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EPA's ECOLOGICAL TOOLS FOR INTEGRATED WATERSHED MANAGEMENT

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Introduction

Watershed management is becoming more holistic and comprehensive

Managers are interested in relating landscape processes to aquatic endpoints

The U.S. EPA has developed useful quantitative tools for Integrated Watershed Management

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EPA's Aquatic Ecology Tools

CADDIS (http://www.epa.gov/caddis/)

- a decision support system for diagnosing causes of biological impairment

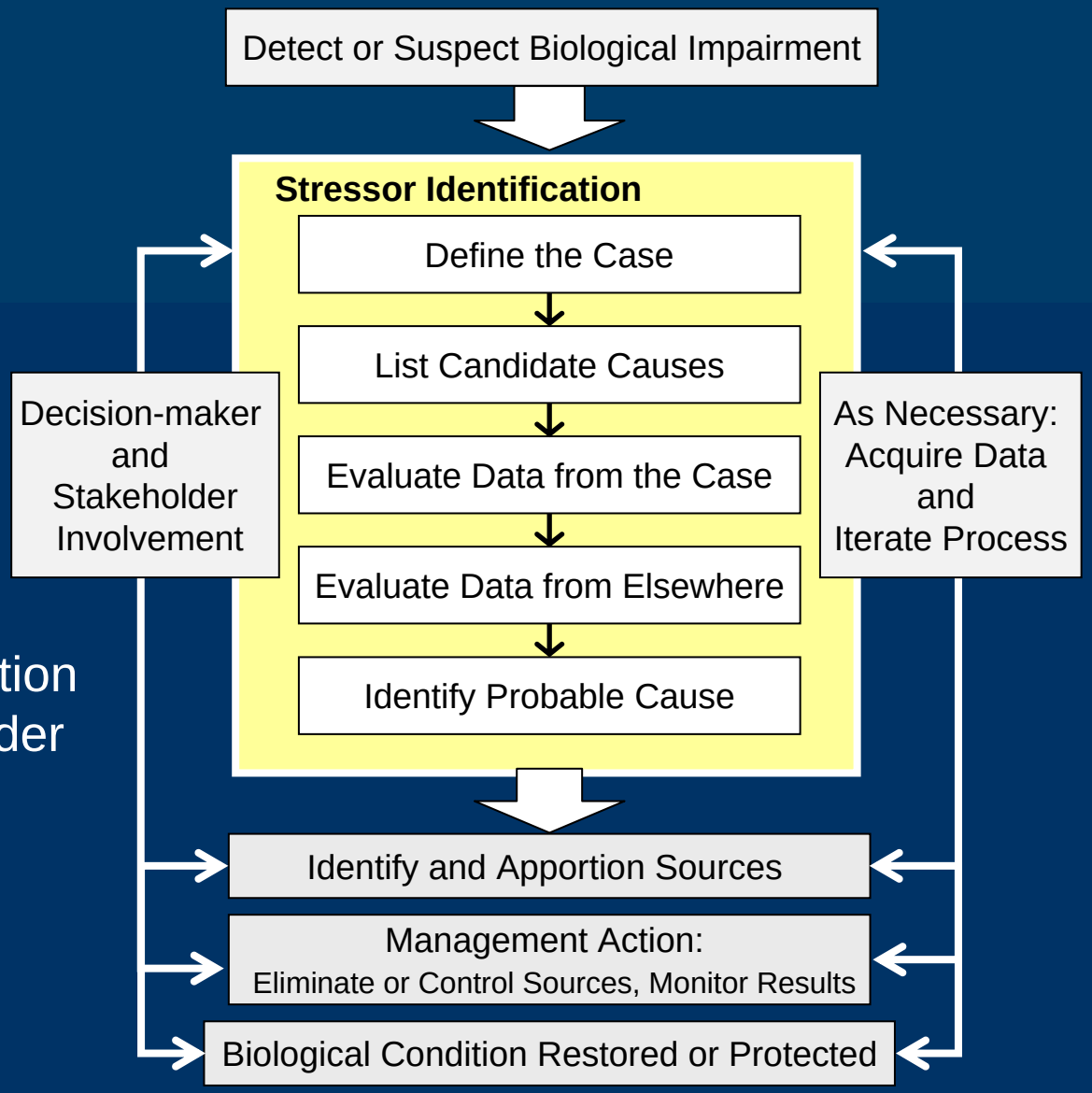
BASS (http://www.epa.gov/ceampubl/fchain/bass/index.htm)

- a model that simulates the population and bioaccumulation dynamics of age-structured fish communities

AQUATOX (http://www.epa.gov/waterscience/models/aquatox/)

- a simulation model that predicts the fate of pollutants and their effects on the aquatic ecosystem (streams, lakes, estuaries)

CADDIS



The Stressor Identification process within its broader management context

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Candidate Causes

Stressors that could be responsible for causing the biological impairment that you are investigating

Common Candidate Causes

CC.1. Metals
CC.2. Sediments
CC.3. Nutrients
CC.4. Dissolved Oxygen
CC.5. Temperature
CC.6. Ionic Strength
CC.7. Flow Alteration
CC.8. Unspecified Toxic Chemicals

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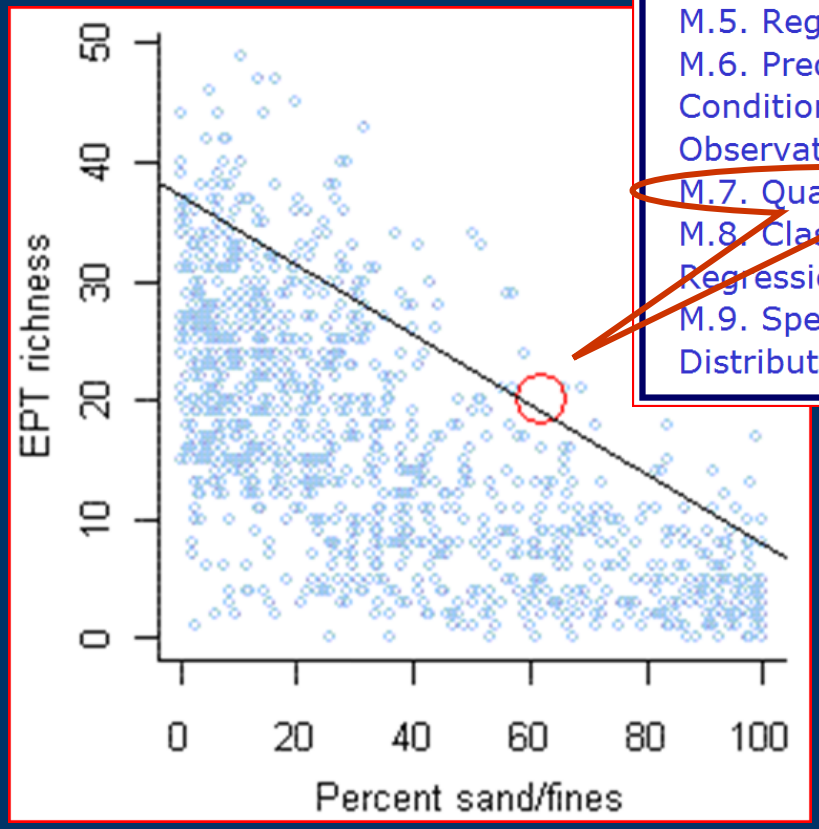
Analyzing Data

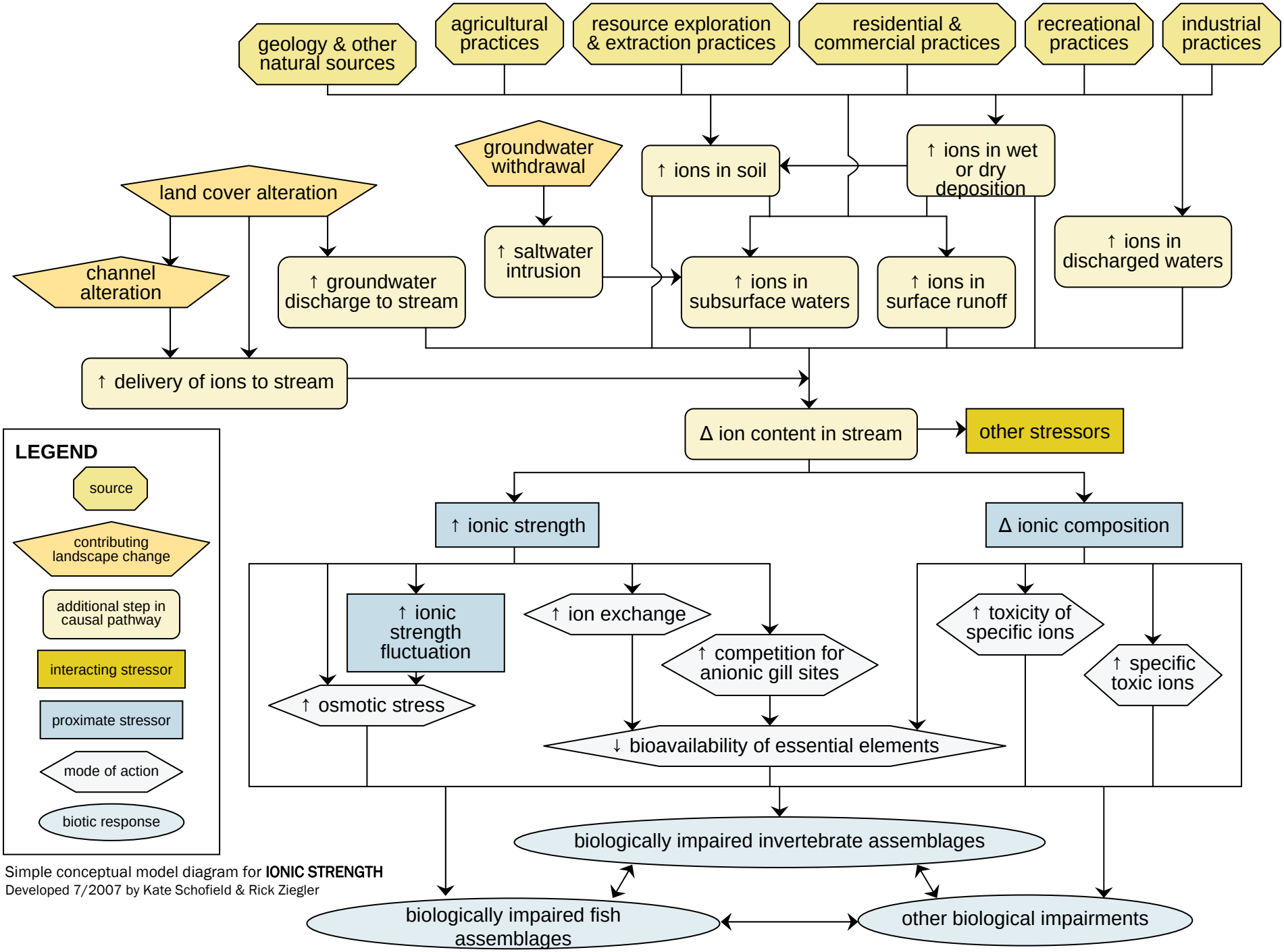
Data Analysis Methods

CADDIS provides access to statistical tools and aids for interpretation



Links to Methods

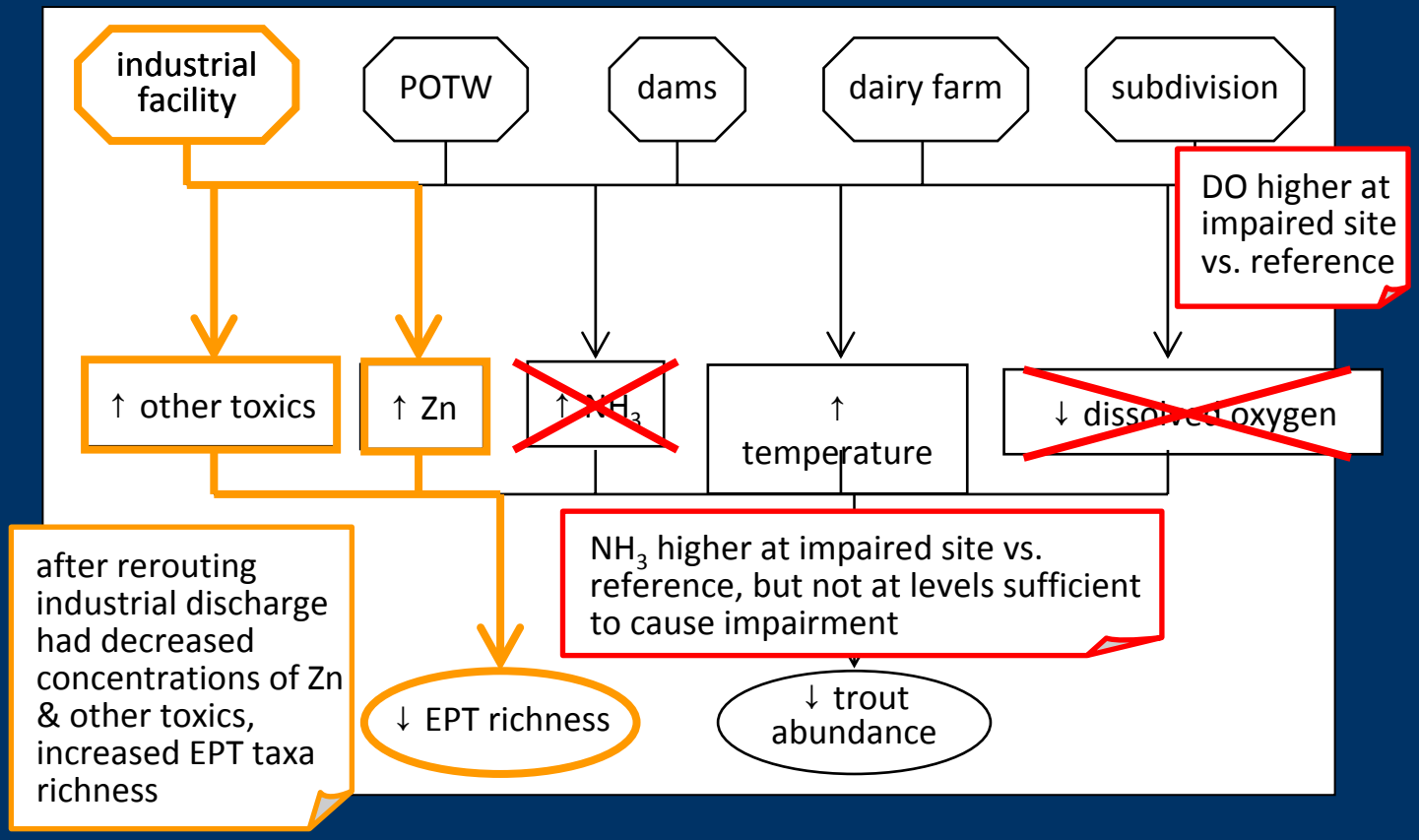
- M.1. Scatter Plots
- M.2. Correlation Analysis
- M.3. Box Plots
- M.4. Conditional Probability Analysis
- M.5. Regression Analysis
- M.6. Predicting Environmental Conditions From Biological Observations
- M.7. Quantile Regression
- M.8. Classification and Regression Trees
- M.9. Species Sensitivity Distributions



Simple conceptual model diagram for **IONIC STRENGTH**
Developed 7/2007 by Kate Schofield & Rick Ziegler

Using Conceptual Models

CADDIS helps you compare evidence to the identify the best explanation for the cause of biological impairments



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BASS Model

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- Food Chain
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- Frequent Questions
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- Related Links
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Bioaccumulation and Aquatic System Simulator (BASS)

- Introduction
- Audience
- Abstract
- Applications and Possible Uses
- Model History
- Technical Support and Training
- Quality Assurance and Quality Control
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- Go to BASS Model Download Page

Introduction

Bioaccumulation and Aquatic System Simulator (BASS) is a model that simulates the population and bioaccumulation dynamics of age-structured fish communities. Although BASS was specifically developed to investigate the bioaccumulation of chemical pollutants within a community or ecosystem context, it can also be used to explore population and community dynamics of fish assemblages that are exposed to a variety of nonchemical stressors such as altered thermal regimes associated with hydrological alterations or industrial activities, commercial or sports fisheries, and introductions of non native or exotic fish species.

The ability to predict accurately the bioaccumulation of chemicals in fish has become an essential component in assessing the ecological and human health risks of chemical pollutants. Accurate bioaccumulation estimates are needed not only to predict realistic dietary exposures to humans and piscivorous wildlife but also to assess more accurately potential ecological risks to fish assemblages themselves. Although the bioaccumulation of many chemicals in fish can often be predicted accurately using simple bioaccumulation factors (BAF) and measured or predicated chemical water concentrations, such calculations frequently fail to predict accurately concentrations of extremely hydrophobic chemicals and metals such as mercury that are often the chemicals of greatest concern. Process-based models like BASS that simulate the toxicokinetic, physiological, and ecological processes of fish can overcome many of the limitations associated with the use BAF approaches.

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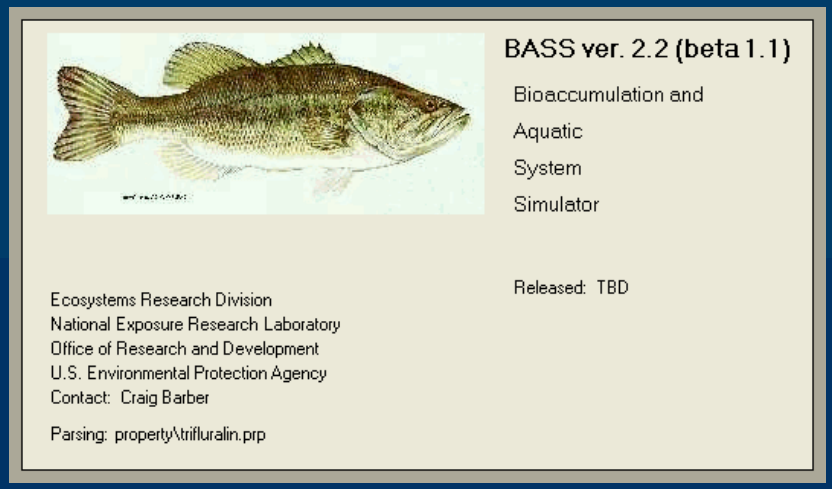
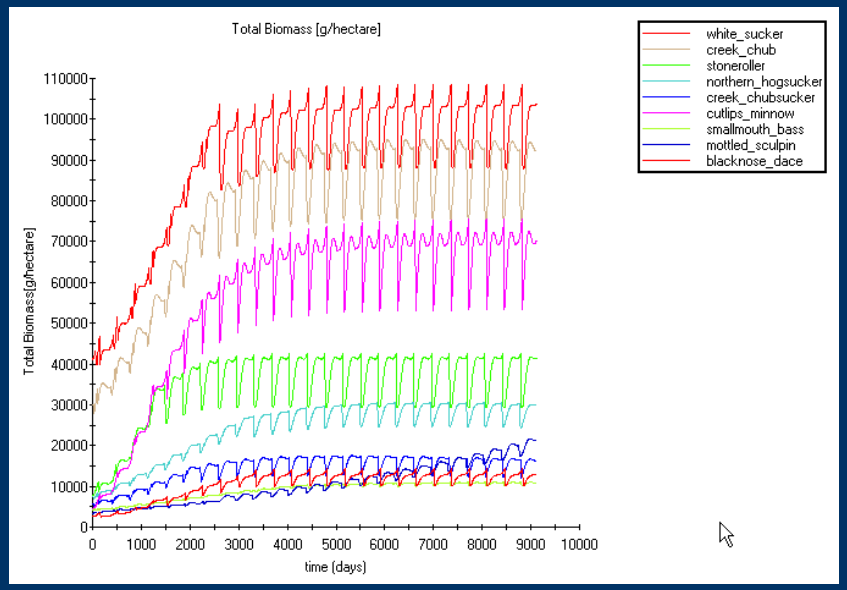
BASS Simulation Modes



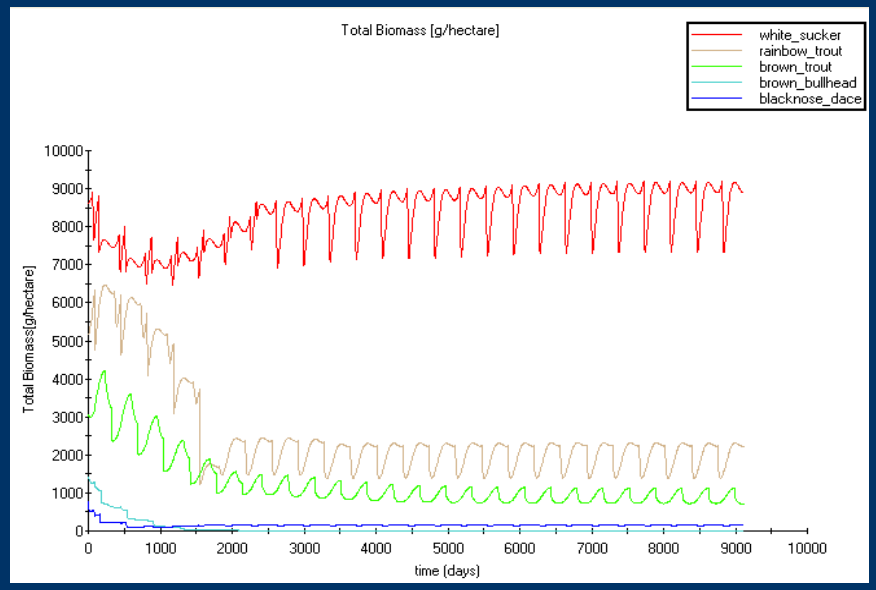
- **FGETS** – cohort growth and bioaccumulation dynamics
- **Leslie matrix projection –** cohort growth, bioaccumulation, and population dynamics where cohort 'mortality' is modeled as a lumped self-thinning process
- **Full community** – cohort growth, bioaccumulation, and population dynamics where cohort 'mortalities' are explicitly modeled as predation, physiological death, and dispersal

Simulated Biomass in BASS

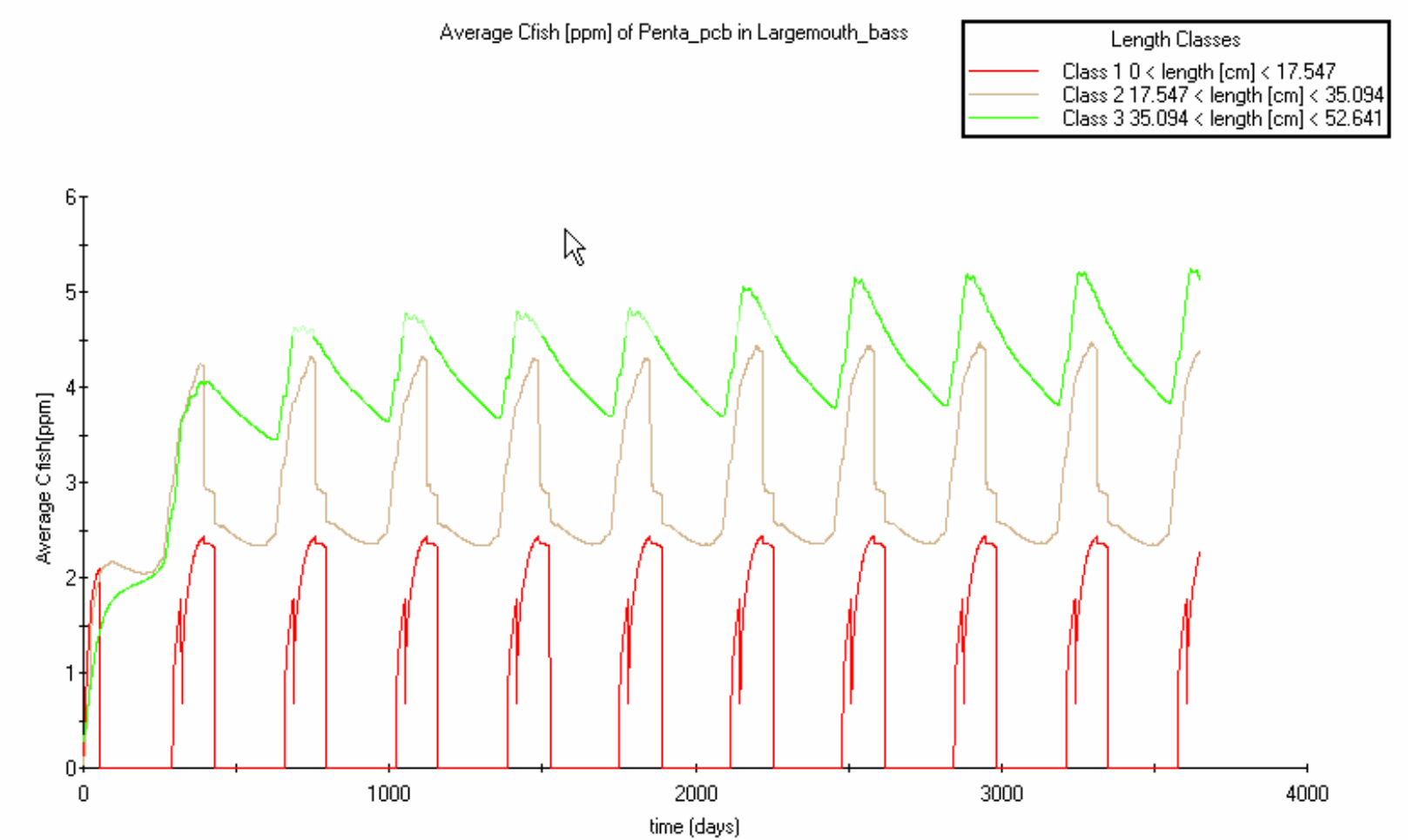
Trout Run, Hardy County, WV



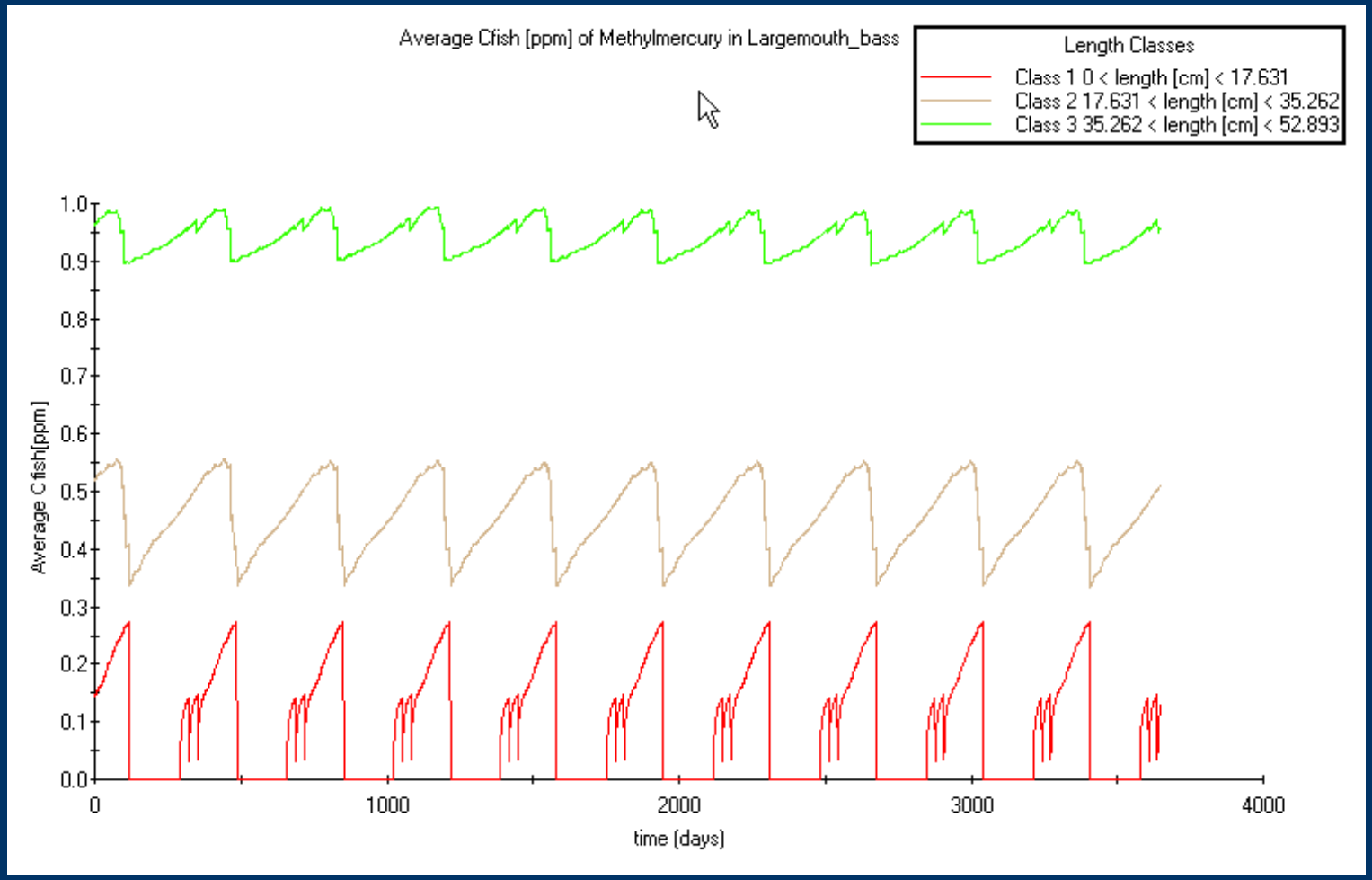
Balls Creek, Wayne County, PA



BASS Output: Largemouth BASS PCB Bioaccumulation in Twelve Mile Creek, SC



BASS Output: Largemouth Bass Methyl Mercury Bioaccumulation in Everglades



AQUATOX Model

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AQUATOX

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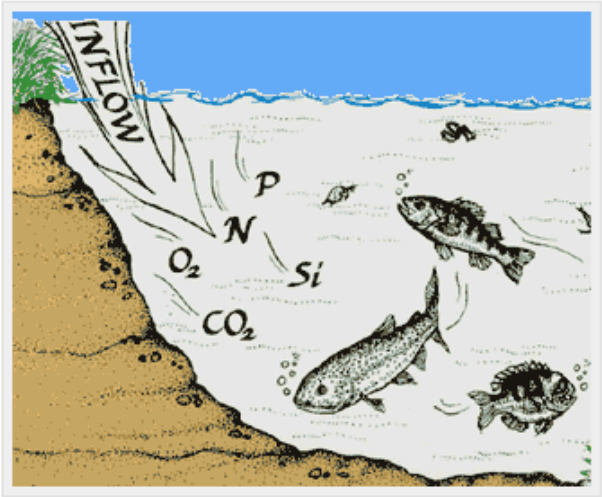
Water Science Home

- AQUATOX Home
- Basic Information
- What does AQUATOX do?
- Potenital Applications
- Features and Tools
- Download AQUATOX and Supporting Materials
- Order CDs and Documents
- Training

Linking water quality and aquatic life

AQUATOX is a simulation model for aquatic systems. AQUATOX predicts the fate of various pollutants, such as nutrients and organic chemicals, and their effects on the ecosystem, including fish, invertebrates, and aquatic plants. This model is a valuable tool for ecologists, biologists, water quality modelers, and anyone involved in performing ecological risk assessments for aquatic ecosystems.

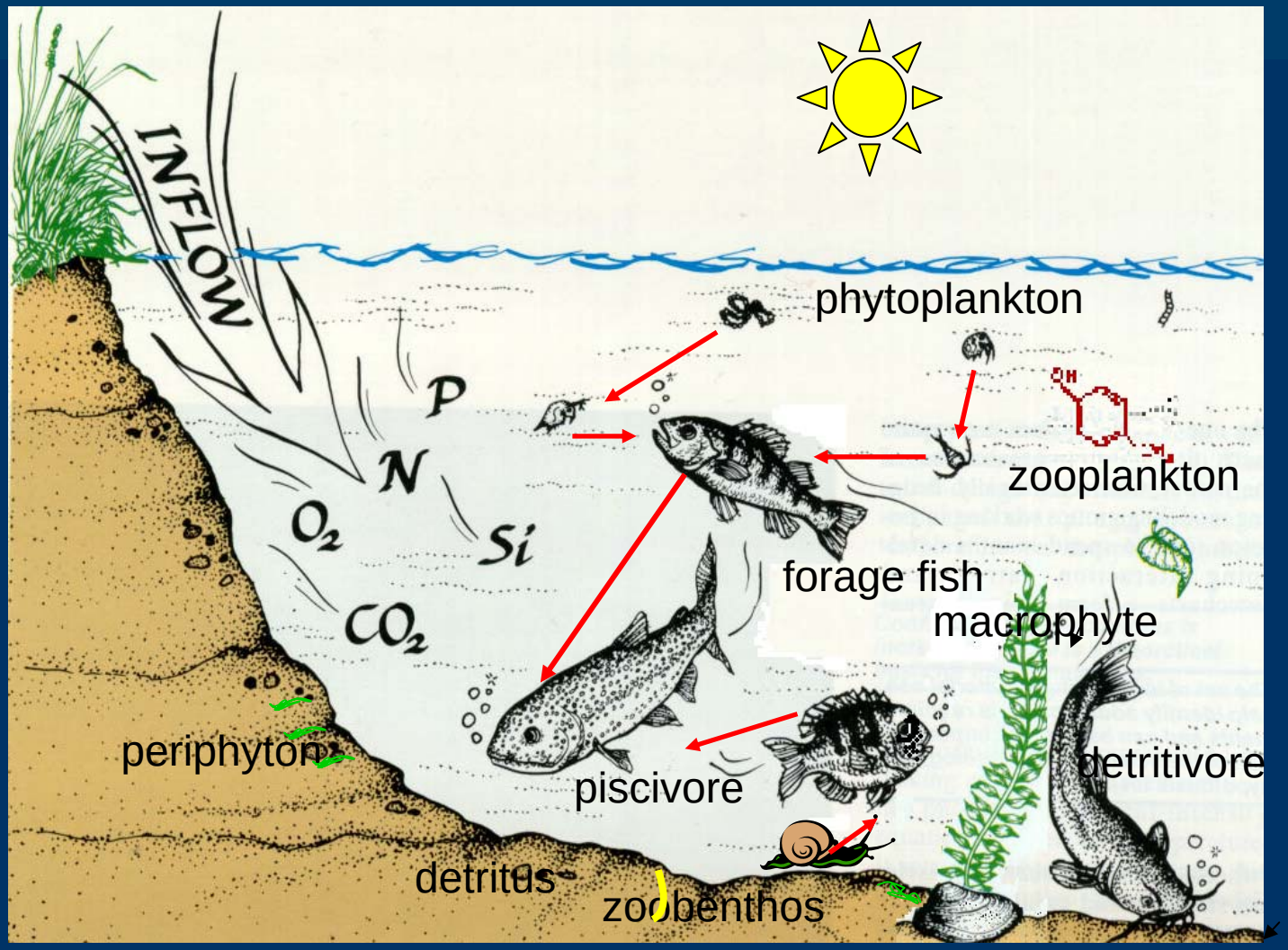


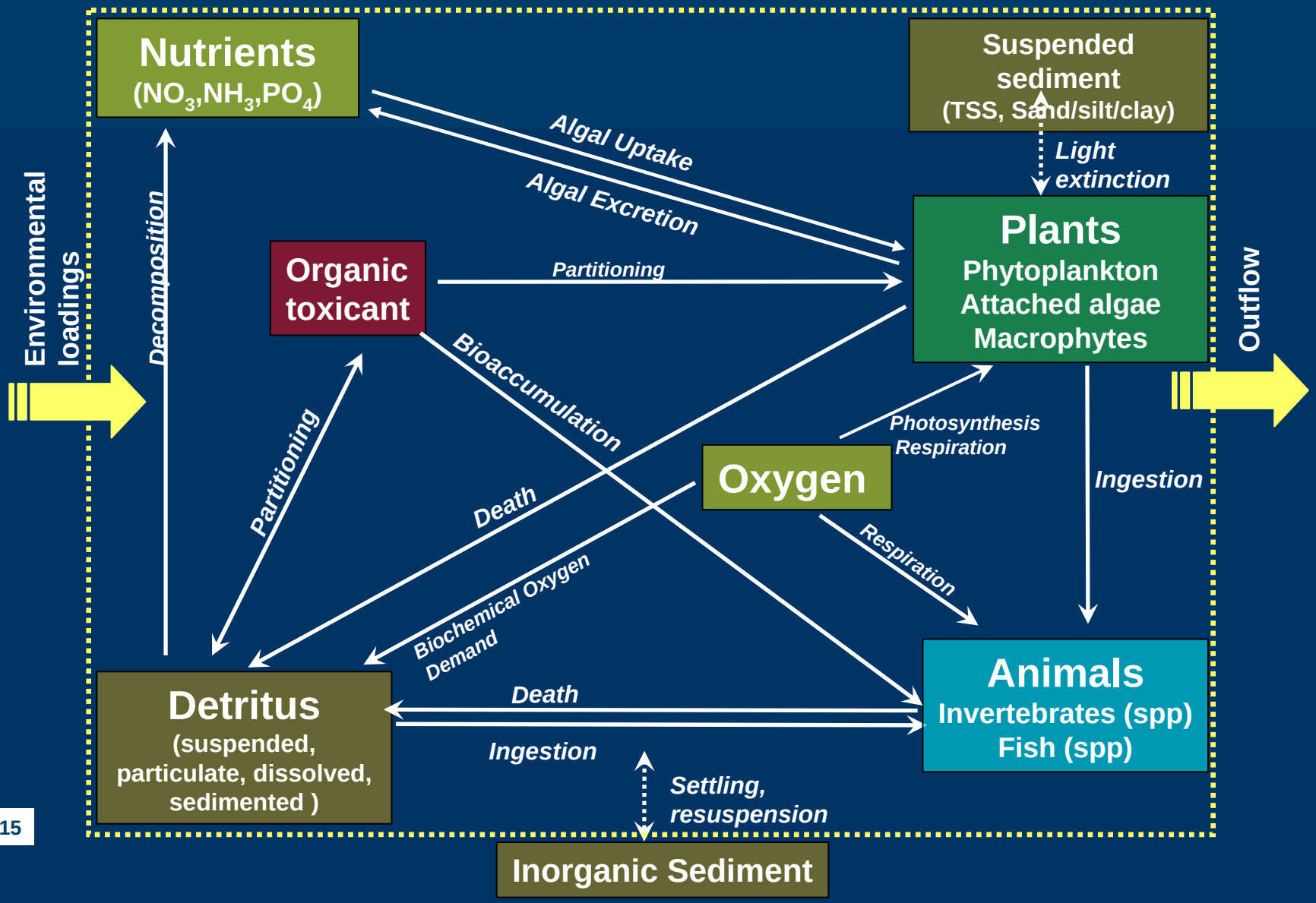
Release 2.1 of AQUATOX is now available. Release 2.1 has enhanced scientific capabilities to better simulate the fate of nutrients and toxic organics and their effects on aquatic ecosystems.

Download the model and support documents

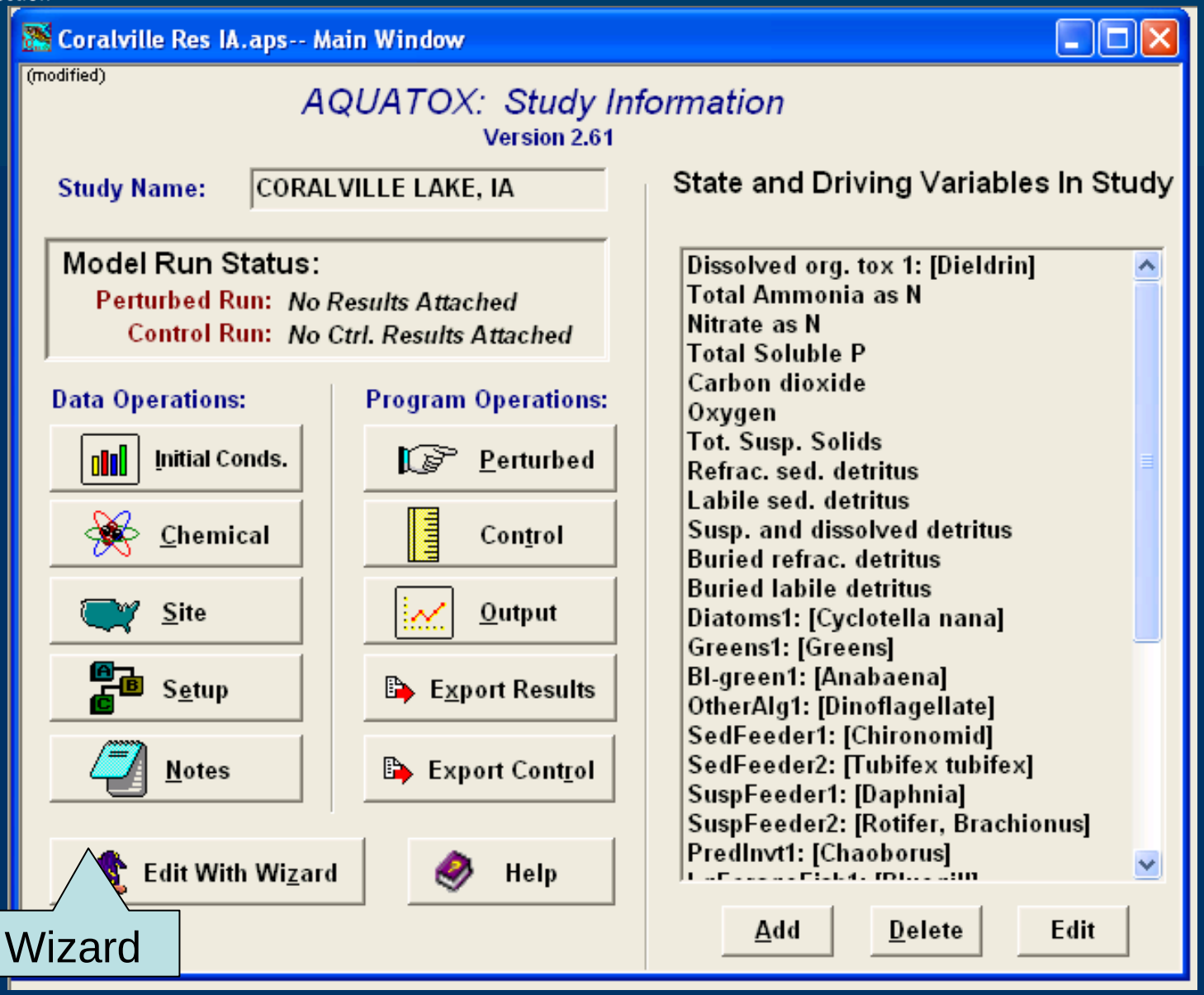
- What's new in release 2.1?
- Basic Information
- What does AQUATOX do?
- Potential applications to water management
- Unique features & operations
- Order CDs & documents
- Training - live classes and downloadable lectures

AQUATOX Ecosystem Components



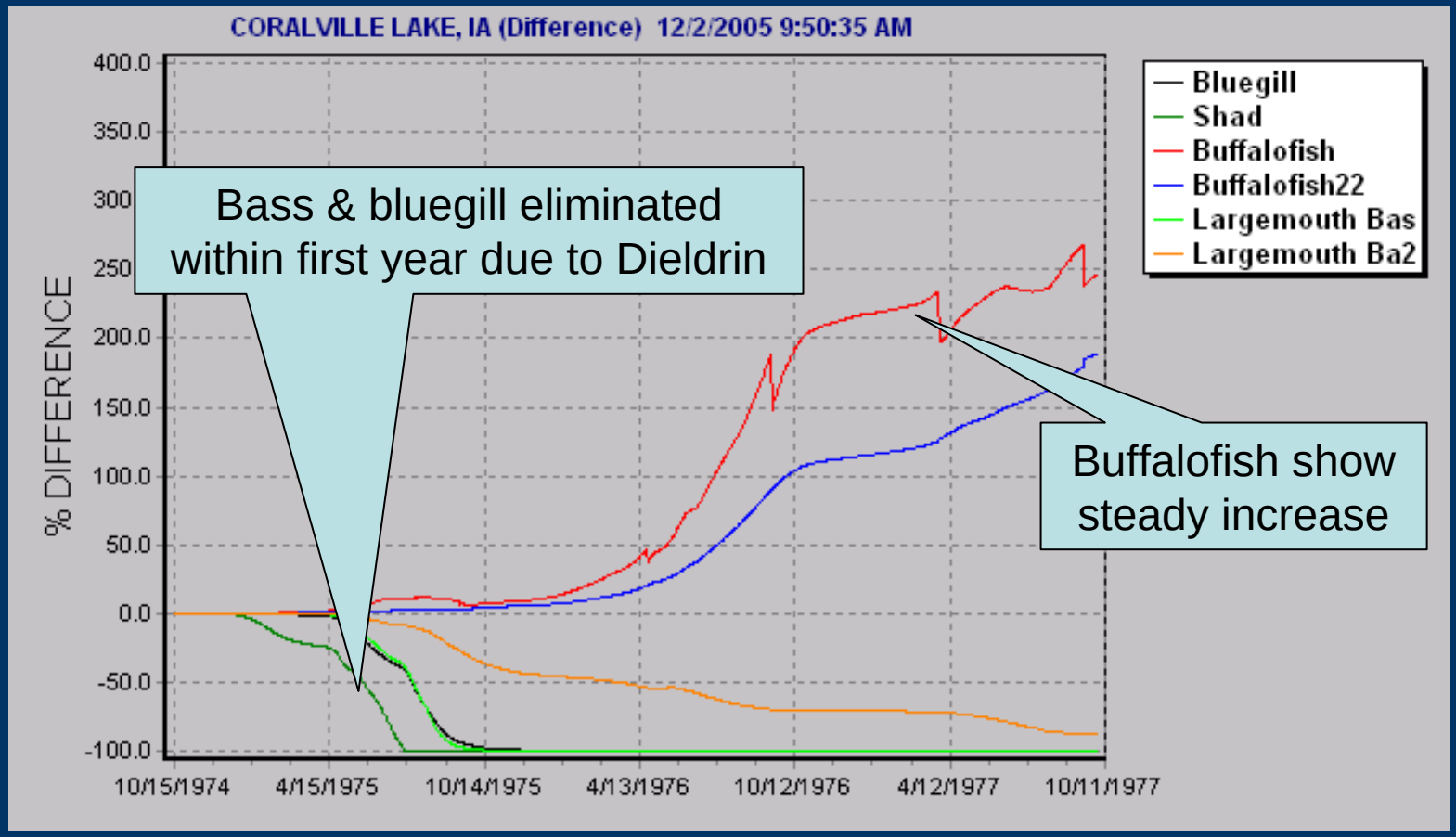

Nutrients
(NO_3,NH_3,PO_4)
Suspended sediment
(TSS, Sand/silt/clay)
Algal Uptake
Algal Excretion
Light extinction
Plants
Phytoplankton
Attached algae
Macrophytes
Organic toxicant
Partitioning
Environmental loadings
Decomposition
Outflow
Bioaccumulation
Partitioning
Photosynthesis
Respiration
Oxygen
Ingestion
Death
Respiration
Biochemical Oxygen Demand
Detritus
(suspended, particulate, dissolved, sedimented)
Death
Ingestion
Animals
Invertebrates (spp)
Fish (spp)
Settling, resuspension
Inorganic Sediment

Main Screen



Use Wizard

Percent Difference Graph



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Conclusions

- Three EPA aquatic ecology tools can be useful in watershed management
- CADDIS allows for diagnosis of impairment
  - Can support TMDLs
- BASS most useful for toxic chemicals, esp. Hg
- AQUATOX most useful for multiple stressors
  - Good for combined effects of toxics and nutrients

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Acknowledgements

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- Although this work was reviewed by EPA and approved for presentation, it may not necessarily reflect official Agency policy.