Hypoxia Effects on Fish and Fisheries
Use of Models: Ecospace

Kim de Mutsert

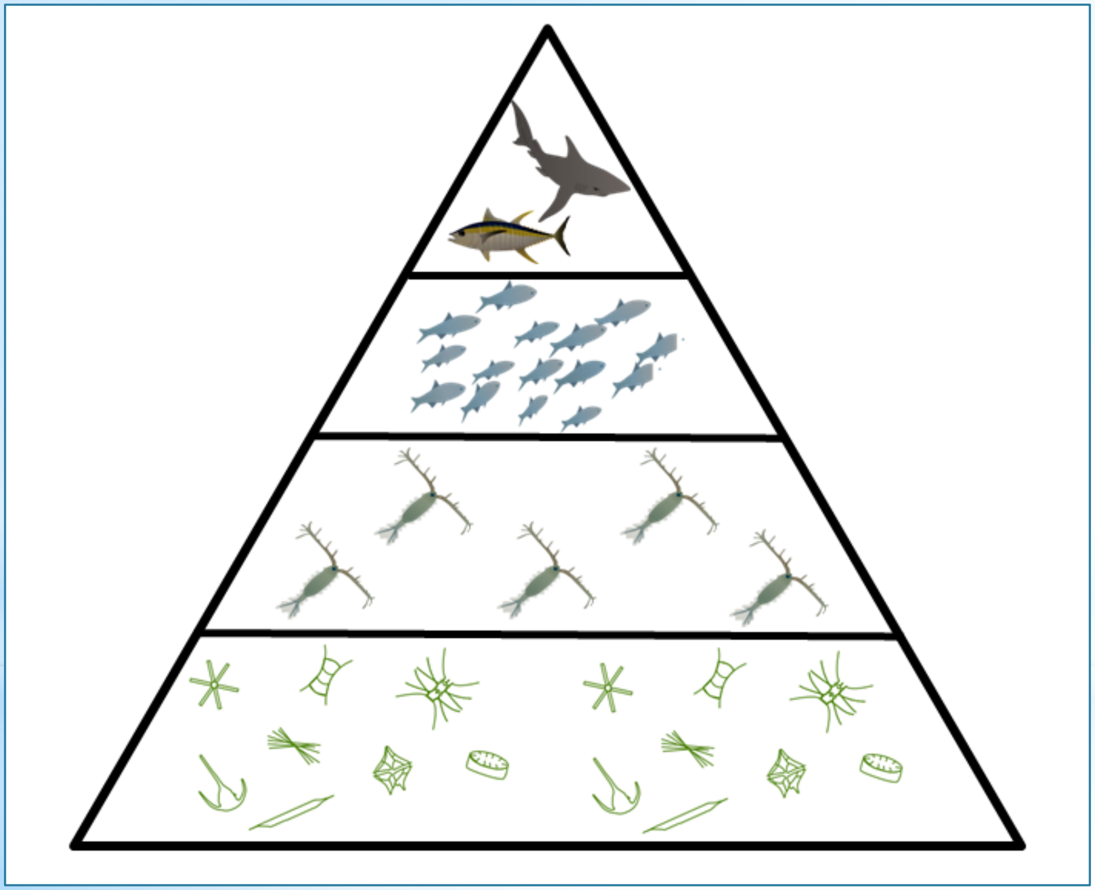
George Mason University

New Orleans, Louisiana
February 6, 2017

Hypoxia Effects on Fish and Fisheries

* Fish:
  * Fish and shrimp can detect and avoid oxygen deficient sea water, resulting in shifts in spatial distribution
  * No behavioral response can result in reduced growth rate, reproduction and/or mortality
  * The combination of these factors can result in reduced abundance/biomass in areas affected by hypoxia
* Fisheries:
  * Fleets aggregate on the edge of the hypoxic zone (Craig 2002)
  * Price of large shrimp is driven up (Smith et al. 2017)

Dead Zone or Strikingly Rich Zone?



An ecosystem approach is used that includes effects of hypoxia, primary productivity, and foodweb interactions

Ecopath with Ecosim and Ecospace

www.ecopath.org

Ecopath: Mass-balance “snapshot” of an ecosystem (initial conditions of the model)

Ecosim: Temporal dynamic simulations (used here for model calibration)

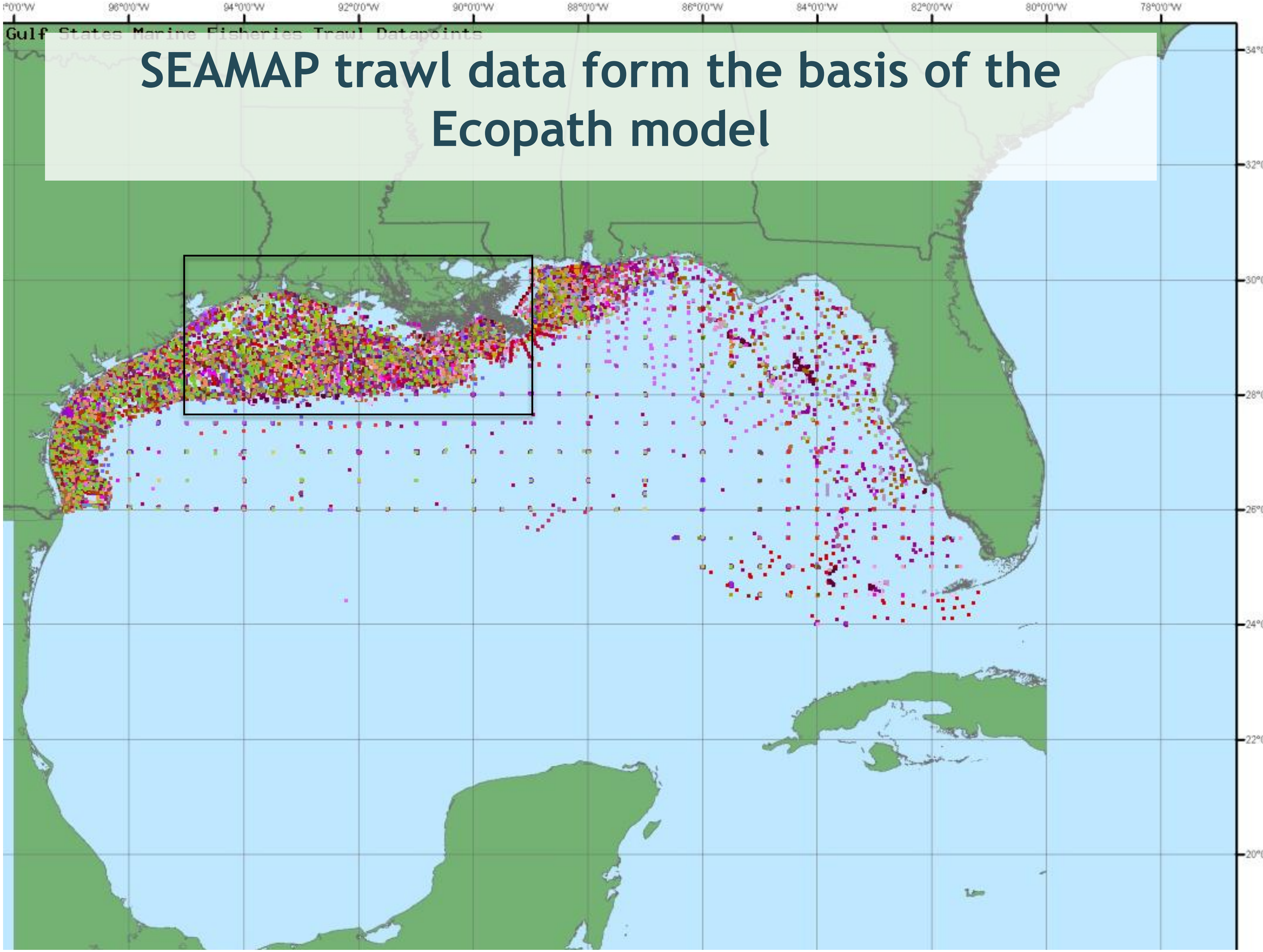
Ecospace: Spatial-temporal modeling (framework of the model)

Model development: Ecopath

Key inputs:

- Average biomass of species representative of northern Gulf of Mexico
- Parameters quantifying turnover and growth: P/B, Q/B, EE, age at maturity, von Bertalanffy growth parameters
- Representative fishing fleets and annual landings
- Diet matrix

SEAMAP trawl data form the basis of the Ecopath model



Taxa/groups in the Ecopath model

Marine Mammals
Tunas
Birds
Atlantic Cutlassfish
Lizardfish
Sharks
Mackerel
Sea Trout
Red Snapper
Groupers
Other Snappers
Red Drum
Rays & Skates
Flounders
Pompano
Atlantic Bumper

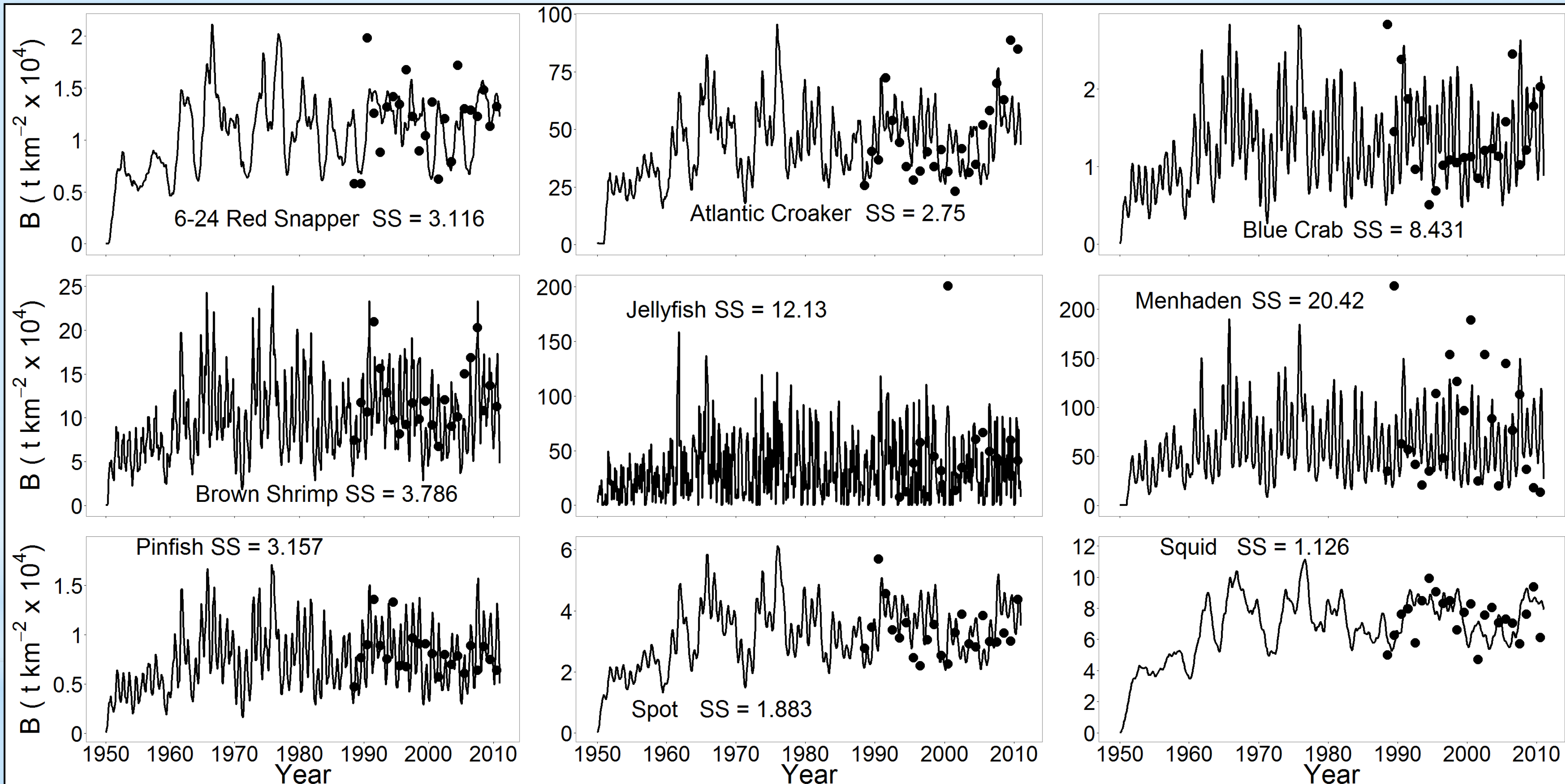
Scad
Atlantic Croaker
Catfish
Spot
Squid
Pinfish
Porgies
Anchovy
Menhaden
Other Clupeids
Mullet
Sea Turtles
Small Forage Fish

Jellyfish
Blue Crab
Brown Shrimp
White Shrimp
Pink Shrimp
Other Shrimp
Benthic Crabs
Benthic Invertebrates
Zooplankton
Benthic Algae/Weeds
Phytoplankton
Detritus

60 groups

ontogenetic splits included

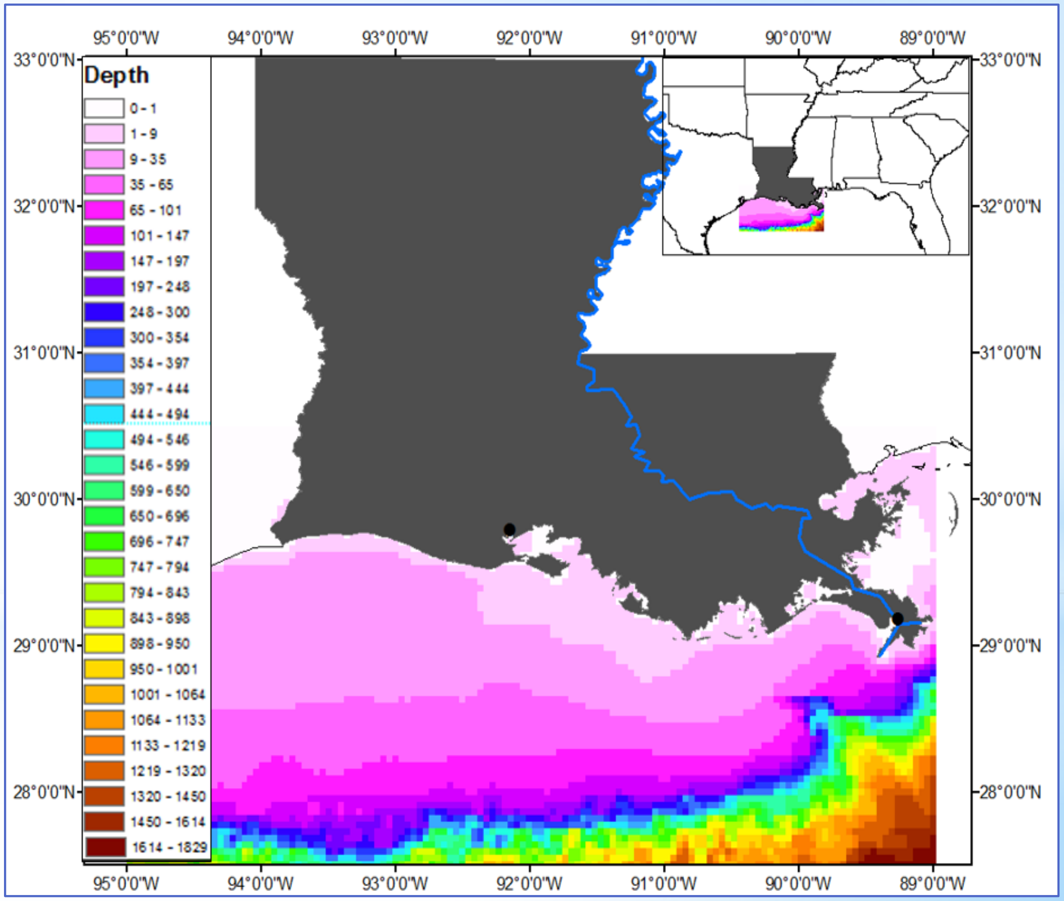
Calibration in Ecosim



Model development: Ecospace

Key inputs:

* Ecopath model
* Basemap of model area with 5 km^2 grid
* Location of ports and price per pound of landings
* Spatial and temporal dissolved oxygen (DO) and Chl *a* as environmental drivers: values per grid cell, per month



A coupled physical-biological model of the Northern Gulf of Mexico shelf: model description, validation and analysis of phytoplankton variability

K. Fennel[1], R. Hetland[2], Y. Feng[2], and S. DiMarco[2]

[1]Departme
[2]Departme

Received:
Revised: 7

Spatial-temporal DO and Chl *a* output of this physical-biological model has been used as environmental input to the Ecospace model

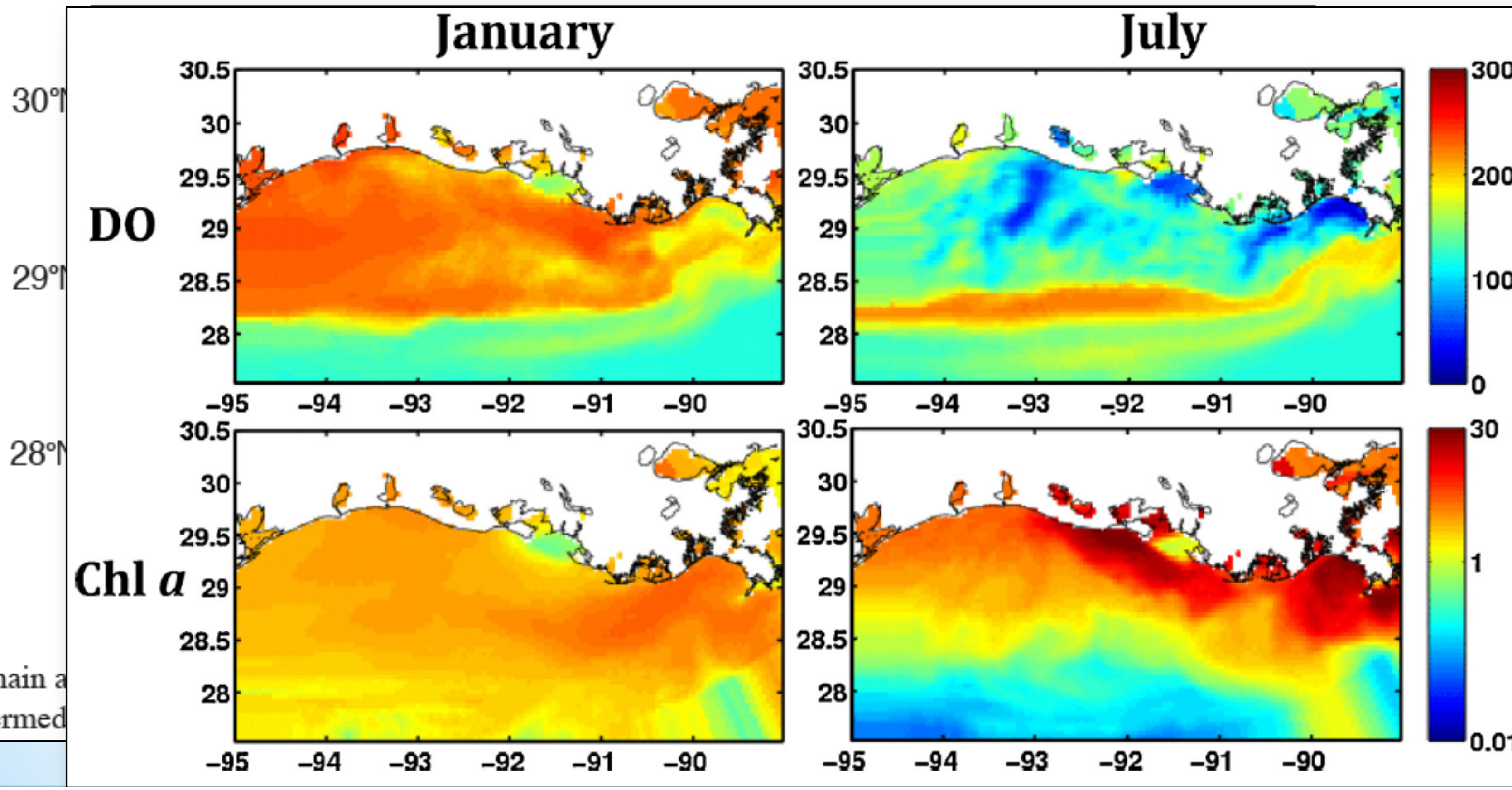


Fig. 1. Model domain a ... as
delta (brown), intermed

Results of previous simulations

* The Mississippi River fuels the Gulf of Mexico coastal ecosystem
* Effects of hypoxia and nutrient enrichment are species-specific
* General trend: Mississippi River discharge increases GOM biomass and landings, hypoxia reduces what could optimally be achieved

De Mutsert et al. 2016

What is next?

* Are current nutrient loads negatively affecting living marine resources in the GOM?
  * Net effect seems positive, but: There are winners and losers, some species-specific negative effect should be explored further
* Does hypoxia in the NGOMEX affect the fish and fisheries to such an extent that it needs to be included in stock assessment and fisheries management?
* How do proposed reductions in nutrient load and size of the hypoxic zone affect fish and fisheries?
* Tools should be transferred to the hands of managers

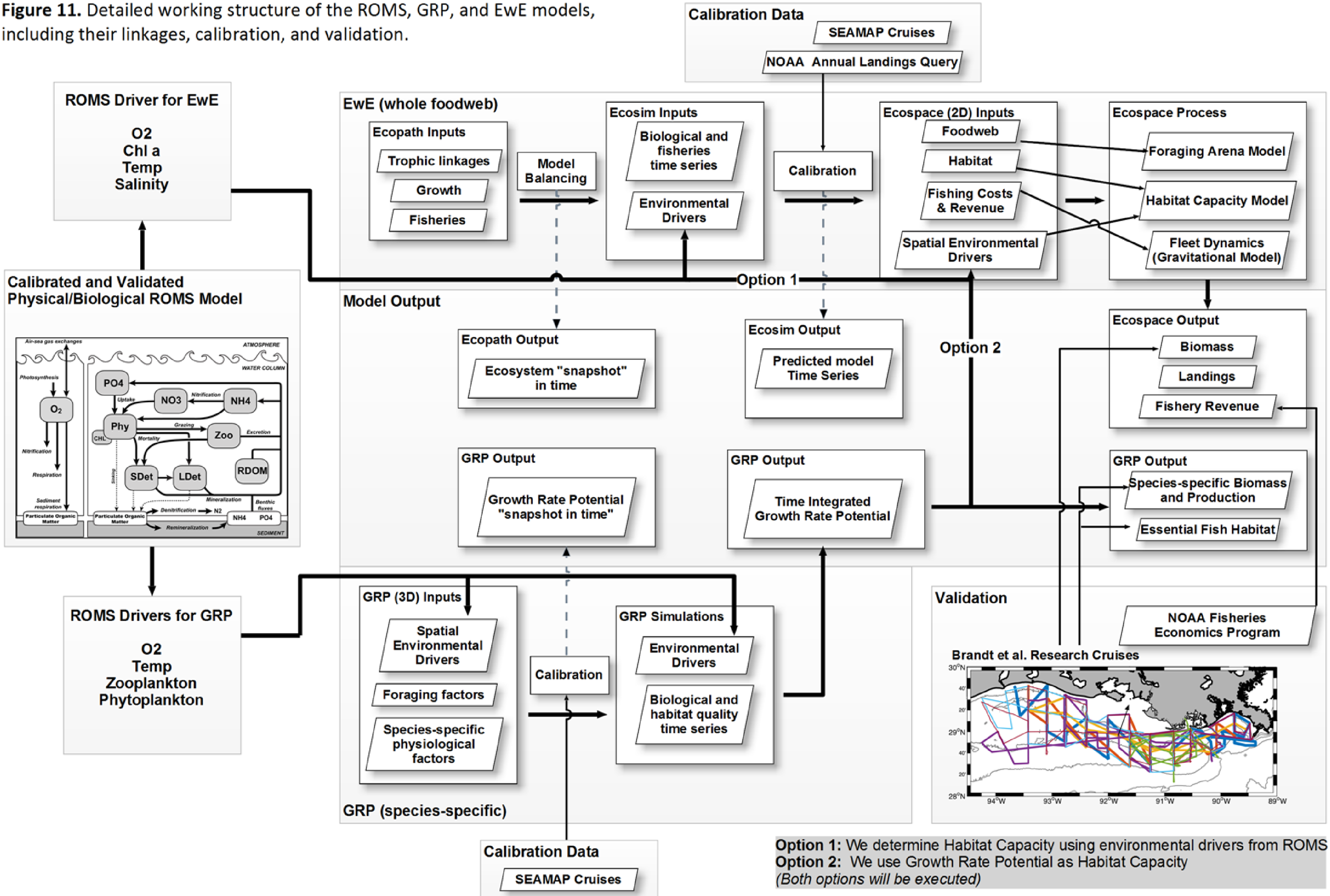


Figure 11. Detailed working structure of the ROMS, GRP, and EwE models, including their linkages, calibration, and validation.

Current goals

* Evaluate effects of varying nutrient loading on living resources with coupled water quality, bioenergetics, and ecosystem models
* Create user-driven predictive tools
* Connect model predictions and management actions in an adaptive management framework

Thank you!

Past and present collaborators of this research: Aaron Adamack, Tunde Adebola, Steve Brandt, Joe Buszowski, Matt Campbell, Jim Cowan, Villy Christensen, Adrian Dahood, Katja Fennel, Rex Herron, Peter Jacobs, Arnaud Laurent, Kristy Lewis, Cynthia Sellinger, Jeroen Steenbeek, and Carl Walters

Data used from SEAMAP and FishBase

Model development was funded by NOAA's Center for Sponsored Coastal Ocean Research (CSCOR) under grant no. NA09NOS4780233

Current research is funded by NOAA's Center for Sponsored Coastal Ocean Research (CSCOR) under grant no. NA16NOS4780202