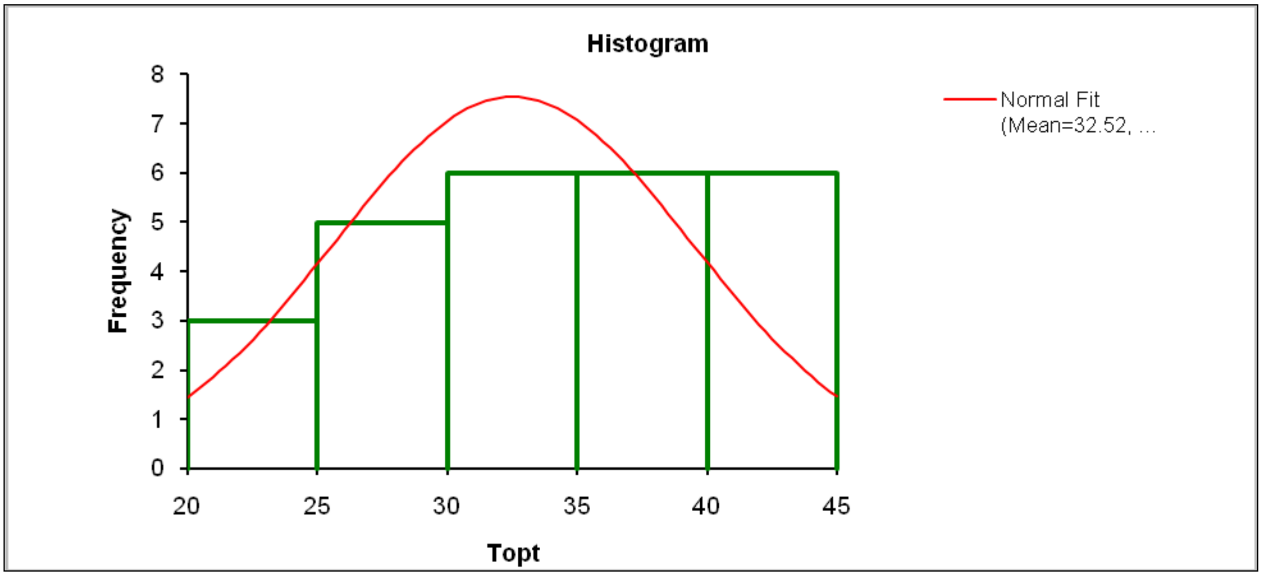

Figure 28. Histogram of observed blue-green *TOpt* values

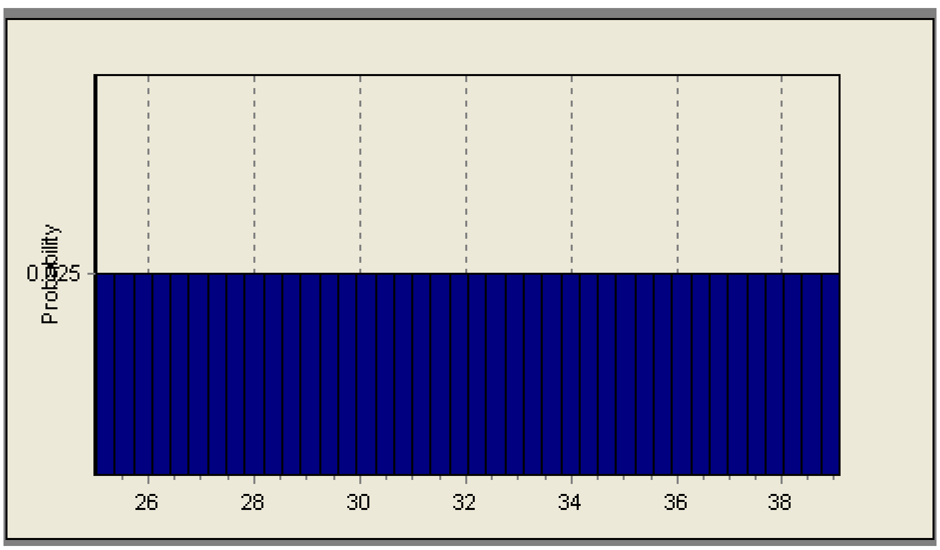

Figure 29. Distribution of blue-green *TOpt* values used in analysis.

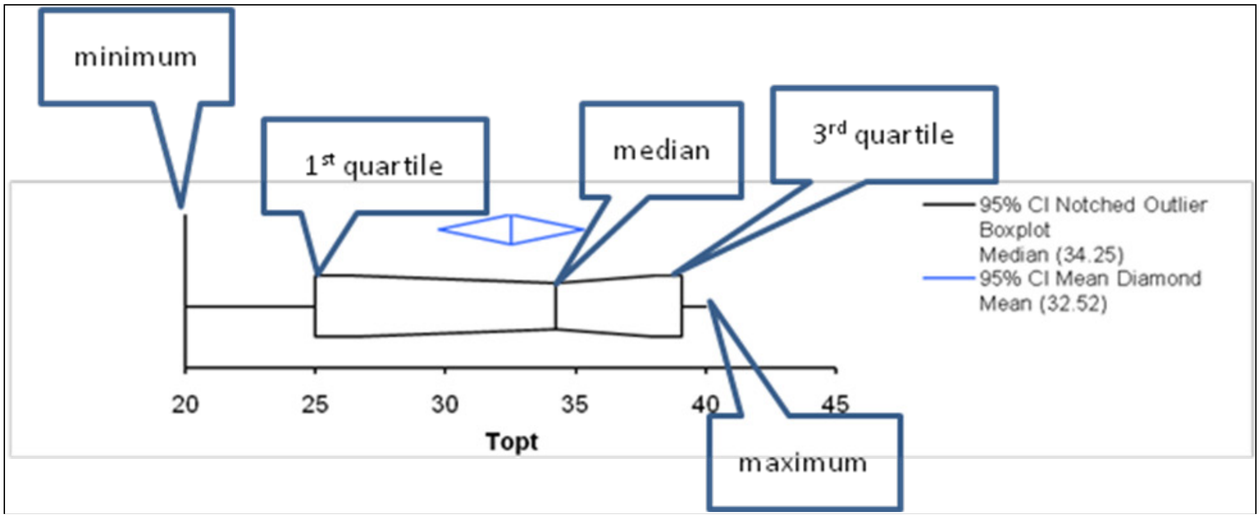

Figure 30. Box and whisker plot of observed blue-green *TOpt* values.

Table 3. Statistics for observed blue-green *TOpt* values.

n	26				
Mean	32.52		Median	34.25	
95% CI	29.74	to 35.30	97.1% CI	26.50	to 38.00
SE	1.351				
			Range	20.0	
Variance	47.43		IQR	14.08	
SD	6.89				
95% CI	5.40	to 9.51	Percentile		
			0th	20.00	(minimum)
CV	21.2%		25th	25.00	(1st quartile)
			50th	34.25	(median)
Skewness	-0.45		75th	39.08	(3rd quartile)
Kurtosis	-1.24		100th	40.00	(maximum)
Shapiro-Wilk W	0.88				
p	0.006				

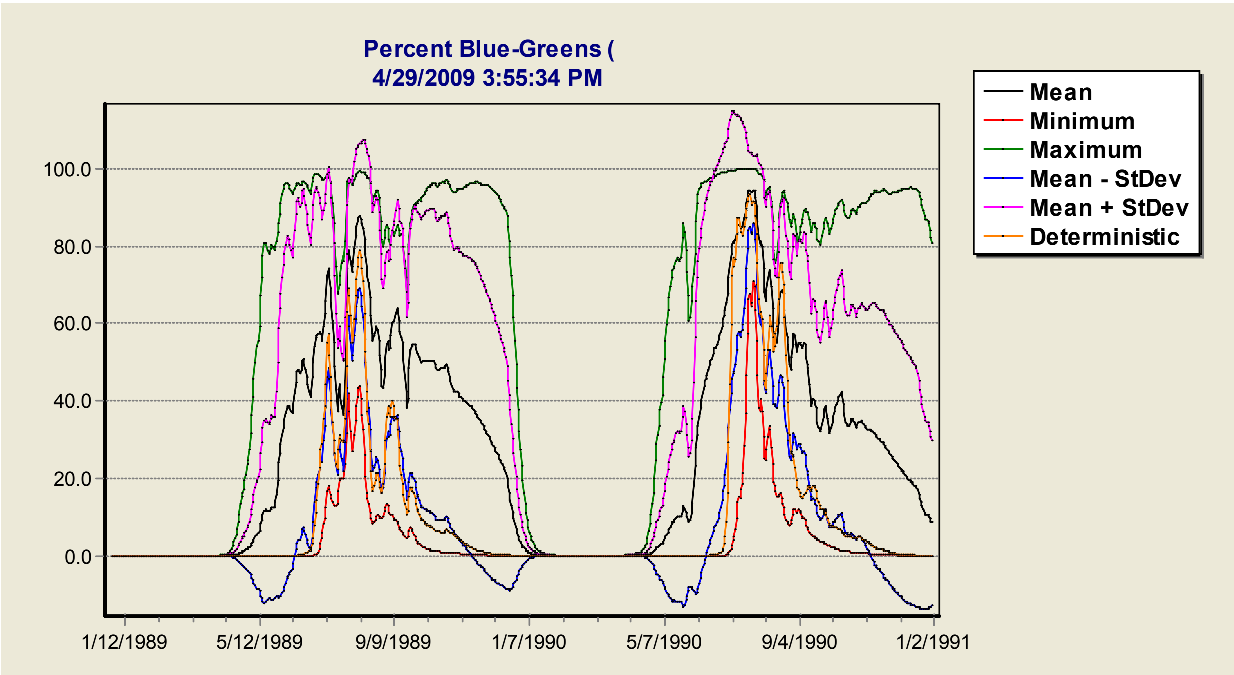

Figure 31. Sensitivity of percent blue-greens to blue-green *TOpt* in Onondaga Lake NY.

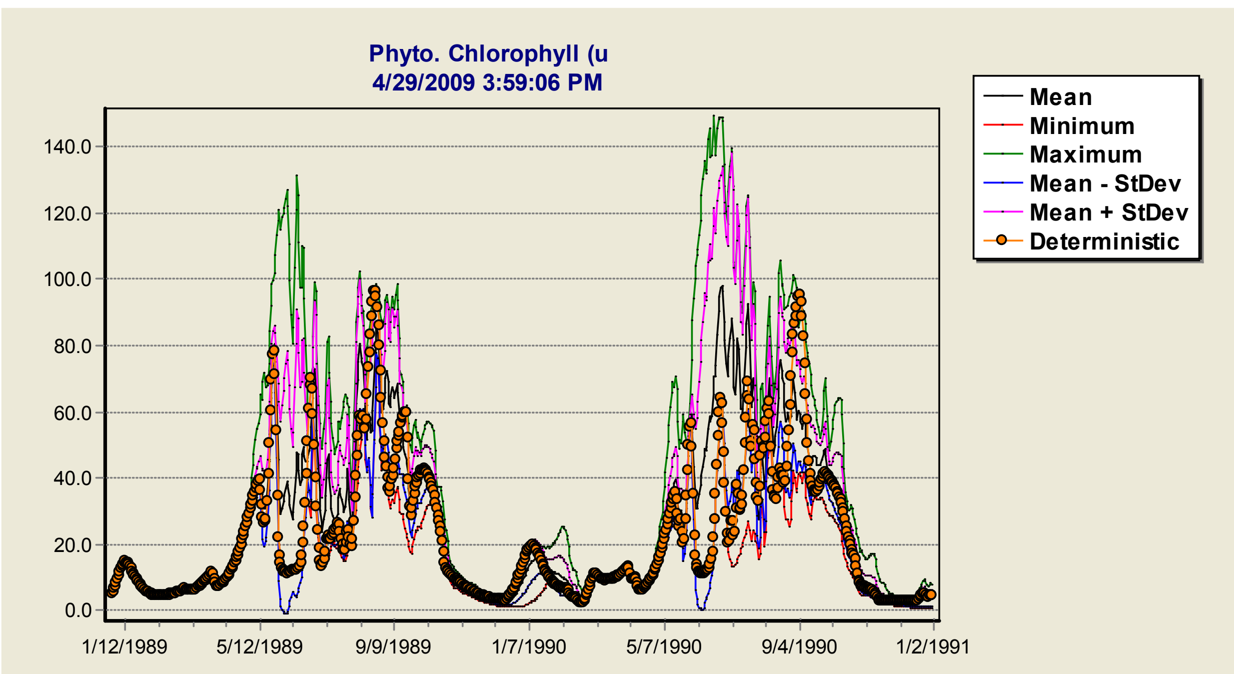

Figure 32. Sensitivity of chlorophyll a to blue-green *TOpt* in Onondaga Lake NY.

CYCLOTELLA PMAX

Again the maximum photosynthetic values were taken from Collins and Wlosinski (1983). *Cyclotella* is a surrogate for a group of diatoms adapted to high-nutrient conditions with corresponding high growth rates. However, the *PMax* used in the nominal range sensitivity analysis (Figure 1) (3.4/d) is at the high end of the range of observed values. Therefore, the distribution of *PMax* values of all diatoms reported by Collins and Wlosinski (1983) was used for the uncertainty analysis (Figure 34), with diatom *PMax* = 1.6 and SD = 0.686 (Figure 33, Figure 34). The observed data exhibit normality (Figure 35, Table 4). Because of competition, percent blue-greens is sensitive to diatom *PMax*, as is chlorophyll a, especially in the fall (Figure 36, Figure 37).

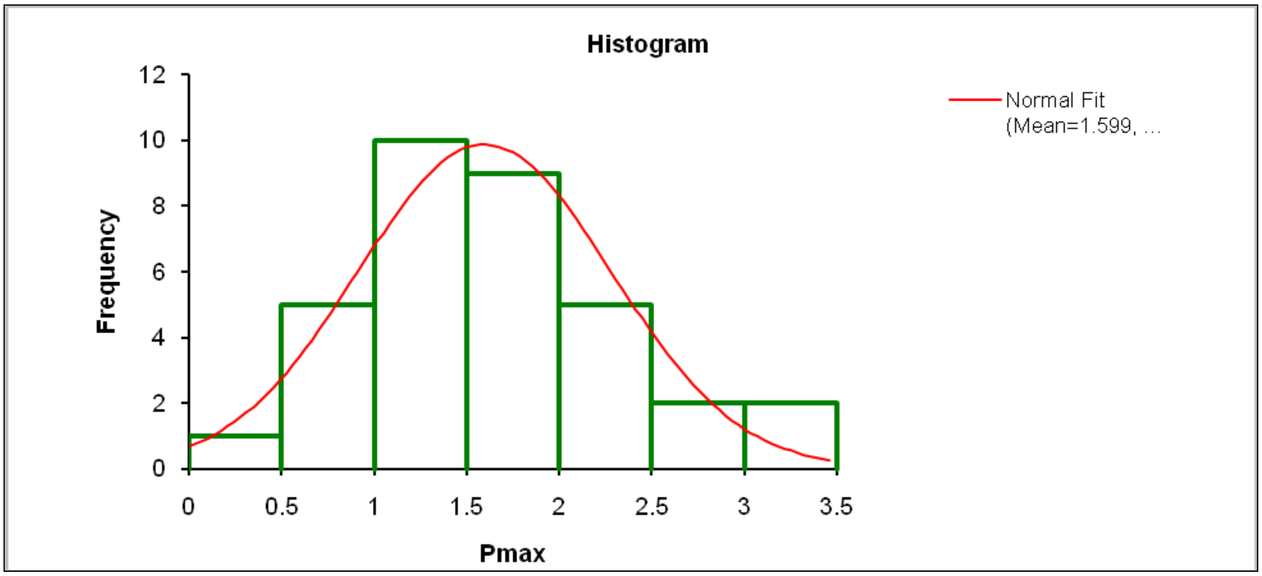

Figure 33. Histogram of observed diatom *PMax* values.

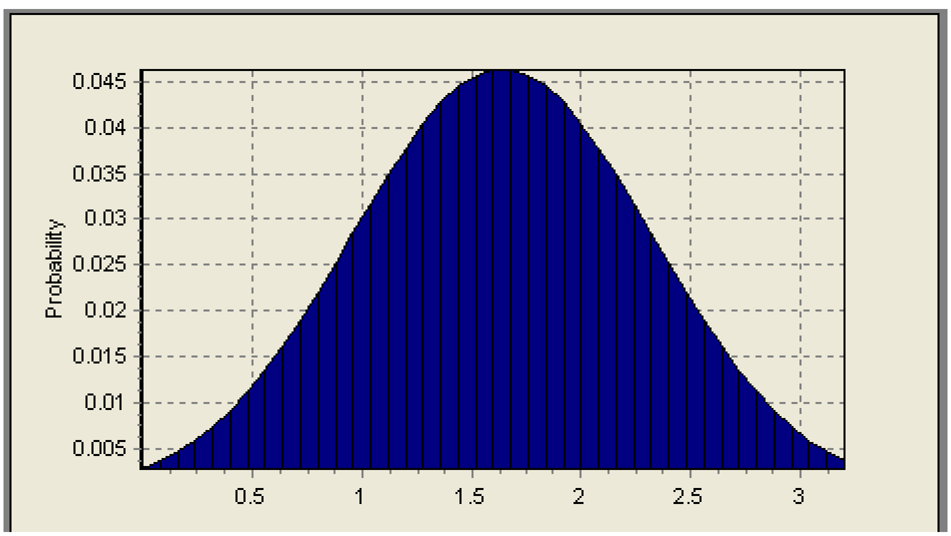

Figure 34. Distribution of diatom *PMax* values used in analysis.

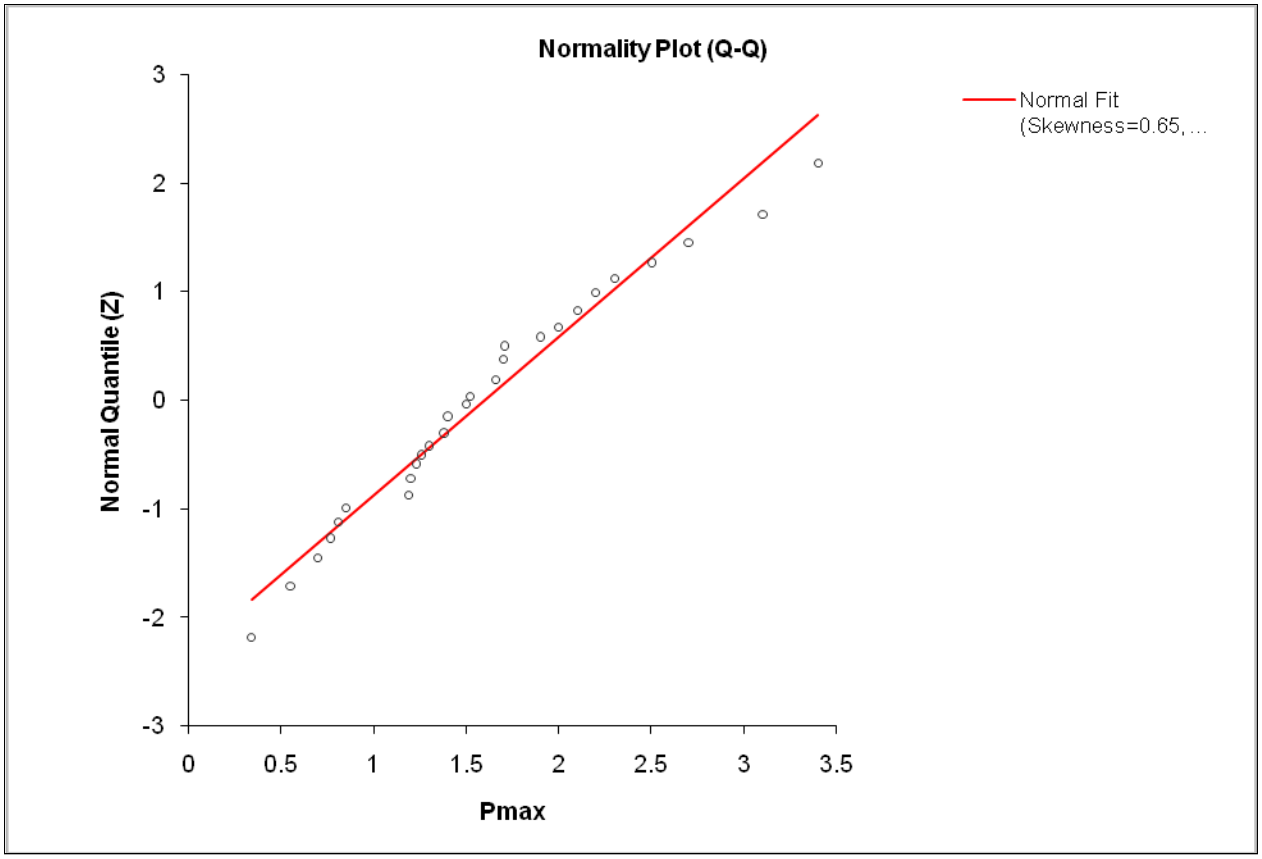

Figure 35. Normality of observed diatom *PMax* values.

Table 4. Statistics for observed diatom *PMax* values.

n	34	
Mean	1.599	
95% CI	1.360	to 1.839
SE	0.1177	
Variance	0.471	
SD	0.686	
95% CI	0.554	to 0.904
CV	42.9%	
Skewness	0.65	
Kurtosis	0.62	
Shapiro-Wilk W	0.96	
p	0.335	

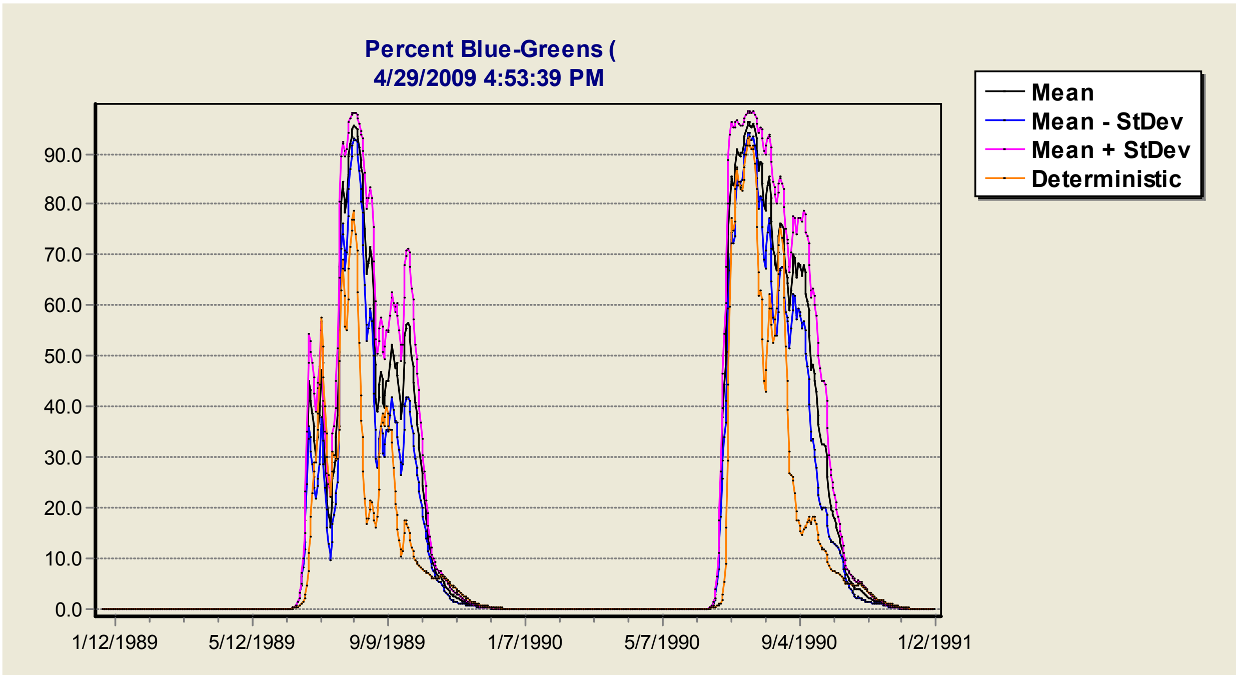

Figure 36. Sensitivity of percent blue-greens to diatom *PMax* in Lake Onondaga NY.

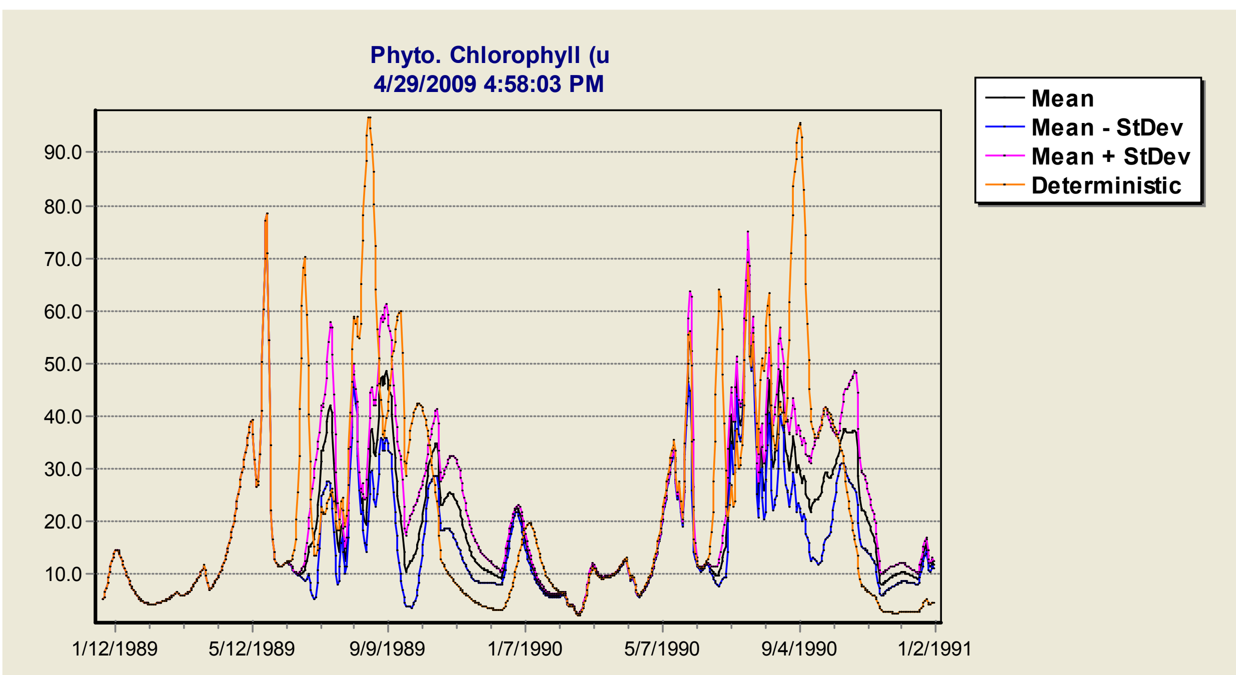

Figure 37. Sensitivity of chlorophyll *a* to diatom *PMax* in Lake Onondaga NY.

The mean results seemed to be a better fit to the chlorophyll a data from the lake than the deterministic, so the model was run with *PMax* = 1.6 (the mean of observed values) instead of the prior value of 3.4, and the results (perturbed) seem better than those with the original value (control), especially in the second year when it simulates a clearing event with low observed chlorophyll *a* (Figure 38, Figure 39). Because this is no longer *Cyclotella*, but rather a generalized diatom, it was renamed “Phyto, Diatom” and saved to the Library. This will now be used as the calibrated study for Lake Onondaga.

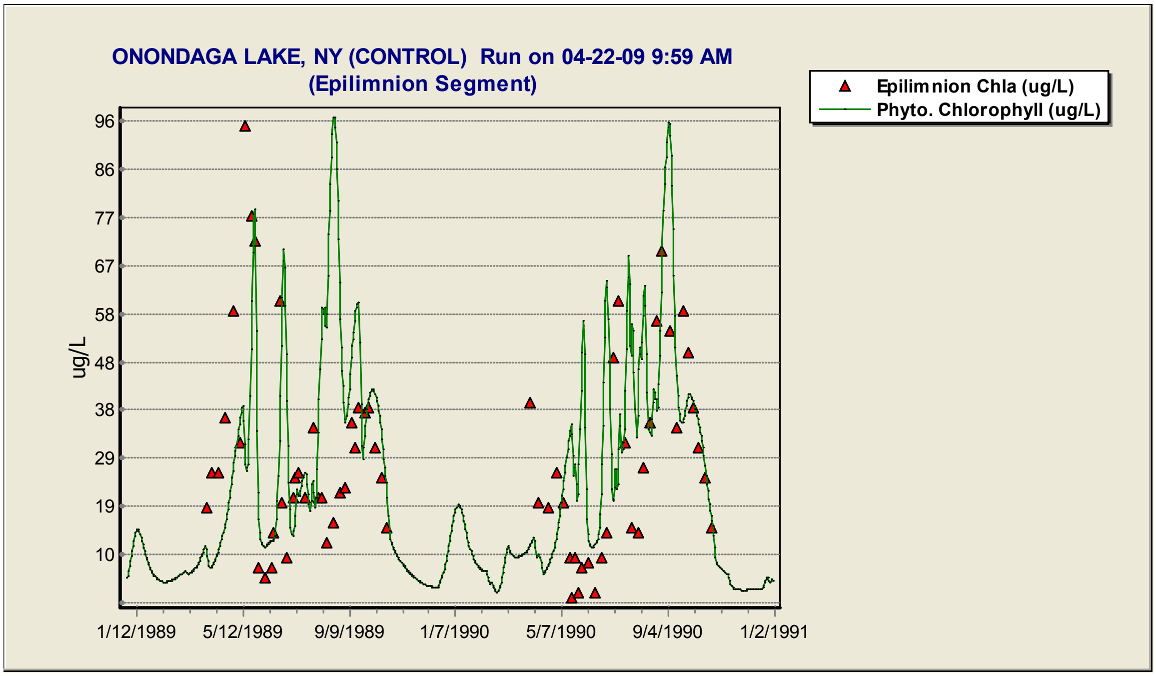

Figure 38. Original calibration of chlorophyll *a* with diatom *PMax* = 3.4 in Onondaga Lake NY.

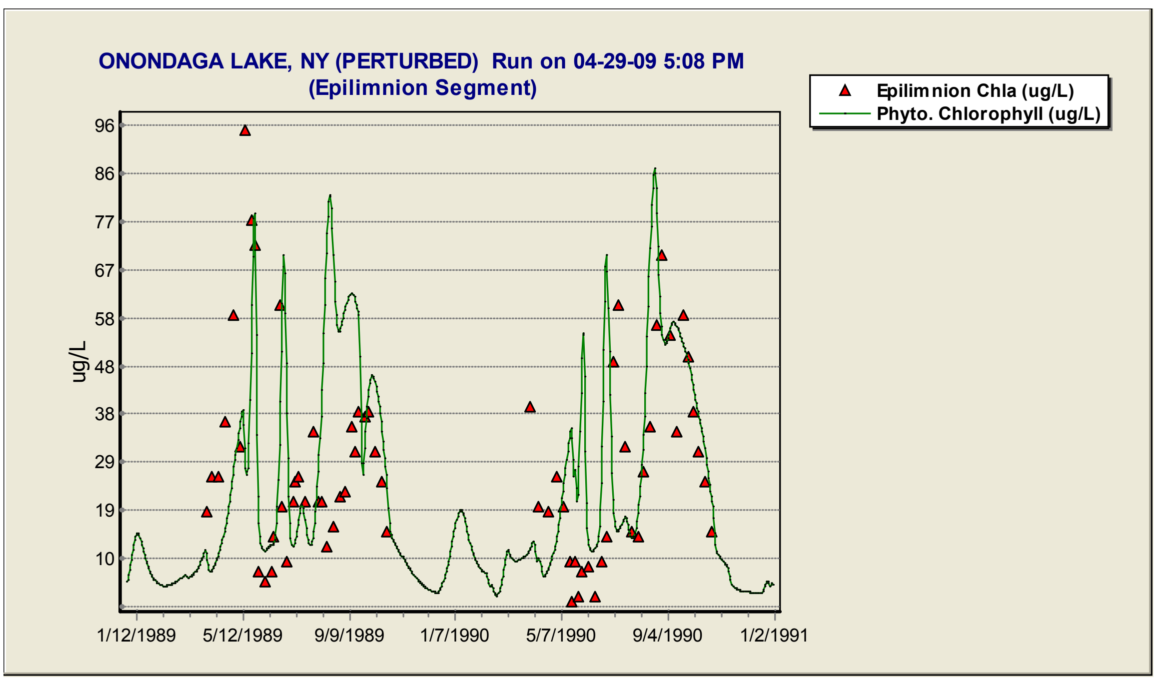

Figure 39. Chlorophyll *a* result with diatom *PMax* = 1.6 in Onondaga Lake NY.

ONONDAGA LAKE, NY, DIAGENESIS

THETA G CLASS 2

The temperature constant *Theta* for refractory particulate organic carbon has limited variability in published applications. Di Toro (2001) uses a value of 1.10 for three dissimilar sites, including both freshwater and saltwater sites; Thomann and Mueller (1987) use a value of 1.04; a value of 1.15 has been used for the Lake Onondaga simulations based on other applications. Because there is no justification for any one value, we used a uniform distribution between 1.04 and 1.15 (Figure 40) with ten iterations. Neither endpoint chosen, sediment oxygen demand nor dissolved oxygen in the hypolimnion, is very sensitive to *Theta* (Figure 41, Figure 42).

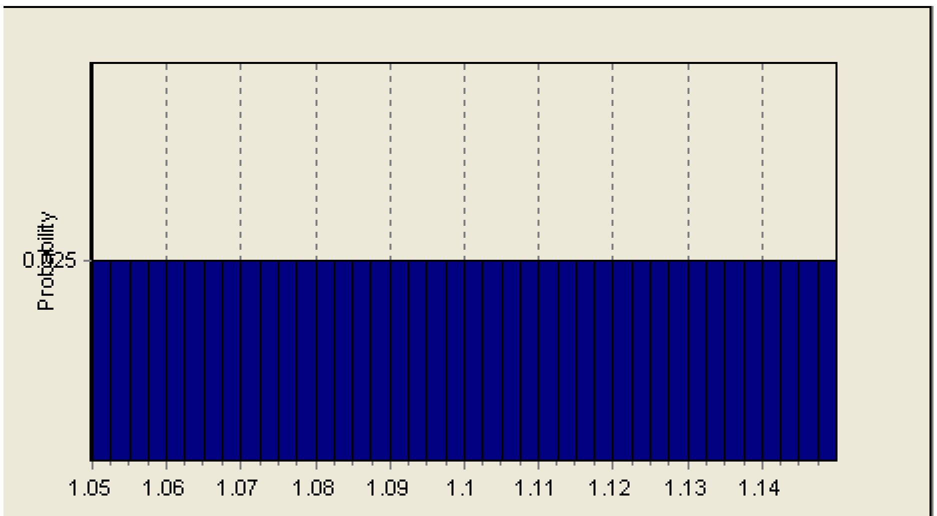

Figure 40. Distribution of *Theta* for refractory particulate organic carbon.

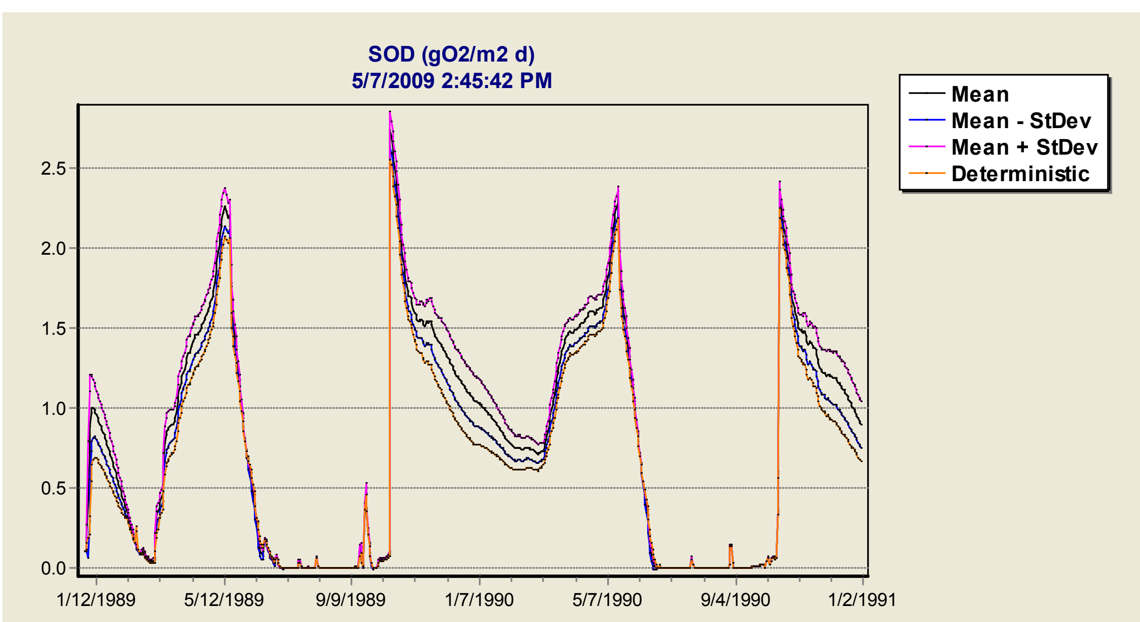

Figure 41. Sensitivity of sediment oxygen demand to *Theta* in Lake Onondaga NY.

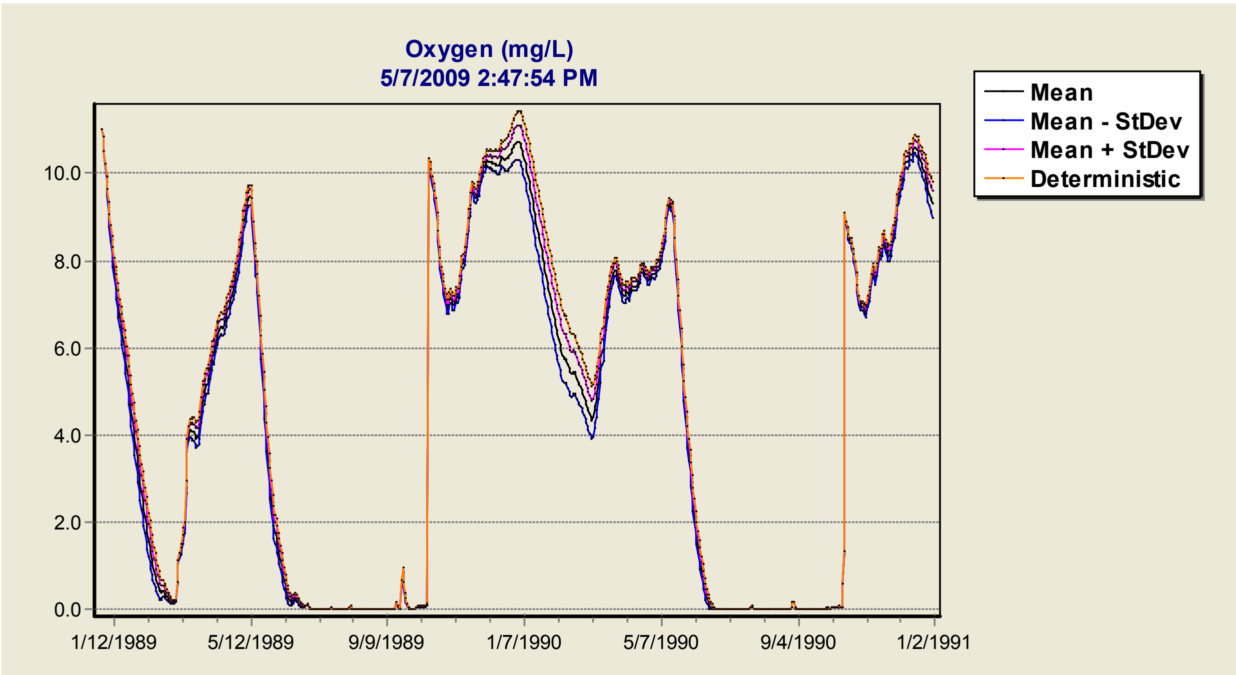

Figure 42. Sensitivity of hypolimnetic dissolved oxygen to *Theta* in Lake Onondaga in Onondaga Lake NY.

Cahaba River, AL

SMALLMOUTH BASS TOPT

Temperature preference by adults is for 28-31° C, as evidenced by positioning when given a choice; and optimal growth occurs between 26 and 29° C (Edwards et al. 1983). A normal curve was fit to these ranges, with the median of 28.5° taken as the mean, and a standard deviation of 1.5° to fit the range (Figure 43). The *TOpt* value used in the deterministic run was 29°, so the mean result differs somewhat from the deterministic result; the model is quite sensitive to the smallmouth bass *TOpt* (Figure 44). Interestingly, the top-down control on shiners and periphyton is negligible by the second year based on the decline in sensitivity (Figure 45, Figure 46).

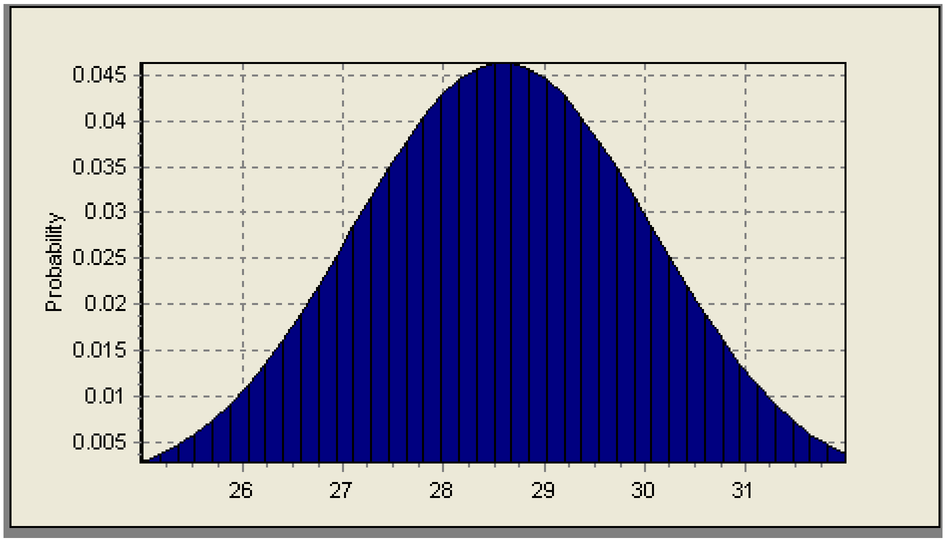

Figure 43. Distribution of smallmouth bass *TOpt* values used in analysis.

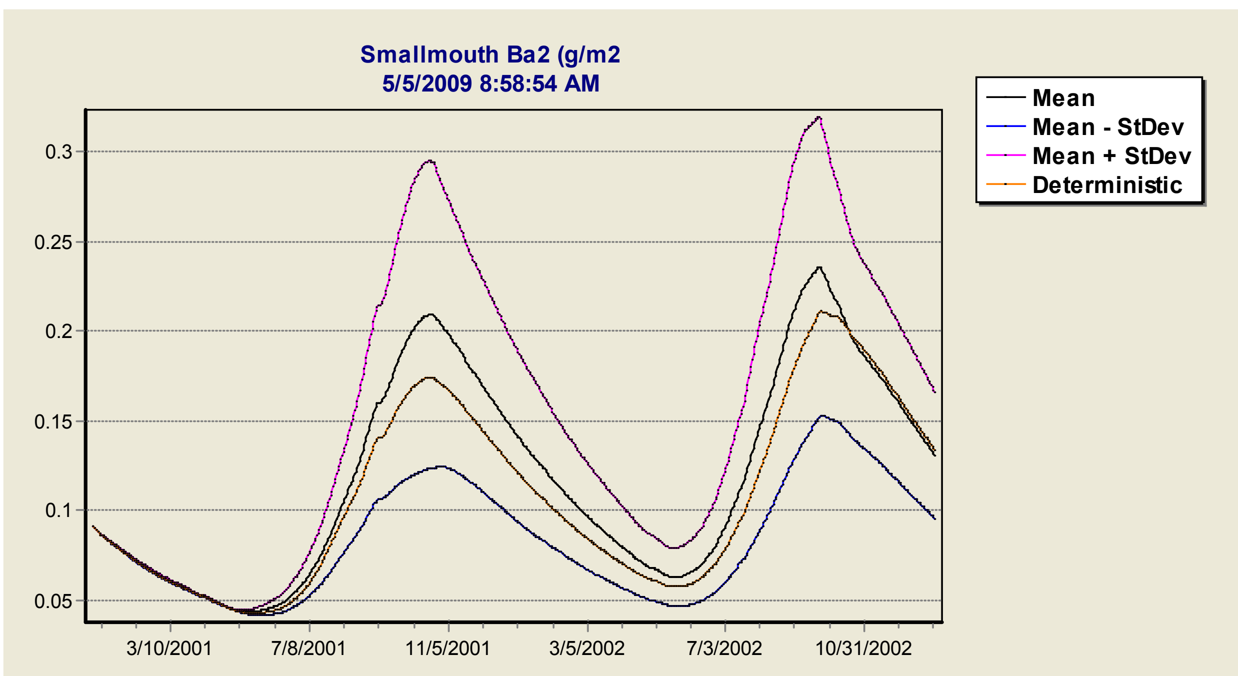

Figure 44. Sensitivity of smallmouth bass to smallmouth bass *TOpt* in Cahaba River AL.

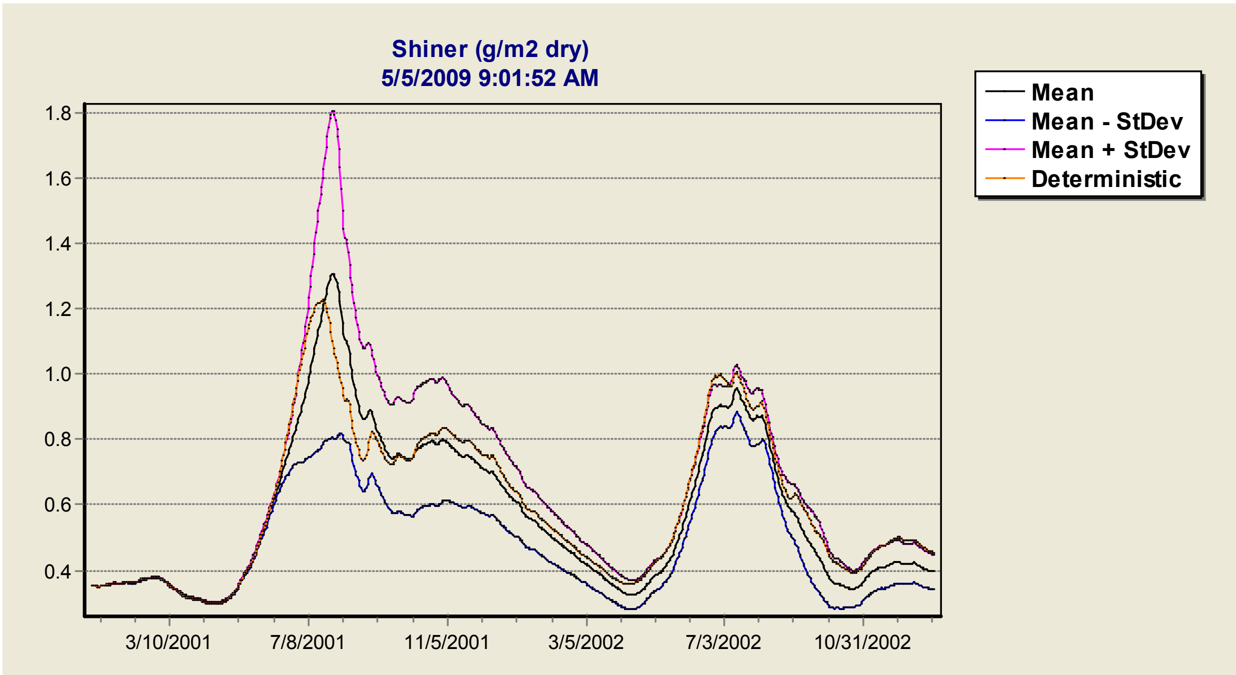

Figure 45. Sensitivity of shiners to smallmouth bass *TOpt* in Cahaba River AL.

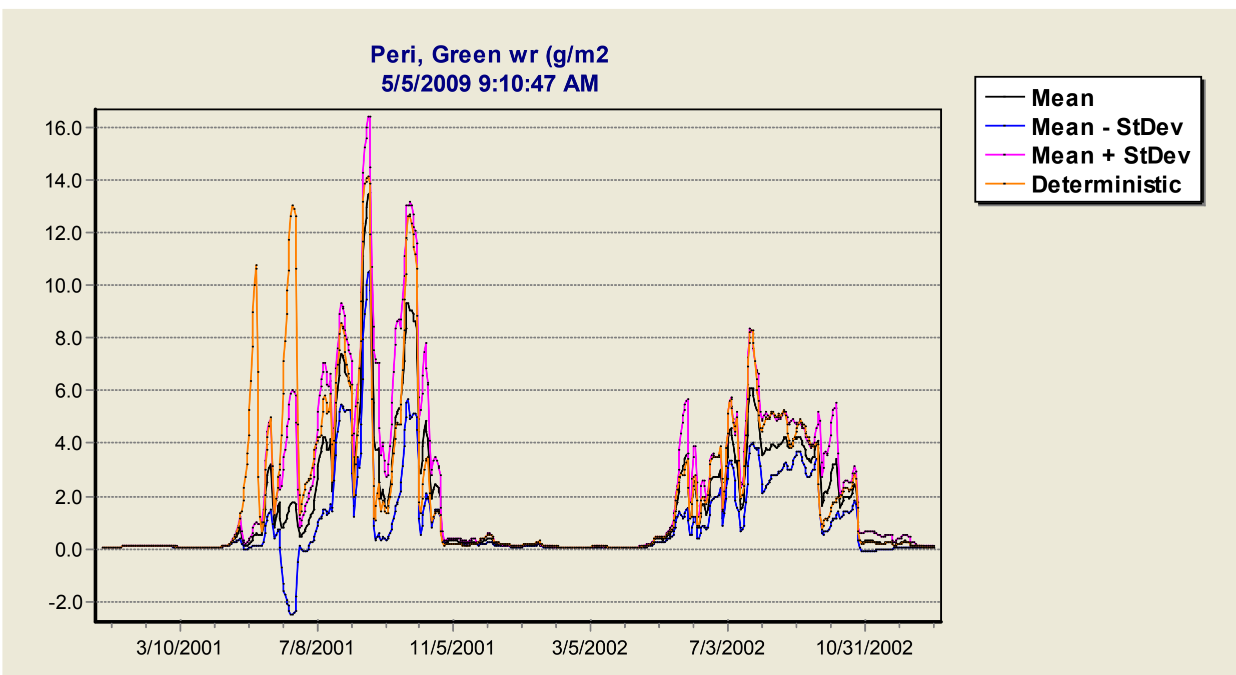

Figure 46. Sensitivity of periphytic green algae to smallmouth bass *TOpt* in Cahaba River AL.

PERIPHYTIC GREEN, % LOST WITH SLOUGHING EVENT

There are no data on which to base the analysis, so a skewed triangular distribution was defined around the calibrated value (Figure 47). Biomass of the periphytic green algae are moderately sensitive to the percent lost with sloughing (Figure 48, Figure 49).

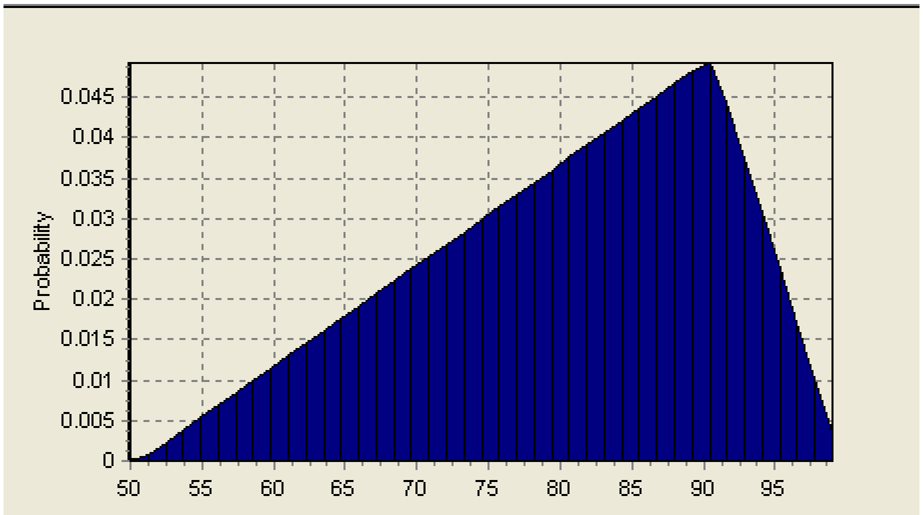

Figure 47. Triangular distribution of percent lost with sloughing used in analysis.

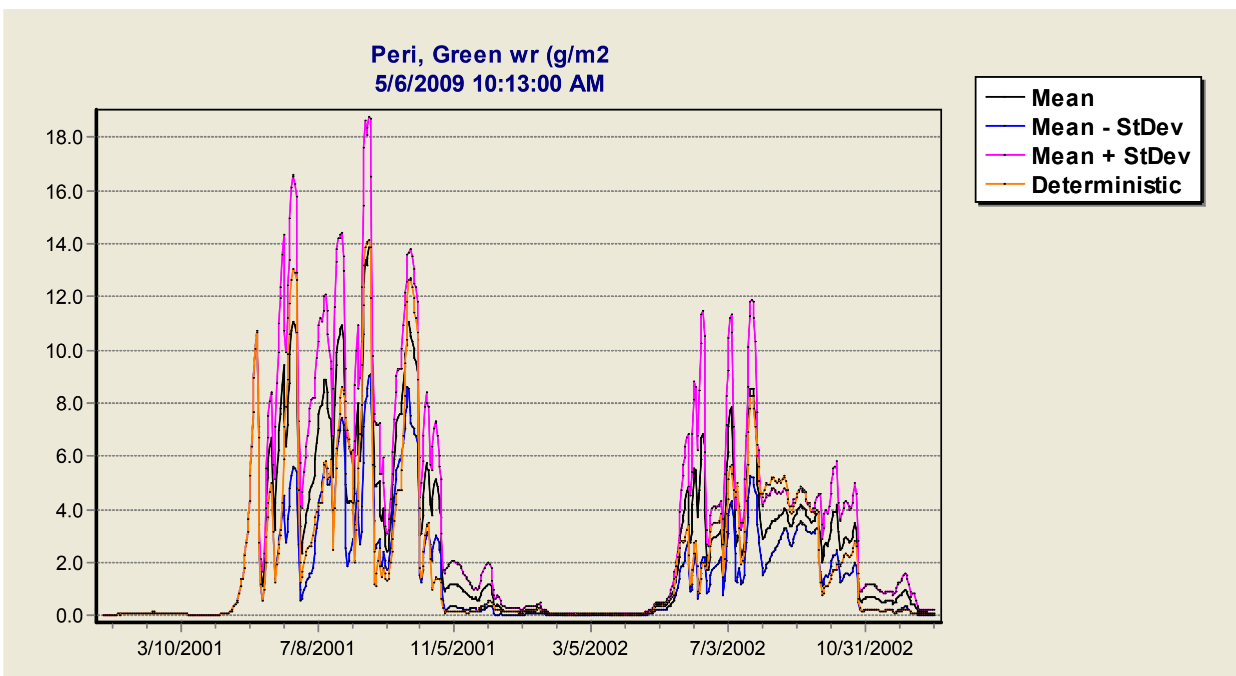

Figure 48. Sensitivity of periphytic green algae to percent lost with sloughing in Cahaba River AL.

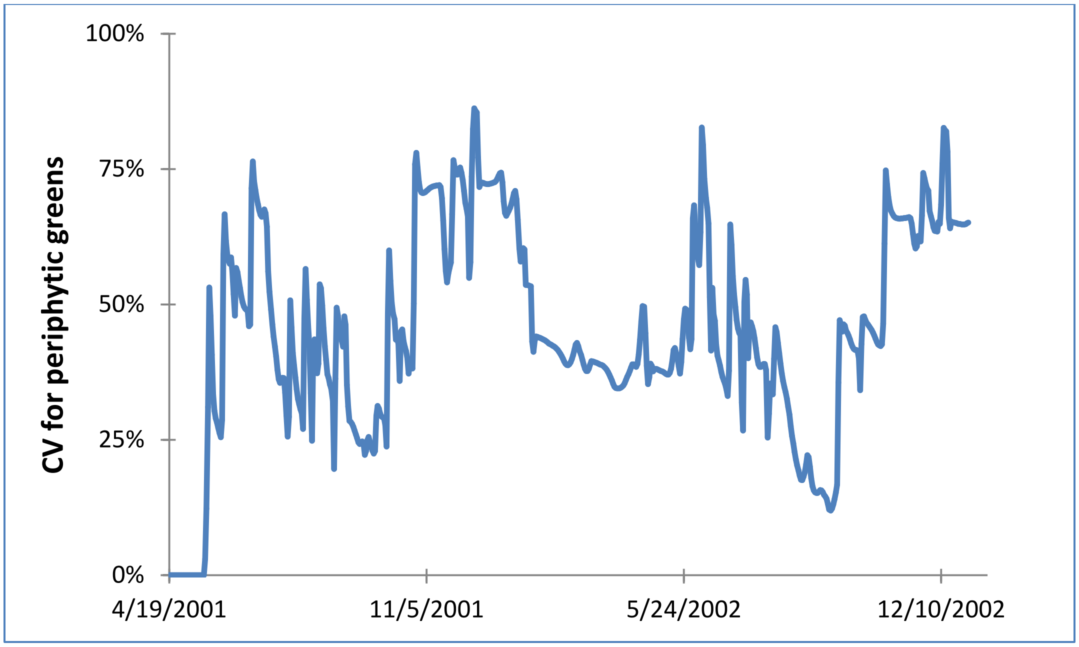

Figure 49. Coefficient of variation for periphytic green algae based on sensitivity analysis of "percent lost with sloughing" in Cahaba River AL.

CHIRONOMID, SELECTIVE SORTING

Chironomids living in sand, as in the Cahaba River, are very selective feeders; however, those living in fine-grained sediment may ingest up to 50% inorganic sediments by larval dry weight; and the average for 12 sediments is 10% (Ristola et al. 1999). Therefore, a skewed triangular distribution was used (Figure 50) with a minimum of 0.4 and the most likely and maximum coinciding at 1 (and 1.0001). In actuality, the highest value used in the analysis was 0.985, and the deterministic simulation exceeded the mean + 1 standard deviation; the chironomids are sensitive to this parameter (Figure 51). This result was obtained only after the code was modified to desensitize the function to deposited sediment; previously, all chironomids died out unless selective sorting equaled 1. In this way the analyses contributed to an improvement in the model.

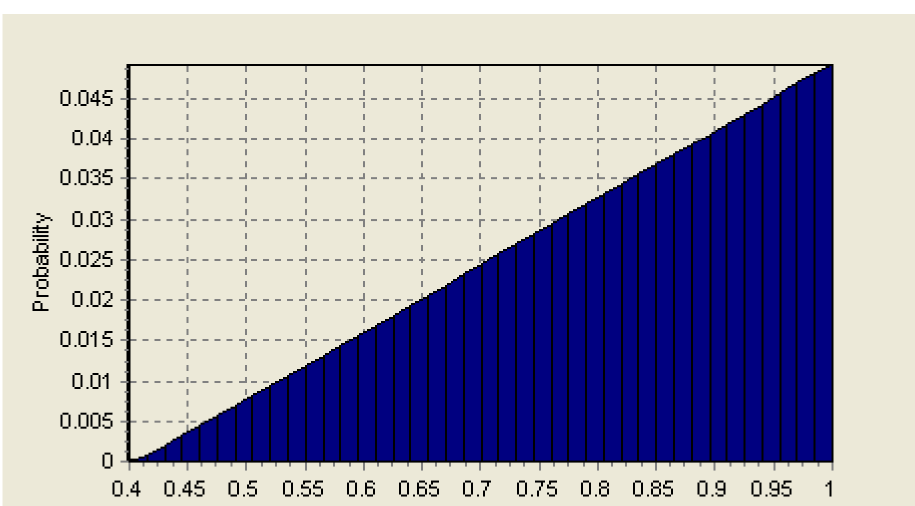

Figure 50. Skewed triangular distribution of selective sorting used in analysis.

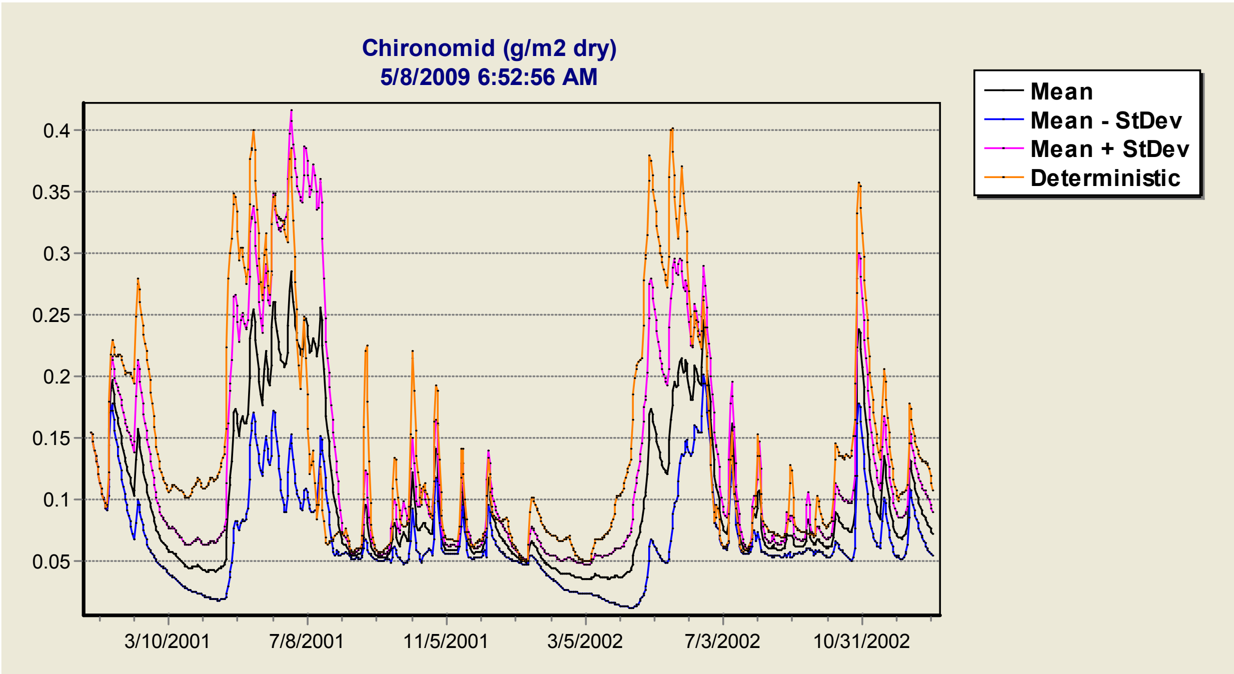

Figure 51. Sensitivity of chironomid biomass to selective sorting by chironomids in Cahaba River.

Based on the literature survey and sensitivity results, the default selective sorting value for chironomids was changed to 0.9. The model was then re-run with the new value (and code); the perturbed simulation is with X2 TSS as a further test of the sensitivity. The perturbed results seem reasonable (Figure 52): depositional events cause a decrease of up to 50% in chironomid biomass. Black arrows on the figure below represent the approximate peaks of depositional periods.

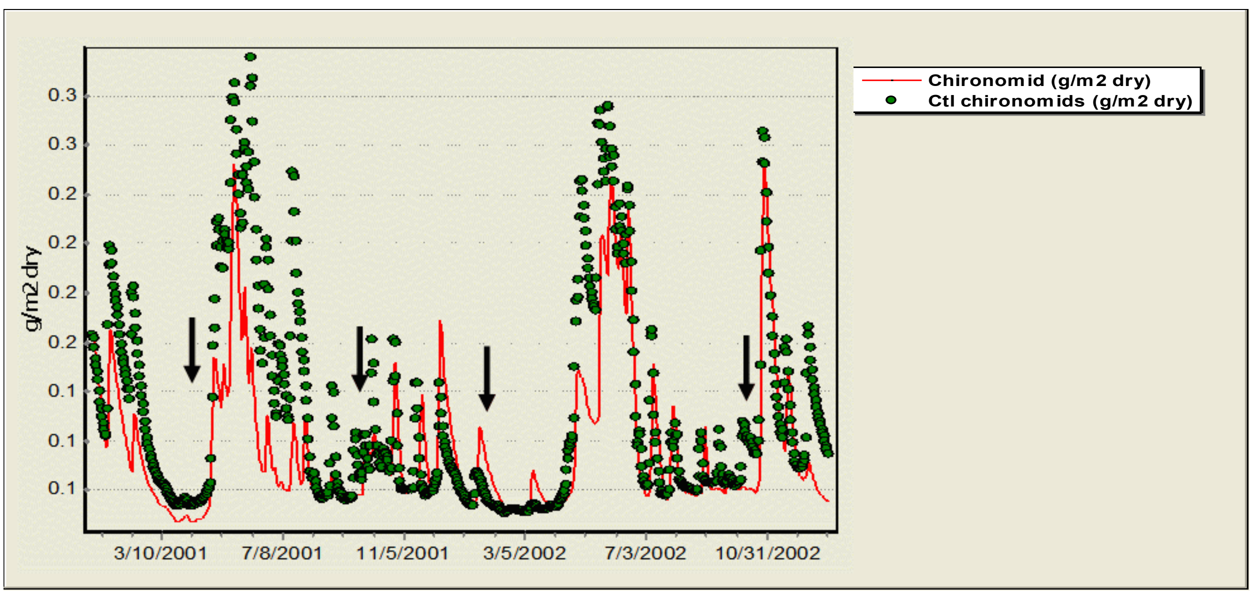

Figure 52. Chironomid biomass perturbed with X2 TSS (red line) compared to control simulation (green dots) in Cahaba River AL.

Duluth Pond, MN, Chlorpyrifos

LOG K_{OW}

The ARS Pesticide Properties Database reports the Log *Kow* of chlorpyrifos as 5 (4.7-5.3), and 5 is used in the deterministic simulation. The Australian National Toxics Network gives the value as 4.96 and several US EPA publications give the value as 4.7. A value of 5 is used as the most likely value in a triangular distribution, with bounding values of 4.6 and 5.4 (Figure 53); compare this to the range of 4.25 to 5.75 used in the nominal-range sensitivity analysis with a 15% change. The concentration of chlorpyrifos in the water is moderately sensitive to the *Kow* (Figure 54). The concentration in adult green sunfish is also moderately sensitive (Figure 55) because of their time-dependent bioaccumulation, and this is reflected in their variable biomass (Figure 56). All other biotic groups exhibit almost immediate and uniform mortality across the range of *Kow*s (Figure 57). Note that the chironomid biomass was most sensitive with the nominal range of 15% (Figure 12), but it was not sensitive to the better defined triangular distribution. The uptake of chlorpyrifos and its effect on chironomids is quite different between log *Kow* of 5.4 and 5.75. A detailed analysis is provided in Appendix A (page 59).

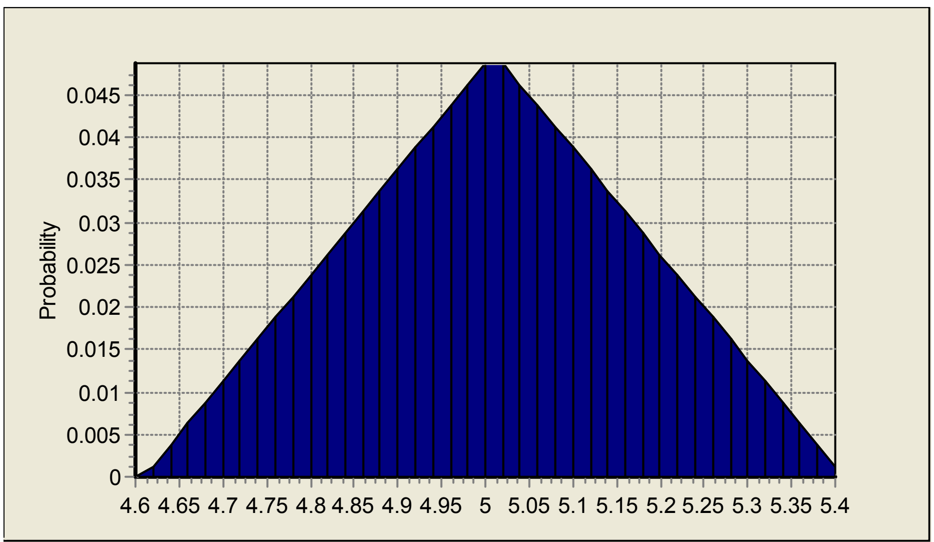

Figure 53. Triangular distribution of log *Kow* for chlorpyrifos used in analysis.

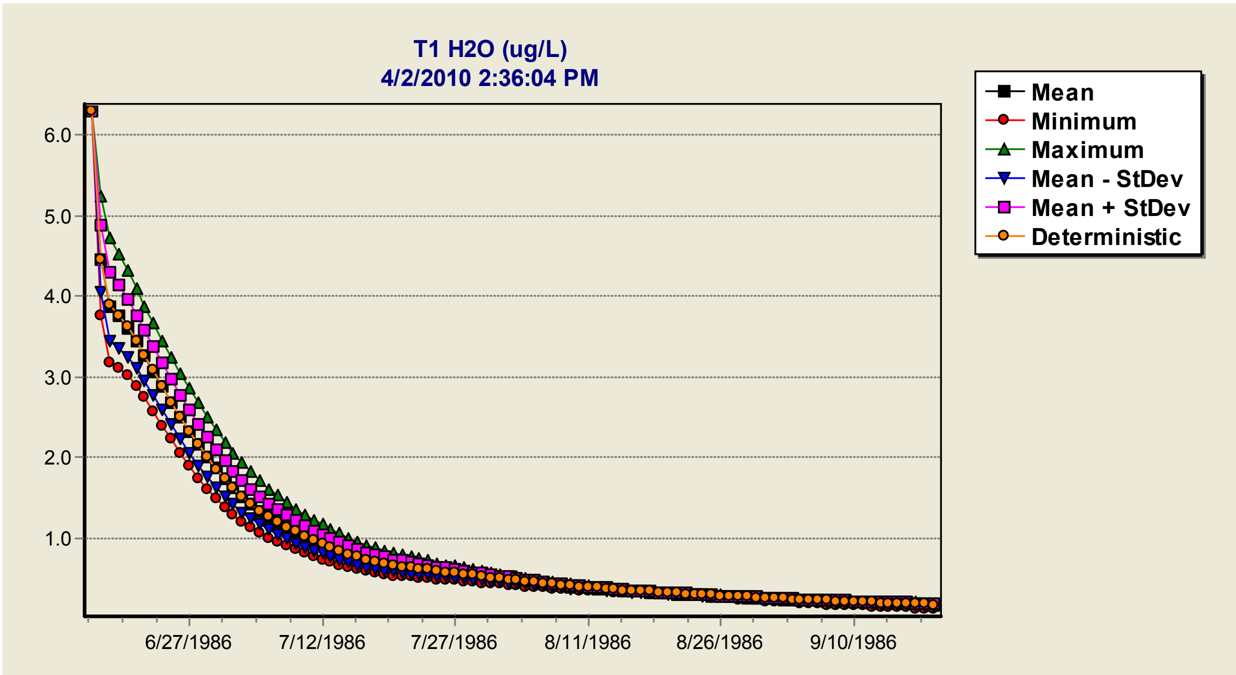

Figure 54. Sensitivity of chlorpyrifos concentration in Duluth pond MN as a function of log *Kow*.

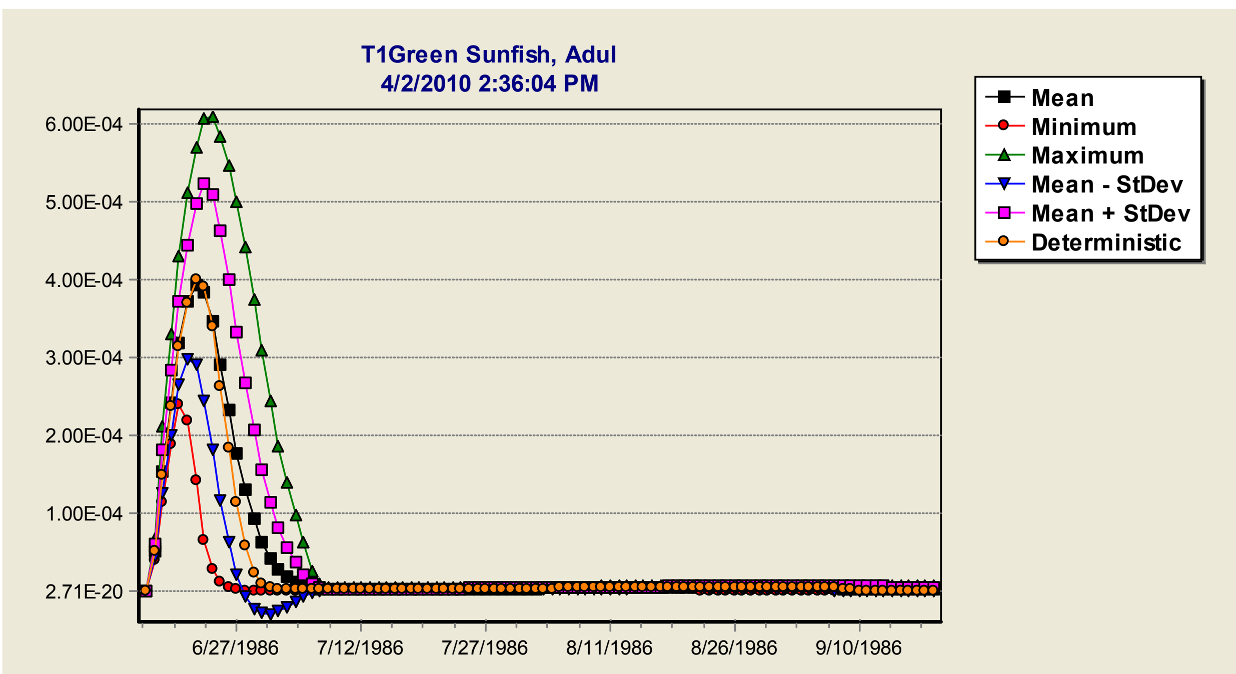

Figure 55. Sensitivity of chlorpyrifos concentration in green sunfish in Duluth pond MN as a function of log *Kow*.

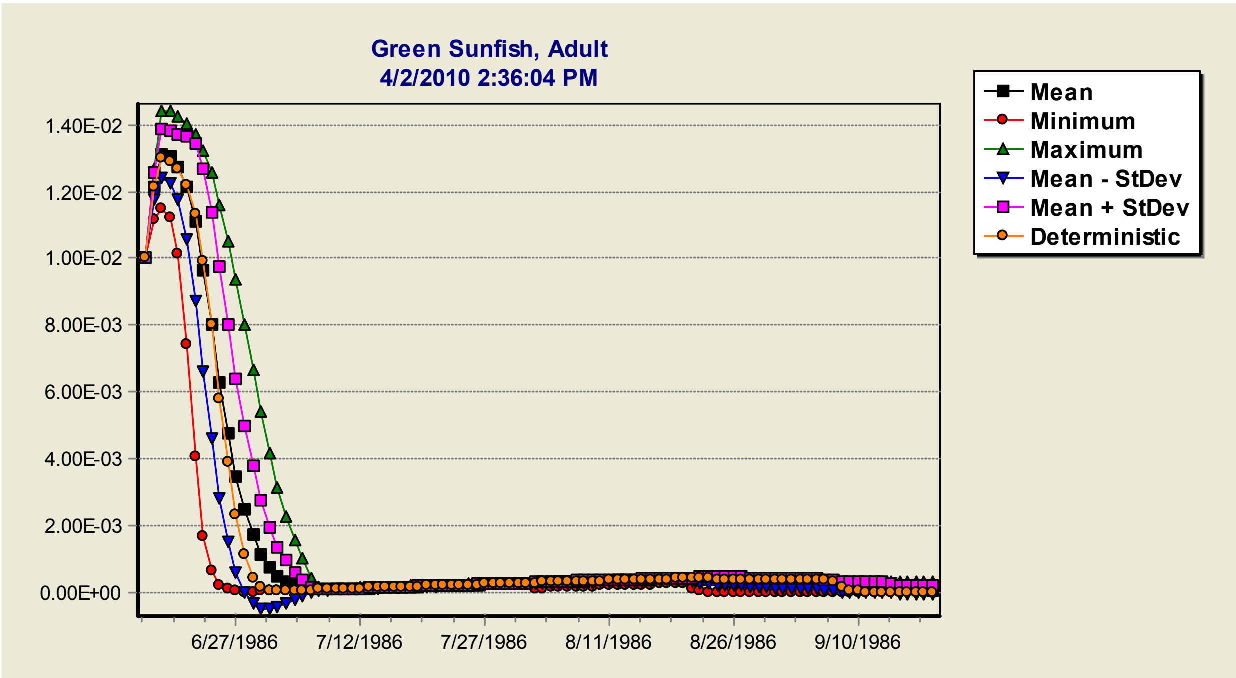

Figure 56. Sensitivity of green sunfish biomass to log *Kow* of chlorpyrifos in Duluth pond MN.

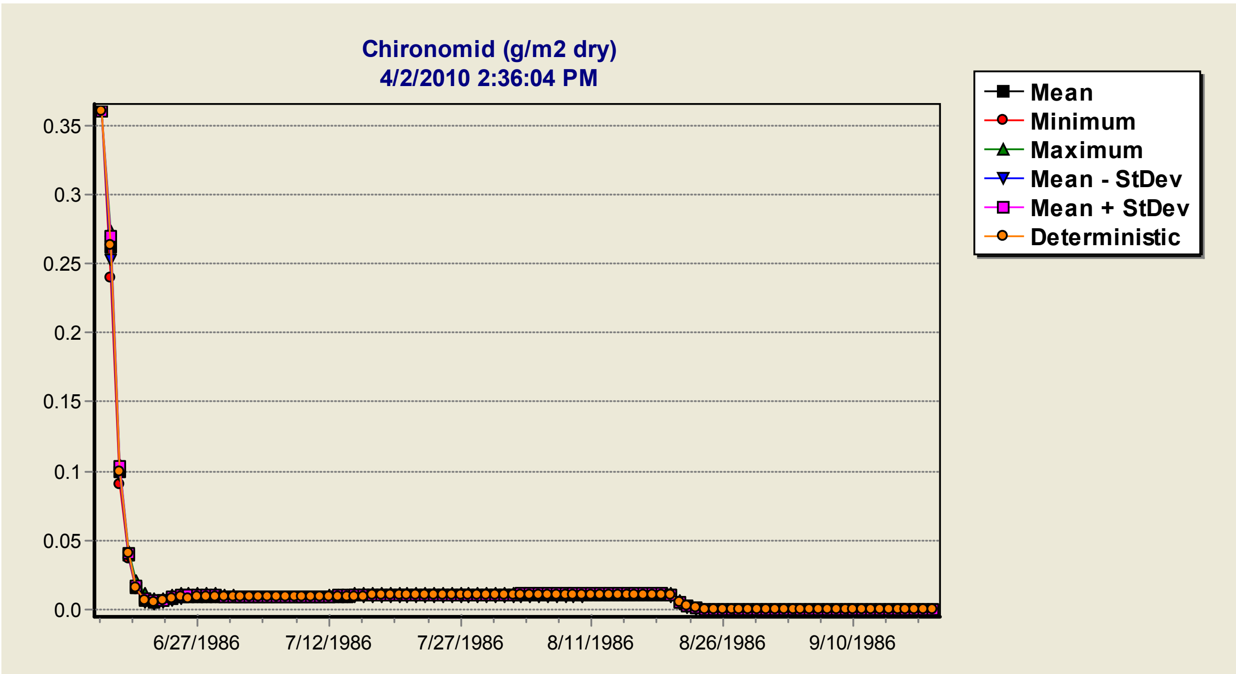

Figure 57. Sensitivity of chironomid biomass to log *Kow* of chlorpyrifos in Duluth pond MN.

Ohio Stream, Chlorpyrifos

YELLOW PERCH LC50

Yellow perch was chosen for analysis because it is the most sensitive biotic group to chlorpyrifos (Figure 58). The yellow perch *LC50* of 2.22 µg/L for chlorpyrifos was estimated from observed bluegill *LC50* using the Interspecies Correlation Estimation (ICE); a standard deviation of 1.08 was also based on ICE statistics (Figure 59). Following the first dose of chlorpyrifos, yellow perch may decline a little or a lot, depending on the *LC50* (Figure 60). Another way of analyzing the response is to plot the results in a risk graph (Figure 61); there is a 50% chance that yellow perch will decline by 58.5% by the end of the simulation and a 100% chance that they will decline by 14.5%. Top-down control of lower trophic levels can be seen in the response of mayflies (Figure 62); due to variable predation by yellow perch, mayflies too are somewhat sensitive to the yellow perch *LC50* values.

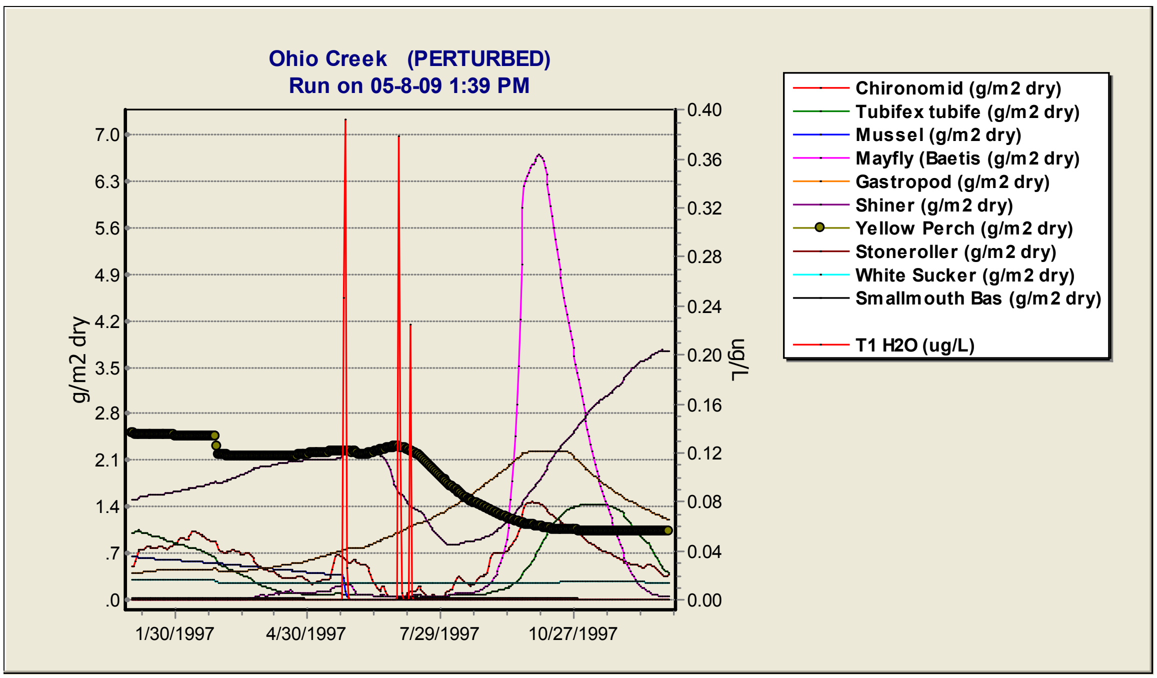

Figure 58. Response of yellow perch (circles) and other animals to pulsed loadings of chlorpyrifos in Ohio stream.

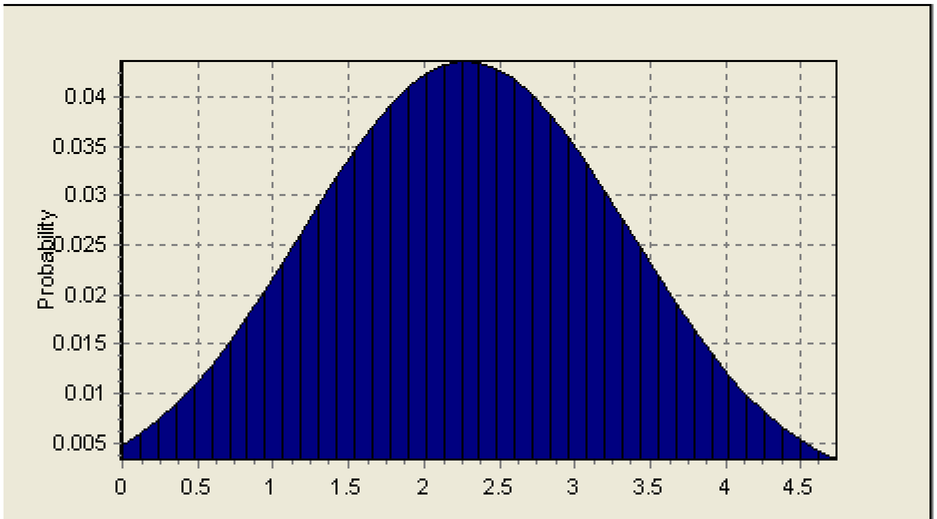

Figure 59. Distribution of yellow perch *LC50* used in analysis.

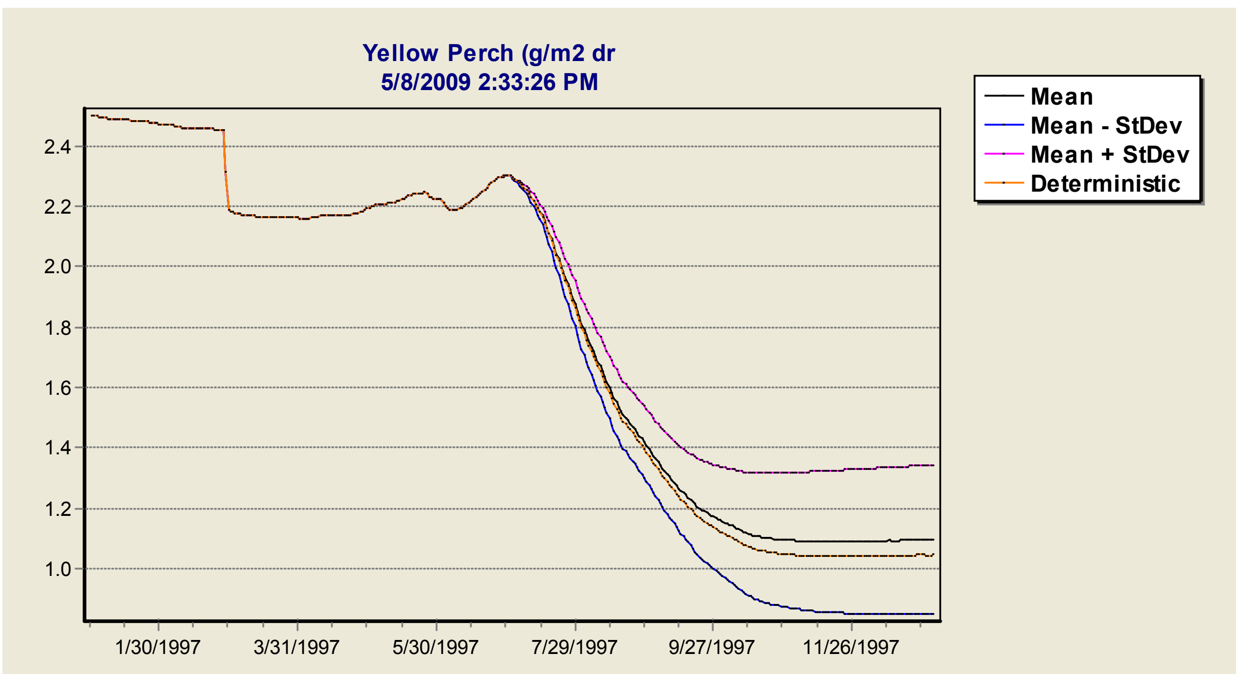

Figure 60. Sensitivity of yellow perch in Ohio stream to chlorpyrifos *LC50*.

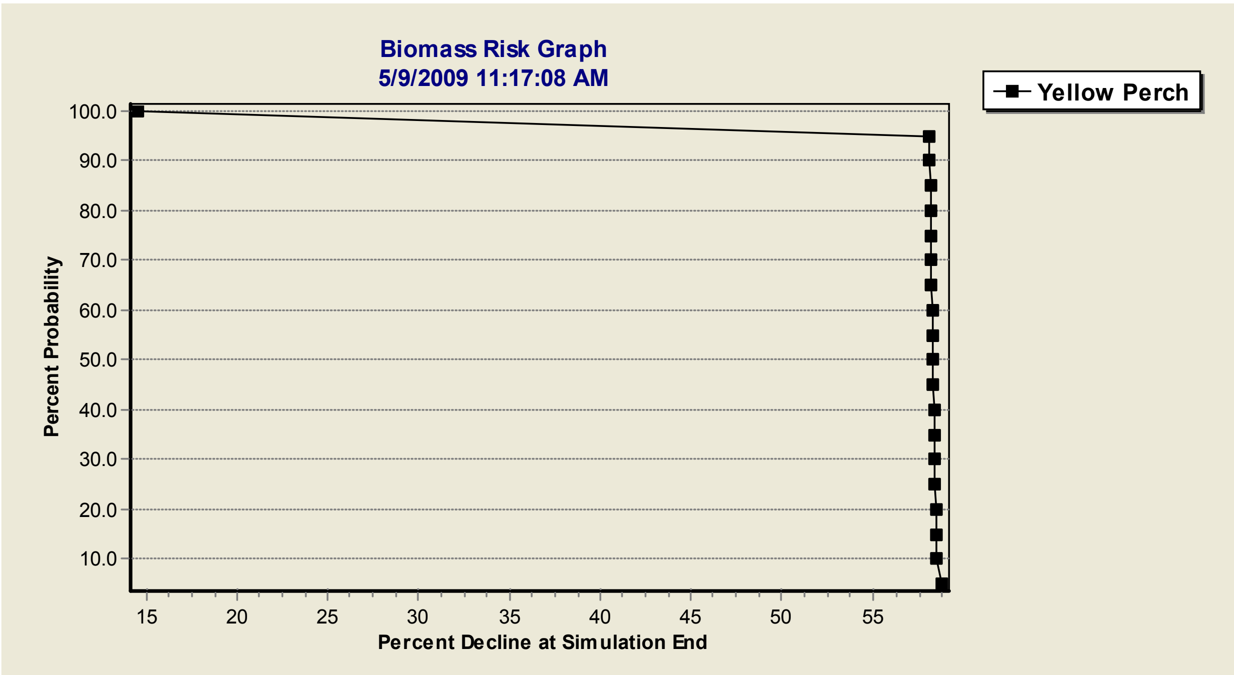

Figure 61. Risk graph demonstrating sensitivity of yellow perch to *LC50* distribution.

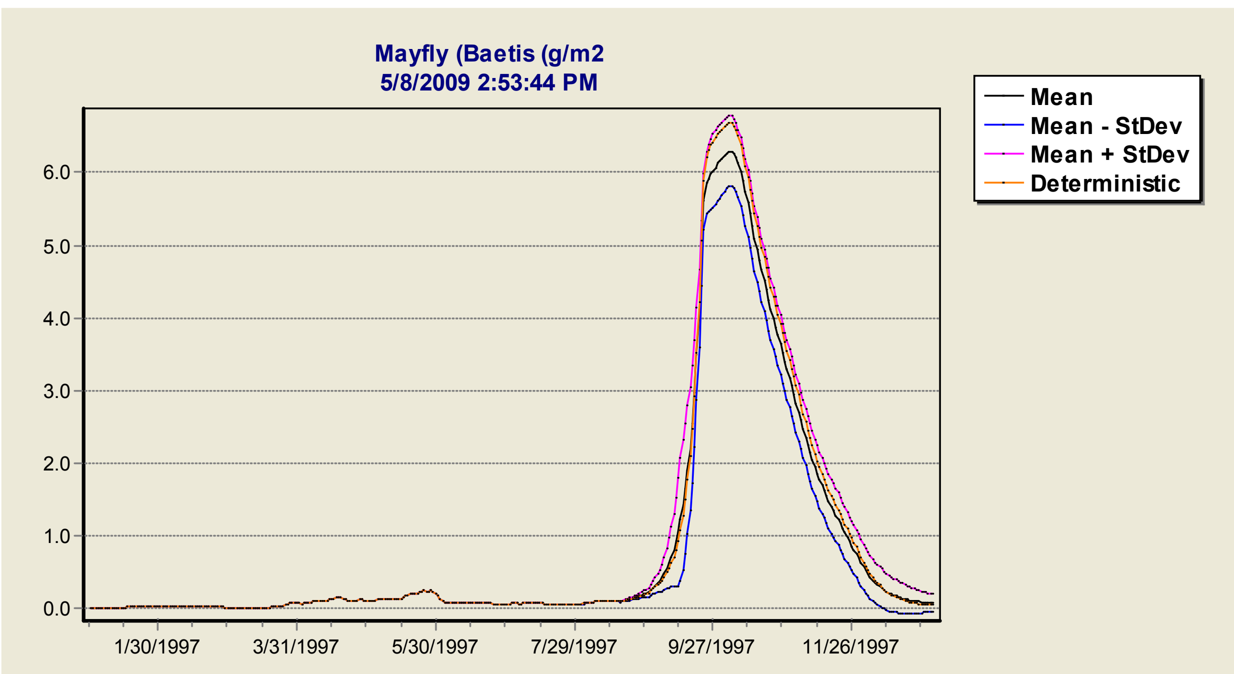

Figure 62. Sensitivity of mayflies in Ohio stream to yellow perch *LC50*.

Galveston Bay, TX, PCBs

SEA TROUT TOPT

A value of 27° for sea trout optimal temperature is supported by the literature and is used in the deterministic simulation. According to the Web page of the Smithsonian Marine Station at Fort Pierce FL, spawning takes place from 24° to 30°; these values were used to obtain a normal distribution (Figure 63, mean = 27°, SD = 1.5). The simulation was cut from three years to one year because equilibrium was obtained in both PCB concentrations and biomass. Sea trout are moderately sensitive to the *TOpt* (Figure 64); however, the concentration of PCBs in sea trout is even more sensitive to the *TOpt* (Figure 65, Figure 66).

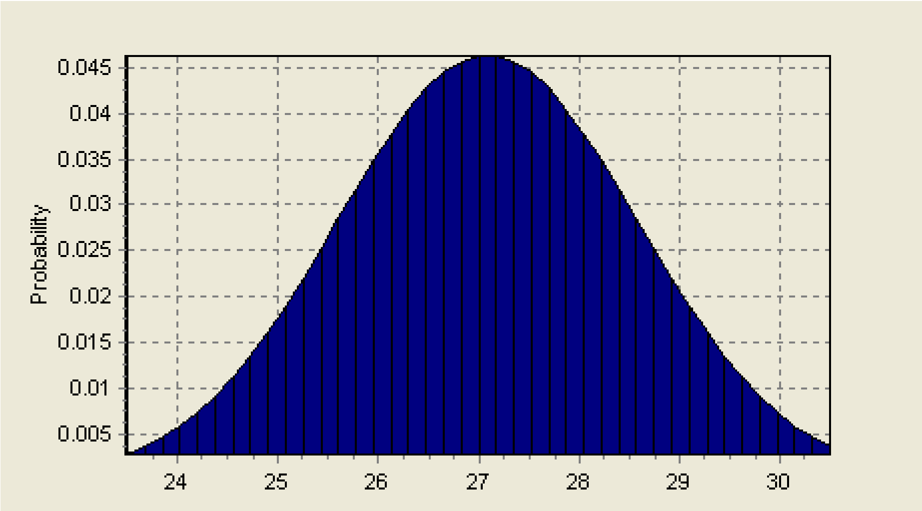

Figure 63. Distribution of sea trout *TOpt* used in analysis.

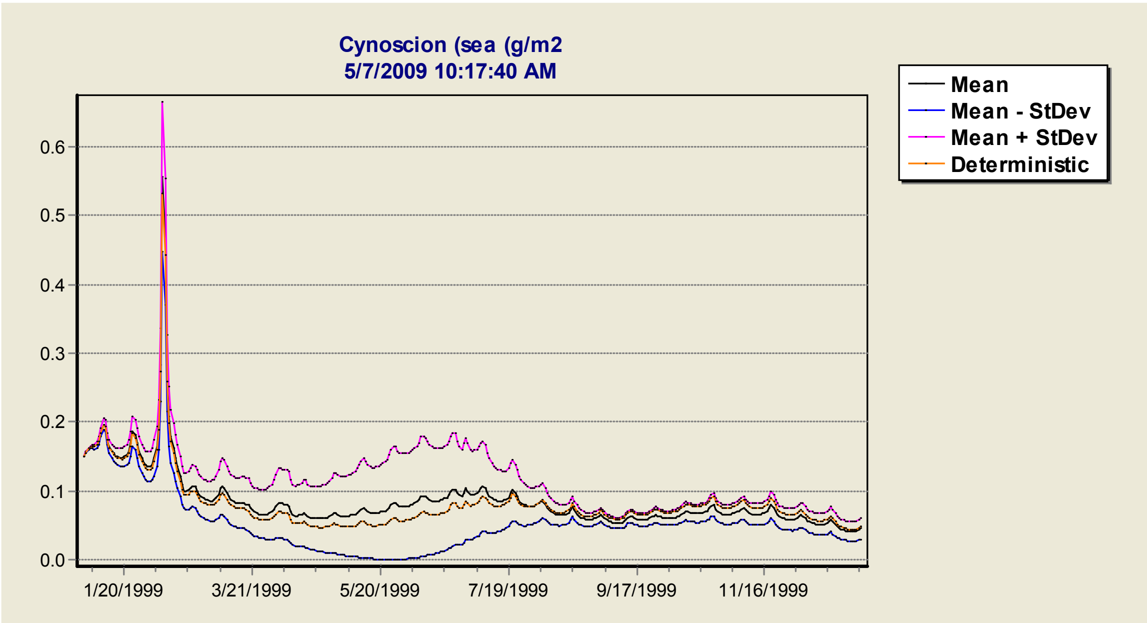

Figure 64. Sensitivity of sea trout to *TOpt* in Galveston Bay TX.

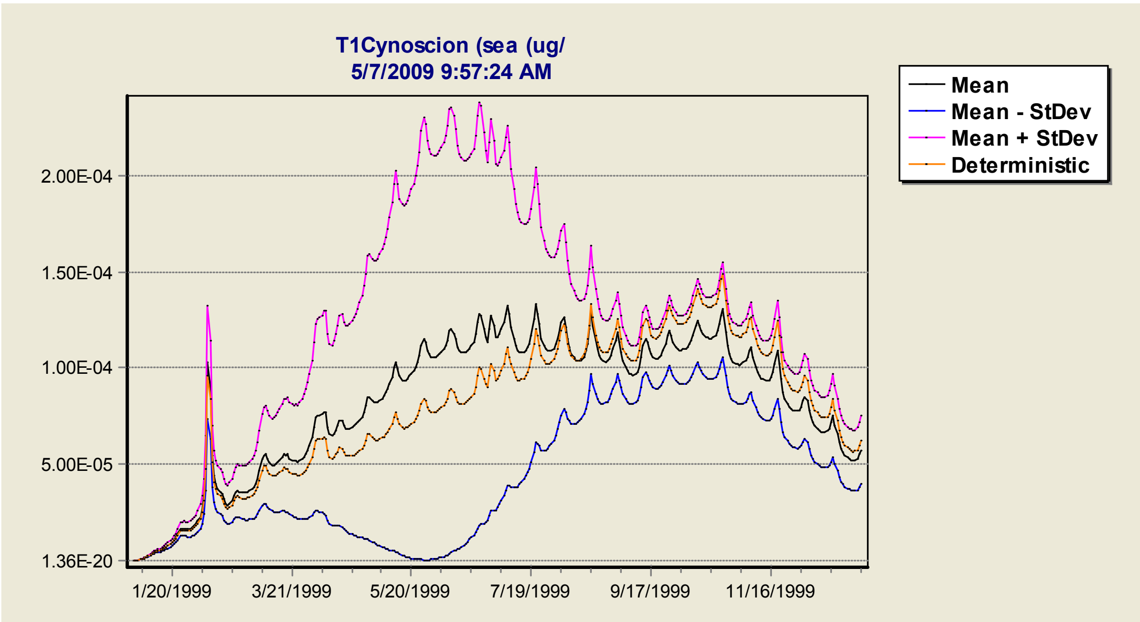

Figure 65. Sensitivity of concentration of PCBs in sea trout as a function of sea trout *TOpt* in Galveston Bay TX.

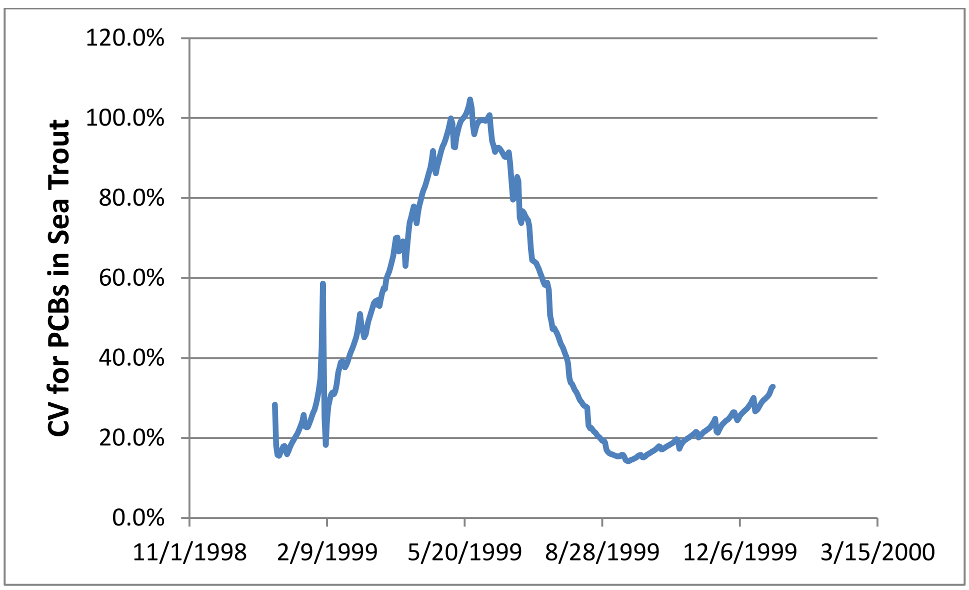

Figure 66. Coefficient of variation for concentration of PCBs in sea trout based on sensitivity analysis of sea trout *TOpt* in Galveston Bay TX.

Discussion of Nominal-Range and Statistical Sensitivity Analyses

Of the two methods, nominal-range sensitivity may be considered the less powerful technique, evaluating variables one at a time with nonparametric statistics. Statistical sensitivity analysis is a parametric technique based on defined distributions and can evaluate interactions among variables. As shown in the case studies, it provided insights beyond nominal-range sensitivity for key ecosystem parameters, boundary conditions, and helped to refine model constructs.

Table 5 summarizes the analyses and shows a rough correspondence between the results of the two methods. The two statistics are not directly comparable, however. *Sensitivity* provides results based that are integrated over the entire study whereas CV represents the variability over the course of a run based on a distribution of feasible parameter values. The most sensitive endpoint-parameter pairing in all the statistical sensitivity analyses was % blue-greens in Lake Onondaga as a function of blue-green *PMax* with CV% = 127. That was followed closely by % blue-greens in Lake Onondaga as a function of blue-green *TOpt*. Both also had high sensitivity % based on nominal-range sensitivity. Chlorophyll a in Lake Onondaga was also sensitive, but much less so.

Table 5. Comparison of sensitivity % (nominal-range sensitivity) and CV % (statistical sensitivity).

Site	Endpoint	Parameter	Test %	Sensitivity %	Distribution	Mean CV %
Lake Onondaga NY	Chlorophyll a	Bl-gr TOpt	15	52.6	Uniform	30.5
		Bl-gr Pmax	15		Normal	27.3
		Diatom Pmax	15	52.5	Normal	18.4
	% Blue-green	Bl-gr TOpt	15	720	Uniform	114.2
		Bl-gr Pmax	15	244	Normal	127.1
		Diatom Pmax	15	119	Normal	15.2
	Hypo. DO	Bl-gr TOpt	15	4.3	Uniform	18*
Lake Onondaga NY, Diagenesis	Hypolimnetic SOD	Theta	15	276	Uniform	10*
	Hypo.DO	Theta	15	88.7	Uniform	21.4*
Cahaba River AL	Smallmouth bass	Smallmouth TOpt	15	369	Normal	24.7
	Shiner biomass	Smallmouth TOpt	15		Normal	13.4
	Periphytic green algae	Smallmouth TOpt	15		Normal	43.2
	Periphytic green algae	% Lost to sloughing	15	76.1	Triangular	47.4
	Chironomid biomass	Chiro. sel. sorting	15	621	Triangular	27.8
Duluth Pond MN	Chlorpyrifos in water	Chlorpyrifos Kow	15	234	Triangular	8.1
	Chlorpyrifos in sunfish	Chlorpyrifos Kow	15		Triangular	63.6
	Sunfish biomass	Chlorpyrifos Kow	15	888	Triangular	47.5
	Chironomid biomass	Chlorpyrifos Kow	15	546	Triangular	11.5
Ohio Stream	Yellow perch biomass	Chlorpyrifos LC50 yellow perch	15	0.25	Normal	7

	Mayfly biomass	Chlorpyrifos LC50 yellow perch	15	0.25	Normal	17.7
Galveston Bay TX	Sea trout biomass	Sea trout TOpt	33	167	Normal	41.8
	PCBs in sea trout	Sea trout TOpt	33		Normal	45.5

A serious drawback to nominal-range sensitivity analysis is that even a 15% variation may result in inappropriate parameter values, especially if the given deterministic parameter value is near the limit of observed values. For example, hypolimnetic SOD in Lake Onondaga had a sensitivity of 276% as a function of Theta. Published values of Theta range from 1.04 to 1.15; the latter value is used in the deterministic simulation, so 15% variation yields 0.98 and 1.32—well beyond the uniform distribution, which has a CV = 10. Additionally, nominal range statistics are computed for the entire run but miss the variability over the course of the simulation.

Sensitivity analysis can also point out problems with model formulations. In this exercise, simulated chironomid biomass in the Cahaba River as a function of selective sorting yielded sensitivity of 621%. When a statistical distribution was used chironomid biomass went to zero. The original sensitivity was an artifact of the sediment effects formulation. The sorting construct was re-formulated, and the results were reasonable, with CV = 27.8%.

Nominal-range sensitivity for the Duluth pond simulations was very sensitive to the log *Kow* values. Statistical sensitivity analysis was moderately sensitive. Because they are log values, a small change in *Kow* values can lead to a large change in result. On the other hand, not all analyses yield sensitive results. The Ohio stream simulation is insensitive to the chlorpyrifos *LC50* for yellow perch because the pulsed loading of chlorpyrifos is only 0.4 µg/L, compared to 6.3 µg/L in the Duluth pond. Sensitivity analysis should always be in the context of the specific site.

Sea trout *TOpt* was varied in a simulation of Galveston Bay in the final analysis; both sea trout biomass and PCB concentrations in sea trout were moderately sensitive using a well defined normal distribution. However, nominal-range sensitivity analysis used 33% variation, which put the sea trout *TOpt* at 18° and 35.9°, compared to the *TMax* of 35°. No wonder it was very sensitive! A variation of 10% should probably be used for most analyses; this led to changing the default percent change to 10%.

Considering patterns of sensitivity, *TOpt* is moderately sensitive across sites using well defined distributions. This is despite the fact that the temperature function incorporates limited adaptation, which should desensitize the function. It is a non-linear function with optimum and maximum temperatures that are usually close (U.S. Environmental Protection Agency 2009, Figure 67). This function, attributed to Stroganov (1956), is well established in the peer-reviewed literature. Sensitivity for specific groups appears to be consistent with the literature.

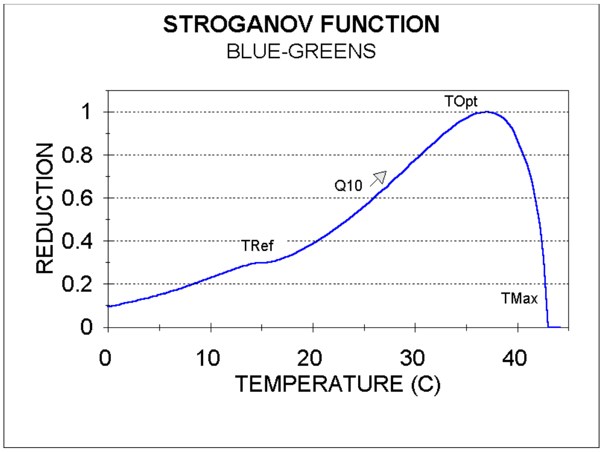

Figure 67. Temperature response of blue-greens.

As we have seen, the algal parameters are also sensitive across sites. This is probably a consequence of potentially rapid growth rates and susceptibility to sloughing (periphyton) and crashes of blooms (phytoplankton). This analysis suggests that users should be careful in choosing parameter values and should be willing to conduct site-specific calibrations.

Summary and Conclusions

This comprehensive sensitivity analysis was designed to exercise the AQUATOX model with a wide range of parameter changes and to summarize overall results. The project was performed partially to test the response of the model to many hundreds of parameterizations to ensure model stability and reasonable results in all cases. The other goal of this exercise was to assist in model calibration. Sensitivity analyses provide a useful tool to understand which parameters are likely to be most fruitful towards pushing the model towards a specific calibration goal without exceeding the defensible range for each parameter.

Overall, the model performed well in the model stress test. Thousands of alternative model parameterizations were executed without producing unreasonable results, or results outside the realm of physical plausibility. However, one model construct was modified as a result of these tests—the manner in which the model interprets the "sorting" parameter for invertebrate feeding. Initial model results indicated that the model was overly sensitive to this new parameter and it has been modified as shown in equation **(120)** of the Release 3.1 *Technical Documentation.*

In general users should use a multi-parameter nominal-range sensitivity analysis when trying to understand the overall response of a system to changes in many of its parameters. When trying to understand the potential effects of a single parameter within the range of uncertainty in its observed values, a statistical sensitivity analysis is a better approach because the observed values can be used to define an appropriate uncertainty distribution.

This sensitivity analysis can also support current and future model calibrations. The general observations listed below have supported recent AQUATOX calibrations and hopefully will assist future calibration efforts for readers of this document.

- AQUATOX biotic state variables are sensitive to temperature parameters. Careful attention should be paid to these variables by anyone calibrating biotic state variables regardless of the type of site being modeled.
- Consumption and respiration parameters are also sensitive, especially when allometric formulations are used for fish.
- Algae are sensitive to their maximum photosynthesis rate (*PMax*) which was also tested more thoroughly through a statistical sensitivity analysis.
- Simpler food-web models are more sensitive to effects from food-web interactions due to lack of alternative prey sources within the model's domain.
- Periphyton biomass is quite sensitive to the effects of sloughing and therefore sloughing parameters such as "percent lost in slough event" are sensitive parameters.
- Log *Kow* is a highly sensitive parameter for toxicant fate and effect.
- Despite the complexity of the AQUATOX model, a comparison of 15% and 33% parameter changes provided similar responses (when normalized to the size of the parameter change as is done by the *sensitivity* statistic).

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U.S. Environmental Protection Agency. 2009. AQUATOX (Release 3) Modeling Environmental Fate and Ecological Effects in Aquatic Ecosystems, Volume 2: Technical Documentation. EPA-823-R-09-004, U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington DC.

Appendix A. Detailed Analysis of the Fate and Effects of Chlorpyrifos in the Duluth Pond

As noted earlier, there was a discrepancy between the nominal-range and statistical sensitivity analysis of chlorpyrifos in a Minnesota pond; and some of the results were counterintuitive. Bounding values of 4.6 and 5.4 were used for a triangular distribution of log *Kow* in the statistical sensitivity analysis of chlorpyrifos (Figure 53), compared to the range of 4.25 to 5.75 used in the nominal-range sensitivity analysis. Chironomid biomass is insensitive up to log *Kow* 5.4 (Figure 57) but is very sensitive to a value of 5.75 (Figure 12). This merits closer examination—which is possible given the extensive output that is available with the model. If we force log *Kow* to have values of 4.25 and 5.75, as in the nominal-range sensitivity analysis, then there is considerable difference between the two simulations of chironomid biomass (Figure A-1, Figure A-2). With the lower *Kow* most chlorpyrifos is predicted to be in the dissolved phase (Figure A-3). With the higher *Kow*, more chlorpyrifos is tied up in the bottom sediments and especially in the abundant macrophytes (Figure A-4). As seen in Figure A-5, log *Kow* 5 to 6 is a critical range for uptake by macrophytes.

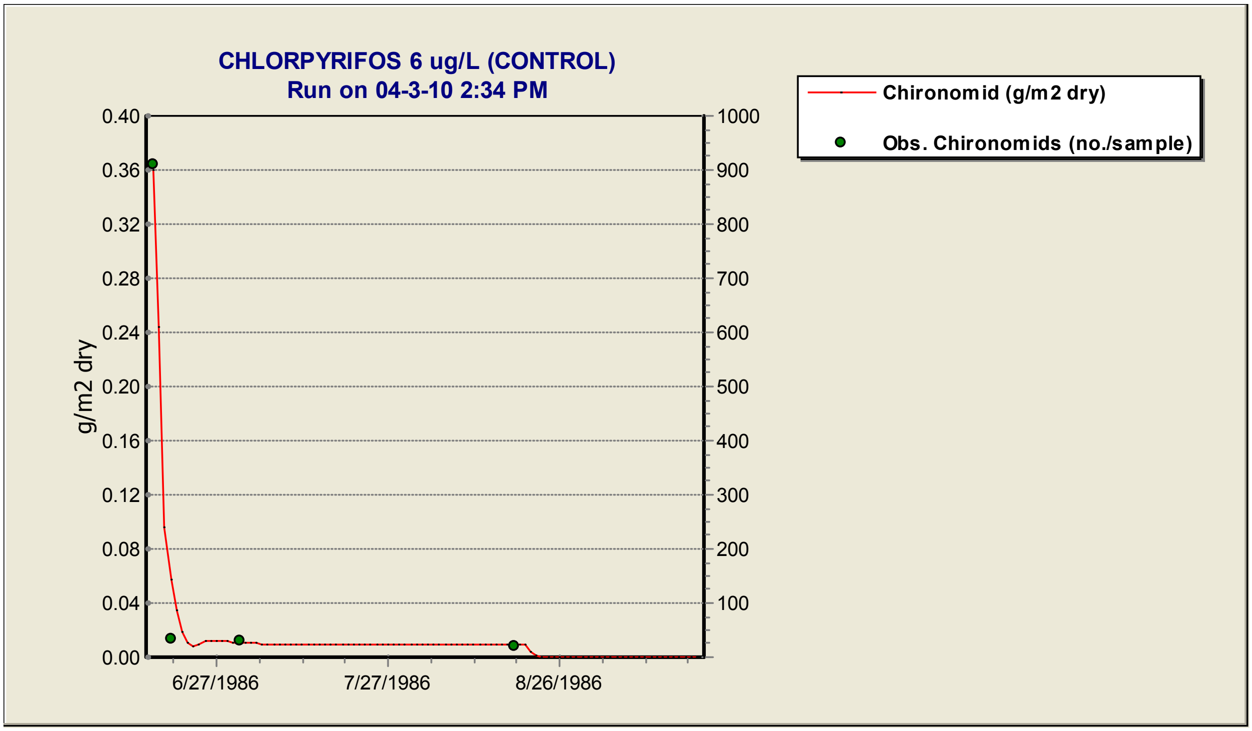

Figure A-1. Predicted biomass of chironomids in Duluth pond with chlorpyrifos log *Kow* = 4.25.

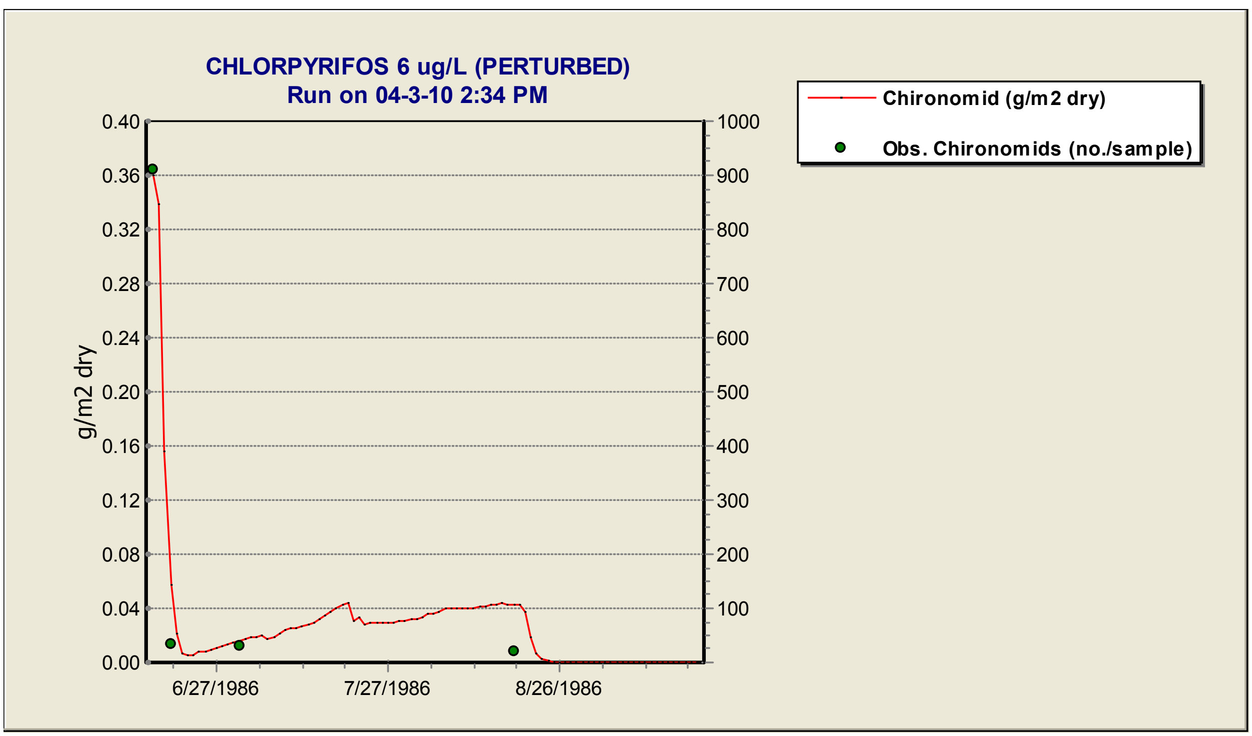

Figure A-2. Predicted biomass of chironomids in Duluth pond with chlorpyrifos log *Kow* = 5.75. Note partial recovery after initial mortality.

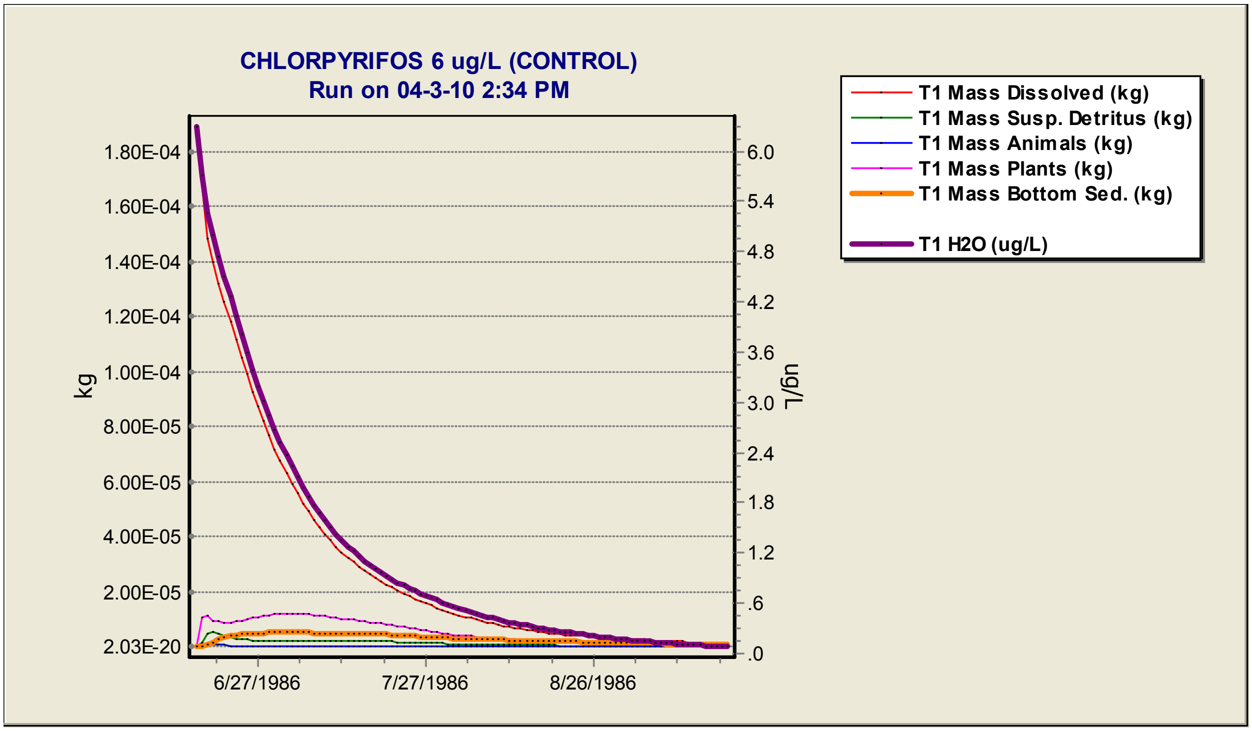

Figure A-3. Predicted distribution of chlorpyrifos mass in Duluth pond with log *Kow* = 4.25.

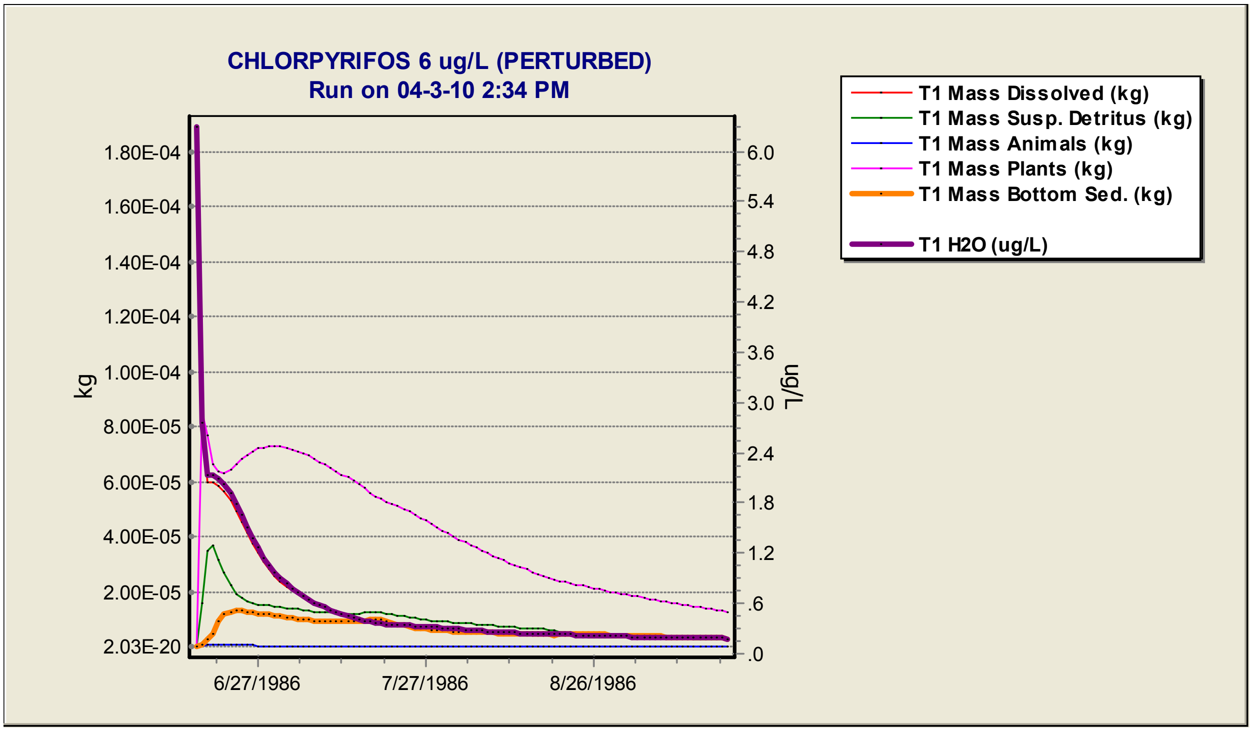

Figure A-4. Predicted distribution of chlorpyrifos mass in Duluth pond with log *Kow* = 5.75.

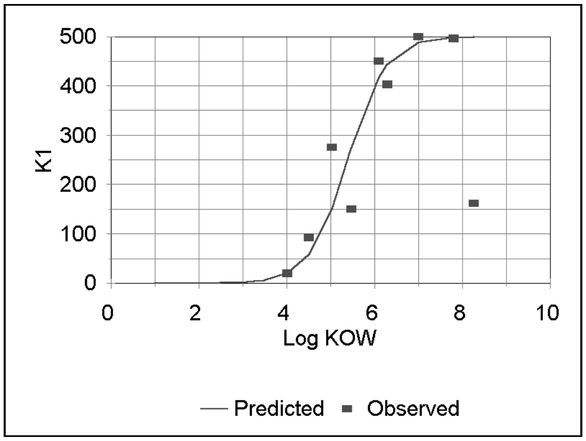

Figure A-5. Uptake rate constant for macrophytes (U.S. Environmental Protection Agency 2009, based on data from Gobas et al. 1991)

Chironomids are parameterized to feed on labile sedimentary detritus, so they are not directly exposed to chlorpyrifos associated with macrophytes. At the lower *Kow* chlorpyrifos is available to be sorbed across the gills (Figure A-6), leading to a high mortality in the simulated chironomids; at the higher *Kow* uptake across the gills is lower and mortality is lower (Figure A-7). Furthermore, disruption of feeding at sublethal concentrations means that there is not as much dietary uptake. In conclusion, by examining distribution of chlorpyrifos mass and rates of uptake predicted by AQUATOX, counterintuitive results can be reconciled.

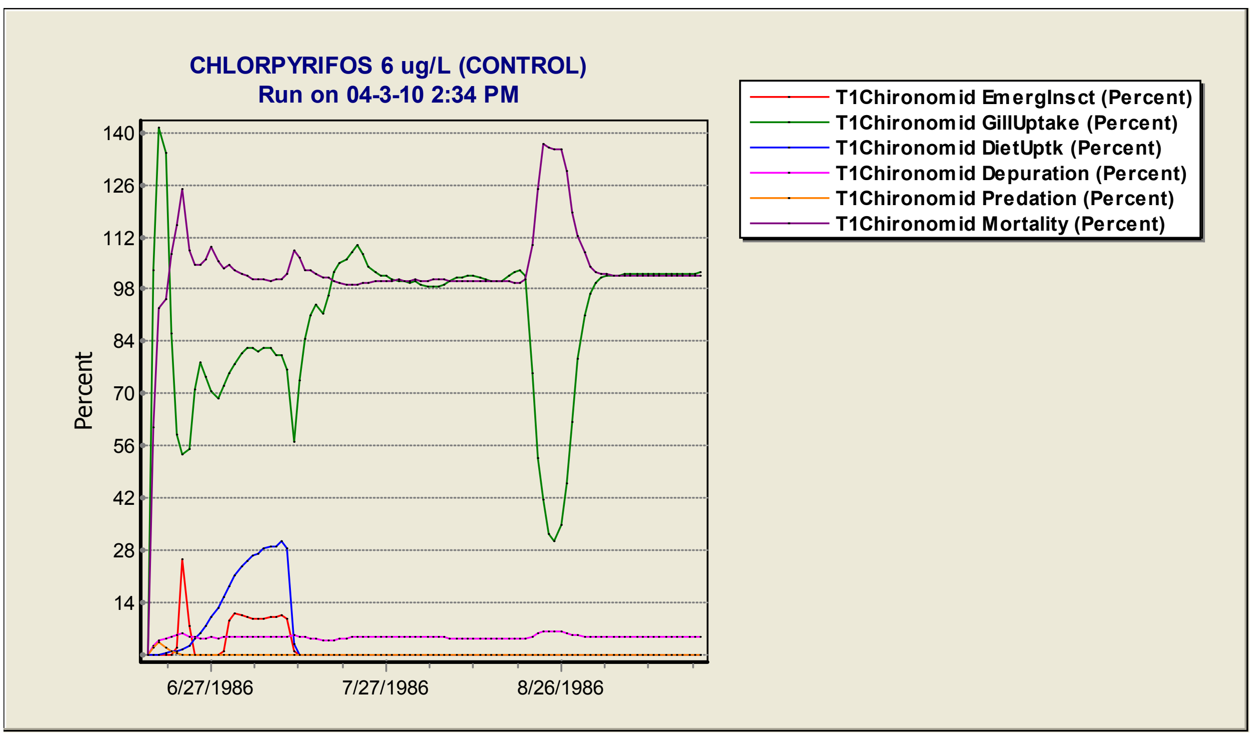

Figure A-6. Predicted processes affecting transfer of chlorpyrifos in chironomids with log *Kow* = 4.25.

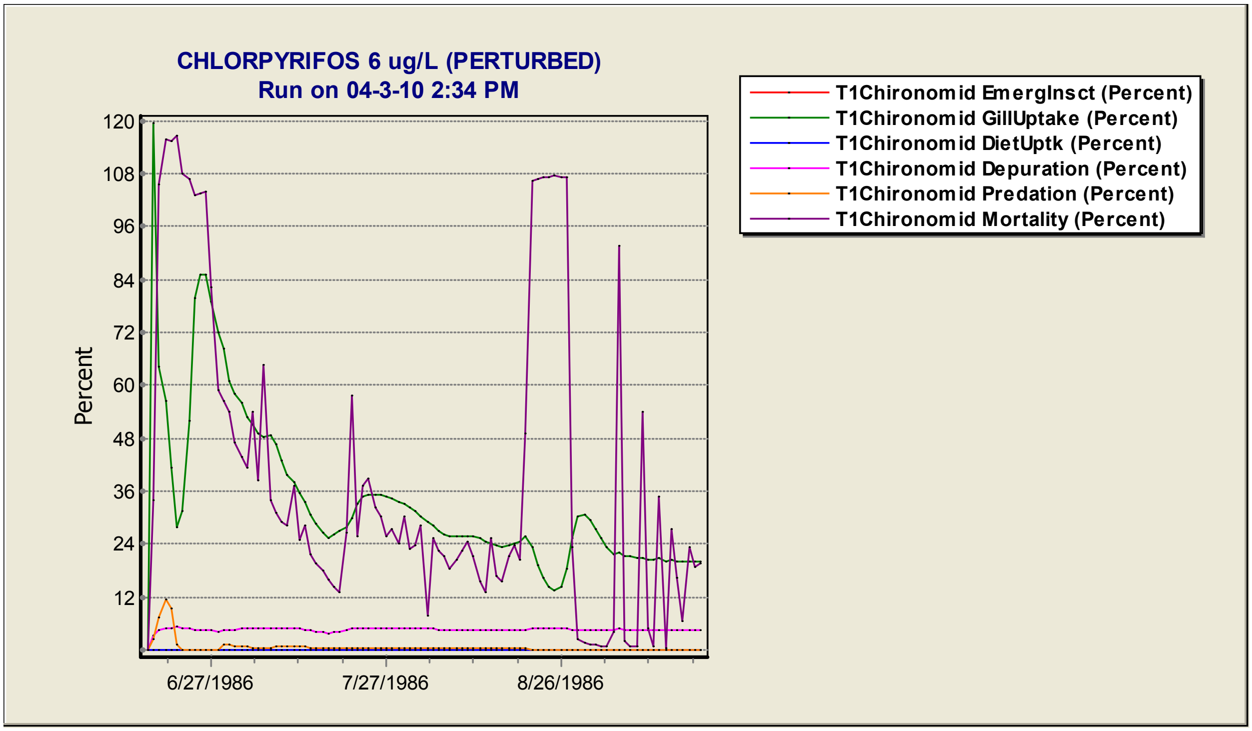

Figure A-7. Predicted processes affecting transfer of chlorpyrifos in chironomids with log *Kow* = 5.75.

Appendix B. Additional Select Tornado Diagrams for Each Simulation

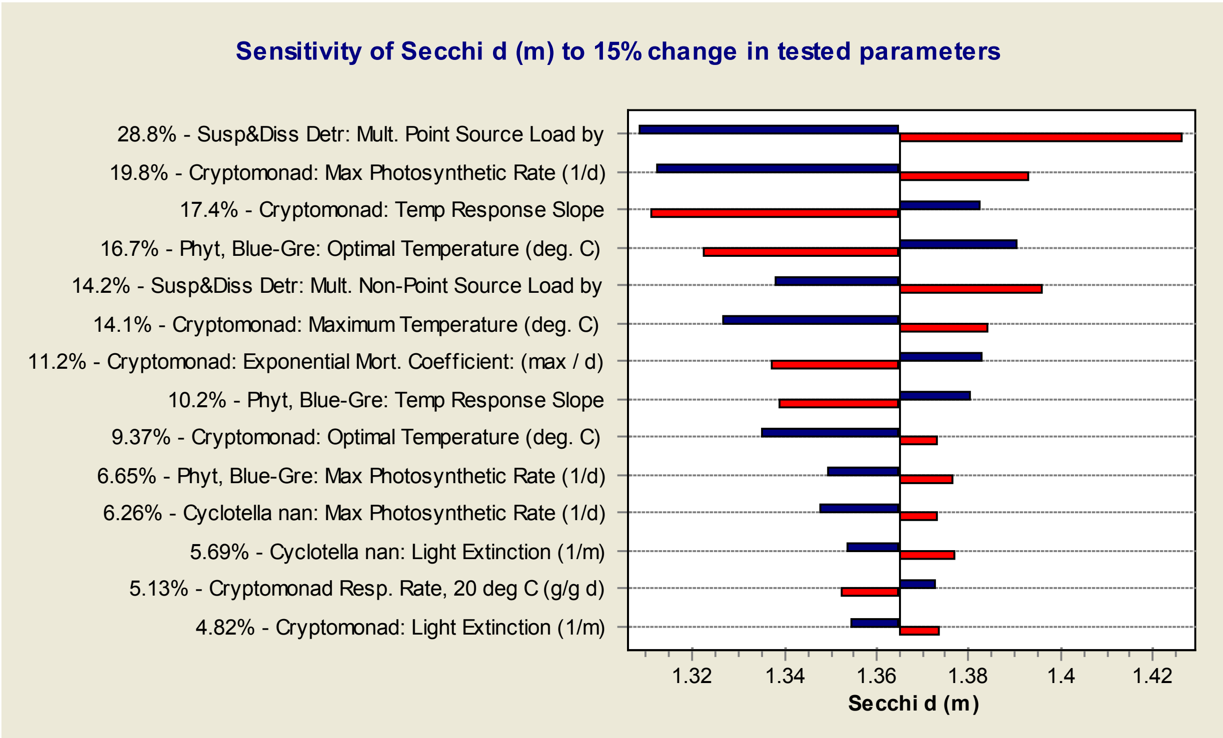

Figure B-1: Onondaga Lake, Turbidity Results (Secchi depth), 15% parameter test.

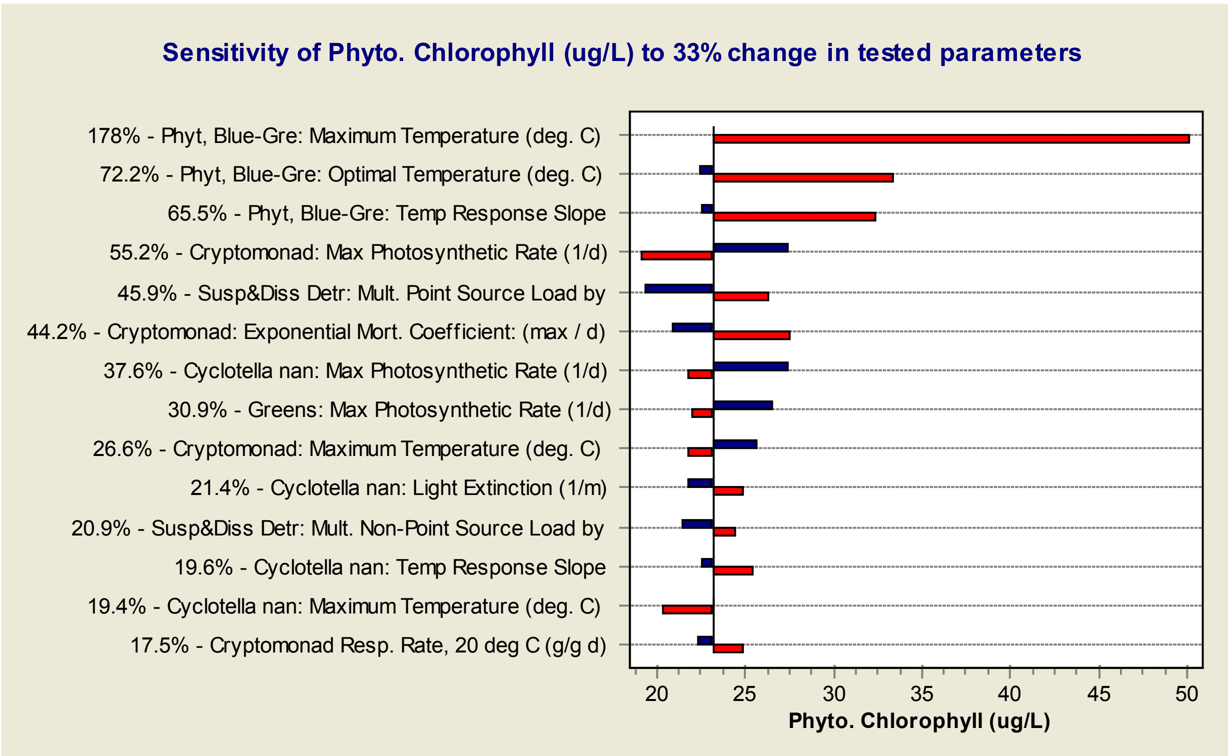

Figure B-2: Onondaga Lake, Chlorophyll a Results, 33% parameter test.

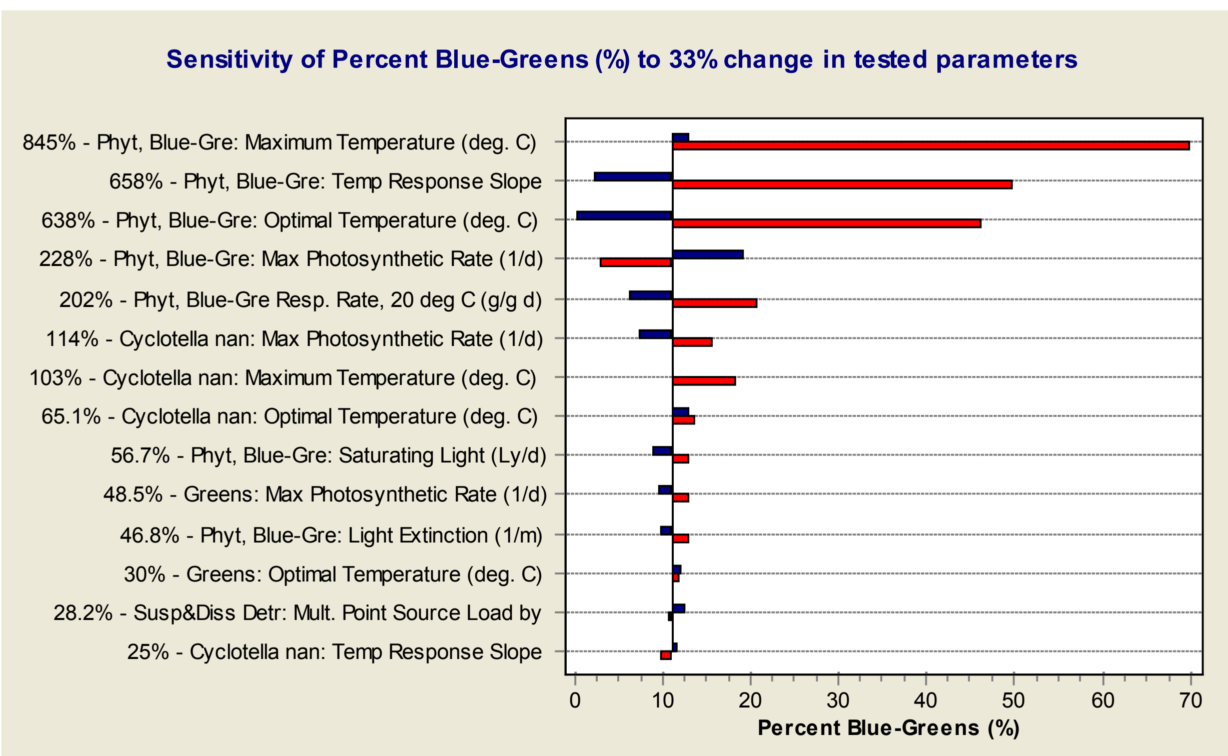

Figure B-3: Onondaga Lake, Percent Blue-Greens Results, 33% parameter test

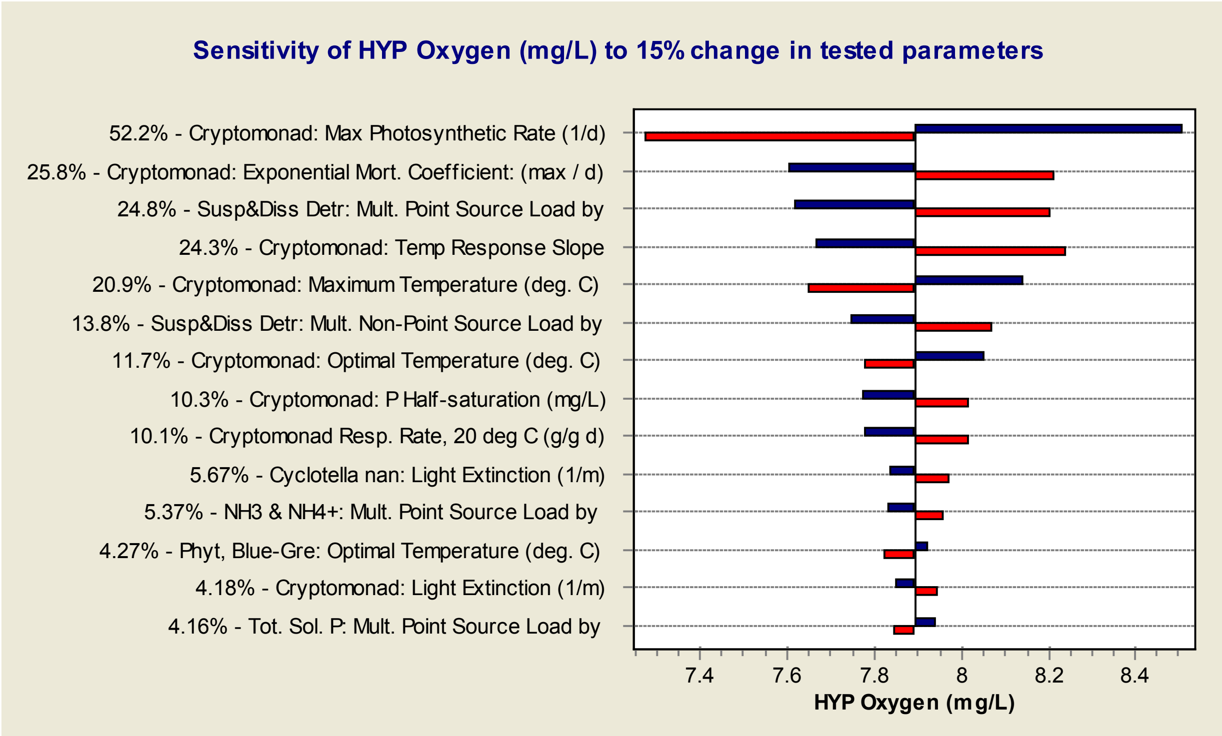

Figure B-4: Onondaga Lake, Hypolimnion Oxygen Results, 15% parameter test.

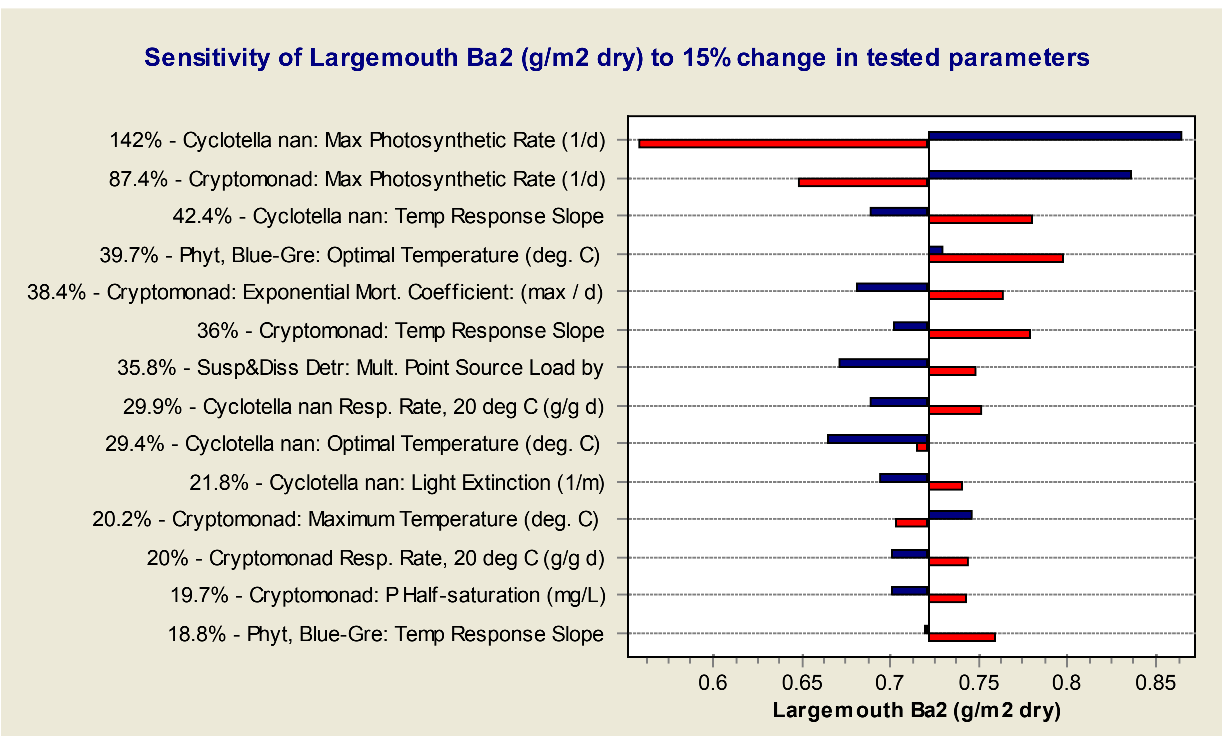

Figure B-5: Onondaga Lake, Largemouth Bass (Adult) Concentrations.

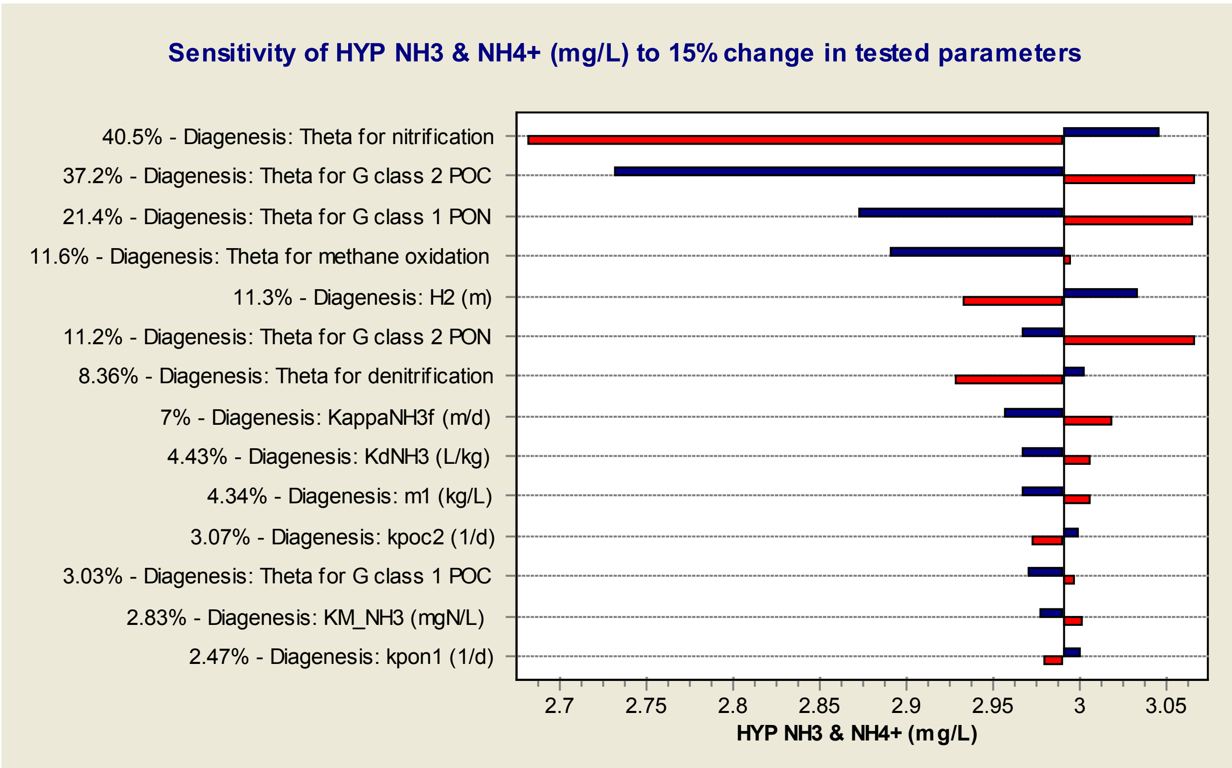

Figure B-6: Onondaga Lake Diagenesis, Ammonia in the Hypolimnion.

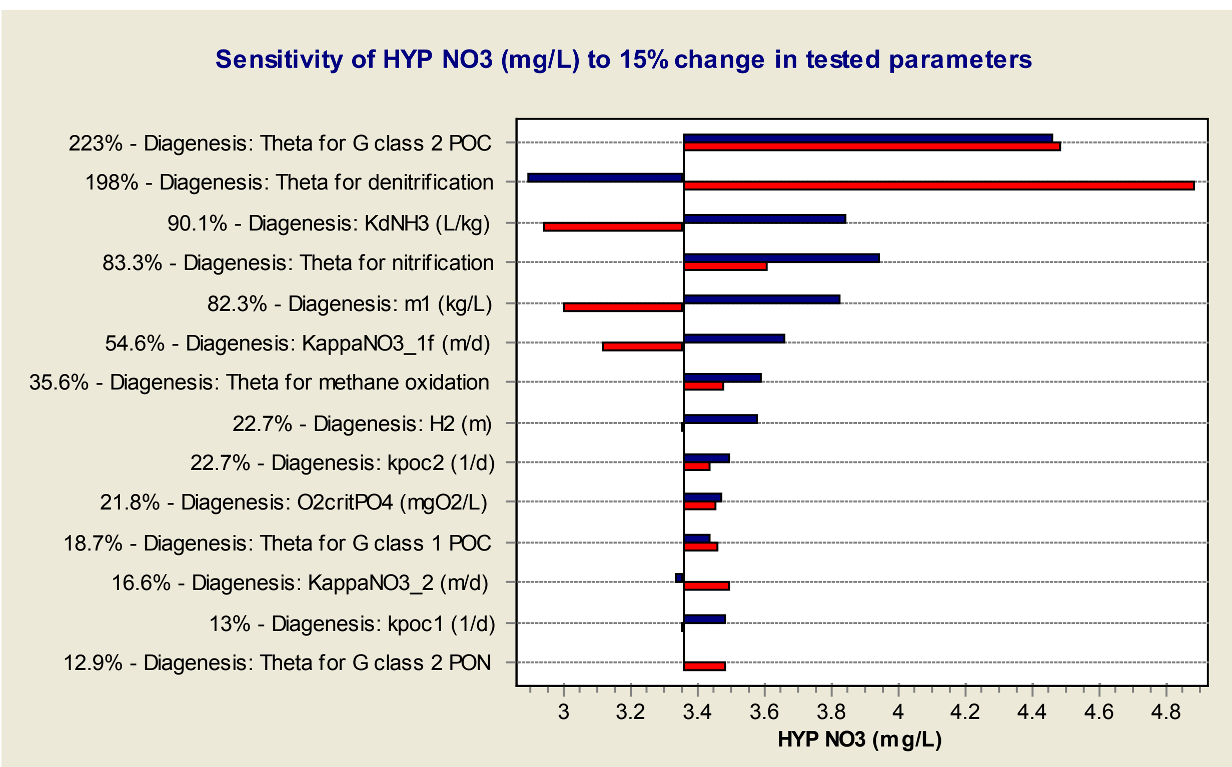

Figure B-7: Onondaga Lake Diagenesis, Nitrate in the Hypolimnion.

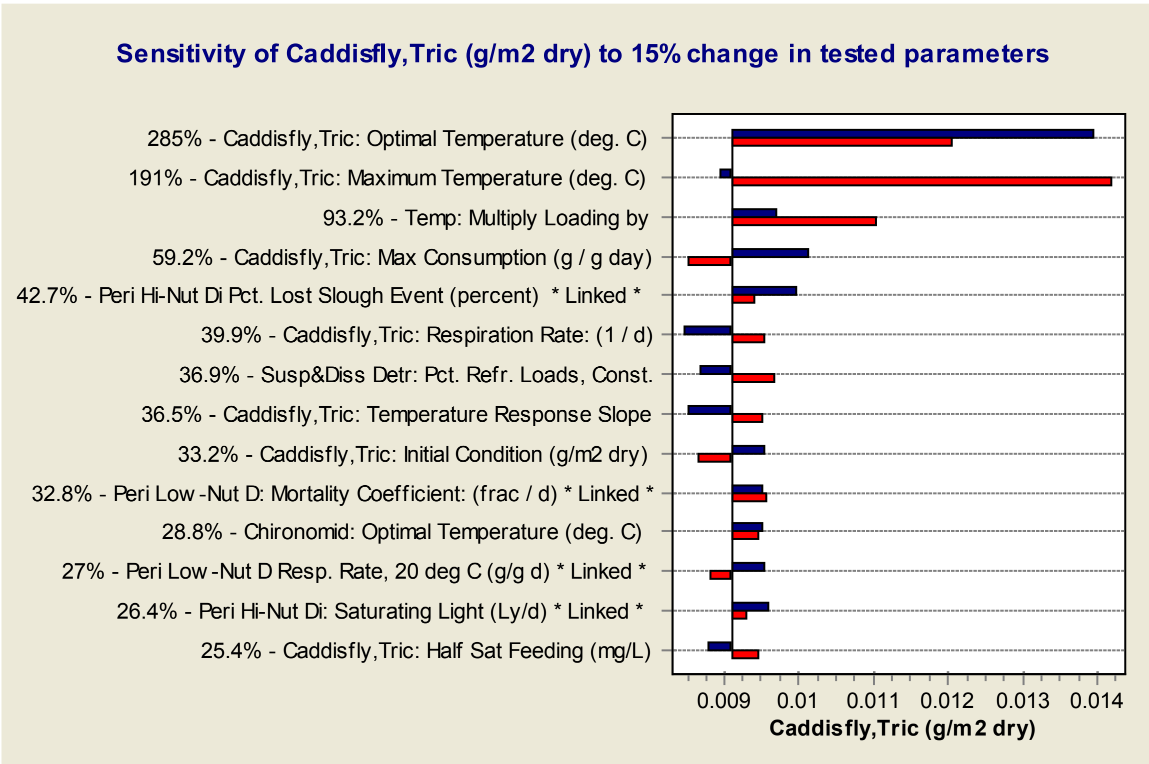

Figure B-8: Cahaba River, Caddisfly.

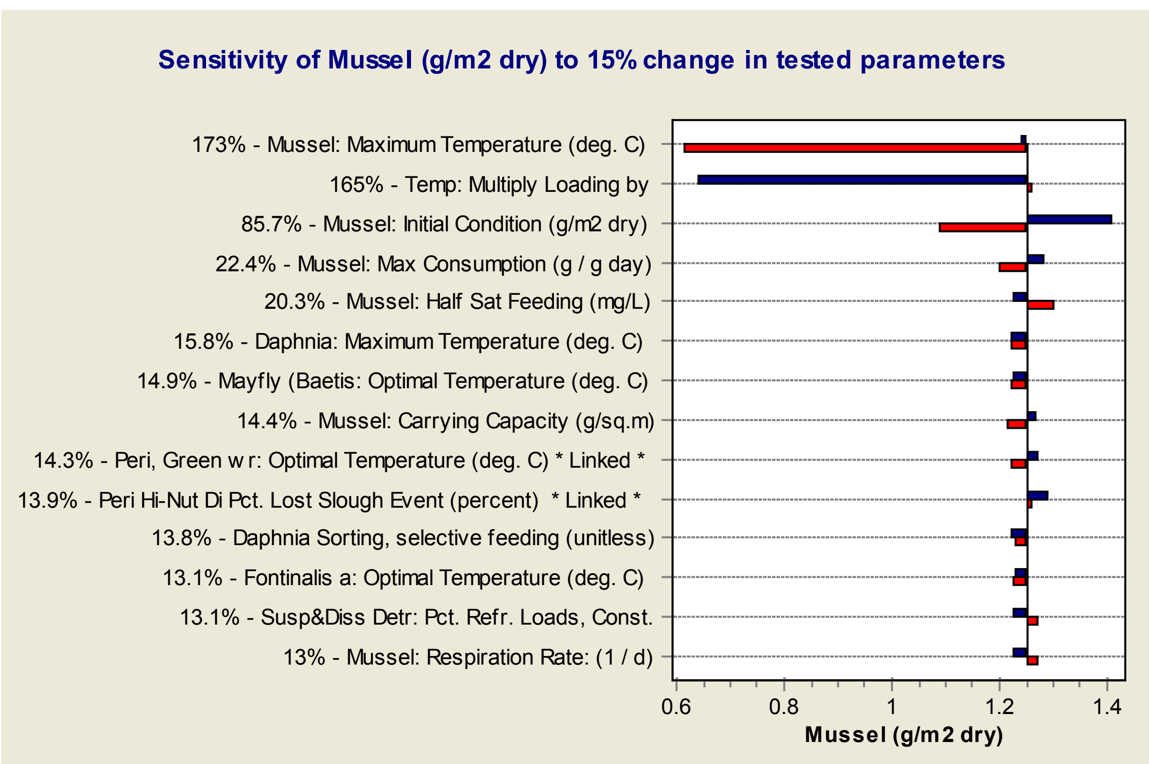

Figure B-9: Cahaba River, Mussel.

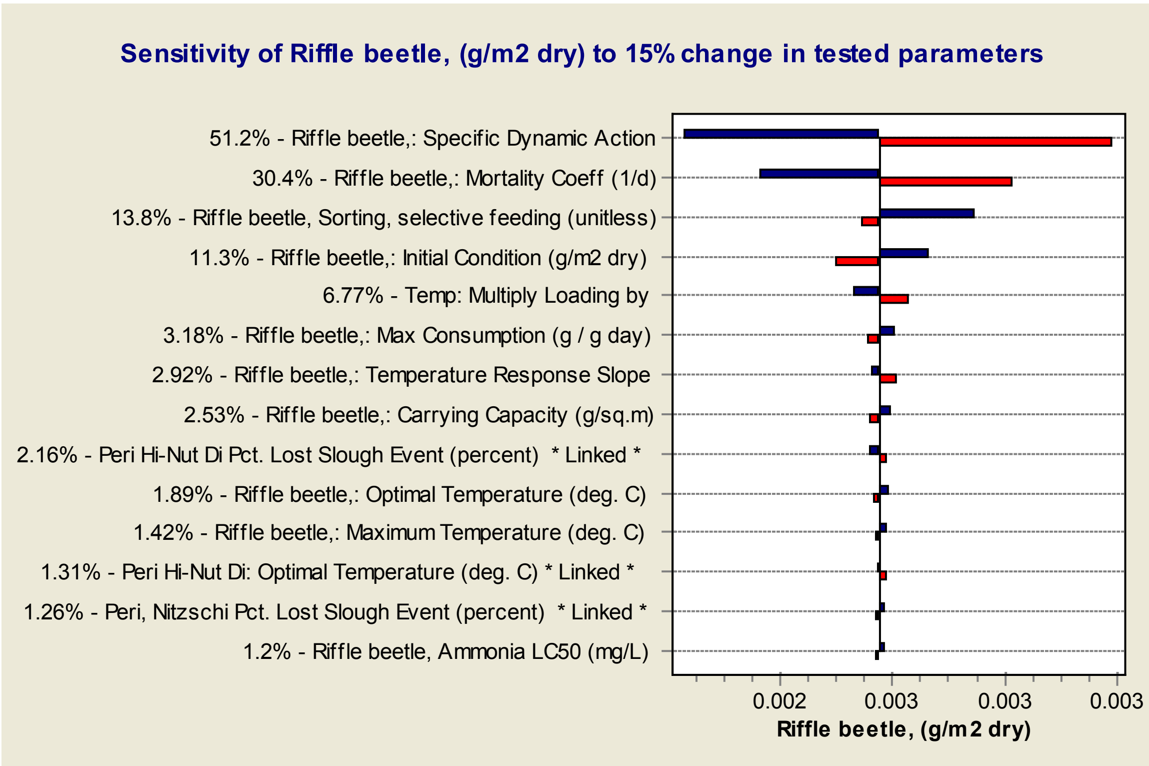

Figure B-10: Cahaba River, Riffle Beetle.

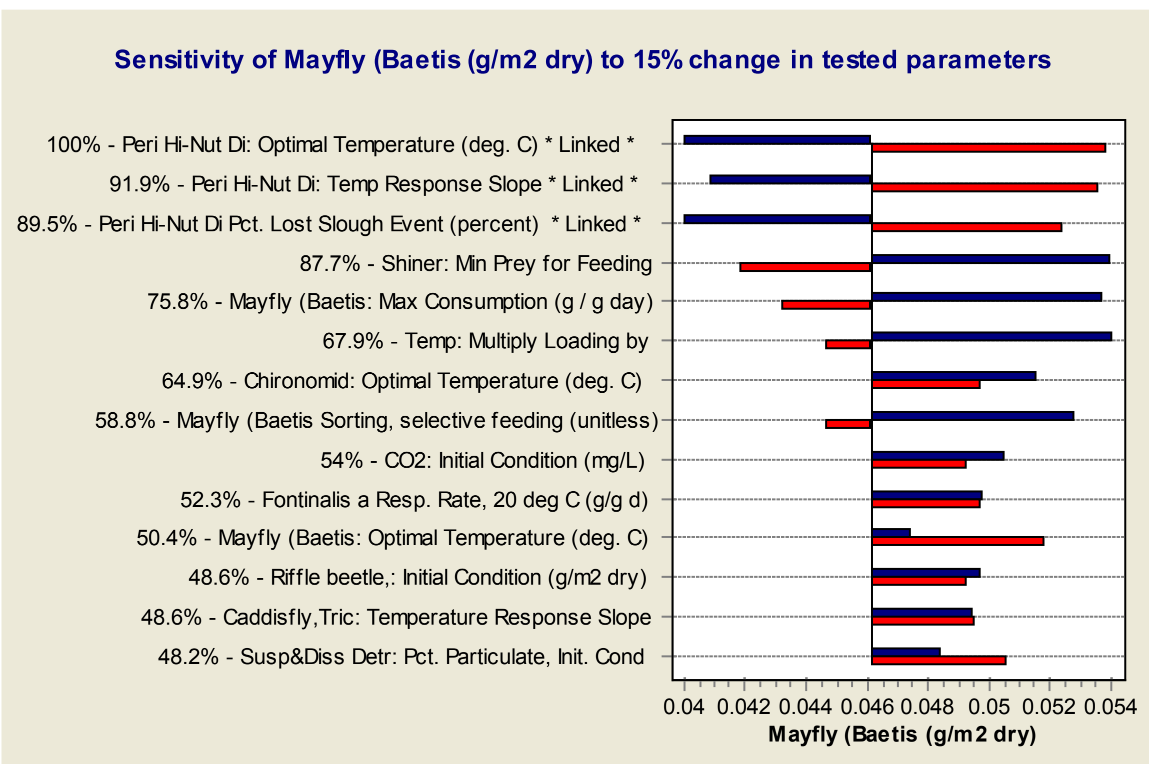

Figure B-11: Cahaba River, Mayfly.

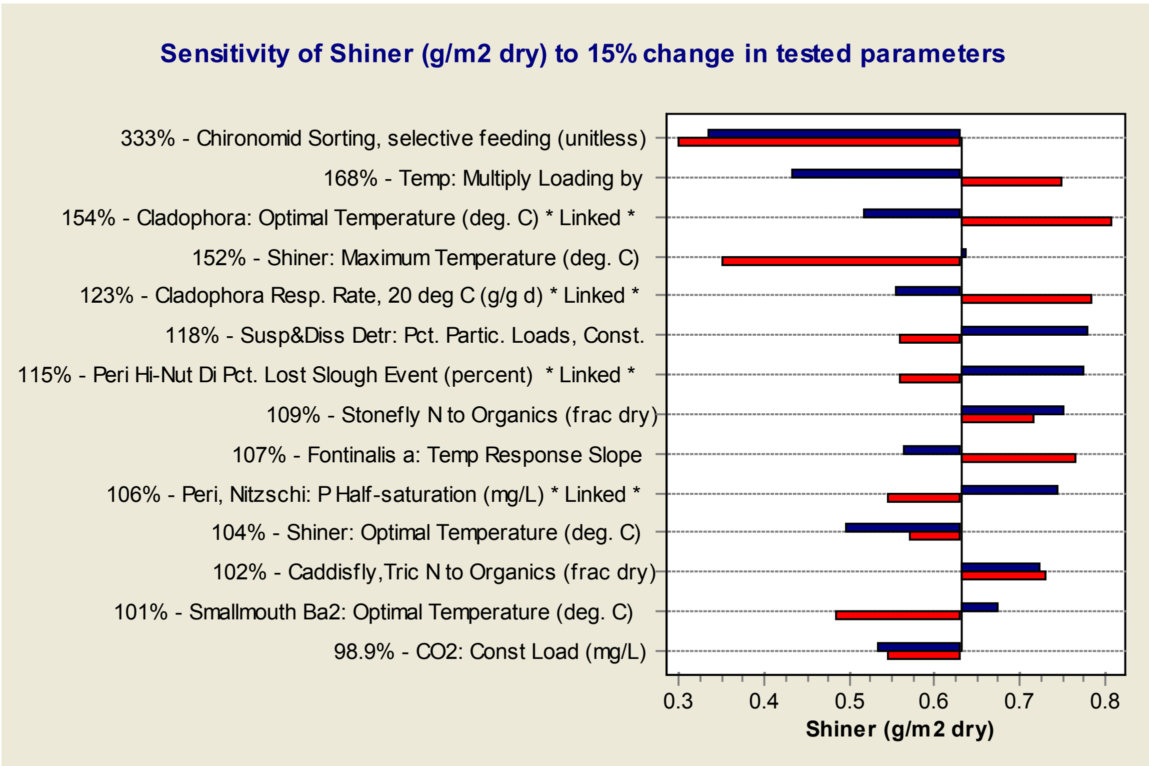

Figure B-12: Cahaba River, Shiner.

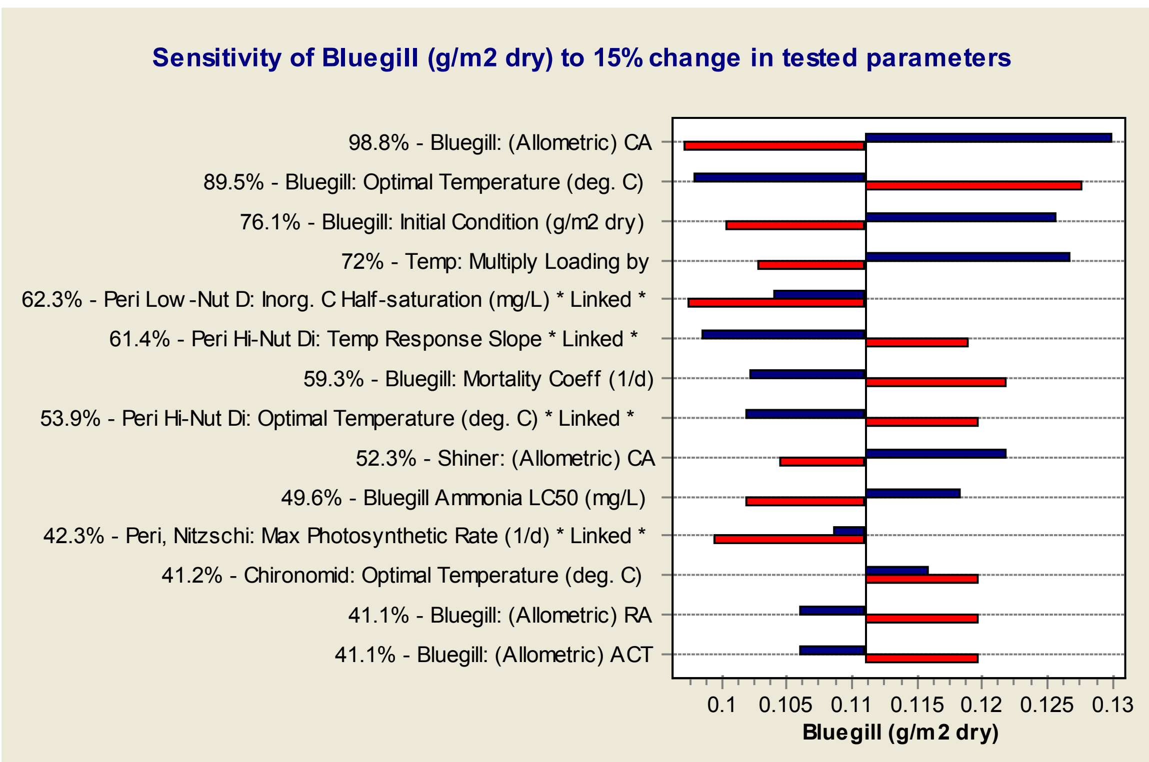

Figure B-13: Cahaba River, Bluegill.

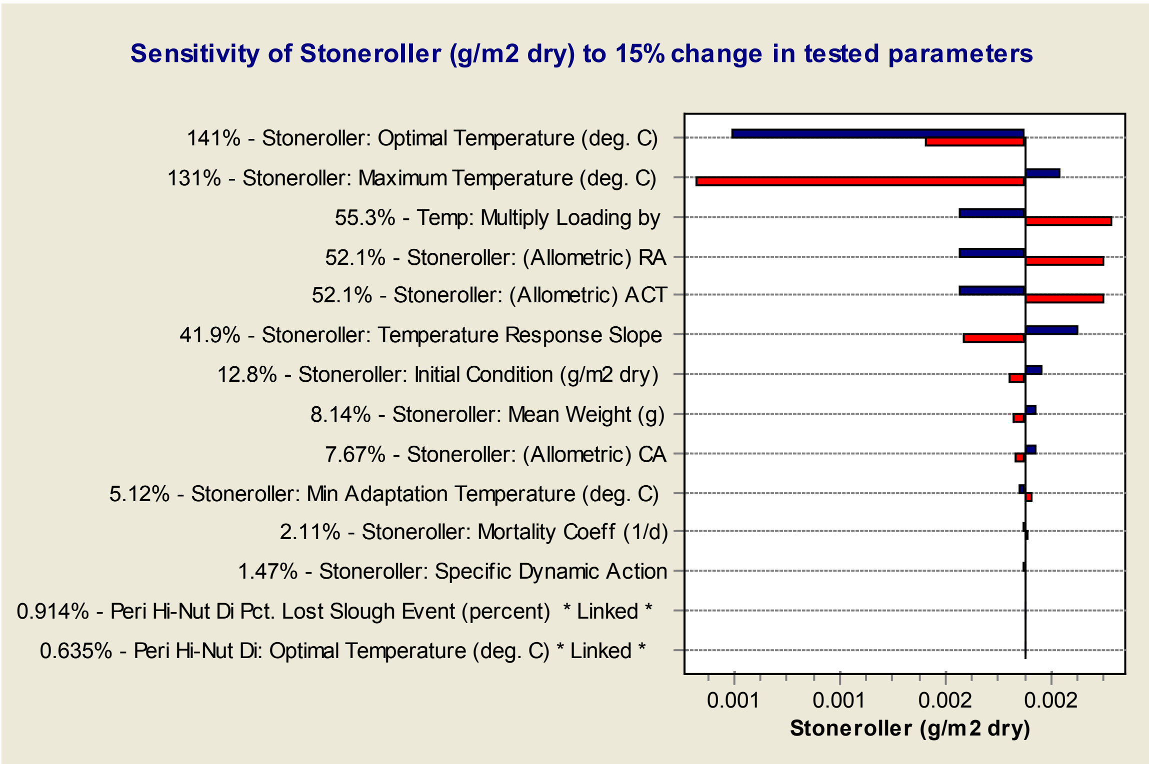

Figure B-14: Cahaba River, Stoneroller.

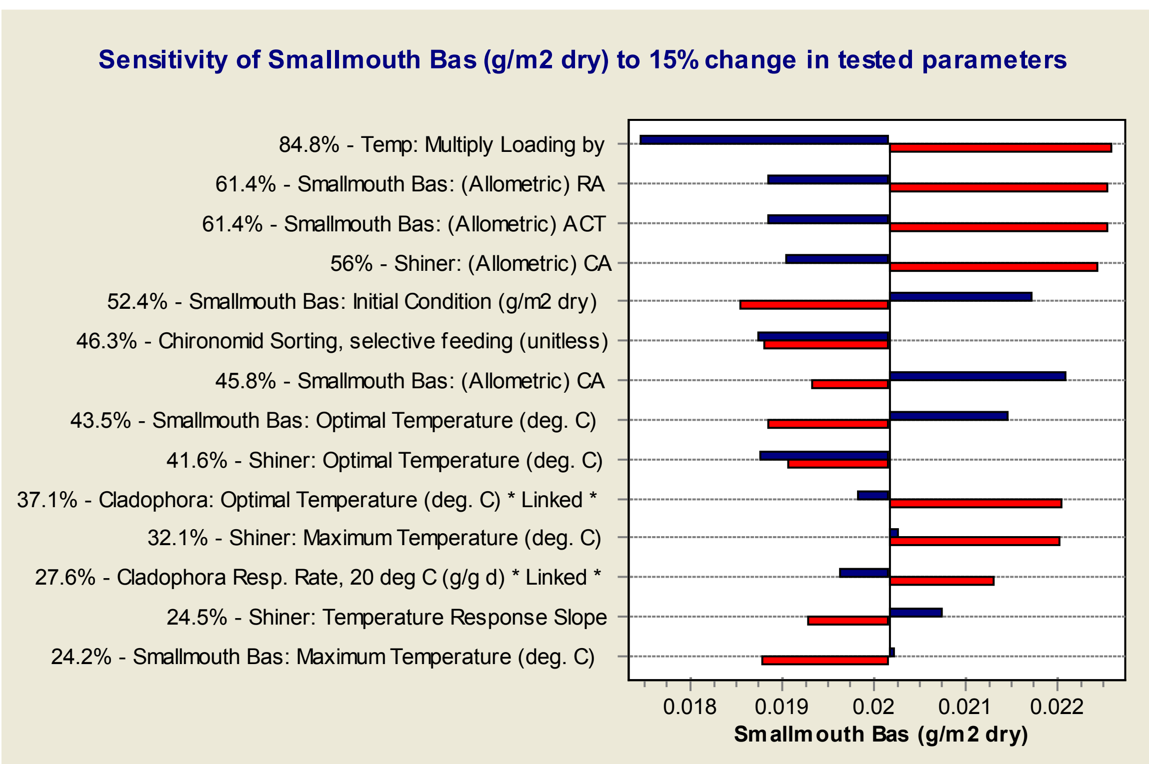

Figure B-15: Cahaba River, Smallmouth Bass, YOY.

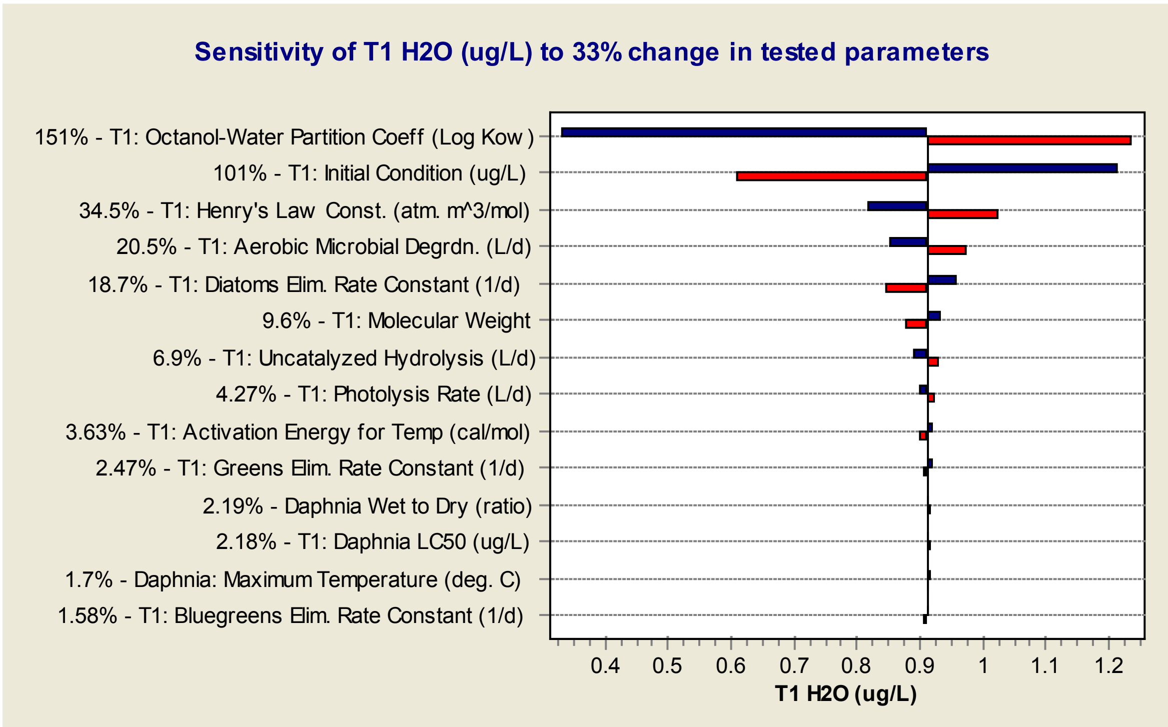

Figure B-16: Duluth Pond, Chlorpyrifos in Water, 33% parameter test.

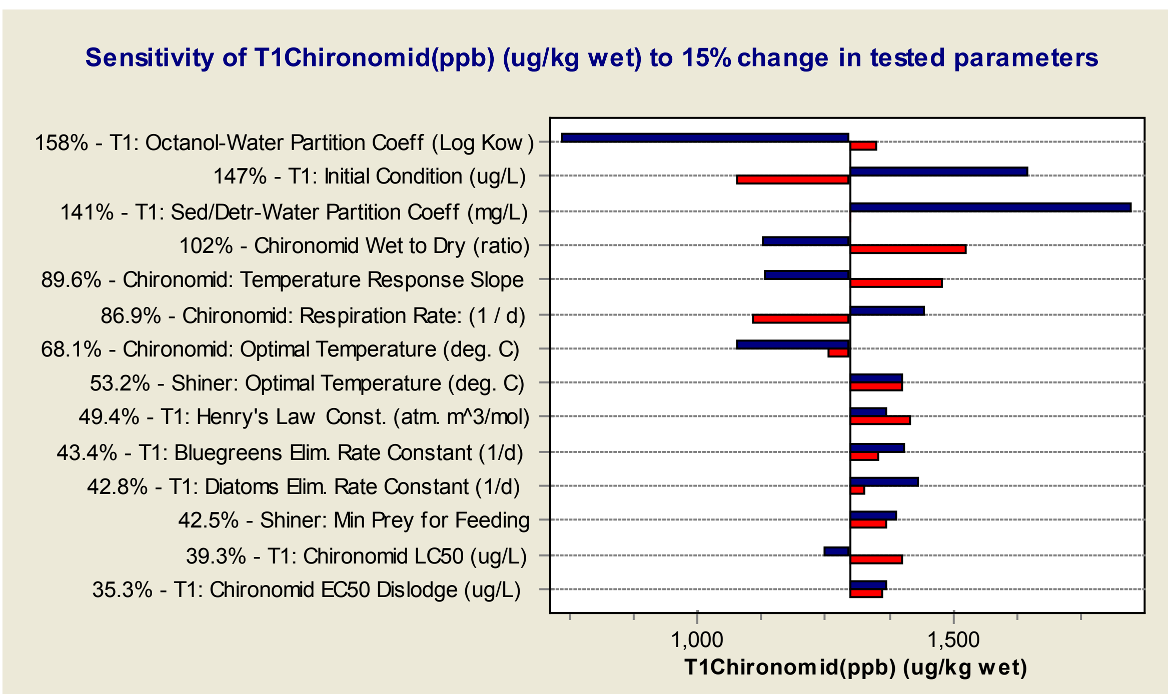

Figure B-17: Duluth Pond, Chlorpyrifos concentration in chironomid.

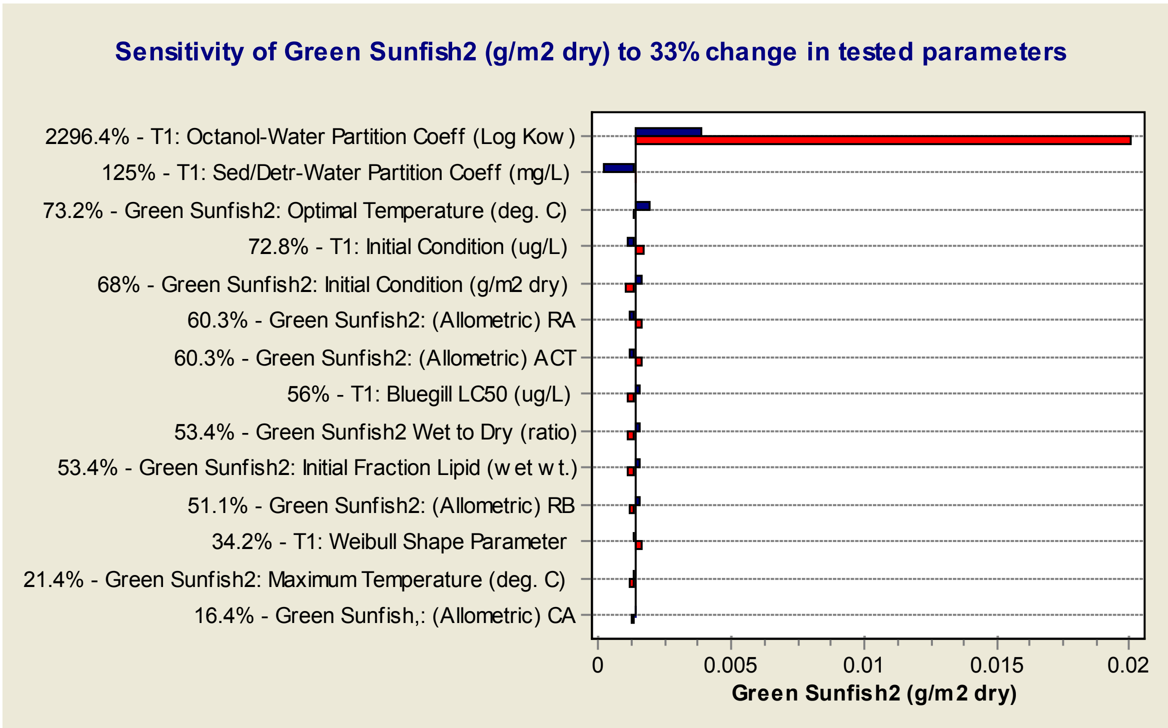

Figure B-18: Duluth Pond, Sunfish, 33% parameter test.

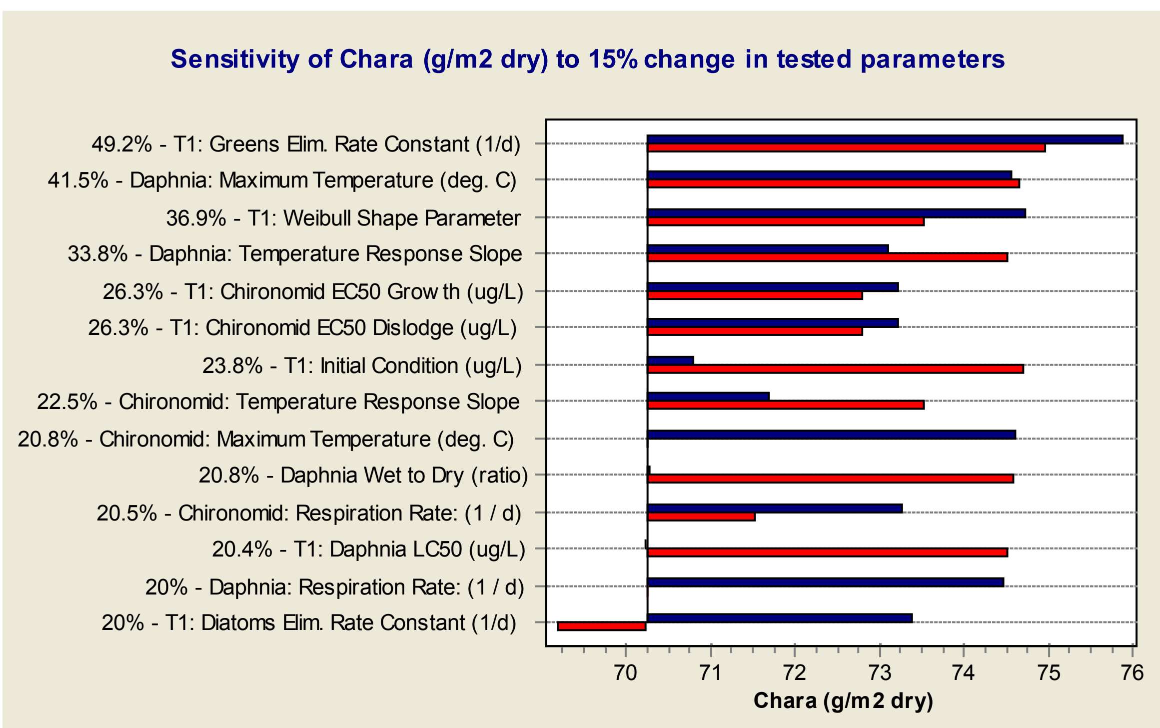

Figure B-19: Duluth Pond, Chara, 15% parameter test.

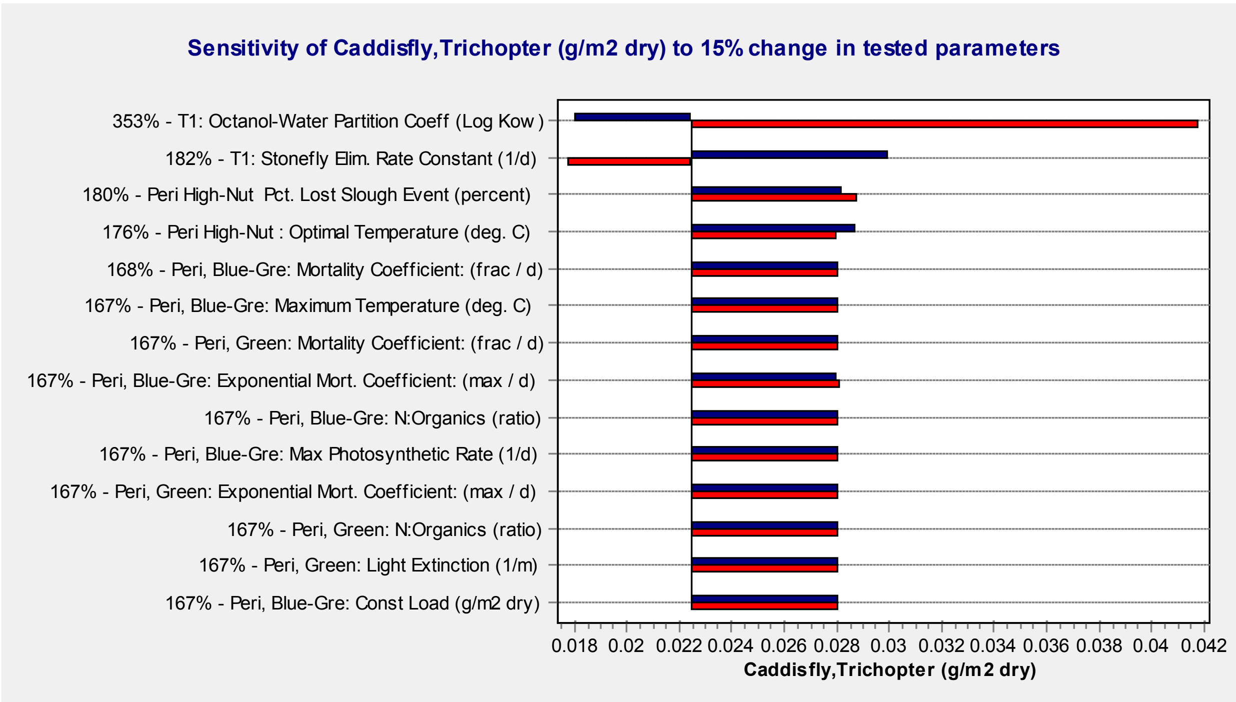

Figure B-20: Ohio Stream Chlorpyrifos, Caddisfly Biomass.

The two most sensitive parameters relate to toxicity and this can have effects that ripple throughout the food web.

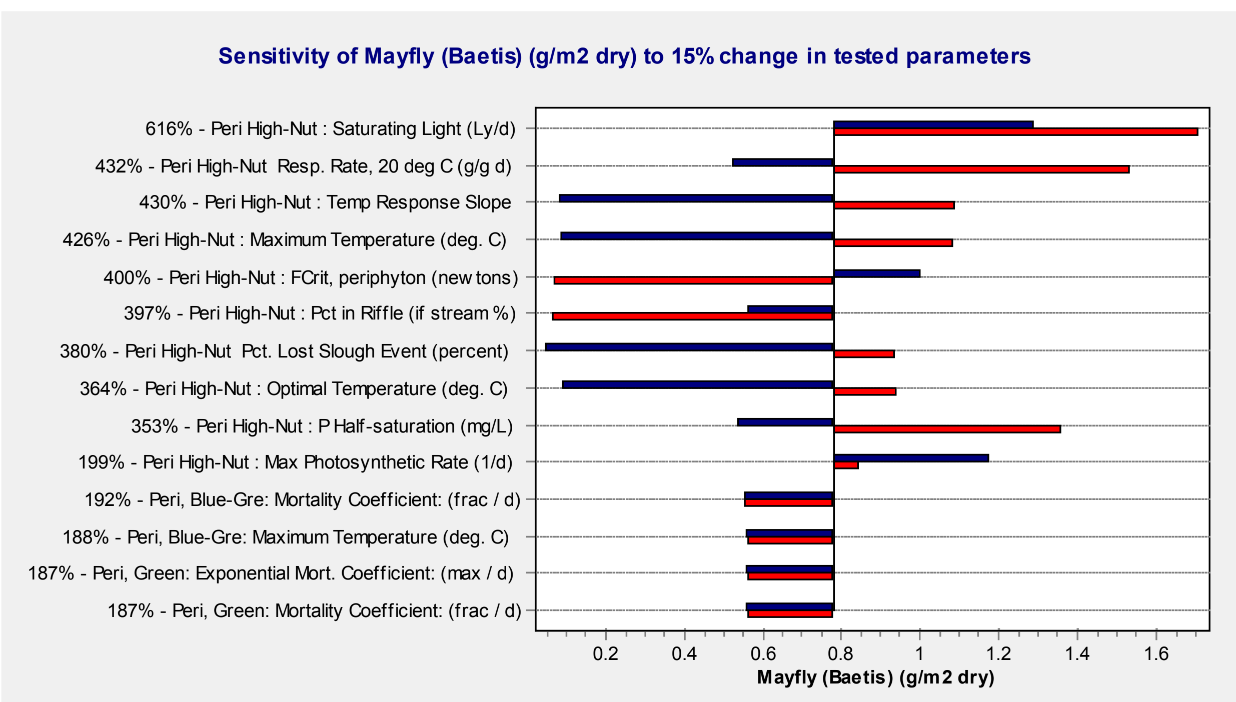

Figure B-21: Ohio Stream Chlorpyrifos, Mayfly Biomass.

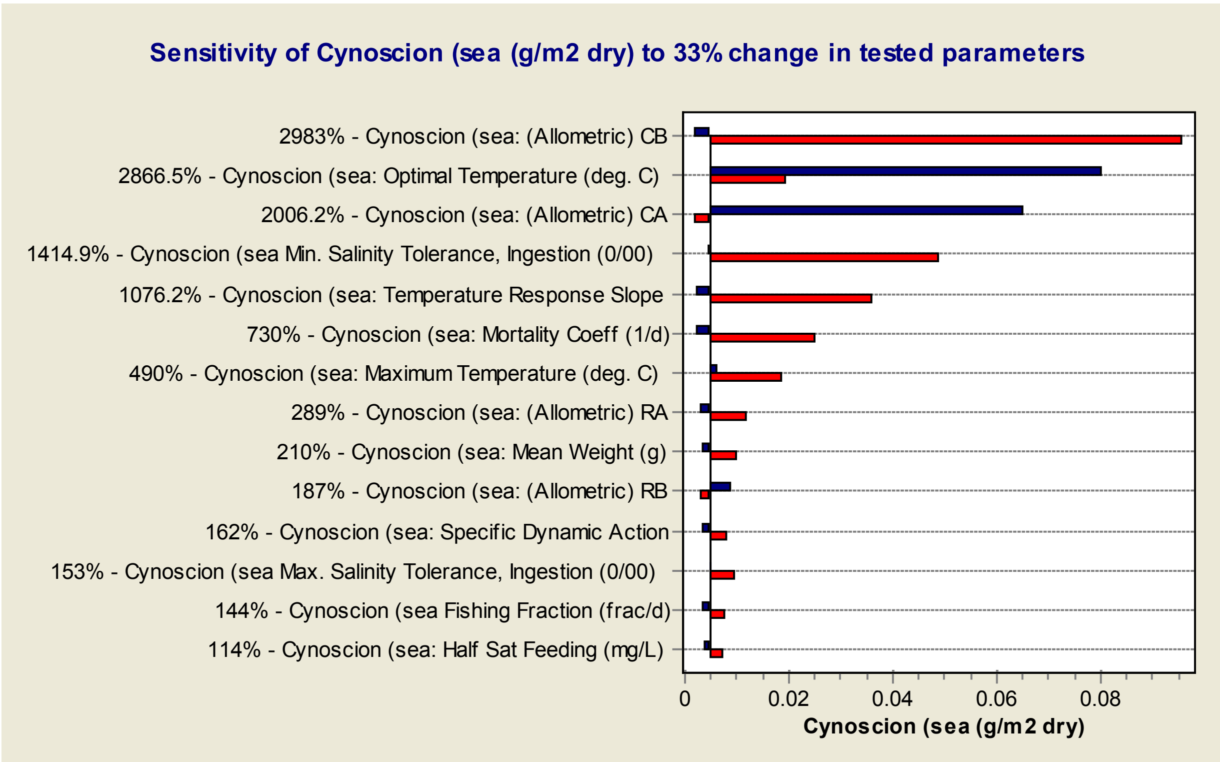

Figure B-22: Galveston Bay, TX, Sea Bass Biomass, 33% parameter test.

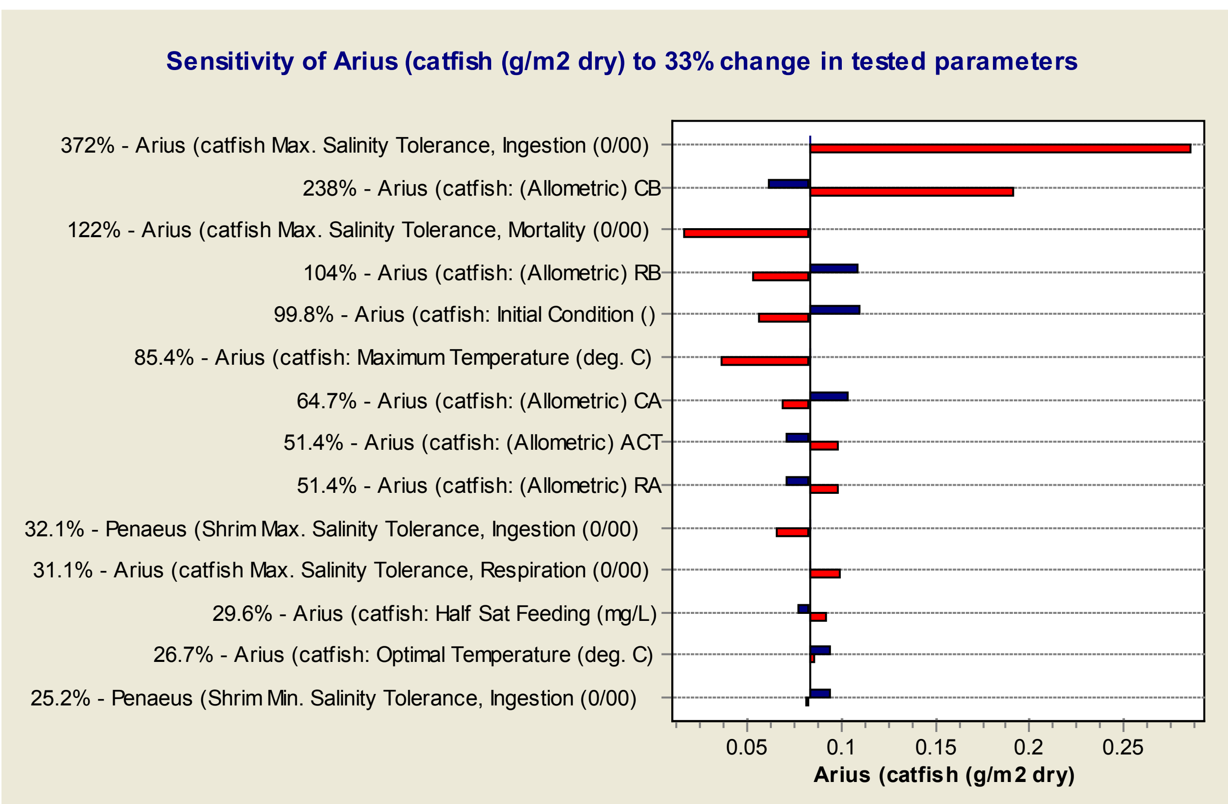

Figure B-23: Galveston Bay, TX, Catfish Biomass, 33% parameter test.

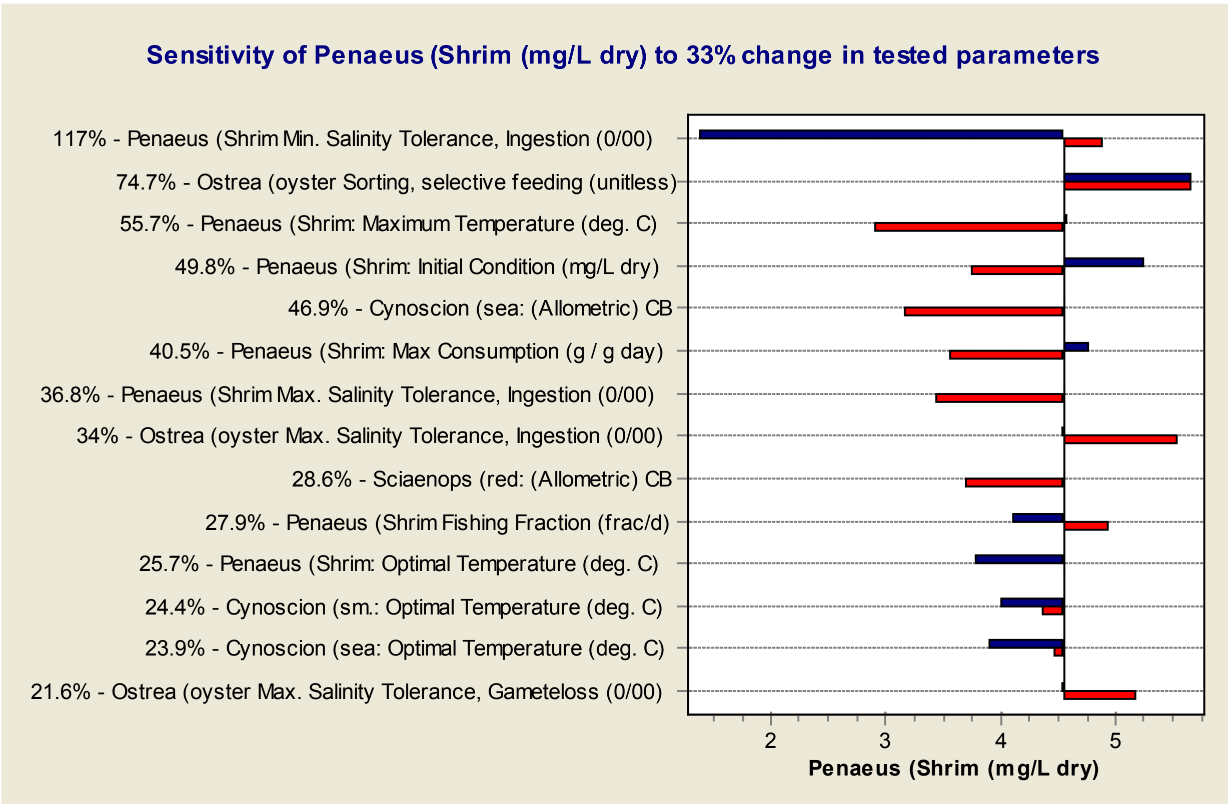

Figure B-24: Galveston Bay, TX, Shrimp Biomass, 33% parameter test.

Appendix C. Comprehensive List of Variables Tested for Each Nominal-range Sensitivity Analysis

Lake Onondaga, NY:

Cyclotella nana: Saturating Light (Ly/d)	Cryptomonad: Maximum Temperature (deg. C)
Greens: Saturating Light (Ly/d)	*Cyclotella nana*: Min Adaptation Temperature (deg. C)
Phyt, Blue-Gre: Saturating Light (Ly/d)	Greens: Min Adaptation Temperature (deg. C)
Cryptomonad: Saturating Light (Ly/d)	Phyt, Blue-Gre: Min Adaptation Temperature (deg. C)
Cyclotella nana: P Half-saturation (mg/L)	Cryptomonad: Min Adaptation Temperature (deg. C)
Greens: P Half-saturation (mg/L)	*Cyclotella nana*: Max Photosynthetic Rate (1/d)
Phyt, Blue-Gre: P Half-saturation (mg/L)	Greens: Max Photosynthetic Rate (1/d)
Cryptomonad: P Half-saturation (mg/L)	Phyt, Blue-Gre: Max Photosynthetic Rate (1/d)
Cyclotella nana: N Half-saturation (mg/L)	Cryptomonad: Max Photosynthetic Rate (1/d)
Greens: N Half-saturation (mg/L)	*Cyclotella nana*: Photorespiration Coefficient (1/d)
Phyt, Blue-Gre: N Half-saturation (mg/L)	Greens: Photorespiration Coefficient (1/d)
Cryptomonad: N Half-saturation (mg/L)	Phyt, Blue-Gre: Photorespiration Coefficient (1/d)
Cyclotella nana: Inorg. C Half-saturation (mg/L)	Cryptomonad: Photorespiration Coefficient (1/d)
Greens: Inorg. C Half-saturation (mg/L)	*Cyclotella nana*: Mortality Coefficient: (frac / d)
Phyt, Blue-Gre: Inorg. C Half-saturation (mg/L)	Greens: Mortality Coefficient: (frac / d)
Cryptomonad: Inorg. C Half-saturation (mg/L)	Phyt, Blue-Gre: Mortality Coefficient: (frac / d)
Cyclotella nana: Temp Response Slope	Cryptomonad: Mortality Coefficient: (frac / d)
Greens: Temp Response Slope	*Cyclotella nana*: Exponential Mort. Coeffi: (max / d)
Phyt, Blue-Gre: Temp Response Slope	Greens: Exponential Mort. Coefficient: (max / d)
Cryptomonad: Temp Response Slope	Phyt, Blue-Gre: Exponential Mort. Coeff.: (max / d)
Cyclotella nana: Optimal Temperature (deg. C)	Cryptomonad: Exponential Mort. Coefficient: (max / d)
Greens: Optimal Temperature (deg. C)	*Cyclotella nana*: P:Organics (ratio)
Phyt, Blue-Gre: Optimal Temperature (deg. C)	Greens: P:Organics (ratio)
Cryptomonad: Optimal Temperature (deg. C)	Phyt, Blue-Gre: P:Organics (ratio)
Cyclotella nana: Maximum Temperature (deg. C)	Cryptomonad: P:Organics (ratio)
Greens: Maximum Temperature (deg. C)	*Cyclotella nana*: N:Organics (ratio)
Phyt, Blue-Gre: Maximum Temperature (deg. C)	Greens: N:Organics (ratio)
Phyt, Blue-Gre: N:Organics (ratio)	*Cyclotella nana*: Initial Condition (mg/L dry)
Cryptomonad: N:Organics (ratio)	Greens: Initial Condition (mg/L dry)
Cyclotella nana: Light Extinction (1/m)	Phyt, Blue-Gre: Initial Condition (mg/L dry)
Greens: Light Extinction (1/m)	Cryptomonad: Initial Condition (mg/L dry)
Phyt, Blue-Gre: Light Extinction (1/m)	NH3 & NH4+: Const Load (mg/L)
Cryptomonad: Light Extinction (1/m)	NO3: Const Load (mg/L)
Cyclotella nana: Sedimentation Rate (1/d)	Tot. Sol. P: Const Load (mg/L)
Greens: Sedimentation Rate (1/d)	TSS: Const Load (mg/L)
Phyt, Blue-Gre: Sedimentation Rate (1/d)	*Cyclotella nana*: Const Load (mg/L dry)
Cryptomonad: Sedimentation Rate (1/d)	Greens: Const Load (mg/L dry)
Cyclotella nana: Exp Sedimentation Coeff	Phyt, Blue-Gre: Const Load (mg/L dry)
Greens: Exp Sedimentation Coeff	Cryptomonad: Const Load (mg/L dry)
Phyt, Blue-Gre: Exp Sedimentation Coeff	NH3 & NH4+: Multiply Loading by
Cryptomonad: Exp Sedimentation Coeff	NO3: Multiply Loading by
Cyclotella nana: Pct in Riffle (if stream %)	Tot. Sol. P: Multiply Loading by
Greens: Pct in Riffle (if stream %)	TSS: Multiply Loading by

Lake Onondaga, NY: Continued

Phyt, Blue-Gre: Pct in Riffle (if stream %)	Susp&Diss Detr: Pct. Refr. Loads, Const.
Cryptomonad: Pct in Riffle (if stream %)	Susp&Diss Detr: Pct. Particulate, Init. Cond
Cyclotella nana: Pct in Pool (if stream %)	Susp&Diss Detr: Pct. Refractory, Init. Cond
Greens: Pct in Pool (if stream %)	Susp&Diss Detr: Multiply Loading by
Phyt, Blue-Gre: Pct in Pool (if stream %)	*Cyclotella nana*: Multiply Loading by
Cryptomonad: Pct in Pool (if stream %)	Greens: Multiply Loading by
NH3 & NH4+: Initial Condition (mg/L)	Phyt, Blue-Gre: Multiply Loading by
NO3: Initial Condition (mg/L)	Cryptomonad: Multiply Loading by
Tot. Sol. P: Initial Condition (mg/L)	NH3 & NH4+: Mult. Direct Precip. Load by
TSS: Initial Condition (mg/L)	NO3: Mult. Direct Precip. Load by
Susp&Diss Detr: Initial Condition (mg/L dry)	Tot. Sol. P: Mult. Direct Precip. Load by
Susp&Diss Detr: Mult. Point Source Load by	NH3 & NH4+: Mult. Point Source Load by
NH3 & NH4+: Mult. Non-Point Source Load by	NO3: Mult. Point Source Load by
NO3: Mult. Non-Point Source Load by	Tot. Sol. P: Mult. Point Source Load by
Tot. Sol. P: Mult. Non-Point Source Load by	Phyt, Blue-Gre Salinity Coeff2, Photo. (unitless)
Susp&Diss Detr: Mult. Non-Point Source Load by	Cryptomonad Salinity Coeff2, Photo. (unitless)
Cyclotella nana KSed Temp. (Estuary Only, deg C.)	*Cyclotella nana* Min. Salinity Tolerance, Mortality (0/00)
Greens KSed Temp. (Estuary Only, deg C.)	Greens Min. Salinity Tolerance, Mortality (0/00)
Phyt, Blue-Gre KSed Temp. (Estuary Only, deg C.)	Phyt, Blue-Gre Min. Salinity Tolerance, Mortality (0/00)
Cryptomonad KSed Temp. (Estuary Only, deg C.)	Cryptomonad Min. Salinity Tolerance, Mortality (0/00)
Cyclotella nana KSed Salinity (Estuary Only, o/oo)	*Cyclotella nana* Max. Salinity Tolerance, Mort. (0/00)
Greens KSed Salinity (Estuary Only, o/oo)	Greens Max. Salinity Tolerance, Mortality (0/00)
Phyt, Blue-Gre KSed Salinity (Estuary Only, o/oo)	Phyt, Blue-Gre Max. Salinity Tolerance, Mort. (0/00)
Cryptomonad KSed Salinity (Estuary Only, o/oo)	Cryptomonad Max. Salinity Tolerance, Mortality (0/00)
Cyclotella nana Min. Salinity Tolerance, Photo. (0/00)	*Cyclotella nana* Salinity Coeff1, Mortality (unitless)
Greens Min. Salinity Tolerance, Photo. (0/00)	Greens Salinity Coeff1, Mortality (unitless)
Phyt, Blue-Gre Min. Salinity Tolerance, Photo. (0/00)	Phyt, Blue-Gre Salinity Coeff1, Mortality (unitless)
Cryptomonad Min. Salinity Tolerance, Photo. (0/00)	Cryptomonad Salinity Coeff1, Mortality (unitless)
Cyclotella nana Max. Salinity Tolerance, Photo. (0/00)	*Cyclotella nana* Salinity Coeff2, Mortality (unitless)
Greens Max. Salinity Tolerance, Photo. (0/00)	Greens Salinity Coeff2, Mortality (unitless)
Phyt, Blue-Gre Max. Salinity Tolerance, Photo. (0/00)	Phyt, Blue-Gre Salinity Coeff2, Mortality (unitless)
Cryptomonad Max. Salinity Tolerance, Photo. (0/00)	Cryptomonad Salinity Coeff2, Mortality (unitless)
Cyclotella nana Salinity Coeff1, Photo. (unitless)	*Cyclotella nana* Wet to Dry (ratio)
Greens Salinity Coeff1, Photo. (unitless)	Greens Wet to Dry (ratio)
Phyt, Blue-Gre Salinity Coeff1, Photo. (unitless)	Phyt, Blue-Gre Wet to Dry (ratio)
Cryptomonad Salinity Coeff1, Photo. (unitless)	Cryptomonad Wet to Dry (ratio)
Cyclotella nana Salinity Coeff2, Photo. (unitless)	*Cyclotella nana* Resp. Rate, 20 deg C (g/g d)
Greens Salinity Coeff2, Photo. (unitless)	Greens Resp. Rate, 20 deg C (g/g d)
Greens Max. Sat. Light (Ly/d)	Phyt, Blue-Gre Resp. Rate, 20 deg C (g/g d)
Phyt, Blue-Gre Max. Sat. Light (Ly/d)	Cryptomonad Resp. Rate, 20 deg C (g/g d)
Cryptomonad Max. Sat. Light (Ly/d)	*Cyclotella nana* Max. Sat. Light (Ly/d)
Cyclotella nana Min. Sat. Light (Ly/d)	
Greens Min. Sat. Light (Ly/d)	
Phyt, Blue-Gre Min. Sat. Light (Ly/d)	
Cryptomonad Min. Sat. Light (Ly/d)	
Susp&Diss Detr: Pct. Partic. Loads, Const.	

Lake Onondaga NY, with Diagenesis:

m1 (kg/L)	KappaH2Sp1 (m/d)
m2 (kg/L)	Theta for sulfide oxidation
H1 (m)	KMHSO2 (mgO2/L)
Dd (m2/d)	KdH2S1 (L/kg)
w2 (m/d)	KdH2S2 (L/kg)
H2 (m)	kpon1 (1/d)
KappaNH3f (m/d)	kpon2 (1/d)
KappaNH3s (m/d)	kpon3 (1/d)
KappaNO3_1f (m/d)	kpoc1 (1/d)
KappaNO3_1s (m/d)	kpoc2 (1/d)
KappaNO3_2 (m/d)	kpoc3 (1/d)
KappaCH4 (m/d)	kpop1 (1/d)
KM_NH3 (mgN/L)	kpop2 (1/d)
KM_O2_NH3 (mgO2/L)	kpop3 (1/d)
KdNH3 (L/kg)	Theta for G class 1 PON
KdPO42 (L/kg)	Theta for G class 2 PON
dKDPO41f (unitless)	Theta for G class 3 PON
dKDPO41s (unitless)	Theta for G class 1 POC
O2critPO4 (mgO2/L)	Theta for G class 2 POC
Theta for nitrification	Theta for G class 3 POC
Theta for denitrification	Theta for G class 1 POP
Theta for methane oxidation	Theta for G class 2 POP
SALTSW (ppt)	Theta for G class 3 POP
SALTND (ppt)	kBEN_STR (1/day)
KappaH2Sd1 (m/d)	Ksi (1/day)

Cahaba River, AL: (Note, parameters listed as “Linked” were changed for periphyton and phytoplankton simultaneously)

Peri Low-Nut D: Saturating Light (Ly/d) * Linked *	Mussel: Initial Condition (g/m2 dry)
Peri Hi-Nut Di: Saturating Light (Ly/d) * Linked *	Riffle beetle,: Initial Condition (g/m2 dry)
Peri, Blue-Gre: Saturating Light (Ly/d) * Linked *	Mayfly (Baetis: Initial Condition (g/m2 dry)
Cladophora: Saturating Light (Ly/d) * Linked *	Gastropod: Initial Condition (g/m2 dry)
Fontinalis a: Saturating Light (Ly/d)	Copepod: Initial Condition (mg/L dry)
Peri Low-Nut D: P Half-saturation (mg/L) * Linked *	Stonefly: Initial Condition (g/m2 dry)
Peri Hi-Nut Di: P Half-saturation (mg/L) * Linked *	Shiner: Initial Condition (g/m2 dry)
Peri, Nitzschi: P Half-saturation (mg/L) * Linked *	Bluegill: Initial Condition (g/m2 dry)
Peri, Green wr: P Half-saturation (mg/L) * Linked *	Stoneroller: Initial Condition (g/m2 dry)
Peri, Blue-Gre: P Half-saturation (mg/L) * Linked *	Smallmouth Bas: Initial Condition (g/m2 dry)
Cladophora: P Half-saturation (mg/L) * Linked *	Smallmouth Ba2: Initial Condition (g/m2 dry)
Fontinalis a: P Half-saturation (mg/L)	NH3 & NH4+: Const Load (mg/L)
Peri Low-Nut D: N Half-saturation (mg/L) * Linked *	NO3: Const Load (mg/L)
Peri Hi-Nut Di: N Half-saturation (mg/L) * Linked *	Tot. Sol. P: Const Load (mg/L)
Peri, Nitzschi: N Half-saturation (mg/L) * Linked *	CO2: Const Load (mg/L)
Peri, Green wr: N Half-saturation (mg/L) * Linked *	Oxygen: Const Load (mg/L)
Peri, Blue-Gre: N Half-saturation (mg/L) * Linked *	NO3: Multiply Loading by
Cladophora: N Half-saturation (mg/L) * Linked *	Tot. Sol. P: Multiply Loading by
Fontinalis a: N Half-saturation (mg/L)	CO2: Multiply Loading by
Peri Low-Nut D: Inorg. C Half-saturation (mg/L) * Linked *	Oxygen: Multiply Loading by
Peri Hi-Nut Di: Inorg. C Half-saturation (mg/L) * Linked *	Susp&Diss Detr: Multiply Loading by
Peri, Nitzschi: Inorg. C Half-saturation (mg/L) * Linked *	NH3 & NH4+: Multiply Loading by
Peri, Green wr: Inorg. C Half-saturation (mg/L) * Linked *	Temp: Multiply Loading by
Peri, Blue-Gre: Inorg. C Half-saturation (mg/L) * Linked *	NH3 & NH4+: Mult. Non-Point Source Load by
Cladophora: Inorg. C Half-saturation (mg/L) * Linked *	NO3: Mult. Non-Point Source Load by
Fontinalis a: Inorg. C Half-saturation (mg/L)	Tot. Sol. P: Mult. Non-Point Source Load by
Peri Low-Nut D: Temp Response Slope * Linked *	Oxygen: Mult. Non-Point Source Load by
Peri Hi-Nut Di: Temp Response Slope * Linked *	Susp&Diss Detr: Mult. Non-Point Source Load by
Peri, Nitzschi: Temp Response Slope * Linked *	Crayfish Frac. in Water Col. (unitless)
Peri, Green wr: Temp Response Slope * Linked *	Rotifer, Brach Frac. in Water Col. (unitless)
Peri, Blue-Gre: Temp Response Slope * Linked *	Chironomid Frac. in Water Col. (unitless)
Cladophora: Temp Response Slope * Linked *	Caddisfly,Tric Frac. in Water Col. (unitless)
Fontinalis a: Temp Response Slope	Daphnia Frac. in Water Col. (unitless)
Peri Low-Nut D: Optimal Temperature (deg. C) * Linked *	Corbicula Frac. in Water Col. (unitless)
Peri Hi-Nut Di: Optimal Temperature (deg. C) * Linked *	Mussel Frac. in Water Col. (unitless)
Peri, Nitzschi: Optimal Temperature (deg. C) * Linked *	Riffle beetle, Frac. in Water Col. (unitless)
Peri, Green wr: Optimal Temperature (deg. C) * Linked *	Mayfly (Baetis Frac. in Water Col. (unitless)
Peri, Blue-Gre: Optimal Temperature (deg. C) * Linked *	Gastropod Frac. in Water Col. (unitless)
Cladophora: Optimal Temperature (deg. C) * Linked *	Copepod Frac. in Water Col. (unitless)
Fontinalis a: Optimal Temperature (deg. C)	Stonefly Frac. in Water Col. (unitless)
Cladophora: Maximum Temperature (deg. C) * Linked *	Shiner Frac. in Water Col. (unitless)
Fontinalis a: Maximum Temperature (deg. C)	Bluegill Frac. in Water Col. (unitless)
Peri Low-Nut D: Min Adaptation Temperature (deg. C) * Linked *	Stoneroller Frac. in Water Col. (unitless)
Peri Hi-Nut Di: Min Adaptation Temperature (deg. C) * Linked *	Smallmouth Bas Frac. in Water Col. (unitless)
Peri, Nitzschi: Min Adaptation Temperature (deg. C) * Linked *	Smallmouth Ba2 Frac. in Water Col. (unitless)
Peri, Green wr: Min Adaptation Temperature (deg. C) * Linked *	Crayfish Fishing Fraction (frac/d)
Peri, Blue-Gre: Min Adaptation Temperature (deg. C) * Linked *	Rotifer, Brach Fishing Fraction (frac/d)
Cladophora: Min Adaptation Temperature (deg. C) * Linked *	Chironomid Fishing Fraction (frac/d)
Fontinalis a: Min Adaptation Temperature (deg. C)	Caddisfly,Tric Fishing Fraction (frac/d)
Peri Low-Nut D: Max Photosynthetic Rate (1/d) * Linked *	Daphnia Fishing Fraction (frac/d)
Peri Hi-Nut Di: Max Photosynthetic Rate (1/d) * Linked *	Corbicula Fishing Fraction (frac/d)
Peri, Nitzschi: Max Photosynthetic Rate (1/d) * Linked *	Mussel Fishing Fraction (frac/d)

Cahaba River, AL: Continued

Peri, Green wr: Max Photosynthetic Rate (1/d) * Linked *	Riffle beetle, Fishing Fraction (frac/d)
Peri, Blue-Gre: Max Photosynthetic Rate (1/d) * Linked *	Mayfly (Baetis Fishing Fraction (frac/d)
Cladophora: Max Photosynthetic Rate (1/d) * Linked *	Gastropod Fishing Fraction (frac/d)
Fontinalis a: Max Photosynthetic Rate (1/d)	Copepod Fishing Fraction (frac/d)
Peri Low-Nut D: Photorespiration Coefficient (1/d) * Linked *	Stonefly Fishing Fraction (frac/d)
Peri Hi-Nut Di: Photorespiration Coefficient (1/d) * Linked *	Shiner Fishing Fraction (frac/d)
Peri, Nitzschi: Photorespiration Coefficient (1/d) * Linked *	Bluegill Fishing Fraction (frac/d)
Peri, Green wr: Photorespiration Coefficient (1/d) * Linked *	Stoneroller Fishing Fraction (frac/d)
Peri, Blue-Gre: Photorespiration Coefficient (1/d) * Linked *	Smallmouth Bas Fishing Fraction (frac/d)
Cladophora: Photorespiration Coefficient (1/d) * Linked *	Smallmouth Ba2 Fishing Fraction (frac/d)
Fontinalis a: Photorespiration Coefficient (1/d)	Crayfish P to Organics (frac dry)
Peri Low-Nut D: Mortality Coefficient: (frac / d) * Linked *	Rotifer, Brach P to Organics (frac dry)
Peri Hi-Nut Di: Mortality Coefficient: (frac / d) * Linked *	Chironomid P to Organics (frac dry)
Peri, Nitzschi: Mortality Coefficient: (frac / d) * Linked *	Caddisfly,Tric P to Organics (frac dry)
Peri, Green wr: Mortality Coefficient: (frac / d) * Linked *	Daphnia P to Organics (frac dry)
Peri, Blue-Gre: Mortality Coefficient: (frac / d) * Linked *	Corbicula P to Organics (frac dry)
Cladophora: Mortality Coefficient: (frac / d) * Linked *	Mussel P to Organics (frac dry)
Fontinalis a: Mortality Coefficient: (frac / d)	Riffle beetle, P to Organics (frac dry)
Peri Low-Nut D: Exponential Mort. Coefficient: (max / d) * Linked *	Mayfly (Baetis P to Organics (frac dry)
Peri Hi-Nut Di: Exponential Mort. Coefficient: (max / d) * Linked *	Gastropod P to Organics (frac dry)
Peri, Nitzschi: Exponential Mort. Coefficient: (max / d) * Linked *	Copepod P to Organics (frac dry)
Peri, Green wr: Exponential Mort. Coefficient: (max / d) * Linked *	Stonefly P to Organics (frac dry)
Peri, Blue-Gre: Exponential Mort. Coefficient: (max / d) * Linked *	Shiner P to Organics (frac dry)
Cladophora: Exponential Mort. Coefficient: (max / d) * Linked *	Bluegill P to Organics (frac dry)
Fontinalis a: Exponential Mort. Coefficient: (max / d)	Stoneroller P to Organics (frac dry)
Peri Low-Nut D: Light Extinction (1/m) * Linked *	Smallmouth Bas P to Organics (frac dry)
Peri Hi-Nut Di: Light Extinction (1/m) * Linked *	Smallmouth Ba2 P to Organics (frac dry)
Peri, Nitzschi: Light Extinction (1/m) * Linked *	Crayfish N to Organics (frac dry)
Peri, Green wr: Light Extinction (1/m) * Linked *	Rotifer, Brach N to Organics (frac dry)
Peri, Blue-Gre: Light Extinction (1/m) * Linked *	Chironomid N to Organics (frac dry)
Cladophora: Light Extinction (1/m) * Linked *	Caddisfly,Tric N to Organics (frac dry)
Fontinalis a: Light Extinction (1/m)	Daphnia N to Organics (frac dry)
Peri Low-Nut D: Carrying Capacity (g/m2) * Linked *	Corbicula N to Organics (frac dry)
Peri Hi-Nut Di: Carrying Capacity (g/m2) * Linked *	Mussel N to Organics (frac dry)
Peri, Nitzschi: Carrying Capacity (g/m2) * Linked *	Riffle beetle, N to Organics (frac dry)
Peri, Green wr: Carrying Capacity (g/m2) * Linked *	Mayfly (Baetis N to Organics (frac dry)
Peri, Blue-Gre: Carrying Capacity (g/m2) * Linked *	Gastropod N to Organics (frac dry)
Cladophora: Carrying Capacity (g/m2) * Linked *	Copepod N to Organics (frac dry)
Fontinalis a: Carrying Capacity (g/m2)	Stonefly N to Organics (frac dry)
Fontinalis a: FCrit, periphyton (newtons)	Shiner N to Organics (frac dry)
Crayfish: Half Sat Feeding (mg/L)	Bluegill N to Organics (frac dry)
Rotifer, Brach: Half Sat Feeding (mg/L)	Stoneroller N to Organics (frac dry)
Chironomid: Half Sat Feeding (mg/L)	Smallmouth Bas N to Organics (frac dry)
Caddisfly,Tric: Half Sat Feeding (mg/L)	Smallmouth Ba2 N to Organics (frac dry)
Daphnia: Half Sat Feeding (mg/L)	Crayfish Wet to Dry (ratio)
Corbicula: Half Sat Feeding (mg/L)	Rotifer, Brach Wet to Dry (ratio)
Riffle beetle,: Half Sat Feeding (mg/L)	Chironomid Wet to Dry (ratio)
Mayfly (Baetis: Half Sat Feeding (mg/L)	Caddisfly,Tric Wet to Dry (ratio)
Gastropod: Half Sat Feeding (mg/L)	Daphnia Wet to Dry (ratio)
Copepod: Half Sat Feeding (mg/L)	Corbicula Wet to Dry (ratio)
Stonefly: Half Sat Feeding (mg/L)	Mussel Wet to Dry (ratio)
Shiner: Half Sat Feeding (mg/L)	Riffle beetle, Wet to Dry (ratio)

Cahaba River, AL: Continued

Bluegill: Half Sat Feeding (mg/L)	Mayfly (Baetis Wet to Dry (ratio)
Stoneroller: Half Sat Feeding (mg/L)	Gastropod Wet to Dry (ratio)
Smallmouth Bas: Half Sat Feeding (mg/L)	Copepod Wet to Dry (ratio)
Smallmouth Ba2: Half Sat Feeding (mg/L)	Stonefly Wet to Dry (ratio)
Mussel: Half Sat Feeding (mg/L)	Shiner Wet to Dry (ratio)
Crayfish: Max Consumption (g / g day)	Bluegill Wet to Dry (ratio)
Rotifer, Brach: Max Consumption (g / g day)	Stoneroller Wet to Dry (ratio)
Chironomid: Max Consumption (g / g day)	Smallmouth Bas Wet to Dry (ratio)
Caddisfly,Tric: Max Consumption (g / g day)	Smallmouth Ba2 Wet to Dry (ratio)
Daphnia: Max Consumption (g / g day)	Crayfish Oxygen Lethal Conc (mg/L 24 hr)
Corbicula: Max Consumption (g / g day)	Rotifer, Brach Oxygen Lethal Conc (mg/L 24 hr)
Riffle beetle,: Max Consumption (g / g day)	Chironomid Oxygen Lethal Conc (mg/L 24 hr)
Mayfly (Baetis: Max Consumption (g / g day)	Caddisfly,Tric Oxygen Lethal Conc (mg/L 24 hr)
Gastropod: Max Consumption (g / g day)	Daphnia Oxygen Lethal Conc (mg/L 24 hr)
Copepod: Max Consumption (g / g day)	Corbicula Oxygen Lethal Conc (mg/L 24 hr)
Stonefly: Max Consumption (g / g day)	Mussel Oxygen Lethal Conc (mg/L 24 hr)
Shiner: Max Consumption (g / g day)	Riffle beetle, Oxygen Lethal Conc (mg/L 24 hr)
Bluegill: Max Consumption (g / g day)	Mayfly (Baetis Oxygen Lethal Conc (mg/L 24 hr)
Stoneroller: Max Consumption (g / g day)	Gastropod Oxygen Lethal Conc (mg/L 24 hr)
Smallmouth Bas: Max Consumption (g / g day)	Copepod Oxygen Lethal Conc (mg/L 24 hr)
Smallmouth Ba2: Max Consumption (g / g day)	Stonefly Oxygen Lethal Conc (mg/L 24 hr)
Mussel: Max Consumption (g / g day)	Shiner Oxygen Lethal Conc (mg/L 24 hr)
Crayfish: Min Prey for Feeding	Bluegill Oxygen Lethal Conc (mg/L 24 hr)
Rotifer, Brach: Min Prey for Feeding	Stoneroller Oxygen Lethal Conc (mg/L 24 hr)
Chironomid: Min Prey for Feeding	Smallmouth Bas Oxygen Lethal Conc (mg/L 24 hr)
Caddisfly,Tric: Min Prey for Feeding	Smallmouth Ba2 Oxygen Lethal Conc (mg/L 24 hr)
Daphnia: Min Prey for Feeding	Crayfish Oxygen Pct. Killed (Percent, 1-99)
Corbicula: Min Prey for Feeding	Rotifer, Brach Oxygen Pct. Killed (Percent, 1-99)
Riffle beetle,: Min Prey for Feeding	Chironomid Oxygen Pct. Killed (Percent, 1-99)
Mayfly (Baetis: Min Prey for Feeding	Caddisfly,Tric Oxygen Pct. Killed (Percent, 1-99)
Gastropod: Min Prey for Feeding	Daphnia Oxygen Pct. Killed (Percent, 1-99)
Copepod: Min Prey for Feeding	Corbicula Oxygen Pct. Killed (Percent, 1-99)
Stonefly: Min Prey for Feeding	Mussel Oxygen Pct. Killed (Percent, 1-99)
Shiner: Min Prey for Feeding	Riffle beetle, Oxygen Pct. Killed (Percent, 1-99)
Bluegill: Min Prey for Feeding	Mayfly (Baetis Oxygen Pct. Killed (Percent, 1-99)
Stoneroller: Min Prey for Feeding	Gastropod Oxygen Pct. Killed (Percent, 1-99)
Smallmouth Bas: Min Prey for Feeding	Copepod Oxygen Pct. Killed (Percent, 1-99)
Smallmouth Ba2: Min Prey for Feeding	Stonefly Oxygen Pct. Killed (Percent, 1-99)
Mussel: Min Prey for Feeding	Shiner Oxygen Pct. Killed (Percent, 1-99)
Crayfish: Temperature Response Slope	Bluegill Oxygen Pct. Killed (Percent, 1-99)
Rotifer, Brach: Temperature Response Slope	Stoneroller Oxygen Pct. Killed (Percent, 1-99)
Chironomid: Temperature Response Slope	Smallmouth Bas Oxygen Pct. Killed (Percent, 1-99)
Caddisfly,Tric: Temperature Response Slope	Smallmouth Ba2 Oxygen Pct. Killed (Percent, 1-99)
Daphnia: Temperature Response Slope	Crayfish Oxygen EC50 Growth (mg/L 24 hr)
Corbicula: Temperature Response Slope	Rotifer, Brach Oxygen EC50 Growth (mg/L 24 hr)
Riffle beetle,: Temperature Response Slope	Chironomid Oxygen EC50 Growth (mg/L 24 hr)
Mayfly (Baetis: Temperature Response Slope	Caddisfly,Tric Oxygen EC50 Growth (mg/L 24 hr)
Gastropod: Temperature Response Slope	Daphnia Oxygen EC50 Growth (mg/L 24 hr)
Copepod: Temperature Response Slope	Corbicula Oxygen EC50 Growth (mg/L 24 hr)
Stonefly: Temperature Response Slope	Mussel Oxygen EC50 Growth (mg/L 24 hr)
Shiner: Temperature Response Slope	Riffle beetle, Oxygen EC50 Growth (mg/L 24 hr)
Bluegill: Temperature Response Slope	Mayfly (Baetis Oxygen EC50 Growth (mg/L 24 hr)

Cahaba River, AL: Continued

Stoneroller: Temperature Response Slope	Gastropod Oxygen EC50 Growth (mg/L 24 hr)
Smallmouth Bas: Temperature Response Slope	Copepod Oxygen EC50 Growth (mg/L 24 hr)
Smallmouth Ba2: Temperature Response Slope	Stonefly Oxygen EC50 Growth (mg/L 24 hr)
Mussel: Temperature Response Slope	Shiner Oxygen EC50 Growth (mg/L 24 hr)
Crayfish: Optimal Temperature (deg. C)	Bluegill Oxygen EC50 Growth (mg/L 24 hr)
Rotifer, Brach: Optimal Temperature (deg. C)	Stoneroller Oxygen EC50 Growth (mg/L 24 hr)
Chironomid: Optimal Temperature (deg. C)	Smallmouth Bas Oxygen EC50 Growth (mg/L 24 hr)
Caddisfly,Tric: Optimal Temperature (deg. C)	Smallmouth Ba2 Oxygen EC50 Growth (mg/L 24 hr)
Daphnia: Optimal Temperature (deg. C)	Crayfish Oxygen EC50 Repro (mg/L 24 hr)
Corbicula: Optimal Temperature (deg. C)	Rotifer, Brach Oxygen EC50 Repro (mg/L 24 hr)
Riffle beetle,: Optimal Temperature (deg. C)	Chironomid Oxygen EC50 Repro (mg/L 24 hr)
Mayfly (Baetis: Optimal Temperature (deg. C)	Caddisfly,Tric Oxygen EC50 Repro (mg/L 24 hr)
Gastropod: Optimal Temperature (deg. C)	Daphnia Oxygen EC50 Repro (mg/L 24 hr)
Copepod: Optimal Temperature (deg. C)	Corbicula Oxygen EC50 Repro (mg/L 24 hr)
Stonefly: Optimal Temperature (deg. C)	Mussel Oxygen EC50 Repro (mg/L 24 hr)
Shiner: Optimal Temperature (deg. C)	Riffle beetle, Oxygen EC50 Repro (mg/L 24 hr)
Bluegill: Optimal Temperature (deg. C)	Mayfly (Baetis Oxygen EC50 Repro (mg/L 24 hr)
Stoneroller: Optimal Temperature (deg. C)	Gastropod Oxygen EC50 Repro (mg/L 24 hr)
Smallmouth Bas: Optimal Temperature (deg. C)	Copepod Oxygen EC50 Repro (mg/L 24 hr)
Smallmouth Ba2: Optimal Temperature (deg. C)	Stonefly Oxygen EC50 Repro (mg/L 24 hr)
Mussel: Optimal Temperature (deg. C)	Shiner Oxygen EC50 Repro (mg/L 24 hr)
Crayfish: Maximum Temperature (deg. C)	Bluegill Oxygen EC50 Repro (mg/L 24 hr)
Rotifer, Brach: Maximum Temperature (deg. C)	Stoneroller Oxygen EC50 Repro (mg/L 24 hr)
Chironomid: Maximum Temperature (deg. C)	Smallmouth Bas Oxygen EC50 Repro (mg/L 24 hr)
Caddisfly,Tric: Maximum Temperature (deg. C)	Smallmouth Ba2 Oxygen EC50 Repro (mg/L 24 hr)
Daphnia: Maximum Temperature (deg. C)	Crayfish Ammonia LC50 (mg/L)
Corbicula: Maximum Temperature (deg. C)	Rotifer, Brach Ammonia LC50 (mg/L)
Riffle beetle,: Maximum Temperature (deg. C)	Chironomid Ammonia LC50 (mg/L)
Mayfly (Baetis: Maximum Temperature (deg. C)	Caddisfly,Tric Ammonia LC50 (mg/L)
Gastropod: Maximum Temperature (deg. C)	Daphnia Ammonia LC50 (mg/L)
Copepod: Maximum Temperature (deg. C)	Corbicula Ammonia LC50 (mg/L)
Stonefly: Maximum Temperature (deg. C)	Mussel Ammonia LC50 (mg/L)
Shiner: Maximum Temperature (deg. C)	Riffle beetle, Ammonia LC50 (mg/L)
Bluegill: Maximum Temperature (deg. C)	Mayfly (Baetis Ammonia LC50 (mg/L)
Stoneroller: Maximum Temperature (deg. C)	Gastropod Ammonia LC50 (mg/L)
Smallmouth Bas: Maximum Temperature (deg. C)	Copepod Ammonia LC50 (mg/L)
Smallmouth Ba2: Maximum Temperature (deg. C)	Stonefly Ammonia LC50 (mg/L)
Mussel: Maximum Temperature (deg. C)	Shiner Ammonia LC50 (mg/L)
Crayfish: Min Adaptation Temperature (deg. C)	Bluegill Ammonia LC50 (mg/L)
Rotifer, Brach: Min Adaptation Temperature (deg. C)	Stoneroller Ammonia LC50 (mg/L)
Chironomid: Min Adaptation Temperature (deg. C)	Smallmouth Bas Ammonia LC50 (mg/L)
Caddisfly,Tric: Min Adaptation Temperature (deg. C)	Smallmouth Ba2 Ammonia LC50 (mg/L)
Daphnia: Min Adaptation Temperature (deg. C)	Crayfish Sorting, selective feeding (unitless)
Corbicula: Min Adaptation Temperature (deg. C)	Rotifer, Brach Sorting, selective feeding (unitless)
Riffle beetle,: Min Adaptation Temperature (deg. C)	Chironomid Sorting, selective feeding (unitless)
Mayfly (Baetis: Min Adaptation Temperature (deg. C)	Caddisfly,Tric Sorting, selective feeding (unitless)
Gastropod: Min Adaptation Temperature (deg. C)	Daphnia Sorting, selective feeding (unitless)
Copepod: Min Adaptation Temperature (deg. C)	Corbicula Sorting, selective feeding (unitless)
Stonefly: Min Adaptation Temperature (deg. C)	Mussel Sorting, selective feeding (unitless)
Shiner: Min Adaptation Temperature (deg. C)	Riffle beetle, Sorting, selective feeding (unitless)
Bluegill: Min Adaptation Temperature (deg. C)	Mayfly (Baetis Sorting, selective feeding (unitless)
Stoneroller: Min Adaptation Temperature (deg. C)	Gastropod Sorting, selective feeding (unitless)

Cahaba River, AL: Continued

Smallmouth Bas: Min Adaptation Temperature (deg. C)	Copepod Sorting, selective feeding (unitless)
Smallmouth Ba2: Min Adaptation Temperature (deg. C)	Stonefly Sorting, selective feeding (unitless)
Mussel: Min Adaptation Temperature (deg. C)	Shiner Sorting, selective feeding (unitless)
Crayfish: Respiration Rate: (1 / d)	Bluegill Sorting, selective feeding (unitless)
Rotifer, Brach: Respiration Rate: (1 / d)	Stoneroller Sorting, selective feeding (unitless)
Chironomid: Respiration Rate: (1 / d)	Smallmouth Bas Sorting, selective feeding (unitless)
Caddisfly,Tric: Respiration Rate: (1 / d)	Smallmouth Ba2 Sorting, selective feeding (unitless)
Daphnia: Respiration Rate: (1 / d)	Crayfish Slope for Sed Response (unitless)
Corbicula: Respiration Rate: (1 / d)	Rotifer, Brach Slope for Sed Response (unitless)
Mussel: Respiration Rate: (1 / d)	Chironomid Slope for Sed Response (unitless)
Riffle beetle,: Respiration Rate: (1 / d)	Caddisfly,Tric Slope for Sed Response (unitless)
Mayfly (Baetis: Respiration Rate: (1 / d)	Daphnia Slope for Sed Response (unitless)
Gastropod: Respiration Rate: (1 / d)	Corbicula Slope for Sed Response (unitless)
Copepod: Respiration Rate: (1 / d)	Mussel Slope for Sed Response (unitless)
Stonefly: Respiration Rate: (1 / d)	Riffle beetle, Slope for Sed Response (unitless)
Shiner: Respiration Rate: (1 / d)	Mayfly (Baetis Slope for Sed Response (unitless)
Bluegill: Respiration Rate: (1 / d)	Gastropod Slope for Sed Response (unitless)
Stoneroller: Respiration Rate: (1 / d)	Copepod Slope for Sed Response (unitless)
Smallmouth Bas: Respiration Rate: (1 / d)	Stonefly Slope for Sed Response (unitless)
Smallmouth Ba2: Respiration Rate: (1 / d)	Shiner Slope for Sed Response (unitless)
Crayfish: Specific Dynamic Action	Bluegill Slope for Sed Response (unitless)
Rotifer, Brach: Specific Dynamic Action	Stoneroller Slope for Sed Response (unitless)
Chironomid: Specific Dynamic Action	Smallmouth Bas Slope for Sed Response (unitless)
Caddisfly,Tric: Specific Dynamic Action	Smallmouth Ba2 Slope for Sed Response (unitless)
Daphnia: Specific Dynamic Action	Crayfish Intercept for Sed Response (unitless)
Corbicula: Specific Dynamic Action	Rotifer, Brach Intercept for Sed Response (unitless)
Mussel: Specific Dynamic Action	Chironomid Intercept for Sed Response (unitless)
Riffle beetle,: Specific Dynamic Action	Caddisfly,Tric Intercept for Sed Response (unitless)
Mayfly (Baetis: Specific Dynamic Action	Daphnia Intercept for Sed Response (unitless)
Gastropod: Specific Dynamic Action	Corbicula Intercept for Sed Response (unitless)
Copepod: Specific Dynamic Action	Mussel Intercept for Sed Response (unitless)
Stonefly: Specific Dynamic Action	Riffle beetle, Intercept for Sed Response (unitless)
Shiner: Specific Dynamic Action	Mayfly (Baetis Intercept for Sed Response (unitless)
Bluegill: Specific Dynamic Action	Gastropod Intercept for Sed Response (unitless)
Stoneroller: Specific Dynamic Action	Copepod Intercept for Sed Response (unitless)
Smallmouth Bas: Specific Dynamic Action	Stonefly Intercept for Sed Response (unitless)
Smallmouth Ba2: Specific Dynamic Action	Shiner Intercept for Sed Response (unitless)
Crayfish: Mortality Coeff (1/d)	Bluegill Intercept for Sed Response (unitless)
Rotifer, Brach: Mortality Coeff (1/d)	Stoneroller Intercept for Sed Response (unitless)
Chironomid: Mortality Coeff (1/d)	Smallmouth Bas Intercept for Sed Response (unitless)
Caddisfly,Tric: Mortality Coeff (1/d)	Smallmouth Ba2 Intercept for Sed Response (unitless)
Daphnia: Mortality Coeff (1/d)	Crayfish Trigger (dep. rate accel. drift in g/sq.m)
Corbicula: Mortality Coeff (1/d)	Rotifer, Brach Trigger (dep. rate accel. drift in g/sq.m)
Mussel: Mortality Coeff (1/d)	Chironomid Trigger (dep. rate accel. drift in g/sq.m)
Riffle beetle,: Mortality Coeff (1/d)	Caddisfly,Tric Trigger (dep. rate accel. drift in g/sq.m)
Mayfly (Baetis: Mortality Coeff (1/d)	Daphnia Trigger (dep. rate accel. drift in g/sq.m)
Gastropod: Mortality Coeff (1/d)	Corbicula Trigger (dep. rate accel. drift in g/sq.m)
Copepod: Mortality Coeff (1/d)	Mussel Trigger (dep. rate accel. drift in g/sq.m)
Stonefly: Mortality Coeff (1/d)	Riffle beetle, Trigger (dep. rate accel. drift in g/sq.m)
Shiner: Mortality Coeff (1/d)	Mayfly (Baetis Trigger (dep. rate accel. drift in g/sq.m)
Bluegill: Mortality Coeff (1/d)	Gastropod Trigger (dep. rate accel. drift in g/sq.m)
Stoneroller: Mortality Coeff (1/d)	Copepod Trigger (dep. rate accel. drift in g/sq.m)

Cahaba River, AL: Continued

Smallmouth Bas: Mortality Coeff (1/d)	Stonefly Trigger (dep. rate accel. drift in g/sq.m)
Smallmouth Ba2: Mortality Coeff (1/d)	Shiner Trigger (dep. rate accel. drift in g/sq.m)
Crayfish: Carrying Capacity (g/sq.m)	Bluegill Trigger (dep. rate accel. drift in g/sq.m)
Rotifer, Brach: Carrying Capacity (g/sq.m)	Stoneroller Trigger (dep. rate accel. drift in g/sq.m)
Chironomid: Carrying Capacity (g/sq.m)	Smallmouth Bas Trigger (dep. rate accel. drift in g/sq.m)
Caddisfly,Tric: Carrying Capacity (g/sq.m)	Smallmouth Ba2 Trigger (dep. rate accel. drift in g/sq.m)
Daphnia: Carrying Capacity (g/sq.m)	Cladophora Min. Salinity Tolerance, Photo. (0/00) * Linked *
Corbicula: Carrying Capacity (g/sq.m)	*Fontinalis* a Min. Salinity Tolerance, Photo. (0/00)
Mussel: Carrying Capacity (g/sq.m)	Cladophora Max. Salinity Tolerance, Photo. (0/00) * Linked *
Riffle beetle,: Carrying Capacity (g/sq.m)	*Fontinalis* a Max. Salinity Tolerance, Photo. (0/00)
Mayfly (Baetis: Carrying Capacity (g/sq.m)	Cladophora Salinity Coeff1, Photo. (unitless) * Linked *
Gastropod: Carrying Capacity (g/sq.m)	*Fontinalis* a Salinity Coeff1, Photo. (unitless)
Copepod: Carrying Capacity (g/sq.m)	Cladophora Salinity Coeff2, Photo. (unitless) * Linked *
Stonefly: Carrying Capacity (g/sq.m)	*Fontinalis* a Salinity Coeff2, Photo. (unitless)
Shiner: Carrying Capacity (g/sq.m)	Cladophora Min. Salinity Tolerance, Mortality (0/00) * Linked *
Bluegill: Carrying Capacity (g/sq.m)	*Fontinalis* a Min. Salinity Tolerance, Mortality (0/00)
Stoneroller: Carrying Capacity (g/sq.m)	Cladophora Max. Salinity Tolerance, Mortality (0/00) *Linked *
Smallmouth Bas: Carrying Capacity (g/sq.m)	*Fontinalis* a Max. Salinity Tolerance, Mortality (0/00)
Smallmouth Ba2: Carrying Capacity (g/sq.m)	Cladophora Salinity Coeff1, Mortality (unitless) * Linked *
Shiner: Mean Weight (g)	*Fontinalis* a Salinity Coeff1, Mortality (unitless)
Bluegill: Mean Weight (g)	Cladophora Salinity Coeff2, Mortality (unitless) * Linked *
Stoneroller: Mean Weight (g)	*Fontinalis* a Salinity Coeff2, Mortality (unitless)
Smallmouth Bas: Mean Weight (g)	Peri Low-Nut D Resp. Rate, 20 deg C (g/g d) * Linked *
Smallmouth Ba2: Mean Weight (g)	Peri Hi-Nut Di Resp. Rate, 20 deg C (g/g d) * Linked *
Shiner: (Allometric) CA	Peri, Nitzschi Resp. Rate, 20 deg C (g/g d) * Linked *
Bluegill: (Allometric) CA	Peri, Green wr Resp. Rate, 20 deg C (g/g d) * Linked *
Stoneroller: (Allometric) CA	Peri, Blue-Gre Resp. Rate, 20 deg C (g/g d) * Linked *
Smallmouth Bas: (Allometric) CA	Cladophora Resp. Rate, 20 deg C (g/g d) * Linked *
Smallmouth Ba2: (Allometric) CA	*Fontinalis* a Resp. Rate, 20 deg C (g/g d)
Shiner: (Allometric) RA	Peri Low-Nut D Pct. Lost Slough Event (percent) * Linked *
Bluegill: (Allometric) RA	Peri Hi-Nut Di Pct. Lost Slough Event (percent) * Linked *
Stoneroller: (Allometric) RA	Peri, Nitzschi Pct. Lost Slough Event (percent) * Linked *
Smallmouth Bas: (Allometric) RA	Peri, Green wr Pct. Lost Slough Event (percent) * Linked *
Smallmouth Ba2: (Allometric) RA	Peri, Blue-Gre Pct. Lost Slough Event (percent) * Linked *
Shiner: (Allometric) ACT	Cladophora Pct. Lost Slough Event (percent) * Linked *
Bluegill: (Allometric) ACT	*Fontinalis* a Pct. Lost Slough Event (percent)
Stoneroller: (Allometric) ACT	Peri Low-Nut D Max. Sat. Light (Ly/d) * Linked *
Smallmouth Bas: (Allometric) ACT	Peri Hi-Nut Di Max. Sat. Light (Ly/d) * Linked *
Smallmouth Ba2: (Allometric) ACT	Peri, Nitzschi Max. Sat. Light (Ly/d) * Linked *
NH3 & NH4+: Initial Condition (mg/L)	Peri, Green wr Max. Sat. Light (Ly/d) * Linked *
NO3: Initial Condition (mg/L)	Peri, Blue-Gre Max. Sat. Light (Ly/d) * Linked *
Tot. Sol. P: Initial Condition (mg/L)	Cladophora Max. Sat. Light (Ly/d) * Linked *
CO2: Initial Condition (mg/L)	*Fontinalis* a Max. Sat. Light (Ly/d)
Oxygen: Initial Condition (mg/L)	Peri Low-Nut D Min. Sat. Light (Ly/d) * Linked *
Susp&Diss Detr: Initial Condition (mg/L dry)	Peri Hi-Nut Di Min. Sat. Light (Ly/d) * Linked *
Cladophora: Initial Condition (g/m2 dry) * Linked *	Peri, Nitzschi Min. Sat. Light (Ly/d) * Linked *
Fontinalis a: Initial Condition (g/m2 dry)	Peri, Green wr Min. Sat. Light (Ly/d) * Linked *
Crayfish: Initial Condition (g/m2 dry)	Peri, Blue-Gre Min. Sat. Light (Ly/d) * Linked *
Rotifer, Brach: Initial Condition (mg/L dry)	Cladophora Min. Sat. Light (Ly/d) * Linked *
Chironomid: Initial Condition (g/m2 dry)	*Fontinalis* a Min. Sat. Light (Ly/d)
Caddisfly,Tric: Initial Condition (g/m2 dry)	Susp&Diss Detr: Pct. Partic. Loads, Const.
Daphnia: Initial Condition (mg/L dry)	Susp&Diss Detr: Pct. Refr. Loads, Const.

Cahaba River, AL: Continued

Corbicula: Initial Condition (g/m2 dry)	Susp&Diss Detr: Pct. Particulate, Init. Cond
	Susp&Diss Detr: Pct. Refractory, Init. Cond

Duluth, MN Pond with Chlorpyrifos:

T1: Molecular Weight	Shiner: (Allometric) RA
T1: Dissasociation Constant (pKa)	Green Sunfish2: (Allometric) RA
T1: Solubility (ppm)	Green Sunfish,: (Allometric) RB
T1: Henry's Law Const. (atm. m^3/mol)	Shiner: (Allometric) RB
T1: Vapor Pressure (mm Hg)	Green Sunfish2: (Allometric) RB
T1: Octanol-Water Partition Coeff (Log Kow)	Green Sunfish,: (Allometric) ACT
T1: Sed/Detr-Water Partition Coeff (mg/L)	Shiner: (Allometric) ACT
T1: Activation Energy for Temp (cal/mol)	Green Sunfish2: (Allometric) ACT
T1: Anaerobic Microbial Degrdn. (L/d)	T1: Initial Condition (ug/L)
T1: Aerobic Microbial Degrdn. (L/d)	Chironomid: Initial Condition (g/m2 dry)
T1: Uncatalyzed Hydrolysis (L/d)	Daphnia: Initial Condition (mg/L dry)
T1: Acid Catalyzed Hydrolysis (L/d)	Green Sunfish,: Initial Condition (g/m2 dry)
T1: Base Catalyzed Hydrolysis (L/d)	Shiner: Initial Condition (g/m2 dry)
T1: Photolysis Rate (L/d)	Green Sunfish2: Initial Condition (g/m2 dry)
T1: Oxidation Rate Const (L/mol day)	T1Chironomid: Initial Condition (ug/kg wet)
T1: Weibull Shape Parameter	T1Daphnia: Initial Condition (ug/kg wet)
T1: Trout LC50 (ug/L)	T1Green Sunfish,: Initial Condition (ug/kg wet)
T1: Bluegill LC50 (ug/L)	T1Shiner: Initial Condition (ug/kg wet)
T1: Bass LC50 (ug/L)	T1Green Sunfish2: Initial Condition (ug/kg wet)
T1: Catfish LC50 (ug/L)	T1: Const Load (ug/L)
T1: Minnow LC50 (ug/L)	Chironomid: Const Load (g/m2 dry)
T1: Daphnia LC50 (ug/L)	Daphnia: Const Load (mg/L dry)
T1: Chironomid LC50 (ug/L)	Green Sunfish,: Const Load (g/m2 dry)
T1: Stonefly LC50 (ug/L)	Shiner: Const Load (g/m2 dry)
T1: Ostracod LC50 (ug/L)	Green Sunfish2: Const Load (g/m2 dry)
T1: Amphipod LC50 (ug/L)	T1Chironomid: Const Load (ug/kg wet)
T1: Other LC50 (ug/L)	T1Daphnia: Const Load (ug/kg wet)
T1: Trout Elim. Rate Constant (1/d)	T1Green Sunfish,: Const Load (ug/kg wet)
T1: Bluegill Elim. Rate Constant (1/d)	T1Shiner: Const Load (ug/kg wet)
T1: Bass Elim. Rate Constant (1/d)	T1Green Sunfish2: Const Load (ug/kg wet)
T1: Catfish Elim. Rate Constant (1/d)	T1: Multiply Loading by
T1: Minnow Elim. Rate Constant (1/d)	Chironomid: Multiply Loading by
T1: Daphnia Elim. Rate Constant (1/d)	Daphnia: Multiply Loading by
T1: Chironomid Elim. Rate Constant (1/d)	Green Sunfish,: Multiply Loading by
T1: Stonefly Elim. Rate Constant (1/d)	Shiner: Multiply Loading by
T1: Ostracod Elim. Rate Constant (1/d)	Green Sunfish2: Multiply Loading by
T1: Amphipod Elim. Rate Constant (1/d)	T1Chironomid: Multiply Loading by
T1: Other Elim. Rate Constant (1/d)	T1Daphnia: Multiply Loading by
T1: Trout Biotransformation Rate (1/d)	T1Green Sunfish,: Multiply Loading by
T1: Bluegill Biotransformation Rate (1/d)	T1Shiner: Multiply Loading by
T1: Bass Biotransformation Rate (1/d)	T1Green Sunfish2: Multiply Loading by
T1: Catfish Biotransformation Rate (1/d)	T1: Mult. Direct Precip. Load by
T1: Minnow Biotransformation Rate (1/d)	T1: Mult. Point Source Load by
T1: Daphnia Biotransformation Rate (1/d)	T1: Mult. Non-Point Source Load by
T1: Chironomid Biotransformation Rate (1/d)	T1: Trout EC50 Dislodge (ug/L)
T1: Stonefly Biotransformation Rate (1/d)	T1: Bluegill EC50 Dislodge (ug/L)
T1: Ostracod Biotransformation Rate (1/d)	T1: Bass EC50 Dislodge (ug/L)
T1: Amphipod Biotransformation Rate (1/d)	T1: Catfish EC50 Dislodge (ug/L)
T1: Other Biotransformation Rate (1/d)	T1: Minnow EC50 Dislodge (ug/L)
T1: Trout EC50 Growth (ug/L)	T1: Daphnia EC50 Dislodge (ug/L)
T1: Bluegill EC50 Growth (ug/L)	T1: Chironomid EC50 Dislodge (ug/L)
T1: Bass EC50 Growth (ug/L)	T1: Stonefly EC50 Dislodge (ug/L)
T1: Catfish EC50 Growth (ug/L)	T1: Ostracod EC50 Dislodge (ug/L)
T1: Minnow EC50 Growth (ug/L)	T1: Amphipod EC50 Dislodge (ug/L)
T1: Daphnia EC50 Growth (ug/L)	T1: Other EC50 Dislodge (ug/L)
T1: Chironomid EC50 Growth (ug/L)	Chironomid Frac. in Water Col. (unitless)

Duluth, MN Pond with Chlorpyrifos: Cont.

T1: Stonefly EC50 Growth (ug/L)	Daphnia Frac. in Water Col. (unitless)
T1: Ostracod EC50 Growth (ug/L)	Green Sunfish, Frac. in Water Col. (unitless)
T1: Amphipod EC50 Growth (ug/L)	Shiner Frac. in Water Col. (unitless)
T1: Other EC50 Growth (ug/L)	Green Sunfish2 Frac. in Water Col. (unitless)
T1: Trout EC50 Repro (ug/L)	Chironomid Min. Salinity Tolerance, Ingestion (0/00)
T1: Bluegill EC50 Repro (ug/L)	Daphnia Min. Salinity Tolerance, Ingestion (0/00)
T1: Bass EC50 Repro (ug/L)	Green Sunfish, Min. Salinity Tolerance, Ingestion (0/00)
T1: Catfish EC50 Repro (ug/L)	Shiner Min. Salinity Tolerance, Ingestion (0/00)
T1: Minnow EC50 Repro (ug/L)	Green Sunfish2 Min. Salinity Tolerance, Ingestion (0/00)
T1: Daphnia EC50 Repro (ug/L)	Chironomid Max. Salinity Tolerance, Ingestion (0/00)
T1: Chironomid EC50 Repro (ug/L)	Daphnia Max. Salinity Tolerance, Ingestion (0/00)
T1: Stonefly EC50 Repro (ug/L)	Green Sunfish, Max. Salinity Tolerance, Ingestion (0/00)
T1: Ostracod EC50 Repro (ug/L)	Shiner Max. Salinity Tolerance, Ingestion (0/00)
T1: Amphipod EC50 Repro (ug/L)	Green Sunfish2 Max. Salinity Tolerance, Ingestion (0/00)
T1: Other EC50 Repro (ug/L)	Chironomid Salinity Coeff1, Ingestion (unitless)
T1: Trout Drift Threshold (ug/L)	Daphnia Salinity Coeff1, Ingestion (unitless)
T1: Bluegill Drift Threshold (ug/L)	Green Sunfish, Salinity Coeff1, Ingestion (unitless)
T1: Bass Drift Threshold (ug/L)	Shiner Salinity Coeff1, Ingestion (unitless)
T1: Catfish Drift Threshold (ug/L)	Green Sunfish2 Salinity Coeff1, Ingestion (unitless)
T1: Minnow Drift Threshold (ug/L)	Chironomid Salinity Coeff2, Ingestion (unitless)
T1: Daphnia Drift Threshold (ug/L)	Daphnia Salinity Coeff2, Ingestion (unitless)
T1: Chironomid Drift Threshold (ug/L)	Green Sunfish, Salinity Coeff2, Ingestion (unitless)
T1: Stonefly Drift Threshold (ug/L)	Shiner Salinity Coeff2, Ingestion (unitless)
T1: Ostracod Drift Threshold (ug/L)	Green Sunfish2 Salinity Coeff2, Ingestion (unitless)
T1: Amphipod Drift Threshold (ug/L)	Chironomid Min. Salinity Tolerance, Gameteloss (0/00)
T1: Other Drift Threshold (ug/L)	Daphnia Min. Salinity Tolerance, Gameteloss (0/00)
T1: Greens EC50 photo (ug/L)	Green Sunfish, Min. Salinity Tolerance, Gameteloss (0/00)
T1: Diatoms EC50 photo (ug/L)	Shiner Min. Salinity Tolerance, Gameteloss (0/00)
T1: Bluegreens EC50 photo (ug/L)	Green Sunfish2 Min. Salinity Tolerance, Gameteloss (0/00)
T1: Macrophytes EC50 photo (ug/L)	Chironomid Max. Salinity Tolerance, Gameteloss (0/00)
T1: Greens LC50 (ug/L)	Daphnia Max. Salinity Tolerance, Gameteloss (0/00)
T1: Diatoms LC50 (ug/L)	Green Sunfish, Max. Salinity Tolerance, Gameteloss (0/00)
T1: Bluegreens LC50 (ug/L)	Shiner Max. Salinity Tolerance, Gameteloss (0/00)
T1: Macrophytes LC50 (ug/L)	Green Sunfish2 Max. Salinity Tolerance, Gameteloss (0/00)
T1: Greens Elim. Rate Constant (1/d)	Chironomid Salinity Coeff1, Gameteloss (unitless)
T1: Diatoms Elim. Rate Constant (1/d)	Daphnia Salinity Coeff1, Gameteloss (unitless)
T1: Bluegreens Elim. Rate Constant (1/d)	Green Sunfish, Salinity Coeff1, Gameteloss (unitless)
T1: Macrophytes Elim. Rate Constant (1/d)	Shiner Salinity Coeff1, Gameteloss (unitless)
T1: Greens Biotransformation Rate (1/d)	Green Sunfish2 Salinity Coeff1, Gameteloss (unitless)
T1: Diatoms Biotransformation Rate (1/d)	Chironomid Salinity Coeff2, Gameteloss (unitless)
T1: Bluegreens Biotransformation Rate (1/d)	Daphnia Salinity Coeff2, Gameteloss (unitless)
T1: Macrophytes Biotransformation Rate (1/d)	Green Sunfish, Salinity Coeff2, Gameteloss (unitless)
Chironomid: Half Sat Feeding (mg/L)	Shiner Salinity Coeff2, Gameteloss (unitless)
Daphnia: Half Sat Feeding (mg/L)	Green Sunfish2 Salinity Coeff2, Gameteloss (unitless)
Green Sunfish,: Half Sat Feeding (mg/L)	Chironomid Min. Salinity Tolerance, Respiration (0/00)
Shiner: Half Sat Feeding (mg/L)	Daphnia Min. Salinity Tolerance, Respiration (0/00)
Green Sunfish2: Half Sat Feeding (mg/L)	Green Sunfish, Min. Salinity Tolerance, Respiration (0/00)
Chironomid: Max Consumption (g / g day)	Shiner Min. Salinity Tolerance, Respiration (0/00)
Daphnia: Max Consumption (g / g day)	Green Sunfish2 Min. Salinity Tolerance, Respiration (0/00)
Green Sunfish,: Max Consumption (g / g day)	Chironomid Max. Salinity Tolerance, Respiration (0/00)
Shiner: Max Consumption (g / g day)	Daphnia Max. Salinity Tolerance, Respiration (0/00)
Green Sunfish2: Max Consumption (g / g day)	Green Sunfish, Max. Salinity Tolerance, Respiration (0/00)
Chironomid: Min Prey for Feeding	Shiner Max. Salinity Tolerance, Respiration (0/00)
Daphnia: Min Prey for Feeding	Green Sunfish2 Max. Salinity Tolerance, Respiration (0/00)
Green Sunfish,: Min Prey for Feeding	Chironomid Salinity Coeff1, Respiration (unitless)
Shiner: Min Prey for Feeding	Daphnia Salinity Coeff1, Respiration (unitless)

Duluth, MN Pond with Chlorpyrifos: Cont.

Green Sunfish2: Min Prey for Feeding	Green Sunfish, Salinity Coeff1, Respiration (unitless)
Chironomid: Temperature Response Slope	Shiner Salinity Coeff1, Respiration (unitless)
Daphnia: Temperature Response Slope	Green Sunfish2 Salinity Coeff1, Respiration (unitless)
Green Sunfish,: Temperature Response Slope	Chironomid Salinity Coeff2, Respiration (unitless)
Shiner: Temperature Response Slope	Daphnia Salinity Coeff2, Respiration (unitless)
Green Sunfish2: Temperature Response Slope	Green Sunfish, Salinity Coeff2, Respiration (unitless)
Chironomid: Optimal Temperature (deg. C)	Shiner Salinity Coeff2, Respiration (unitless)
Daphnia: Optimal Temperature (deg. C)	Green Sunfish2 Salinity Coeff2, Respiration (unitless)
Green Sunfish,: Optimal Temperature (deg. C)	Chironomid Min. Salinity Tolerance, Mortality (0/00)
Shiner: Optimal Temperature (deg. C)	Daphnia Min. Salinity Tolerance, Mortality (0/00)
Green Sunfish2: Optimal Temperature (deg. C)	Green Sunfish, Min. Salinity Tolerance, Mortality (0/00)
Chironomid: Maximum Temperature (deg. C)	Shiner Min. Salinity Tolerance, Mortality (0/00)
Daphnia: Maximum Temperature (deg. C)	Green Sunfish2 Min. Salinity Tolerance, Mortality (0/00)
Green Sunfish,: Maximum Temperature (deg. C)	Chironomid Max. Salinity Tolerance, Mortality (0/00)
Shiner: Maximum Temperature (deg. C)	Daphnia Max. Salinity Tolerance, Mortality (0/00)
Green Sunfish2: Maximum Temperature (deg. C)	Green Sunfish, Max. Salinity Tolerance, Mortality (0/00)
Chironomid: Min Adaptation Temperature (deg. C)	Shiner Max. Salinity Tolerance, Mortality (0/00)
Daphnia: Min Adaptation Temperature (deg. C)	Green Sunfish2 Max. Salinity Tolerance, Mortality (0/00)
Green Sunfish,: Min Adaptation Temperature (deg. C)	Chironomid Salinity Coeff1, Mortality (unitless)
Shiner: Min Adaptation Temperature (deg. C)	Daphnia Salinity Coeff1, Mortality (unitless)
Green Sunfish2: Min Adaptation Temperature (deg. C)	Green Sunfish, Salinity Coeff1, Mortality (unitless)
Chironomid: Respiration Rate: (1 / d)	Shiner Salinity Coeff1, Mortality (unitless)
Daphnia: Respiration Rate: (1 / d)	Green Sunfish2 Salinity Coeff1, Mortality (unitless)
Green Sunfish,: Respiration Rate: (1 / d)	Chironomid Salinity Coeff2, Mortality (unitless)
Shiner: Respiration Rate: (1 / d)	Daphnia Salinity Coeff2, Mortality (unitless)
Green Sunfish2: Respiration Rate: (1 / d)	Green Sunfish, Salinity Coeff2, Mortality (unitless)
Chironomid: Specific Dynamic Action	Shiner Salinity Coeff2, Mortality (unitless)
Daphnia: Specific Dynamic Action	Green Sunfish2 Salinity Coeff2, Mortality (unitless)
Green Sunfish,: Specific Dynamic Action	Chironomid Fishing Fraction (frac/d)
Shiner: Specific Dynamic Action	Daphnia Fishing Fraction (frac/d)
Green Sunfish2: Specific Dynamic Action	Green Sunfish, Fishing Fraction (frac/d)
Chironomid: Excretion:Respiration (ratio)	Shiner Fishing Fraction (frac/d)
Daphnia: Excretion:Respiration (ratio)	Green Sunfish2 Fishing Fraction (frac/d)
Green Sunfish,: Excretion:Respiration (ratio)	Chironomid P to Organics (frac dry)
Shiner: Excretion:Respiration (ratio)	Daphnia P to Organics (frac dry)
Green Sunfish2: Excretion:Respiration (ratio)	Green Sunfish, P to Organics (frac dry)
Chironomid: Gametes:Biomass (ratio)	Shiner P to Organics (frac dry)
Daphnia: Gametes:Biomass (ratio)	Green Sunfish2 P to Organics (frac dry)
Green Sunfish,: Gametes:Biomass (ratio)	Chironomid N to Organics (frac dry)
Shiner: Gametes:Biomass (ratio)	Daphnia N to Organics (frac dry)
Green Sunfish2: Gametes:Biomass (ratio)	Green Sunfish, N to Organics (frac dry)
Chironomid: Gametes Mortality (1/d)	Shiner N to Organics (frac dry)
Daphnia: Gametes Mortality (1/d)	Green Sunfish2 N to Organics (frac dry)
Green Sunfish,: Gametes Mortality (1/d)	Chironomid Wet to Dry (ratio)
Shiner: Gametes Mortality (1/d)	Daphnia Wet to Dry (ratio)
Green Sunfish2: Gametes Mortality (1/d)	Green Sunfish, Wet to Dry (ratio)
Chironomid: Mortality Coeff (1/d)	Shiner Wet to Dry (ratio)
Daphnia: Mortality Coeff (1/d)	Green Sunfish2 Wet to Dry (ratio)
Green Sunfish,: Mortality Coeff (1/d)	Chironomid Oxygen Lethal Conc (mg/L 24 hr)
Shiner: Mortality Coeff (1/d)	Daphnia Oxygen Lethal Conc (mg/L 24 hr)
Green Sunfish2: Mortality Coeff (1/d)	Green Sunfish, Oxygen Lethal Conc (mg/L 24 hr)
Chironomid: Carrying Capacity (g/sq.m)	Shiner Oxygen Lethal Conc (mg/L 24 hr)
Daphnia: Carrying Capacity (g/sq.m)	Green Sunfish2 Oxygen Lethal Conc (mg/L 24 hr)
Green Sunfish,: Carrying Capacity (g/sq.m)	Chironomid Oxygen Pct. Killed (Percent, 1-99)
Shiner: Carrying Capacity (g/sq.m)	Daphnia Oxygen Pct. Killed (Percent, 1-99)
Green Sunfish2: Carrying Capacity (g/sq.m)	Green Sunfish, Oxygen Pct. Killed (Percent, 1-99)

Duluth, MN Pond with Chlorpyrifos: Cont.

Chironomid: Average Drift (frac/day)	Shiner Oxygen Pct. Killed (Percent, 1-99)
Daphnia: Average Drift (frac/day)	Green Sunfish2 Oxygen Pct. Killed (Percent, 1-99)
Green Sunfish,: Average Drift (frac/day)	Chironomid Oxygen EC50 Growth (mg/L 24 hr)
Shiner: Average Drift (frac/day)	Daphnia Oxygen EC50 Growth (mg/L 24 hr)
Green Sunfish2: Average Drift (frac/day)	Green Sunfish, Oxygen EC50 Growth (mg/L 24 hr)
Chironomid: VelMax (cm/s)	Shiner Oxygen EC50 Growth (mg/L 24 hr)
Daphnia: VelMax (cm/s)	Green Sunfish2 Oxygen EC50 Growth (mg/L 24 hr)
Green Sunfish,: VelMax (cm/s)	Chironomid Oxygen EC50 Repro (mg/L 24 hr)
Shiner: VelMax (cm/s)	Daphnia Oxygen EC50 Repro (mg/L 24 hr)
Green Sunfish2: VelMax (cm/s)	Green Sunfish, Oxygen EC50 Repro (mg/L 24 hr)
Chironomid: Mean Lifespan (days)	Shiner Oxygen EC50 Repro (mg/L 24 hr)
Daphnia: Mean Lifespan (days)	Green Sunfish2 Oxygen EC50 Repro (mg/L 24 hr)
Green Sunfish,: Mean Lifespan (days)	Chironomid Ammonia LC50 (mg/L)
Shiner: Mean Lifespan (days)	Daphnia Ammonia LC50 (mg/L)
Green Sunfish2: Mean Lifespan (days)	Green Sunfish, Ammonia LC50 (mg/L)
Chironomid: Initial Fraction Lipid (wet wt.)	Shiner Ammonia LC50 (mg/L)
Daphnia: Initial Fraction Lipid (wet wt.)	Green Sunfish2 Ammonia LC50 (mg/L)
Green Sunfish,: Initial Fraction Lipid (wet wt.)	Chironomid Sorting, selective feeding (unitless)
Shiner: Initial Fraction Lipid (wet wt.)	Daphnia Sorting, selective feeding (unitless)
Green Sunfish2: Initial Fraction Lipid (wet wt.)	Green Sunfish, Sorting, selective feeding (unitless)
Chironomid: Mean Weight (g)	Shiner Sorting, selective feeding (unitless)
Daphnia: Mean Weight (g)	Green Sunfish2 Sorting, selective feeding (unitless)
Green Sunfish,: Mean Weight (g)	Chironomid Slope for Sed Response (unitless)
Shiner: Mean Weight (g)	Daphnia Slope for Sed Response (unitless)
Green Sunfish2: Mean Weight (g)	Green Sunfish, Slope for Sed Response (unitless)
Chironomid: Pct in Riffle (if stream %)	Shiner Slope for Sed Response (unitless)
Daphnia: Pct in Riffle (if stream %)	Green Sunfish2 Slope for Sed Response (unitless)
Green Sunfish,: Pct in Riffle (if stream %)	Chironomid Intercept for Sed Response (unitless)
Shiner: Pct in Riffle (if stream %)	Daphnia Intercept for Sed Response (unitless)
Green Sunfish2: Pct in Riffle (if stream %)	Green Sunfish, Intercept for Sed Response (unitless)
Chironomid: Pct in Pool (if stream %)	Shiner Intercept for Sed Response (unitless)
Daphnia: Pct in Pool (if stream %)	Green Sunfish2 Intercept for Sed Response (unitless)
Green Sunfish,: Pct in Pool (if stream %)	Chironomid Trigger (dep. rate accel. drift in g/sq.m)
Shiner: Pct in Pool (if stream %)	Daphnia Trigger (dep. rate accel. drift in g/sq.m)
Green Sunfish2: Pct in Pool (if stream %)	Green Sunfish, Trigger (dep. rate accel. drift in g/sq.m)
Green Sunfish,: (Allometric) CA	Shiner Trigger (dep. rate accel. drift in g/sq.m)
Shiner: (Allometric) CA	Green Sunfish2 Trigger (dep. rate accel. drift in g/sq.m)
Green Sunfish2: (Allometric) CA	Chironomid Pct. Embedded Threshold
Green Sunfish,: (Allometric) CB	Green Sunfish, Pct. Embedded Threshold
Shiner: (Allometric) CB	Shiner Pct. Embedded Threshold
Green Sunfish2: (Allometric) CB	Green Sunfish2 Pct. Embedded Threshold
Green Sunfish,: (Allometric) RA	

Galveston Bay, TX:

T1: Molecular Weight	T1*Cynoscion* (sea: Multiply Loading by
T1: Dissasociation Constant (pKa)	T1: Mult. Direct Precip. Load by
T1: Solubility (ppm)	T1: Mult. Point Source Load by
T1: Henry's Law Const. (atm. m^3/mol)	Susp&Diss Detr: Mult. Point Source Load by
T1: Vapor Pressure (mm Hg)	T1: Mult. Non-Point Source Load by
T1: Octanol-Water Partition Coeff (Log Kow)	Susp&Diss Detr: Mult. Non-Point Source Load by
T1: Sed/Detr-Water Partition Coeff (mg/L)	Mulinia Frac. in Water Col. (unitless)
T1: Activation Energy for Temp (cal/mol)	Ostrea (oyster Frac. in Water Col. (unitless)
T1: Anaerobic Microbial Degrdn. (L/d)	Acteocina (gas Frac. in Water Col. (unitless)
T1: Aerobic Microbial Degrdn. (L/d)	Oyster Drill Frac. in Water Col. (unitless)
T1: Uncatalyzed Hydrolysis (L/d)	Penaeus (Shrim Frac. in Water Col. (unitless)
T1: Acid Catalyzed Hydrolysis (L/d)	Callinectes (C Frac. in Water Col. (unitless)
T1: Base Catalyzed Hydrolysis (L/d)	Anchoa (anchov Frac. in Water Col. (unitless)
T1: Photolysis Rate (L/d)	Brevoortia (me Frac. in Water Col. (unitless)
T1: Oxidation Rate Const (L/mol day)	Micropogonias Frac. in Water Col. (unitless)
T1: Weibull Shape Parameter	Mugil (mullet) Frac. in Water Col. (unitless)
Mulinia: Half Sat Feeding (mg/L)	Sciaenops (red Frac. in Water Col. (unitless)
Ostrea (oyster: Half Sat Feeding (mg/L)	Arius (catfish Frac. in Water Col. (unitless)
Acteocina (gas: Half Sat Feeding (mg/L)	*Cynoscion* (sm. Frac. in Water Col. (unitless)
Oyster Drill: Half Sat Feeding (mg/L)	*Cynoscion* (sea Frac. in Water Col. (unitless)
Penaeus (Shrim: Half Sat Feeding (mg/L)	Mulinia Min. Salinity Tolerance, Ingestion (0/00)
Callinectes (C: Half Sat Feeding (mg/L)	Ostrea (oyster Min. Salinity Tolerance, Ingestion (0/00)
Anchoa (anchov: Half Sat Feeding (mg/L)	Acteocina (gas Min. Salinity Tolerance, Ingestion (0/00)
Brevoortia (me: Half Sat Feeding (mg/L)	Oyster Drill Min. Salinity Tolerance, Ingestion (0/00)
Micropogonias : Half Sat Feeding (mg/L)	Penaeus (Shrim Min. Salinity Tolerance, Ingestion (0/00)
Mugil (mullet): Half Sat Feeding (mg/L)	Callinectes (C Min. Salinity Tolerance, Ingestion (0/00)
Sciaenops (red: Half Sat Feeding (mg/L)	Anchoa (anchov Min. Salinity Tolerance, Ingestion (0/00)
Arius (catfish: Half Sat Feeding (mg/L)	Brevoortia (me Min. Salinity Tolerance, Ingestion (0/00)
Cynoscion (sm.: Half Sat Feeding (mg/L)	Micropogonias Min. Salinity Tolerance, Ingestion (0/00)
Cynoscion (sea: Half Sat Feeding (mg/L)	Mugil (mullet) Min. Salinity Tolerance, Ingestion (0/00)
Mulinia: Max Consumption (g / g day)	Sciaenops (red Min. Salinity Tolerance, Ingestion (0/00)
Ostrea (oyster: Max Consumption (g / g day)	Arius (catfish Min. Salinity Tolerance, Ingestion (0/00)
Acteocina (gas: Max Consumption (g / g day)	*Cynoscion* (sm. Min. Salinity Tolerance, Ingestion (0/00)
Oyster Drill: Max Consumption (g / g day)	*Cynoscion* (sea Min. Salinity Tolerance, Ingestion (0/00)
Penaeus (Shrim: Max Consumption (g / g day)	Mulinia Max. Salinity Tolerance, Ingestion (0/00)
Callinectes (C: Max Consumption (g / g day)	Ostrea (oyster Max. Salinity Tolerance, Ingestion (0/00)
Anchoa (anchov: Max Consumption (g / g day)	Acteocina (gas Max. Salinity Tolerance, Ingestion (0/00)
Brevoortia (me: Max Consumption (g / g day)	Oyster Drill Max. Salinity Tolerance, Ingestion (0/00)
Micropogonias : Max Consumption (g / g day)	Penaeus (Shrim Max. Salinity Tolerance, Ingestion (0/00)
Mugil (mullet): Max Consumption (g / g day)	Callinectes (C Max. Salinity Tolerance, Ingestion (0/00)
Sciaenops (red: Max Consumption (g / g day)	Anchoa (anchov Max. Salinity Tolerance, Ingestion (0/00)
Arius (catfish: Max Consumption (g / g day)	Brevoortia (me Max. Salinity Tolerance, Ingestion (0/00)
Cynoscion (sm.: Max Consumption (g / g day)	Micropogonias Max. Salinity Tolerance, Ingestion (0/00)
Cynoscion (sea: Max Consumption (g / g day)	Mugil (mullet) Max. Salinity Tolerance, Ingestion (0/00)
Mulinia: Min Prey for Feeding	Sciaenops (red Max. Salinity Tolerance, Ingestion (0/00)
Ostrea (oyster: Min Prey for Feeding	Arius (catfish Max. Salinity Tolerance, Ingestion (0/00)
Acteocina (gas: Min Prey for Feeding	*Cynoscion* (sm. Max. Salinity Tolerance, Ingestion (0/00)
Oyster Drill: Min Prey for Feeding	*Cynoscion* (sea Max. Salinity Tolerance, Ingestion (0/00)
Penaeus (Shrim: Min Prey for Feeding	Mulinia Salinity Coeff1, Ingestion (unitless)
Callinectes (C: Min Prey for Feeding	Ostrea (oyster Salinity Coeff1, Ingestion (unitless)
Anchoa (anchov: Min Prey for Feeding	Acteocina (gas Salinity Coeff1, Ingestion (unitless)
Brevoortia (me: Min Prey for Feeding	Oyster Drill Salinity Coeff1, Ingestion (unitless)
Micropogonias : Min Prey for Feeding	Penaeus (Shrim Salinity Coeff1, Ingestion (unitless)

Galveston Bay, TX: Continued

Mugil (mullet): Min Prey for Feeding	Callinectes (C Salinity Coeff1, Ingestion (unitless)
Sciaenops (red: Min Prey for Feeding	Anchoa (anchov Salinity Coeff1, Ingestion (unitless)
Arius (catfish: Min Prey for Feeding	Brevoortia (me Salinity Coeff1, Ingestion (unitless)
Cynoscion (sm.: Min Prey for Feeding	Micropogonias Salinity Coeff1, Ingestion (unitless)
Cynoscion (sea: Min Prey for Feeding	Mugil (mullet) Salinity Coeff1, Ingestion (unitless)
Mulinia: Temperature Response Slope	Sciaenops (red Salinity Coeff1, Ingestion (unitless)
Ostrea (oyster: Temperature Response Slope	Arius (catfish Salinity Coeff1, Ingestion (unitless)
Acteocina (gas: Temperature Response Slope	*Cynoscion* (sm. Salinity Coeff1, Ingestion (unitless)
Oyster Drill: Temperature Response Slope	*Cynoscion* (sea Salinity Coeff1, Ingestion (unitless)
Penaeus (Shrim: Temperature Response Slope	Mulinia Salinity Coeff2, Ingestion (unitless)
Callinectes (C: Temperature Response Slope	Ostrea (oyster Salinity Coeff2, Ingestion (unitless)
Anchoa (anchov: Temperature Response Slope	Acteocina (gas Salinity Coeff2, Ingestion (unitless)
Brevoortia (me: Temperature Response Slope	Oyster Drill Salinity Coeff2, Ingestion (unitless)
Micropogonias : Temperature Response Slope	Penaeus (Shrim Salinity Coeff2, Ingestion (unitless)
Mugil (mullet): Temperature Response Slope	Callinectes (C Salinity Coeff2, Ingestion (unitless)
Sciaenops (red: Temperature Response Slope	Anchoa (anchov Salinity Coeff2, Ingestion (unitless)
Arius (catfish: Temperature Response Slope	Brevoortia (me Salinity Coeff2, Ingestion (unitless)
Cynoscion (sm.: Temperature Response Slope	Micropogonias Salinity Coeff2, Ingestion (unitless)
Cynoscion (sea: Temperature Response Slope	Mugil (mullet) Salinity Coeff2, Ingestion (unitless)
Mulinia: Optimal Temperature (deg. C)	Sciaenops (red Salinity Coeff2, Ingestion (unitless)
Ostrea (oyster: Optimal Temperature (deg. C)	Arius (catfish Salinity Coeff2, Ingestion (unitless)
Acteocina (gas: Optimal Temperature (deg. C)	*Cynoscion* (sm. Salinity Coeff2, Ingestion (unitless)
Oyster Drill: Optimal Temperature (deg. C)	*Cynoscion* (sea Salinity Coeff2, Ingestion (unitless)
Penaeus (Shrim: Optimal Temperature (deg. C)	Mulinia Min. Salinity Tolerance, Gameteloss (0/00)
Callinectes (C: Optimal Temperature (deg. C)	Ostrea (oyster Min. Salinity Tolerance, Gameteloss (0/00)
Anchoa (anchov: Optimal Temperature (deg. C)	Acteocina (gas Min. Salinity Tolerance, Gameteloss (0/00)
Brevoortia (me: Optimal Temperature (deg. C)	Oyster Drill Min. Salinity Tolerance, Gameteloss (0/00)
Micropogonias : Optimal Temperature (deg. C)	Penaeus (Shrim Min. Salinity Tolerance, Gameteloss (0/00)
Mugil (mullet): Optimal Temperature (deg. C)	Callinectes (C Min. Salinity Tolerance, Gameteloss (0/00)
Sciaenops (red: Optimal Temperature (deg. C)	Anchoa (anchov Min. Salinity Tolerance, Gameteloss (0/00)
Arius (catfish: Optimal Temperature (deg. C)	Brevoortia (me Min. Salinity Tolerance, Gameteloss (0/00)
Cynoscion (sm.: Optimal Temperature (deg. C)	Micropogonias Min. Salinity Tolerance, Gameteloss (0/00)
Cynoscion (sea: Optimal Temperature (deg. C)	Mugil (mullet) Min. Salinity Tolerance, Gameteloss (0/00)
Mulinia: Maximum Temperature (deg. C)	Sciaenops (red Min. Salinity Tolerance, Gameteloss (0/00)
Ostrea (oyster: Maximum Temperature (deg. C)	Arius (catfish Min. Salinity Tolerance, Gameteloss (0/00)
Acteocina (gas: Maximum Temperature (deg. C)	*Cynoscion* (sm. Min. Salinity Tolerance, Gameteloss (0/00)
Oyster Drill: Maximum Temperature (deg. C)	*Cynoscion* (sea Min. Salinity Tolerance, Gameteloss (0/00)
Penaeus (Shrim: Maximum Temperature (deg. C)	Mulinia Max. Salinity Tolerance, Gameteloss (0/00)
Callinectes (C: Maximum Temperature (deg. C)	Ostrea (oyster Max. Salinity Tolerance, Gameteloss (0/00)
Anchoa (anchov: Maximum Temperature (deg. C)	Acteocina (gas Max. Salinity Tolerance, Gameteloss (0/00)
Brevoortia (me: Maximum Temperature (deg. C)	Oyster Drill Max. Salinity Tolerance, Gameteloss (0/00)
Micropogonias : Maximum Temperature (deg. C)	Penaeus (Shrim Max. Salinity Tolerance, Gameteloss (0/00)
Mugil (mullet): Maximum Temperature (deg. C)	Callinectes (C Max. Salinity Tolerance, Gameteloss (0/00)
Sciaenops (red: Maximum Temperature (deg. C)	Anchoa (anchov Max. Salinity Tolerance, Gameteloss (0/00)
Arius (catfish: Maximum Temperature (deg. C)	Brevoortia (me Max. Salinity Tolerance, Gameteloss (0/00)
Cynoscion (sm.: Maximum Temperature (deg. C)	Micropogonias Max. Salinity Tolerance, Gameteloss (0/00)
Cynoscion (sea: Maximum Temperature (deg. C)	Mugil (mullet) Max. Salinity Tolerance, Gameteloss (0/00)
Mulinia: Min Adaptation Temperature (deg. C)	Sciaenops (red Max. Salinity Tolerance, Gameteloss (0/00)
Ostrea (oyster: Min Adaptation Temperature (deg. C)	Arius (catfish Max. Salinity Tolerance, Gameteloss (0/00)
Acteocina (gas: Min Adaptation Temperature (deg. C)	*Cynoscion* (sm. Max. Salinity Tolerance, Gameteloss (0/00)
Oyster Drill: Min Adaptation Temperature (deg. C)	*Cynoscion* (sea Max. Salinity Tolerance, Gameteloss (0/00)
Penaeus (Shrim: Min Adaptation Temperature (deg. C)	Mulinia Salinity Coeff1, Gameteloss (unitless)
Callinectes (C: Min Adaptation Temperature (deg. C)	Ostrea (oyster Salinity Coeff1, Gameteloss (unitless)

Galveston Bay, TX: Continued

Anchoa (anchov: Min Adaptation Temperature (deg. C)	Acteocina (gas Salinity Coeff1, Gameteloss (unitless)
Brevoortia (me: Min Adaptation Temperature (deg. C)	Oyster Drill Salinity Coeff1, Gameteloss (unitless)
Micropogonias : Min Adaptation Temperature (deg. C)	Penaeus (Shrim Salinity Coeff1, Gameteloss (unitless)
Mugil (mullet): Min Adaptation Temperature (deg. C)	Callinectes (C Salinity Coeff1, Gameteloss (unitless)
Sciaenops (red: Min Adaptation Temperature (deg. C)	Anchoa (anchov Salinity Coeff1, Gameteloss (unitless)
Arius (catfish: Min Adaptation Temperature (deg. C)	Brevoortia (me Salinity Coeff1, Gameteloss (unitless)
Cynoscion (sm.: Min Adaptation Temperature (deg. C)	Micropogonias Salinity Coeff1, Gameteloss (unitless)
Cynoscion (sea: Min Adaptation Temperature (deg. C)	Mugil (mullet) Salinity Coeff1, Gameteloss (unitless)
Mulinia: Respiration Rate: (1 / d)	Sciaenops (red Salinity Coeff1, Gameteloss (unitless)
Ostrea (oyster: Respiration Rate: (1 / d)	Arius (catfish Salinity Coeff1, Gameteloss (unitless)
Acteocina (gas: Respiration Rate: (1 / d)	*Cynoscion* (sm. Salinity Coeff1, Gameteloss (unitless)
Oyster Drill: Respiration Rate: (1 / d)	*Cynoscion* (sea Salinity Coeff1, Gameteloss (unitless)
Penaeus (Shrim: Respiration Rate: (1 / d)	Mulinia Salinity Coeff2, Gameteloss (unitless)
Callinectes (C: Respiration Rate: (1 / d)	Ostrea (oyster Salinity Coeff2, Gameteloss (unitless)
Anchoa (anchov: Respiration Rate: (1 / d)	Acteocina (gas Salinity Coeff2, Gameteloss (unitless)
Brevoortia (me: Respiration Rate: (1 / d)	Oyster Drill Salinity Coeff2, Gameteloss (unitless)
Micropogonias : Respiration Rate: (1 / d)	Penaeus (Shrim Salinity Coeff2, Gameteloss (unitless)
Mugil (mullet): Respiration Rate: (1 / d)	Callinectes (C Salinity Coeff2, Gameteloss (unitless)
Sciaenops (red: Respiration Rate: (1 / d)	Anchoa (anchov Salinity Coeff2, Gameteloss (unitless)
Arius (catfish: Respiration Rate: (1 / d)	Brevoortia (me Salinity Coeff2, Gameteloss (unitless)
Cynoscion (sm.: Respiration Rate: (1 / d)	Micropogonias Salinity Coeff2, Gameteloss (unitless)
Cynoscion (sea: Respiration Rate: (1 / d)	Mugil (mullet) Salinity Coeff2, Gameteloss (unitless)
Mulinia: Specific Dynamic Action	Sciaenops (red Salinity Coeff2, Gameteloss (unitless)
Ostrea (oyster: Specific Dynamic Action	Arius (catfish Salinity Coeff2, Gameteloss (unitless)
Acteocina (gas: Specific Dynamic Action	*Cynoscion* (sm. Salinity Coeff2, Gameteloss (unitless)
Oyster Drill: Specific Dynamic Action	*Cynoscion* (sea Salinity Coeff2, Gameteloss (unitless)
Penaeus (Shrim: Specific Dynamic Action	Mulinia Min. Salinity Tolerance, Respiration (0/00)
Callinectes (C: Specific Dynamic Action	Ostrea (oyster Min. Salinity Tolerance, Respiration (0/00)
Anchoa (anchov: Specific Dynamic Action	Acteocina (gas Min. Salinity Tolerance, Respiration (0/00)
Brevoortia (me: Specific Dynamic Action	Oyster Drill Min. Salinity Tolerance, Respiration (0/00)
Micropogonias : Specific Dynamic Action	Penaeus (Shrim Min. Salinity Tolerance, Respiration (0/00)
Mugil (mullet): Specific Dynamic Action	Callinectes (C Min. Salinity Tolerance, Respiration (0/00)
Sciaenops (red: Specific Dynamic Action	Anchoa (anchov Min. Salinity Tolerance, Respiration (0/00)
Arius (catfish: Specific Dynamic Action	Brevoortia (me Min. Salinity Tolerance, Respiration (0/00)
Cynoscion (sm.: Specific Dynamic Action	Micropogonias Min. Salinity Tolerance, Respiration (0/00)
Cynoscion (sea: Specific Dynamic Action	Mugil (mullet) Min. Salinity Tolerance, Respiration (0/00)
Mulinia: Excretion:Respiration (ratio)	Sciaenops (red Min. Salinity Tolerance, Respiration (0/00)
Ostrea (oyster: Excretion:Respiration (ratio)	Arius (catfish Min. Salinity Tolerance, Respiration (0/00)
Acteocina (gas: Excretion:Respiration (ratio)	*Cynoscion* (sm. Min. Salinity Tolerance, Respiration (0/00)
Oyster Drill: Excretion:Respiration (ratio)	*Cynoscion* (sea Min. Salinity Tolerance, Respiration (0/00)
Penaeus (Shrim: Excretion:Respiration (ratio)	Mulinia Max. Salinity Tolerance, Respiration (0/00)
Callinectes (C: Excretion:Respiration (ratio)	Ostrea (oyster Max. Salinity Tolerance, Respiration (0/00)
Anchoa (anchov: Excretion:Respiration (ratio)	Acteocina (gas Max. Salinity Tolerance, Respiration (0/00)
Brevoortia (me: Excretion:Respiration (ratio)	Oyster Drill Max. Salinity Tolerance, Respiration (0/00)
Micropogonias : Excretion:Respiration (ratio)	Penaeus (Shrim Max. Salinity Tolerance, Respiration (0/00)
Mugil (mullet): Excretion:Respiration (ratio)	Callinectes (C Max. Salinity Tolerance, Respiration (0/00)
Sciaenops (red: Excretion:Respiration (ratio)	Anchoa (anchov Max. Salinity Tolerance, Respiration (0/00)
Arius (catfish: Excretion:Respiration (ratio)	Brevoortia (me Max. Salinity Tolerance, Respiration (0/00)
Cynoscion (sm.: Excretion:Respiration (ratio)	Micropogonias Max. Salinity Tolerance, Respiration (0/00)
Cynoscion (sea: Excretion:Respiration (ratio)	Mugil (mullet) Max. Salinity Tolerance, Respiration (0/00)
Mulinia: Gametes:Biomass (ratio)	Sciaenops (red Max. Salinity Tolerance, Respiration (0/00)
Ostrea (oyster: Gametes:Biomass (ratio)	Arius (catfish Max. Salinity Tolerance, Respiration (0/00)
Acteocina (gas: Gametes:Biomass (ratio)	*Cynoscion* (sm. Max. Salinity Tolerance, Respiration (0/00)

Galveston Bay, TX: Continued

Oyster Drill: Gametes:Biomass (ratio)	*Cynoscion* (sea Max. Salinity Tolerance, Respiration (0/00)
Penaeus (Shrim: Gametes:Biomass (ratio)	Mulinia Salinity Coeff1, Respiration (unitless)
Callinectes (C: Gametes:Biomass (ratio)	Ostrea (oyster Salinity Coeff1, Respiration (unitless)
Anchoa (anchov: Gametes:Biomass (ratio)	Acteocina (gas Salinity Coeff1, Respiration (unitless)
Brevoortia (me: Gametes:Biomass (ratio)	Oyster Drill Salinity Coeff1, Respiration (unitless)
Micropogonias : Gametes:Biomass (ratio)	Penaeus (Shrim Salinity Coeff1, Respiration (unitless)
Mugil (mullet): Gametes:Biomass (ratio)	Callinectes (C Salinity Coeff1, Respiration (unitless)
Sciaenops (red: Gametes:Biomass (ratio)	Anchoa (anchov Salinity Coeff1, Respiration (unitless)
Arius (catfish: Gametes:Biomass (ratio)	Brevoortia (me Salinity Coeff1, Respiration (unitless)
Cynoscion (sm.: Gametes:Biomass (ratio)	Micropogonias Salinity Coeff1, Respiration (unitless)
Cynoscion (sea: Gametes:Biomass (ratio)	Mugil (mullet) Salinity Coeff1, Respiration (unitless)
Mulinia: Gametes Mortality (1/d)	Sciaenops (red Salinity Coeff1, Respiration (unitless)
Ostrea (oyster: Gametes Mortality (1/d)	Arius (catfish Salinity Coeff1, Respiration (unitless)
Acteocina (gas: Gametes Mortality (1/d)	*Cynoscion* (sm. Salinity Coeff1, Respiration (unitless)
Oyster Drill: Gametes Mortality (1/d)	*Cynoscion* (sea Salinity Coeff1, Respiration (unitless)
Penaeus (Shrim: Gametes Mortality (1/d)	Mulinia Salinity Coeff2, Respiration (unitless)
Callinectes (C: Gametes Mortality (1/d)	Ostrea (oyster Salinity Coeff2, Respiration (unitless)
Anchoa (anchov: Gametes Mortality (1/d)	Acteocina (gas Salinity Coeff2, Respiration (unitless)
Brevoortia (me: Gametes Mortality (1/d)	Oyster Drill Salinity Coeff2, Respiration (unitless)
Micropogonias : Gametes Mortality (1/d)	Penaeus (Shrim Salinity Coeff2, Respiration (unitless)
Mugil (mullet): Gametes Mortality (1/d)	Callinectes (C Salinity Coeff2, Respiration (unitless)
Sciaenops (red: Gametes Mortality (1/d)	Anchoa (anchov Salinity Coeff2, Respiration (unitless)
Arius (catfish: Gametes Mortality (1/d)	Brevoortia (me Salinity Coeff2, Respiration (unitless)
Cynoscion (sm.: Gametes Mortality (1/d)	Micropogonias Salinity Coeff2, Respiration (unitless)
Cynoscion (sea: Gametes Mortality (1/d)	Mugil (mullet) Salinity Coeff2, Respiration (unitless)
Mulinia: Mortality Coeff (1/d)	Sciaenops (red Salinity Coeff2, Respiration (unitless)
Ostrea (oyster: Mortality Coeff (1/d)	Arius (catfish Salinity Coeff2, Respiration (unitless)
Acteocina (gas: Mortality Coeff (1/d)	*Cynoscion* (sm. Salinity Coeff2, Respiration (unitless)
Oyster Drill: Mortality Coeff (1/d)	*Cynoscion* (sea Salinity Coeff2, Respiration (unitless)
Penaeus (Shrim: Mortality Coeff (1/d)	Mulinia Min. Salinity Tolerance, Mortality (0/00)
Callinectes (C: Mortality Coeff (1/d)	Ostrea (oyster Min. Salinity Tolerance, Mortality (0/00)
Anchoa (anchov: Mortality Coeff (1/d)	Acteocina (gas Min. Salinity Tolerance, Mortality (0/00)
Brevoortia (me: Mortality Coeff (1/d)	Oyster Drill Min. Salinity Tolerance, Mortality (0/00)
Micropogonias : Mortality Coeff (1/d)	Penaeus (Shrim Min. Salinity Tolerance, Mortality (0/00)
Mugil (mullet): Mortality Coeff (1/d)	Callinectes (C Min. Salinity Tolerance, Mortality (0/00)
Sciaenops (red: Mortality Coeff (1/d)	Anchoa (anchov Min. Salinity Tolerance, Mortality (0/00)
Arius (catfish: Mortality Coeff (1/d)	Brevoortia (me Min. Salinity Tolerance, Mortality (0/00)
Cynoscion (sm.: Mortality Coeff (1/d)	Micropogonias Min. Salinity Tolerance, Mortality (0/00)
Cynoscion (sea: Mortality Coeff (1/d)	Mugil (mullet) Min. Salinity Tolerance, Mortality (0/00)
Mulinia: Carrying Capacity (g/sq.m)	Sciaenops (red Min. Salinity Tolerance, Mortality (0/00)
Ostrea (oyster: Carrying Capacity (g/sq.m)	Arius (catfish Min. Salinity Tolerance, Mortality (0/00)
Acteocina (gas: Carrying Capacity (g/sq.m)	*Cynoscion* (sm. Min. Salinity Tolerance, Mortality (0/00)
Oyster Drill: Carrying Capacity (g/sq.m)	*Cynoscion* (sea Min. Salinity Tolerance, Mortality (0/00)
Penaeus (Shrim: Carrying Capacity (g/sq.m)	Mulinia Max. Salinity Tolerance, Mortality (0/00)
Callinectes (C: Carrying Capacity (g/sq.m)	Ostrea (oyster Max. Salinity Tolerance, Mortality (0/00)
Anchoa (anchov: Carrying Capacity (g/sq.m)	Acteocina (gas Max. Salinity Tolerance, Mortality (0/00)
Brevoortia (me: Carrying Capacity (g/sq.m)	Oyster Drill Max. Salinity Tolerance, Mortality (0/00)
Micropogonias : Carrying Capacity (g/sq.m)	Penaeus (Shrim Max. Salinity Tolerance, Mortality (0/00)
Mugil (mullet): Carrying Capacity (g/sq.m)	Callinectes (C Max. Salinity Tolerance, Mortality (0/00)
Sciaenops (red: Carrying Capacity (g/sq.m)	Anchoa (anchov Max. Salinity Tolerance, Mortality (0/00)
Arius (catfish: Carrying Capacity (g/sq.m)	Brevoortia (me Max. Salinity Tolerance, Mortality (0/00)
Cynoscion (sm.: Carrying Capacity (g/sq.m)	Micropogonias Max. Salinity Tolerance, Mortality (0/00)
Cynoscion (sea: Carrying Capacity (g/sq.m)	Mugil (mullet) Max. Salinity Tolerance, Mortality (0/00)

Galveston Bay, TX: Continued

Mulinia: Average Drift (frac/day)	Sciaenops (red Max. Salinity Tolerance, Mortality (0/00)
Ostrea (oyster: Average Drift (frac/day)	Arius (catfish Max. Salinity Tolerance, Mortality (0/00)
Acteocina (gas: Average Drift (frac/day)	*Cynoscion* (sm. Max. Salinity Tolerance, Mortality (0/00)
Oyster Drill: Average Drift (frac/day)	*Cynoscion* (sea Max. Salinity Tolerance, Mortality (0/00)
Penaeus (Shrim: Average Drift (frac/day)	Mulinia Salinity Coeff1, Mortality (unitless)
Callinectes (C: Average Drift (frac/day)	Ostrea (oyster Salinity Coeff1, Mortality (unitless)
Anchoa (anchov: Average Drift (frac/day)	Acteocina (gas Salinity Coeff1, Mortality (unitless)
Brevoortia (me: Average Drift (frac/day)	Oyster Drill Salinity Coeff1, Mortality (unitless)
Micropogonias : Average Drift (frac/day)	Penaeus (Shrim Salinity Coeff1, Mortality (unitless)
Mugil (mullet): Average Drift (frac/day)	Callinectes (C Salinity Coeff1, Mortality (unitless)
Sciaenops (red: Average Drift (frac/day)	Anchoa (anchov Salinity Coeff1, Mortality (unitless)
Arius (catfish: Average Drift (frac/day)	Brevoortia (me Salinity Coeff1, Mortality (unitless)
Cynoscion (sm.: Average Drift (frac/day)	Micropogonias Salinity Coeff1, Mortality (unitless)
Cynoscion (sea: Average Drift (frac/day)	Mugil (mullet) Salinity Coeff1, Mortality (unitless)
Mulinia: VelMax (cm/s)	Sciaenops (red Salinity Coeff1, Mortality (unitless)
Ostrea (oyster: VelMax (cm/s)	Arius (catfish Salinity Coeff1, Mortality (unitless)
Acteocina (gas: VelMax (cm/s)	*Cynoscion* (sm. Salinity Coeff1, Mortality (unitless)
Oyster Drill: VelMax (cm/s)	*Cynoscion* (sea Salinity Coeff1, Mortality (unitless)
Penaeus (Shrim: VelMax (cm/s)	Mulinia Salinity Coeff2, Mortality (unitless)
Callinectes (C: VelMax (cm/s)	Ostrea (oyster Salinity Coeff2, Mortality (unitless)
Anchoa (anchov: VelMax (cm/s)	Acteocina (gas Salinity Coeff2, Mortality (unitless)
Brevoortia (me: VelMax (cm/s)	Oyster Drill Salinity Coeff2, Mortality (unitless)
Micropogonias : VelMax (cm/s)	Penaeus (Shrim Salinity Coeff2, Mortality (unitless)
Mugil (mullet): VelMax (cm/s)	Callinectes (C Salinity Coeff2, Mortality (unitless)
Sciaenops (red: VelMax (cm/s)	Anchoa (anchov Salinity Coeff2, Mortality (unitless)
Arius (catfish: VelMax (cm/s)	Brevoortia (me Salinity Coeff2, Mortality (unitless)
Cynoscion (sm.: VelMax (cm/s)	Micropogonias Salinity Coeff2, Mortality (unitless)
Cynoscion (sea: VelMax (cm/s)	Mugil (mullet) Salinity Coeff2, Mortality (unitless)
Mulinia: Mean Lifespan (days)	Sciaenops (red Salinity Coeff2, Mortality (unitless)
Ostrea (oyster: Mean Lifespan (days)	Arius (catfish Salinity Coeff2, Mortality (unitless)
Acteocina (gas: Mean Lifespan (days)	*Cynoscion* (sm. Salinity Coeff2, Mortality (unitless)
Oyster Drill: Mean Lifespan (days)	*Cynoscion* (sea Salinity Coeff2, Mortality (unitless)
Penaeus (Shrim: Mean Lifespan (days)	Mulinia Fishing Fraction (frac/d)
Callinectes (C: Mean Lifespan (days)	Ostrea (oyster Fishing Fraction (frac/d)
Anchoa (anchov: Mean Lifespan (days)	Acteocina (gas Fishing Fraction (frac/d)
Brevoortia (me: Mean Lifespan (days)	Oyster Drill Fishing Fraction (frac/d)
Micropogonias : Mean Lifespan (days)	Penaeus (Shrim Fishing Fraction (frac/d)
Mugil (mullet): Mean Lifespan (days)	Callinectes (C Fishing Fraction (frac/d)
Sciaenops (red: Mean Lifespan (days)	Anchoa (anchov Fishing Fraction (frac/d)
Arius (catfish: Mean Lifespan (days)	Brevoortia (me Fishing Fraction (frac/d)
Cynoscion (sm.: Mean Lifespan (days)	Micropogonias Fishing Fraction (frac/d)
Cynoscion (sea: Mean Lifespan (days)	Mugil (mullet) Fishing Fraction (frac/d)
Mulinia: Initial Fraction Lipid (wet wt.)	Sciaenops (red Fishing Fraction (frac/d)
Ostrea (oyster: Initial Fraction Lipid (wet wt.)	Arius (catfish Fishing Fraction (frac/d)
Acteocina (gas: Initial Fraction Lipid (wet wt.)	*Cynoscion* (sm. Fishing Fraction (frac/d)
Oyster Drill: Initial Fraction Lipid (wet wt.)	*Cynoscion* (sea Fishing Fraction (frac/d)
Penaeus (Shrim: Initial Fraction Lipid (wet wt.)	Mulinia P to Organics (frac dry)
Callinectes (C: Initial Fraction Lipid (wet wt.)	Ostrea (oyster P to Organics (frac dry)
Anchoa (anchov: Initial Fraction Lipid (wet wt.)	Acteocina (gas P to Organics (frac dry)
Brevoortia (me: Initial Fraction Lipid (wet wt.)	Oyster Drill P to Organics (frac dry)
Micropogonias : Initial Fraction Lipid (wet wt.)	Penaeus (Shrim P to Organics (frac dry)
Mugil (mullet): Initial Fraction Lipid (wet wt.)	Callinectes (C P to Organics (frac dry)
Sciaenops (red: Initial Fraction Lipid (wet wt.)	Anchoa (anchov P to Organics (frac dry)

Galveston Bay, TX: Continued

Arius (catfish: Initial Fraction Lipid (wet wt.)	Brevoortia (me P to Organics (frac dry)
Cynoscion (sm.: Initial Fraction Lipid (wet wt.)	Micropogonias P to Organics (frac dry)
Cynoscion (sea: Initial Fraction Lipid (wet wt.)	Mugil (mullet) P to Organics (frac dry)
Mulinia: Mean Weight (g)	Sciaenops (red P to Organics (frac dry)
Ostrea (oyster: Mean Weight (g)	Arius (catfish P to Organics (frac dry)
Acteocina (gas: Mean Weight (g)	*Cynoscion* (sm. P to Organics (frac dry)
Oyster Drill: Mean Weight (g)	*Cynoscion* (sea P to Organics (frac dry)
Penaeus (Shrim: Mean Weight (g)	Mulinia N to Organics (frac dry)
Callinectes (C: Mean Weight (g)	Ostrea (oyster N to Organics (frac dry)
Anchoa (anchov: Mean Weight (g)	Acteocina (gas N to Organics (frac dry)
Brevoortia (me: Mean Weight (g)	Oyster Drill N to Organics (frac dry)
Micropogonias : Mean Weight (g)	Penaeus (Shrim N to Organics (frac dry)
Mugil (mullet): Mean Weight (g)	Callinectes (C N to Organics (frac dry)
Sciaenops (red: Mean Weight (g)	Anchoa (anchov N to Organics (frac dry)
Arius (catfish: Mean Weight (g)	Brevoortia (me N to Organics (frac dry)
Cynoscion (sm.: Mean Weight (g)	Micropogonias N to Organics (frac dry)
Cynoscion (sea: Mean Weight (g)	Mugil (mullet) N to Organics (frac dry)
Mulinia: Pct in Riffle (if stream %)	Sciaenops (red N to Organics (frac dry)
Ostrea (oyster: Pct in Riffle (if stream %)	Arius (catfish N to Organics (frac dry)
Acteocina (gas: Pct in Riffle (if stream %)	*Cynoscion* (sm. N to Organics (frac dry)
Oyster Drill: Pct in Riffle (if stream %)	*Cynoscion* (sea N to Organics (frac dry)
Penaeus (Shrim: Pct in Riffle (if stream %)	Mulinia Wet to Dry (ratio)
Callinectes (C: Pct in Riffle (if stream %)	Ostrea (oyster Wet to Dry (ratio)
Anchoa (anchov: Pct in Riffle (if stream %)	Acteocina (gas Wet to Dry (ratio)
Brevoortia (me: Pct in Riffle (if stream %)	Oyster Drill Wet to Dry (ratio)
Micropogonias : Pct in Riffle (if stream %)	Penaeus (Shrim Wet to Dry (ratio)
Mugil (mullet): Pct in Riffle (if stream %)	Callinectes (C Wet to Dry (ratio)
Sciaenops (red: Pct in Riffle (if stream %)	Anchoa (anchov Wet to Dry (ratio)
Arius (catfish: Pct in Riffle (if stream %)	Brevoortia (me Wet to Dry (ratio)
Cynoscion (sm.: Pct in Riffle (if stream %)	Micropogonias Wet to Dry (ratio)
Cynoscion (sea: Pct in Riffle (if stream %)	Mugil (mullet) Wet to Dry (ratio)
Mulinia: Pct in Pool (if stream %)	Sciaenops (red Wet to Dry (ratio)
Ostrea (oyster: Pct in Pool (if stream %)	Arius (catfish Wet to Dry (ratio)
Acteocina (gas: Pct in Pool (if stream %)	*Cynoscion* (sm. Wet to Dry (ratio)
Oyster Drill: Pct in Pool (if stream %)	*Cynoscion* (sea Wet to Dry (ratio)
Penaeus (Shrim: Pct in Pool (if stream %)	Mulinia Oxygen Lethal Conc (mg/L 24 hr)
Callinectes (C: Pct in Pool (if stream %)	Ostrea (oyster Oxygen Lethal Conc (mg/L 24 hr)
Anchoa (anchov: Pct in Pool (if stream %)	Acteocina (gas Oxygen Lethal Conc (mg/L 24 hr)
Brevoortia (me: Pct in Pool (if stream %)	Oyster Drill Oxygen Lethal Conc (mg/L 24 hr)
Micropogonias : Pct in Pool (if stream %)	Penaeus (Shrim Oxygen Lethal Conc (mg/L 24 hr)
Mugil (mullet): Pct in Pool (if stream %)	Callinectes (C Oxygen Lethal Conc (mg/L 24 hr)
Sciaenops (red: Pct in Pool (if stream %)	Anchoa (anchov Oxygen Lethal Conc (mg/L 24 hr)
Arius (catfish: Pct in Pool (if stream %)	Brevoortia (me Oxygen Lethal Conc (mg/L 24 hr)
Cynoscion (sm.: Pct in Pool (if stream %)	Micropogonias Oxygen Lethal Conc (mg/L 24 hr)
Cynoscion (sea: Pct in Pool (if stream %)	Mugil (mullet) Oxygen Lethal Conc (mg/L 24 hr)
Anchoa (anchov: (Allometric) CA	Sciaenops (red Oxygen Lethal Conc (mg/L 24 hr)
Brevoortia (me: (Allometric) CA	Arius (catfish Oxygen Lethal Conc (mg/L 24 hr)
Micropogonias : (Allometric) CA	*Cynoscion* (sm. Oxygen Lethal Conc (mg/L 24 hr)
Mugil (mullet): (Allometric) CA	*Cynoscion* (sea Oxygen Lethal Conc (mg/L 24 hr)
Sciaenops (red: (Allometric) CA	Mulinia Oxygen Pct. Killed (Percent, 1-99)
Arius (catfish: (Allometric) CA	Ostrea (oyster Oxygen Pct. Killed (Percent, 1-99)
Cynoscion (sm.: (Allometric) CA	Acteocina (gas Oxygen Pct. Killed (Percent, 1-99)
Cynoscion (sea: (Allometric) CA	Oyster Drill Oxygen Pct. Killed (Percent, 1-99)

Galveston Bay, TX: Continued

Anchoa (anchov: (Allometric) CB	Penaeus (Shrim Oxygen Pct. Killed (Percent, 1-99)
Brevoortia (me: (Allometric) CB	Callinectes (C Oxygen Pct. Killed (Percent, 1-99)
Micropogonias : (Allometric) CB	Anchoa (anchov Oxygen Pct. Killed (Percent, 1-99)
Mugil (mullet): (Allometric) CB	Brevoortia (me Oxygen Pct. Killed (Percent, 1-99)
Sciaenops (red: (Allometric) CB	Micropogonias Oxygen Pct. Killed (Percent, 1-99)
Arius (catfish: (Allometric) CB	Mugil (mullet) Oxygen Pct. Killed (Percent, 1-99)
Cynoscion (sm.: (Allometric) CB	Sciaenops (red Oxygen Pct. Killed (Percent, 1-99)
Cynoscion (sea: (Allometric) CB	Arius (catfish Oxygen Pct. Killed (Percent, 1-99)
Anchoa (anchov: (Allometric) RA	*Cynoscion* (sm. Oxygen Pct. Killed (Percent, 1-99)
Brevoortia (me: (Allometric) RA	*Cynoscion* (sea Oxygen Pct. Killed (Percent, 1-99)
Micropogonias : (Allometric) RA	Mulinia Oxygen EC50 Growth (mg/L 24 hr)
Mugil (mullet): (Allometric) RA	Ostrea (oyster Oxygen EC50 Growth (mg/L 24 hr)
Sciaenops (red: (Allometric) RA	Acteocina (gas Oxygen EC50 Growth (mg/L 24 hr)
Arius (catfish: (Allometric) RA	Oyster Drill Oxygen EC50 Growth (mg/L 24 hr)
Cynoscion (sm.: (Allometric) RA	Penaeus (Shrim Oxygen EC50 Growth (mg/L 24 hr)
Cynoscion (sea: (Allometric) RA	Callinectes (C Oxygen EC50 Growth (mg/L 24 hr)
Anchoa (anchov: (Allometric) RB	Anchoa (anchov Oxygen EC50 Growth (mg/L 24 hr)
Brevoortia (me: (Allometric) RB	Brevoortia (me Oxygen EC50 Growth (mg/L 24 hr)
Micropogonias : (Allometric) RB	Micropogonias Oxygen EC50 Growth (mg/L 24 hr)
Mugil (mullet): (Allometric) RB	Mugil (mullet) Oxygen EC50 Growth (mg/L 24 hr)
Sciaenops (red: (Allometric) RB	Sciaenops (red Oxygen EC50 Growth (mg/L 24 hr)
Arius (catfish: (Allometric) RB	Arius (catfish Oxygen EC50 Growth (mg/L 24 hr)
Cynoscion (sm.: (Allometric) RB	*Cynoscion* (sm. Oxygen EC50 Growth (mg/L 24 hr)
Cynoscion (sea: (Allometric) RB	*Cynoscion* (sea Oxygen EC50 Growth (mg/L 24 hr)
Anchoa (anchov: (Allometric) ACT	Mulinia Oxygen EC50 Repro (mg/L 24 hr)
Brevoortia (me: (Allometric) ACT	Ostrea (oyster Oxygen EC50 Repro (mg/L 24 hr)
Micropogonias : (Allometric) ACT	Acteocina (gas Oxygen EC50 Repro (mg/L 24 hr)
Mugil (mullet): (Allometric) ACT	Oyster Drill Oxygen EC50 Repro (mg/L 24 hr)
Sciaenops (red: (Allometric) ACT	Penaeus (Shrim Oxygen EC50 Repro (mg/L 24 hr)
Arius (catfish: (Allometric) ACT	Callinectes (C Oxygen EC50 Repro (mg/L 24 hr)
Cynoscion (sm.: (Allometric) ACT	Anchoa (anchov Oxygen EC50 Repro (mg/L 24 hr)
Cynoscion (sea: (Allometric) ACT	Brevoortia (me Oxygen EC50 Repro (mg/L 24 hr)
R detr sed: Initial Condition (g/m2 dry)	Micropogonias Oxygen EC50 Repro (mg/L 24 hr)
L detr sed: Initial Condition (g/m2 dry)	Mugil (mullet) Oxygen EC50 Repro (mg/L 24 hr)
BuryRDetr: Initial Condition (g/m2)	Sciaenops (red Oxygen EC50 Repro (mg/L 24 hr)
T1R detr sed: Initial Condition (ug/kg dry)	Arius (catfish Oxygen EC50 Repro (mg/L 24 hr)
T1L detr sed: Initial Condition (ug/kg dry)	*Cynoscion* (sm. Oxygen EC50 Repro (mg/L 24 hr)
T1BuryRDetr: Initial Condition (ug/kg dry)	*Cynoscion* (sea Oxygen EC50 Repro (mg/L 24 hr)
T1: Initial Condition (ug/L)	Mulinia Ammonia LC50 (mg/L)
Susp&Diss Detr: Initial Condition (mg/L dry)	Ostrea (oyster Ammonia LC50 (mg/L)
Mulinia: Initial Condition (g/m2 dry)	Acteocina (gas Ammonia LC50 (mg/L)
Ostrea (oyster: Initial Condition (g/m2 dry)	Oyster Drill Ammonia LC50 (mg/L)
Acteocina (gas: Initial Condition (g/m2 dry)	Penaeus (Shrim Ammonia LC50 (mg/L)
Oyster Drill: Initial Condition (g/m2 dry)	Callinectes (C Ammonia LC50 (mg/L)
Penaeus (Shrim: Initial Condition (mg/L dry)	Anchoa (anchov Ammonia LC50 (mg/L)
Callinectes (C: Initial Condition (g/m2 dry)	Brevoortia (me Ammonia LC50 (mg/L)
Anchoa (anchov: Initial Condition ()	Micropogonias Ammonia LC50 (mg/L)
Brevoortia (me: Initial Condition ()	Mugil (mullet) Ammonia LC50 (mg/L)
Micropogonias : Initial Condition ()	Sciaenops (red Ammonia LC50 (mg/L)
Mugil (mullet): Initial Condition ()	Arius (catfish Ammonia LC50 (mg/L)
Sciaenops (red: Initial Condition ()	*Cynoscion* (sm. Ammonia LC50 (mg/L)
Arius (catfish: Initial Condition ()	*Cynoscion* (sea Ammonia LC50 (mg/L)
Cynoscion (sm.: Initial Condition ()	Mulinia Sorting, selective feeding (unitless)

Galveston Bay, TX: Continued

Cynoscion (sea: Initial Condition ()	Ostrea (oyster Sorting, selective feeding (unitless)
T1Susp&Diss Detr: Initial Condition (ug/kg dry)	Acteocina (gas Sorting, selective feeding (unitless)
T1Mulinia: Initial Condition (ug/kg wet)	Oyster Drill Sorting, selective feeding (unitless)
T1Ostrea (oyster: Initial Condition (ug/kg wet)	Penaeus (Shrim Sorting, selective feeding (unitless)
T1Acteocina (gas: Initial Condition (ug/kg wet)	Callinectes (C Sorting, selective feeding (unitless)
T1Oyster Drill: Initial Condition (ug/kg wet)	Anchoa (anchov Sorting, selective feeding (unitless)
T1Penaeus (Shrim: Initial Condition (ug/kg wet)	Brevoortia (me Sorting, selective feeding (unitless)
T1Callinectes (C: Initial Condition (ug/kg wet)	Micropogonias Sorting, selective feeding (unitless)
T1Anchoa (anchov: Initial Condition (ug/kg wet)	Mugil (mullet) Sorting, selective feeding (unitless)
T1Brevoortia (me: Initial Condition (ug/kg wet)	Sciaenops (red Sorting, selective feeding (unitless)
T1Micropogonias : Initial Condition (ug/kg wet)	Arius (catfish Sorting, selective feeding (unitless)
T1Mugil (mullet): Initial Condition (ug/kg wet)	*Cynoscion* (sm. Sorting, selective feeding (unitless)
T1Sciaenops (red: Initial Condition (ug/kg wet)	*Cynoscion* (sea Sorting, selective feeding (unitless)
T1Arius (catfish: Initial Condition (ug/kg wet)	Mulinia Slope for Sed Response (unitless)
T1*Cynoscion* (sm.: Initial Condition (ug/kg wet)	Ostrea (oyster Slope for Sed Response (unitless)
T1*Cynoscion* (sea: Initial Condition (ug/kg wet)	Acteocina (gas Slope for Sed Response (unitless)
T1: Const Load (ug/L)	Oyster Drill Slope for Sed Response (unitless)
Mulinia: Const Load (g/m2 dry)	Penaeus (Shrim Slope for Sed Response (unitless)
Ostrea (oyster: Const Load (g/m2 dry)	Callinectes (C Slope for Sed Response (unitless)
Acteocina (gas: Const Load (g/m2 dry)	Anchoa (anchov Slope for Sed Response (unitless)
Oyster Drill: Const Load (g/m2 dry)	Brevoortia (me Slope for Sed Response (unitless)
Penaeus (Shrim: Const Load (mg/L dry)	Micropogonias Slope for Sed Response (unitless)
Callinectes (C: Const Load (g/m2 dry)	Mugil (mullet) Slope for Sed Response (unitless)
Anchoa (anchov: Const Load ()	Sciaenops (red Slope for Sed Response (unitless)
Brevoortia (me: Const Load ()	Arius (catfish Slope for Sed Response (unitless)
Micropogonias : Const Load ()	*Cynoscion* (sm. Slope for Sed Response (unitless)
Mugil (mullet): Const Load ()	*Cynoscion* (sea Slope for Sed Response (unitless)
Sciaenops (red: Const Load ()	Mulinia Intercept for Sed Response (unitless)
Arius (catfish: Const Load ()	Ostrea (oyster Intercept for Sed Response (unitless)
Cynoscion (sm.: Const Load ()	Acteocina (gas Intercept for Sed Response (unitless)
Cynoscion (sea: Const Load ()	Oyster Drill Intercept for Sed Response (unitless)
T1Mulinia: Const Load (ug/kg wet)	Penaeus (Shrim Intercept for Sed Response (unitless)
T1Ostrea (oyster: Const Load (ug/kg wet)	Callinectes (C Intercept for Sed Response (unitless)
T1Acteocina (gas: Const Load (ug/kg wet)	Anchoa (anchov Intercept for Sed Response (unitless)
T1Oyster Drill: Const Load (ug/kg wet)	Brevoortia (me Intercept for Sed Response (unitless)
T1Penaeus (Shrim: Const Load (ug/kg wet)	Micropogonias Intercept for Sed Response (unitless)
T1Callinectes (C: Const Load (ug/kg wet)	Mugil (mullet) Intercept for Sed Response (unitless)
T1Anchoa (anchov: Const Load (ug/kg wet)	Sciaenops (red Intercept for Sed Response (unitless)
T1Brevoortia (me: Const Load (ug/kg wet)	Arius (catfish Intercept for Sed Response (unitless)
T1Micropogonias : Const Load (ug/kg wet)	*Cynoscion* (sm. Intercept for Sed Response (unitless)
T1Mugil (mullet): Const Load (ug/kg wet)	*Cynoscion* (sea Intercept for Sed Response (unitless)
T1Sciaenops (red: Const Load (ug/kg wet)	Mulinia Trigger (dep. rate accel. drift in g/sq.m)
T1Arius (catfish: Const Load (ug/kg wet)	Ostrea (oyster Trigger (dep. rate accel. drift in g/sq.m)
T1*Cynoscion* (sm.: Const Load (ug/kg wet)	Acteocina (gas Trigger (dep. rate accel. drift in g/sq.m)
T1*Cynoscion* (sea: Const Load (ug/kg wet)	Oyster Drill Trigger (dep. rate accel. drift in g/sq.m)
T1: Multiply Loading by	Penaeus (Shrim Trigger (dep. rate accel. drift in g/sq.m)
Susp&Diss Detr: Multiply Loading by	Callinectes (C Trigger (dep. rate accel. drift in g/sq.m)
Mulinia: Multiply Loading by	Anchoa (anchov Trigger (dep. rate accel. drift in g/sq.m)
Ostrea (oyster: Multiply Loading by	Brevoortia (me Trigger (dep. rate accel. drift in g/sq.m)
Acteocina (gas: Multiply Loading by	Micropogonias Trigger (dep. rate accel. drift in g/sq.m)
Oyster Drill: Multiply Loading by	Mugil (mullet) Trigger (dep. rate accel. drift in g/sq.m)
Penaeus (Shrim: Multiply Loading by	Sciaenops (red Trigger (dep. rate accel. drift in g/sq.m)
Callinectes (C: Multiply Loading by	Arius (catfish Trigger (dep. rate accel. drift in g/sq.m)

Galveston Bay, TX: Continued

Anchoa (anchov: Multiply Loading by	*Cynoscion* (sm. Trigger (dep. rate accel. drift in g/sq.m)
Brevoortia (me: Multiply Loading by	*Cynoscion* (sea Trigger (dep. rate accel. drift in g/sq.m)
Micropogonias : Multiply Loading by	Susp&Diss Detr: Pct. Partic. Loads, Const.
Mugil (mullet): Multiply Loading by	Susp&Diss Detr: Pct. Refr. Loads, Const.
Sciaenops (red: Multiply Loading by	Susp&Diss Detr: Pct. Particulate, Init. Cond
Arius (catfish: Multiply Loading by	Susp&Diss Detr: Pct. Refractory, Init. Cond
Cynoscion (sm.: Multiply Loading by	Mulinia Pct. Embedded Threshold
Cynoscion (sea: Multiply Loading by	Ostrea (oyster Pct. Embedded Threshold
T1Susp&Diss Detr: Multiply Loading by	Acteocina (gas Pct. Embedded Threshold
T1Mulinia: Multiply Loading by	Oyster Drill Pct. Embedded Threshold
T1Ostrea (oyster: Multiply Loading by	Penaeus (Shrim Pct. Embedded Threshold
T1Acteocina (gas: Multiply Loading by	Callinectes (C Pct. Embedded Threshold
T1Oyster Drill: Multiply Loading by	Anchoa (anchov Pct. Embedded Threshold
T1Penaeus (Shrim: Multiply Loading by	Brevoortia (me Pct. Embedded Threshold
T1Callinectes (C: Multiply Loading by	Micropogonias Pct. Embedded Threshold
T1Anchoa (anchov: Multiply Loading by	Mugil (mullet) Pct. Embedded Threshold
T1Brevoortia (me: Multiply Loading by	Sciaenops (red Pct. Embedded Threshold
T1Micropogonias : Multiply Loading by	Arius (catfish Pct. Embedded Threshold
T1Mugil (mullet): Multiply Loading by	*Cynoscion* (sm. Pct. Embedded Threshold
T1Sciaenops (red: Multiply Loading by	*Cynoscion* (sea Pct. Embedded Threshold
T1Arius (catfish: Multiply Loading by	
T1*Cynoscion* (sm.: Multiply Loading by	

Ohio Stream with Chlorpyrifos:

Peri High-Nut Max. Salinity Tolerance, Mortality (0/00)	Peri High-Nut Max. Salinity Tolerance, Photo. (0/00)
Peri High-Nut Max. Sat. Light (Ly/d)	Peri High-Nut Min. Salinity Tolerance, Mortality (0/00)
Peri High-Nut Min. Salinity Tolerance, Photo. (0/00)	Peri High-Nut Min. Sat. Light (Ly/d)
Peri High-Nut Pct. Lost Slough Event (percent)	Peri High-Nut Resp. Rate, 20 deg C (g/g d)
Peri High-Nut Salinity Coeff1, Mortality (unitless)	Peri High-Nut Salinity Coeff1, Photo. (unitless)
Peri High-Nut Salinity Coeff2, Mortality (unitless)	Peri High-Nut Salinity Coeff2, Photo. (unitless)
Peri High-Nut Wet to Dry (ratio)	Peri High-Nut : Carrying Capacity (g/m2)
Peri High-Nut : Const Load (g/m2 dry)	Peri High-Nut : Exponential Mort. Coefficient: (max / d)
Peri High-Nut : FCrit, periphyton (newtons)	Peri High-Nut : Initial Condition (g/m2 dry)
Peri High-Nut : Inorg. C Half-saturation (mg/L)	Peri High-Nut : Light Extinction (1/m)
Peri High-Nut : Max Photosynthetic Rate (1/d)	Peri High-Nut : Maximum Temperature (deg. C)
Peri High-Nut : Min Adaptation Temperature (deg. C)	Peri High-Nut : Mortality Coefficient: (frac / d)
Peri High-Nut : Multiply Loading by	Peri High-Nut : N Half-saturation (mg/L)
Peri High-Nut : N:Organics (ratio)	Peri High-Nut : Optimal Temperature (deg. C)
Peri High-Nut : P Half-saturation (mg/L)	Peri High-Nut : P:Organics (ratio)
Peri High-Nut : Pct in Pool (if stream %)	Peri High-Nut : Pct in Riffle (if stream %)
Peri High-Nut : Photorespiration Coefficient (1/d)	Peri High-Nut : Red in Still Water (frac)
Peri High-Nut : Saturating Light (Ly/d)	Peri High-Nut : Temp Response Slope
Peri High-Nut : VelMax Macrophytes (cm/s)	Peri Low-Nut D Max. Salinity Tolerance, Mortality (0/00)
Peri Low-Nut D Max. Salinity Tolerance, Photo. (0/00)	Peri Low-Nut D Max. Sat. Light (Ly/d)
Peri Low-Nut D Min. Salinity Tolerance, Mortality (0/00)	Peri Low-Nut D Min. Salinity Tolerance, Photo. (0/00)
Peri Low-Nut D Min. Sat. Light (Ly/d)	Peri Low-Nut D Pct. Lost Slough Event (percent)
Peri Low-Nut D Resp. Rate, 20 deg C (g/g d)	Peri Low-Nut D Salinity Coeff1, Mortality (unitless)
Peri Low-Nut D Salinity Coeff1, Photo. (unitless)	Peri Low-Nut D Salinity Coeff2, Mortality (unitless)
Peri Low-Nut D Salinity Coeff2, Photo. (unitless)	Peri Low-Nut D Wet to Dry (ratio)
Peri Low-Nut D: Carrying Capacity (g/m2)	Peri Low-Nut D: Const Load (g/m2 dry)
Peri Low-Nut D: Exponential Mort. Coefficient: (max / d)	Peri Low-Nut D: FCrit, periphyton (newtons)
Peri Low-Nut D: Initial Condition (g/m2 dry)	Peri Low-Nut D: Inorg. C Half-saturation (mg/L)
Peri Low-Nut D: Light Extinction (1/m)	Peri Low-Nut D: Max Photosynthetic Rate (1/d)
Peri Low-Nut D: Maximum Temperature (deg. C)	Peri Low-Nut D: Min Adaptation Temperature (deg. C)
Peri Low-Nut D: Mortality Coefficient: (frac / d)	Peri Low-Nut D: Multiply Loading by
Peri Low-Nut D: N Half-saturation (mg/L)	Peri Low-Nut D: N:Organics (ratio)
Peri Low-Nut D: Optimal Temperature (deg. C)	Peri Low-Nut D: P Half-saturation (mg/L)
Peri Low-Nut D: P:Organics (ratio)	Peri Low-Nut D: Pct in Pool (if stream %)
Peri Low-Nut D: Pct in Riffle (if stream %)	Peri Low-Nut D: Photorespiration Coefficient (1/d)
Peri Low-Nut D: Red in Still Water (frac)	Peri Low-Nut D: Saturating Light (Ly/d)
Peri Low-Nut D: Temp Response Slope	Peri Low-Nut D: VelMax Macrophytes (cm/s)
Peri, Blue-Gre Max. Salinity Tolerance, Mortality (0/00)	Peri, Blue-Gre Max. Salinity Tolerance, Photo. (0/00)
Peri, Blue-Gre Max. Sat. Light (Ly/d)	Peri, Blue-Gre Min. Salinity Tolerance, Mortality (0/00)
Peri, Blue-Gre Min. Salinity Tolerance, Photo. (0/00)	Peri, Blue-Gre Min. Sat. Light (Ly/d)
Peri, Blue-Gre Pct. Lost Slough Event (percent)	Peri, Blue-Gre Resp. Rate, 20 deg C (g/g d)
Peri, Blue-Gre Salinity Coeff1, Mortality (unitless)	Peri, Blue-Gre Salinity Coeff1, Photo. (unitless)
Peri, Blue-Gre Salinity Coeff2, Mortality (unitless)	Peri, Blue-Gre Salinity Coeff2, Photo. (unitless)
Peri, Blue-Gre Wet to Dry (ratio)	Peri, Blue-Gre: Carrying Capacity (g/m2)
Peri, Blue-Gre: Const Load (g/m2 dry)	Peri, Blue-Gre: Exponential Mort. Coefficient: (max / d)
Peri, Blue-Gre: FCrit, periphyton (newtons)	Peri, Blue-Gre: Initial Condition (g/m2 dry)
Peri, Blue-Gre: Inorg. C Half-saturation (mg/L)	Peri, Blue-Gre: Light Extinction (1/m)
Peri, Blue-Gre: Max Photosynthetic Rate (1/d)	Peri, Blue-Gre: Maximum Temperature (deg. C)
Peri, Blue-Gre: Min Adaptation Temperature (deg. C)	Peri, Blue-Gre: Mortality Coefficient: (frac / d)
Peri, Blue-Gre: Multiply Loading by	Peri, Blue-Gre: N Half-saturation (mg/L)
Peri, Blue-Gre: N:Organics (ratio)	Peri, Blue-Gre: Optimal Temperature (deg. C)
Peri, Blue-Gre: P Half-saturation (mg/L)	Peri, Blue-Gre: P:Organics (ratio)
Peri, Blue-Gre: Pct in Pool (if stream %)	Peri, Blue-Gre: Pct in Riffle (if stream %)
Peri, Blue-Gre: Photorespiration Coefficient (1/d)	Peri, Blue-Gre: Red in Still Water (frac)
Peri, Blue-Gre: Saturating Light (Ly/d)	Peri, Blue-Gre: Temp Response Slope
Peri, Blue-Gre: VelMax Macrophytes (cm/s)	Peri, Green Max. Salinity Tolerance, Mortality (0/00)

Ohio Stream with Chlorpyrifos (cont.):

Peri, Green Salinity Coeff1, Photo. (unitless)	Peri, Green Salinity Coeff2, Mortality (unitless)
Peri, Green Salinity Coeff2, Photo. (unitless)	Peri, Green Wet to Dry (ratio)
Peri, Green: Carrying Capacity (g/m2)	Peri, Green: Const Load (g/m2 dry)
Peri, Green: Exponential Mort. Coefficient: (max / d)	Peri, Green: FCrit, periphyton (newtons)
Peri, Green: Initial Condition (g/m2 dry)	Peri, Green: Inorg. C Half-saturation (mg/L)
Peri, Green: Light Extinction (1/m)	Peri, Green: Max Photosynthetic Rate (1/d)
Peri, Green: Maximum Temperature (deg. C)	Peri, Green: Min Adaptation Temperature (deg. C)
Peri, Green: Mortality Coefficient: (frac / d)	Peri, Green: Multiply Loading by
Peri, Green: N Half-saturation (mg/L)	Peri, Green: N:Organics (ratio)
Peri, Green: Optimal Temperature (deg. C)	Peri, Green: P Half-saturation (mg/L)
Peri, Green: P:Organics (ratio)	Peri, Green: Pct in Pool (if stream %)
Peri, Green: Pct in Riffle (if stream %)	Peri, Green: Photorespiration Coefficient (1/d)
Peri, Green: Red in Still Water (frac)	Peri, Green: Saturating Light (Ly/d)
Peri, Green: Temp Response Slope	Peri, Green: VelMax Macrophytes (cm/s)
T1: Acid Catalyzed Hydrolysis (L/d)	T1: Activation Energy for Temp (cal/mol)
T1: Aerobic Microbial Degrdn. (L/d)	T1: Amphipod EC50 Dislodge (ug/L)
T1: Amphipod EC50 Growth (ug/L)	T1: Amphipod EC50 Repro (ug/L)
T1: Amphipod Elim. Rate Constant (1/d)	T1: Amphipod LC50 (ug/L)
T1: Anaerobic Microbial Degrdn. (L/d)	T1: Base Catalyzed Hydrolysis (L/d)
T1: Bass EC50 Dislodge (ug/L)	T1: Bass EC50 Growth (ug/L)
T1: Bass EC50 Repro (ug/L)	T1: Bass Elim. Rate Constant (1/d)
T1: Bass LC50 (ug/L)	T1: Bluegill EC50 Dislodge (ug/L)
T1: Bluegill EC50 Growth (ug/L)	T1: Bluegill EC50 Repro (ug/L)
T1: Bluegill Elim. Rate Constant (1/d)	T1: Bluegill LC50 (ug/L)
T1: Bluegreens EC50 photo (ug/L)	T1: Bluegreens Elim. Rate Constant (1/d)
T1: Bluegreens LC50 (ug/L)	T1: Catfish EC50 Dislodge (ug/L)
T1: Catfish EC50 Growth (ug/L)	T1: Catfish EC50 Repro (ug/L)
T1: Catfish Elim. Rate Constant (1/d)	T1: Catfish LC50 (ug/L)
T1: Chironomid EC50 Dislodge (ug/L)	T1: Chironomid EC50 Growth (ug/L)
T1: Chironomid EC50 Repro (ug/L)	T1: Chironomid Elim. Rate Constant (1/d)
T1: Chironomid LC50 (ug/L)	T1: Const Load (ug/L)
T1: Daphnia EC50 Dislodge (ug/L)	T1: Daphnia EC50 Growth (ug/L)
T1: Daphnia EC50 Repro (ug/L)	T1: Daphnia Elim. Rate Constant (1/d)
T1: Daphnia LC50 (ug/L)	T1: Diatoms EC50 photo (ug/L)
T1: Diatoms Elim. Rate Constant (1/d)	T1: Diatoms LC50 (ug/L)
T1: Dissasociation Constant (pKa)	T1: Gastropod EC50 Dislodge (ug/L)
T1: Gastropod EC50 Growth (ug/L)	T1: Gastropod EC50 Repro (ug/L)
T1: Gastropod Elim. Rate Constant (1/d)	T1: Gastropod LC50 (ug/L)
T1: Greens EC50 photo (ug/L)	T1: Greens Elim. Rate Constant (1/d)
T1: Greens LC50 (ug/L)	T1: Henry's Law Const. (atm. m^3/mol)
T1: Initial Condition (ug/L)	T1: Macrophytes EC50 photo (ug/L)
T1: Macrophytes Elim. Rate Constant (1/d)	T1: Macrophytes LC50 (ug/L)
T1: Minnow EC50 Dislodge (ug/L)	T1: Minnow EC50 Growth (ug/L)
T1: Minnow EC50 Repro (ug/L)	T1: Minnow Elim. Rate Constant (1/d)
T1: Minnow LC50 (ug/L)	T1: Molecular Weight
T1: Mult. Direct Precip. Load by	T1: Mult. Non-Point Source Load by
T1: Mult. Point Source Load by	T1: Multiply Loading by
T1: Mussel EC50 Dislodge (ug/L)	T1: Mussel EC50 Growth (ug/L)
T1: Mussel EC50 Repro (ug/L)	T1: Mussel Elim. Rate Constant (1/d)
T1: Mussel LC50 (ug/L)	T1: Octanol-Water Partition Coeff (Log Kow)
T1: Oligochaete EC50 Dislodge (ug/L)	T1: Oligochaete EC50 Growth (ug/L)
T1: Oligochaete EC50 Repro (ug/L)	T1: Oligochaete Elim. Rate Constant (1/d)
T1: Oligochaete LC50 (ug/L)	T1: Ostracod EC50 Dislodge (ug/L)
T1: Ostracod EC50 Growth (ug/L)	T1: Ostracod EC50 Repro (ug/L)
T1: Ostracod Elim. Rate Constant (1/d)	T1: Ostracod LC50 (ug/L)
T1: Oxidation Rate Const (L/mol day)	T1: Photolysis Rate (L/d)

Ohio Stream with Chlorpyrifos (cont.):

T1: Sed/Detr-Water Partition Coeff (mg/L)
T1: Smallmouth bass EC50 Growth (ug/L)
T1: Smallmouth bass Elim. Rate Constant (1/d)
T1: Solubility (ppm)
T1: Stonefly EC50 Growth (ug/L)
T1: Stonefly Elim. Rate Constant (1/d)
T1: Trout EC50 Dislodge (ug/L)
T1: Trout EC50 Repro (ug/L)
T1: Trout LC50 (ug/L)
T1: Vapor Pressure (mm Hg)
T1: White sucker EC50 Dislodge (ug/L)
T1: White sucker EC50 Repro (ug/L)
T1: White sucker LC50 (ug/L)
T1: Yellow perch EC50 Growth (ug/L)
T1: Yellow perch Elim. Rate Constant (1/d)
T1Peri High-Nut : Const Load (ug/kg wet)
T1Peri High-Nut : Multiply Loading by
T1Peri Low-Nut D: Initial Condition (ug/kg wet)
T1Peri, Blue-Gre: Const Load (ug/kg wet)
T1Peri, Blue-Gre: Multiply Loading by
T1Peri, Green: Initial Condition (ug/kg wet)
T1: Sed/Detr-Water Partition Coeff (mg/L)
T1: Smallmouth bass EC50 Growth (ug/L)
T1: Smallmouth bass Elim. Rate Constant (1/d)
T1: Solubility (ppm)
T1: Stonefly EC50 Growth (ug/L)
T1: Stonefly Elim. Rate Constant (1/d)
T1: Trout EC50 Dislodge (ug/L)
T1: Trout EC50 Repro (ug/L)
T1: Trout LC50 (ug/L)
T1: Vapor Pressure (mm Hg)
T1: White sucker EC50 Dislodge (ug/L)
T1: White sucker EC50 Repro (ug/L)
T1: White sucker LC50 (ug/L)
T1: Yellow perch EC50 Growth (ug/L)
T1: Yellow perch Elim. Rate Constant (1/d)
T1Peri High-Nut : Const Load (ug/kg wet)
T1Peri High-Nut : Multiply Loading by
T1Peri Low-Nut D: Initial Condition (ug/kg wet)
T1Peri, Blue-Gre: Const Load (ug/kg wet)
T1Peri, Blue-Gre: Multiply Loading by
T1Peri, Green: Initial Condition (ug/kg wet)