GREAT BAY ESTUARY SYSTEM MODEL: A MECHANISTIC & QUANTIFIABLE FRAMEWORK FOR ASSESSMENT OF RESOURCE MANAGEMENT DECISIONS

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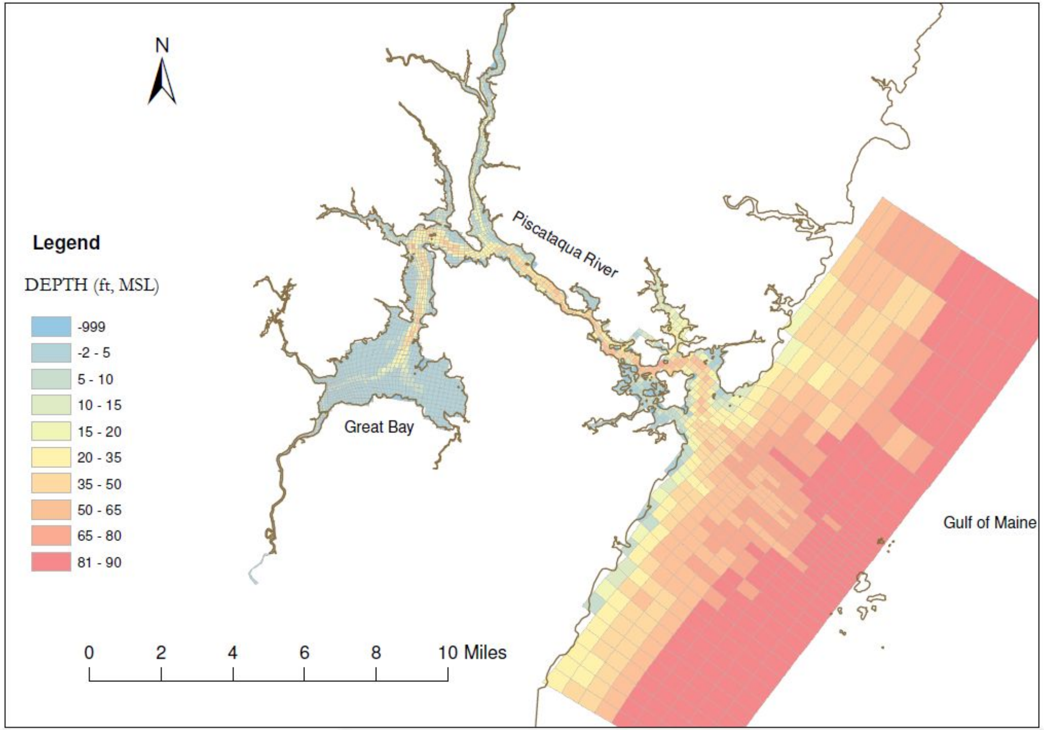
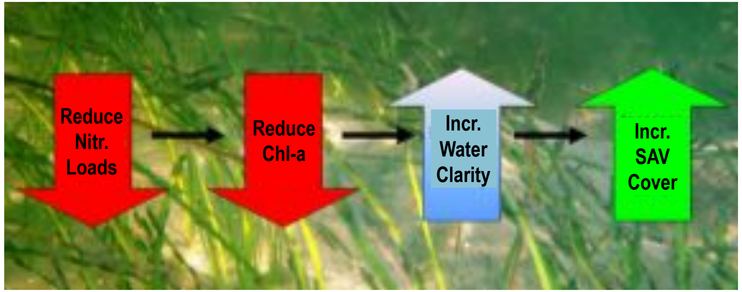
AGENDA

- Background & Overview of Great Bay Estuary System (GBES) Model
  - Why developed?
- Model Setup & Calibration
  - How developed?
- Applications & Potential Uses
  - What to do with model?



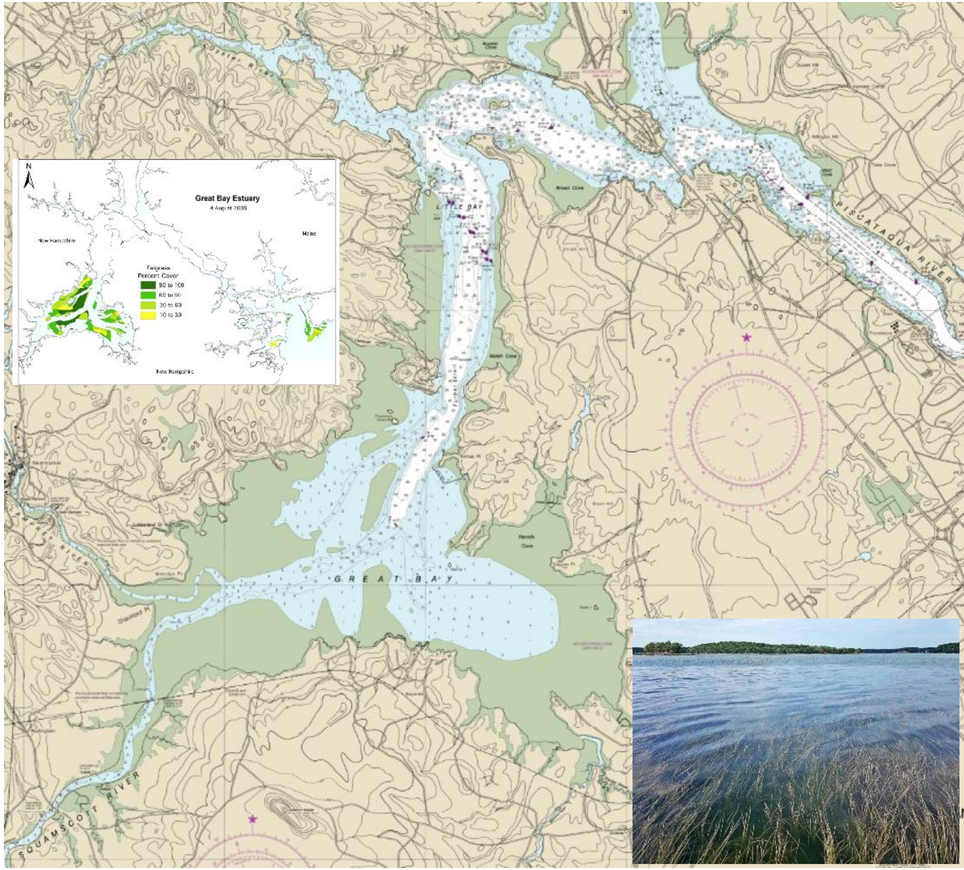


GREAT BAY ESTUARY

- Bay is about 6,000 acres not including tidal tribs
  - Mean tide range near Portsmouth is about 8 feet
  - Results in about 40% of bay volume exchanged each tidal cycle

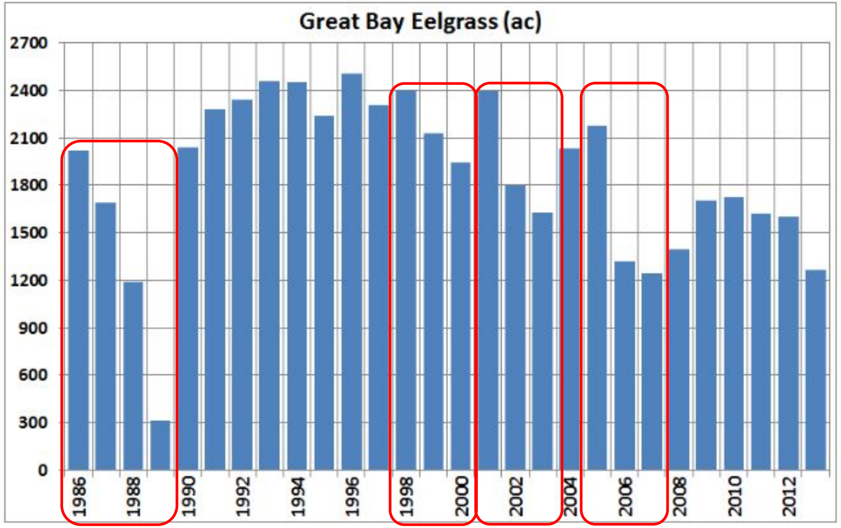
- Bay enters the Piscataqua River at Hilton Point, which then flows downstream into Gulf of Maine
  - Lower Piscataqua River depths range from about 30-50 feet, average bay depth is about 8 feet
  - Peak river current speeds are about 3.5-7.5 fps

- Bay has extensive tidal flats & eelgrass habitat



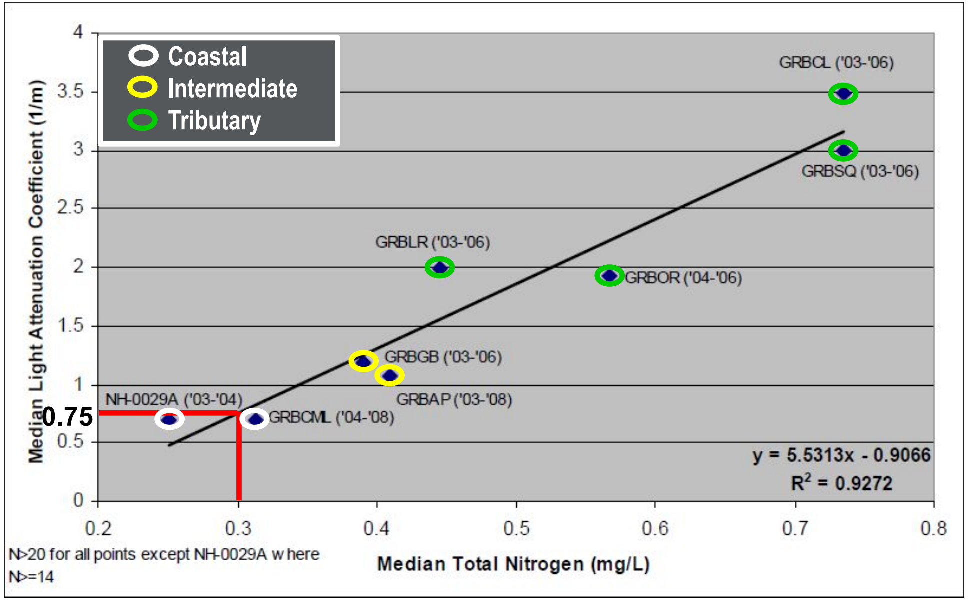
WATER QUALITY ISSUES

- A Case for Restoration and Recovery of *Zostera marina* L. in the Great Bay Estuary (PREP, 2020)
  - Eelgrass is a cornerstone species of healthy estuaries, providing habitat for fish and shellfish, and producing significant amounts of organic matter for the larger food web
  - In recent decades, the Great Bay-Piscataqua Estuary has lost over half of the acreage of eelgrass due to land use/demographic changes, changing precipitation/temperature patterns, and declining water quality



WATER QUALITY CAUSES

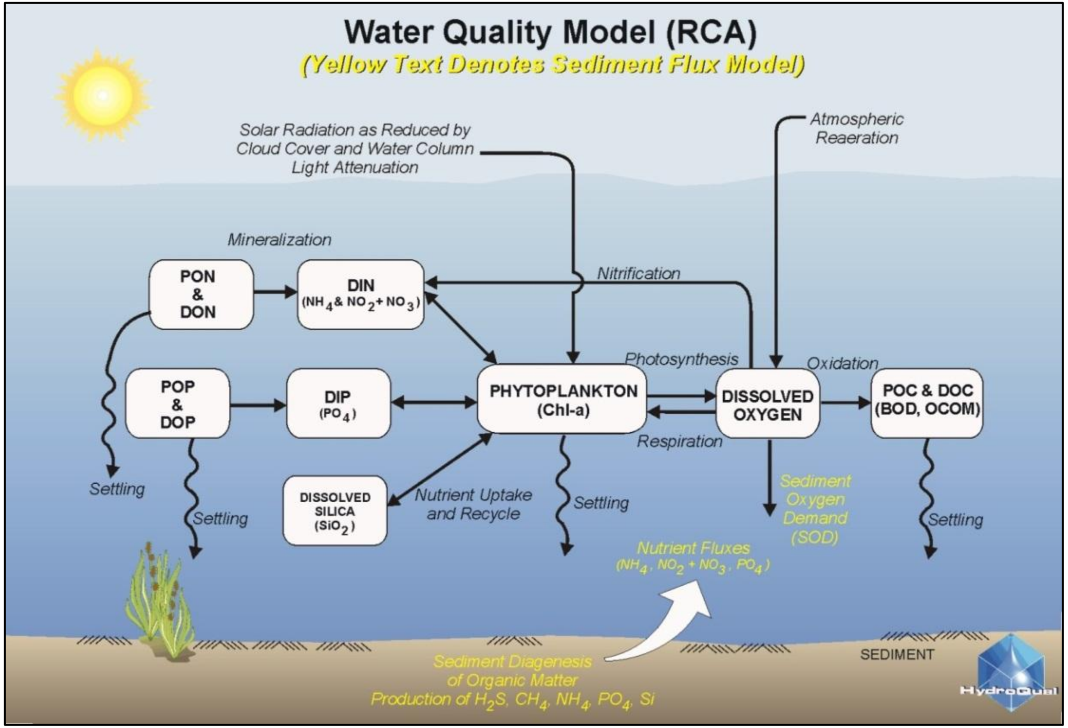
- Are eelgrass declines due to anthropogenic causes (e.g., TN loads, decr. water clarity)?
  - Other effects (e.g., wasting disease)
- Simple model developed to relate TN concentration to light attenuation
  - Correlation looks good but mixed ocean/tributary data with different TN & light attenuation levels
- Many “other” factors affect nutrient effects in water bodies
  - Residence time, available light (affected by turbidity/color/algae), epiphytes, temperature, TSS, toxics, habitat, circulations



WATER QUALITY MODELS

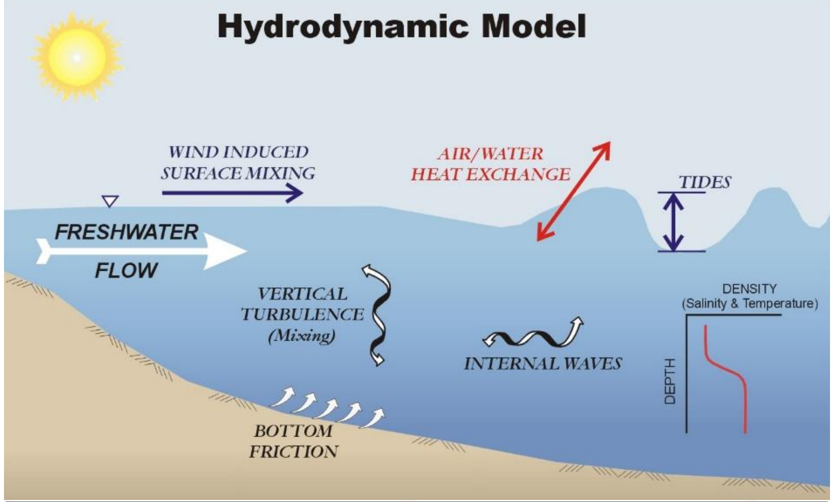
- Models provide a quantitative framework to determine water body response to:
  - Water movement (circulation)
  - External loads (PS & NPS)
  - Internal nutrient cycling (algal growth, sediment interactions)
  - Meteorology (wind, climate change)

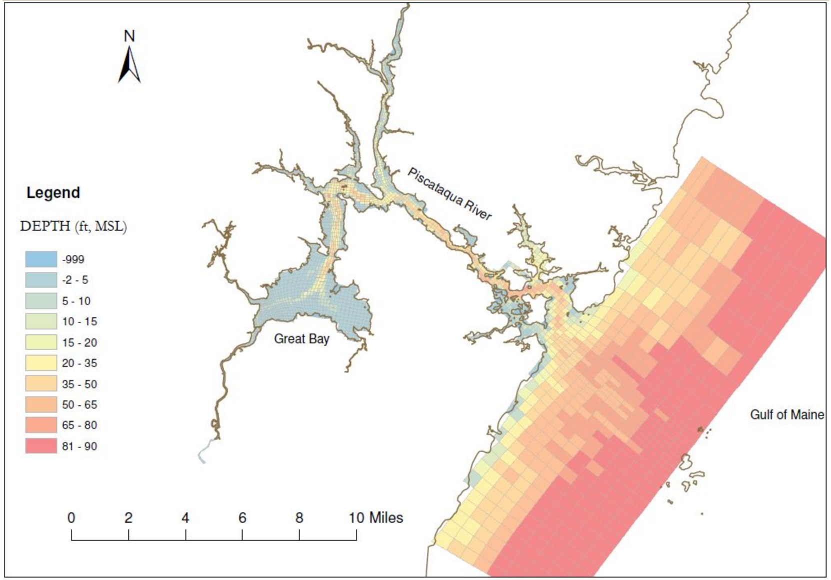
- By setting nutrient “effects” criteria (e.g., chl-a, DO, % bottom light), water quality models can be used to determine allowable conc. or loads (i.e., TMDL, WLA)



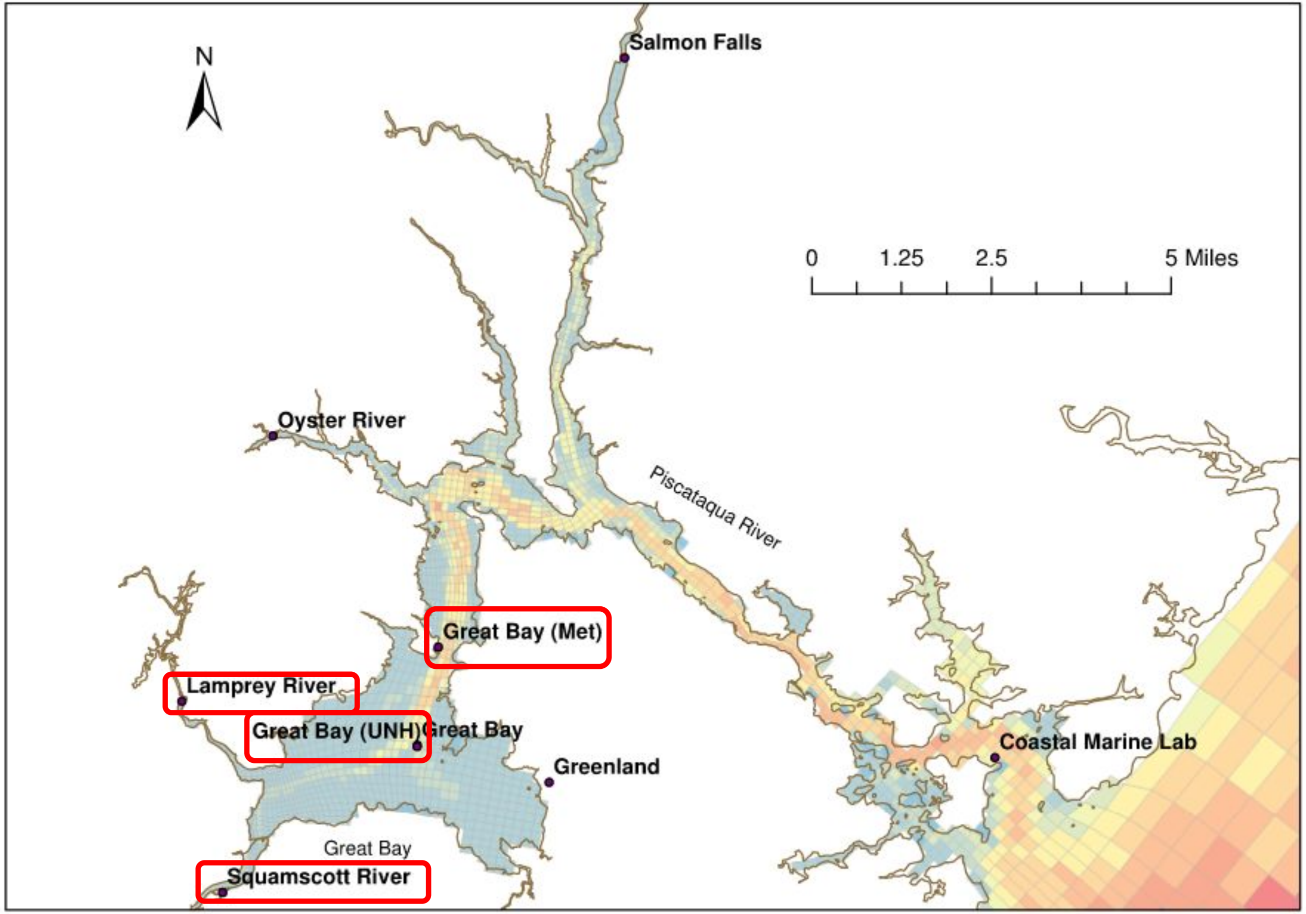
GREAT BAY ESTUARY SYSTEM (GBES) MODEL

- Developed hydrodynamic model to calculate tidal circulation due to:
  - Tides, density, freshwater, meteorology
- Model calibrated to available salinity & temperature data from 2010, 2011 & 2017
  - 2010 lower summer flow year than 2011
  - Model was successfully calibrated to available data
- TN was treated as a conservative substance in the model & calibrated to available data
  - Assumes no significant physical, chemical or biological processes affect conc.

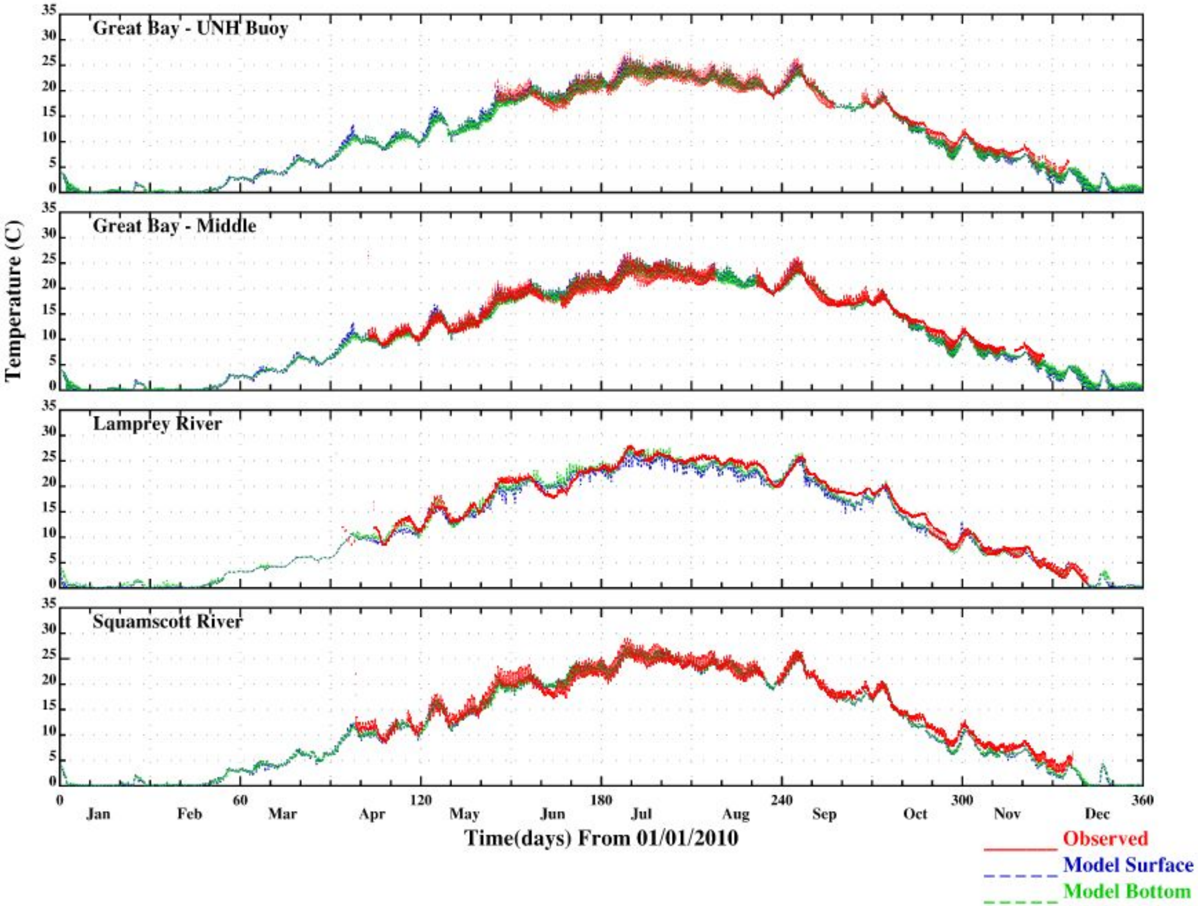




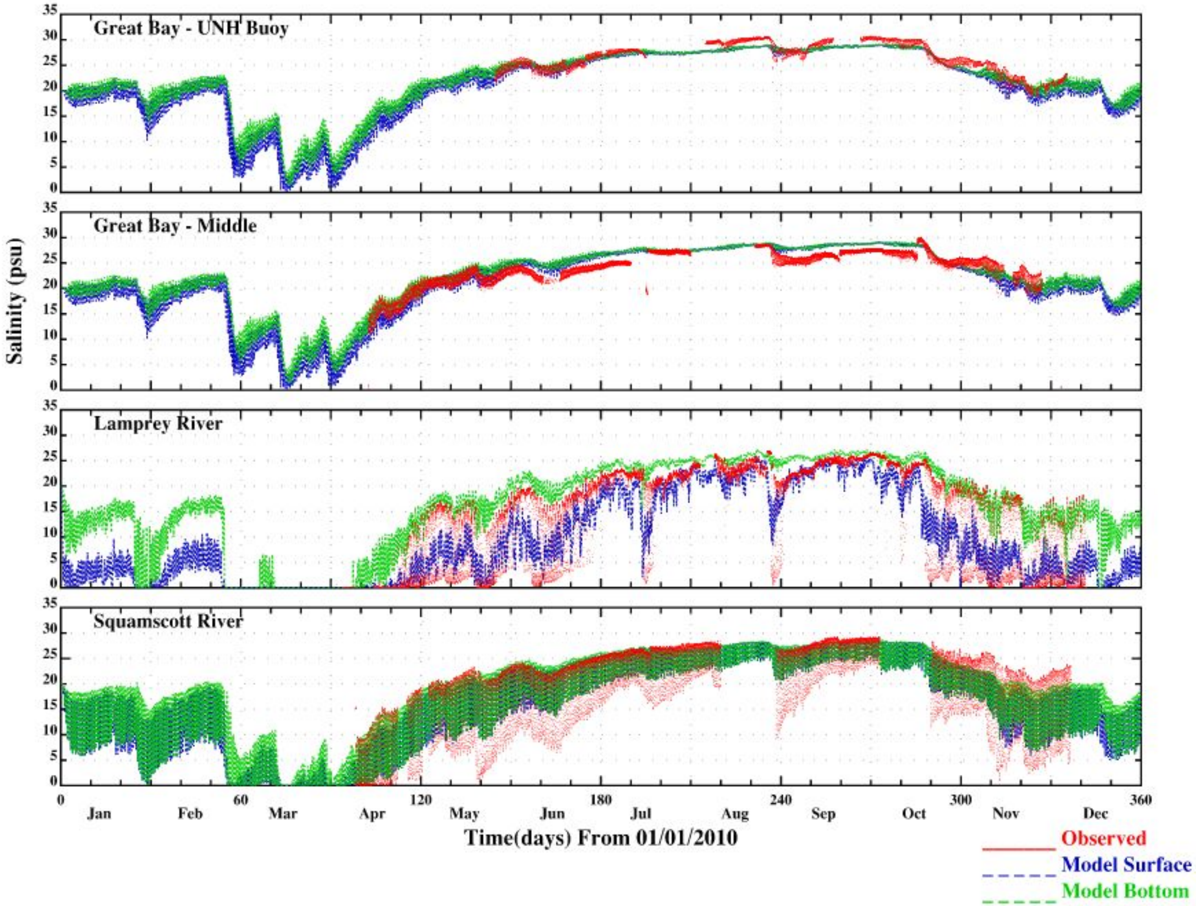
CONTINUOUS MONITORING DATA LOCATIONS



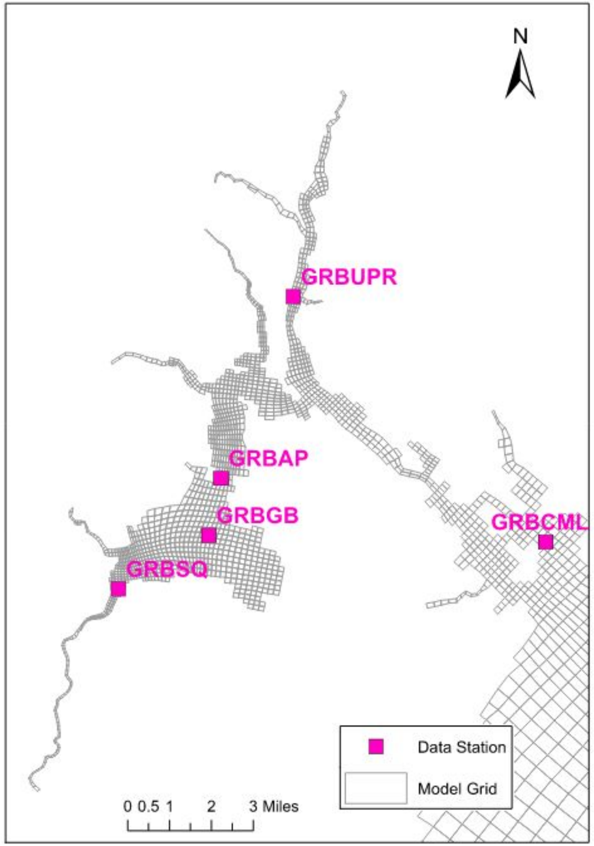
2010 MODEL-DATA TEMPERATURE COMPARISONS

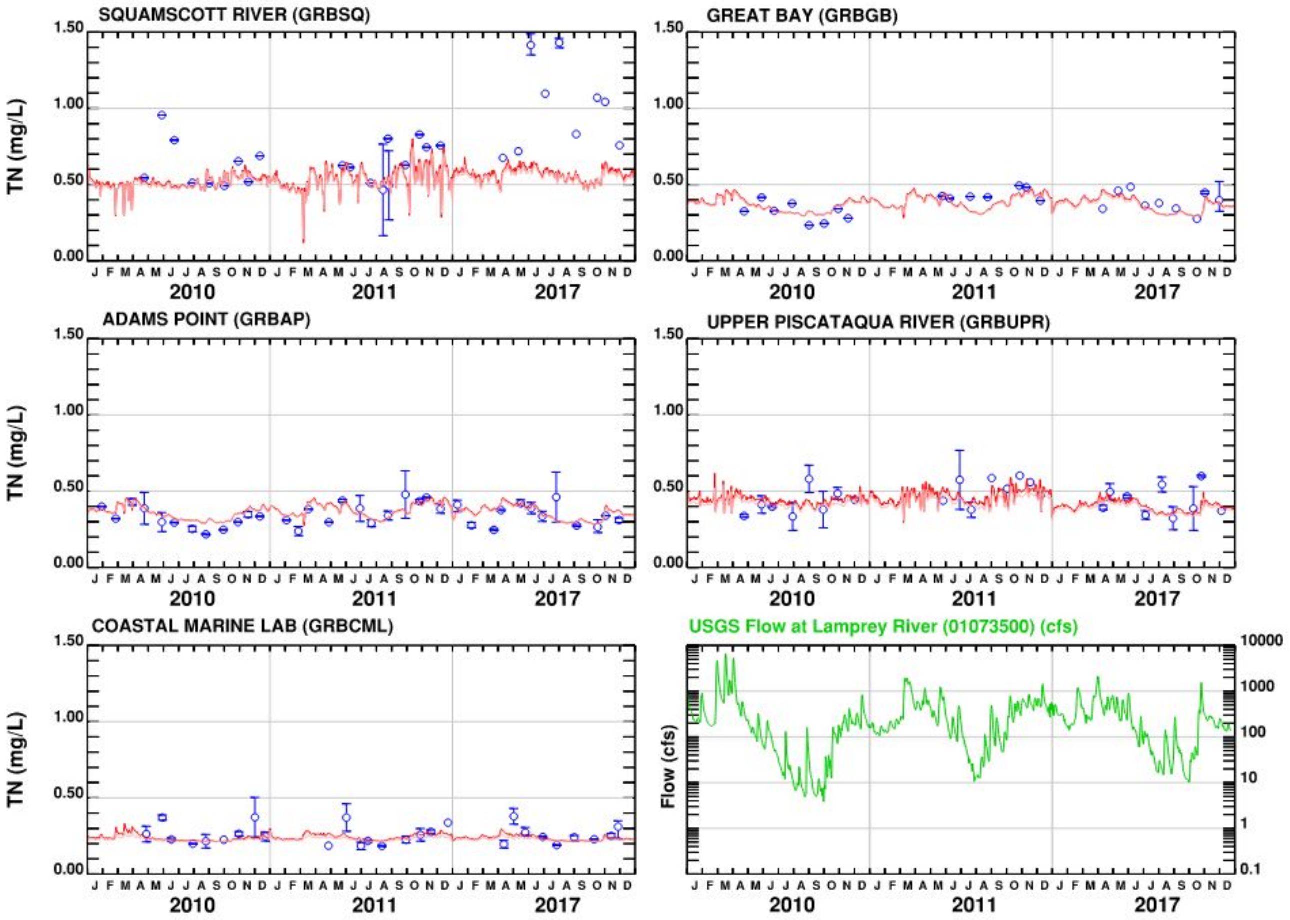


2010 MODEL-DATA SALINITY COMPARISONS



MODEL-DATA TN COMPARISONS

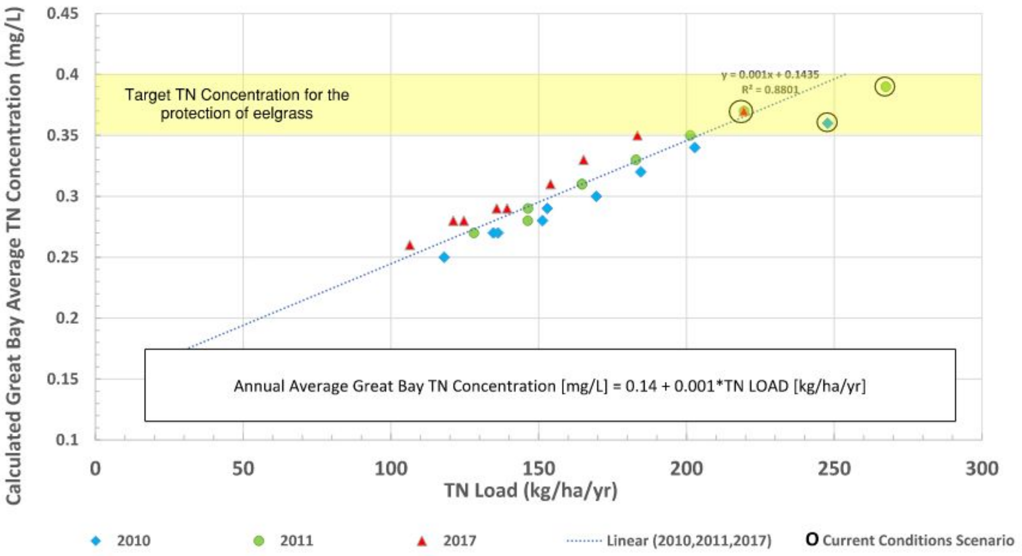




MODEL LINKS LOADS TO BAY CONCENTRATIONS

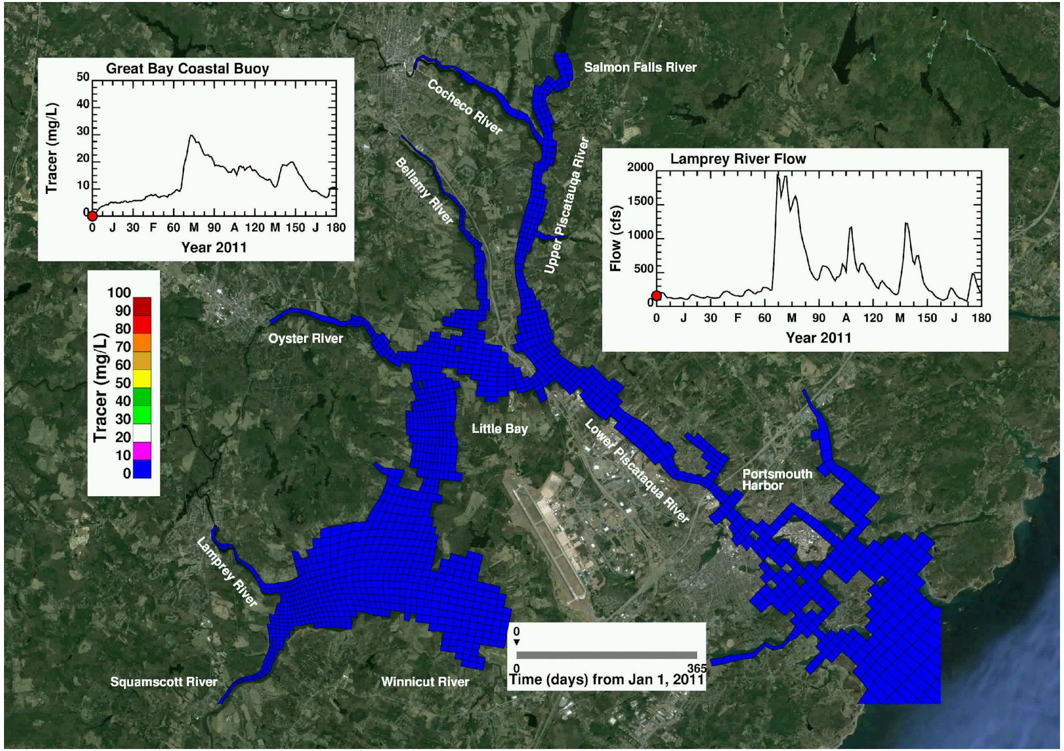
- In complex tidal systems such as Great Bay, linking bay effects to loads is difficult with a simple model
  - Simple models can be effective in lakes & rivers depending on the endpoint

- A hydrodynamic model is the first step in evaluating effects in a tidal system
  - Provides tidal circulation
  - Use of a conservative tracer (e.g., TN) can be an effective method to evaluate load-concentration relationships



SUMMARY

- Tidal systems such as Great Bay require more than a simple model to evaluate effects of loadings (PS, NPS, SW)
- A hydrodynamic model & use of a tracer can be an effective method to evaluate bay concentrations due to loads
- Hydrodynamic model provides foundation for further water quality evaluations
  - Eutrophication (algae, DO, light attenuation)
  - Bacteria, toxics



QUESTIONS

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