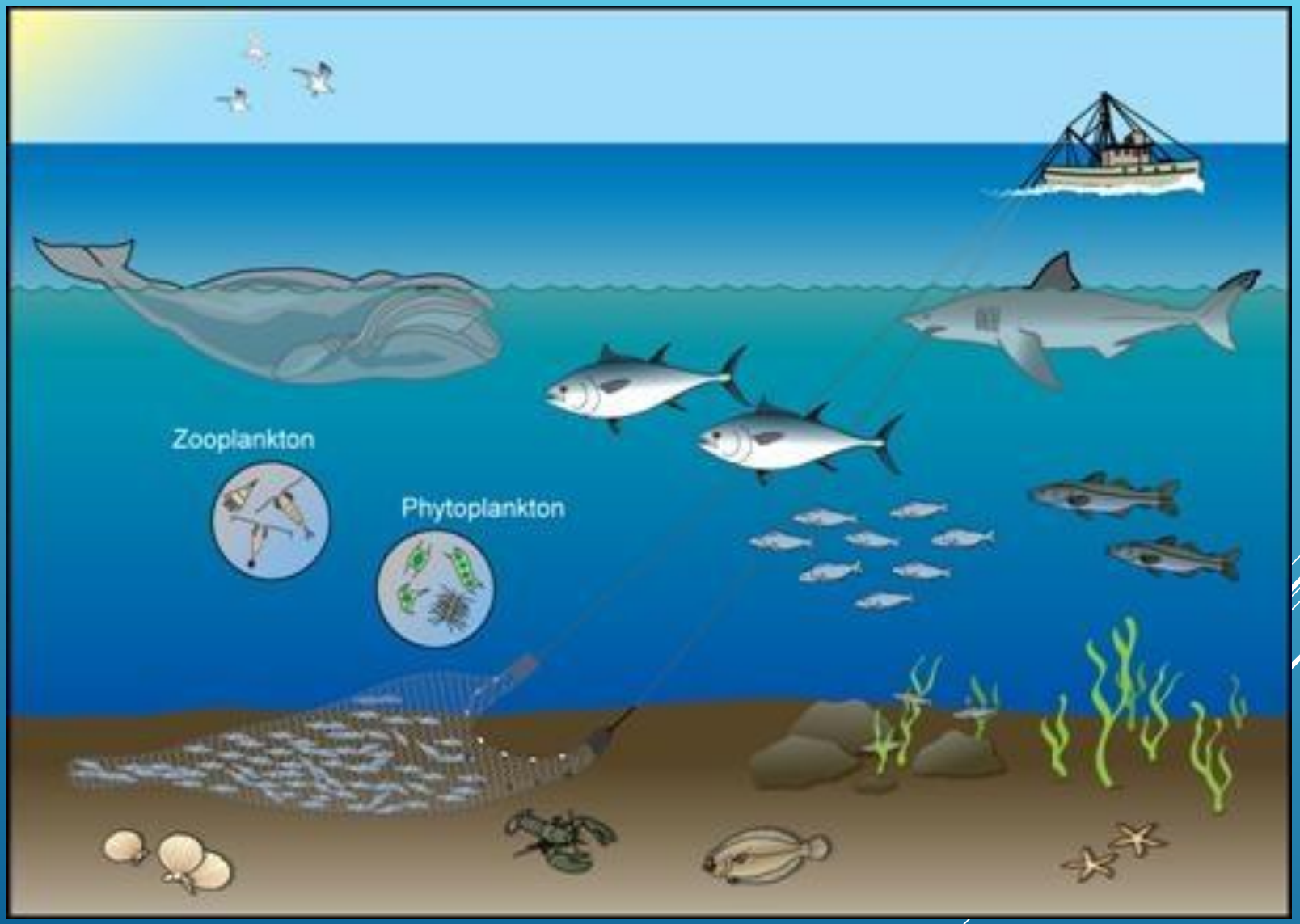
THE SOUTH ATLANTIC REGION ECOPATH MODEL

Refined model completion and coordination with SAFMC SSC

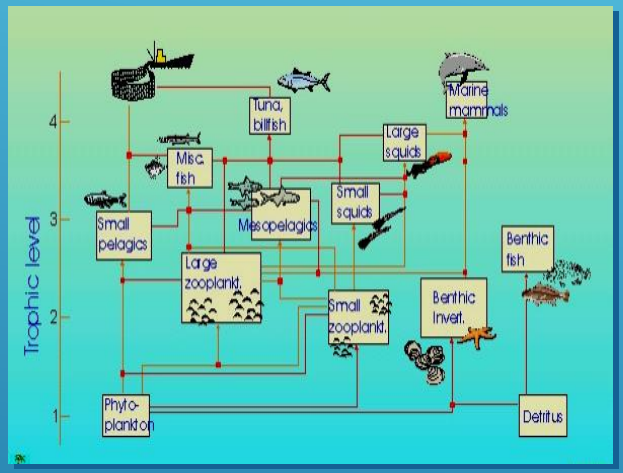
Tom Okey, Ocean Integrity Research and the University of Victoria
Roger Pugliese, South Atlantic Fishery Management Council
Howard Townsend, NOAA/NMFS/ST/Ecosystems

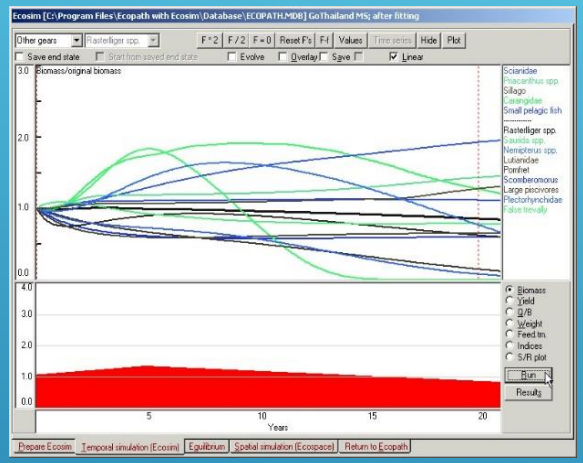
Habitat Protection and Ecosystem-Based Management Advisory Panel
8 November 2018

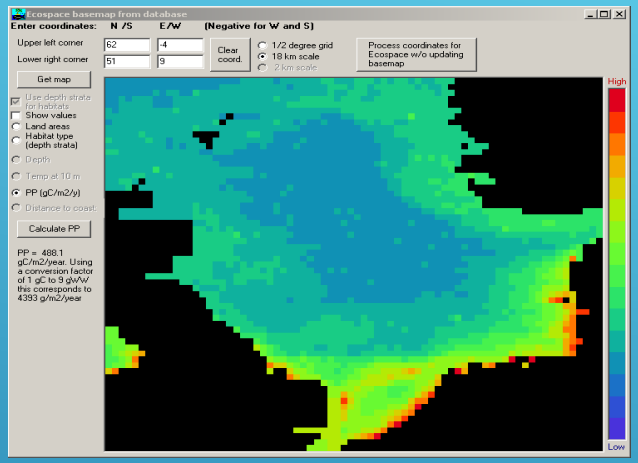
FISHERY-ECOSYSTEM MODEL



ECOPATH / ECOSIM / ECOSPACE

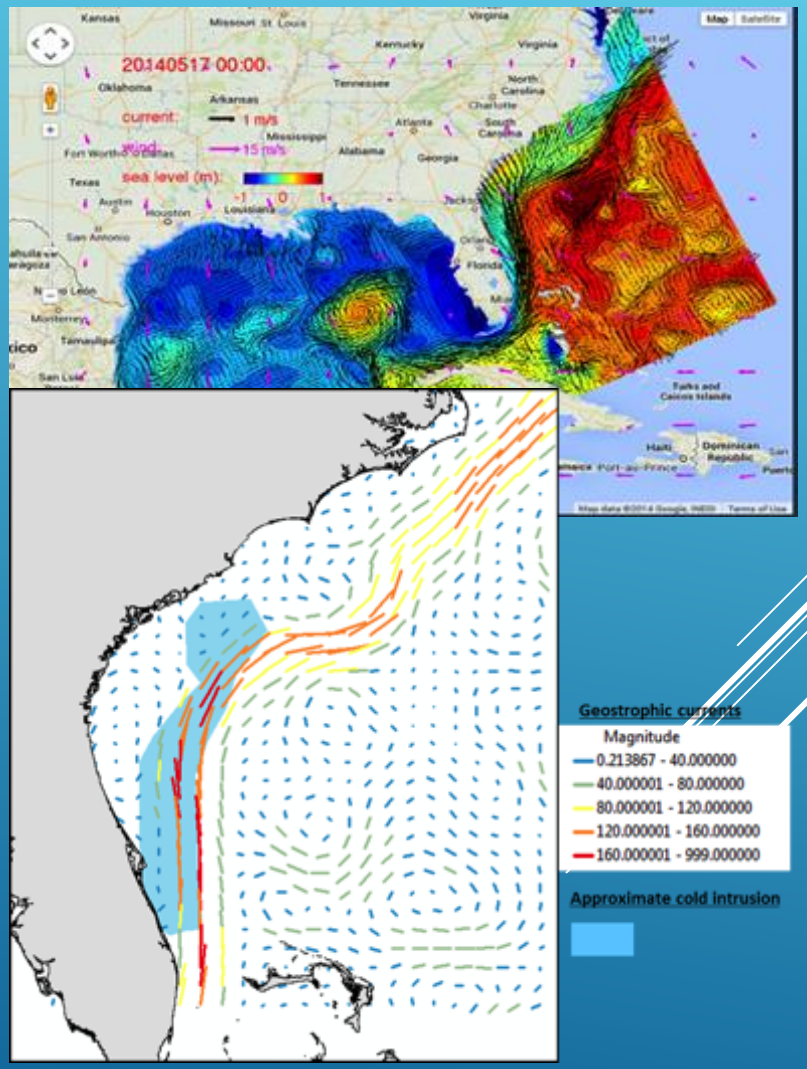






THE UPDATED ECOPATH MODEL WILL:

- **Support the SA Fishery Management Council's move to ecosystem-based management**
- **Advance and refine the LCC conservation blueprint**
- Link to hydrodynamic oceanographic models and satellite data
- Provide more realistic predictions about spatial policy options
- Estimate impacts of episodic events that are limited in space (oil spills, red tides, upwelling)
- Meet the immediate needs of the SSC and the South Atlantic Council



HISTORY OF THE SAB MODEL

- 2001 - Strawman 48-group model constructed
- 2004 - Preliminary 98-group model developed
- 2014 - Model refined to address forage fish questions (99 groups)
- 2018 – Model refinement to articulate managed species (141 boxes)

Preliminary SAS model

- Sponsored by SAFMC
- 42-box model
- 98-box model

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Southeastern United States, Atlantic Shelf, Page 167

A PRELIMINARY ECOPATH MODEL OF THE ATLANTIC CONTINENTAL SHELF ADJACENT TO THE SOUTHEASTERN UNITED STATES

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ABSTRACT

The biological communities of the Atlantic continental shelf adjacent to the southeastern United States are well known, but this knowledge is not integrated into a cohesive description of that region. We constructed a preliminary food web model of this area using Ecopath with Ecosim, as a way to initiate a long-term process of integrating this knowledge, learning more about the structure and resiliency of the system, and helping to guide research priorities in the future. The current model is considered to be a first iteration that can be used as a vehicle to stimulate a more rigorous refinement effort in the near future. The ecologically defined area covered by this model extends from Cape Hatteras, North Carolina to the easternmost extent of the Florida Keys, and from the intertidal zone (or the entrance of estuarine systems) to the 500 m isobath. The time period characterized by this preliminary model is the four years from 1995 to 1998.

the Gulf Stream advect the underlying nutrient rich slope waters onto the shelf (Mallin *et al.* 2000).. This region as a whole supports a diverse assemblage of marine organisms, as it is somewhat of an ecological interface, or gradient, between warm-water and cold-water species assemblages. We refer the reader to Mallin *et al.* (2000) for a general description of the ecological setting, processes, and related research. A brief overview of special habitats is presented below.

Human activities along the east coast of the southeastern United States have influenced the adjacent continental shelf ecosystem for thousands of years, as native Americans conducted some limited artisanal fisheries and modified fire regimes and the vegetation in upland watersheds (e.g., Cronon, 1983). Modifications to the ecology of the continental shelf ecosystem accelerated soon after the arrival of Europeans, who began fishing coastal waters (e.g., Mowat, 1984; Reeves *et al.*, 1999) in addition to introducing domesticated livestock, weed plants, disease, and new kinds of agriculture (e.g., Crosby, 1986).

Other profound anthropogenic modifications to this continental shelf occurred during the 20th century with the widespread use of powered fishing and whaling vessels, and coastal urbanization and industrialization. One particularly destructive type of fishing is bottom trawling, which destroys biogenic seafloor habitat in addition to simply removing fishes (Watling and Norse, 1998; Turner *et al.*, 1999).

Trawling activity is intense in this area, and little doubt remains that these activities have considerably modified the continental shelf. The

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Forage version 2014

- Sponsored by Pew Charitable Trusts
- Forage groups articulated
- 99-box model

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The University of British Columbia

Working Paper Series

Working Paper #2014 - 14

Exploring the Trophodynamic Signatures of Forage Species in the U.S. South Atlantic Bight Ecosystem to Maximize System-Wide Values

Thomas A. Okey, Andrés M. Cisneros-Montemayor, Roger Pugliese, Ussif R. Sumaila

Year: 2014

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Articulated forage groups in the 2014 99-box South Atlantic Bight *EwE* model

- Anchovies
- Atlantic menhaden
- Atlantic silverside
- Halfbeaks
- Mullets
- Sardines
- Scads
- Shad
- Thread herring
- Pelagic oceanic planktivores
- Squids
- Shrimps

Focused on predatory fish of particular value in the 99-box SAB ecosystem model

Spanish/king mackerels
Vermillion snapper
Gag grouper
Dolphinfish
Black seabass
Greater amberjack
Cobia
Red snapper

Species / Groups in the 2014 SAB 99-box model

Coastal bottlenose dolphin	Thread herring	Seabass	Estuarine infaunal crustaceans
Manatees	Shad	Wreckfish	Estuarine polychaetes
Large coastal sharks	Anchovies	Other fishes	Bivalves/Oysters
Small coastal sharks	Atlantic silverside	Sea turtles	Offshore infaunal crustaceans
Baleen whales	Halfbeaks	Carnivorous jellies	Offshore polychaetes
Pelagic sharks	Pelagic oceanic invertivores	Birds -- oceanic piscivores	Small mobile epifauna
Rays and skates	Demersal coastal invertivores	Birds -- shorebirds	Calico scallops
Dogfish sharks	Demersal coastal omnivores	Birds -- shelf piscivores	Benthic meiofauna
Adult mackerel	Benthic oceanic piscivores	Birds -- herbivores	Deep-burrowing infauna
Juvenile mackerel	Benthic oceanic invertivores	Birds -- wading piscivores	Carnivorous zooplankton
Bluefish	Benthic coastal piscivores	Birds -- shelf invertivores	Aquatic and other insects
Weakfish	Benthic coastal invertivores	Birds -- raptors	Other zooplankton
Red drum	Benthic coastal planktivores	Encrusting fauna	Ichthyoplankton
Atlantic menhaden	Reef associated piscivores	Squids	Microbial heterotrophs
Mullets	Reef associated omnivores	Stomatopods	Phytoplankton
Other Drums & Croakers	Triggerfish	Octopods	Microphytobenthos
Striped bass	Shallow water grouper/tilefish	Blue crabs	Benthic macroalgae
Highly migratory pelagics	Goliath grouper	Horseshoe crabs	Pelagic macroalgae
Dolphinfish	Nassau grouper	Golden crabs	Seagrasses
Pelagic oceanic piscivores	Deep-water grouper/tilefish	Stone crabs	Marsh vegetation
Pelagic coastal piscivores	Shallow-water snapper	Spiny lobster	Estuarine benthic detritus
Nearshore piscivores	Mid-shelf snapper	Rock shrimps	Offshore benthic detritus
Pelagic oceanic planktivores	Jacks	Penaeid shrimps	Water-column detritus
Sardines	Red porgy	Megafaunal predators	Dead carcasses
Scads	Grunts and porgys	Echinoderms and gastropods	

SOUTH ATLANTIC REGION FOOD WEB (99-BOX)

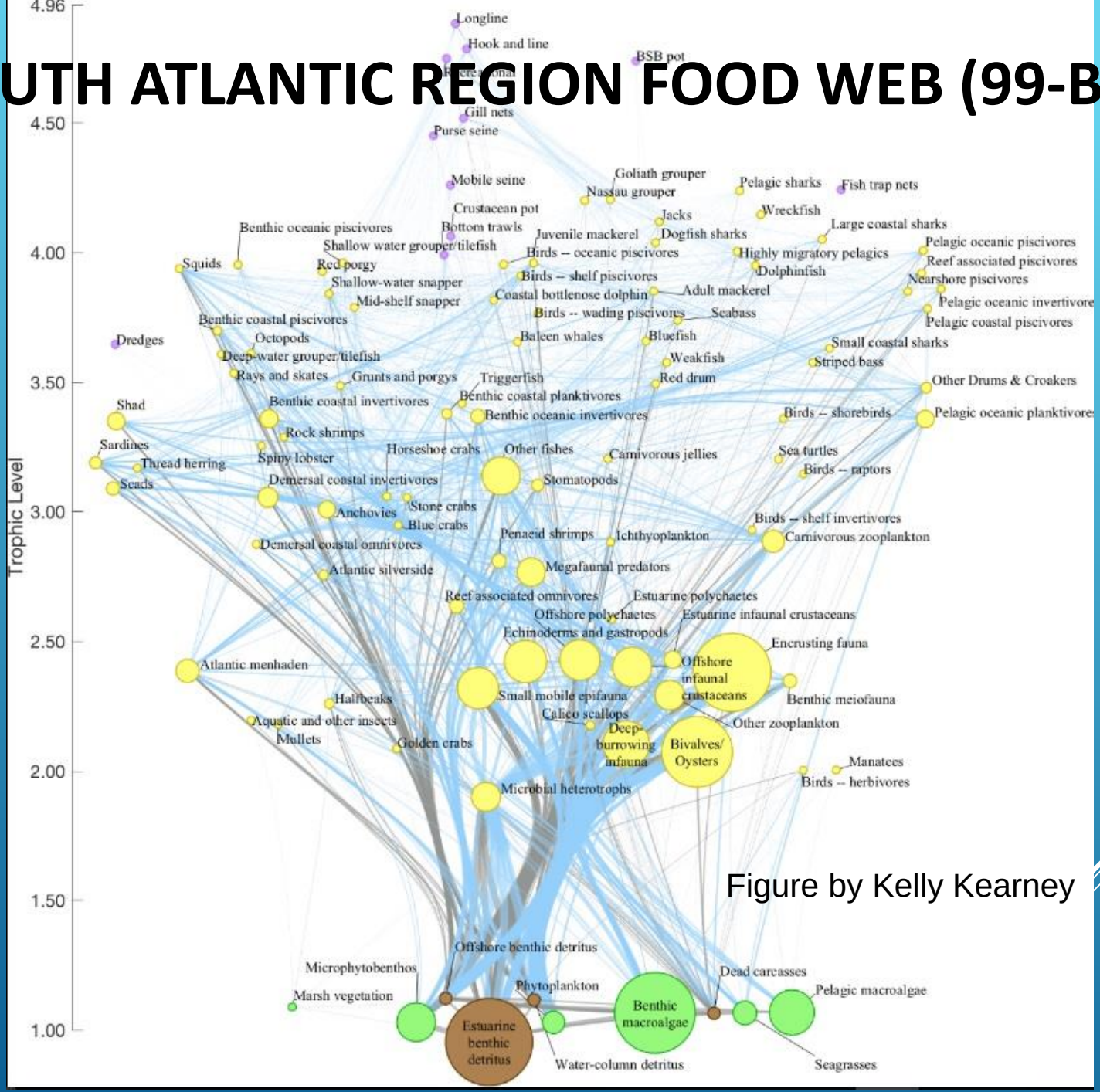

Figure by Kelly Kearney

Adding (Articulating) Managed Species / Groups

Adult king mackerel	Red grouper	Vermilion snapper
Juvenile king mackerel	Black grouper	Silk snapper
Spanish Mackerel	Scamp grouper	Red snapper
Juvenile spanish mackerel	Other shallow grouper/tilefish	Other mid-shelf snapper
Spotted seatrout	Snowy grouper	Greater amberjack
Snook	Yellowedge grouper	Almaco jack
Tarpon	Other deep grouper	Bar Jack
Cobia	Blueline tilefish	Banded rudderfish
Bonefish	Golden tilefish	Blue runner
Permit	Yellowtail snapper	Other jacks
Atlantic Spadefish	Mutton snapper	Other porgys
Hogfish	Gray snapper	White grunt
Ocean triggerfish	Lane snapper	Other grunts
Gray triggerfish	Cubera snapper	Black Seabass
Gag grouper	Other shallow snapper	Bank/Rock seabass

Species / Groups in SAB 137-box model

Coastal bottlenose dolphin	Nearshore piscivores	Gag grouper	Red porgy	Penaeid shrimps
Manatees	Pelagic oceanic planktivores	Red grouper	Other porgys	Megafaunal predators
Large coastal sharks	Sardines	Black grouper	White grunt	Echinoderms and gastropods
Small coastal sharks	Scads	Scamp grouper	Other grunts	Estuarine infaunal crustaceans
Baleen whales	Thread herring	Goliath grouper	Black seabass	Estuarine polychaetes
Pelagic sharks	Shad	Nassau grouper	Rock/Bank seabass	Bivalves/Oysters
Rays and skates	Anchovies	Other shallow grouper/tilefish	Wreckfish	Offshore infaunal crustaceans
Dogfish sharks	Atlantic silverside	Snowy grouper	Other fishes	Offshore polychaetes
Adult king mackerel	Halfbeaks	Yellowedge grouper	Sea turtles	Small mobile epifauna
Juvenile king mackerel	Pelagic oceanic invertivores	Other deep grouper	Carnivorous jellies	Calico scallops
Spanish mackerel	Permit	Blueline tilefish	Birds -- oceanic piscivores	Benthic meiofauna
Juv Spanish mackerel	Demersal coastal invertivores	Golden tilefish	Birds -- shorebirds	Deep-burrowing infauna
Bluefish	Demersal coastal omnivores	Yellowtail snapper	Birds -- shelf piscivores	Carnivorous zooplankton
Weakfish	Atlantic spadefish	Mutton snapper	Birds -- herbivores	Other zooplankton
Red drum	Benthic oceanic piscivores	Gray snapper	Birds -- wading piscivores	Ichthyoplankton
Atlantic menhaden	Benthic oceanic invertivores	Lane snapper	Birds -- shelf invertivores	Microbial heterotrophs
Spotted seatrout	Red Lionfish	Cubera snapper	Birds -- raptors	Phytoplankton
Mullets	Summer flounder	Other shallow snapper	Encrusting fauna	Microphytobenthos
Other Drums & Croakers	Southern flounder	Vermilion snapper	Squids	Benthic macroalgae
Striped bass	Gulf flounder	Silk snapper	Stomatopods	Pelagic macroalgae
Highly migratory pelagics	Benthic coastal piscivores	Red snapper	Octopods	Seagrasses
Dolphinfish	Benthic coastal invertivores	Other mid-shelf snapper	Blue crabs	Marsh vegetation
Pelagic oceanic piscivores	Hogfish	Greater amberjack	Horseshoe crabs	Estuarine benthic detritus
Snook	Benthic coastal planktivores	Almaco jack	Golden crabs	Offshore benthic detritus
Tarpon	Reef associated piscivores	Bar jack	Stone crabs	Water-column detritus
Pelagic coastal piscivores	Reef associated omnivores	Banded rudderfish	Spiny lobster	Dead carcasses
Cobia	Ocean triggerfish	Blue runner	Rock shrimps	
Bonefish	Gray triggerfish	Other jacks		

CURRENT WORKING GROUP

- **Roger Pugliese –** South Atlantic Fishery Management Council
- **Dr. Rua Mordecai**, SALCC, **Dr. Simeon Yurek**, USGS
- **Dr. Marcel J. Reichert –** Marine Resources Research Institute, South Carolina Department of Natural Resources (**Tracey Smart, Wally Bubley**)
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- **Dr. Patrick N. Halpin –** Director, Geospatial Analysis Program Duke University
- **Dr. Luke McCracken –** Florida Wildlife Research Institute (FWRI)

UPDATED DATA UNDERLYING THE MODEL

Data	Contacts	Delivery
Diets: Southeast Reef Fish Survey (SERFS): MARMAP/SEAMAP-SA/SEFIS	Tracey Smart, Kevin Spanik, Marcel Reichert	12-Oct-17
Diets: Refining diet matrix of the SAR model with Ecospecies data staff	Kathleen Okeife, Lauren Gentry	Discussing
SERFS: MARMAP/SEAMAP-SA/SEFIS Abundance index data	Tracey Smart, Kevin Spanik, Marcel Reichert	06-Nov-17
SEAMAP-SA Coastal Trawl Survey biomass data	Tracey Smart, Kevin Spanik, Marcel Reichert	06-Nov-17
South Atlantic Landings 1995-2017	Julie Defilippi Simpson, Mike Rinaldi	10-Oct-18
Annual total biomass & catch from SA assessments (SEDAR)	Kevin Craig	31-May-18
Headboat recreational landings and Discards, SRHS_SA 1981-2016	Kelly Firspatrick	12-Oct-17
Recreational, non-headboat, MRIP – Marine Recreational Program	Available Online	Available
Spatial data from various sources	Rua Mordecai and multiple contacts	Available

SUMMARY AND FUTURE DIRECTION

- **First Phase (Ecopath)** provides a snapshot of SA ecosystem - SAFMC species, relevant prey & predators, and the lower trophic levels that potentially influence their production.
- **The Second Phase (Ecosim)** is underway. Time series are secured for tuning dynamic simulations (calibration).
- Tune model to available data to address broad, strategic issues - "what-if" scenarios.
- **The Third Phase (Ecosim)** has been explored by Rua Mordecai and Simeon Yurek, and will benefit from Jeroen Steenbeek.
- EwE submodels or other ecosystem/multi-species models can also be derived to address more focused questions for tactical decision-making

NEXT STEPS

- Complete Ecopath model and proceed with second phase (Ecosim tuning and example “what-if” scenarios) prior to spring 2019 SSC meeting
  - Examples
    - Simulate use of MSY for all managed species to explore the broad ecosystem effects
    - Begin investigating red snapper and black sea bass interactions
- SSC review terms of reference for possible establishment of an SSC workgroup or coordination with modeling workgoup
- Identify long-term strategies to maintain and regularly run the models.

Questions?