Adaptation of the CASM to Evaluate Food Web Dynamics and Species Responses in Louisiana's Estuaries

Funding provided by USFWS via Atkins Global

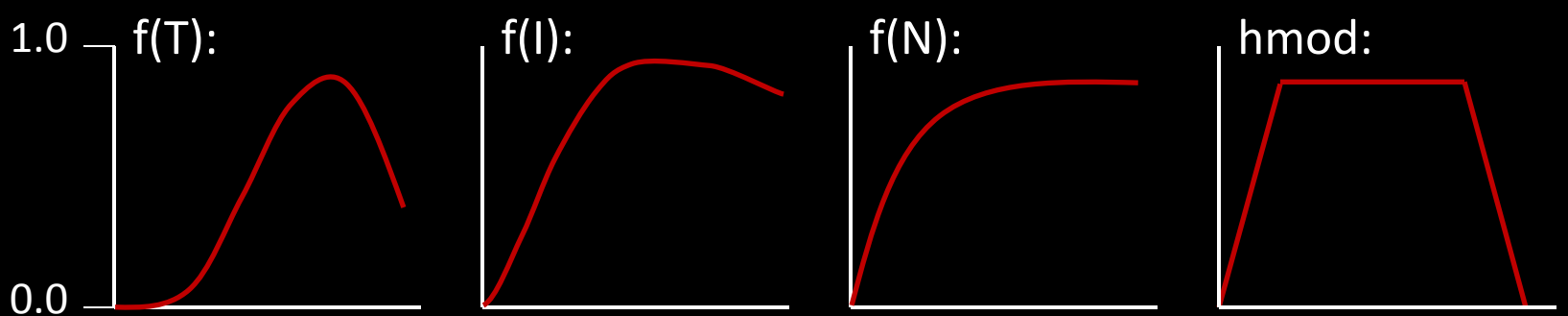
LA Coastal Protection and Restoration Authority (CPRA) and USACE, New Orleans District

*** NMFS, LDWF, CPRA, USFWS, USACE

Dynamic Solutions LLC

CASM

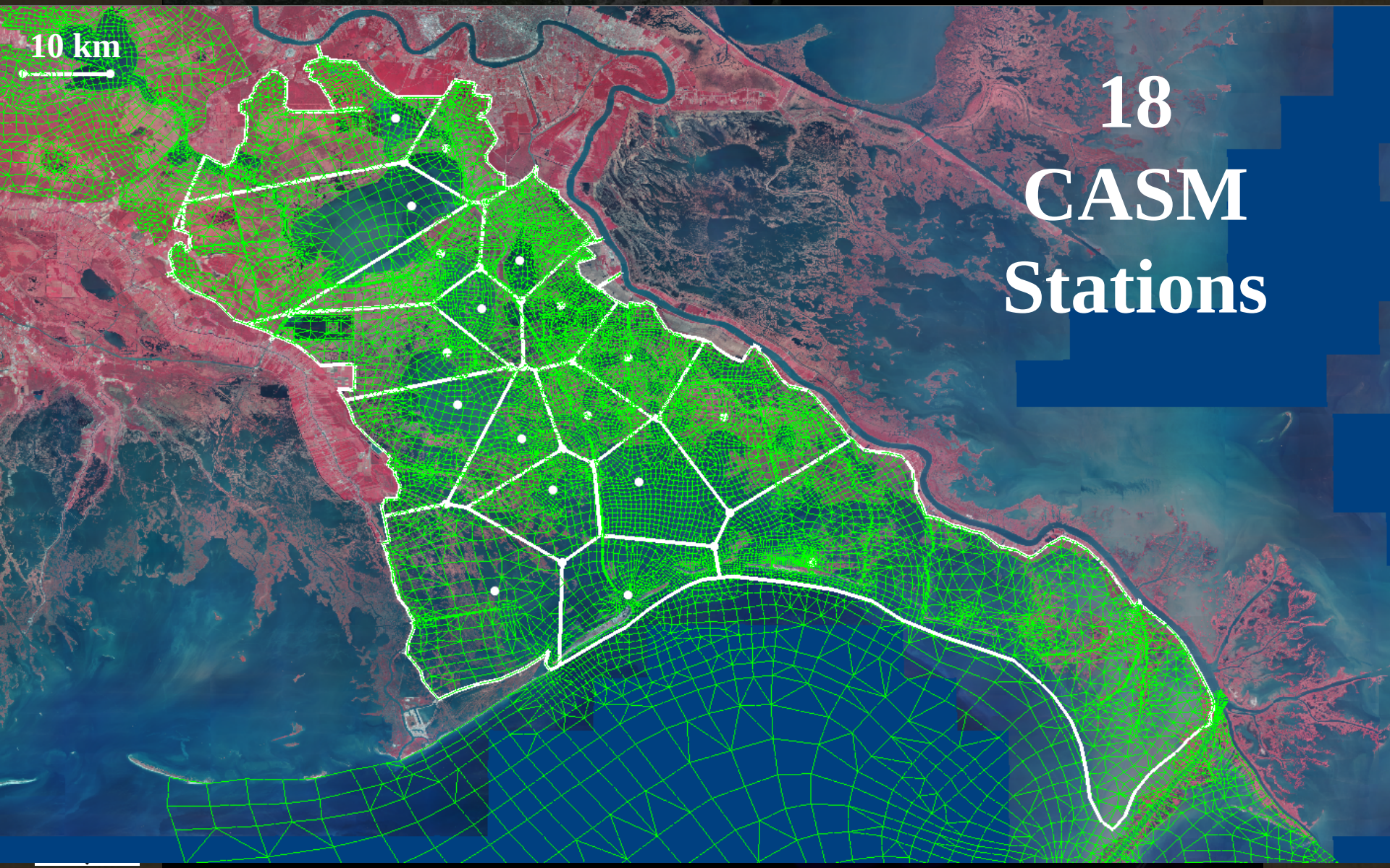
- Bioenergetics-based growth in an aquatic food web model
- Producers: $dB_P/B_P dt$ = Photosynthesis – Photorespiration – Dark Respiration – Sinking – Natural Mortality – Grazing
- Consumers: $dB_C/B_C dt$ = {Consumption - (Egest+Excrete+SDA) – Respiration – Natural Mortality – Predation}*hmod
- Consumption dependent upon prey and predator biomasses

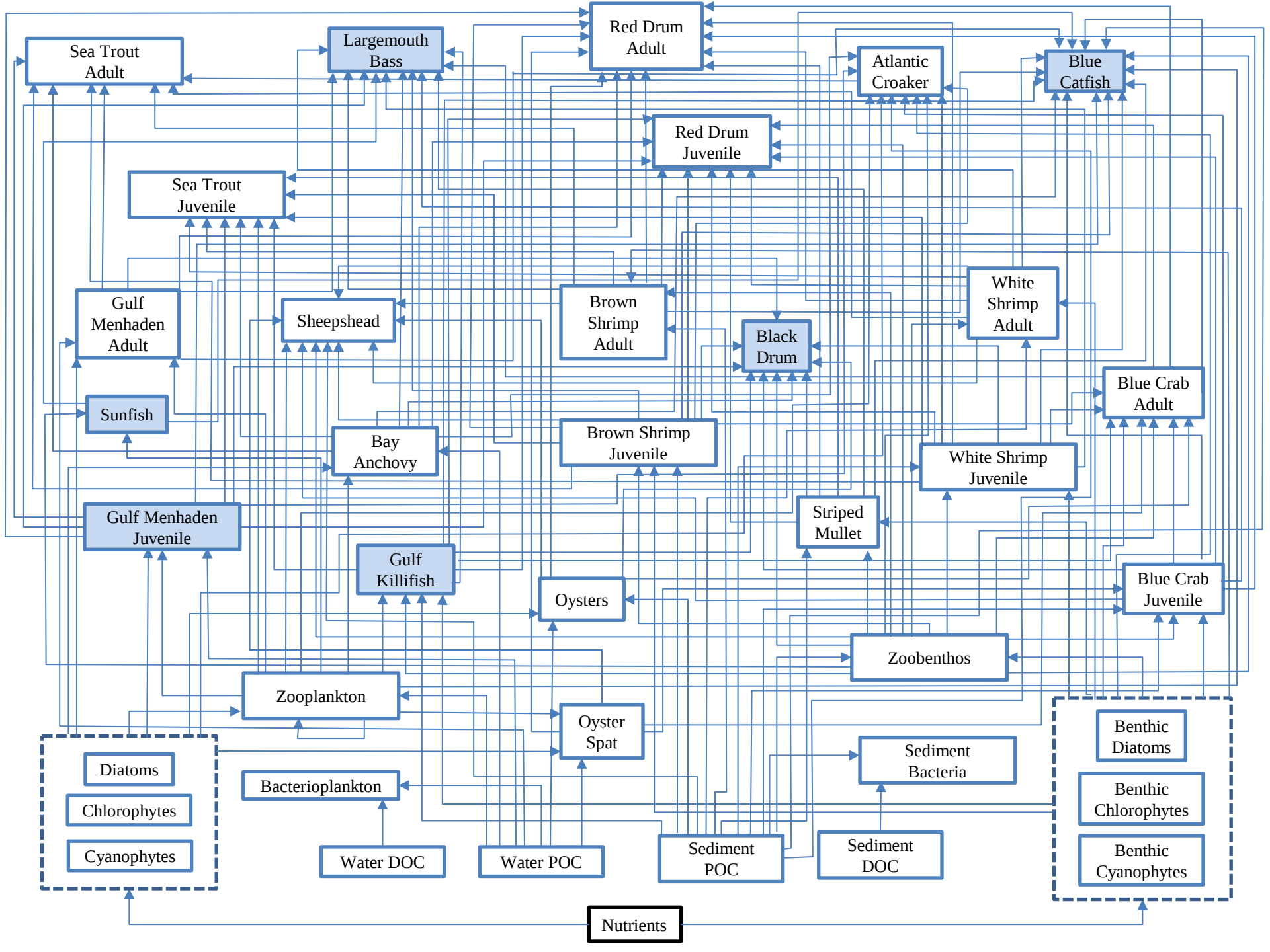


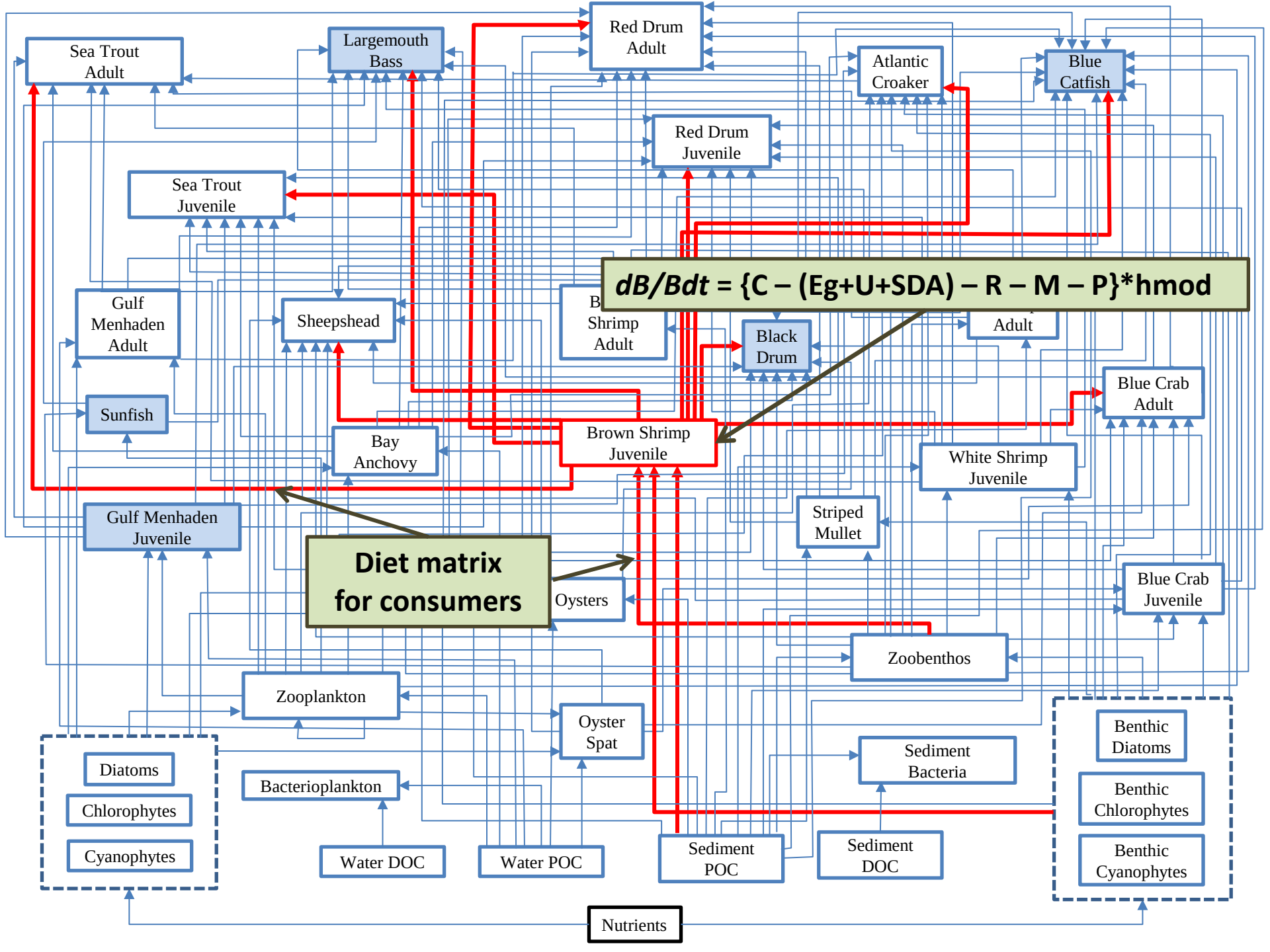
CASM Approach for Barataria

- 33 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
- 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

CASM Polygons on Hydrodynamic Grid



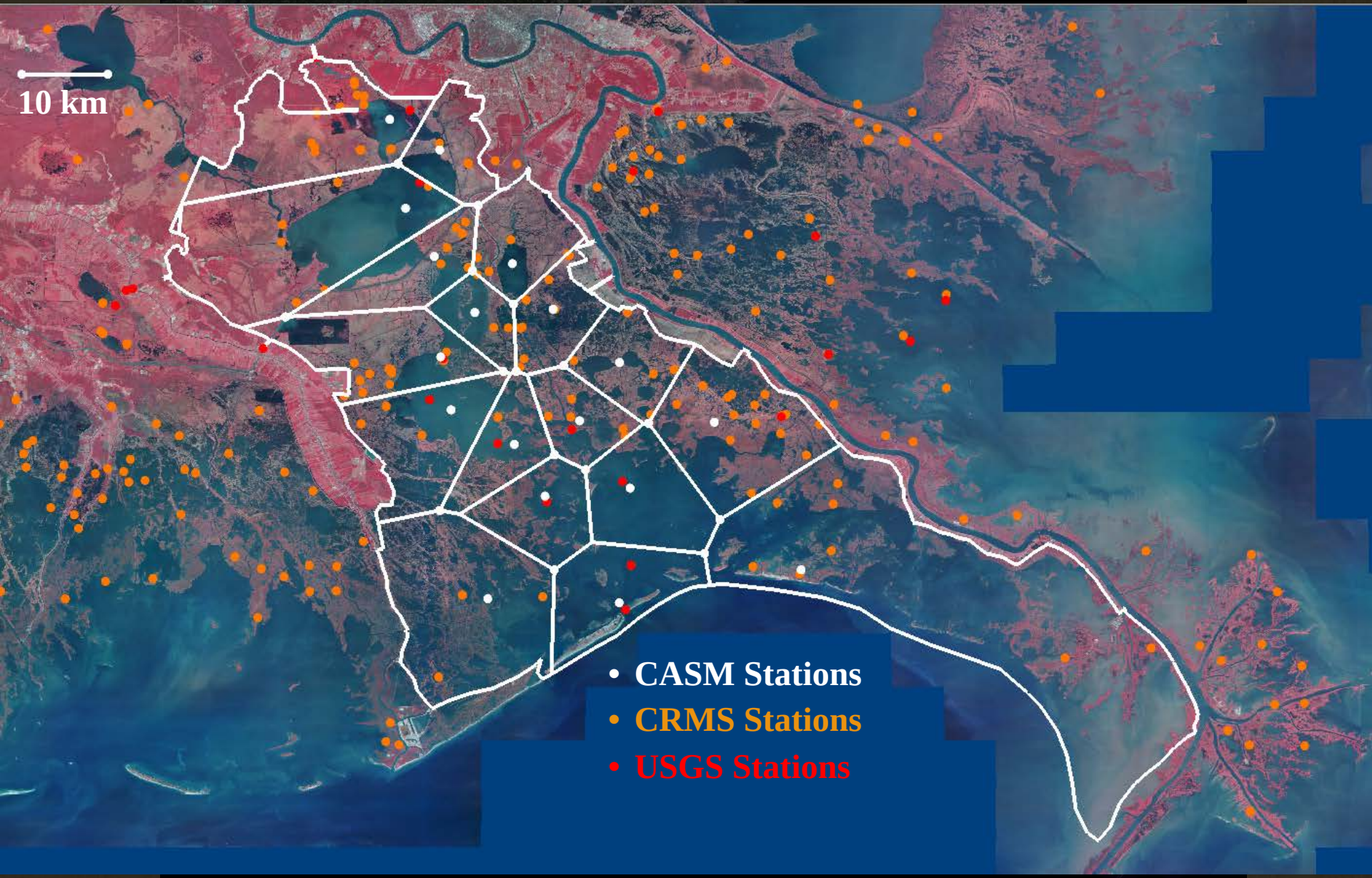

Sea Trout Adult
Largemouth Bass
Red Drum Adult
Atlantic Croaker
Blue Catfish
Red Drum Juvenile
Sea Trout Juvenile
Gulf Menhaden Adult
Sheepshead
Brown Shrimp Adult
Black Drum
White Shrimp Adult
Blue Crab Adult
Sunfish
Bay Anchovy
Brown Shrimp Juvenile
White Shrimp Juvenile
Gulf Menhaden Juvenile
Striped Mullet
Gulf Killifish
Oysters
Blue Crab Juvenile
Zoobenthos
Zooplankton
Oyster Spat
Diatoms
Chlorophytes
Cyanophytes
Bacterioplankton
Sediment Bacteria
Benthic Diatoms
Benthic Chlorophytes
Benthic Cyanophytes
Water DOC
Water POC
Sediment POC
Sediment DOC
Nutrients


Sea Trout Adult
Largemouth Bass
Red Drum Adult
Atlantic Croaker
Blue Catfish
Red Drum Juvenile
Sea Trout Juvenile
dB/Bdt = {C – (Eg+U+SDA) – R – M – P}*hmod
Gulf Menhaden Adult
Sheepshead
Shrimp Adult
Black Drum
Adult
Blue Crab Adult
Sunfish
Bay Anchovy
Brown Shrimp Juvenile
White Shrimp Juvenile
Striped Mullet
Gulf Menhaden Juvenile
Diet matrix for consumers
Oysters
Blue Crab Juvenile
Zoobenthos
Zooplankton
Oyster Spat
Benthic Diatoms
Sediment Bacteria
Diatoms
Chlorophytes
Cyanophytes
Bacterioplankton
Benthic Chlorophytes
Water DOC
Water POC
Sediment POC
Sediment DOC
Benthic Cyanophytes
Nutrients

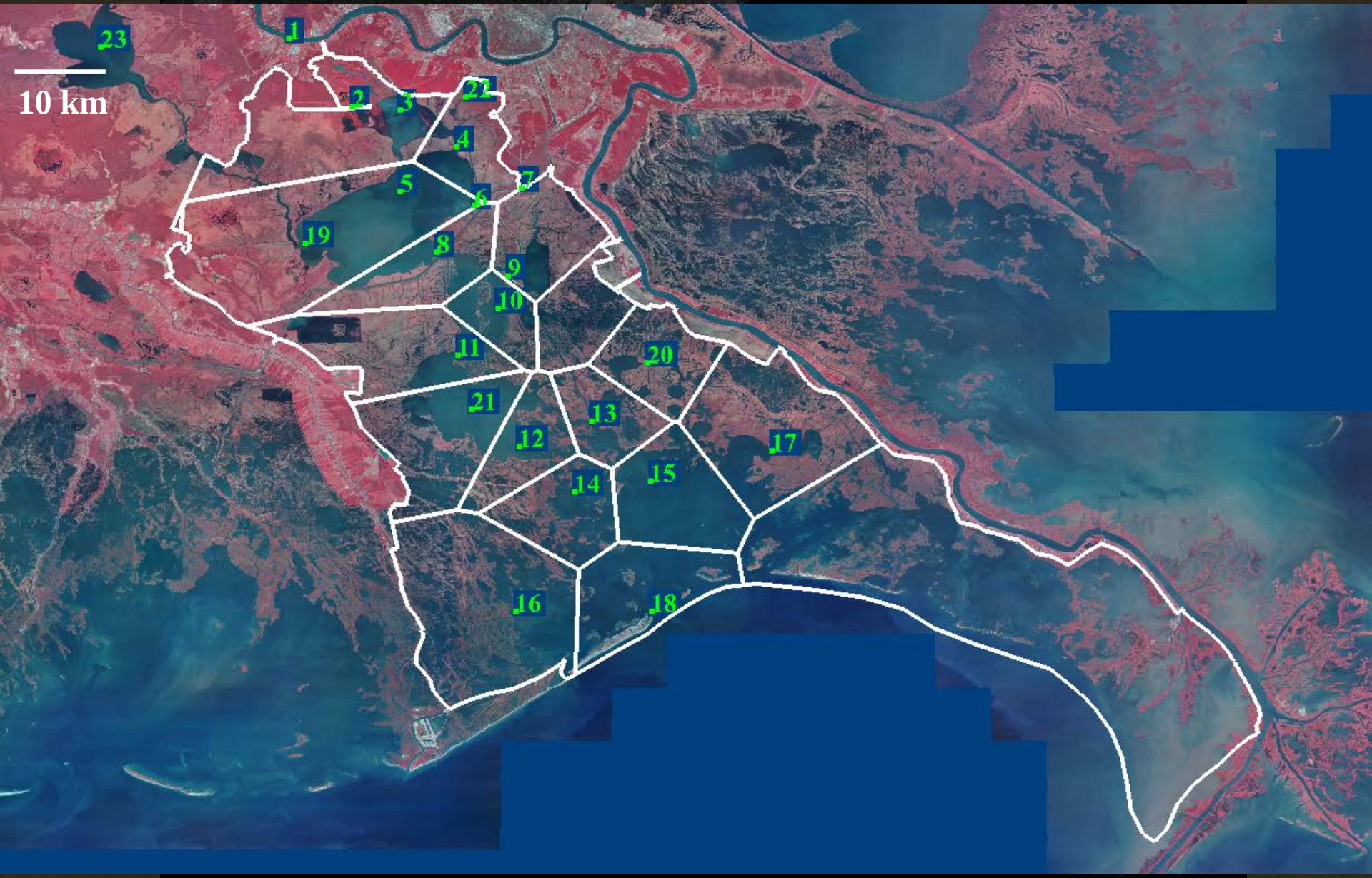
Data Used for Model Development

Monitoring Programs	Dates of Record	Sampling Frequency	Variables Measured or Estimated
National Solar Radiation Database New Orleans Airport	1960 - 2010	Hourly	Surface light intensity (PAR)
USACE Water Quality Sampling	1997 - 2008	Monthly	NO_3, PO_4, TIS, POC, SiO_3, salinity, Chl concentration
Coast-wide Reference Monitoring System (CWPPRA)	2006 - present	Continuous	Temperature, salinity,
USGS Sampling	1998 - present	Continuous	Temperature, salinity
LDWF Fisheries-Independent monitoring	1967 - present	Monthly	Abundance , biomass, size of fish, invertebrates, oysters, habitat modifiers
Barataria Basin nekton sampling (Reed et al. 2007, NOAA)	2002, 2005, 2006	Spring and Fall	Nekton density, biomass, size in marsh, ponds

Environmental Data: Salinity, Temperature, Elevation



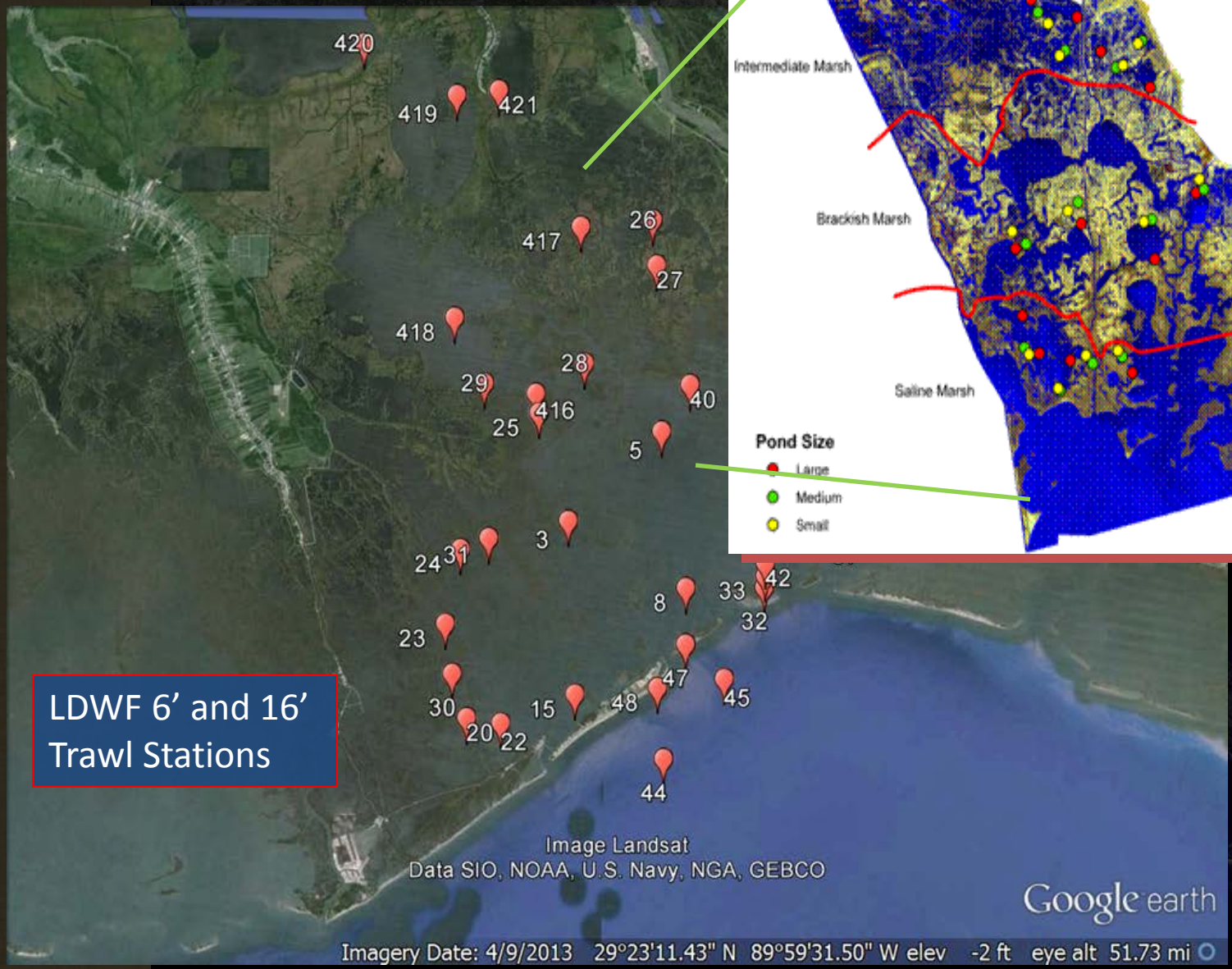
Environmental Data: USACE Water Quality

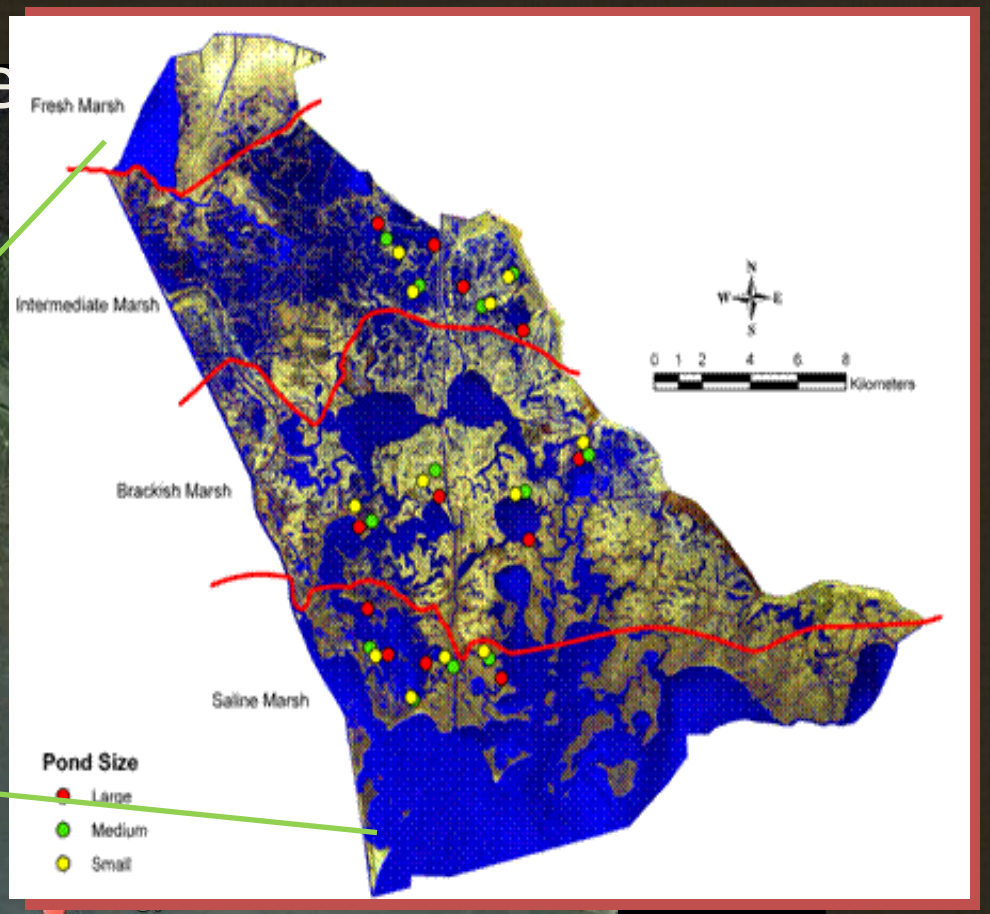


Biological Data: Species Biomasses

- Mean monthly species biomass (g/m^2) calculated from LDWF seines and trawls and NOAA 1-m^2 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

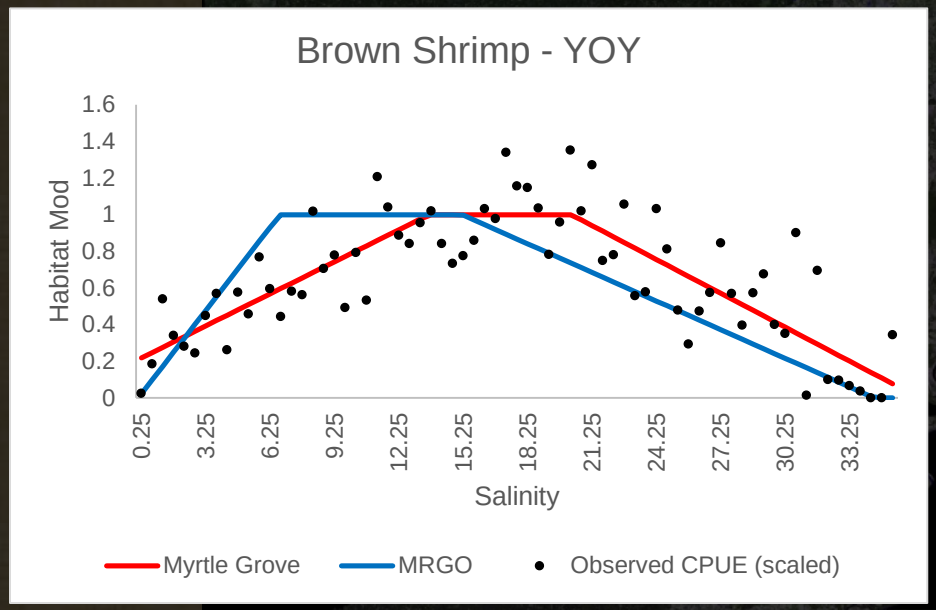
Biological Data: Specie

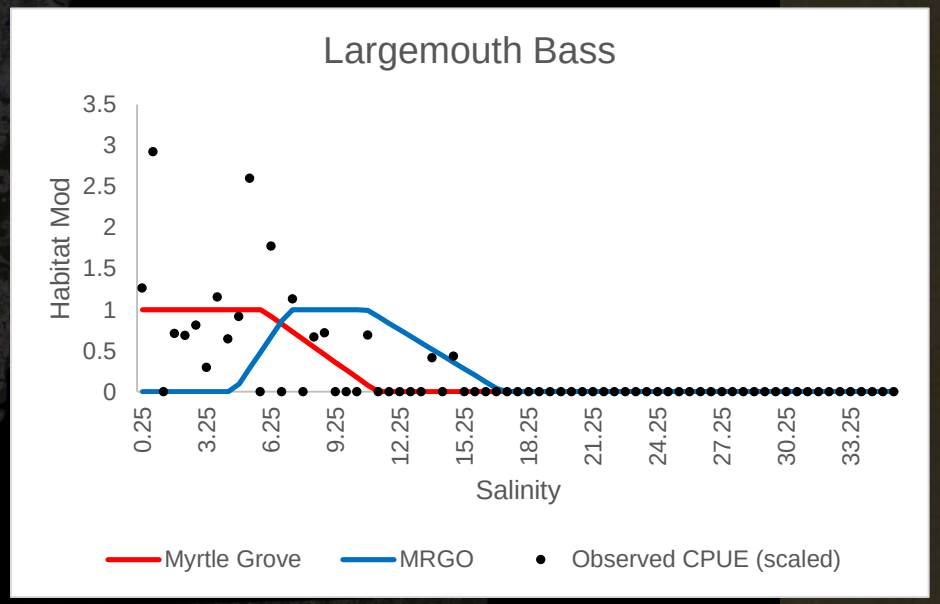


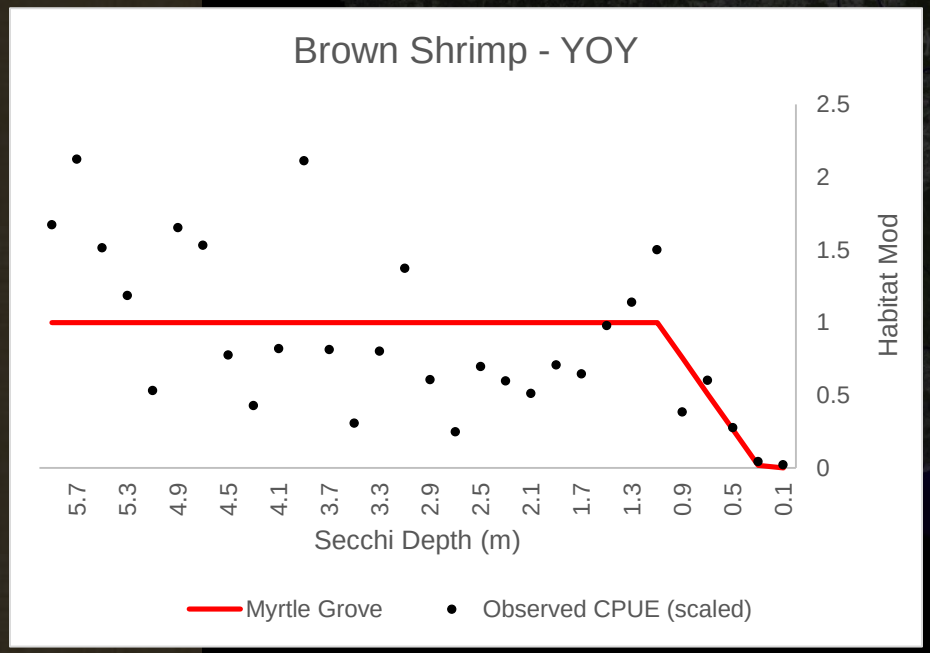


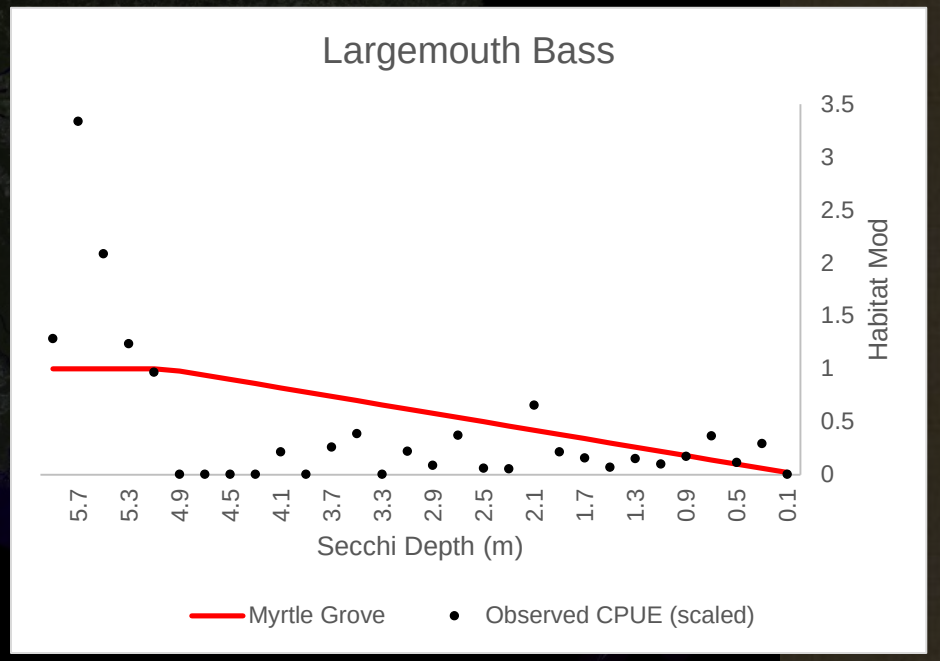
LDWF 6’ and 16’ Trawl Stations

Biological Data: Habitat Modifiers



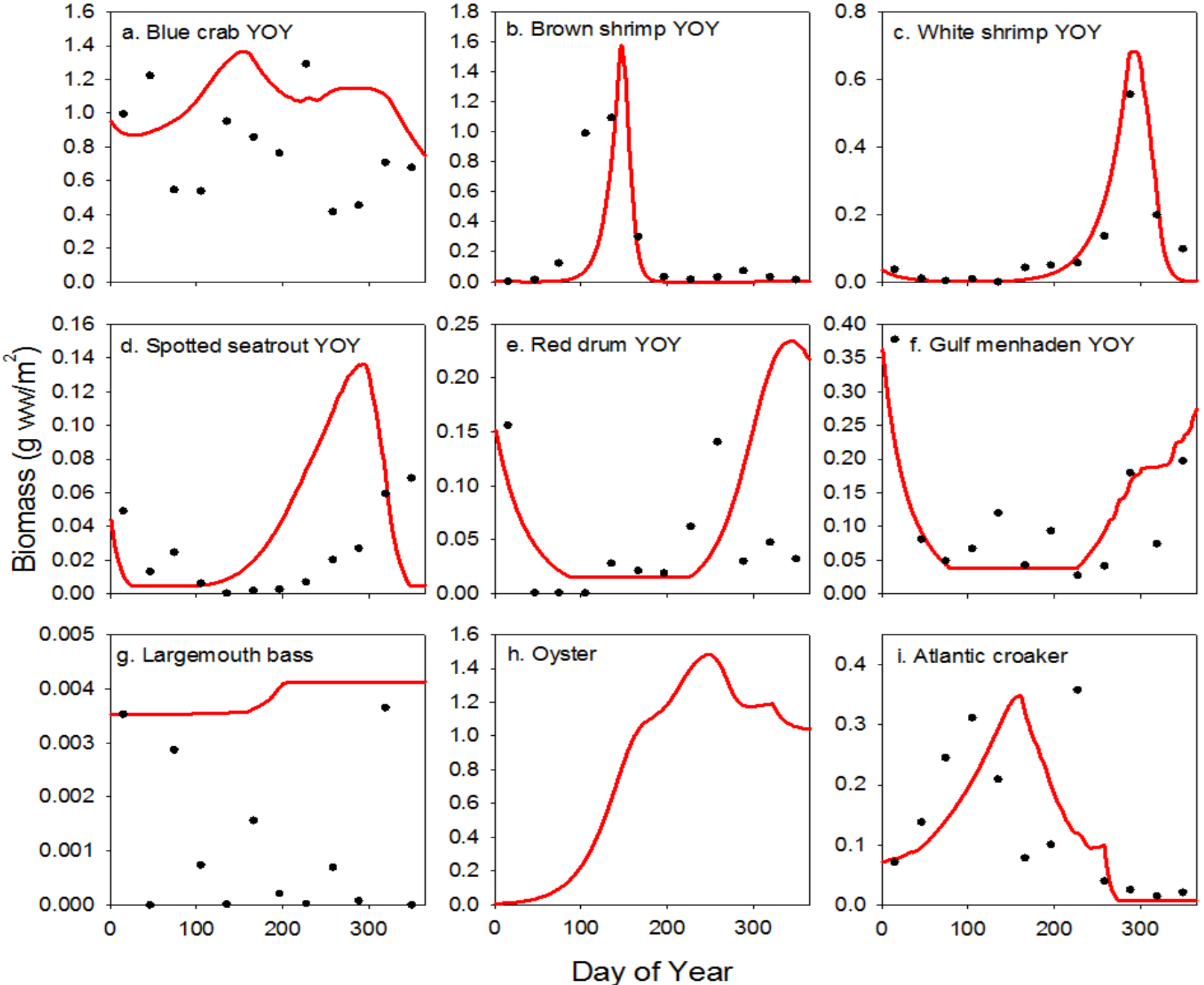


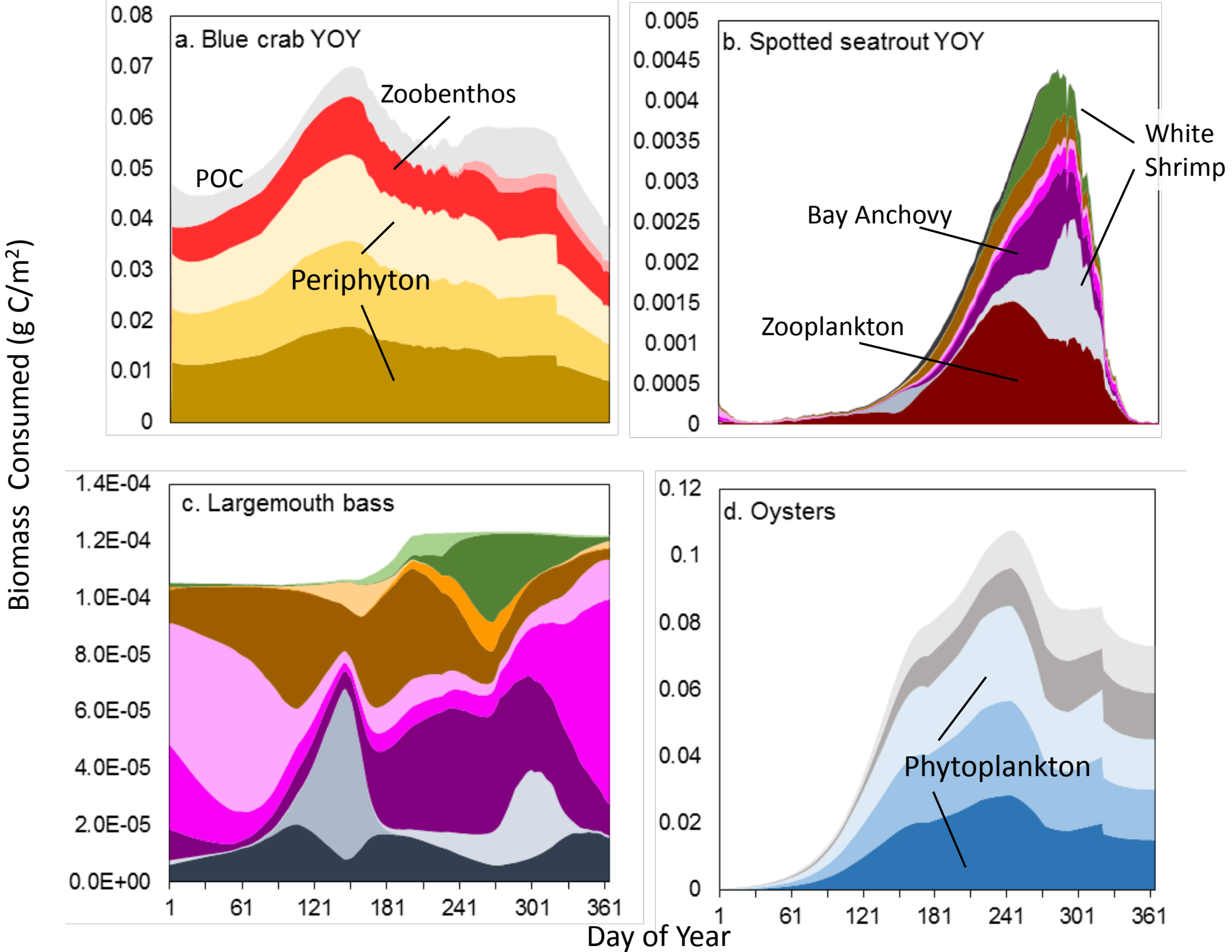


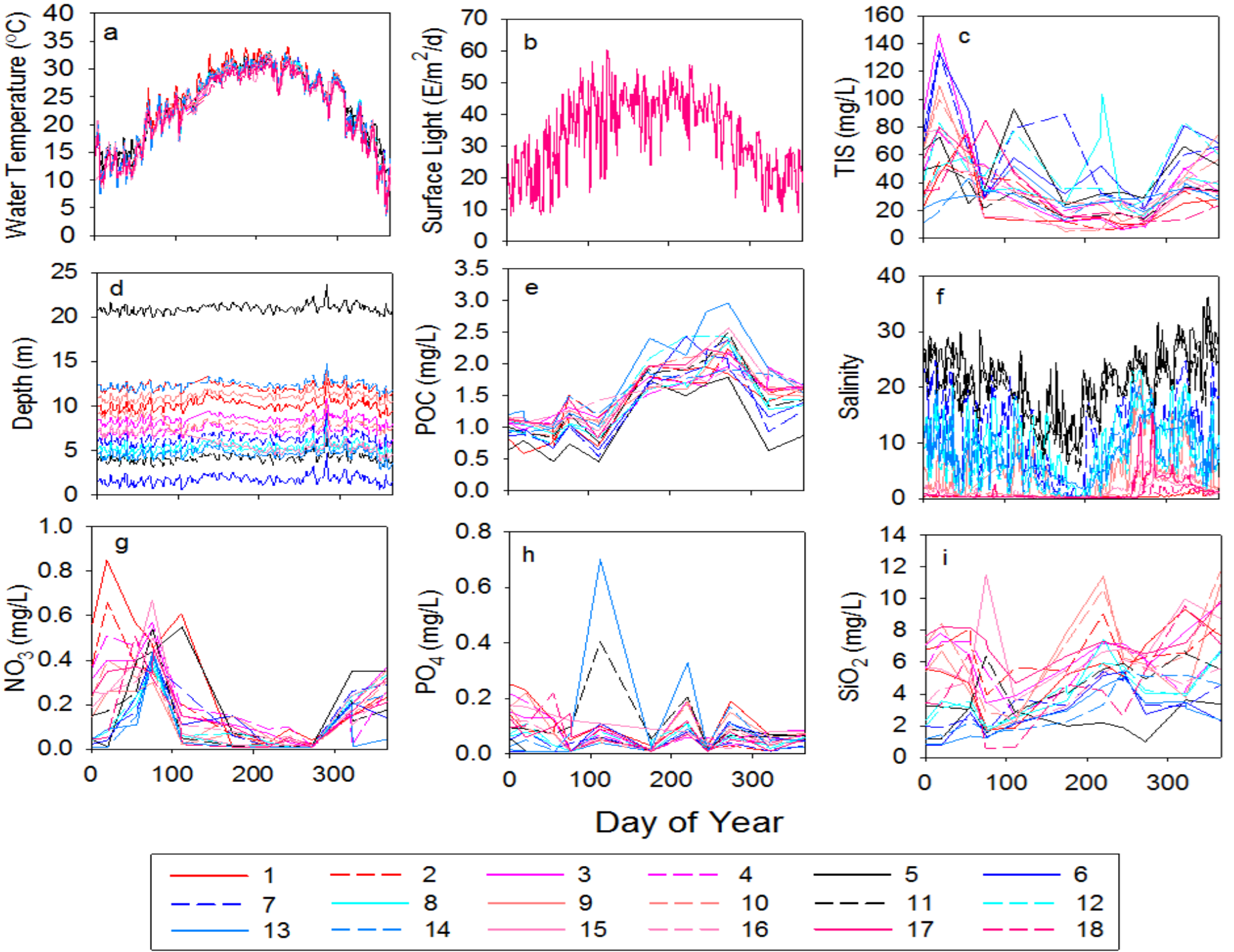


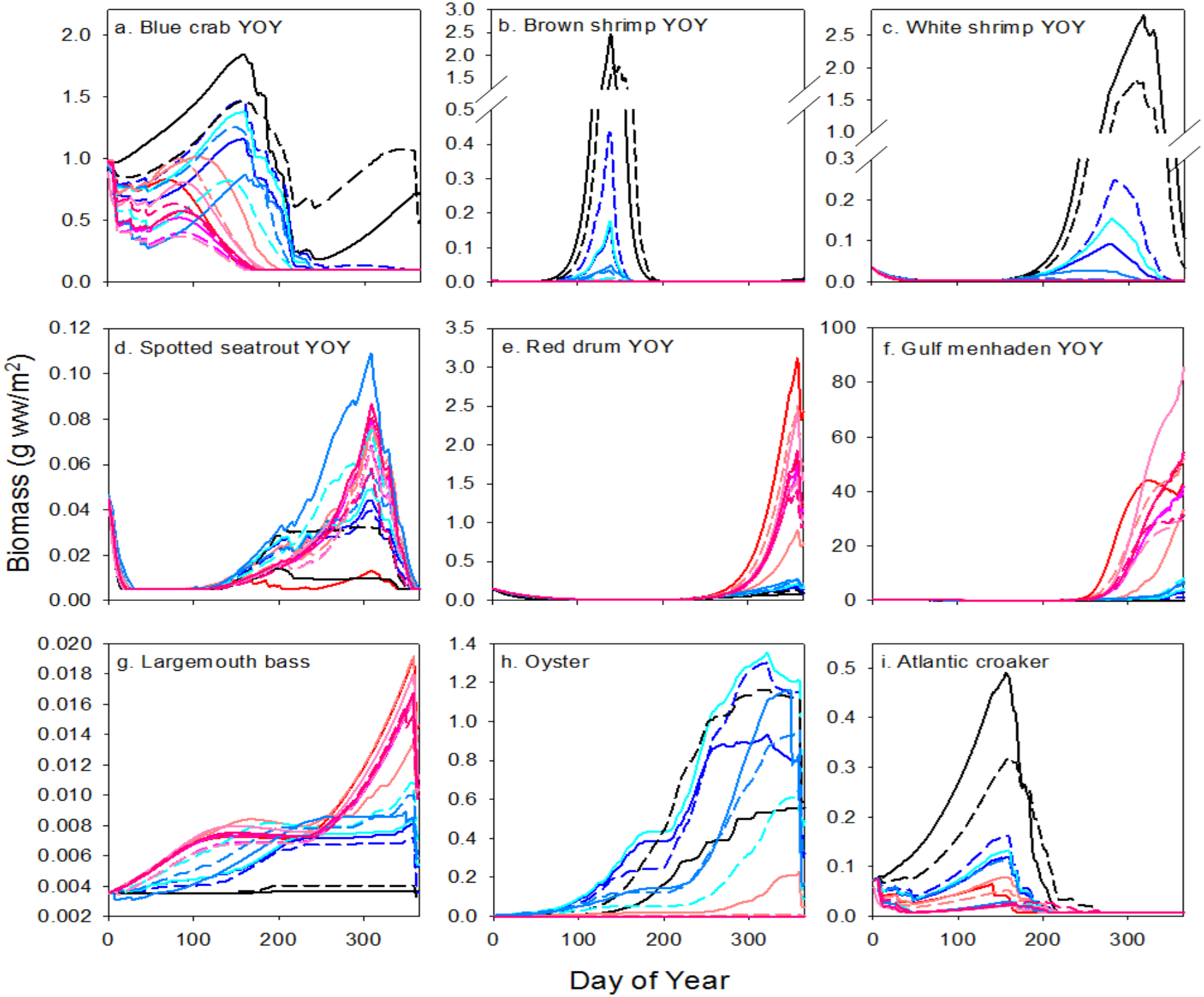
Baseline CASM Results for Existing Conditions

- 18 CASM Stations using environmental field data from 1999-2010 throughout basin
- Food web dynamics driven by temperature, light, nutrients, salinity
- Demonstrate seasonal biomass trends and distribution of species due to environmental gradients and shifting food web in estuary

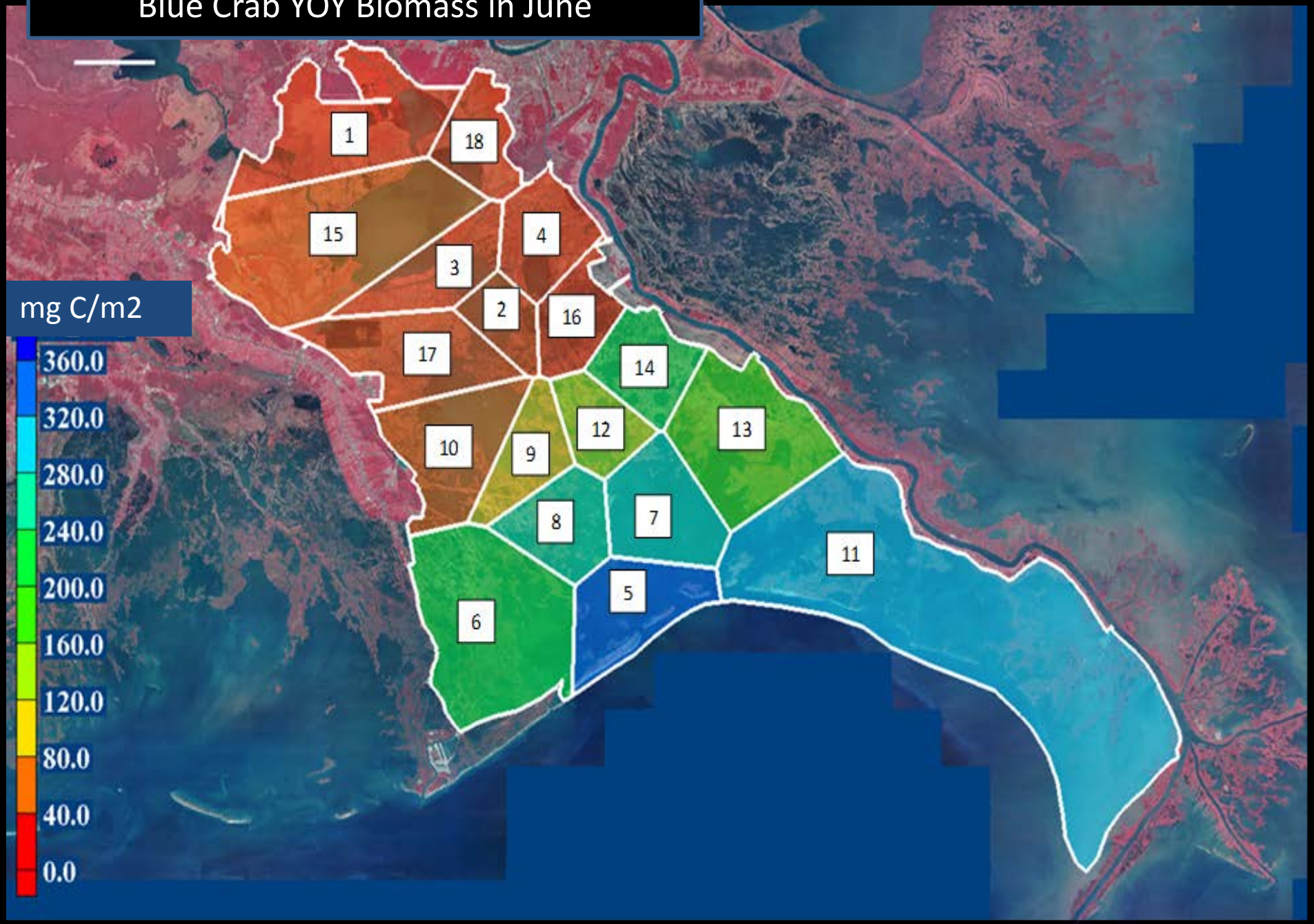

a. Blue crab YOY
b. Brown shrimp YOY
c. White shrimp YOY
d. Spotted seatrout YOY
e. Red drum YOY
f. Gulf menhaden YOY
g. Largemouth bass
h. Oyster
i. Atlantic croaker
Biomass (g ww/m2)
Day of Year

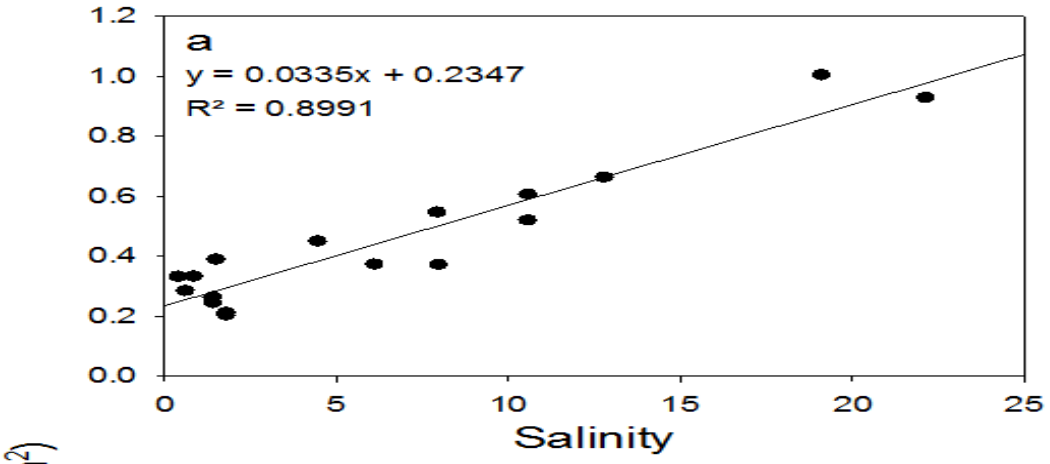

a. Blue crab YOY
Zoobenthos
POC
Periphyton
b. Spotted seatrout YOY
White Shrimp
Bay Anchovy
Zooplankton
c. Largemouth bass
d. Oysters
Phytoplankton
Biomass Consumed (g C/m²)
Day of Year

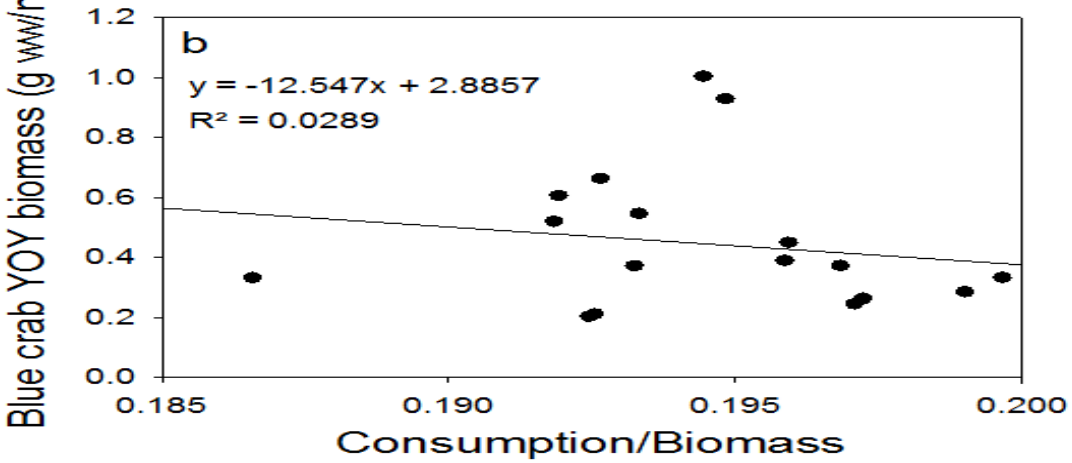

a
Water Temperature (°C)
b
Surface Light (E/m²/d)
c
TIS (mg/L)
d
Depth (m)
e
POC (mg/L)
f
Salinity
g
NO3 (mg/L)
h
PO4 (mg/L)
i
SiO2 (mg/L)
Day of Year
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

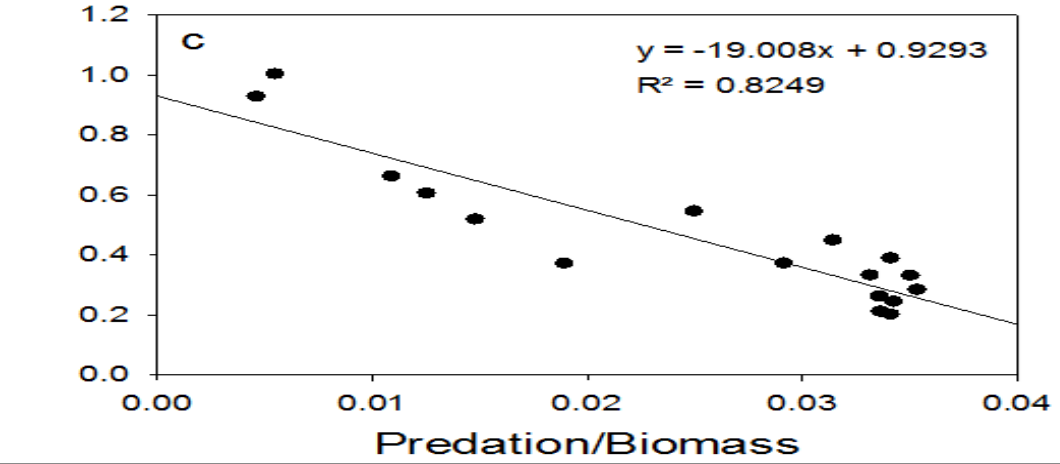

a. Blue crab YOY
b. Brown shrimp YOY
c. White shrimp YOY
d. Spotted seatrout YOY
e. Red drum YOY
f. Gulf menhaden YOY
g. Largemouth bass
h. Oyster
i. Atlantic croaker
Biomass (g ww/m2)
Day of Year

Blue Crab YOY Biomass in June









Blue crab YOY biomass (g ww/m^2)

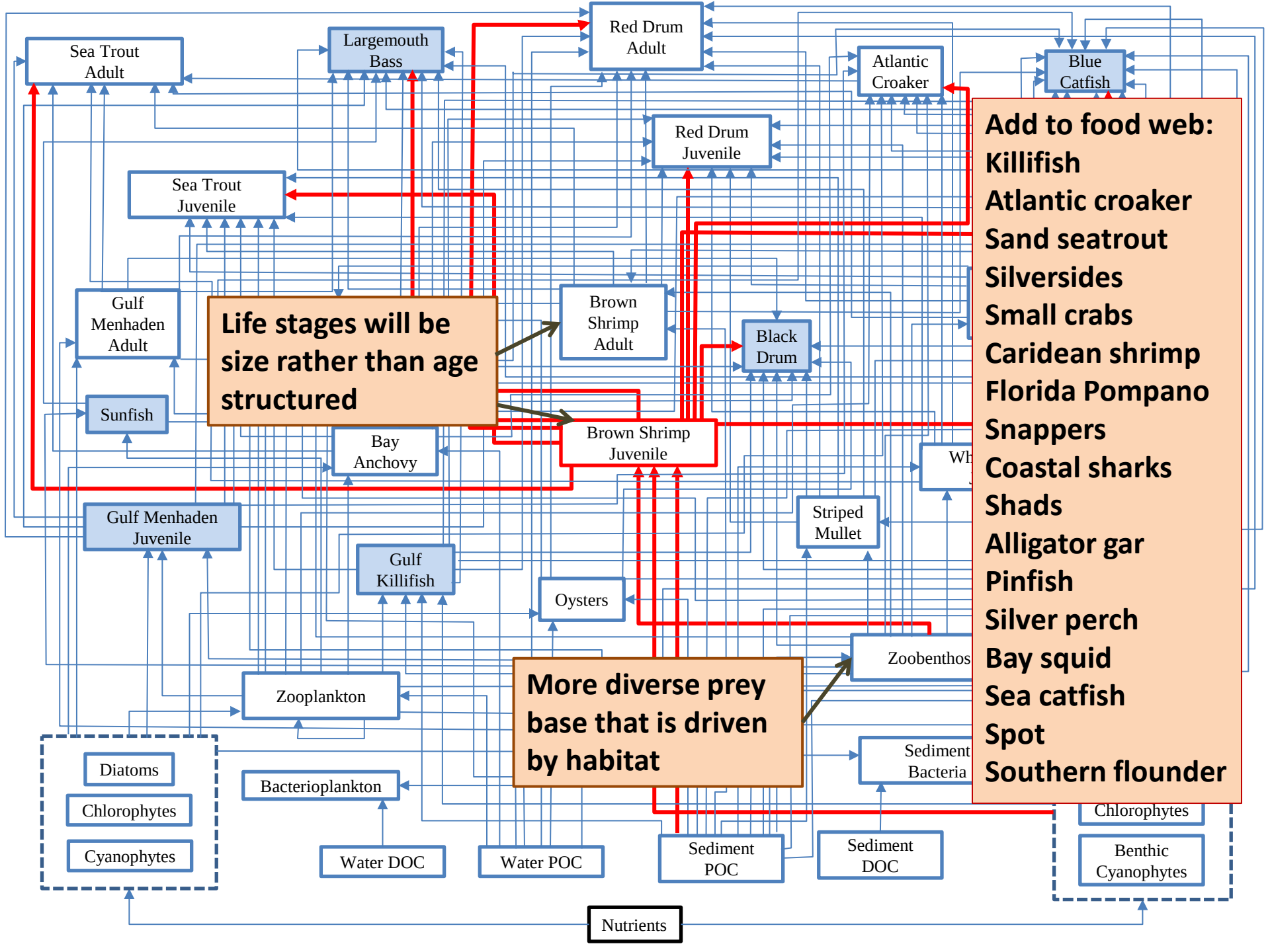
CASM Approach for Delta Management

- *55* species/functional groups in the food web
- *A lot* of CASM food webs set up on model domain
- Daily time step simulated over *multiple years with regenerating populations*
- CASM inputs are averaged daily values from field data and outputs from the hydro model, *veg model*
- Environmental inputs modify producer and consumer processes in food webs

CASM Approach for Delta Management

- Differences in species/life stage biomasses by habitat from LDWF and NMFS sampling
  - Habitat: marsh (EAV); open water; SAV; oyster reef
- Differences in base prey due to habitat and water quality
  - Prey: phytoplankton, periphyton, zooplankton, benthic infauna, bivalves
- CASM set up and initialization based on available data for model domain **and** post-auditing of Barataria model

Delta Management Modeling Project Domain

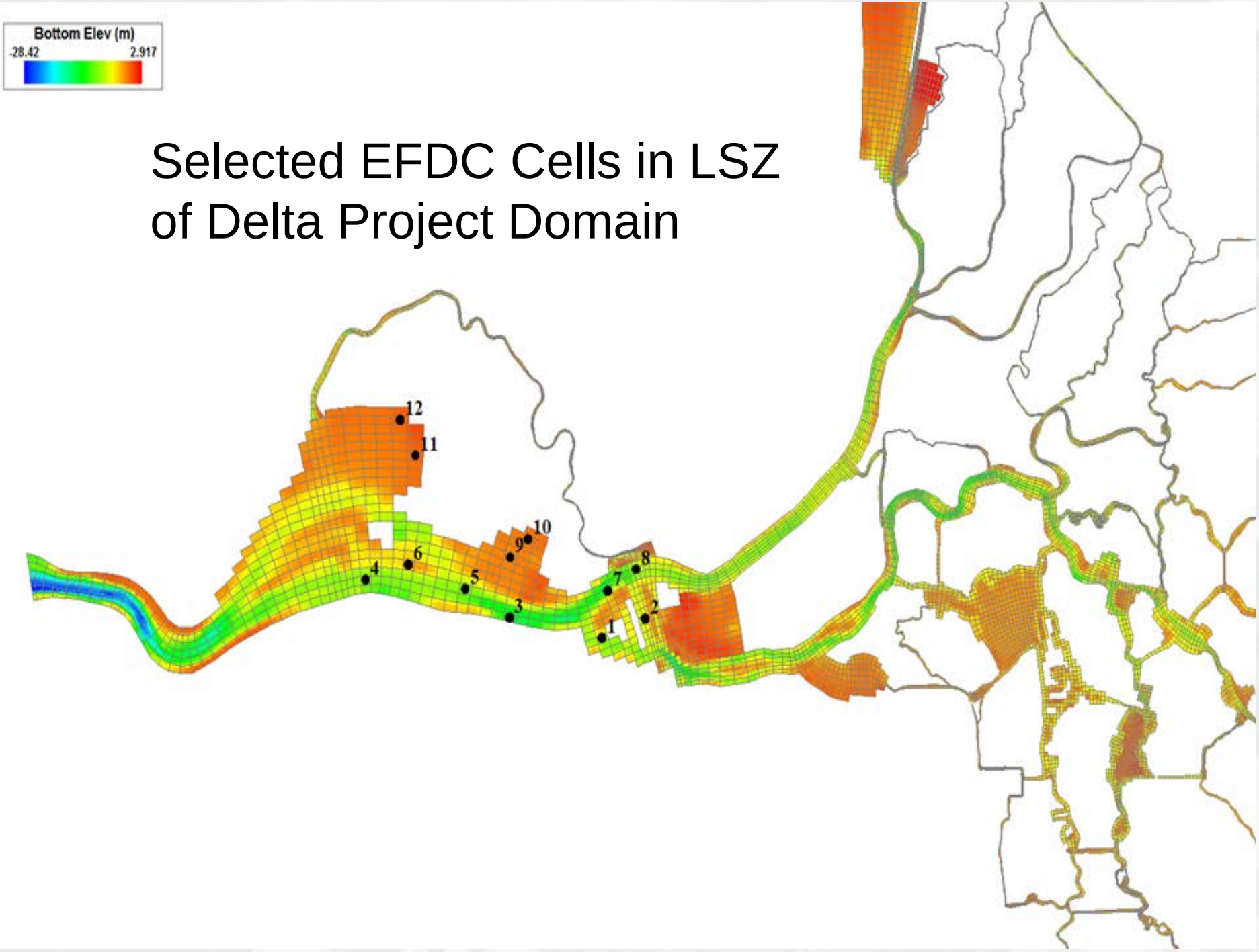

Sea Trout Adult
Largemouth Bass
Red Drum Adult
Atlantic Croaker
Blue Catfish
Red Drum Juvenile
Sea Trout Juvenile
Gulf Menhaden Adult
Life stages will be size rather than age structured
Brown Shrimp Adult
Black Drum
Sunfish
Bay Anchovy
Brown Shrimp Juvenile
Gulf Menhaden Juvenile
Striped Mullet
Gulf Killifish
Oysters
Zoobenthos
Zooplankton
More diverse prey base that is driven by habitat
Diatoms
Chlorophytes
Cyanophytes
Bacterioplankton
Sediment Bacteria
Chlorophytes
Benthic Cyanophytes
Water DOC
Water POC
Sediment POC
Sediment DOC
Nutrients
Add to food web:
Killifish
Atlantic croaker
Sand seatrout
Silversides
Small crabs
Caridean shrimp
Florida Pompano
Snappers
Coastal sharks
Shads
Alligator gar
Pinfish
Silver perch
Bay squid
Sea catfish
Spot
Southern flounder

Then there's California…

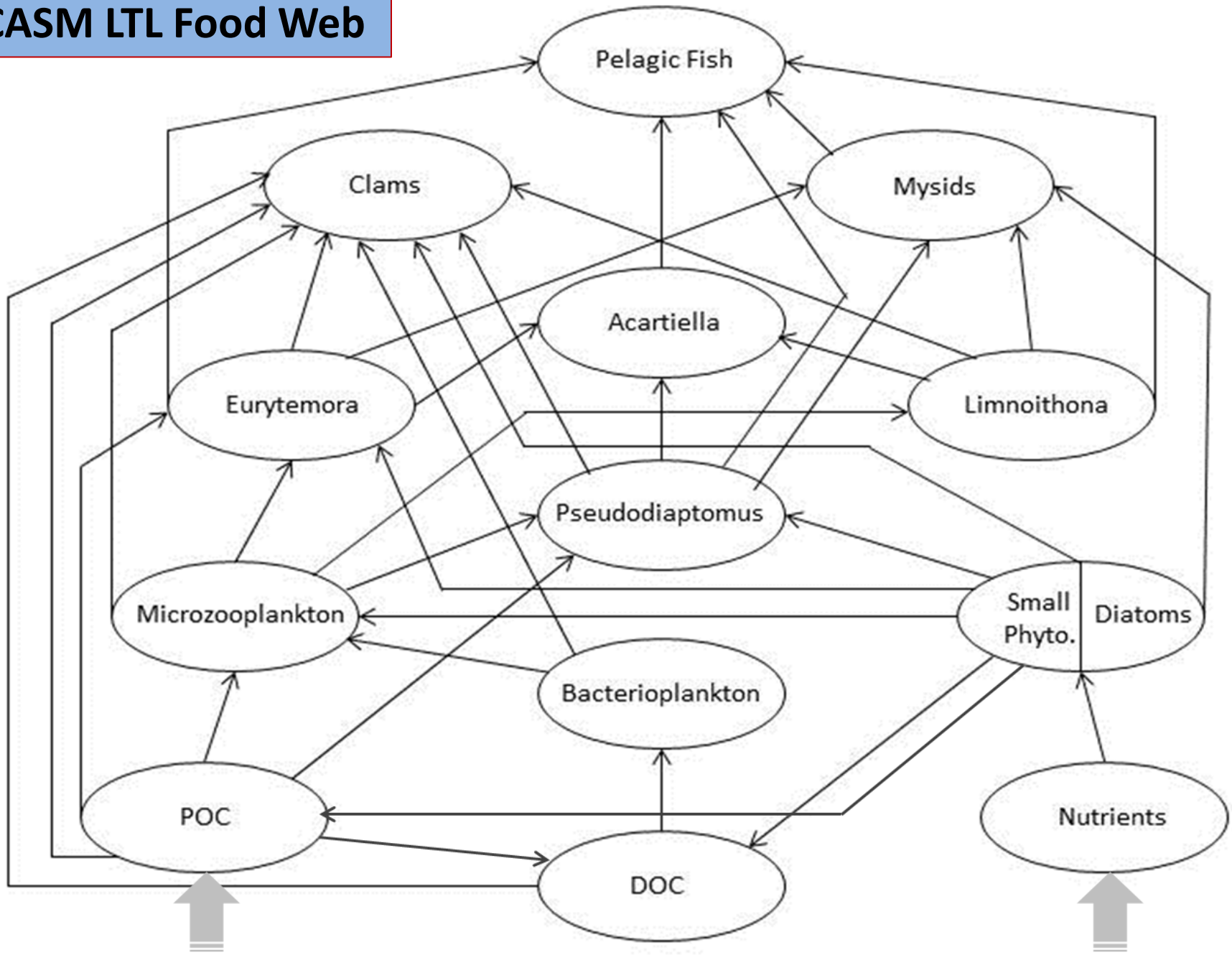
A Lower Trophic Level Food Web Model to Support Understanding and Evaluation of Ecological Responses in the Low Salinity Zone (LSZ) of San Francisco Estuary

Shaye Sable, Dynamic Solutions
Kenneth Rose, Louisiana State University
Wim Kimmerer, San Francisco State University
Steven Bartell, CARDNO Entrix
Eugene Maak, USACOE-SD

U.S Army Corps of Engineers
BUILDING STRONG®


Bottom Elev (m)
-28.42
2.917
Selected EFDC Cells in LSZ
of Delta Project Domain
12
11
10
9
8
7
6
5
4
3
2
1

CASM LTL Food Web



CASM for Gulf Restoration

- CASM (other models) set up for specific coastal regions to evaluate lethal and sub-lethal effects from DWHOS on key species in food web
- Food web dynamics driven by temperature, light, nutrients, salinity, habitat structure, species effects from toxins measured in the field and laboratory
- Environmental inputs from data and/or linked with hydrodynamic and water quality models
- Evaluate bottom-up effects and species interactions at daily and seasonal, annual and multiyear time scales
  - Short-term, pulsed, decaying or varying effects