Revised Algal Speciation Model for the Potomac River Estuary

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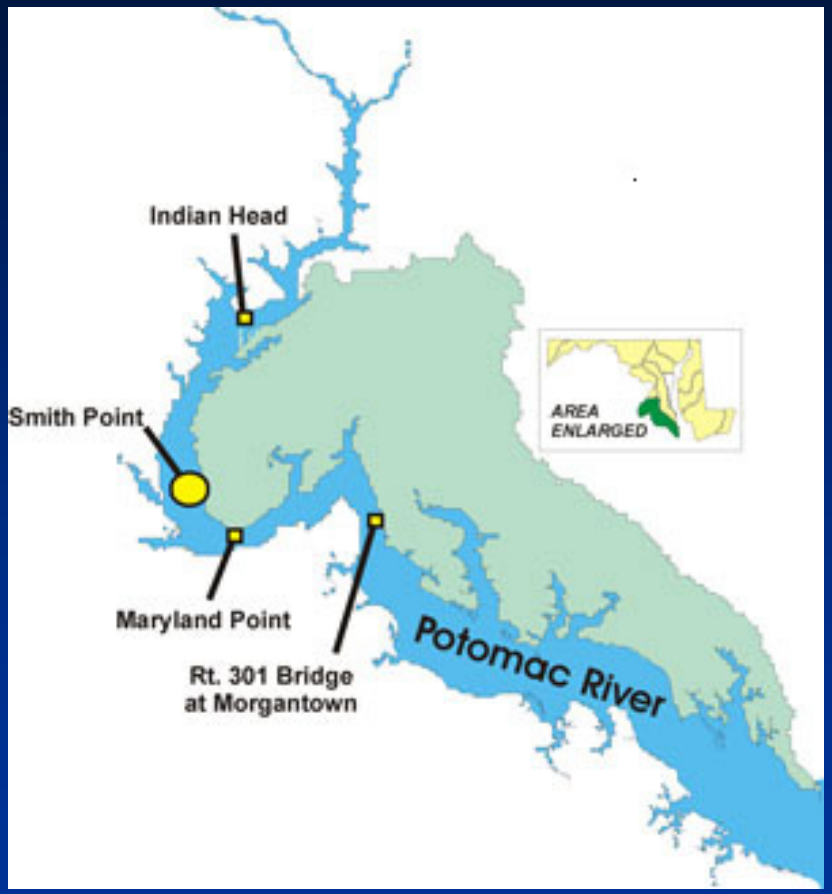
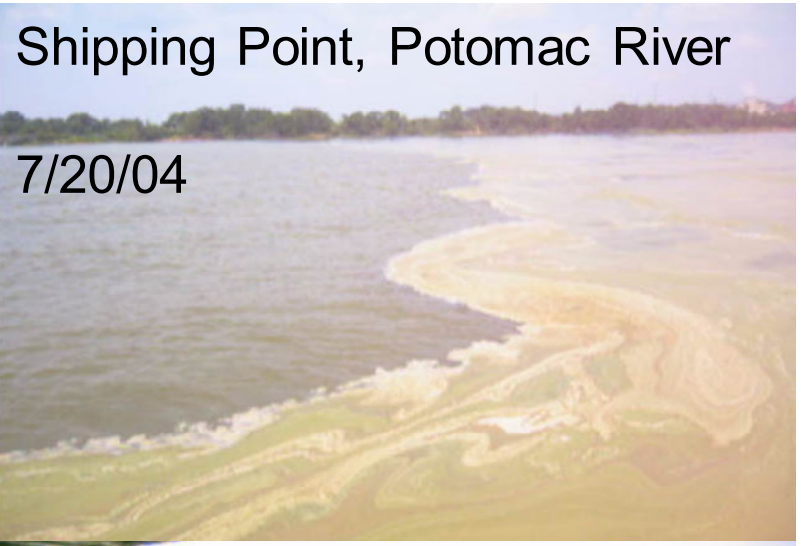
Potomac River Estuary

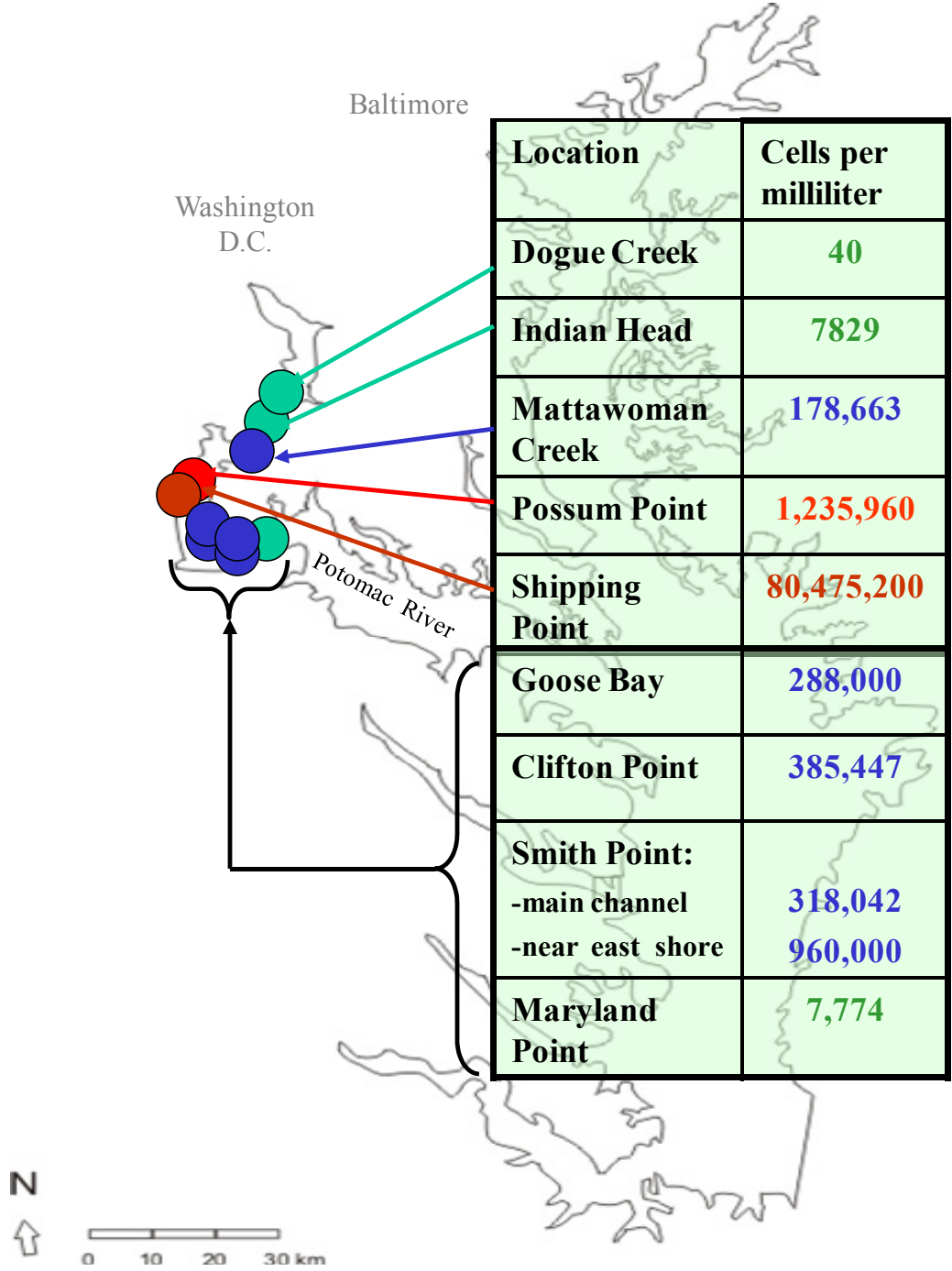


- Largest estuarine tributary to Chesapeake Bay
- 118 miles from head of tide to Chesapeake Bay
- Watershed area 2,537 mi^2
- Potomac basin population 5.8 million
- Oxygen depletion in bottom waters
- Excess chlorophyll concentrations
- Diminished living resources

Problems Unique to Potomac

- Blooms of blue-green algae
- Elevated pH
- P limitation in tidal fresh portion

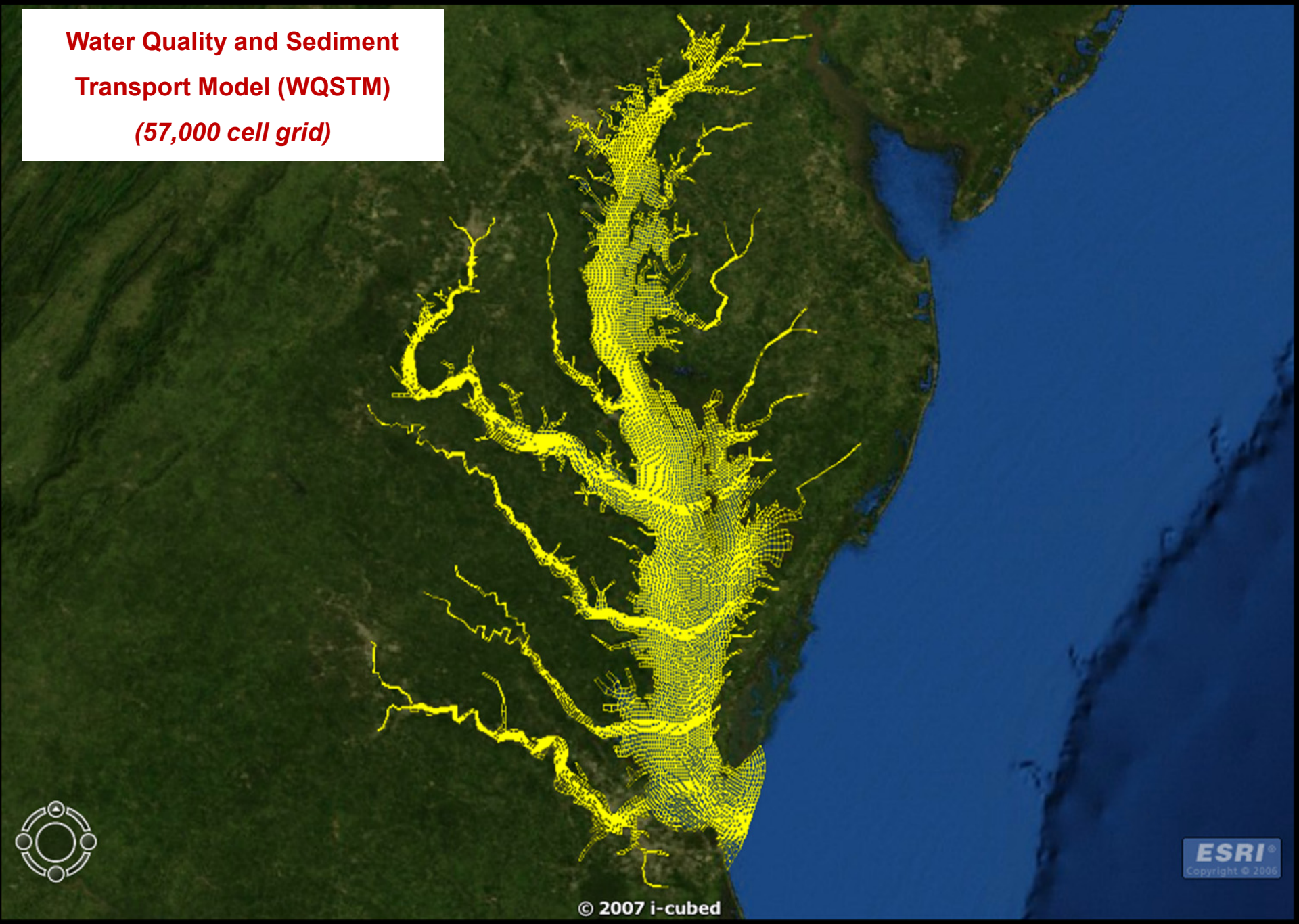




Location	Cells per milliliter
Dogue Creek	40
Indian Head	7829
Mattawoman Creek	178,663
Possum Point	1,235,960
Shipping Point	80,475,200
Goose Bay	288,000
Clifton Point	385,447
Smith Point: -main channel -near east shore	 318,042 960,000
Maryland Point	7,774

Study Objectives

- Refine algal groups in Potomac portion of bay water quality model
- Calibrate the revised Potomac model


Water Quality and Sediment
Transport Model (WQSTM)
(57,000 cell grid)
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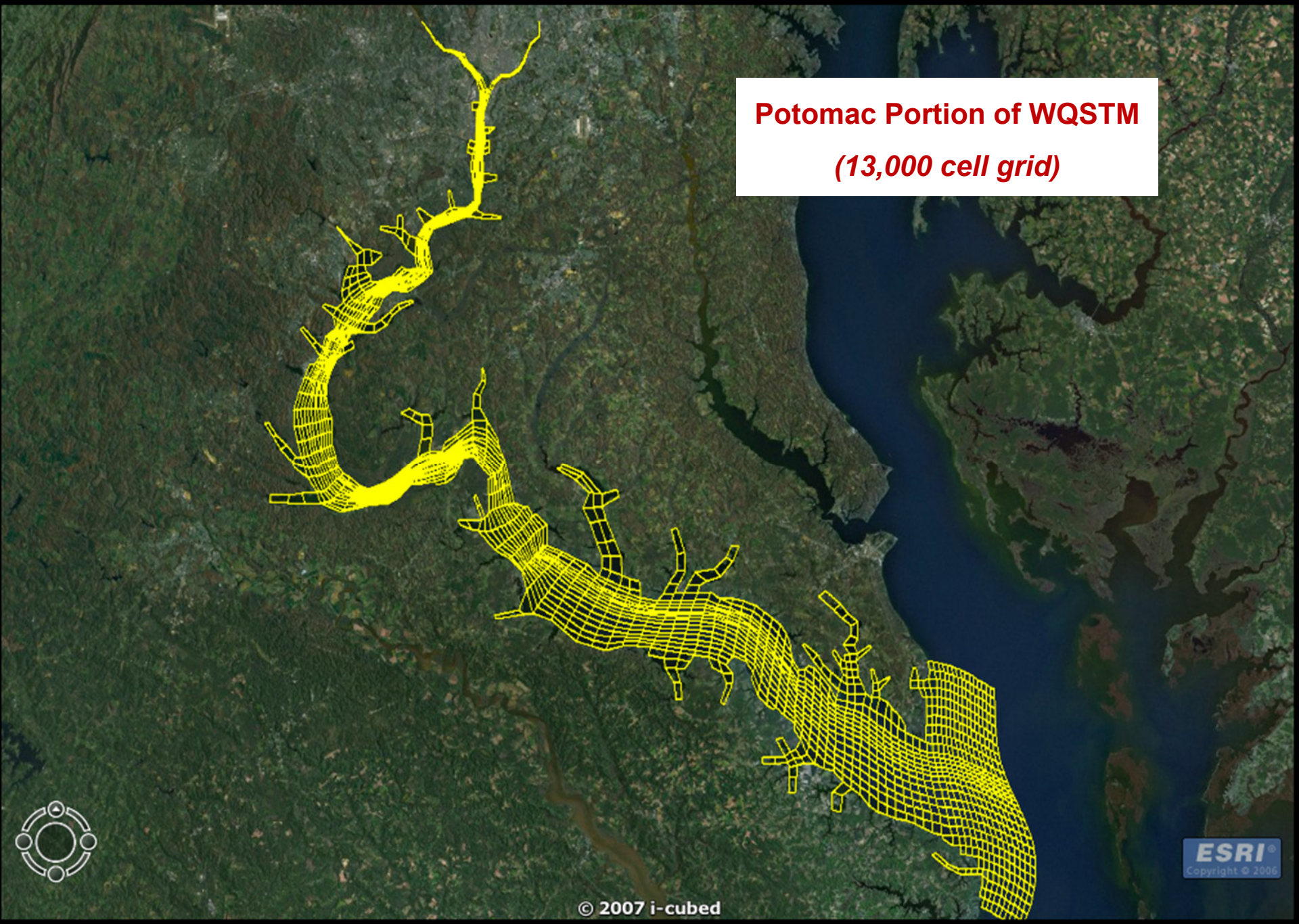
Potomac Portion of WQSTM
(13,000 cell grid)
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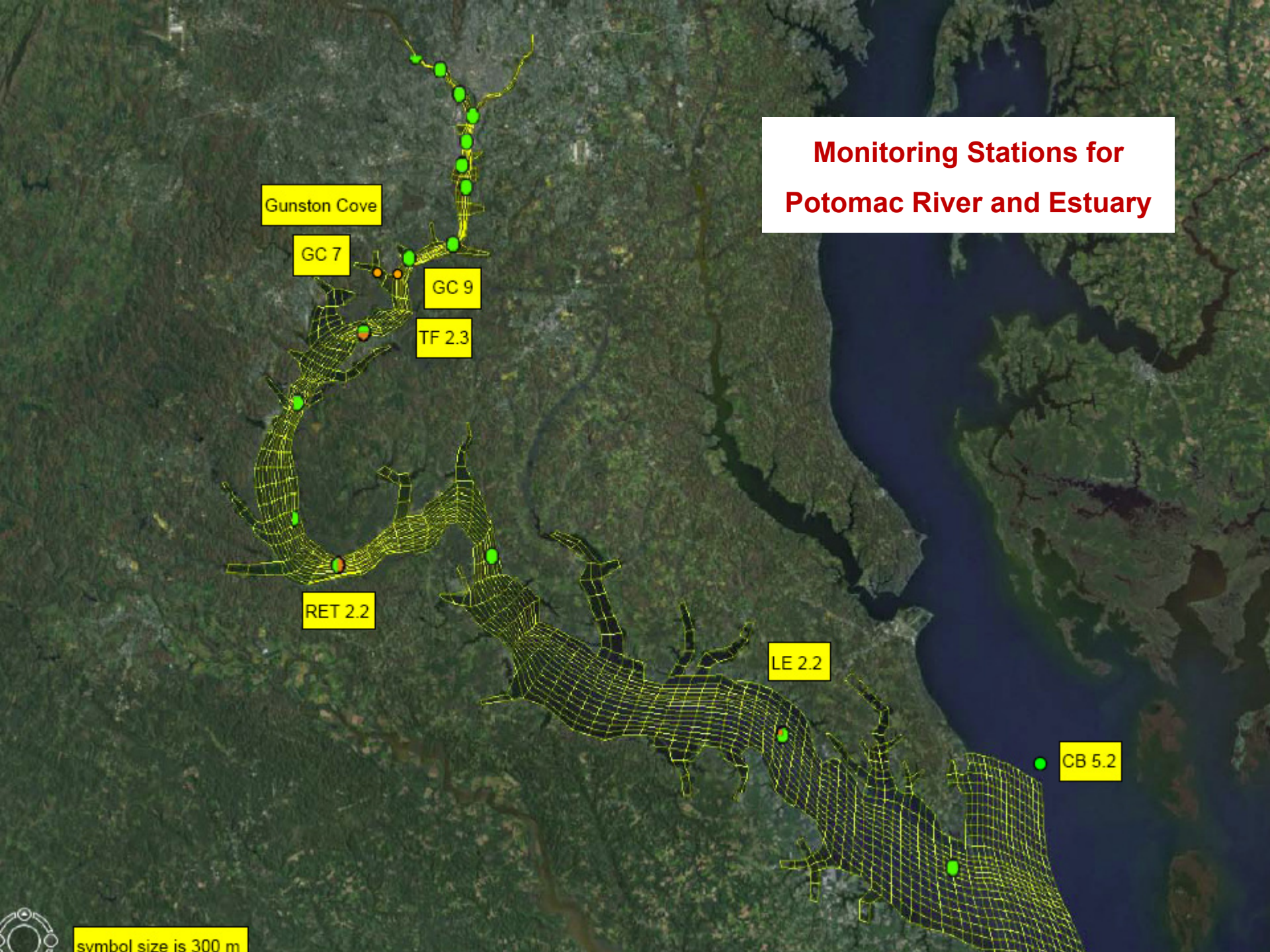
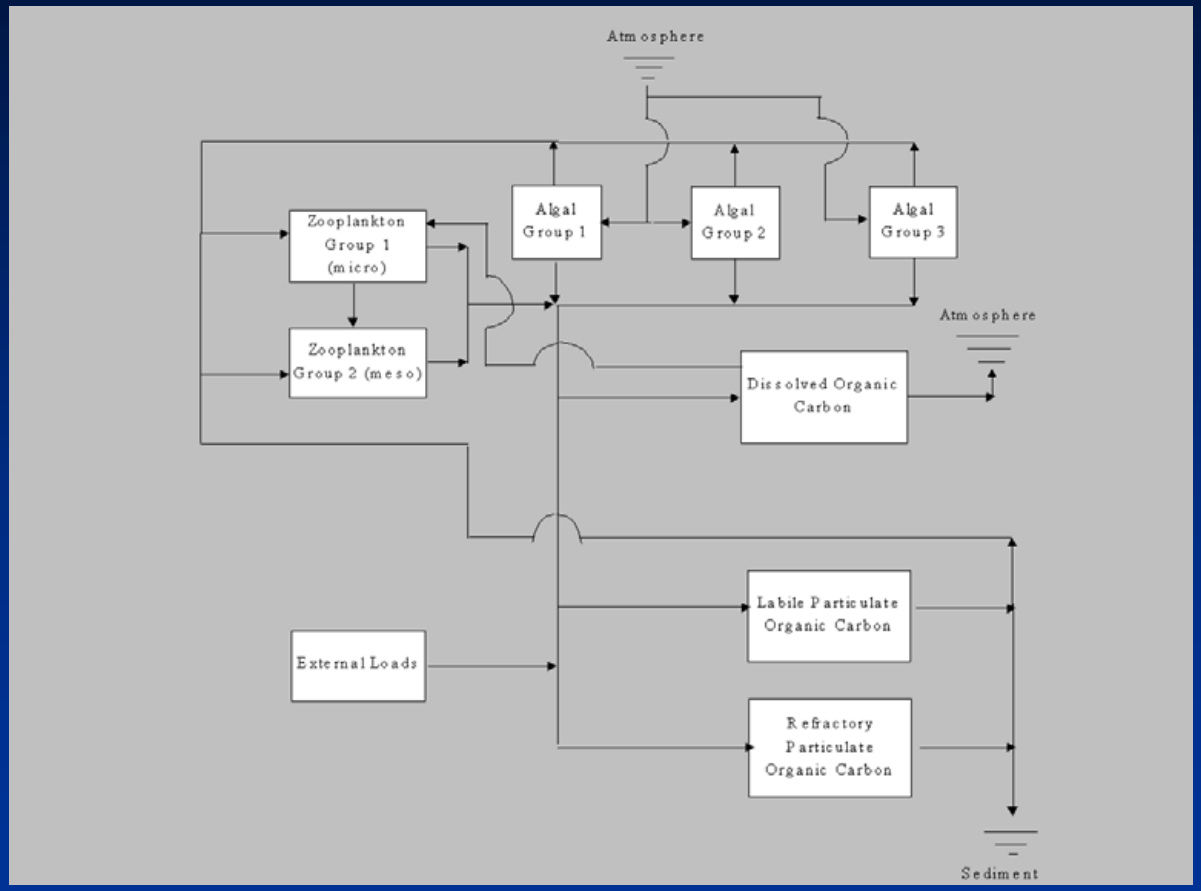

Monitoring Stations for
Potomac River and Estuary
Gunston Cove
GC 7
GC 9
TF 2.3
RET 2.2
LE 2.2
CB 5.2
symbol size is 300 m

Existing Algal Sub-Model in WQSTM



- Spring Diatoms
- Cyanobacteria (Blue-Greens)
- Other Green Algae

Considerations for Revised Algal Model

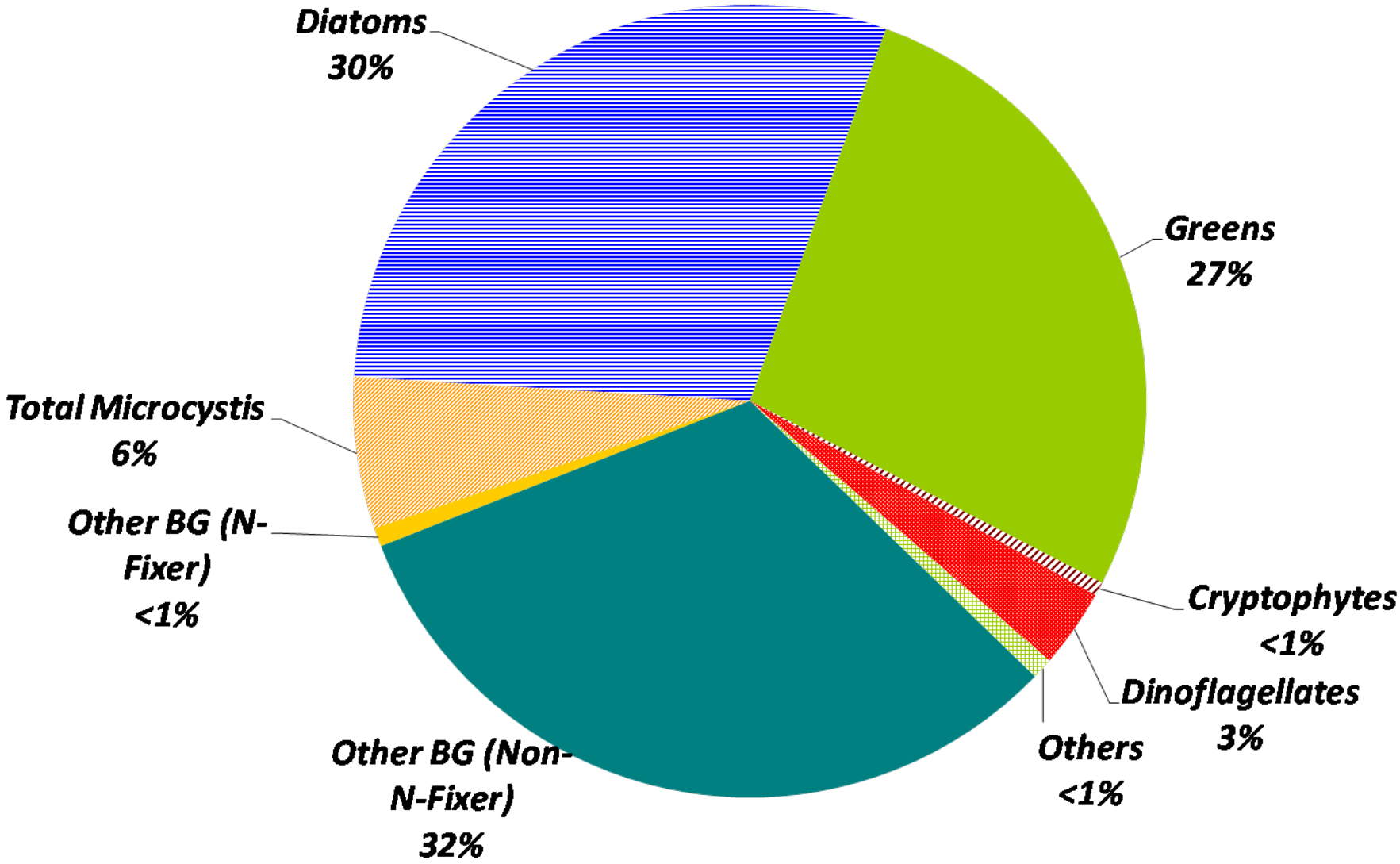
- Nutrient requirements
- Salinity tolerance
- Temperature requirements
- Susceptibility to grazing
- Water quality management issues
  - Microcystis blooms
- Model complexity
  - Difficult to model more than five groups
- Mass balance
  - Want to capture $\geq$ 95% of algal biomass

Phytoplankton Groups

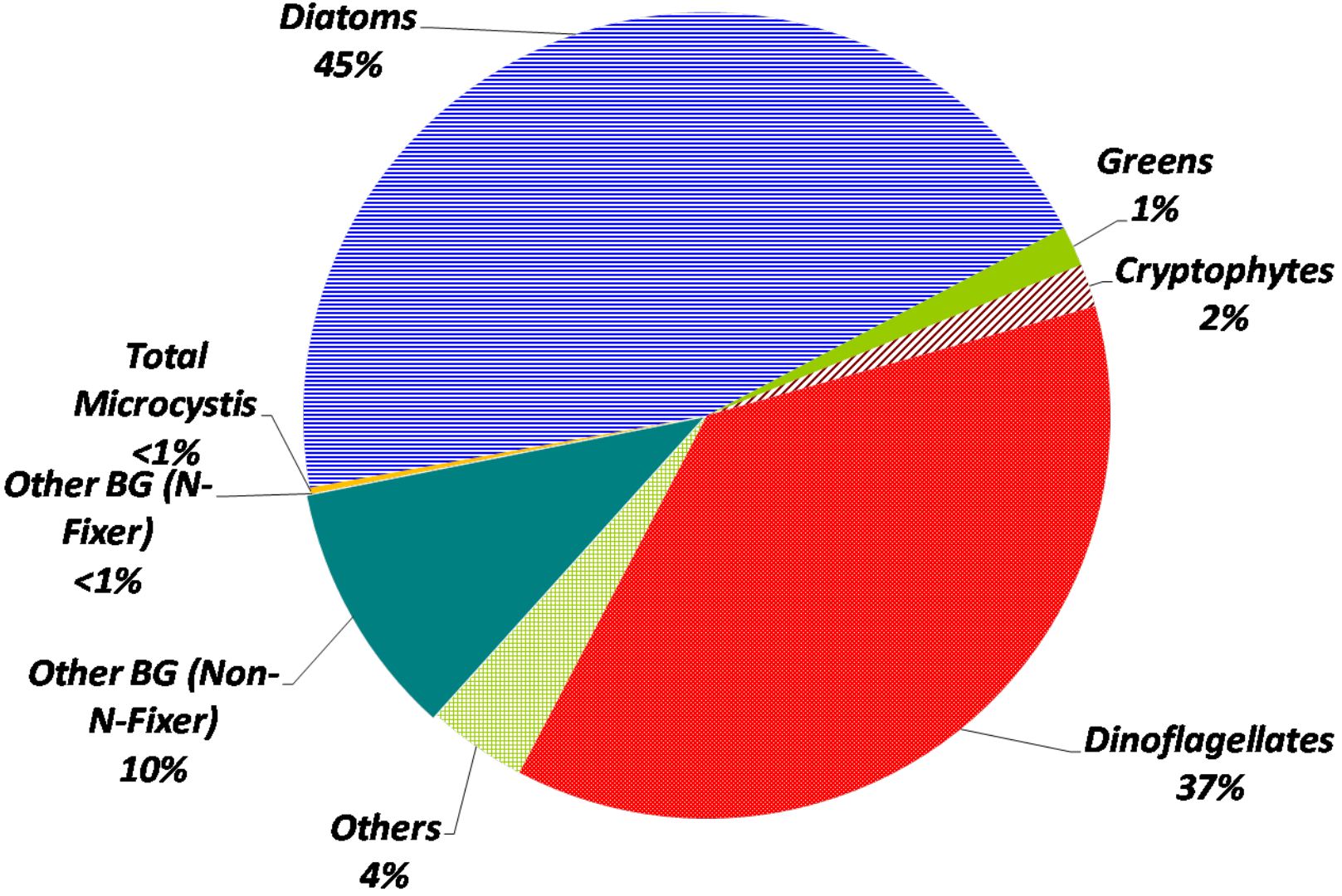
How to lump?

How to split?

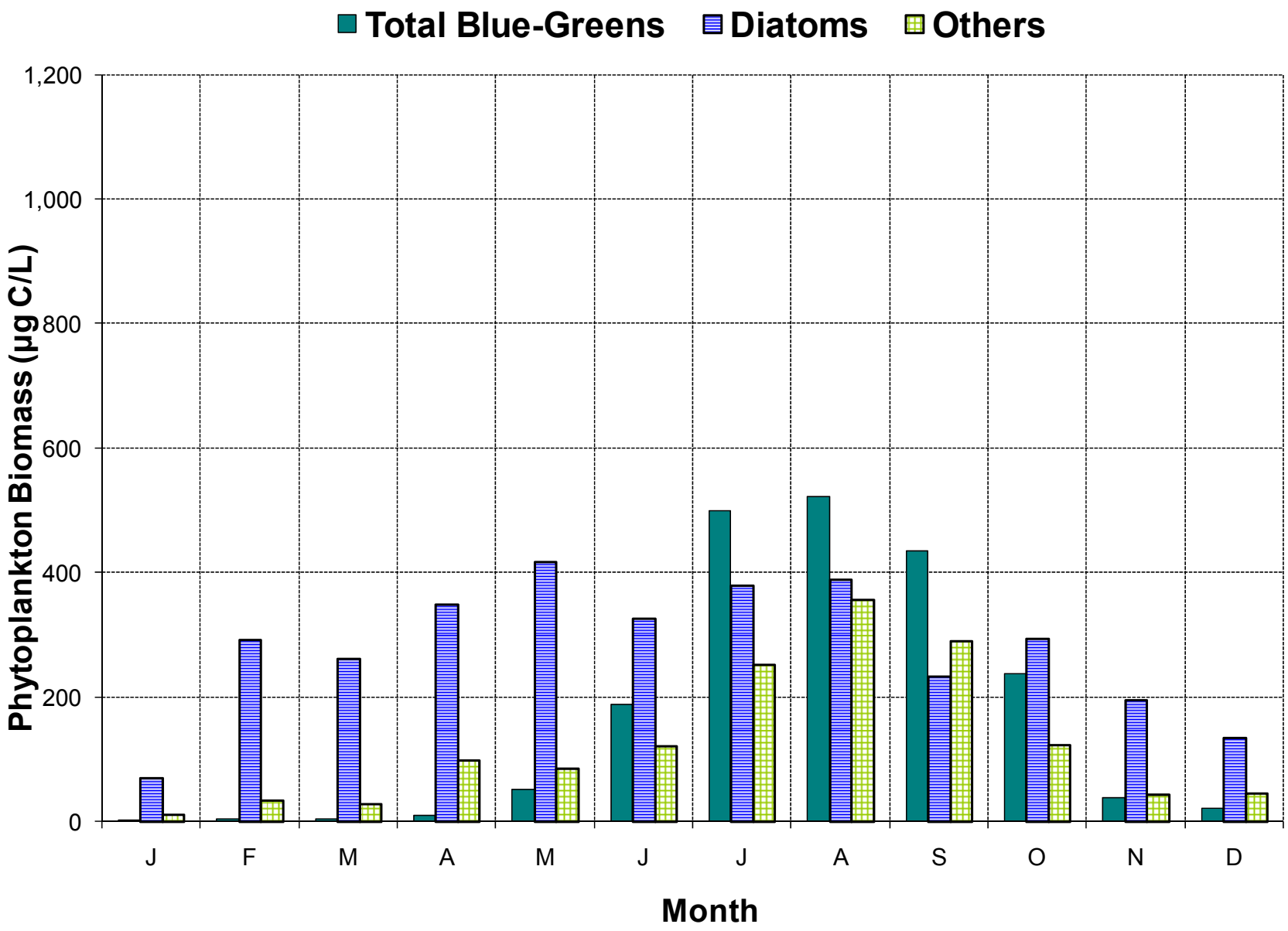
Percent Composition as Organic Carbon
Tidal Fresh (1994-2000)

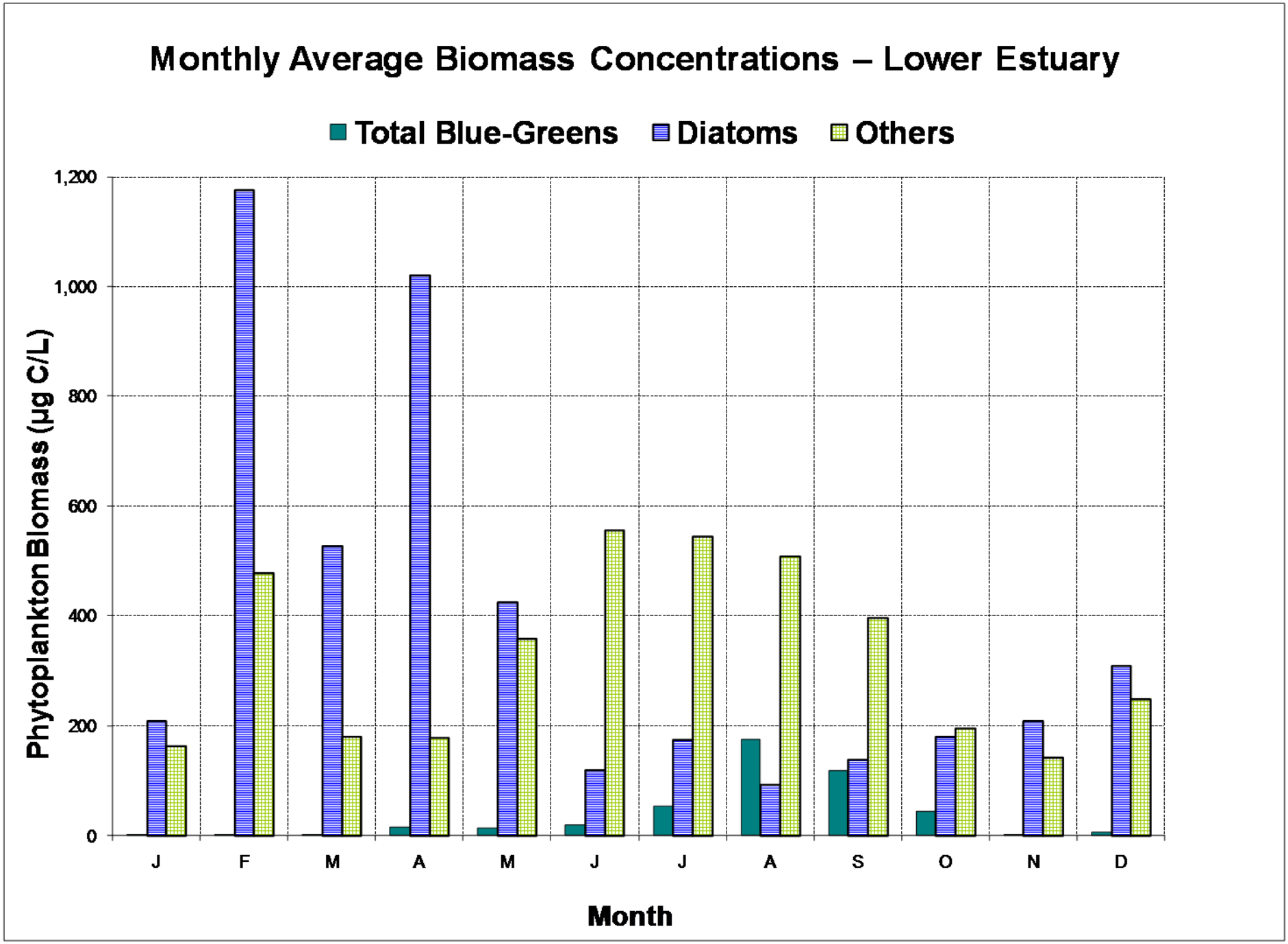


Percent Composition as Organic Carbon
Lower Estuary (1994-2000)



Monthly Average Biomass Concentrations – Tidal Fresh




Monthly Average Biomass Concentrations – Lower Estuary
Total Blue-Greens
Diatoms
Others
Phytoplankton Biomass (µg C/L)
1,200
1,000
800
600
400
200
0
J
F
M
A
M
J
J
A
S
O
N
D
Month

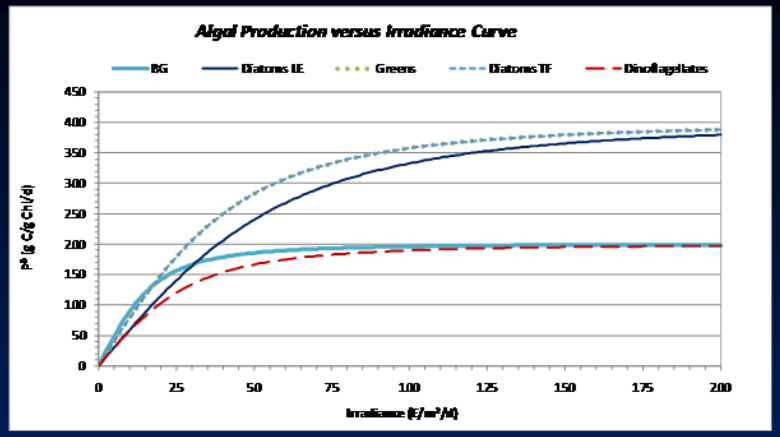
Five Algal Groups in Revised Model

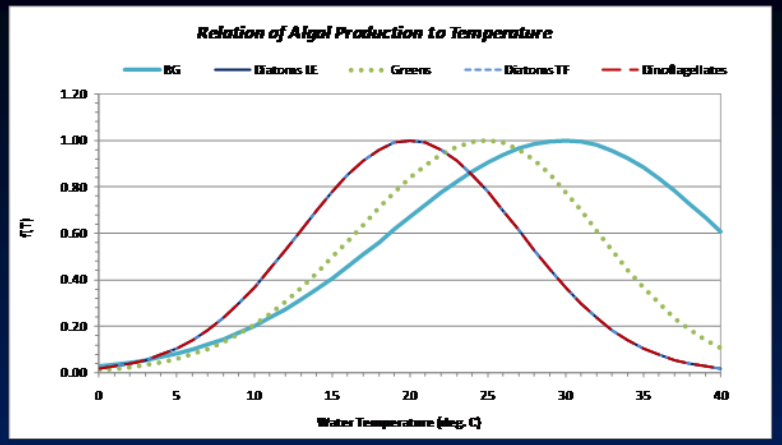
- Tidal Freshwater Diatoms
- Greens
- Blue-Greens

Dominant in Tidal Fresh

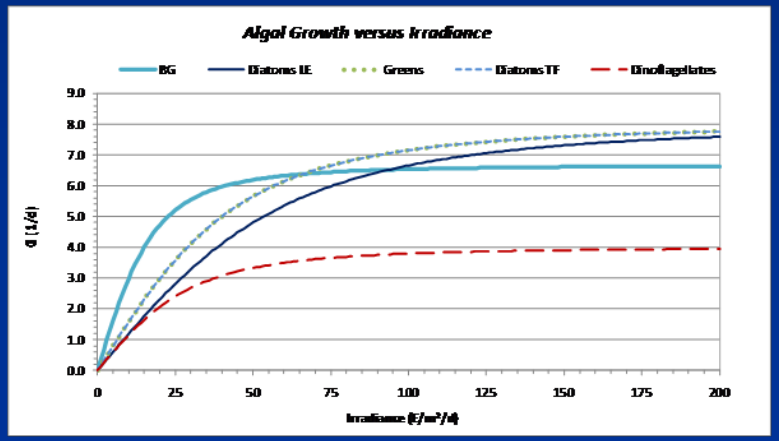
- Lower Estuary Diatoms
- Dinoflagellates

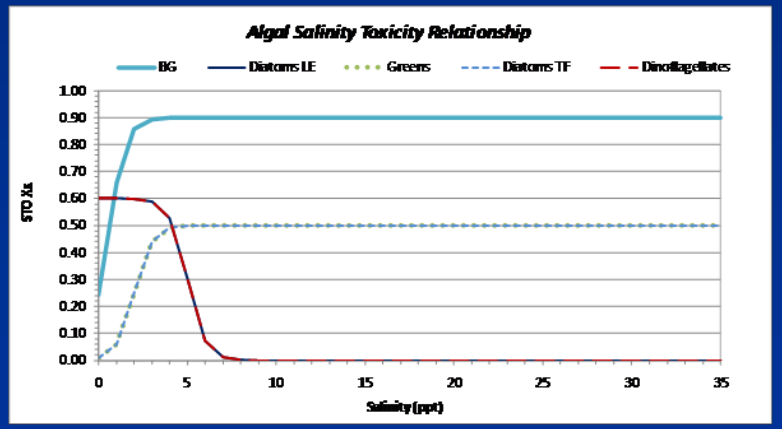
Dominant in Lower Estuary



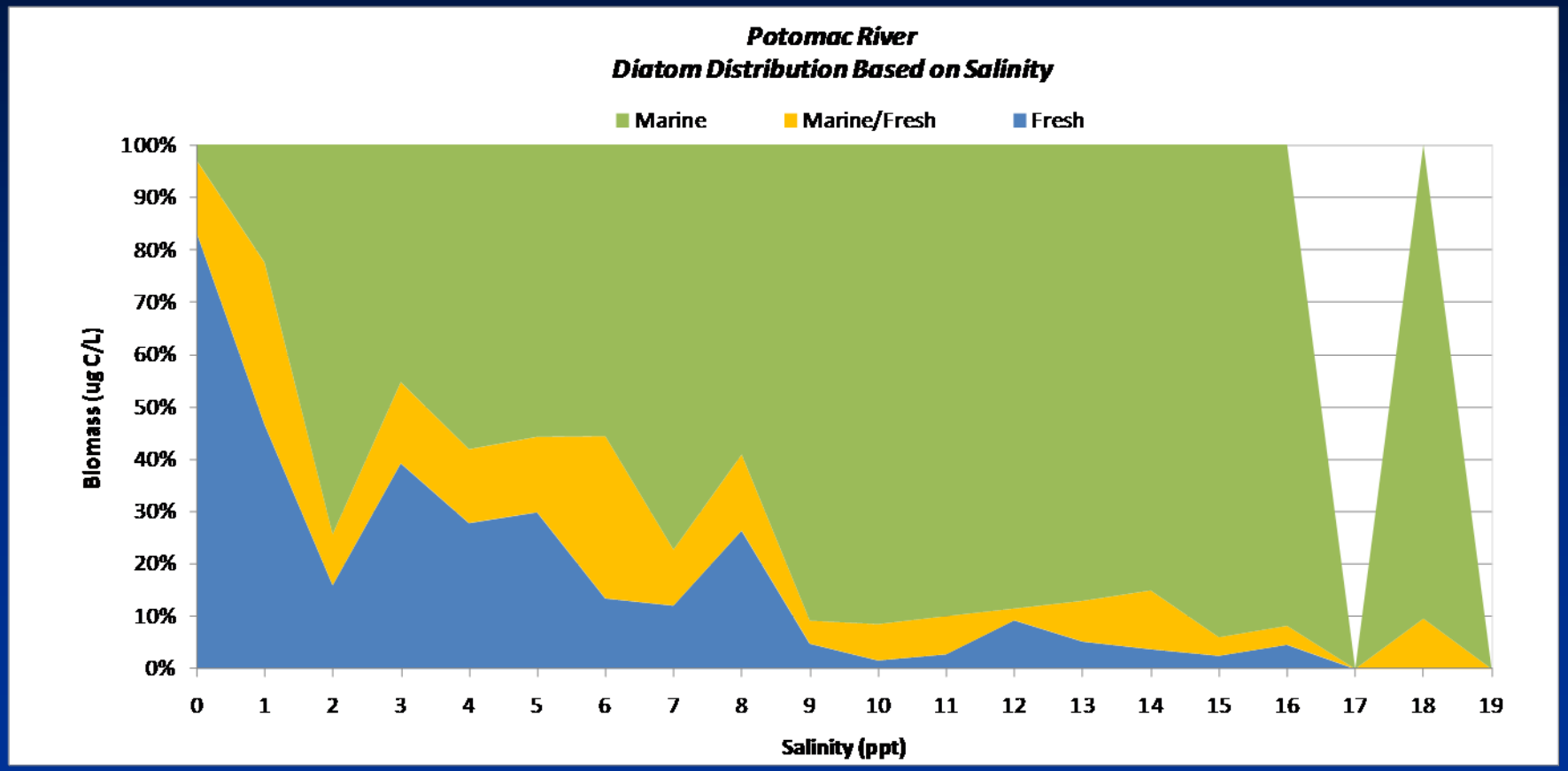


Light, temperature and salinity responses are principal drivers for algal differences



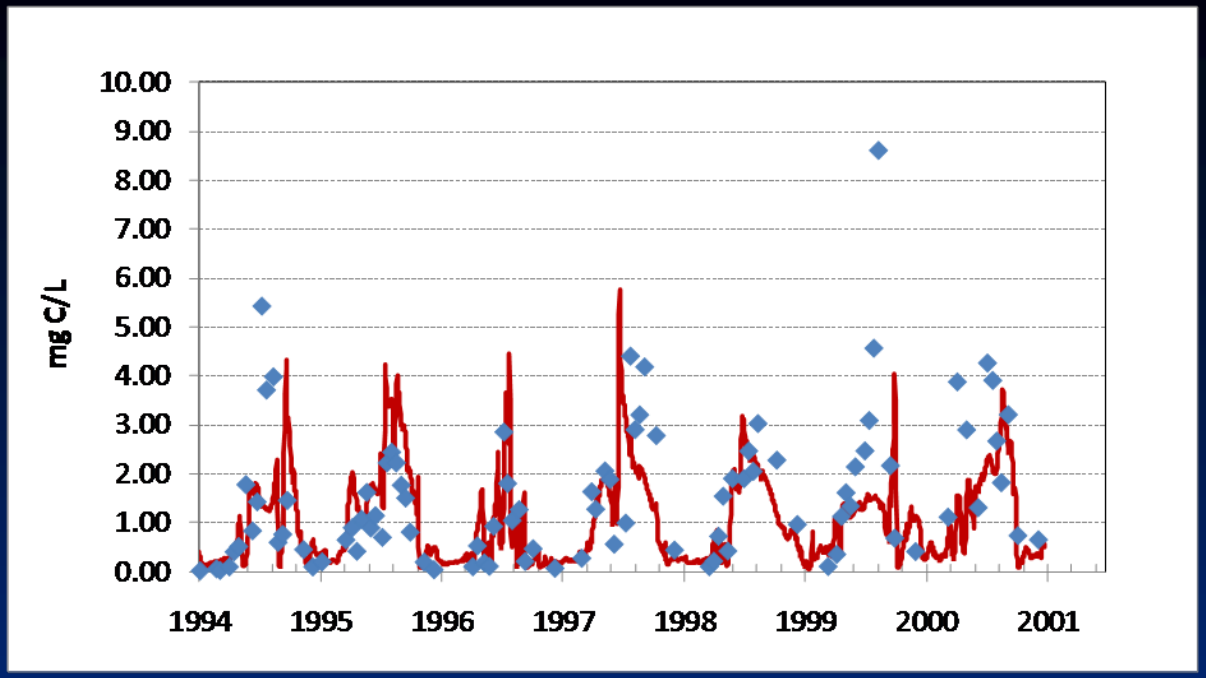


Diatom Responses to Salinity

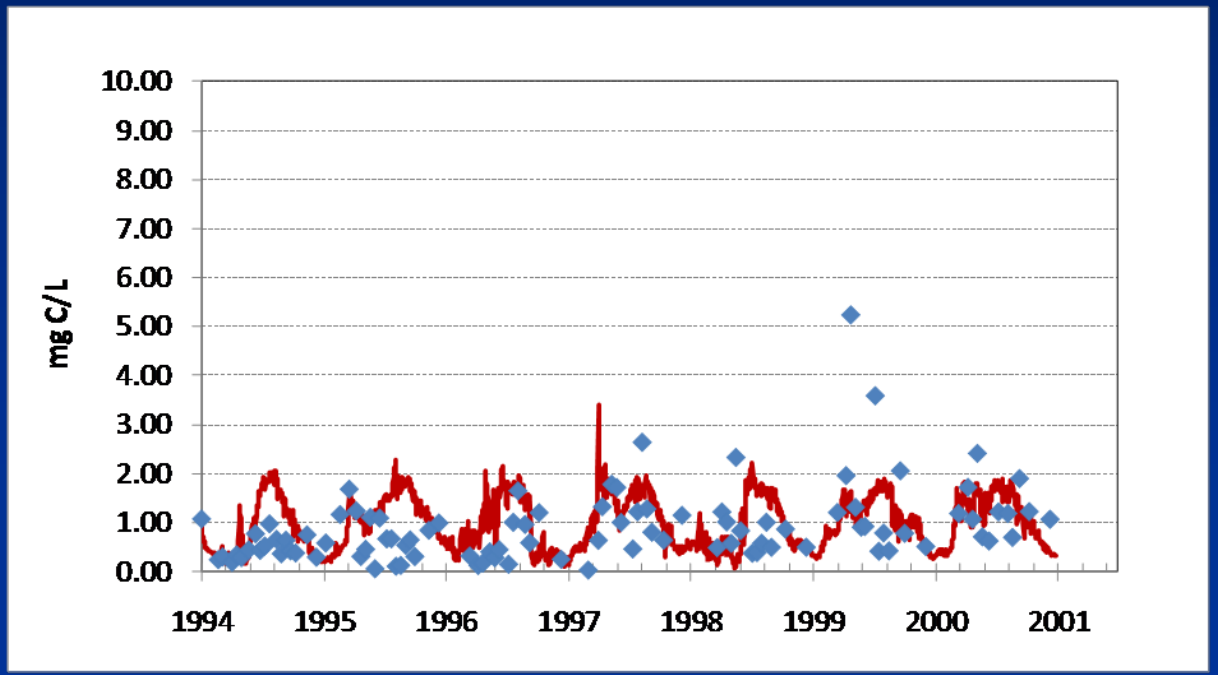


Model Calibration Results

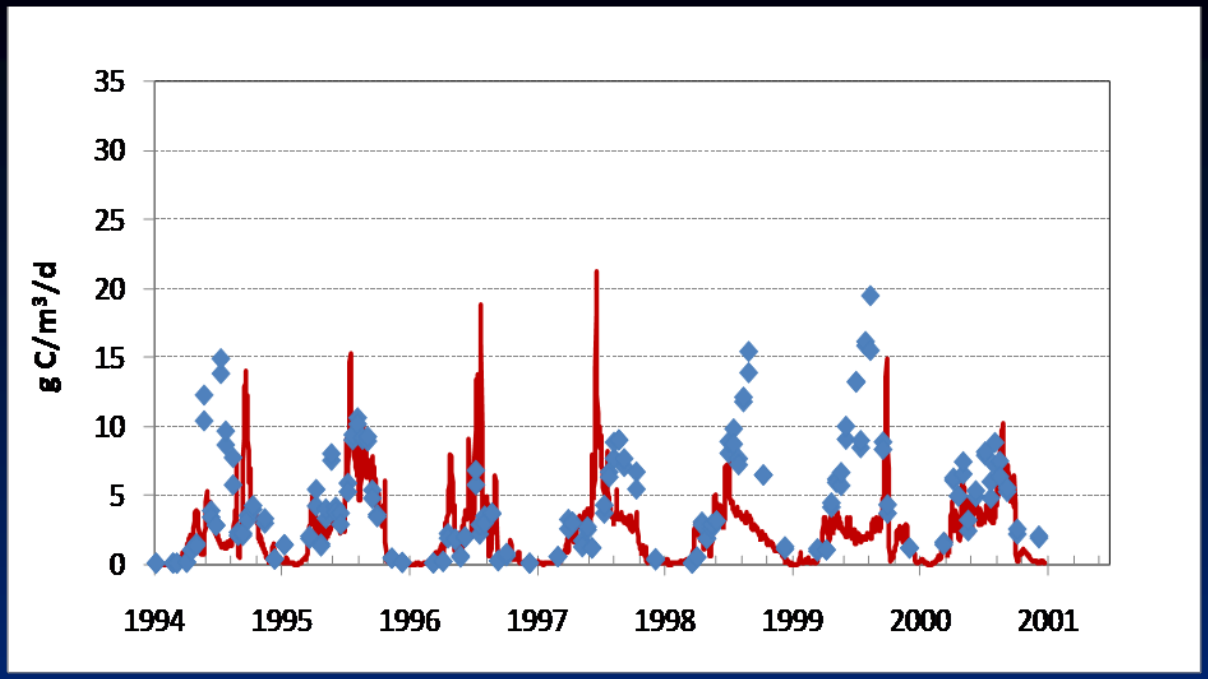
Computed and Observed Values



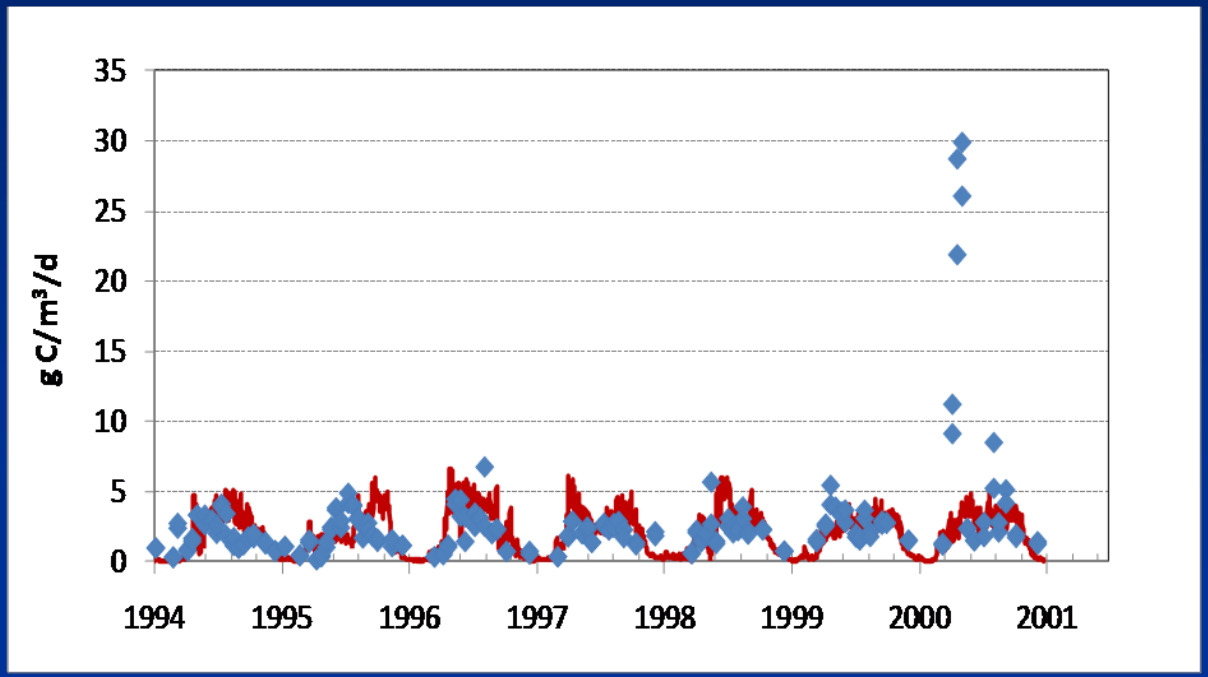
Total Biomass
Tidal Fresh



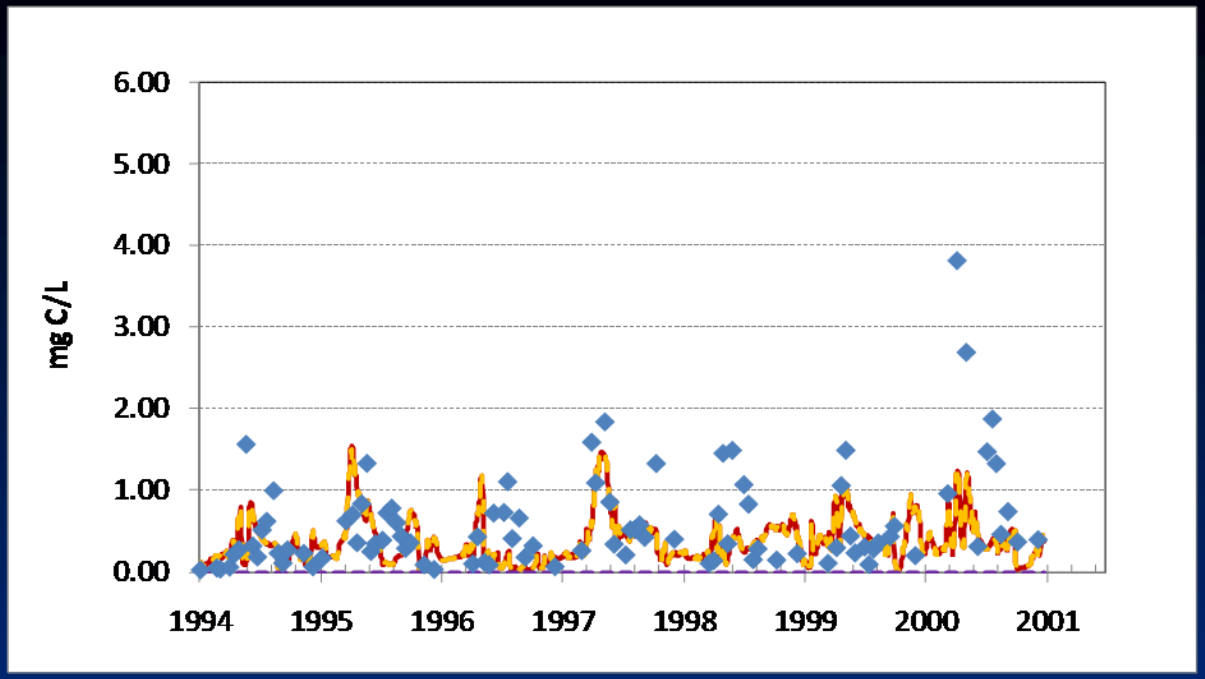
Total Biomass
Lower Estuary



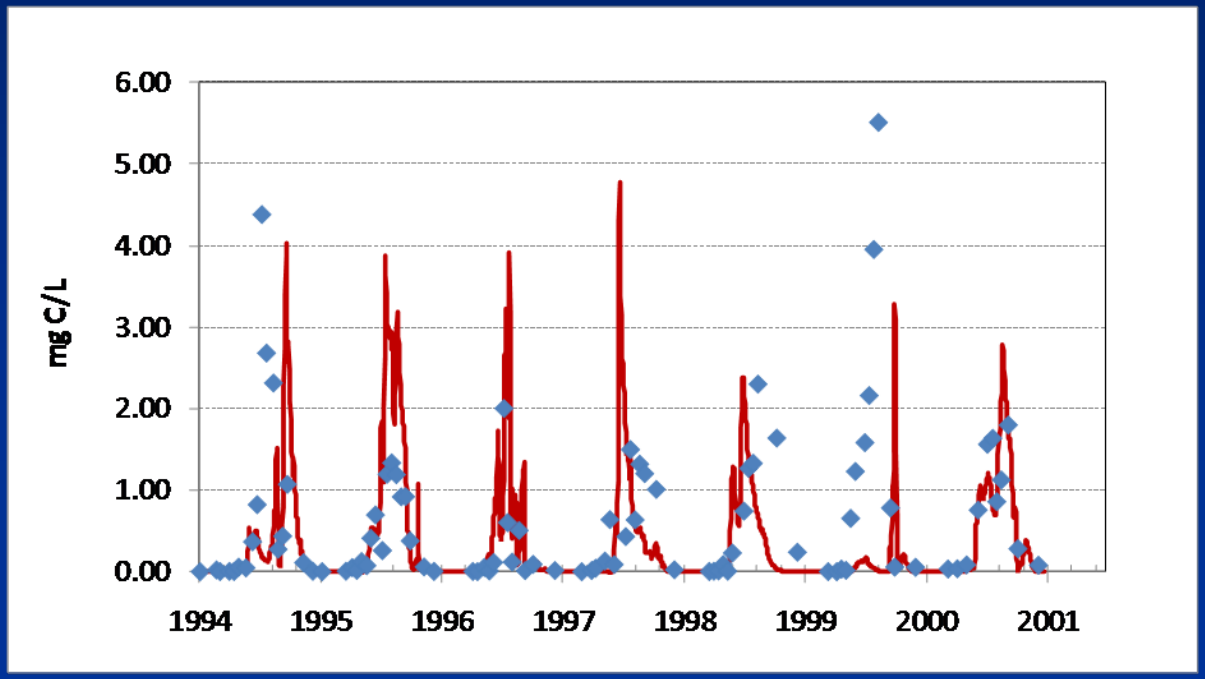
Carbon Fixation
Tidal Fresh



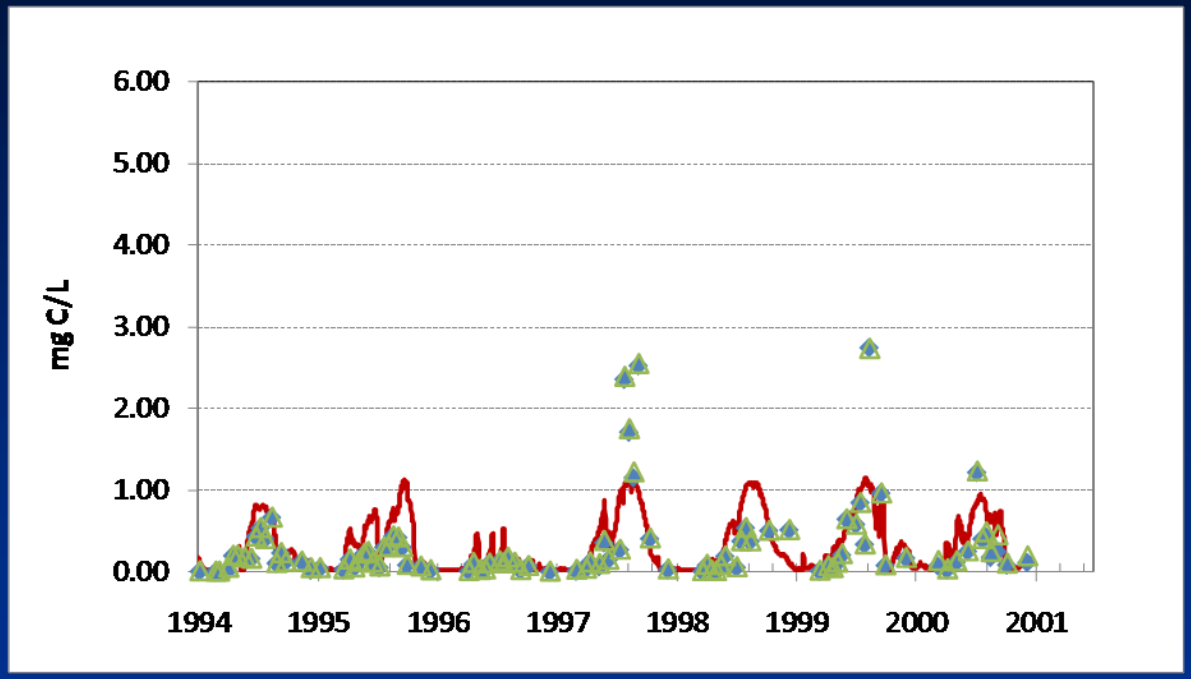
Carbon Fixation
Lower Estuary



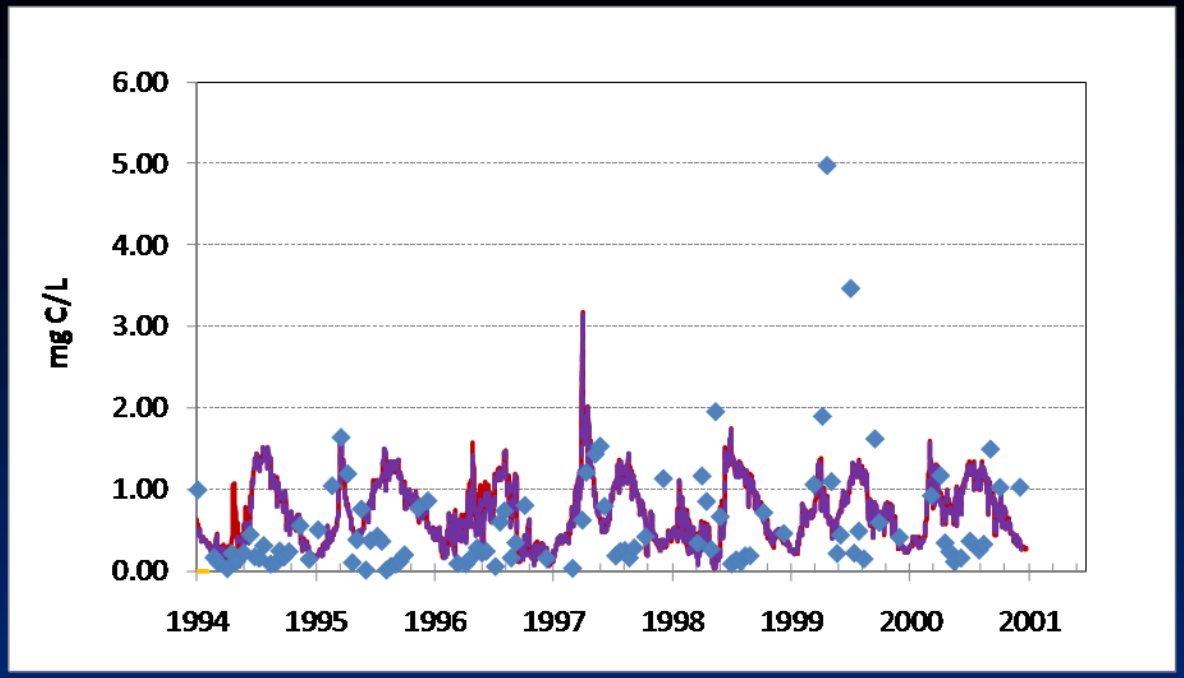
Diatom Biomass Tidal Fresh



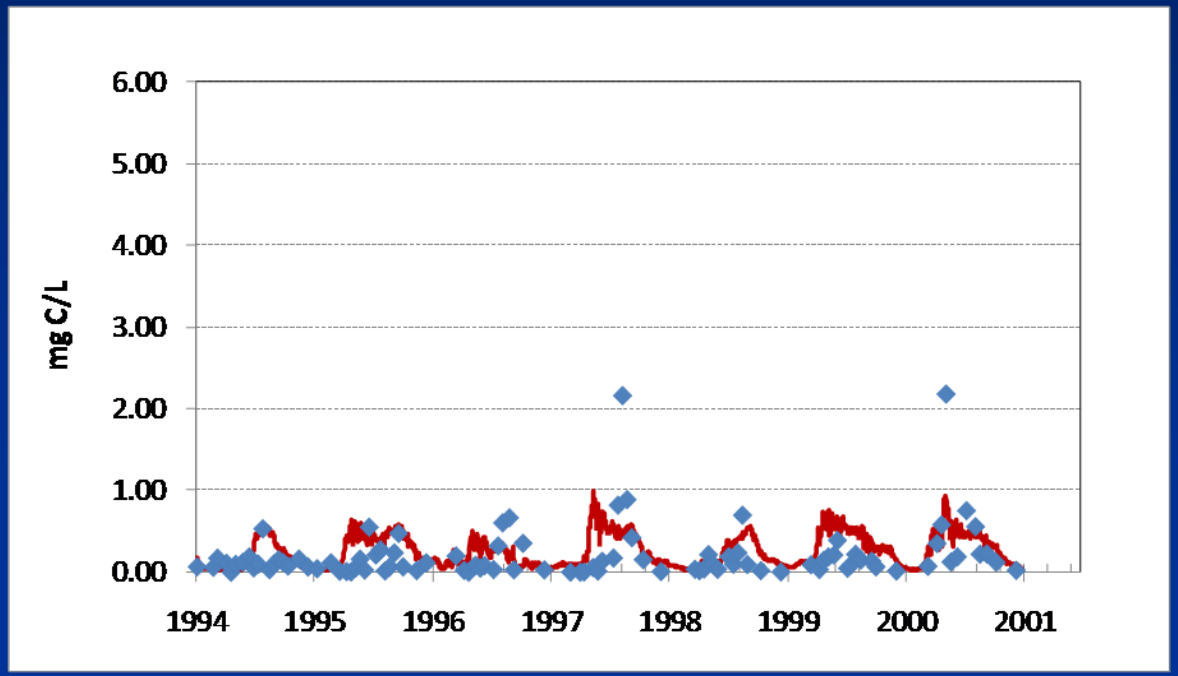
Blue-Green Biomass Tidal Fresh



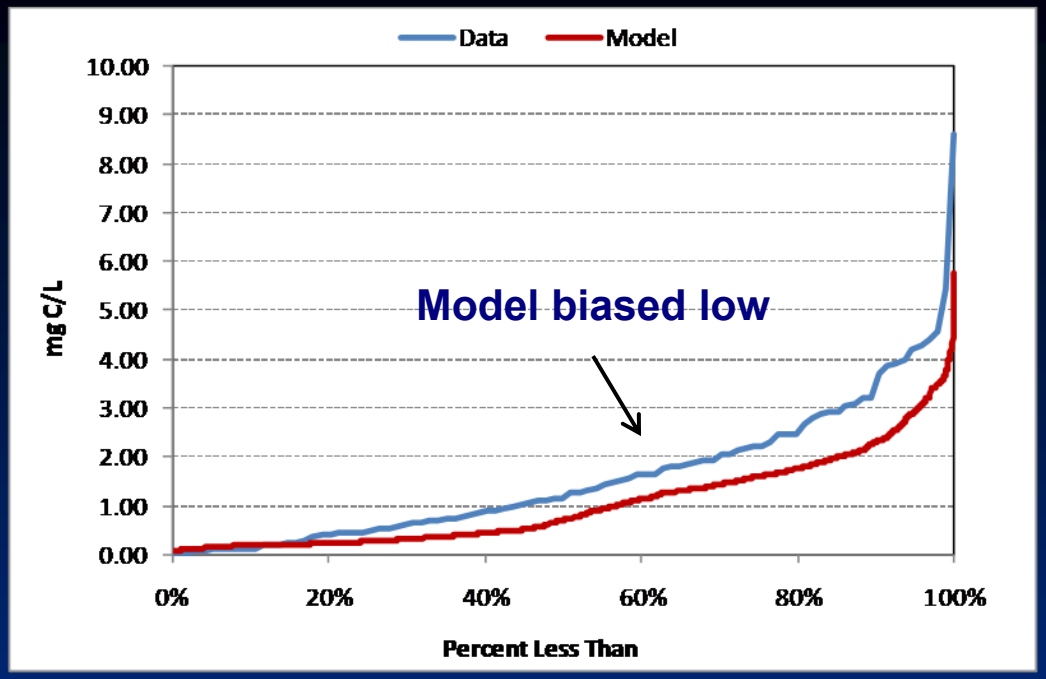
Green Biomass
Tidal Fresh



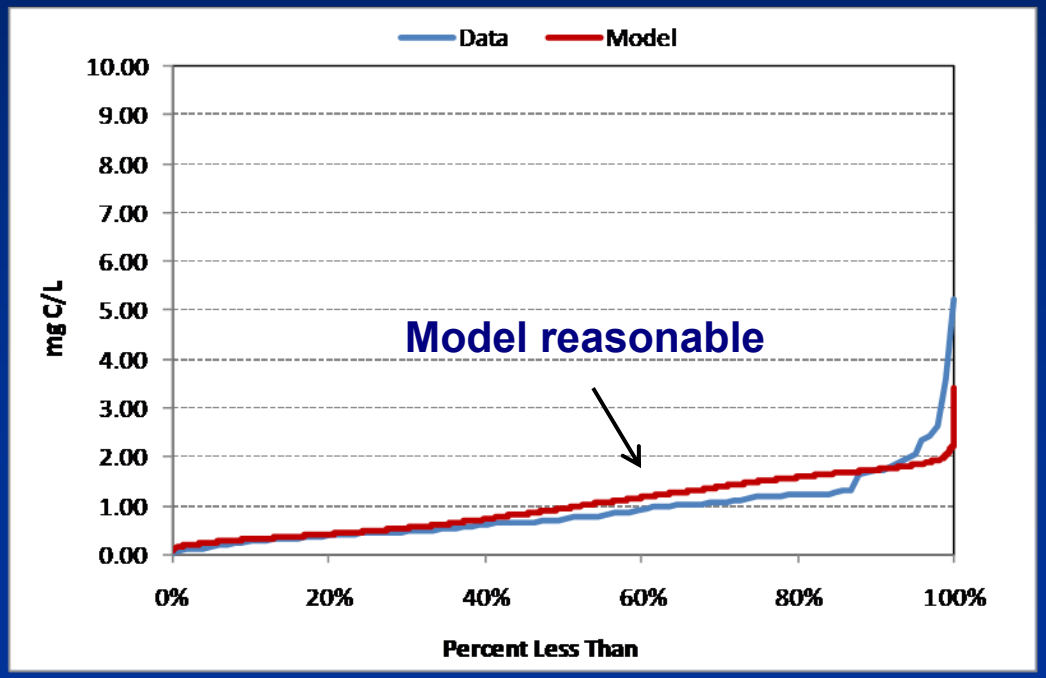
Diatom Biomass Lower Estuary



Dinoflagellate Biomass Lower Estuary

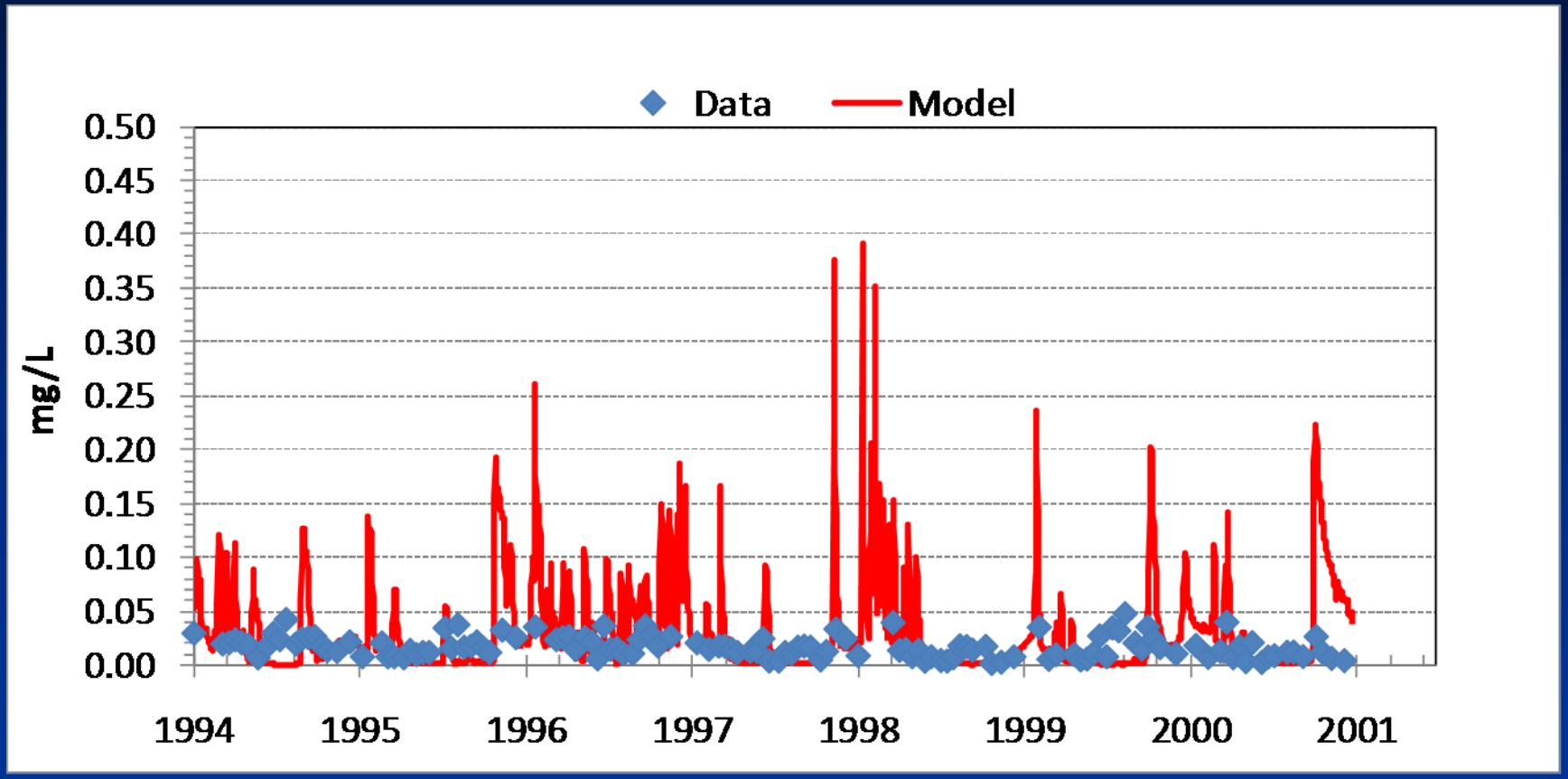


Total Biomass
Tidal Fresh

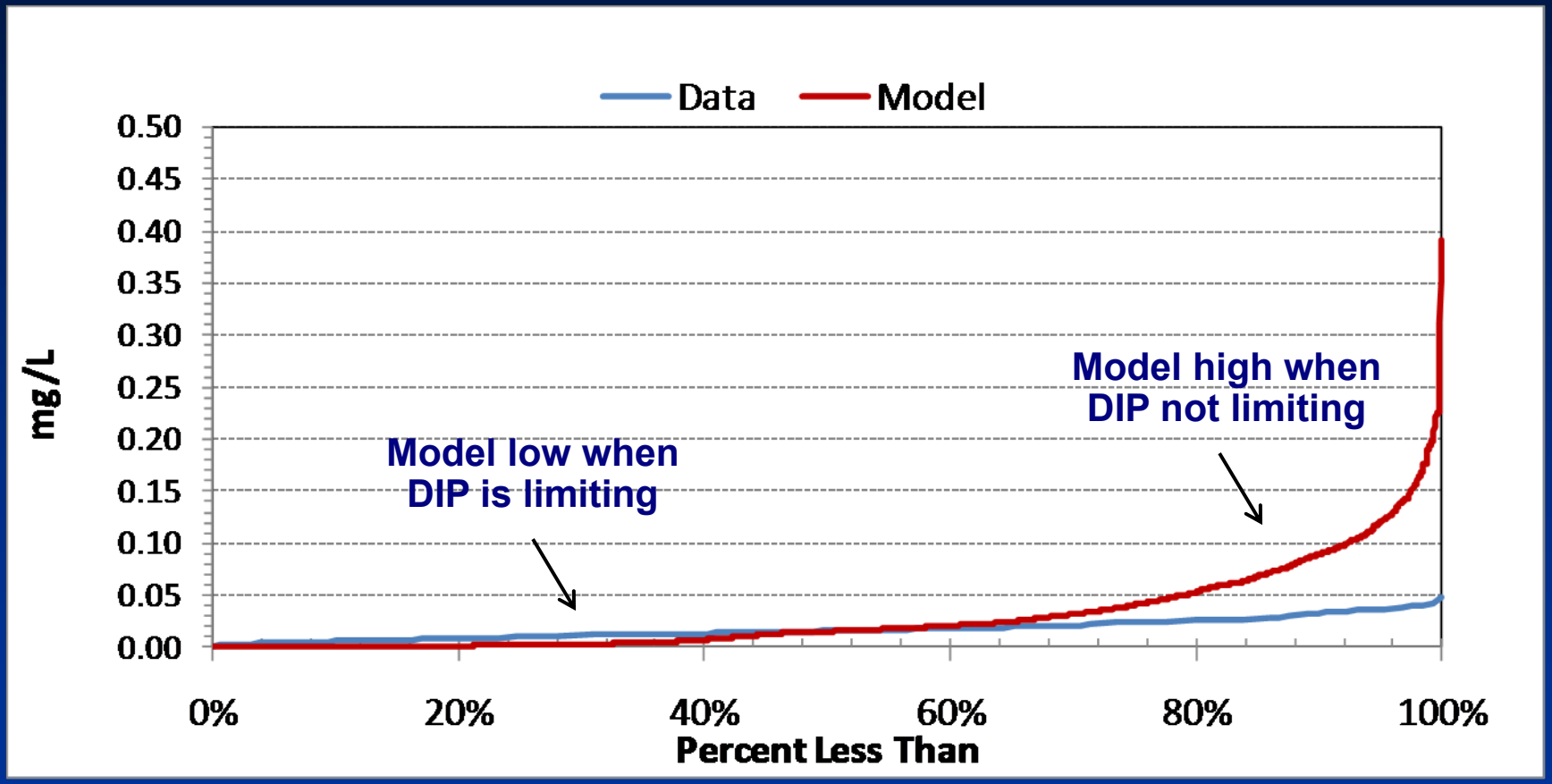


Total Biomass
Lower Estuary

Dissolved Inorganic P (Tidal Fresh)
Time Series

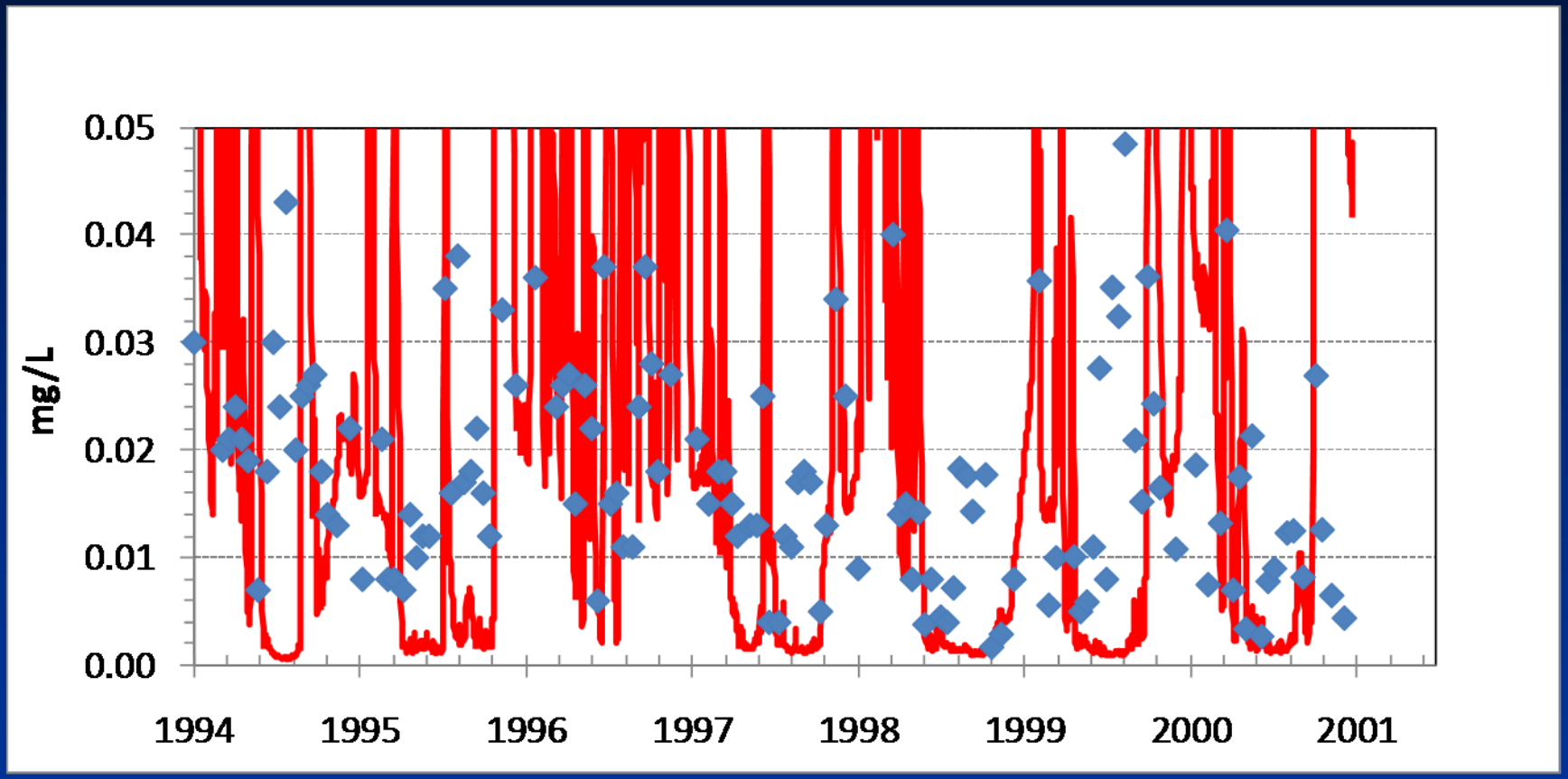


Dissolved Inorganic P (Tidal Fresh)
Cumulative Frequency Distribution



Dissolved Inorganic P (Tidal Fresh)

Time Series with Expanded Scale



Conclusions

- The feasibility of a regional-scale application of a portion of the full 57,000 cell WQSTM was demonstrated
- The feasibility of developing and calibrating a multi-algal group model was demonstrated for a major Chesapeake Bay tributary
- The revised Potomac portion of the WQSTM provided a reasonable representation of the spatial and temporal distributions of the dominant algal groups
- The calibration results suggest that sediment-water fluxes of dissolved inorganic phosphorus are important and that additional refinements are needed in the pH-alkalinity sub-model for the Potomac
- The revised Potomac model is a research testbed and consideration should be given to incorporating its capabilities into the WQSTM

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