SYNERGISTIC PROJECT

Using Linked Models to Predict the Impacts of Hypoxia on Gulf Coast Fisheries under Scenarios of Watershed and River Management

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LSU

Workshop: Hypoxia effects on fish and fisheries: kick-off meeting of decision support tool development

February 6, 2016

[1]After June 1: Horn Point Lab, Univ. of Maryland Center for Environmental Science

Today

- Brief overview of NGOMEX project
- Synergistic project to the host project of this workshop
- PIs want to leverage the workshop and the results of the projects through coordination and collaboration
  - Same questions
  - Complementary approaches
  - Shared scenarios
  - Similar format of advice to management

Does hypoxia have population level effects on coastal fish?

- Much evidence for hypoxia effects on individuals
- Less conclusive evidence for population-level effects
- Multiple stressors, high variability, and density-dependence make detection difficult
- Need for population studies that quantify exposure and separate hypoxia effects from other stressors

Rose et. al. 2009. “Musings from the virtual world”. J Exp Mar Biol Ecol

People

People	Role	Responsibilities	Tasks
Justic	Co-PI	Program coordination; FVCOM and WASP	4,5,12,14
Rose	Project PI	Program coordination; population models; communication	7,8,9,14
Craig	Application PI	Management Committee; communication; population models	10,14
Huang	Co-PI	Coupling of FVCOM and population models	6,15
Tian	Co-PI	DLEM; land-use scenarios; future scenarios	1,2,16
Meselhe	Co-PI	Delft3D; estuarine fluxes; diversion scenarios	1,2,3
Xue	Co-PI	Model linkages; high performance computing	11,13

Guiding Questions

- ***How do nutrient loadings and diversion operations affect hypoxia?***

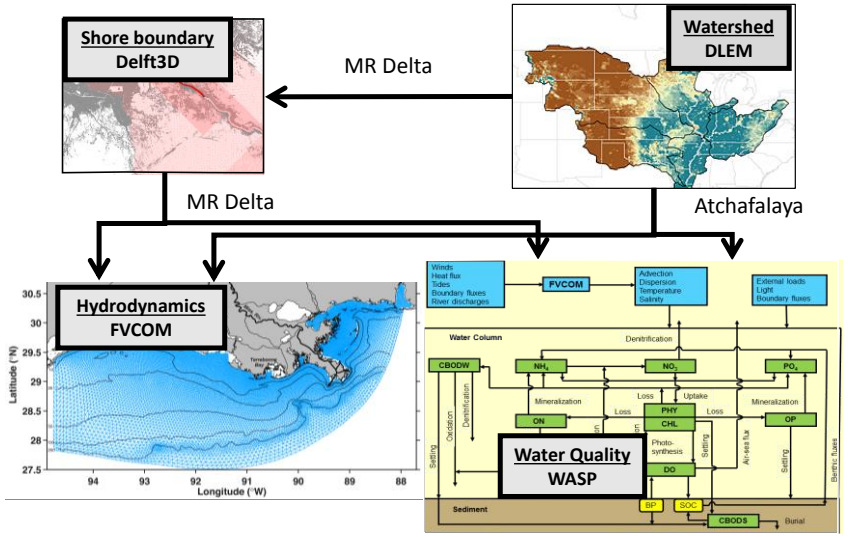
- ***What are defensible estimates of the population-level abundance changes in response to watershed management and diversion operations effects on hypoxia and food?***

- ***What is the sensitivity of predicted responses under interannual variation and under possible future conditions?***

Guiding Questions

- ***What are the relative contributions of reduced nutrient loadings (food), diversions, and hypoxia to the overall fish and shrimp population level responses?***

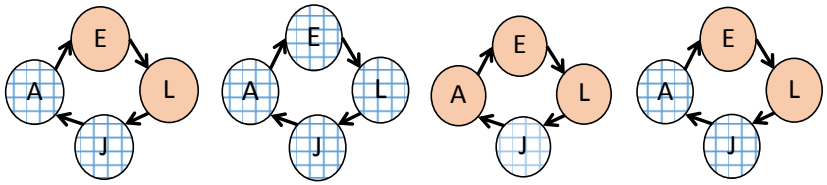
- ***What are some possible watershed management scenarios that feasibly lead to the hypoxia reductions deemed desirable based on the simulated population responses?***



IBM in FVCOM for Exposed Stages

Exposure-Effects

Off-grid for stages not exposed



Croaker | Menhaden | Red snapper | Shrimp

Management Committee

Managers' Workshop

Scenarios and Cross-Species Comparisons

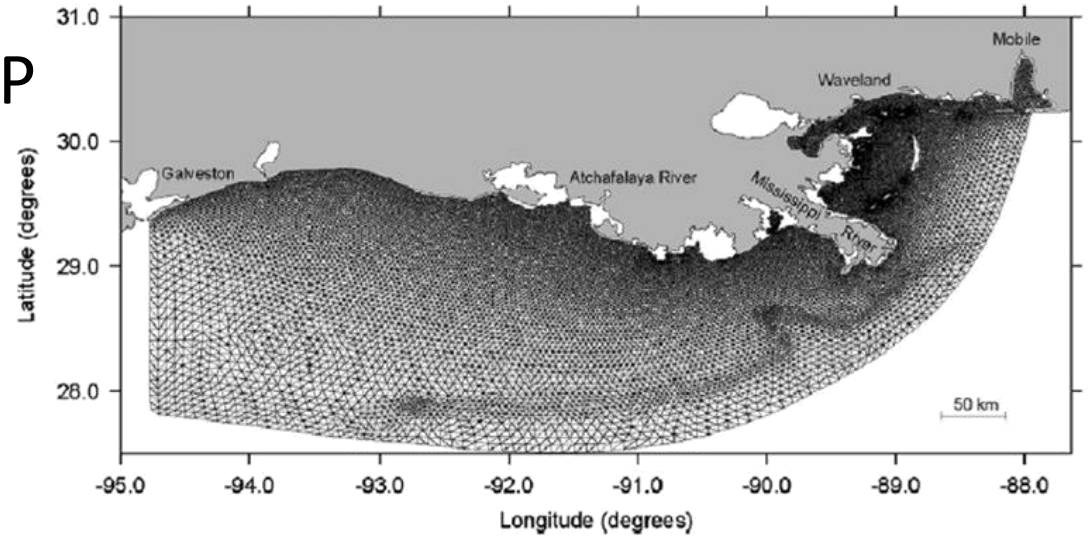
Communication of Results to Management

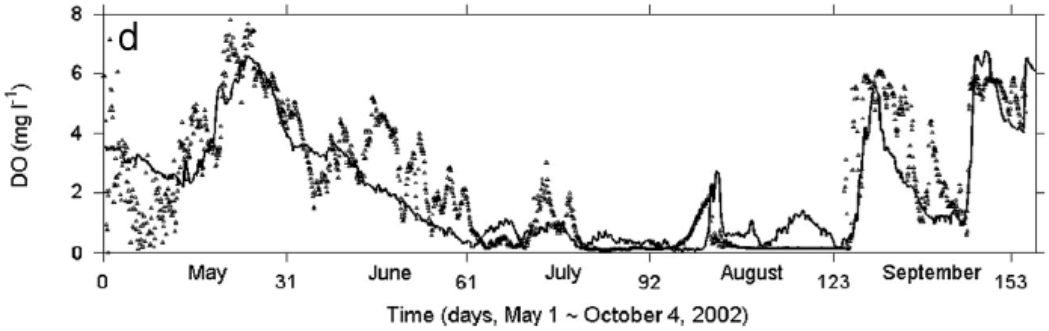
Application PI

Dissolved Oxygen

- 3-D FVCOM/WASP

- Calibrated and assessed using multiple independent data sources for 2002





Justic and Wang. 2014. Continental Shelf Research

Example from Prior Project

- Previously, we simulated hypoxia effects on croaker at the population level
- We used separate 2-D grid with input data from multiple sources (FVCOM, climatological, ROMS)
- Now, we will use consistent, seamless inputs by simulating fish in 3-D within the FVCOM grid
  - Watershed management
  - Diversions
- Expand to shrimp, menhaden, and red snapper
- Example of what results will look like

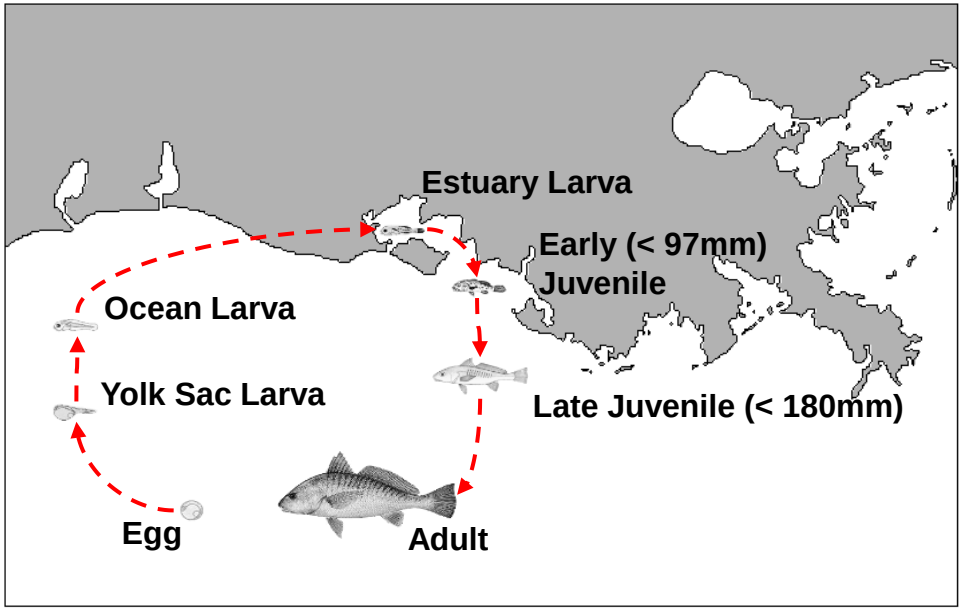
Modeling Strategy

- Individual-based population model
- Exposure determined by movement
- Effects determined by lab experiments and field data applied to growth, mortality, and reproduction
- Strategy:
  - Build-up with a solid and credible empirical basis
  - Ability to keep things constant
  - No explicit food web interactions

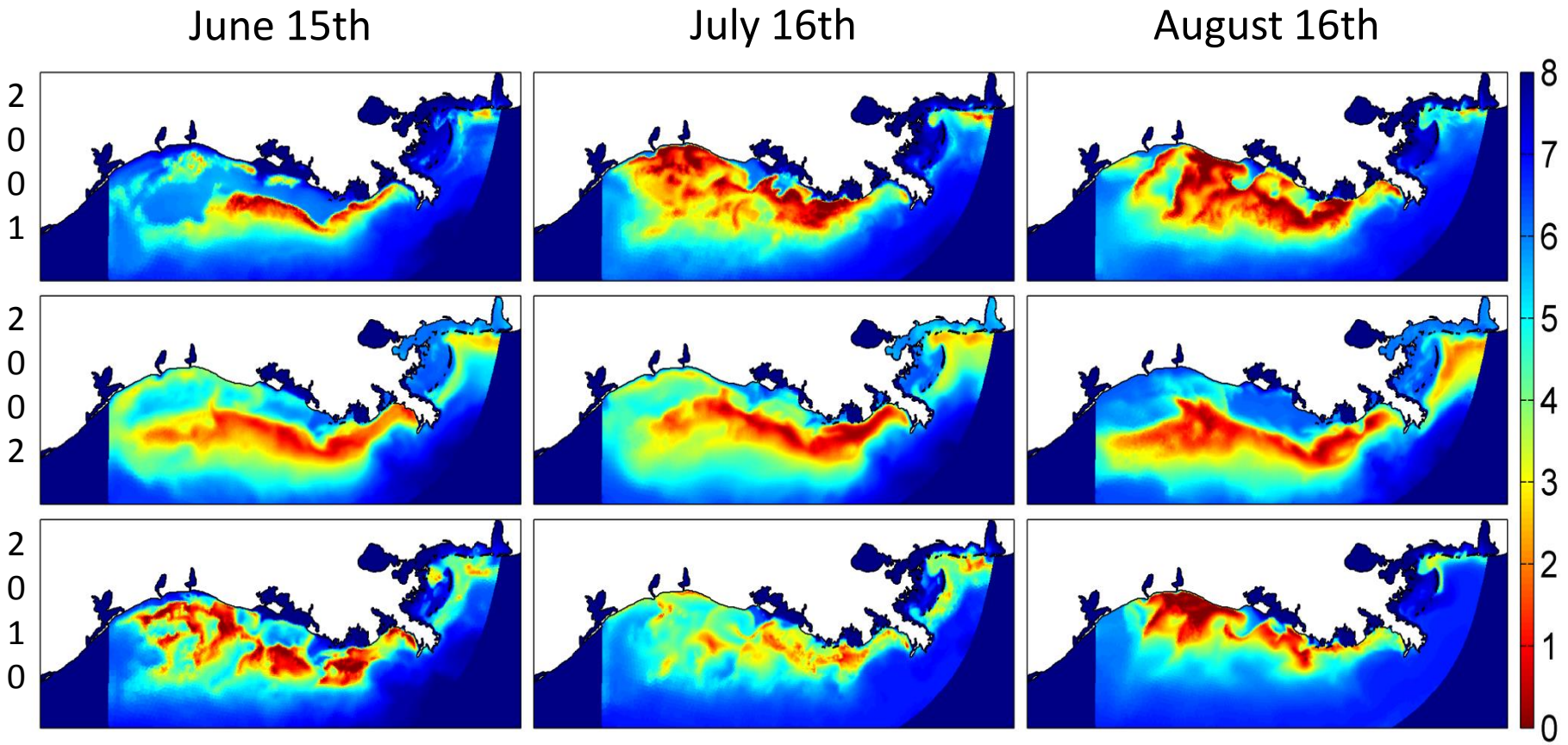
Model Overview

- Spatially explicit, IBM
  - Follows 7 stages to age 8
  - September 1 birthday
  - Model year begins Sept. 1
  - Each year 365 days long

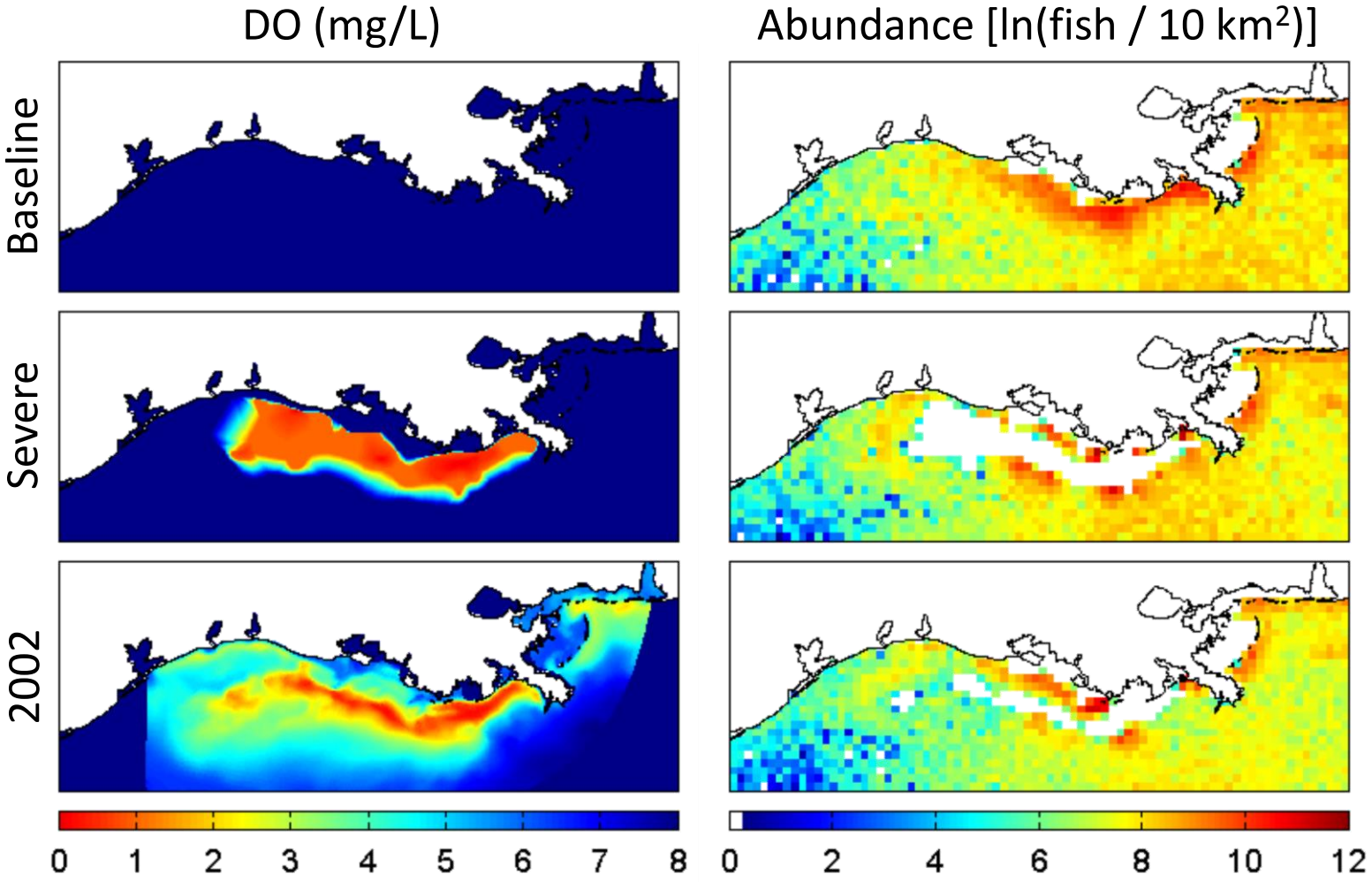
- Hourly processes
  - Growth
  - Mortality
  - Reproduction
  - Movement



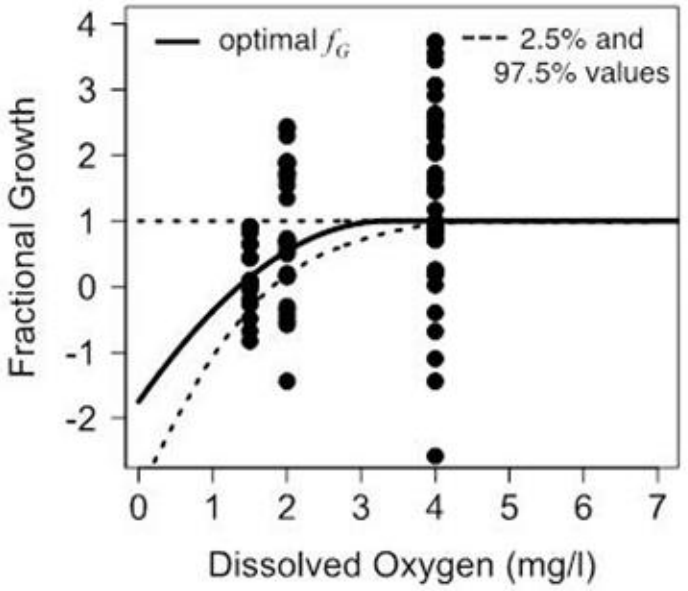
Dissolved Oxygen

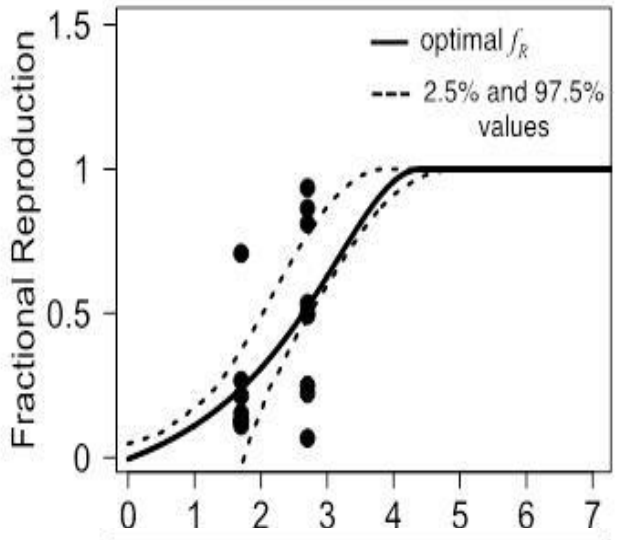


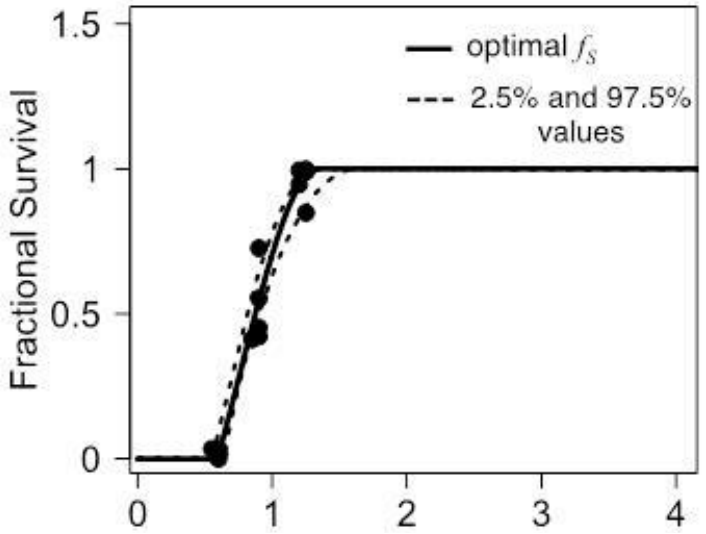
Avoidance
(July 16th)



DO Effects


optimal f_G
2.5% and 97.5% values
Fractional Growth
Dissolved Oxygen (mg/l)

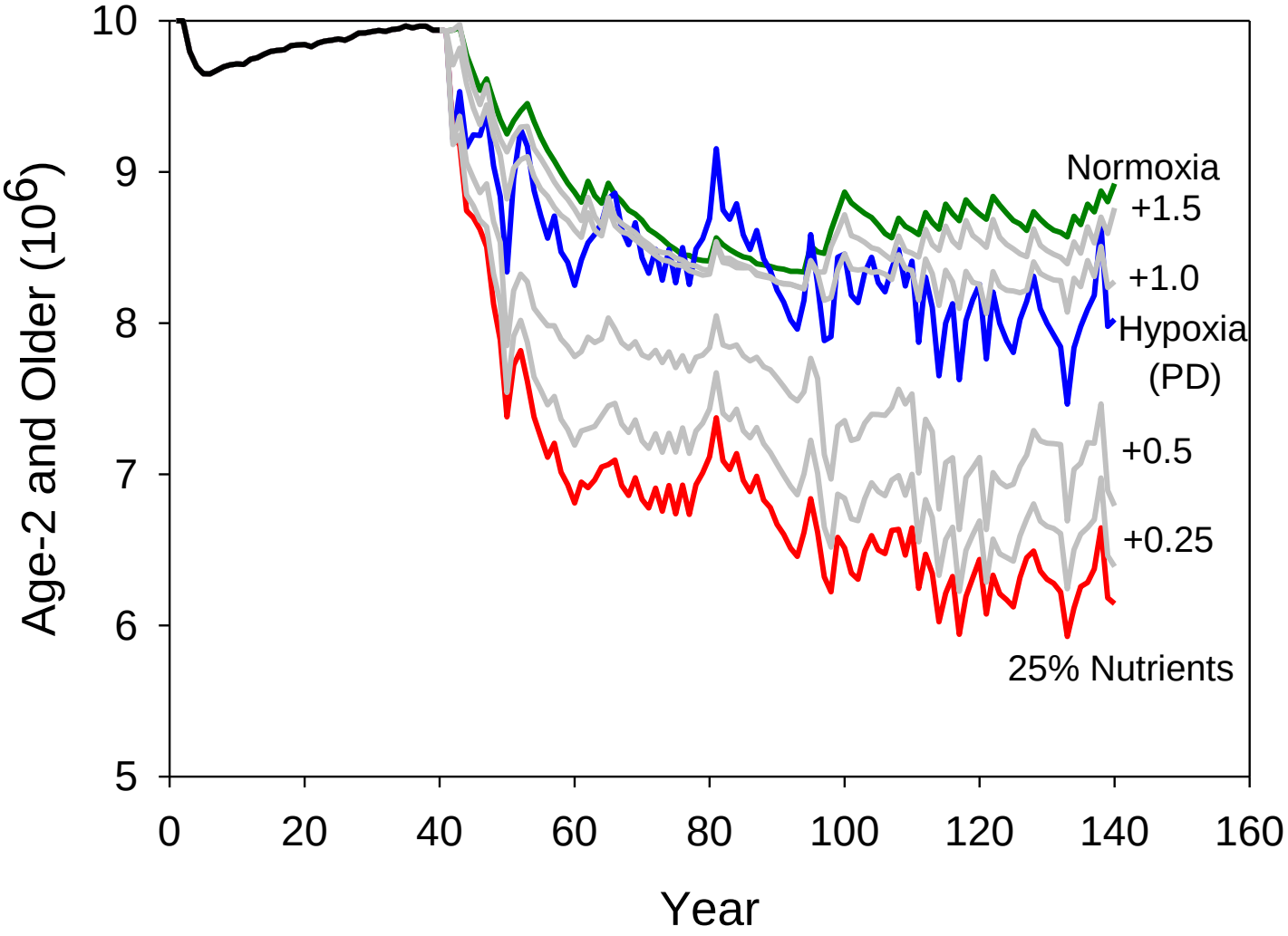

optimal f_R
2.5% and 97.5% values
Fractional Reproduction

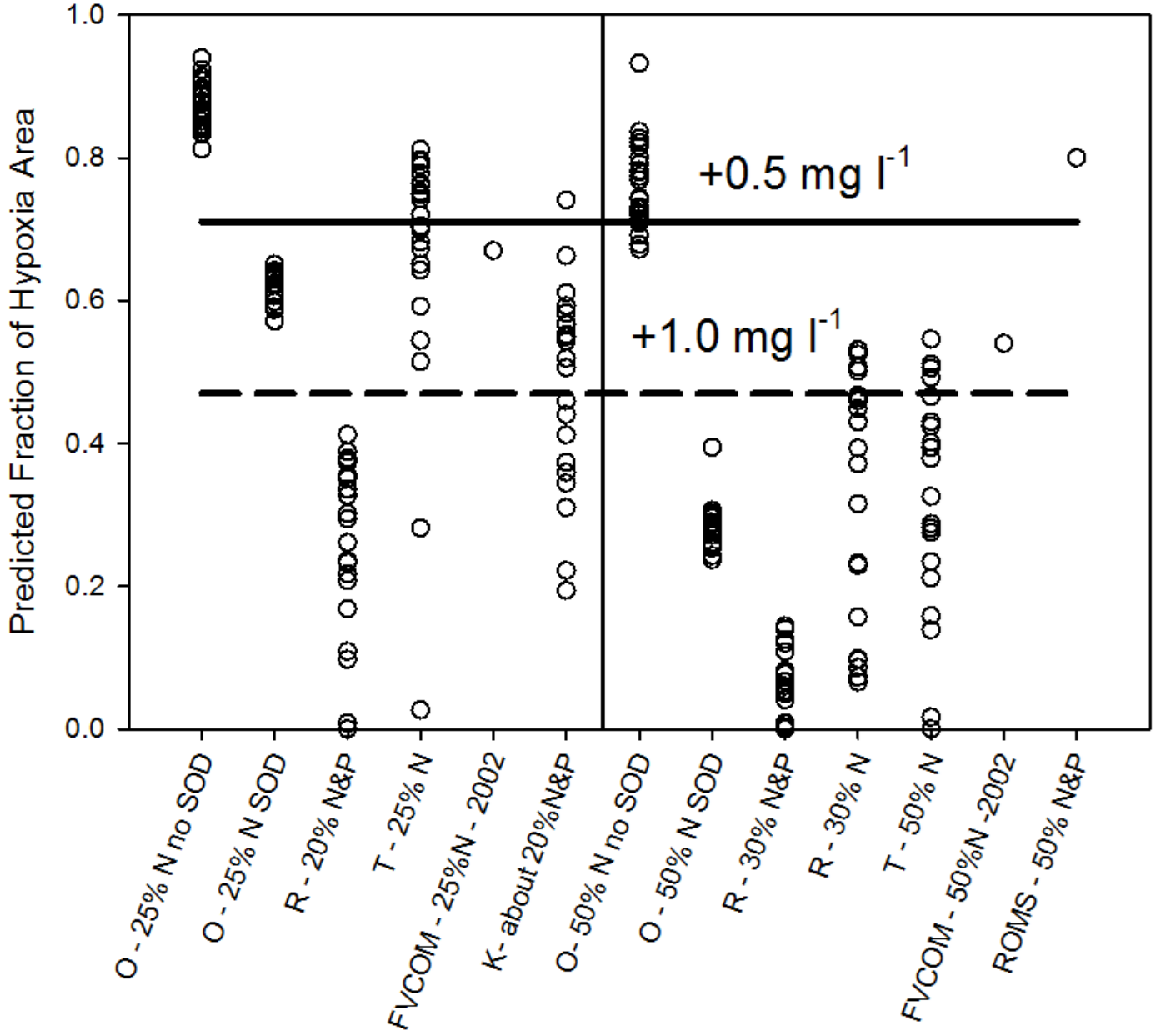

optimal f_S
2.5% and 97.5% values
Fractional Survival

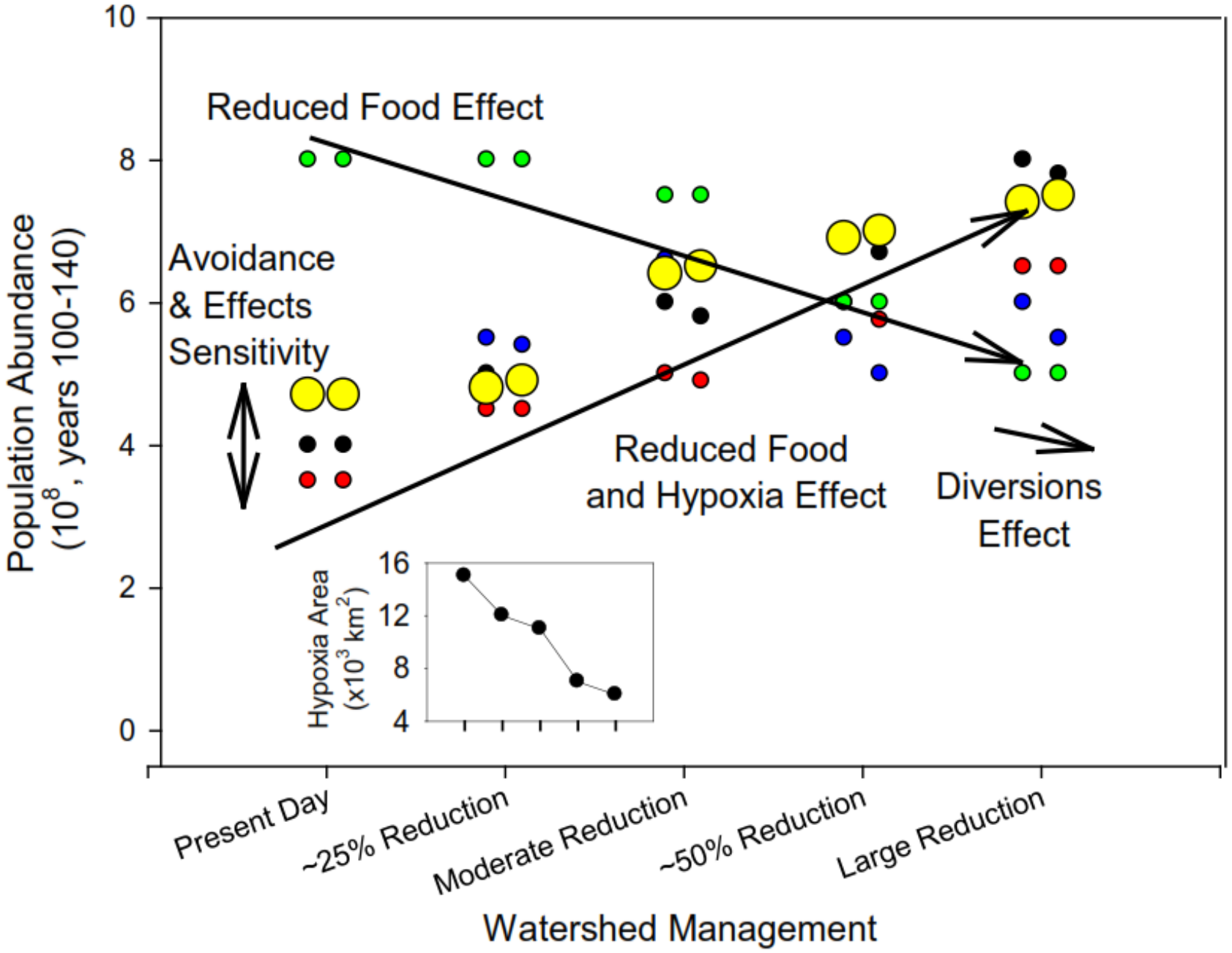
25% Reduction in Nutrients

PD: benefit if only croaker = +0.5 mg/L (↓25% area) feasible

Normoxia: best can be expected = +1.0 (↓50% area) not feasible




Predicted Fraction of Hypoxia Area
1.0
0.8
0.6
0.4
0.2
0.0
+0.5 mg l-1
+1.0 mg l-1
O - 25% N no SOD
O - 25% N SOD
R - 20% N&P
T - 25% N
FVCOM - 25%N - 2002
K- about 20%N&P
O- 50% N no SOD
O - 50% N SOD
R - 30% N&P
R - 30% N
T - 50% N
FVCOM - 50%N -2002
ROMS - 50% N&P


Reduced Food Effect
Avoidance
& Effects
Sensitivity
Reduced Food
and Hypoxia Effect
Diversions
Effect
Hypoxia Area
(x10^3 km^2)
16
12
8
4
10
8
6
4
2
0
Population Abundance
(10^8, years 100-140)
Present Day
~25% Reduction
Moderate Reduction
~50% Reduction
Large Reduction
Watershed Management

Informing Management

- Management Help Committee
  - Julie Anderson (Sea Grant); Doug Daigle (Task Force); John Lehrter (EPA); CPRA; Rex Caffey (economist)

- Application PI
  - Kevin Craig - NOAA