Development and Adaptation of the CASM to Evaluate Food Web Dynamics and Species Responses in Barataria Bay

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CASM

- Bioenergetics-based growth in an aquatic food web model
- Producers: \( dB_p / B_p \Delta t = \text{Photosynthesis} - \text{Photorespiration} - \text{Dark Respiration} - \text{Sinking} - \text{Natural Mortality} - \text{Grazing} \)
- Consumers: \( dB_c / B_c \Delta t = \{\text{Consumption} - (\text{Egest} + \text{Excrete} + \text{SDA}) - \text{Respiration} - \text{Mortality} - \text{Predation}\} \times h_{mod} \)
- Consumption dependent upon prey and predator biomasses

\[
\begin{align*}
    f(T): & \quad 1.0 \\
    f(I): & \quad \text{Light Intensity} \\
    f(N): & \quad \text{Nutrient Conc.} \\
    h_{mod}: & \quad \text{Salinity, Turbidity, DO}
\end{align*}
\]
CASM Approach for Barataria

• 30 species/functional groups in the food web
• 18 CASM food webs set up on the hydro model grid
• Daily time step simulated over single years
  – Next iteration will include multi-year simulations with closed life cycle
• CASM inputs are averaged daily values from field data and cell outputs from the hydro model
• Environmental inputs modify producer and consumer processes in food webs
**Improvement:** Populations will be structured by size rather than life stage.

**Diet matrix for consumers**

**Improvement:** More diverse prey base that is driven by habitat.

\[
\frac{dB}{Bdt} = \{C - (E_g + U + SDA) - R - M - P\} * h_{mod}
\]
CASM Polygons on Hydrodynamic Grid

18 CASM Stations
<table>
<thead>
<tr>
<th>Monitoring Programs</th>
<th>Dates of Record</th>
<th>Sampling Frequency</th>
<th>Variables Measured or Estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Solar Radiation Database New Orleans Airport</td>
<td>1960 - 2010</td>
<td>Hourly</td>
<td>Surface light intensity (PAR)</td>
</tr>
<tr>
<td>USACE Water Quality Sampling</td>
<td>1997 - 2008</td>
<td>Monthly</td>
<td>NO$_3$, PO$_4$, TIS, POC, SiO$_3$, salinity, Chl concentration</td>
</tr>
<tr>
<td>Coast-wide Reference Monitoring System (CWPPRA)</td>
<td>2006 - present</td>
<td>Continuous</td>
<td>Temperature, salinity,</td>
</tr>
<tr>
<td>USGS Sampling</td>
<td>1998 - present</td>
<td>Continuous</td>
<td>Temperature, salinity,</td>
</tr>
<tr>
<td>LDWF Fisheries-Independent monitoring</td>
<td>1967 - present</td>
<td>Monthly</td>
<td>Abundance, biomass, size of fish, invertebrates, oysters, habitat modifiers</td>
</tr>
<tr>
<td>Barataria Basin nekton sampling (Reed et al. 2007, NOAA)</td>
<td>2002, 2005, 2006</td>
<td>Spring and Fall</td>
<td>Nekton density, biomass, size in marsh, ponds</td>
</tr>
</tbody>
</table>
Environmental Data: Salinity, Temperature, Elevation

- CASM Stations
- CRMS Stations
- USGS Stations
Environmental Data: USACE Water Quality
Biological Data: Species Biomasses: Field Data

Reed et al. 2007

LDWF 6’ and 16’ Trawl Stations

Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Imagery Date: 4/9/2013 29°23'11.43" N 89°59'31.50" W elev -2 ft eye alt 51.73 mi
Biological Data: Species Biomasses

- Mean monthly species biomass (g/m²) calculated from LDWF seines and trawls and NOAA 1-m² drop samplers
- Weight sample mean biomass by marsh and open water habitat in basin (Reed et al. 2007)
- January biomasses initialize the CASM
- Monthly (seasonal) biomasses used to calibrate the CASM
Improvements to Species Biomass

- Adjust biomass for catchability, salinity (for freshwater species)
- Incorporate meter-square oyster data
- Explicitly modeling structural habitat:
  - Assign species/life stages to specific habitat types (e.g., marsh vs. open water)
  - Monthly biomass estimates will only come from the gear type(s) in which a species is well represented
  - Account for the amount of each habitat when estimating biomass (g/m²)
Biological Data: Habitat Modifiers

Next Iteration:

Brown Shrimp - YOY

Salinity

Habitat Mod

0.25 0.5 0.75 1 1.25 1.5 1.75 2 2.25 2.5 2.75 3 3.25 3.5 3.75 4 4.25 4.5 4.75 5 5.25 5.5 5.75 6 6.25 6.5 6.75 7 7.25 7.5 7.75 8 8.25 8.5 8.75 9 9.25 9.5 9.75 10 10.25 10.5 10.75 11 11.25 11.5 11.75 12 12.25 12.5 12.75 13 13.25 13.5 13.75 14 14.25 14.5 14.75 15 15.25 15.5 15.75 16 16.25 16.5 16.75 17 17.25 17.5 17.75 18 18.25 18.5 18.75 19 19.25 19.5 19.75 20 20.25 20.5 20.75 21 21.25 21.5 21.75 22 22.25 22.5 22.75 23 23.25 23.5 23.75 24 24.25 24.5 24.75 25 25.25 25.5 25.75 26 26.25 26.5 26.75 27 27.25 27.5 27.75 28 28.25 28.5 28.75 29 29.25 29.5 29.75 30 30.25 30.5 30.75 31 31.25 31.5 31.75 32 32.25 32.5 32.75 33 33.25 33.5 33.75 34 34.25 34.5 34.75 35 35.25 35.5 35.75 36 36.25 36.5 36.75 37 37.25 37.5 37.75 38 38.25 38.5 38.75 39 39.25 39.5 39.75 40 40.25 40.5 40.75 41 41.25 41.5 41.75 42 42.25 42.5 42.75 43 43.25 43.5 43.75 44 44.25 44.5 44.75 45 45.25 45.5 45.75 46 46.25 46.5 46.75 47 47.25 47.5 47.75 48 48.25 48.5 48.75 49 49.25 49.5 49.75 50 50.25 50.5 50.75 51 51.25 51.5 51.75 52 52.25 52.5 52.75 53 53.25 53.5 53.75 54 54.25 54.5 54.75 55 55.25 55.5 55.75 56 56.25 56.5 56.75 57 57.25 57.5 57.75 58 58.25 58.5 58.75 59 59.25 59.5 59.75 60 60.25 60.5 60.75 61 61.25 61.5 61.75 62 62.25 62.5 62.75 63 63.25 63.5 63.75 64 64.25 64.5 64.75 65 65.25 65.5 65.75 66 66.25 66.5 66.75 67 67.25 67.5 67.75 68 68.25 68.5 68.75 69 69.25 69.5 69.75 70 70.25 70.5 70.75 71 71.25 71.5 71.75 72 72.25 72.5 72.75 73 73.25 73.5 73.75 74 74.25 74.5 74.75 75 75.25 75.5 75.75 76 76.25 76.5 76.75 77 77.25 77.5 77.75 78 78.25 78.5 78.75 79 79.25 79.5 79.75 80 80.25 80.5 80.75 81 81.25 81.5 81.75 82 82.25 82.5 82.75 83 83.25 83.5 83.75 84 84.25 84.5 84.75 85 85.25 85.5 85.75 86 86.25 86.5 86.75 87 87.25 87.5 87.75 88 88.25 88.5 88.75 89 89.25 89.5 89.75 90 90.25 90.5 90.75 91 91.25 91.5 91.75 92 92.25 92.5 92.75 93 93.25 93.5 93.75 94 94.25 94.5 94.75 95 95.25 95.5 95.75 96 96.25 96.5 96.75 97 97.25 97.5 97.75 98 98.25 98.5 98.75 99 99.25 99.5 99.75 100

Brown Shrimp - YOY

Secchi Depth (m)

Habitat Mod

0.1 0.5 1 1.5 2 2.5

0.1 0.5 1 1.5 2 2.5

0.1 0.5 1 1.5 2 2.5
MG CASM Calibration

• Environmental inputs averaged across stations and years

• Mortality and diet matrix parameters adjusted to match simulated biomass to monthly biomass estimates averaged across years

  — Next iteration use inputs and biomass estimates for individual years to generate more realistic seasonal distributions
Baseline CASM Results for Existing Conditions

- 18 CASM Stations using environmental field data from 1999-2010 throughout basin
- Demonstrate seasonal biomass trends and distribution of species due to environmental gradients and shifting food web in estuary
Blue Crab YOY Biomass in June

mg C/m²

- 360.0
- 320.0
- 280.0
- 240.0
- 200.0
- 160.0
- 120.0
- 80.0
- 40.0
- 0.0
Habitat Mod

Blue Crab-Juv

Observed CPUE (scaled)

(Rozas & Minello pers. comm.)
Questions?