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Data Needs for Modeling Nearshore Systems in the Great Lakes

J.V. DePinto
LimnoTech, Ann Arbor, MI

LimnoTech
Water | Environment | Scientists | Engineers

Today's Great Lakes ecosystem is very different than in 1970s and early 1980s

- **Dreissenids and other invasive species**
  - Change in both pelagic and benthic trophic structure and energy flow
- **Re-occurrence of harmful *Microcystis* blooms in bays, nearshore areas, and river plumes**
- **Return of nearshore benthic nuisance algae – *Cladophora***
- **Persistence of hypoxia problems in Lake Erie central basin**
- **Precipitous declines of Diporeia in all lakes;**
- **"Desertification" (loss of productivity) of offshore pelagic waters, particularly Lake Huron, Lake Michigan, and Ontario;**
  - **Dangerously low forage fish base in Lake Huron, Lake Michigan, Lake Ontario**
  - **Enormous recent increases in water clarity in offshore waters of Great Lakes**
  - **Extreme decreases in zooplankton in Lake Huron and Michigan that would support forage fish.**

Today's Great Lakes ecosystem is very different than in 1970s and early 1980s (cont.)

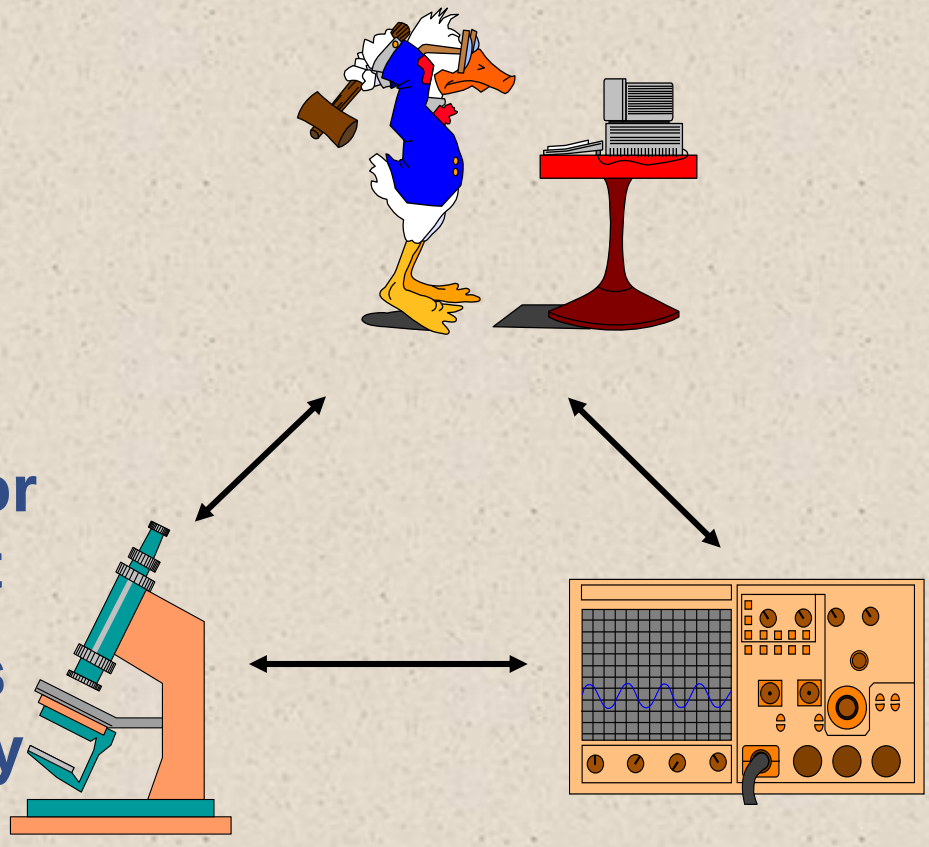
- Stable and relatively high populations of invasive predatory cladocerans that have the potential to keep zooplankton populations during summer and benefit from water clarity
- Increased importance of non-point sources of nutrients relative to point sources
- Hydrologic and physical transport, trophic transfer, biogeochemical process alterations due to climate change
- increases in the frequencies of beach closings; and
- botulism toxicity events re-emerging in the late 1990s and early 2000s for the first time in the Great Lakes since 1963-64

IJC Nearshore Issues

- Overall Nearshore Framework
- Eutrophication
  - nuisance and hazardous algal blooms in nearshore zones
- Beach Closures and Postings
- PTS in nearshore of the Great Lakes
  - Fish Consumption by *at-risk* populations along coastal zones
  - Chemicals of Emerging Concern – major source of chemicals such as PPCPs is WWTPs discharging into tributaries and nearshore zones
- Aquatic Invasive Species
  - Alter ecosystem structure and function
  - Affect beneficial uses of coastal zones

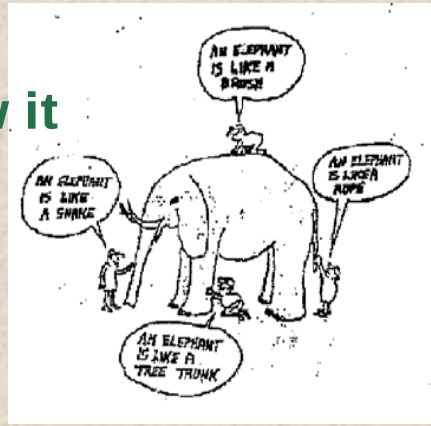
We need to refine models to understanding and help manage the changed Great Lakes ecosystem.

- **Models** provide insight and make projections
- **Research** provides Understanding and parameterization for Model Development
- **Monitoring** provides input and credibility for Models

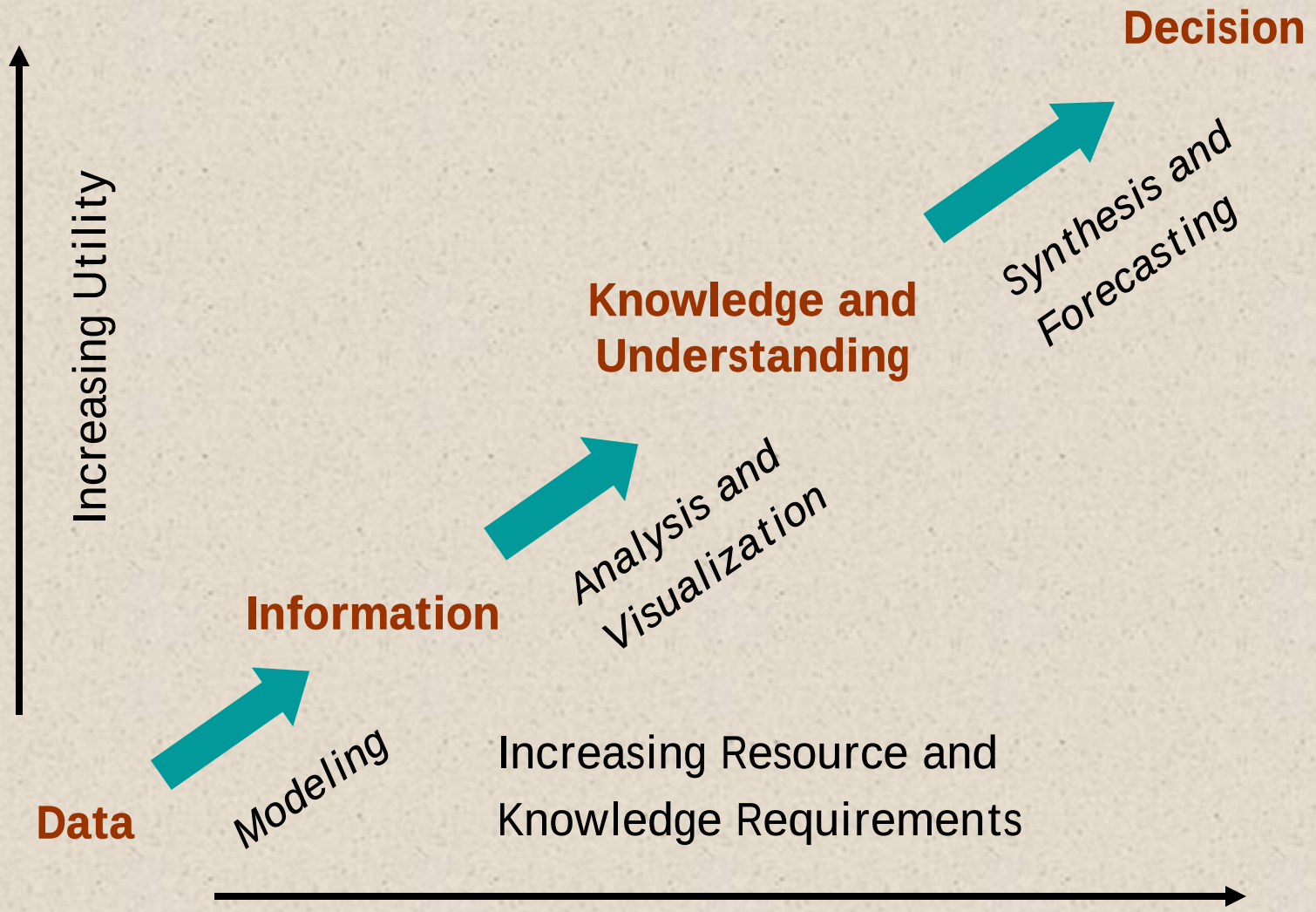


Benefits of Whole System Process Models

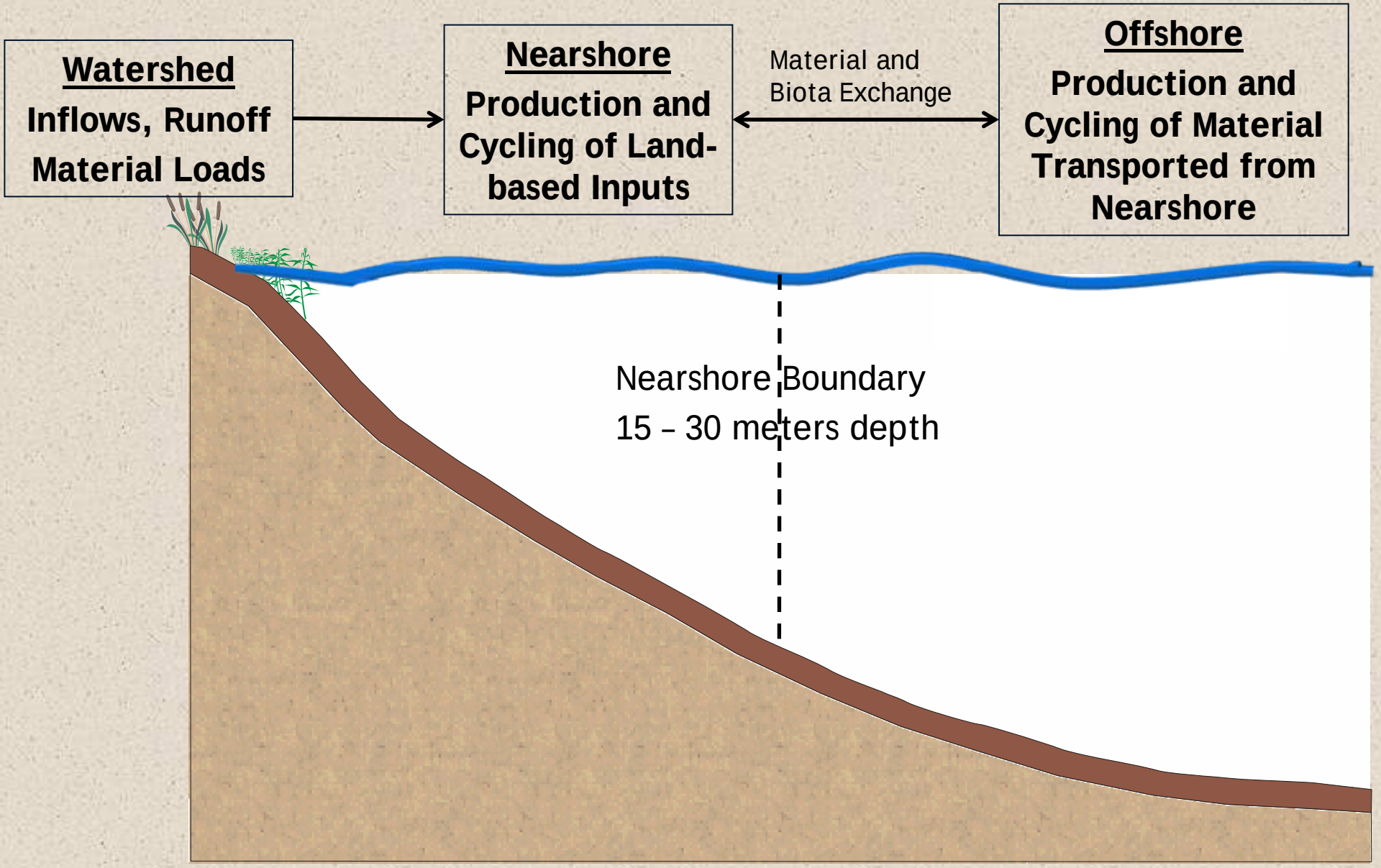
- Models provide a means of synthesizing available system data and knowledge in a given problem domain
  - Quantify the state of a system and explain how it functions
  - Identify data/knowledge gaps and help design monitoring and research programs
- Models provide a means of quantifying the relationship between key forcing functions (e.g., loads) and ecosystem responses of concern
  - Compare and evaluate management options
  - Quantify and assess outcomes of management actions
  - forecast the impact of extreme events for which there is no actual experience



Converting Data to a Decision



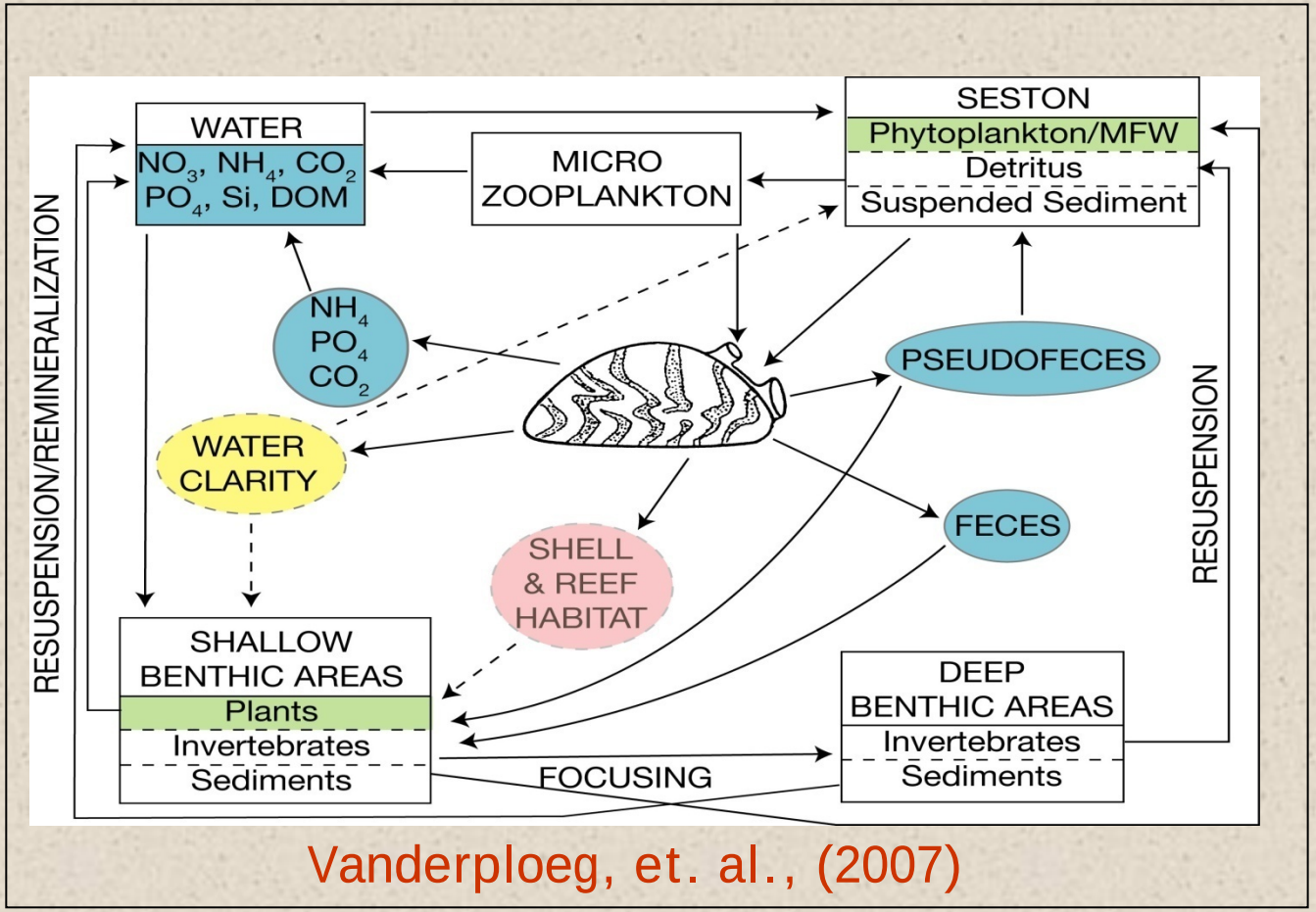
Modeling Analysis of Nearshore Problems



Eutrophication – Hypothesis for Nearshore – Offshore Paradox (DePinto)

- Increase in loading of bioavailable P from non-point sources
  - Heidelberg data for Lake Erie tributaries
- Much of this P is being effectively "trapped" in the nearshore
  - By dreissenid filtration of phytoplankton and other particulate P
  - By *Cladophora*, which are re-occurring because of dreissenid induced water clarity and higher bioavailable P levels in nearshore
- Nearshore P trapping is leading to a reduced transport of P to offshore, which leads to a reduced offshore production and associated carrying capacity

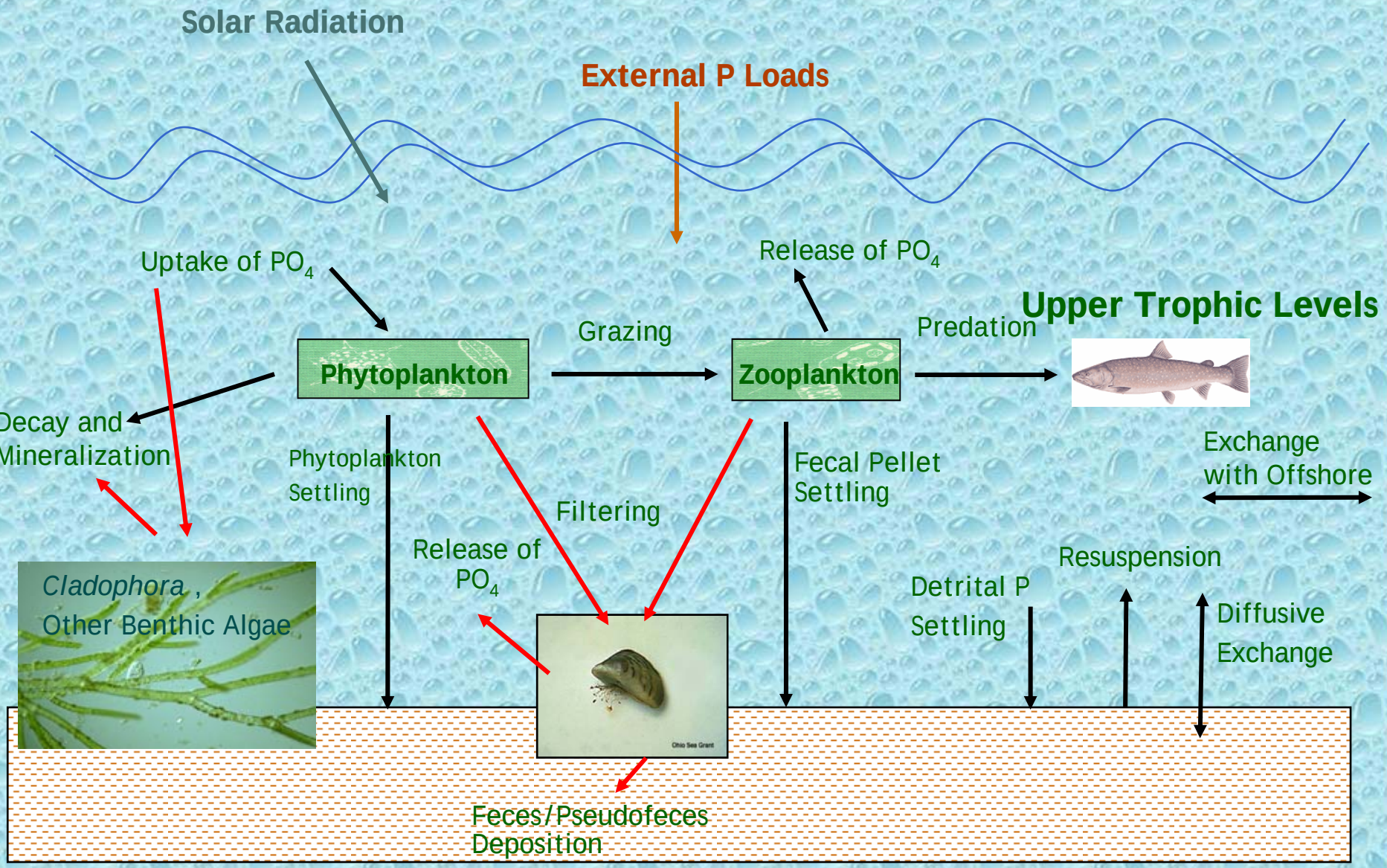
Dreissenids are Effective Ecosystem Engineers



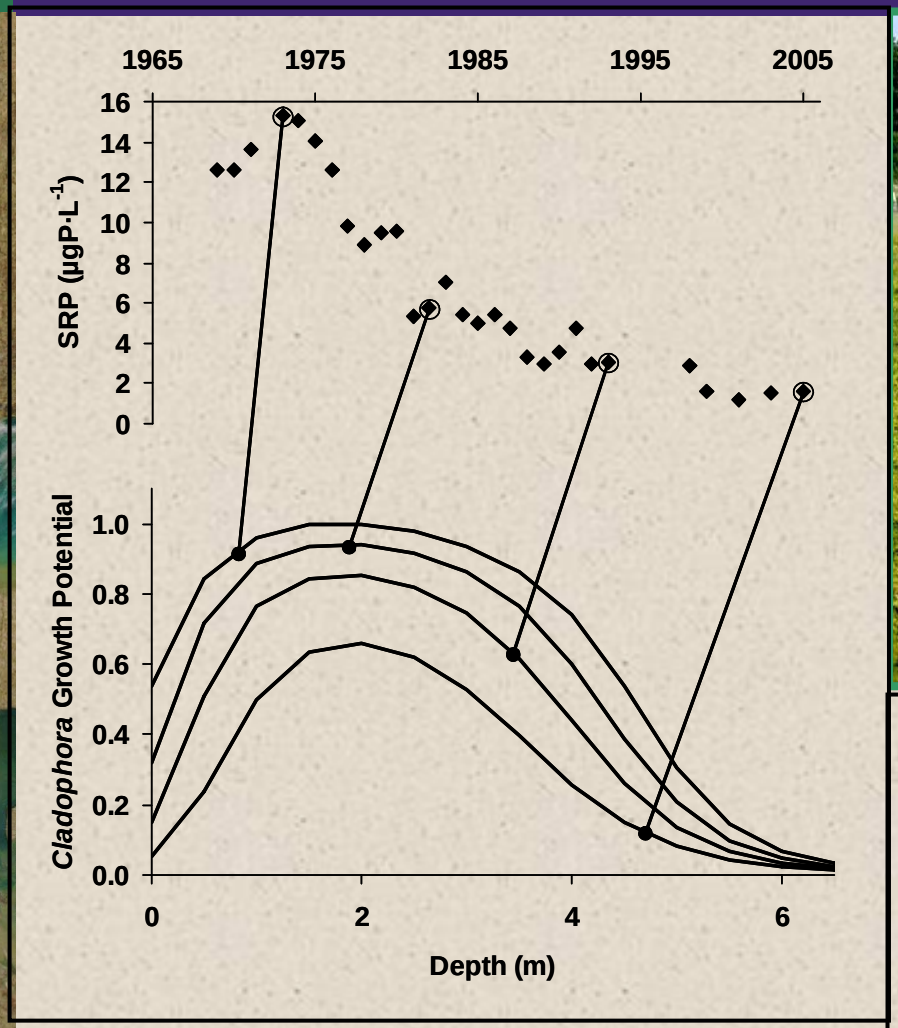
Vanderploeg, et. al., (2007)

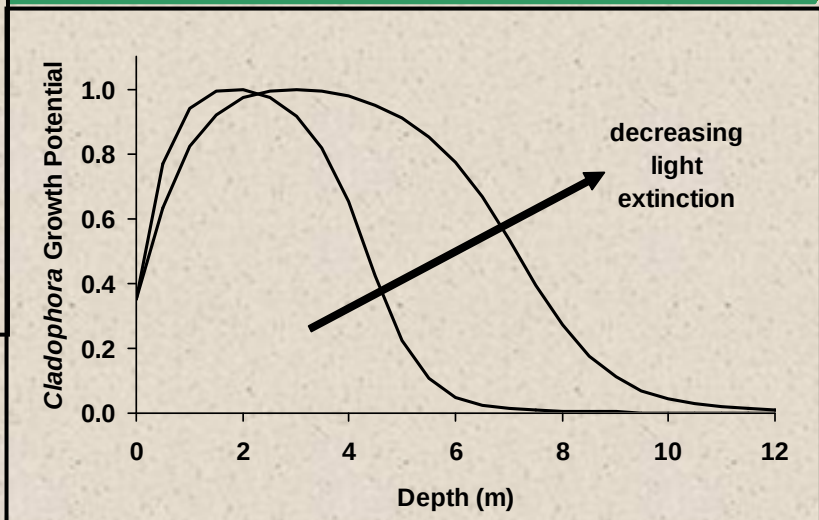
Interactions of dreissenid mussels with other ecosystem components in shallow systems via mussel feeding, nutrient excretion (blue), and physical ecosystem engineering (habitat modification: yellow & red). Solid lines indicate material flow (C, nutrients, sediment), and broken

Phosphorus Cycling in Nearshore Ecosystem

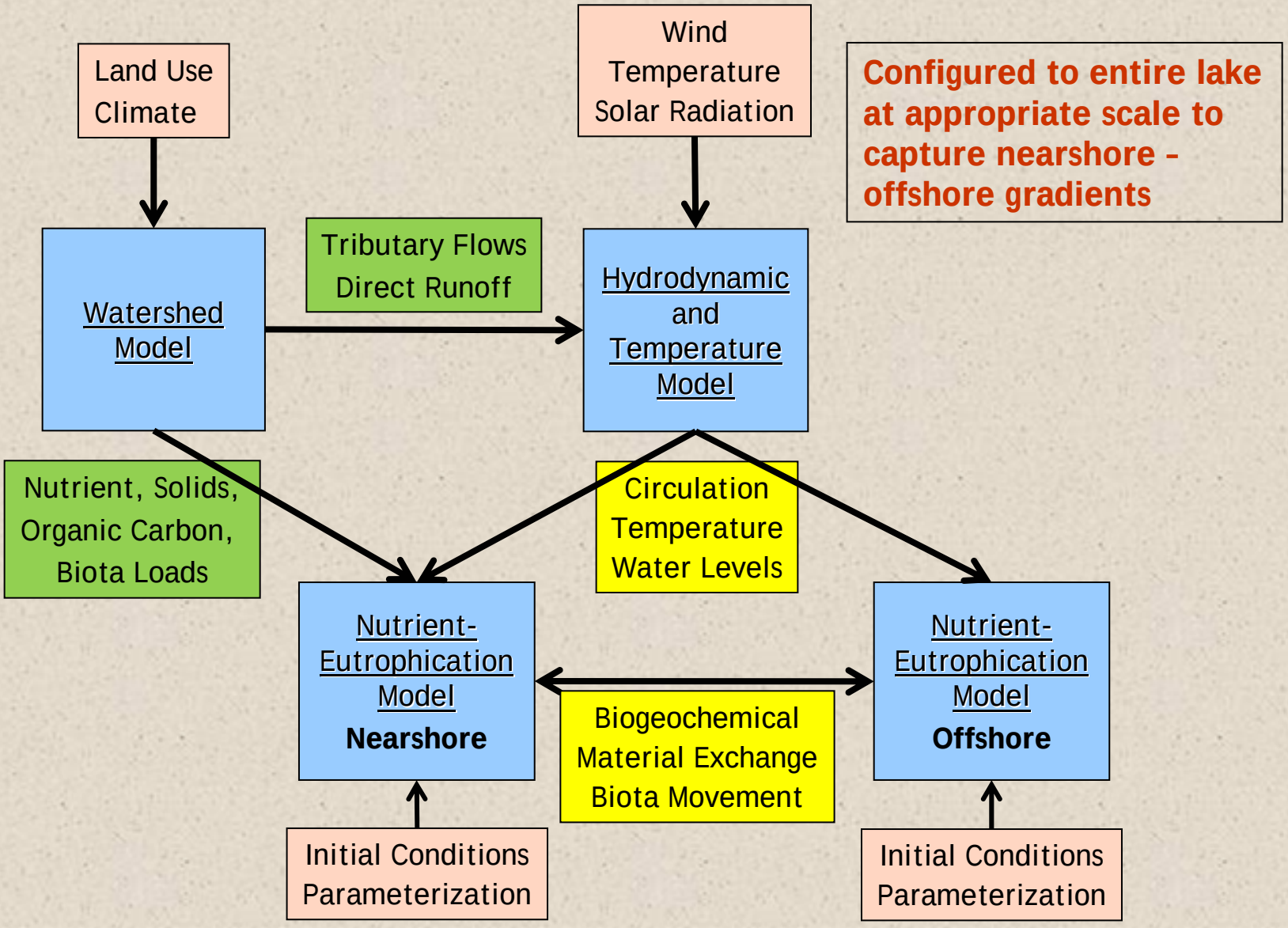


Chladophora Respond to Nearshore SRP and Light Availability (Auer, Higgins, et al.)





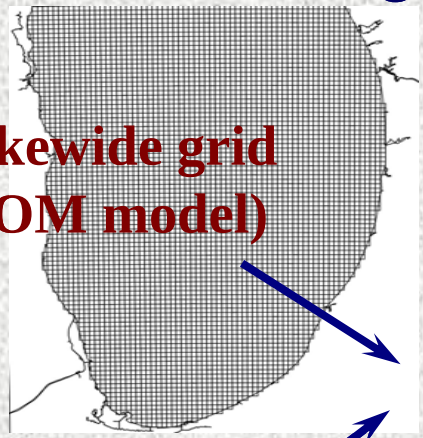
Data Needs for Nearshore Eutrophication Models



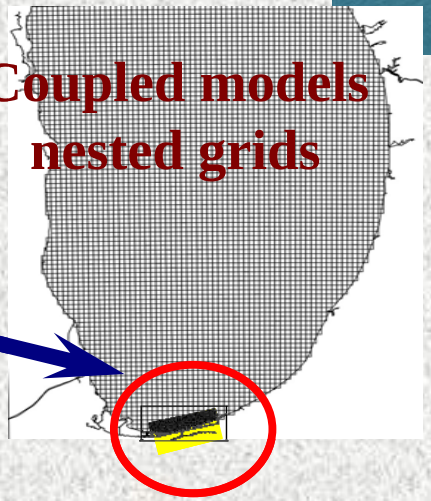
Beach Source-Receptor Tracking Model Development

Developing 3D modeling system for forecasting *E. coli* and *Enterococci* along Great Lakes coasts – pilot study at Burns Ditch, IN on Lake Michigan

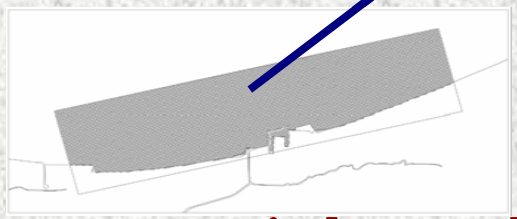
Lake Michigan Model Grids



Lakewide grid (POM model)



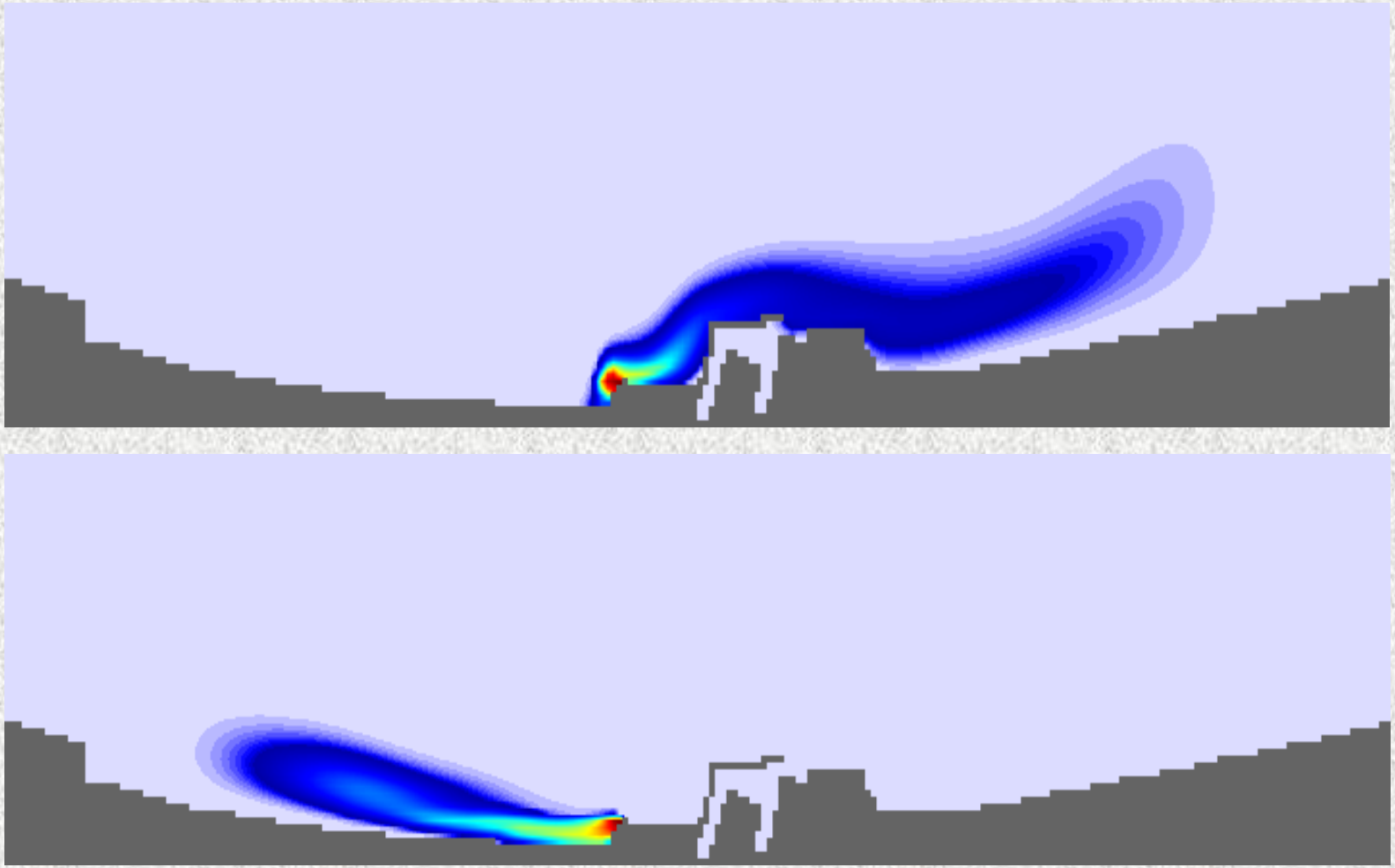
Coupled models nested grids



Burns Ditch nested model grid

(Source: David Schwab, GLERL)

Simulations for Two Different Wind Conditions



(Source: David Schwab, GLERL)

Sources of Fecal Coliform to Monitor for Beach Forecasting Models

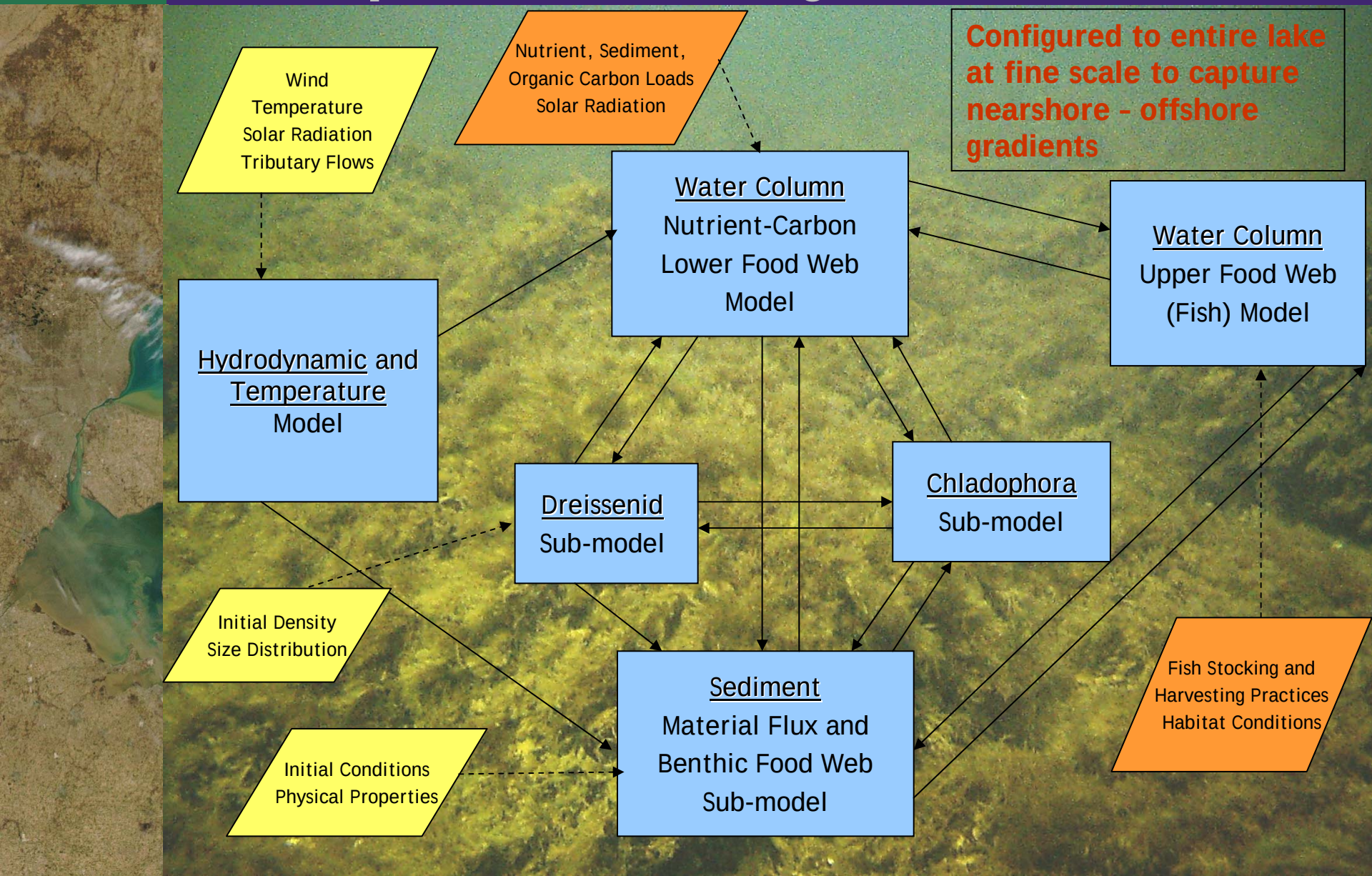
- Birds and Wildlife
  - Gulls produce 3.4E08 *E. coli* / gm feces
- Sewage discharges/CSOs
  - Raw sewage contains ~2.5e6 CFU/100 ml
- Storm sewer outfalls
- Agriculture and urban runoff
- Nearshore benthic algae

- Beach sand can serve as a repository for pathogens


Keep 'em Great!

Extra Slides

Proposal for a Great Lakes Ecosystem Eutrophication Management Model



Nearshore Shunt Hypothesis
(Hecky, et. al., CJFAS (2004)