Development of CASMs for Coastal Louisiana

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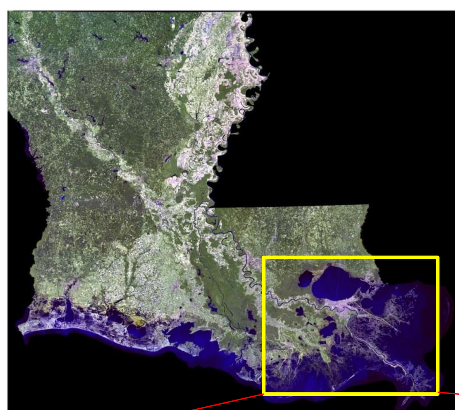
Supported By:

Background

The Louisiana Coastal Protection and Restoration Authority (CPRA) supported the development, testing, and application of several linked large-scale numerical models to simulate operational scenarios of planned Mississippi River diversions and assess impacts to the estuarine ecosystem (Fig. 1).



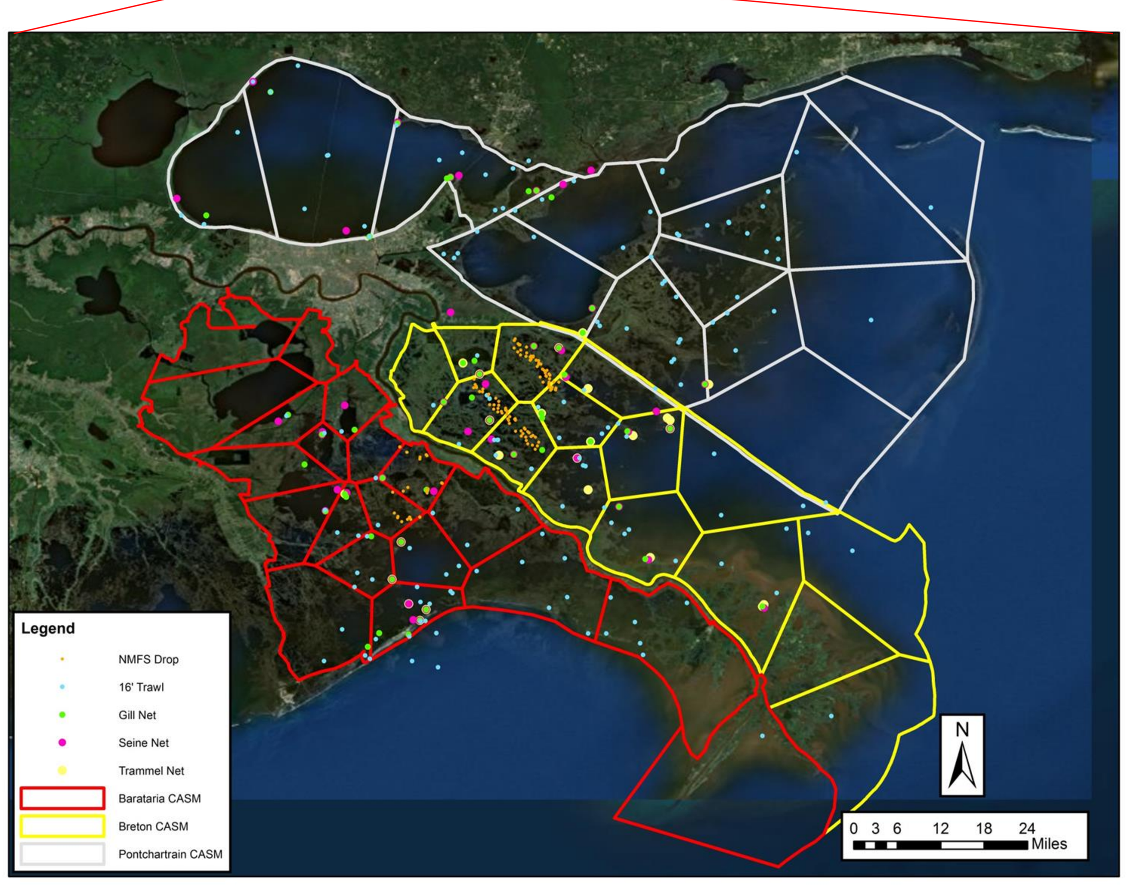


Fig. 1. Mississippi River Delta Management study area and CASM polygons with biological sampling sites.

Methods

The Comprehensive Aquatic Systems Model (CASM) is a daily-bioenergetics-based model that used temperature, salinity, Chl a, and vegetation input data to predict biomass of 32 taxa within a food web context (Fig. 2).

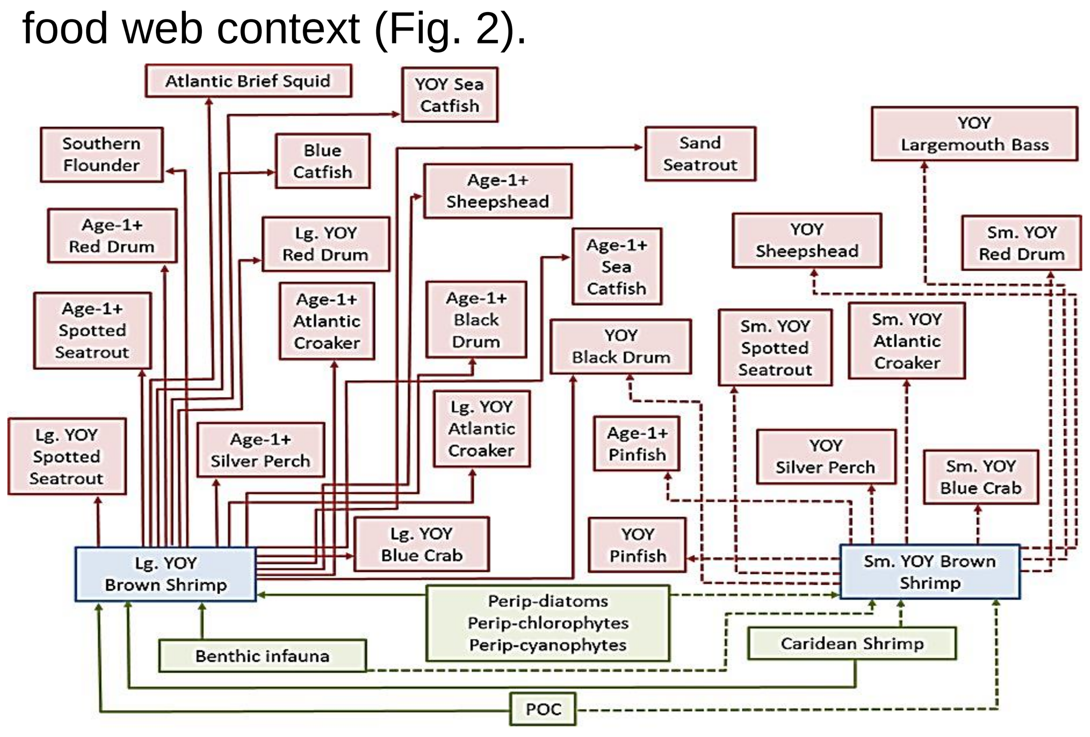


Fig. 2. CASM food web centered around YOY brown shrimp.

The CASM was initialized, calibrated and validated with biomass data (g/m^2) collected in 1995-2010 by the Louisiana Department of Wildlife and Fisheries and NOAA NMFS Science Center (Fig. 1). Biomass estimates were averaged across years to represent a 'climatic year' for seasonal calibration (Fig. 3)

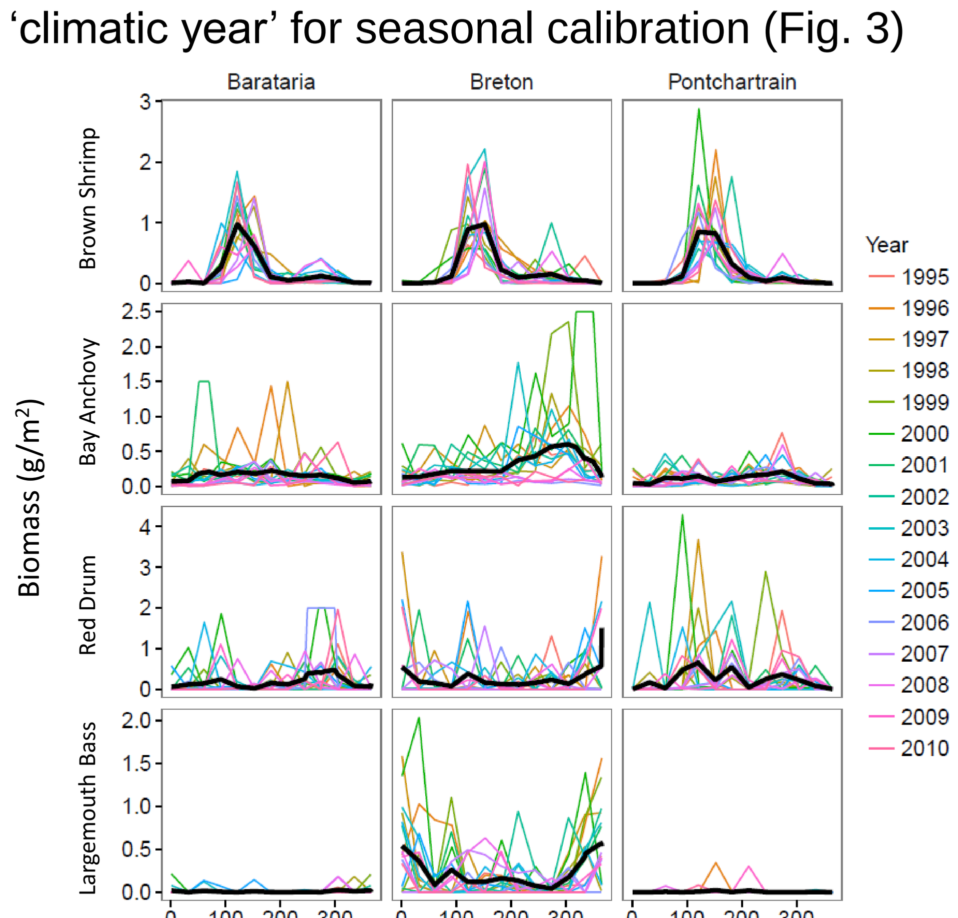


Fig. 3. Daily biomass for 1995-2010 and the averaged 'climatic' year (black line).

Methods

Environmental inputs:

- Temperature was used to seasonally modify consumption and respiration parameters.
- Salinity was used to adjust daily production using species-specific habitat modifying functions (Fig. 4).
- Chl a was used to estimate primary producer (phytoplankton and periphyton) biomass.
- Proportion of area vegetated was constant and used to adjust daily production using species-specific habitat modifying functions (Fig. 4).

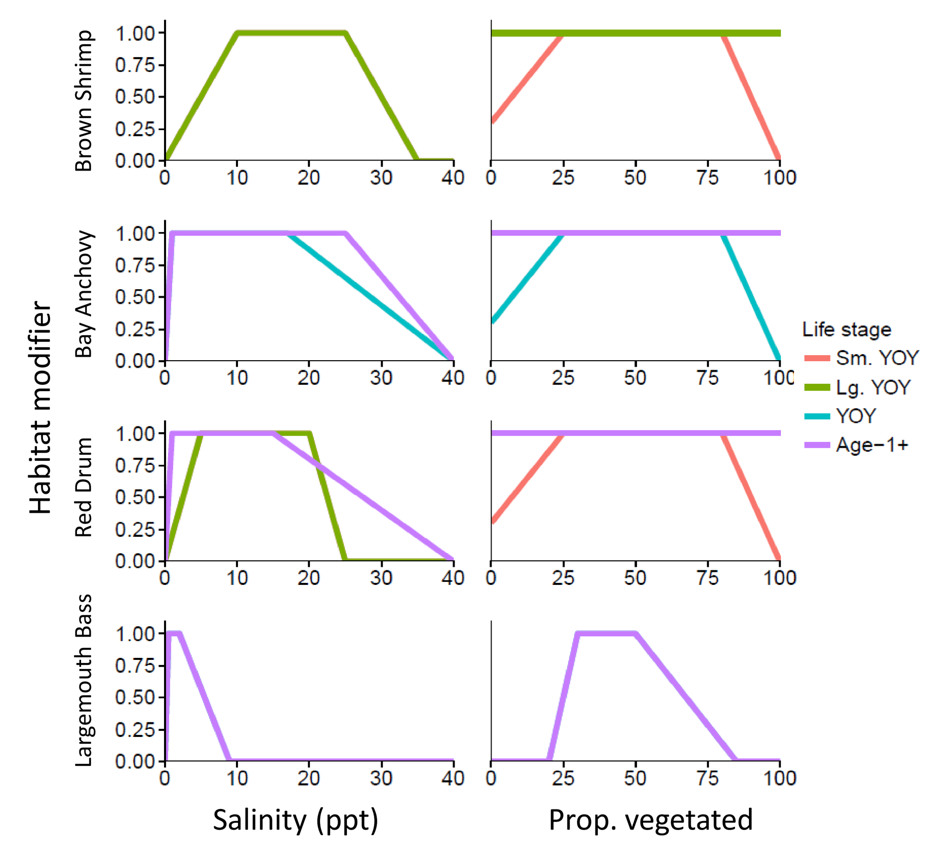


Fig. 4. Species/life stage specific multipliers used to adjust daily production.

Simulated temperature, salinity, Chl a, and vegetation data from 2012 Louisiana Master Plan models were used as inputs to calibrate and validate the CASM (Figs. 5 and 6).

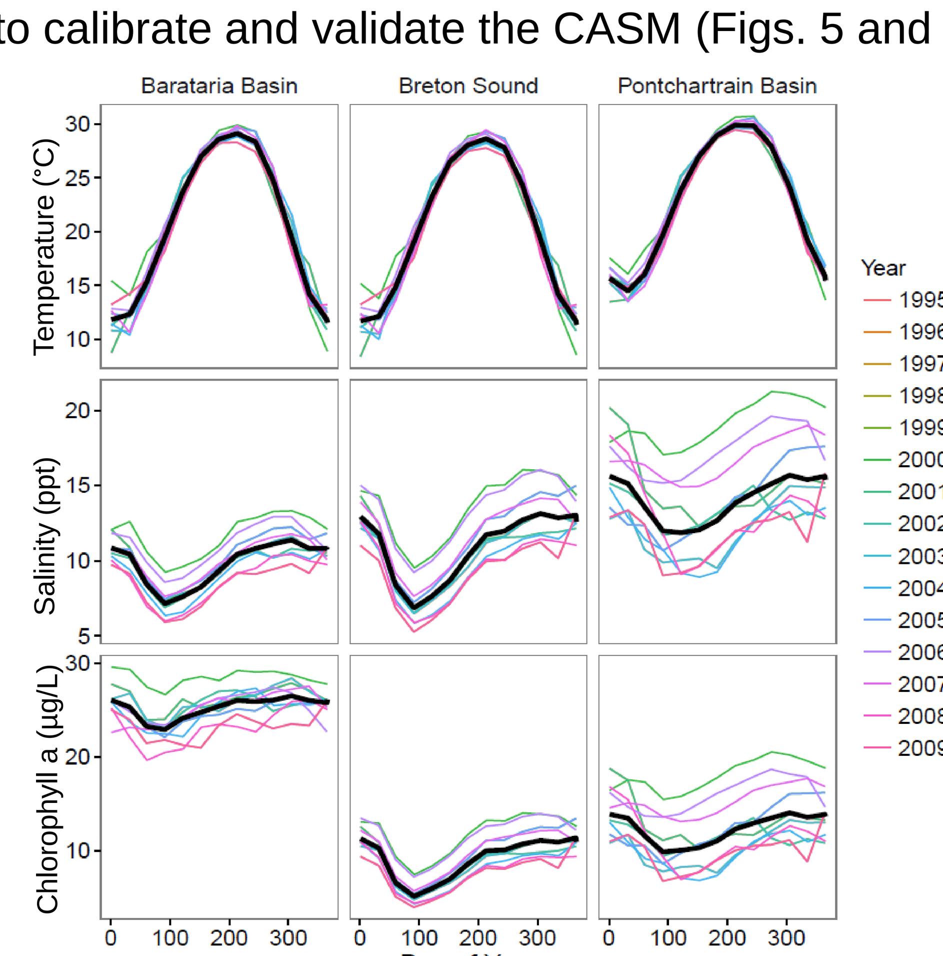


Fig. 5. Spatially-averaged, daily environmental inputs by basin and the averaged 'climatic' year (black line).

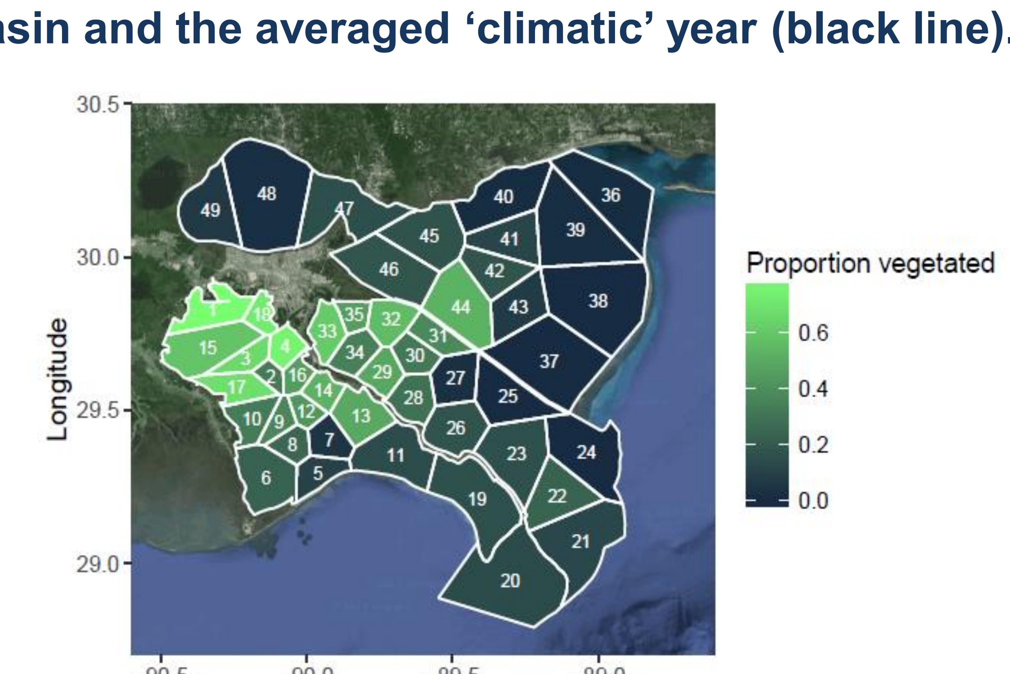


Fig. 6. The proportion of each polygon with emergent vegetation.

Calibration approach:

- Biomasses were calibrated to the climatic year.
- PEST calibration software was used to guide calibration, but parameters were also adjusted ad hoc.
- Maximum consumption, mortality, temperature parameters, and parameters determining flux between life stages were calibrated for Barataria Basin.
- Diet parameters were subsequently adjusted for Breton Sound and Pontchartrain Basin.

Results and Conclusions

Calibration results for key species:

- Predicted brown shrimp biomass fit the data well in part because they have strong, consistent seasonal patterns (Fig. 7).
- Bay anchovy showed mixed results. Young of the year (YOY) predictions fit the data well. Age-1+ were intentionally calibrated to a flat distribution of higher biomass based on life history.
- Red drum were calibrated ad hoc to fit known life history traits that were not reflected in the data.
- Largemouth bass showed poor calibration success, but are not caught or under-sampled in the calibration data.

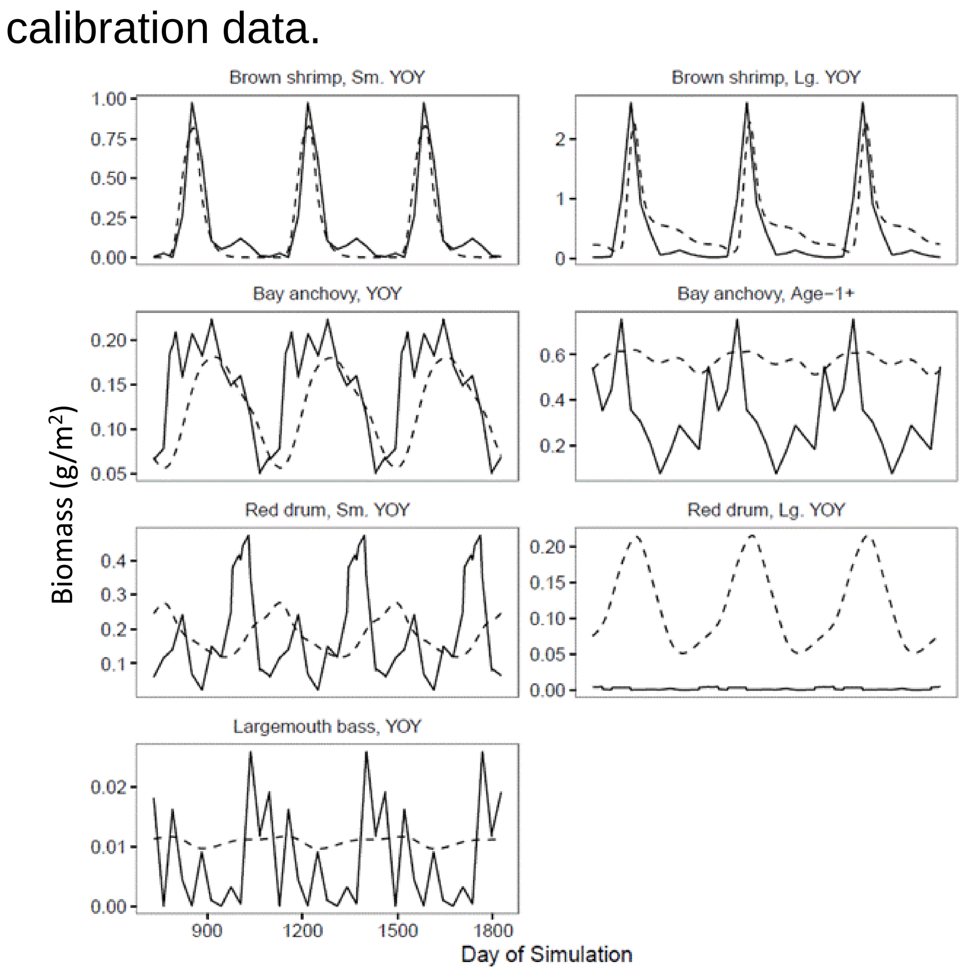


Fig. 7. Predicted (dashed) and climatic (solid) daily biomass of key species/life stages in Barataria Basin after calibration.

Primary production (Chl a) was the main driver of predicted biomass for many species. However, interactive effects occurred with other variables (e.g., salinity) at extreme values (Fig. 8).

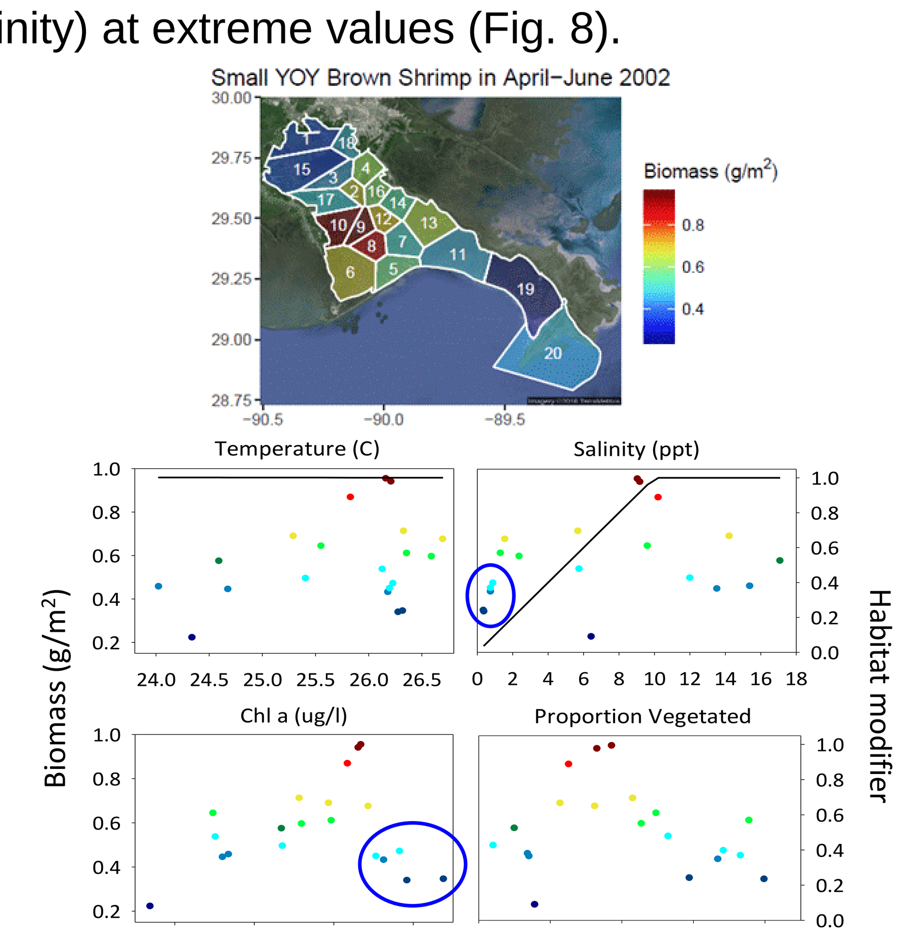


Fig. 8. Mean biomass by polygon in Barataria Basin and the relationships between polygon biomass and each input variable with modeled habitat modifiers (black lines).

Next Steps and Future Directions

- Simulations to assess potential impacts of proposed large-scale river diversions. Results to be presented Thursday at 11:00 (session 34).
- Further model testing and improvements:
  - Simplify food web
  - Include movement between polygons
  - Improve recruitment and links between life stages