

The CASM for Evaluating Changes in Fish and Shellfish Communities from the Delta Management Study

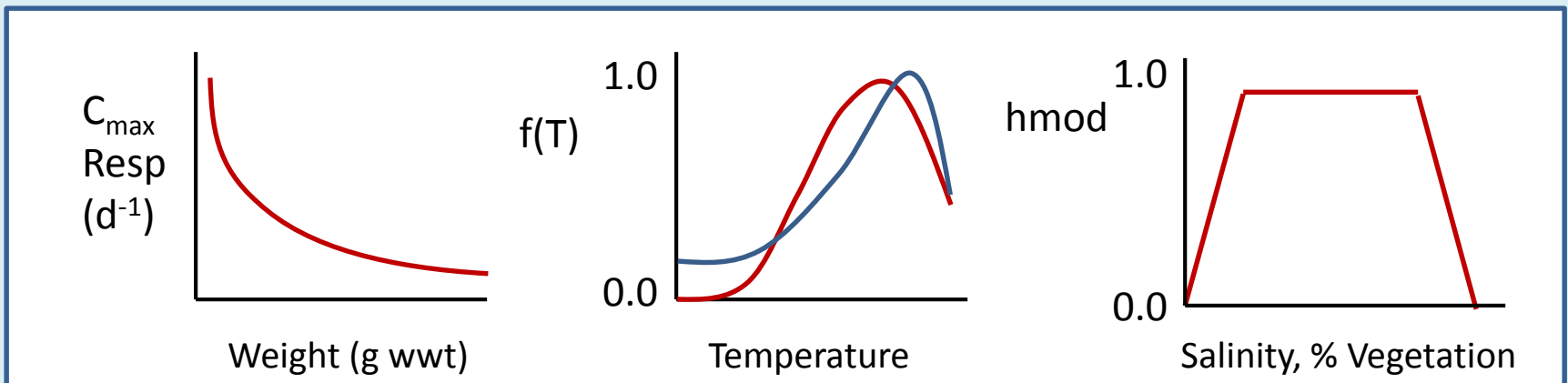
Diversion Panel Presentation – Oct 27, 2015

Dynamic Solutions, LLC



CASM

- Bioenergetics-based growth in an aquatic food web
- Producers: $dB/Bdt = \text{Photosynthesis} - \text{Photorespiration} - \text{Dark Respiration} - \text{Sinking} - \text{Mortality} - \text{Grazing}$
- Consumers: $dB/Bdt = [\{\text{Consumption} - (\text{Egest} + \text{Excrete} + \text{SDA}) - \text{Respiration} - \text{Mortality} - \text{Predation}\} + \text{flux}] * h_{\text{mod}}$
- Consumption and respiration depend on size, temperature; Consumption on prey and predator biomasses
- Growth modified by salinity, proportion of vegetation



MRDM CASM

MRDM

Inputs:

Salinity

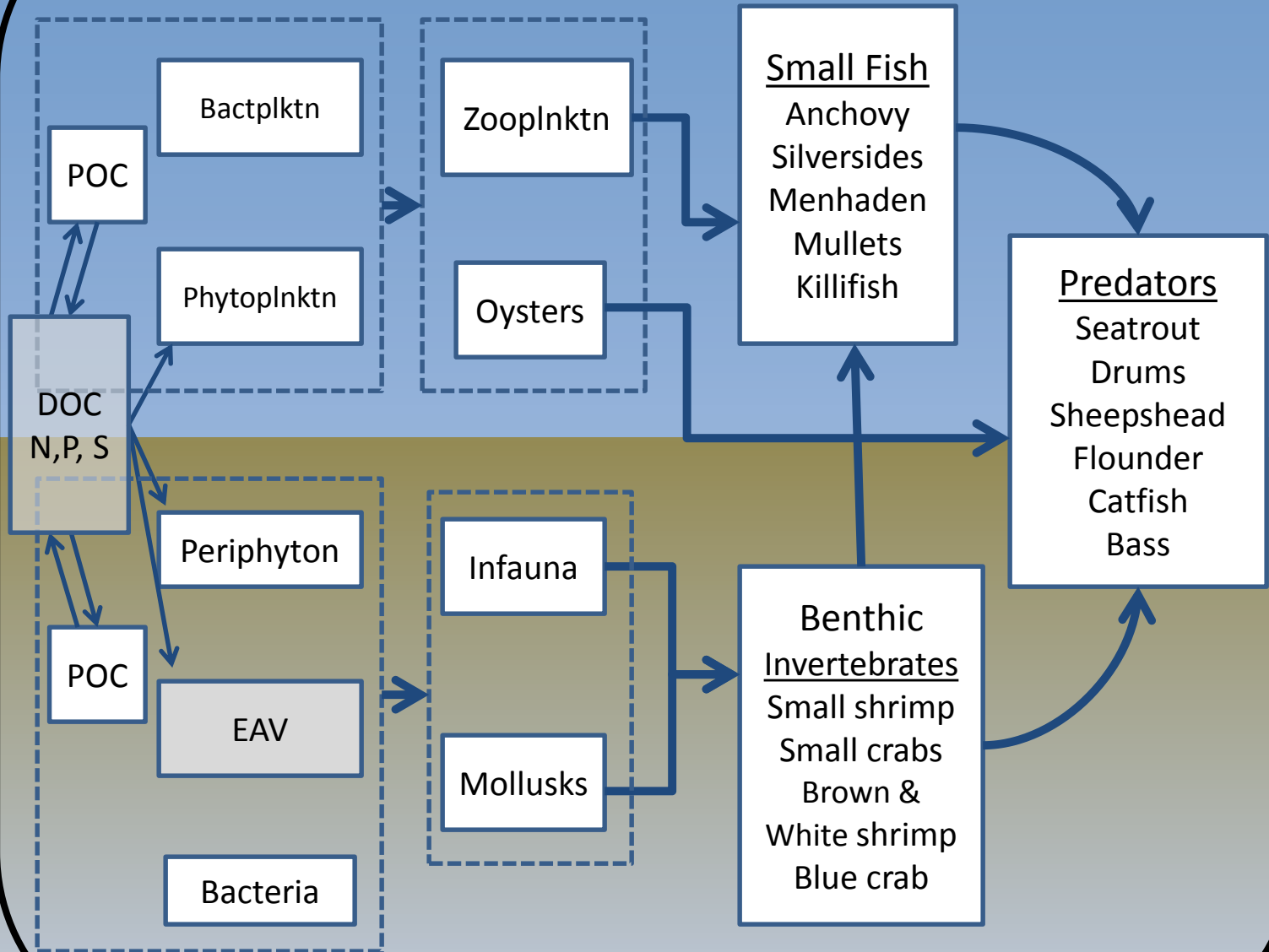
Temperature

Chlorophyll

Water Depth

EAV: Water

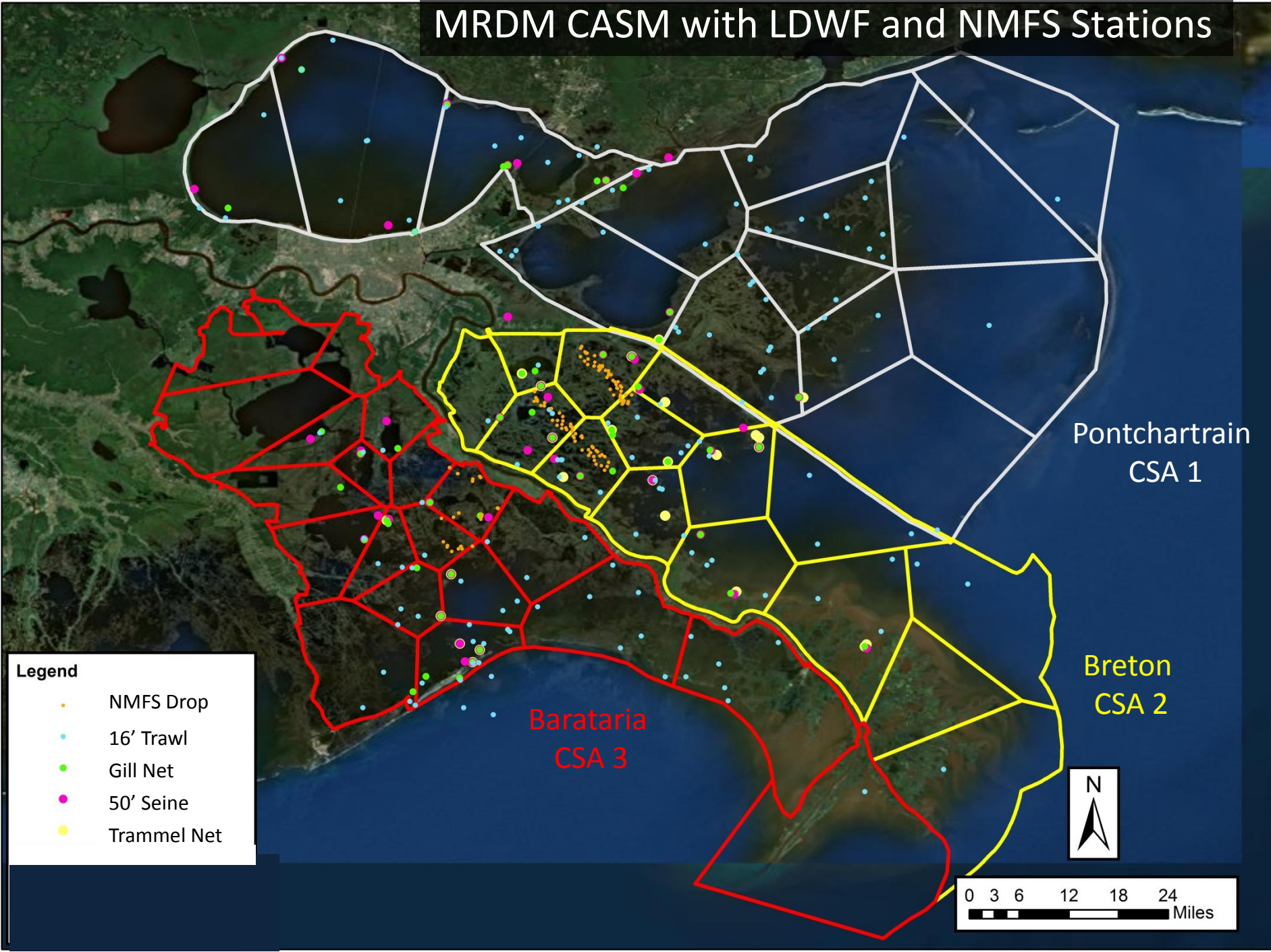
Oyster reef



Biological Data for the CASM

- Biomass (g/m^2) for initialization and calibration from LDWF seines and trawls, NMFS drop samplers
- Lengths, catch-per-unit effort from LDWF and NMFS data
- Bioenergetic parameters, L-W, diets from literature
- Benthic infauna data from NMFS (Minello and Rozas)
- Stage-specific mortality, growth, reproduction, migration for fluxes between life stages and in and out of estuaries to complete life cycle (Baker et al. 2014; EPRI 2005; Pattillo et al. 1997)
- Habitat preferences/tolerances for temperature, salinity, vegetation for life stages, benthic infauna from LDWF and NMFS data, 2017 Master Plan HSI models, literature

MRDM CASM with LDWF and NMFS Stations

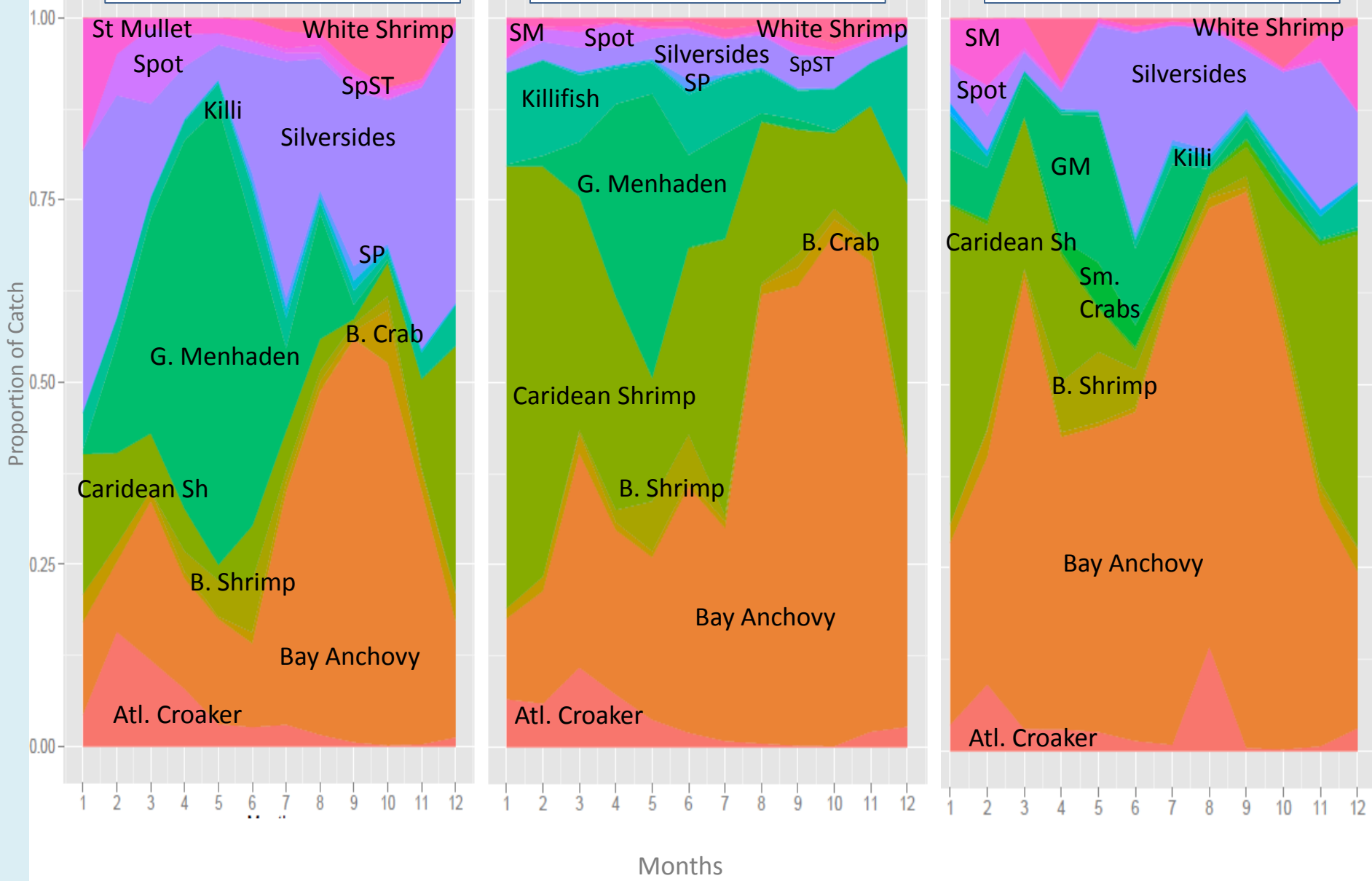


Mean Monthly Model Species Composition in LDWF Seines from 1995-2010

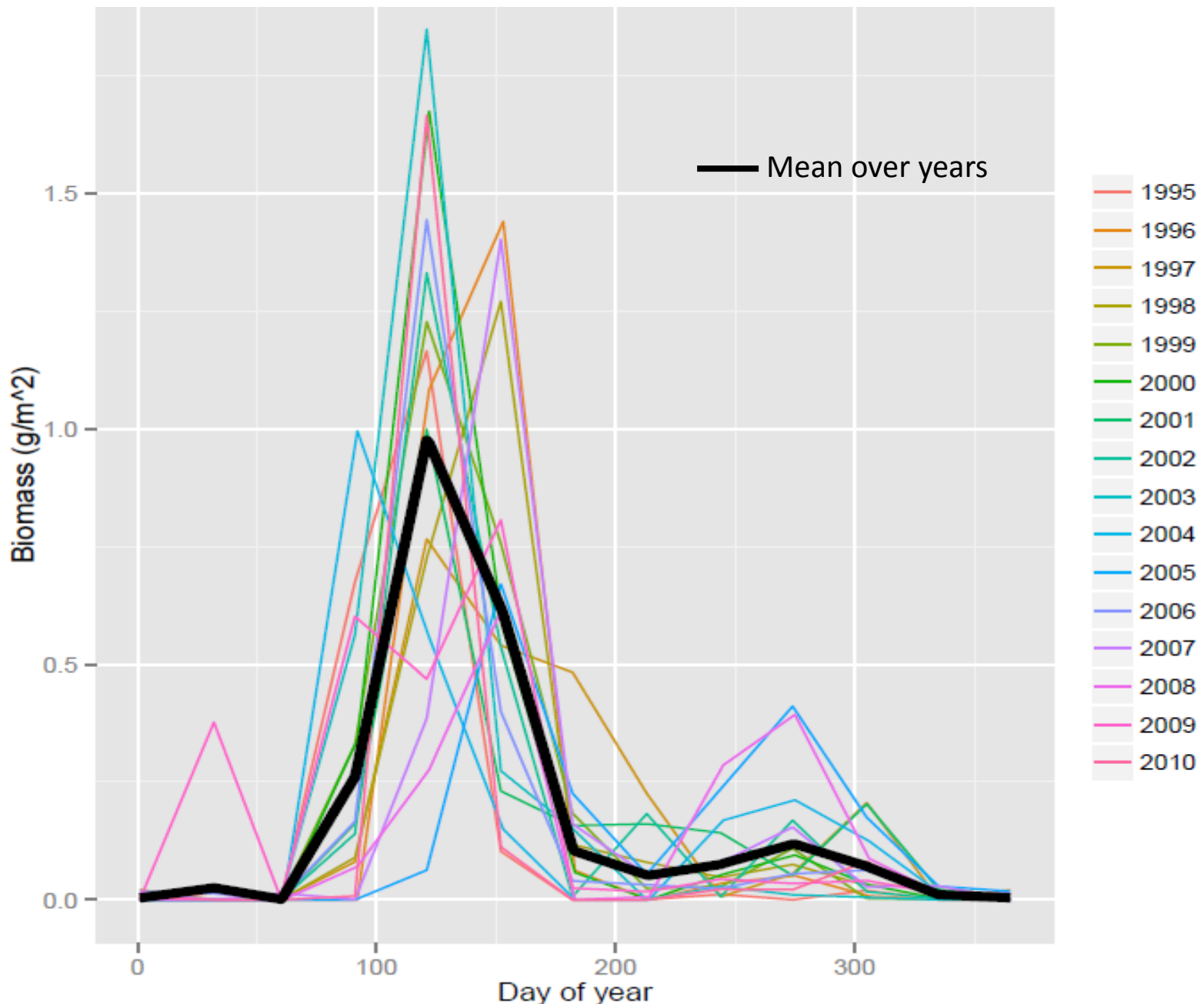
CSA 1 (94% of total catch)

CSA 2 (94% of total catch)

CSA 3 (92% of total catch)

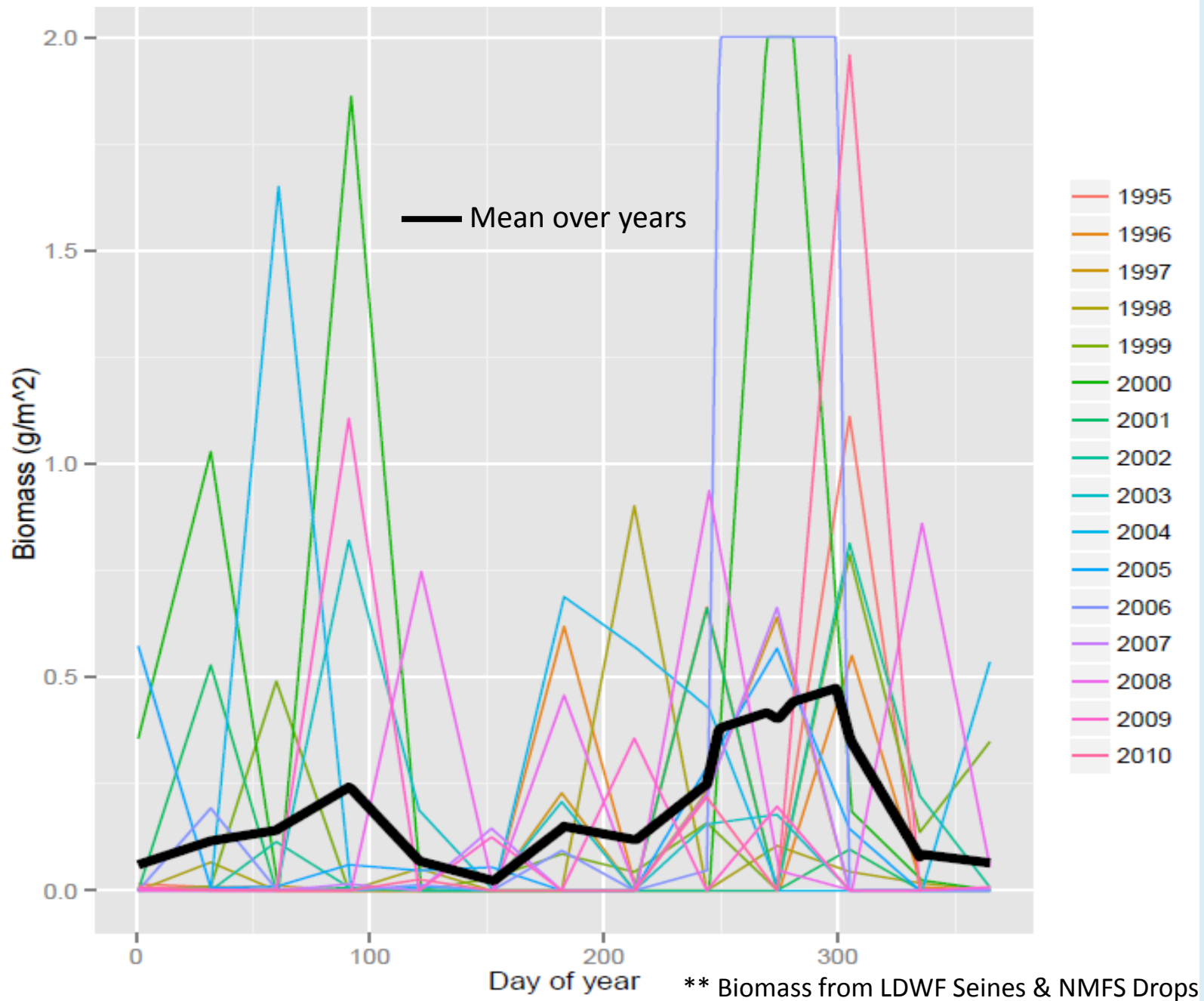


Brown Shrimp Early YOY Biomass Estimates from Data for Barataria Basin



** Biomass from LDWF Seines & NMFS Drops

Red Drum Early YOY Biomass Estimates from Data for Barataria Basin



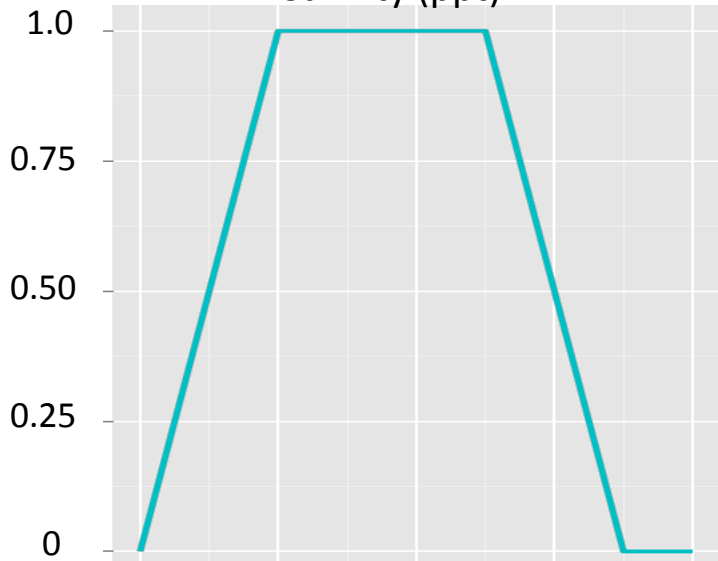
** Biomass from LDWF Seines & NMFS Drops

	Early YOY Blue Crab	Early YOY Brown Shrimp	Early YOY Red Drum	Early YOY Spt Seatrout	YOY Menhaden	YOY Black Drum
Water column POC					X	
Sediment/Detritus	X	X				
Phytoplankton					X	
Periphyton	X	X				
Zooplankton					X	
Benthic Infauna	X	X				X
Mollusks (bivalves, snails added)	X		X			X
Caridean shrimp	X	X	X	X		X
Small crabs	X		X	X		X
Oyster spat	X		X			X
Seed/sack oysters						
Early YOY blue crab			X	X		X
Lg jv/sub blue crab				X		X
Early YOY brown shrimp	X		X	X		X
Lg jv/sub brown shrimp				X		X

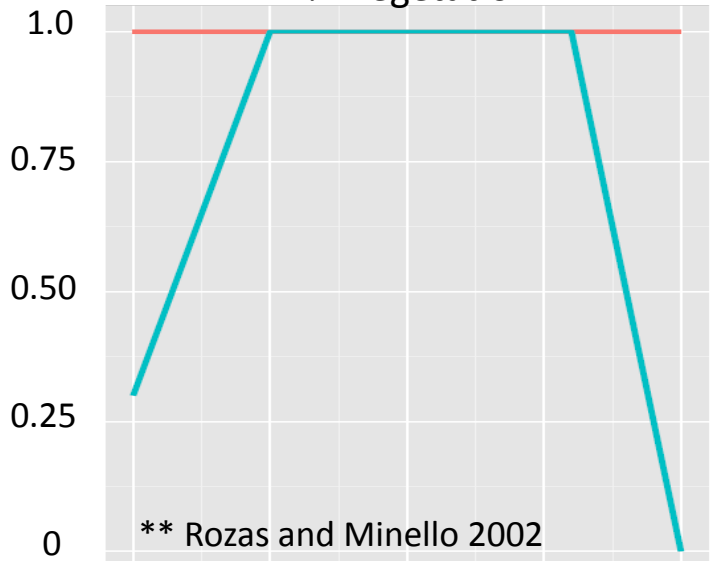
Species-Specific Habitat Modifier Functions from Data

Brown Shrimp

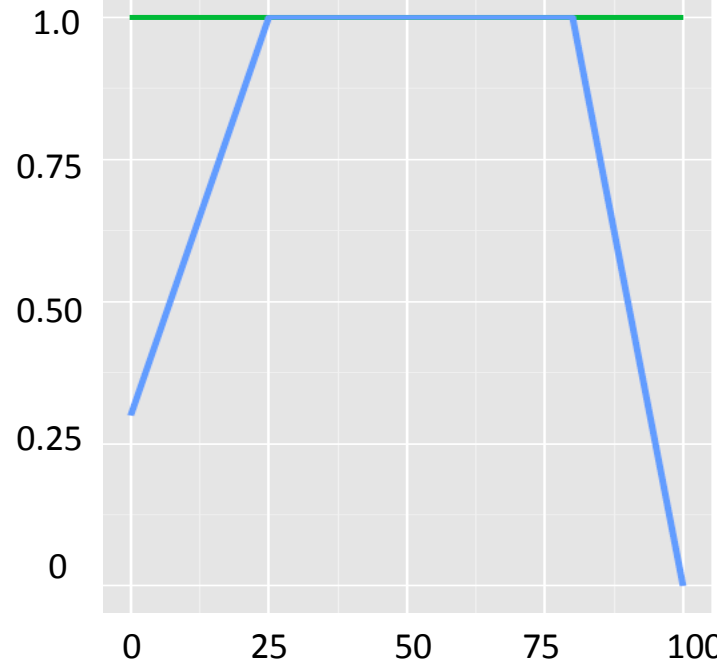
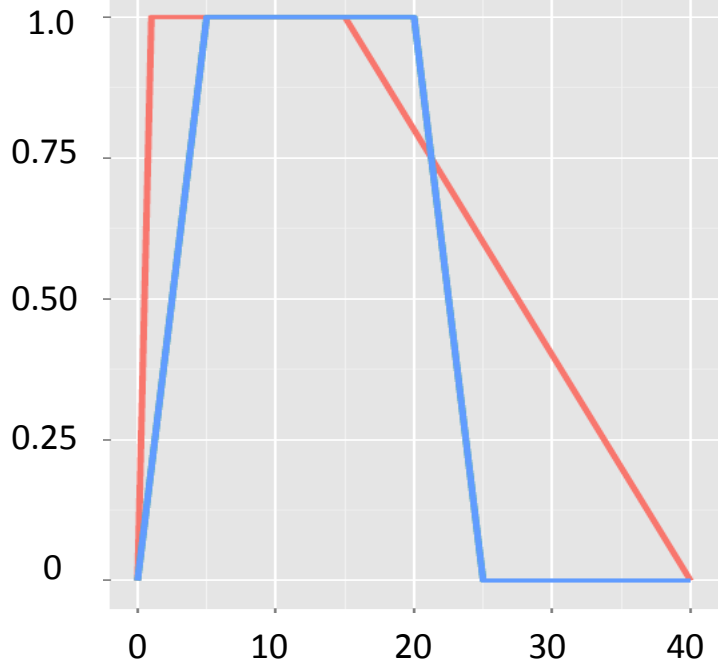
Salinity (ppt)



% Vegetation



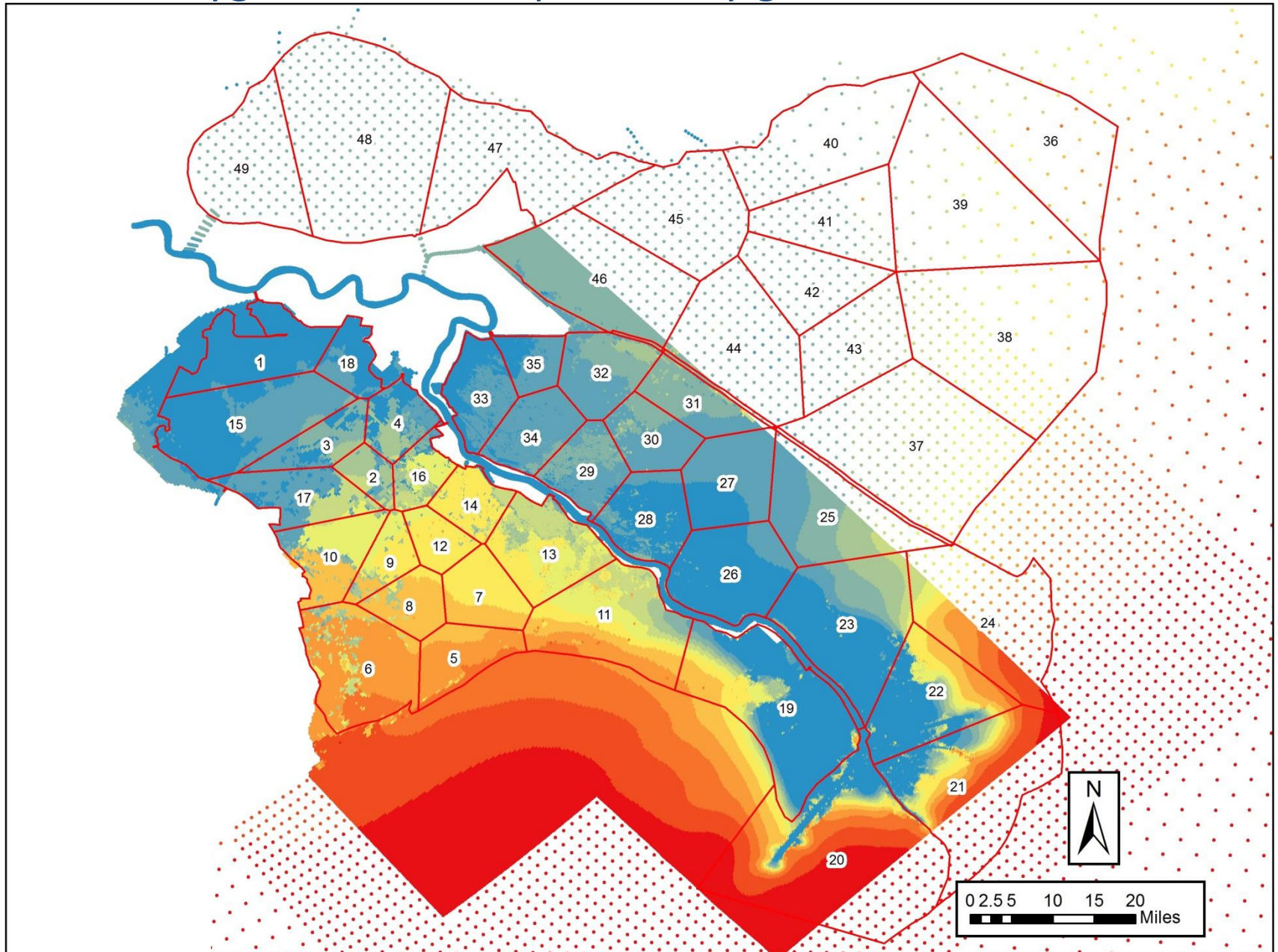
Red Drum



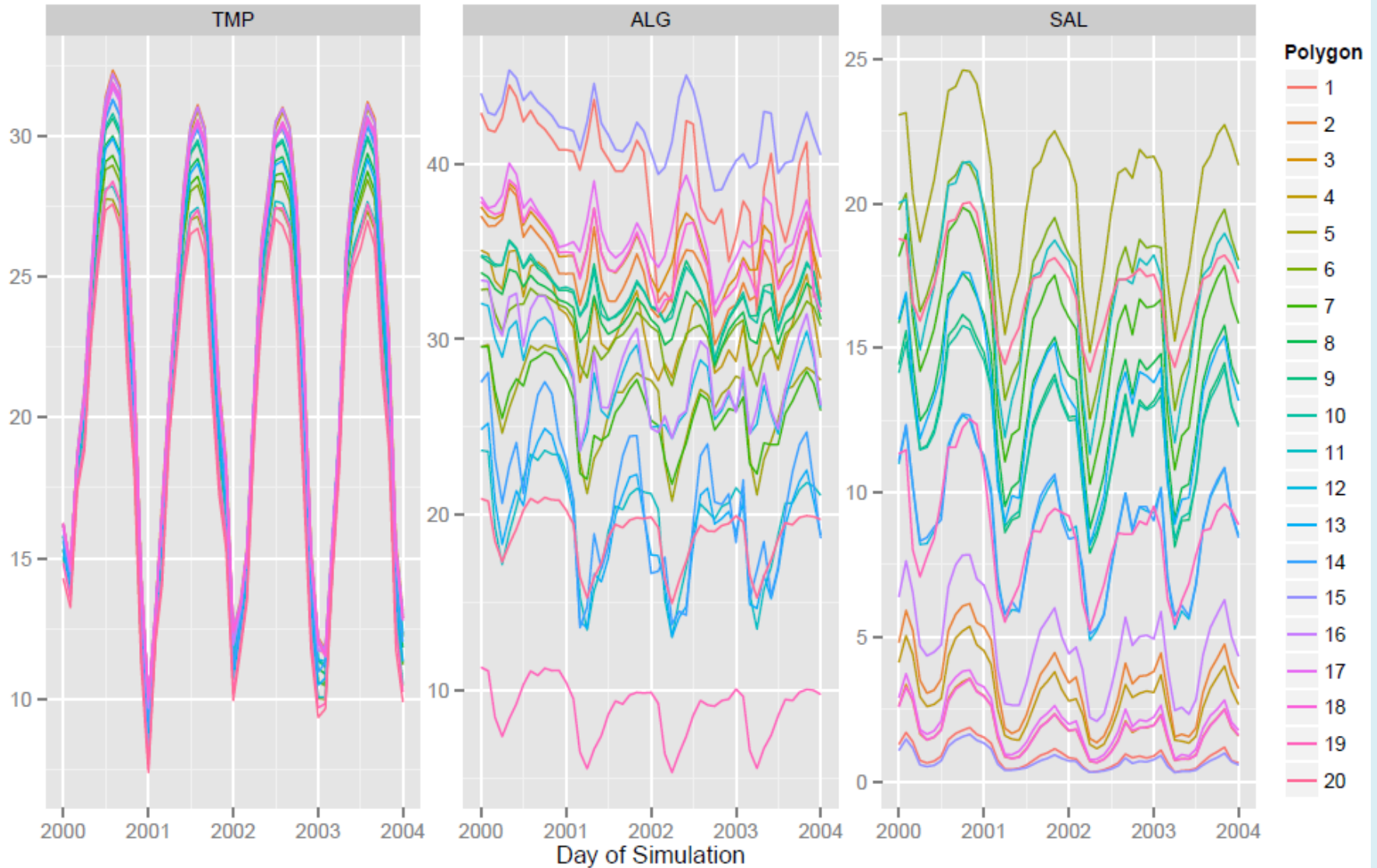
Environmental Data for the CASM

- Existing conditions from 1995-2010 for model calibration and validation
 - Daily salinity (ppt), temperature ($^{\circ}\text{C}$), and Chl a ($\mu\text{g/l}$) from 2012 Eco-Morphology model (Meselhe et al. 2013)
 - 2012 Vegetation:Water map (Couvillion et al. 2013)
 - Used for CASM calibration and validation
- MRDM Project Alternative Scenarios for 50 years
 - Daily salinity, temperature, Chl a from DELFT-3D with D-WAQ (Meselhe et al., in prep)
 - Vegetation:Water maps at 10 year intervals from Delft-3D with LA-VEG (Meselhe et al., Duke-Sylvester et al.)
 - Used as CASM inputs to evaluate key species responses

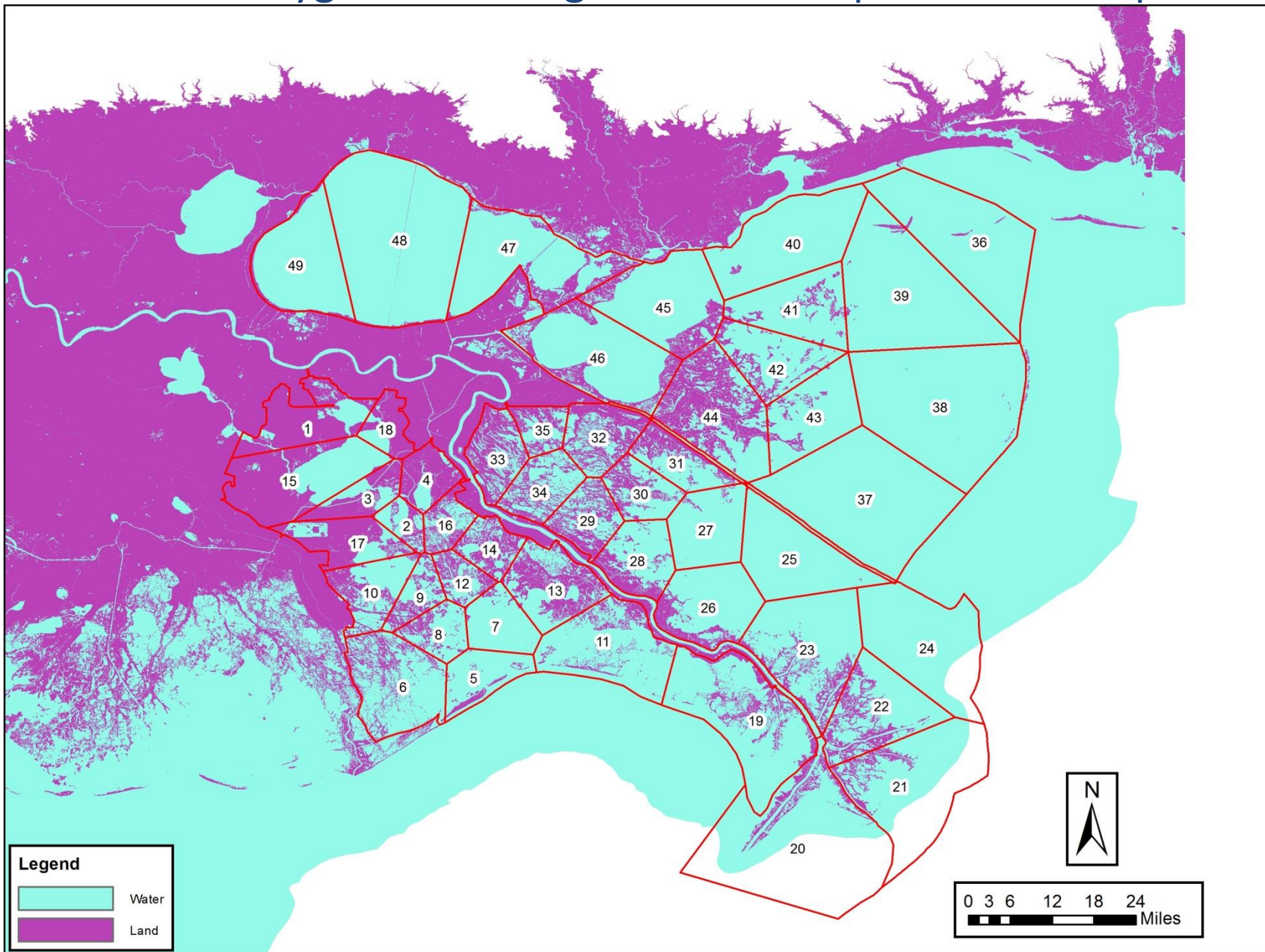
CASM Polygons with Example Salinity generated from Delft-3D



Daily Environmental Inputs for Barataria Polygons



CASM Polygons with Vegetation and Open Water Map



CASM Calibration and Validation

- Calibrate predicted biomasses to averaged observed biomass data from 1995-2010
- Adjust daily mortality rates, life stage fluxes, diet parameters, and temperature parameters
- Validate spatial distribution of species within basins related to conditions, habitat, food web
- Not shown but important to show model is a realistic and accurate representation of system

Evaluating Species Responses to MRDM Project Scenarios

- Delft-3D generated daily salinity, temperature, Chl a, Vegetation:Water inputs to 49 CASM polygons over 50 years
- Seven MRDM diversion scenarios including FWOP, single diversions, all four diversions at low and aggressive operations
- Report key species responses from TY0 for first 10 years, 20 years and at 50 years
 - Brown and white shrimp, blue crab, red drum, seatrout, menhaden, largemouth bass, oysters
 - System-wide, basins (CSA 1, 2, 3), and sub-basins (upper, mid, lower regions in basin)

Gulf Menhaden Biomass: Change from Initial Conditions

Year 10

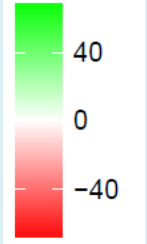
Year 20

Year 50

Future
Without
Project



% change



All Four
Diversions
Aggressive
Operation



Red Drum Biomass: Change from Initial Conditions

Year 10

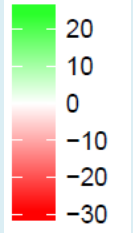
Year 20

Year 50

Future
Without
Project



% change



All Four
Diversions
Aggressive
Operation



Brown Shrimp Biomass: Change from Initial Conditions

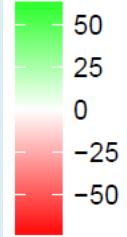
Year 10

Year 20

Year 50

Future
Without
Project

% change



All Four
Diversions
Aggressive
Operation



Brown Shrimp:

System-Wide Responses Relative to TY 0

Years	<u>MBARD</u>	<u>FWOP</u>	<u>MBSD</u>	<u>LBSD</u>	<u>LBARD</u>	<u>ALL-L</u>	<u>ALL-A</u>
	PR1	PR2	PR3	PR4	PR5	PR6	PR7
1	-16.01	-4.18	-12.48	-5.71	-5.58	-15.59	0.32
3	-18.37	-5.61	-14.15	-7.26	-7.78	-18.11	3.77
5	-18.32	-6.05	-14.09	-7.31	-7.95	-18.71	3.38
10	-8.92	6.12	-1.60	2.35	0.01	-17.16	13.85
20	-5.11	7.87	1.82	6.18	5.50	-7.91	16.36
50	-0.87	24.64	23.98	20.95	16.26	-4.46	14.21

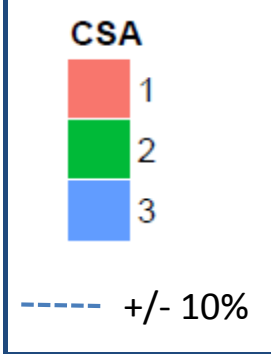
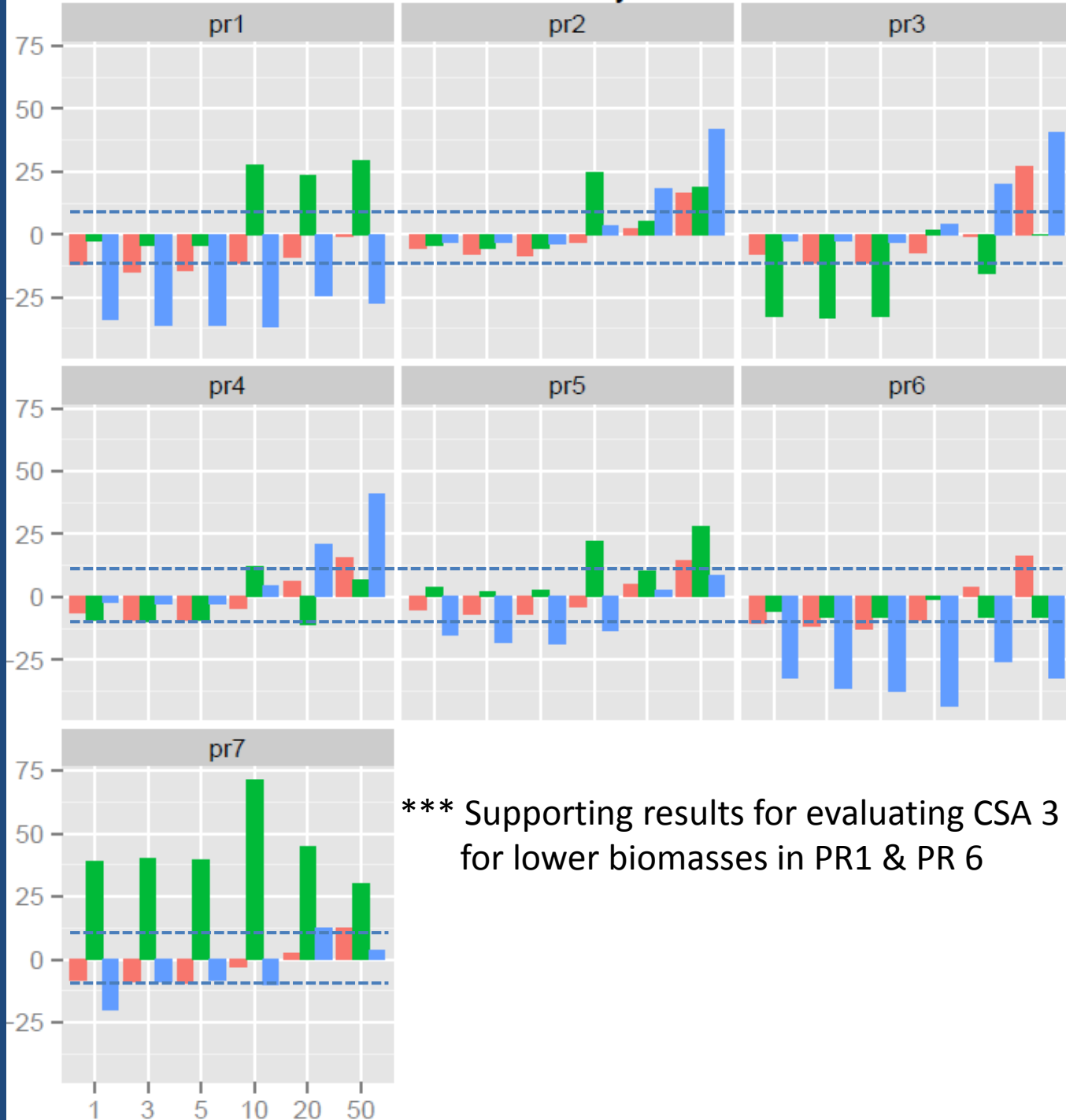
** Minimum threshold response +/-10% = No response due to variation and uncertainty

** Red more than 10% reduction; Green more than 10% increase from TY 0

FWOP ~ LBS ~ LBAR ~ MBS ~ All-A over 50 years

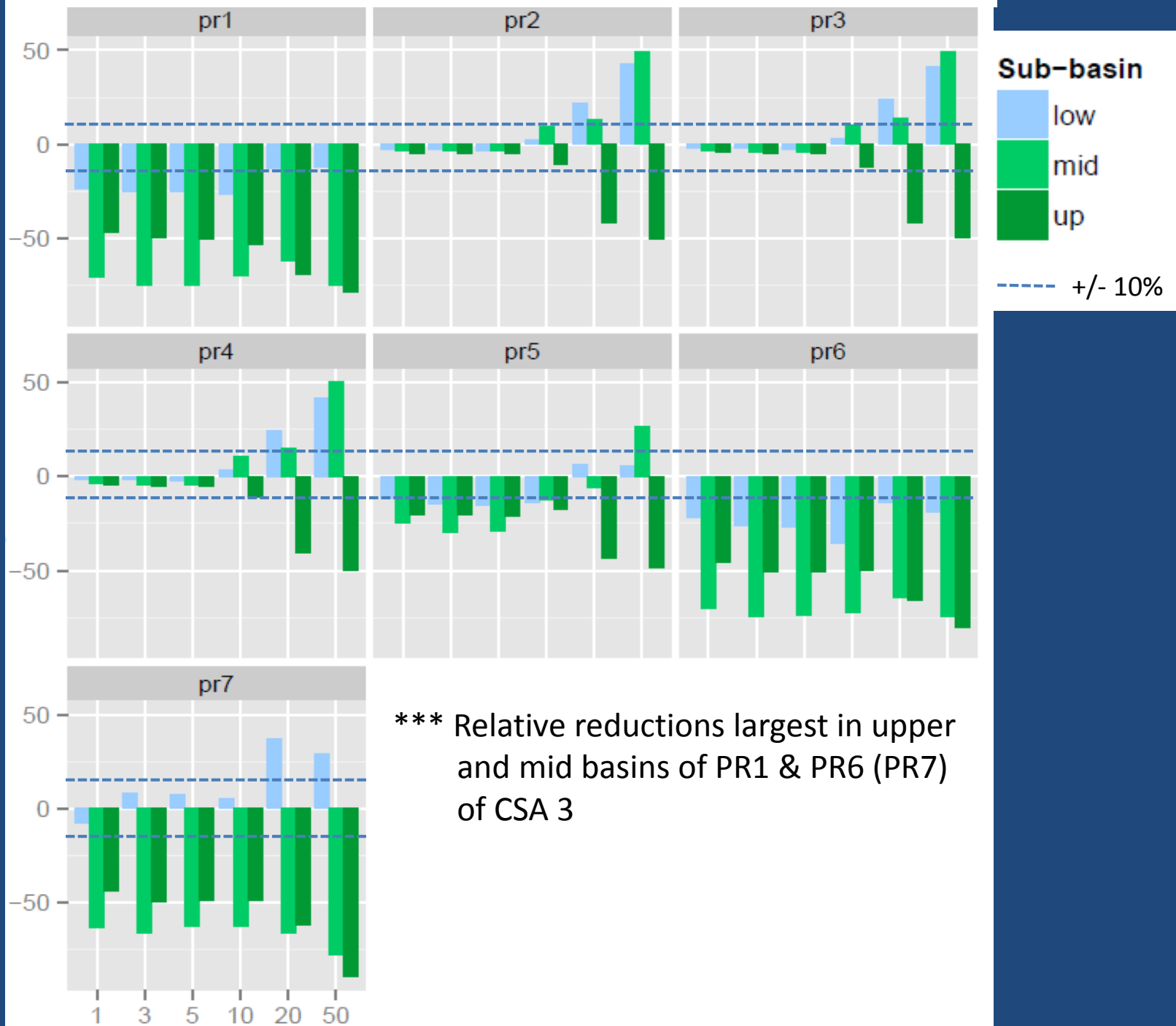
MBAR ~ All-L reduced ~ 18% early but gone by TY 20 and 50

Relative Response (%) in Brown Shrimp Biomass from TY 0

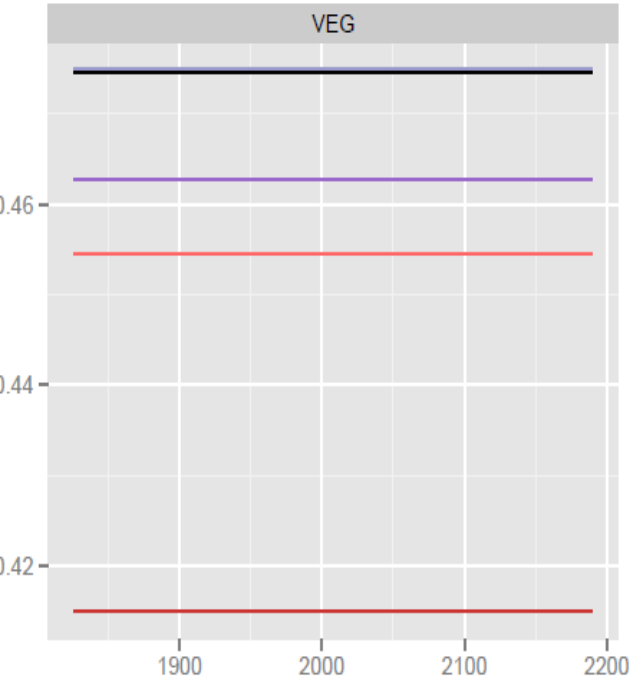
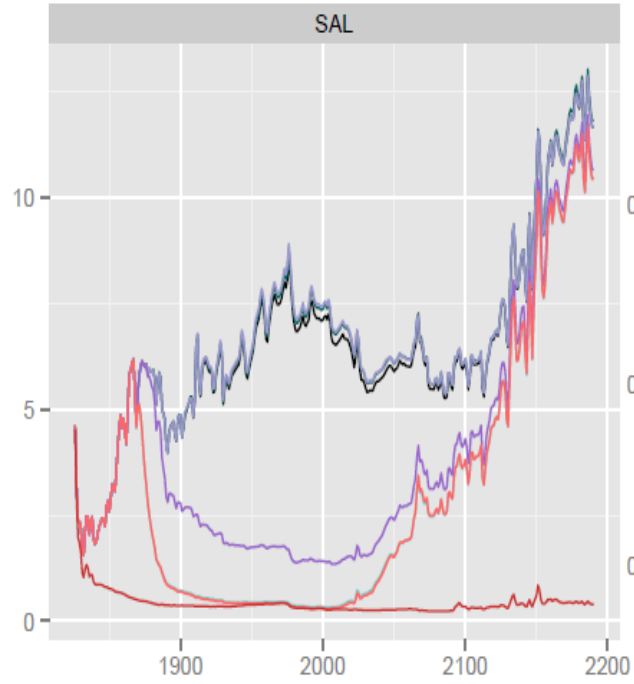
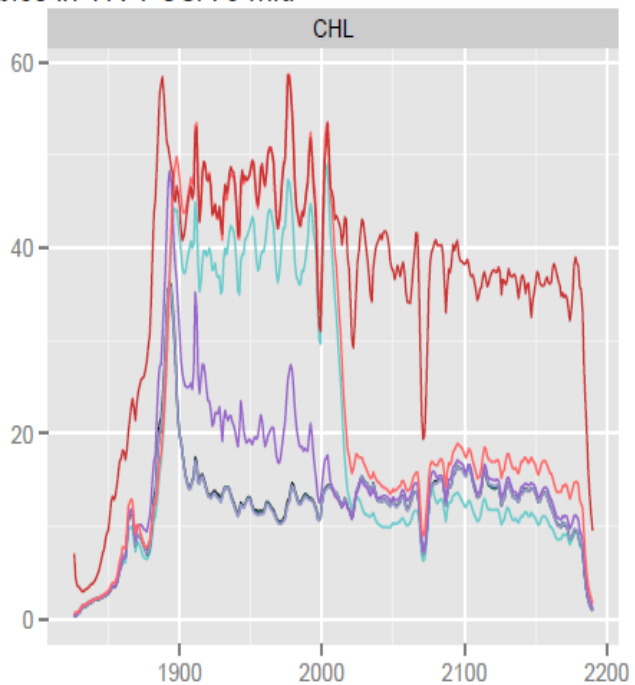
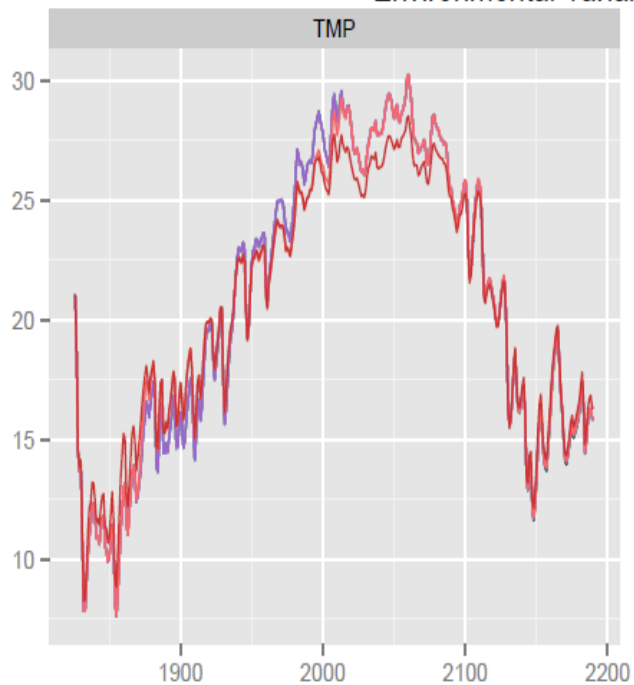


*** Supporting results for evaluating CSA 3 for lower biomasses in PR1 & PR 6

Relative Response (%) in Brown Shrimp Biomass from TY 0
In Barataria Basin

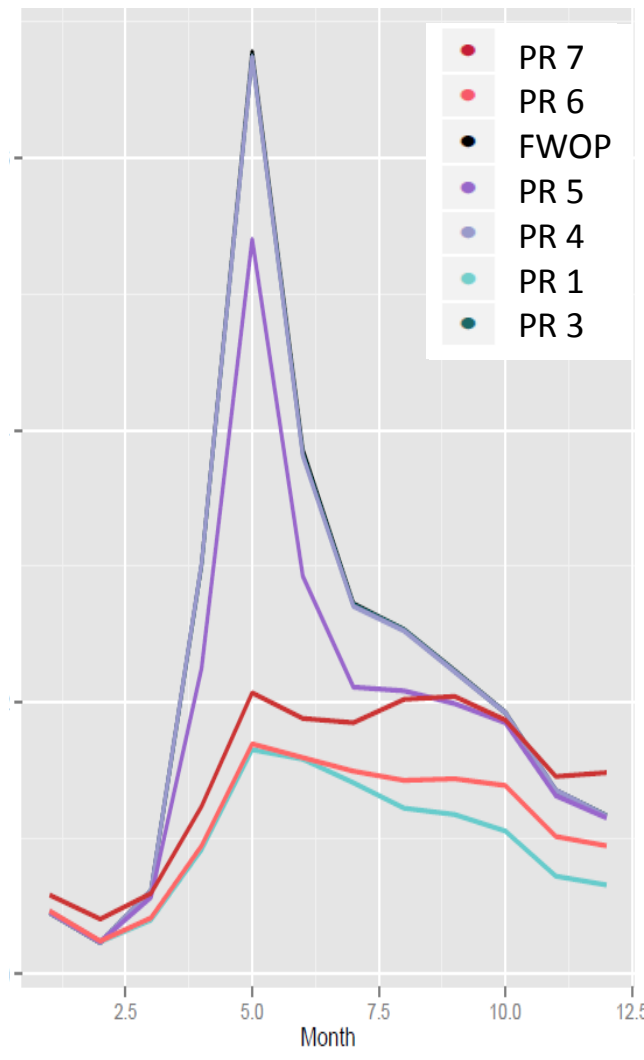


Environmental Variables in YR 1 CSA 3 mid

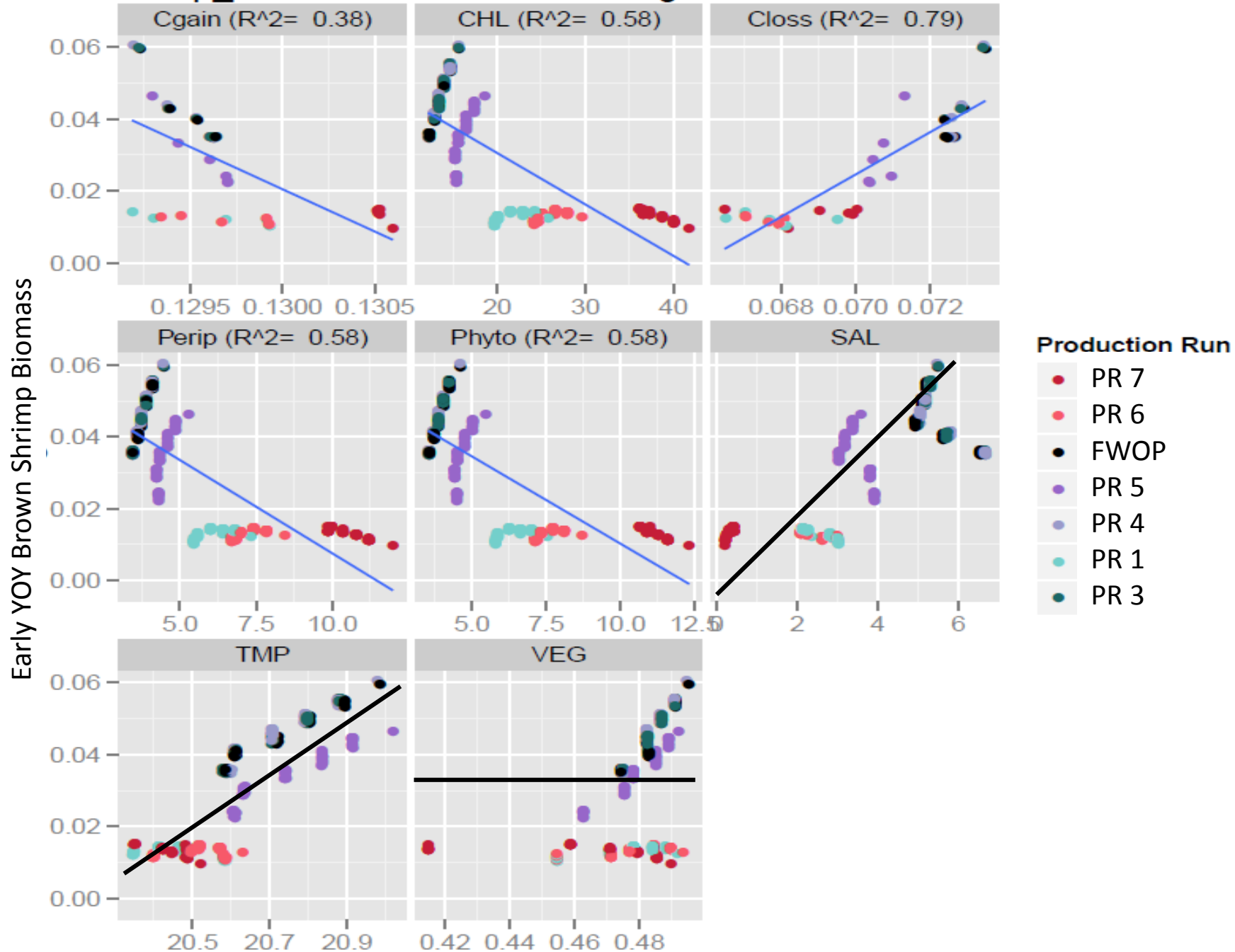


Day of Simulation

Monthly Brown Shrimp Biomass in YR 1 CSA3 mid



BrShrimp_smYOY Biomass vs. driving variables in CSA 3 mid



Evaluating Species Responses to MRDM Project Scenarios

- Key species responses from initial conditions often less than +/-10%
- Responses vary by species and are complex
 - Salinity, temperature, Chl a, Vegetation:Water, food web interactions differentially effect species and life stages within basins and by diversion scenarios
- Agency scientists working with modeling teams to interpret species responses and identify information gaps