

# State Ecological Forecasting in the Ocean Environment

NC  
SC  
GA  
FL

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**NOAA says:**

Ecological Forecasts predict likely changes in ecosystems and ecosystem components in response to environmental drivers and resulting impacts to people, economies, and communities that depend on ecosystem services.

**States say:**

“We do not necessarily think of the things we do as Ecological Forecasting but we are very interested in trying to explain the patterns we see and how we might then predict them in the future”.



ARE WE THAT FAR APART ???

States identify issues (event recognition)...

then respond (study)...

identify drivers...

then introduce programs to monitor, assess, and remediate.

Ecological Forecasting could be the next step to these processes ...

... but for the most part, the States are not there yet, **ESPECIALLY IN THE OCEAN ENVIRONMENT.**



Why are the States, for the most part, not there yet?

We're talking about the oceans here – The ocean environment, as important as we all recognize it to be, has not been the standard operating area or management focus area for the states, except for Fisheries that are operating under a regional management structure existing for half a century or more.

## Other Reasons ???

\$\$\$\$'s

But ---

Recent Federal pushes, especially towards Marine Planning, with funding and commensurate prioritization, the onset of ocean issues awareness including energy interests and sand for nourishment/beneficial use, are bringing the ocean world off our coasts to the attention of state managers and their programs.



## State Ecological Forecasting in the Ocean Environment - 4 Topic Areas Assessed:

- Harmful Algal Blooms (HAB's)

- Hypoxia

- Pathogens

- Habitat/Species Distribution

# NORTH CAROLINA

Per se, no ocean ecological forecasting by state.

HAB's

Hypoxia

Pathogens

Habitat/Species Distributions

## SOUTH CAROLINA

Per se, no ocean ecological forecasting by state.

**HAB's** - Not an issue in the ocean environment. State does not have a HAB Management Plan for ocean environment, but there has been discussion of developing a plan.

**Hypoxia** – History of shoreline hypoxic conditions in Long Bay. See slides.

**Pathogens** – No program in ocean environment.

**Habitat/Species Distributions** - See Fisheries slides.

# LONG BAY HYPOXIA STUDY: A COLLABORATIVE AND MULTIDISCIPLINARY APPROACH

D Sanger - South Carolina Sea Grant Consortium

E Smith, G Voulgaris - University of South Carolina

S Libes, E Koepfler, C McCoy, R Viso, R Peterson – Coastal Carolina University

D Bergquist, D Greenfield, D Whitaker, G Riekerk, D Cain, K Reynolds – SC Department of Natural Resources



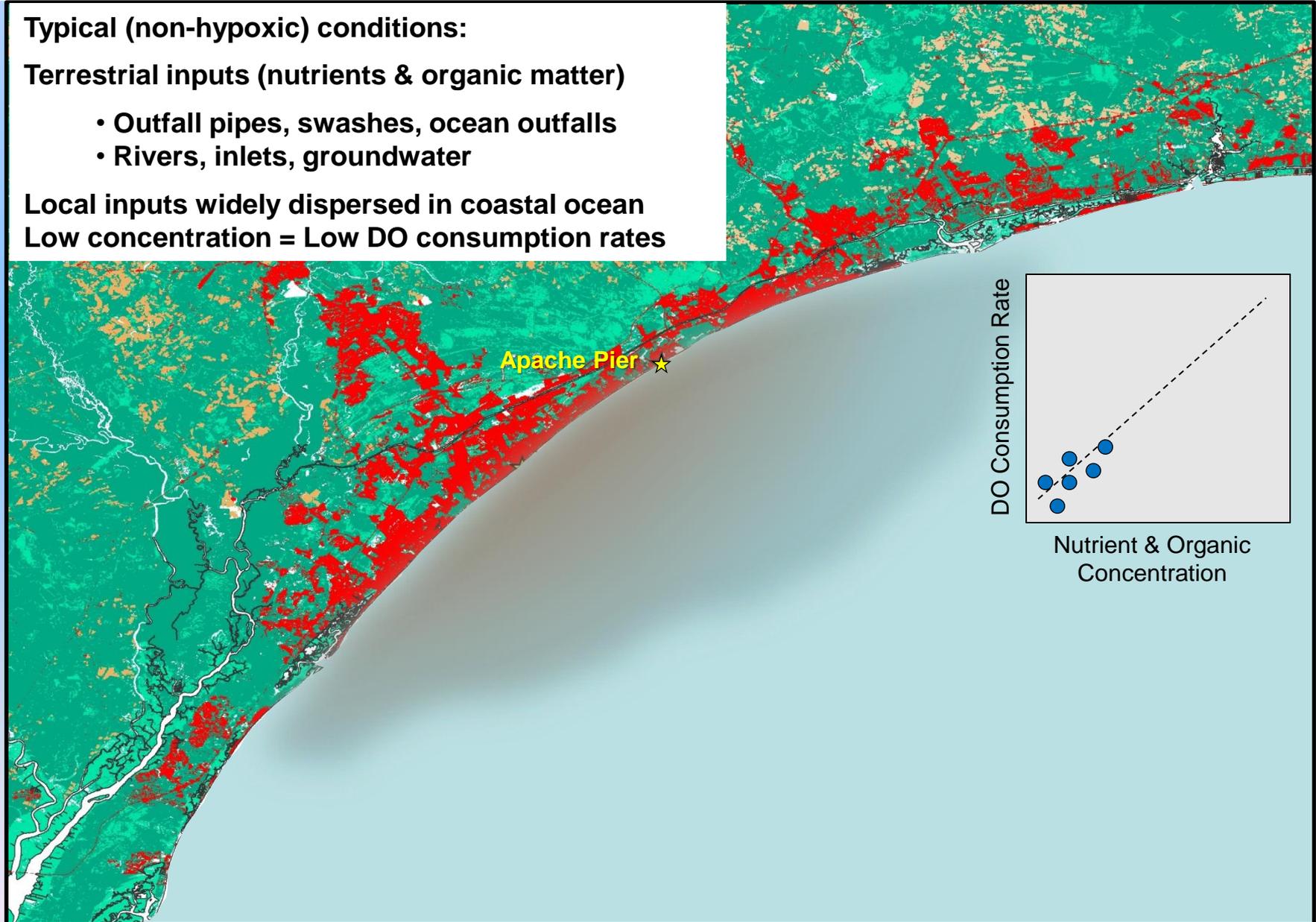
# “Constrained Enrichment” Hypothesis for Hypoxia Formation along the Grand Strand

**Typical (non-hypoxic) conditions:**

**Terrestrial inputs (nutrients & organic matter)**

- Outfall pipes, swashes, ocean outfalls
- Rivers, inlets, groundwater

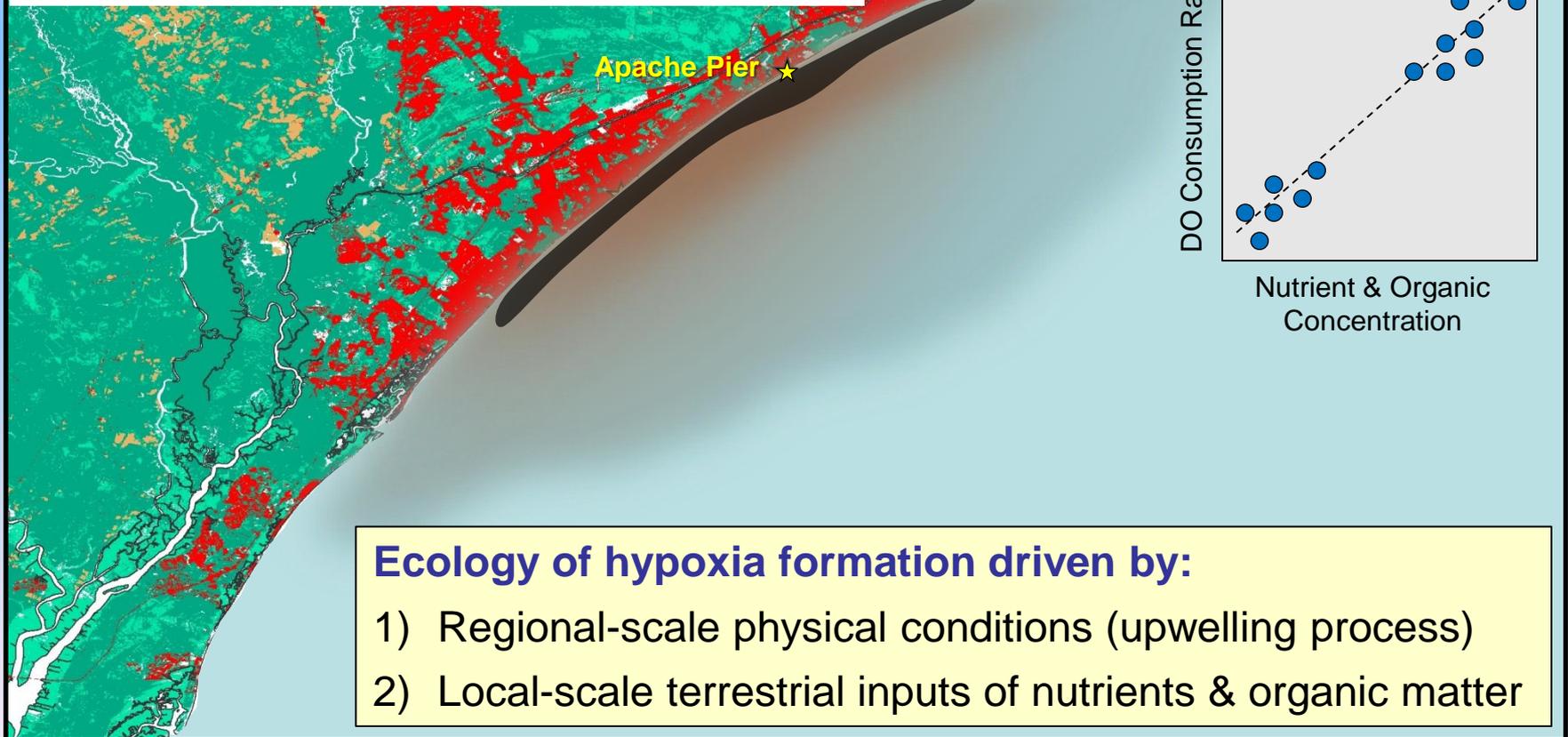
**Local inputs widely dispersed in coastal ocean  
Low concentration = Low DO consumption rates**



# “Constrained Enrichment” Hypothesis for Hypoxia Formation along the Grand Strand

## Hypoxic conditions:

- 1) SW winds cause upwelling of bottom water
- 2) Bottom water intrusion acts as a physical barrier preventing dispersion of inputs
- 3) Inputs concentrate inshore
- 4) Elevated concentrations greatly stimulate DO consumption rates leading to localized hypoxia



## Ecology of hypoxia formation driven by:

- 1) Regional-scale physical conditions (upwelling process)
- 2) Local-scale terrestrial inputs of nutrients & organic matter

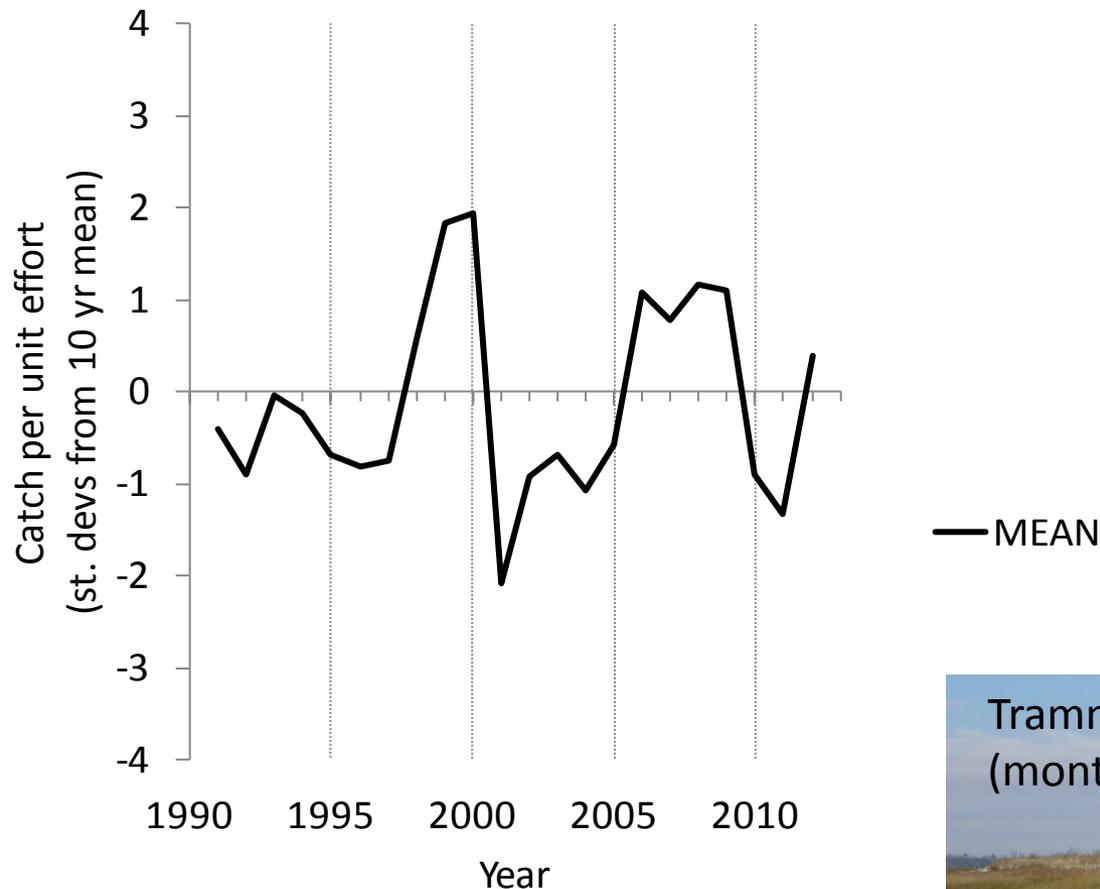
# Relationships between climate indices, water temperature and estuarine fish populations in South Carolina.



Stephen A. Arnott  
David Whitaker

Marine Resources Research Institute  
South Carolina Department of Natural Resources

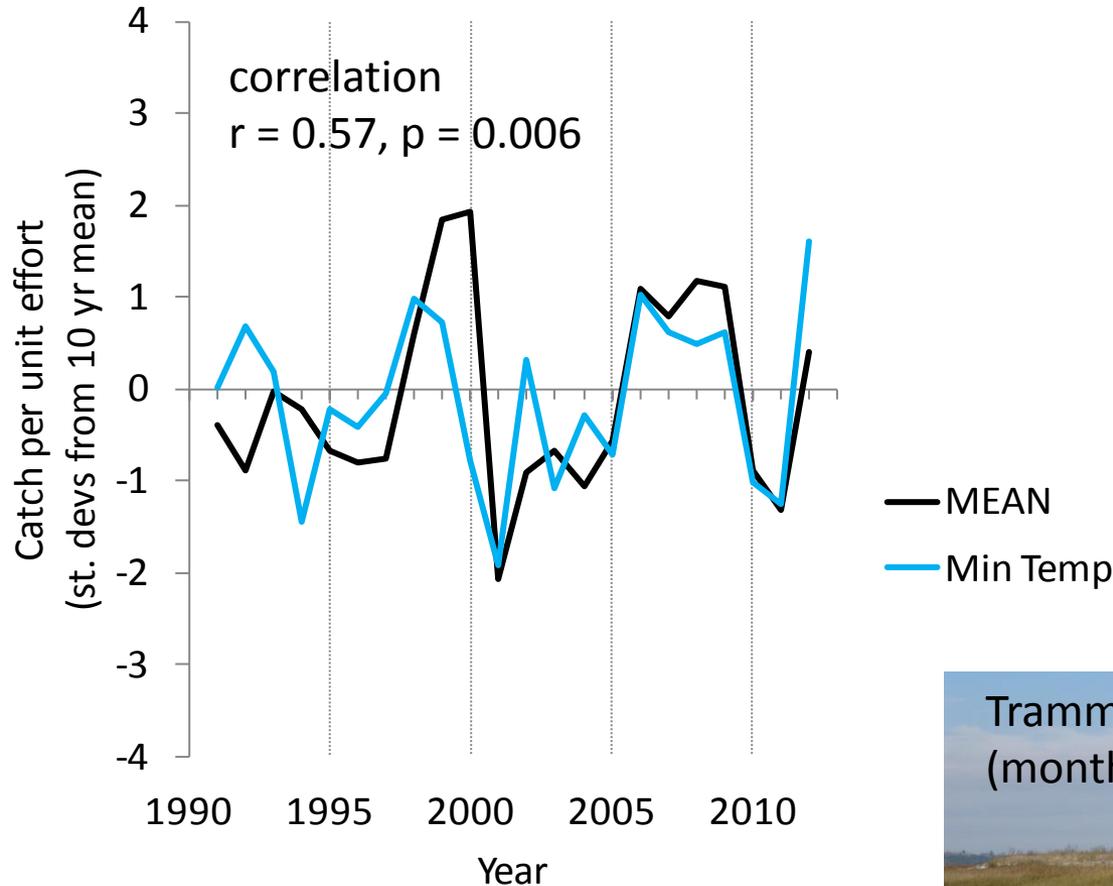
# Statewide index of abundance for spotted seatrout in SC



Spotted seatrout  
*Cynoscion nebulosus*



# Relationship between minimum water temperature and spotted seatrout abundance

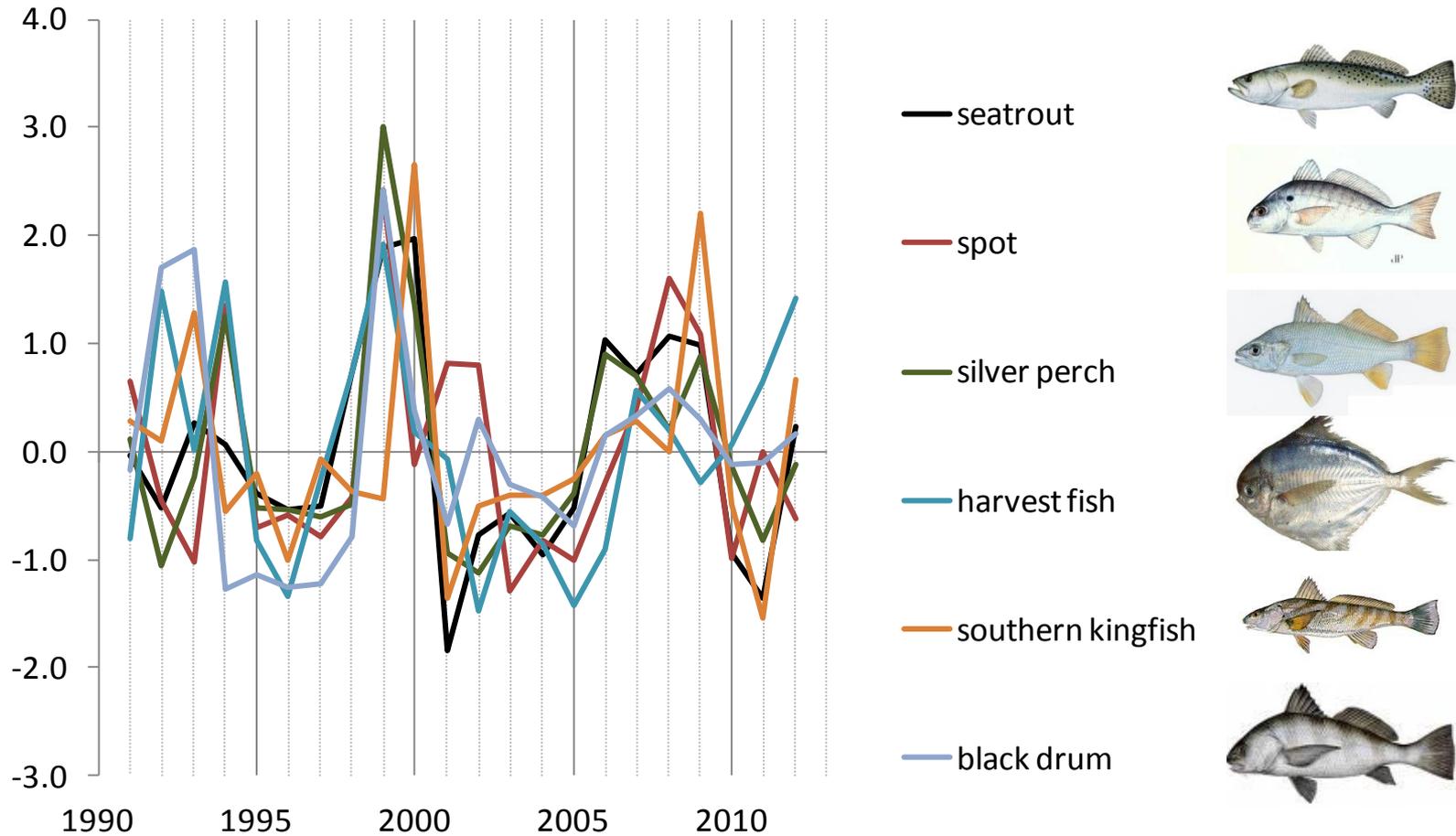


Spotted seatrout  
*Cynoscion nebulosus*

Trammel net survey  
(monthly, 1991 – present)



# Relationship between minimum water temperature and other fish populations





# Conclusions

- Charleston Harbor water temperatures have changed significantly since 1950
- General increase in temperatures, with spring arriving earlier and fall arriving later
- Much of the temperature variation is linked with large-scale, climatic-related indices (AMO, AO, ENSO)
- Winter is the most variable season
- **Winter temperature variation is associated with significant ecosystem-wide effects**
- Future work: identify proximate causes of winter effects

# GEORGIA

Per se, no ocean ecological forecasting by state.

**HAB's** – “Coastal GA HAB Response Plan; A Public Health and Natural Resource Response”. In place, never used, as we have had no bloom, no reports, no marine mammal casualties, no large fish kills, no human complaints – that are attributable to HAB's.

**Hypoxia** – No program, not known to be a problem.

**Pathogens** – DNR conducts EPA funded beach WQ monitoring program. Infrequent advisories occur on ocean beaches. No forecasting conducted.

**Habitat/Species Distributions** – Work is not Ecological Forecasting, but is conducted on a yearly time frame basis. The DNR Marine Fisheries ...

## GEORGIA, continued

... Section has interest in offshore wind and current conditions as they are linked with the distribution of larvae and eggs (= larval recruitment) and stream input (freshwater volume, flow, timing). These variables affect year class.

## FLORIDA

!!!! YES, there is ocean ecological forecasting by State !!! But, not for the Atlantic side.

**HAB's** – FL does forecasting for the red tide organism, *K. brevis*, on the southwest FL Gulf Coast. FL does not forecast for the east coast as it is rarely transported to the east coast. If a bloom is identified, FL FWC works with USF's College of Marine Science to forecast the paths of the bloom. FL will be working to incorporate satellite imagery into the ID and forecast program.

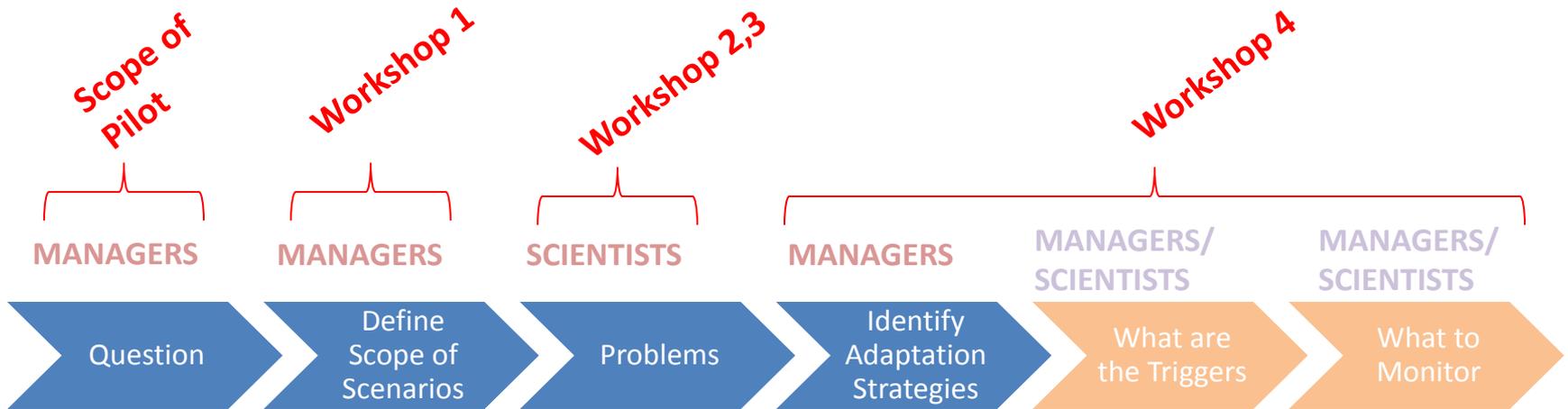
**Hypoxia** – There is perceived potential for hypoxic conditions in the South Atlantic Bight. The St. Johns Management District is interested because hydrodynamic modeling suggests it may be contributing to episodic St. Johns River hypoxia. FL does have hypoxic conditions in inshore estuarine waters but not known if contributes to lower oceanic DO. There is no statewide program of ecological forecasting for hypoxia in FL estuaries.

## FLORIDA - continued

**Pathogens** – Ecological Forecasting for Pathogens would fall within FL's Building Resilience Against Climatic Effects Program (BRACE) within the FL Department of Health. Not yet doing the forecasts and is now debating time scale (seasonal vs. longer term) to be considered.

**Habitat/Species Distributions** – FL Keys Marine Adaptation Planning (KeysMAP). KeysMAP is a spatial scenario planning project to model effects of changes in water temperatures, socioeconomics, demographics, and sea level rise on critical habitats and sentinel species. See slides.

# KeysMAP - Framing the Process



# Marine Scenario Planning



- Alternative Futures Under Climate Change for the Florida Key's Benthic and Coral Systems

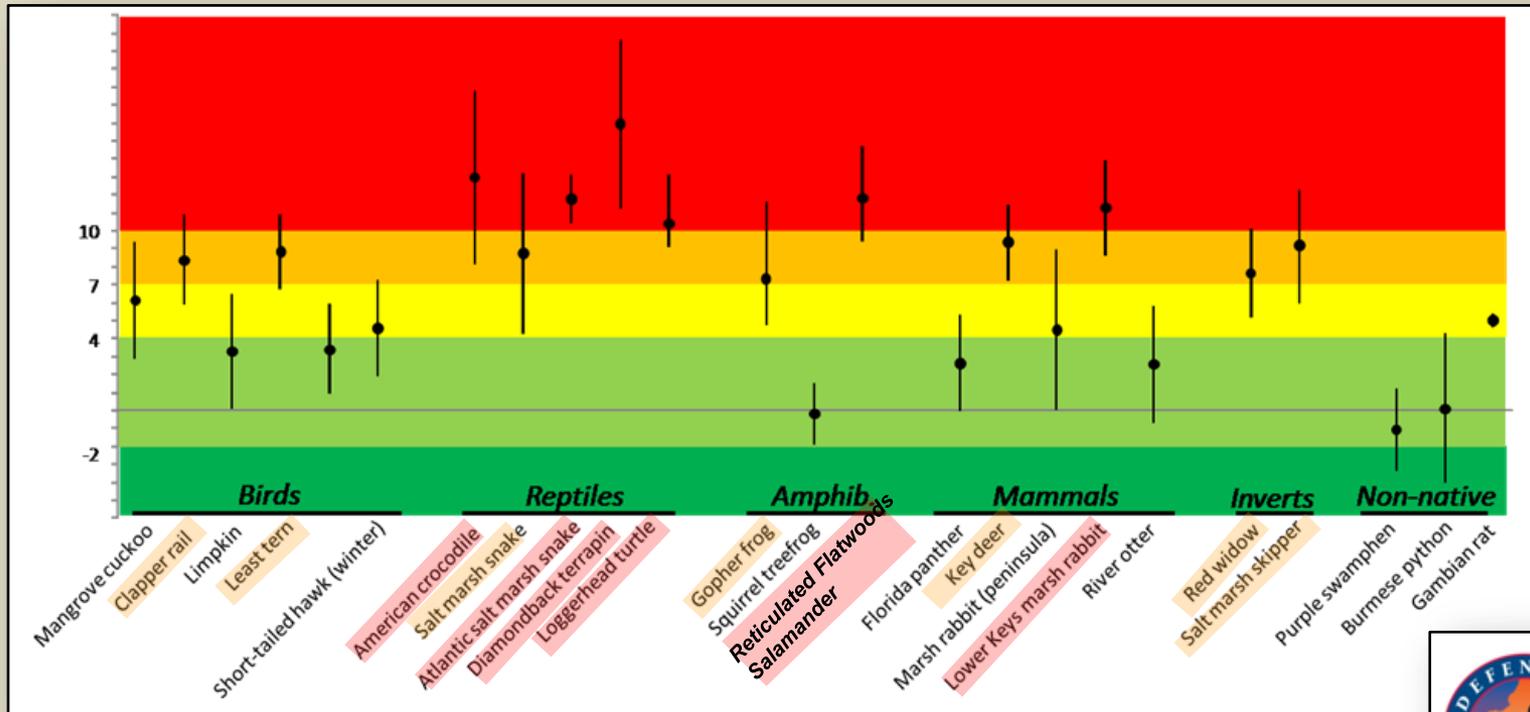
- Species

- Goliath Grouper
- Loggerhead Turtle
- Spiny Lobster

- Habitat

- Mangroves
- Beaches
- Corals

# Index Scores - CCVI

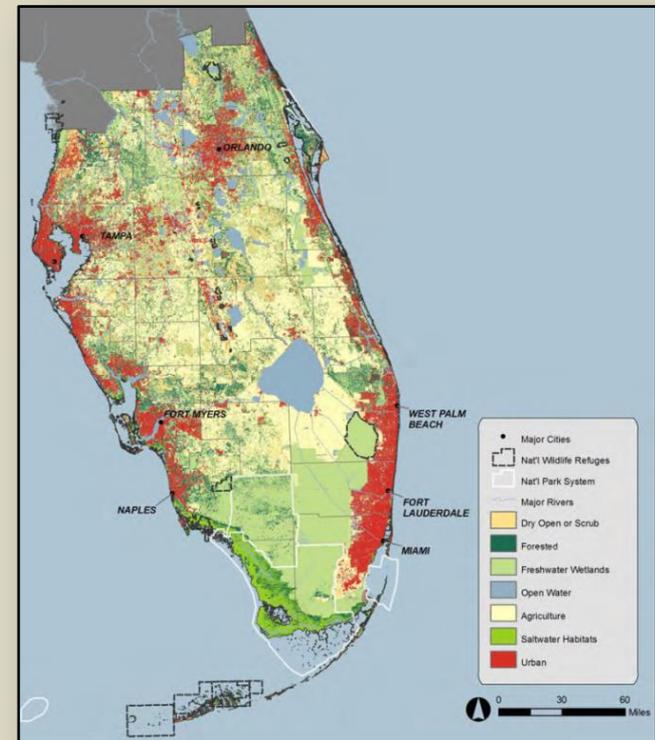


- Extremely Vulnerable
- Highly Vulnerable
- Moderately Vulnerable
- Not Vulnerable/Presumed Stable
- Not Vulnerable/Increase Likely

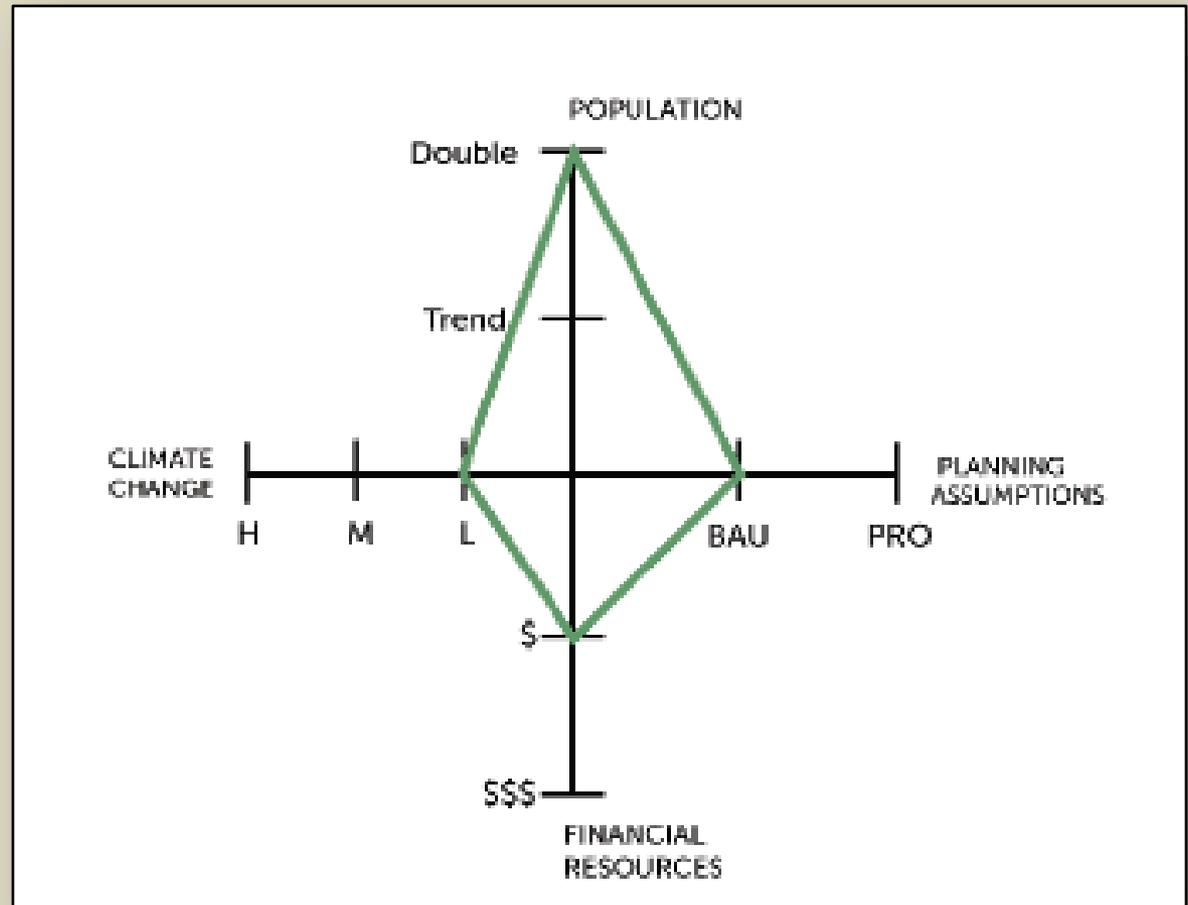


# Alternative Futures/Scenario Planning

- Scenarios varied across 4 dimensions:
  - Climate change
  - Human population change
  - Land & water planning policies
  - Availability of public resources
- 50 years into the future
  - 2010, 2040, and 2060



# Scenario Dimensions





QUESTIONS ??