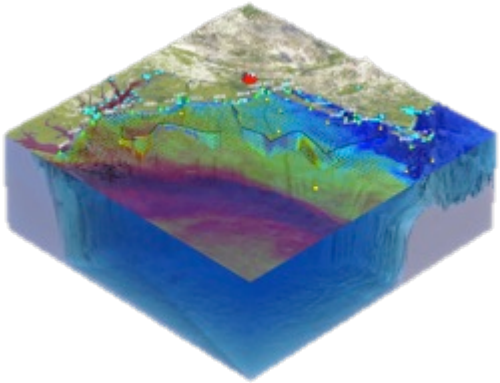
Using ocean observing systems and local ecological knowledge to nowcast butterfish bycatch events in the Mid-Atlantic Bight longfin squid fishery



Industry/Outreach
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Eleanor A. Bochenek (Rutgers)
Chris Roebuck
Dan & Lars Axelsson
Lunds Fisheries
Seafreeze ltd
John Hoey (NOAA/NMFS/NEFSC)

Fishery Scientists/ Ecologists
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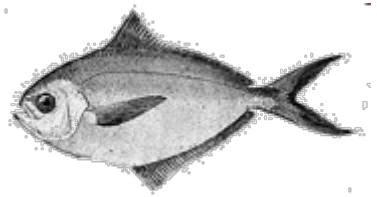
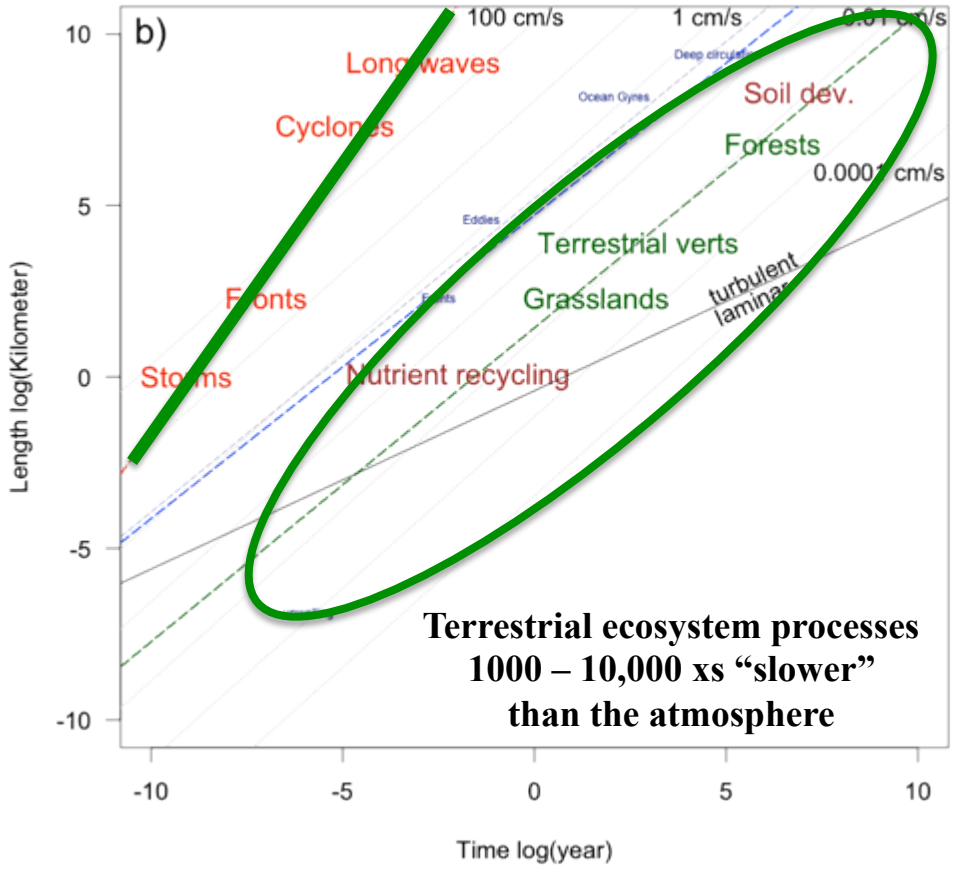


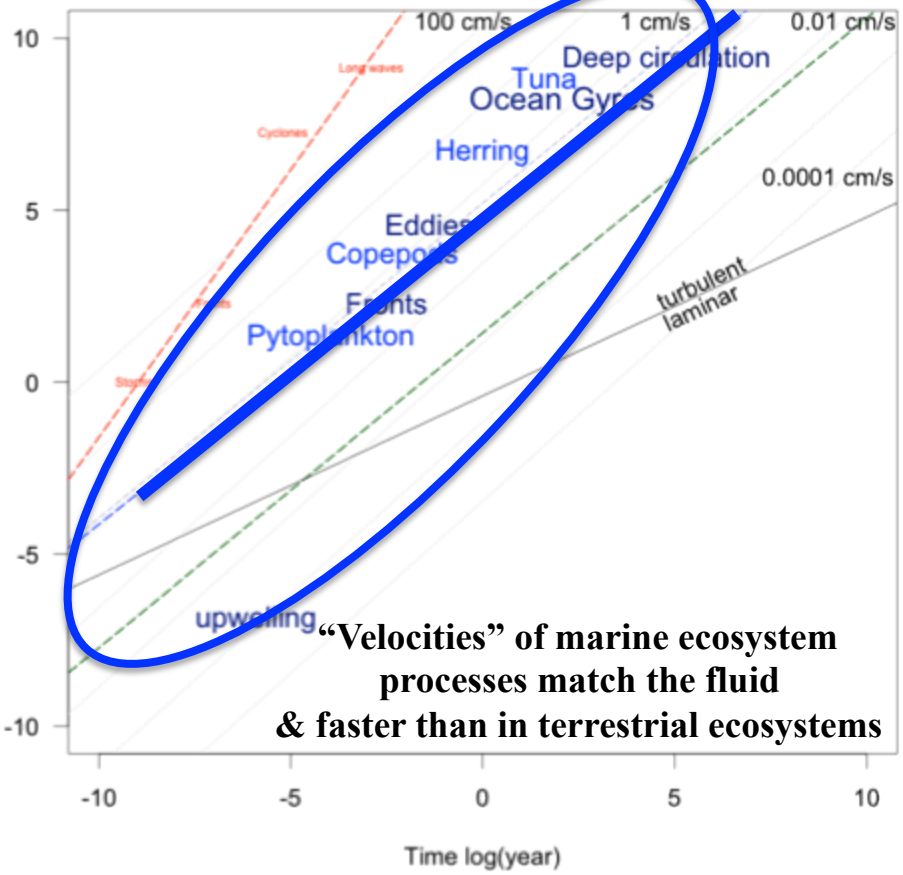
Length-time scales of turbulent structures in the atmosphere & ocean & ecosystem processes

Landscape



Terrestrial ecosystem processes 1000 – 10,000 xs "slower" than the atmosphere

Seascape



"Velocities" of marine ecosystem processes match the fluid & faster than in terrestrial ecosystems

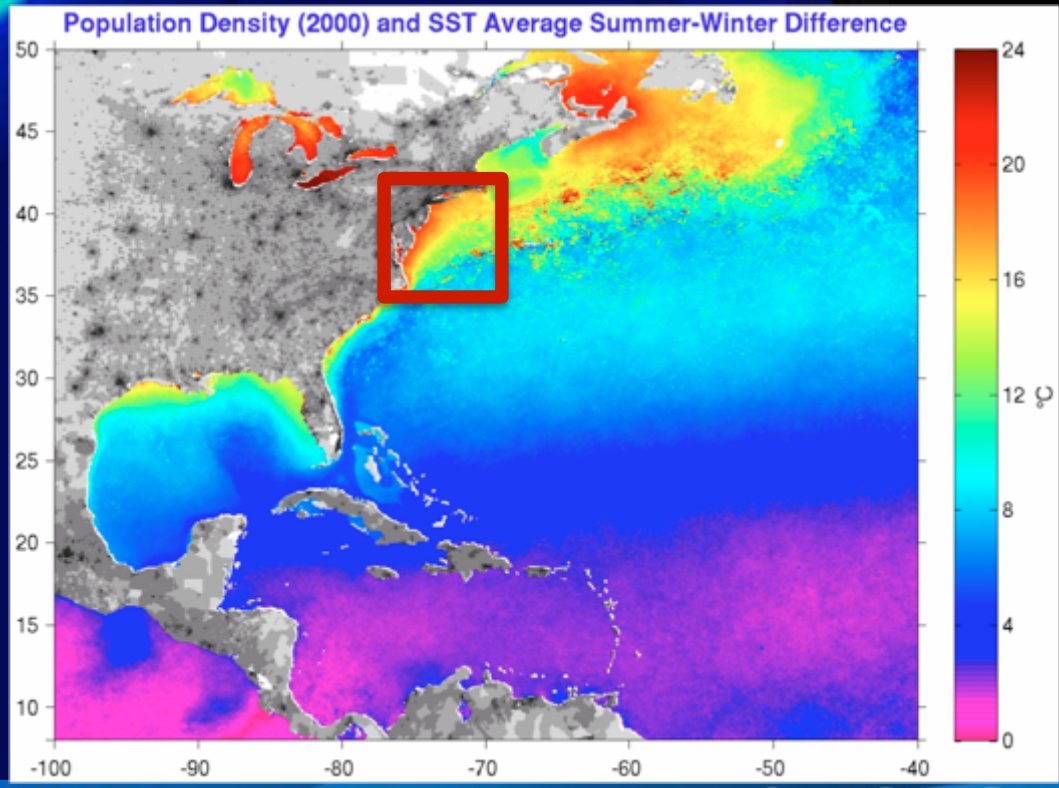
MIDDLE ATLANTIC REGIONAL ASSOCIATION COASTAL OCEAN OBSERVING SYSTEM

1000 km
Cape to Cape

CT
RI
MA
Cape Cod
NY
PA
NJ
DE
MD
VA
NC
Cape Hatteras

Mid-Atlantic Regional Association Coastal Ocean Observing System: From Observations to Forecasts

MANY MANY MANY PEOPLE



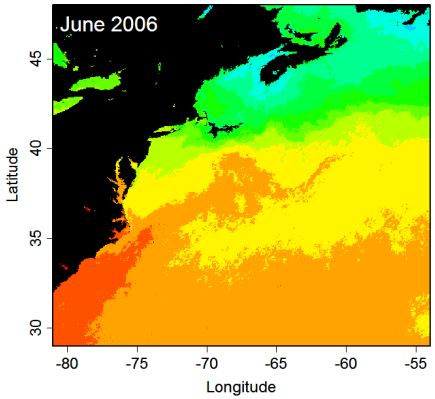
MARACOOS
Ocean Information for a Changing World

IOOS
INTEGRATED OCEAN OBSERVING SYSTEM

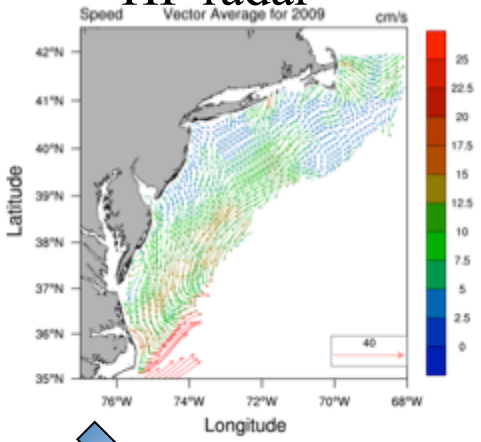
Regional Ocean Observing System

MARACOOS
Ocean Information for a Changing World

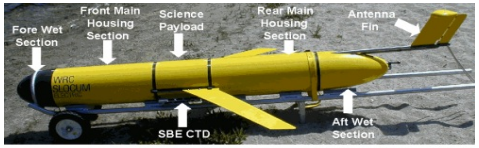
Data: Satellites

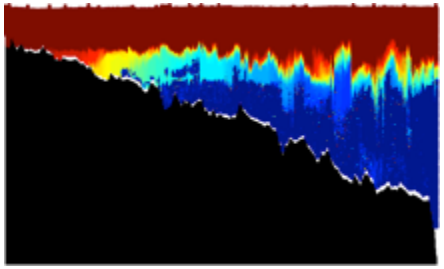


HF radar

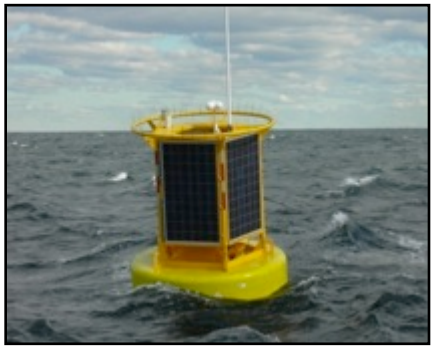


Gliders

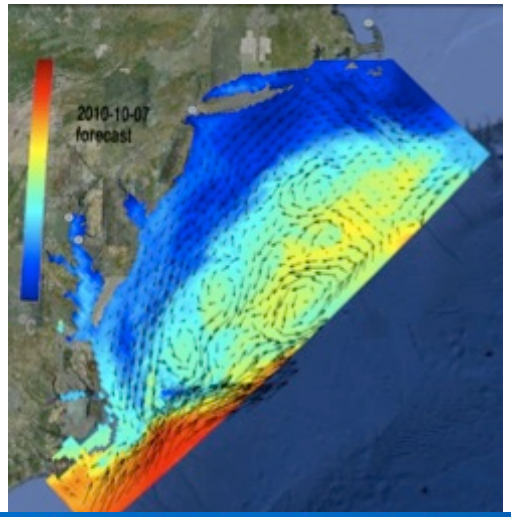


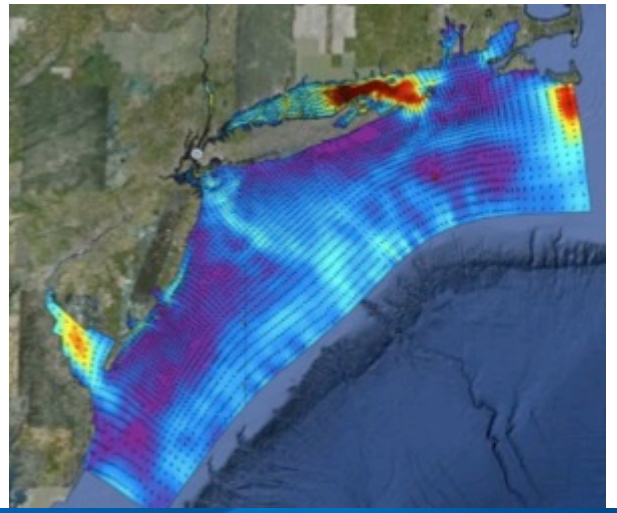


Buoys

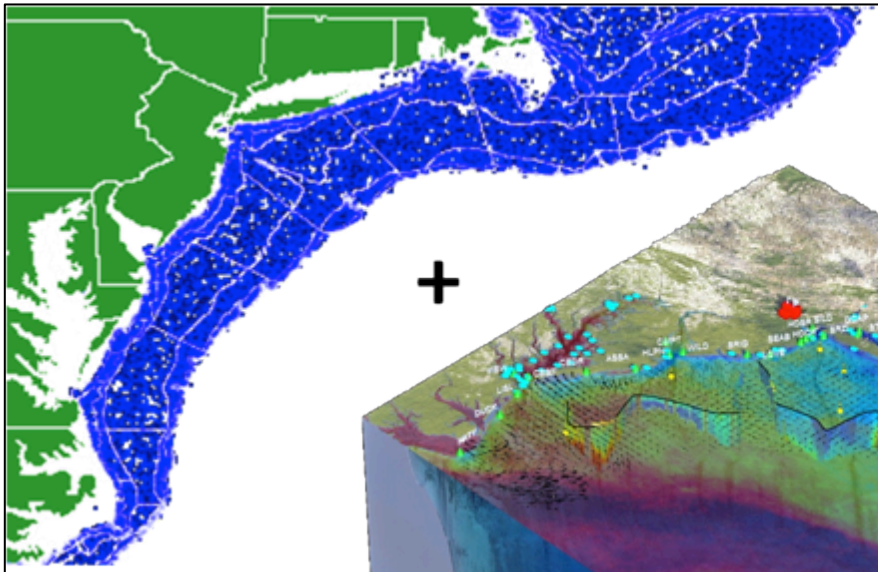


Ensemble of Assimilation Models



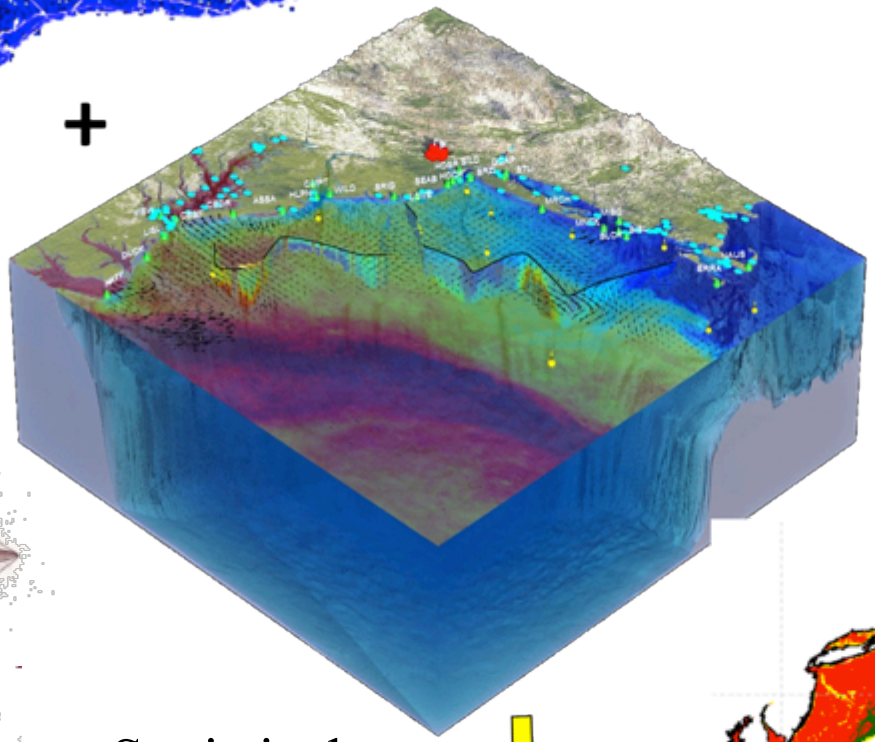


Approach: statistical species distribution models

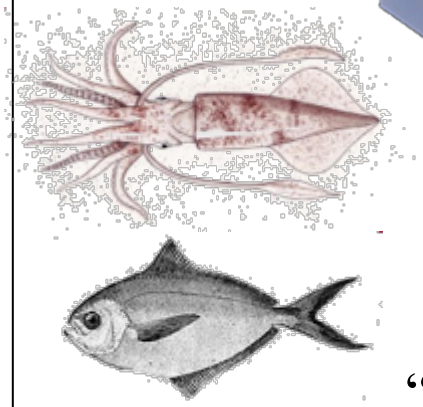


NOAA US Fishery Data
Spatial grain = 11km

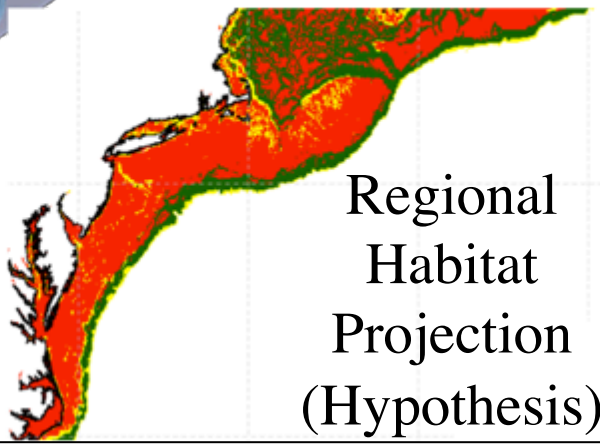
+



Ocean
observations
+
Regional
Seabed data



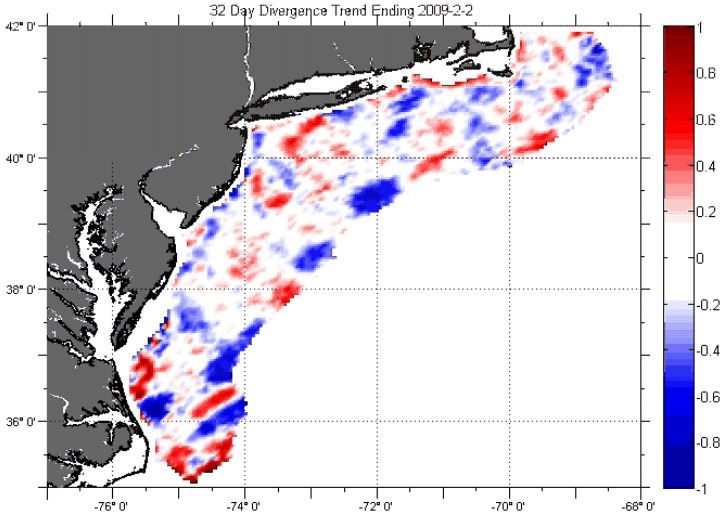
Statistical
"niche" models
(e.g. GAM, GLM, MAXENT)



Regional
Habitat
Projection
(Hypothesis)

Response models

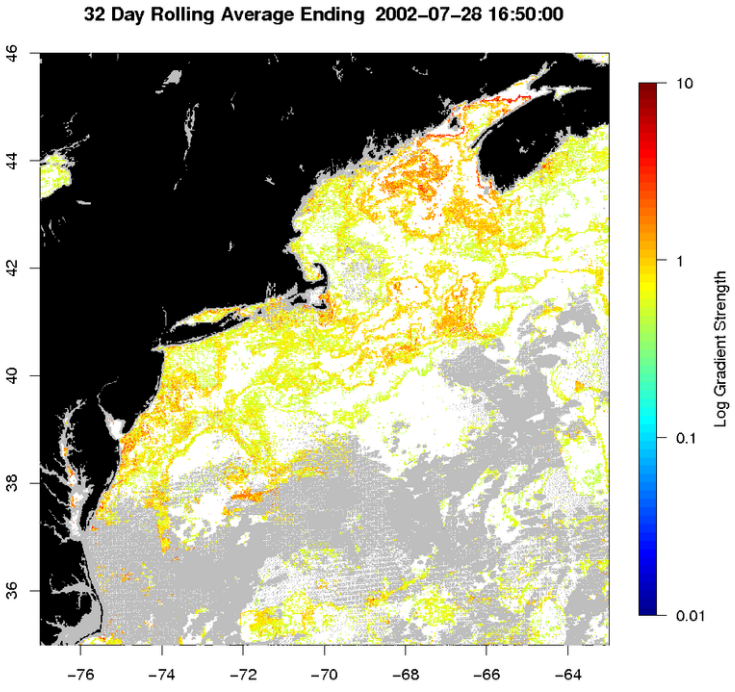
HF radar data



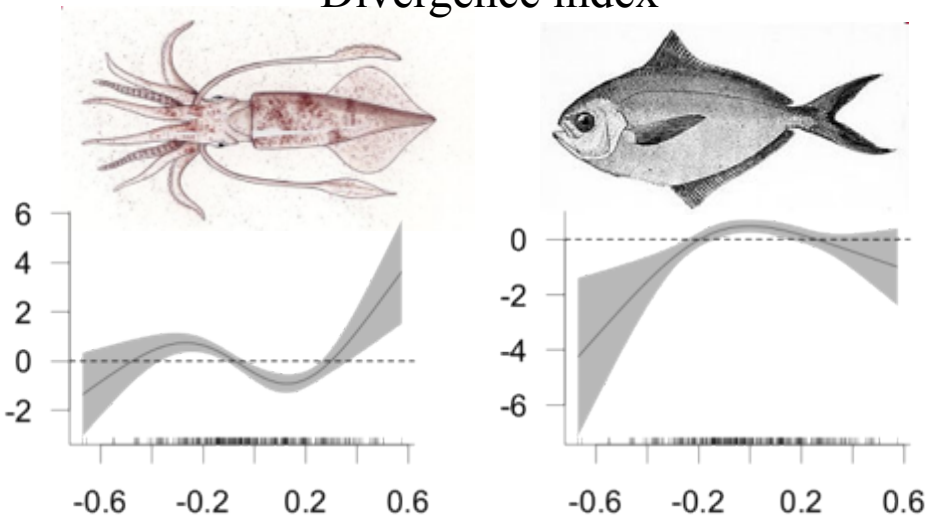
Upwelling

Downwelling

Satellite data

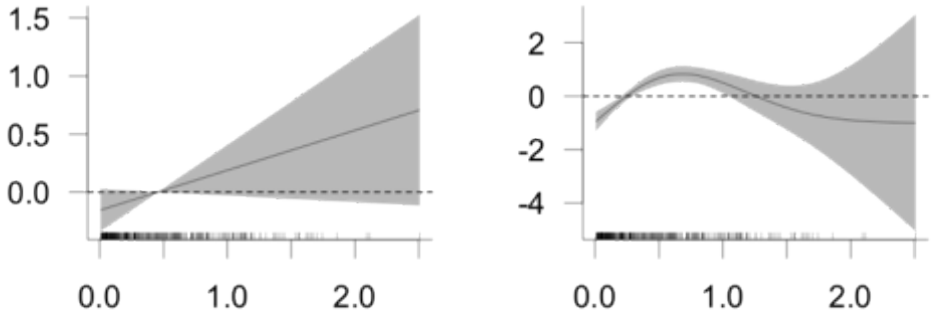


Divergence index



Downwelling Upwelling

Frontal index

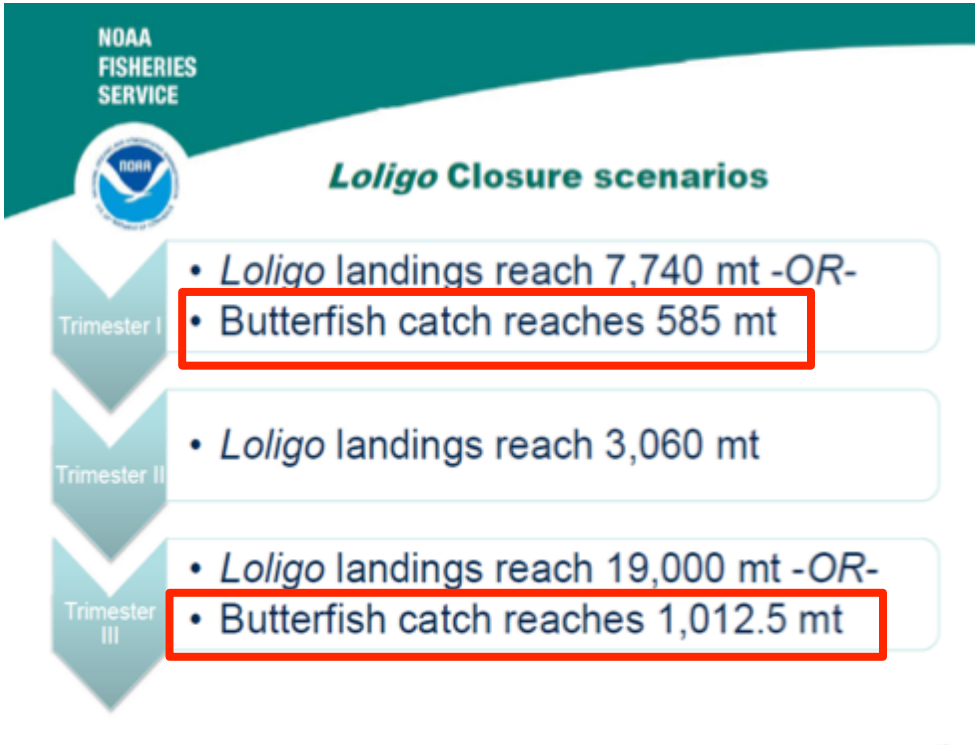


Distance: Far Close

Strength: Weak Strong

Sometimes a management problem finds you

Butterfish by-catch mortality cap in the longfin inshore squid fishery



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Human Dimensions
Steven Gray (U Hawaii)

Enlist industry experts in model refinement

Ask the fisherman about the fish

Hypothesis:

Combining fishermen & scientists' knowledge within an operational Ocean Observing System should:

(1) Increase chance of capturing space- time scales of animal behaviors & ecological processes

(2) Should enable adaptive decision making at scales matching ecosystem

Scientists & Fishermen

Scientists

Index of "upwelling"

Fishermen

Sediment grain size

Lunar Phase

Chlorophyll

+

Bottom Temperature

Solar elevation

Day length

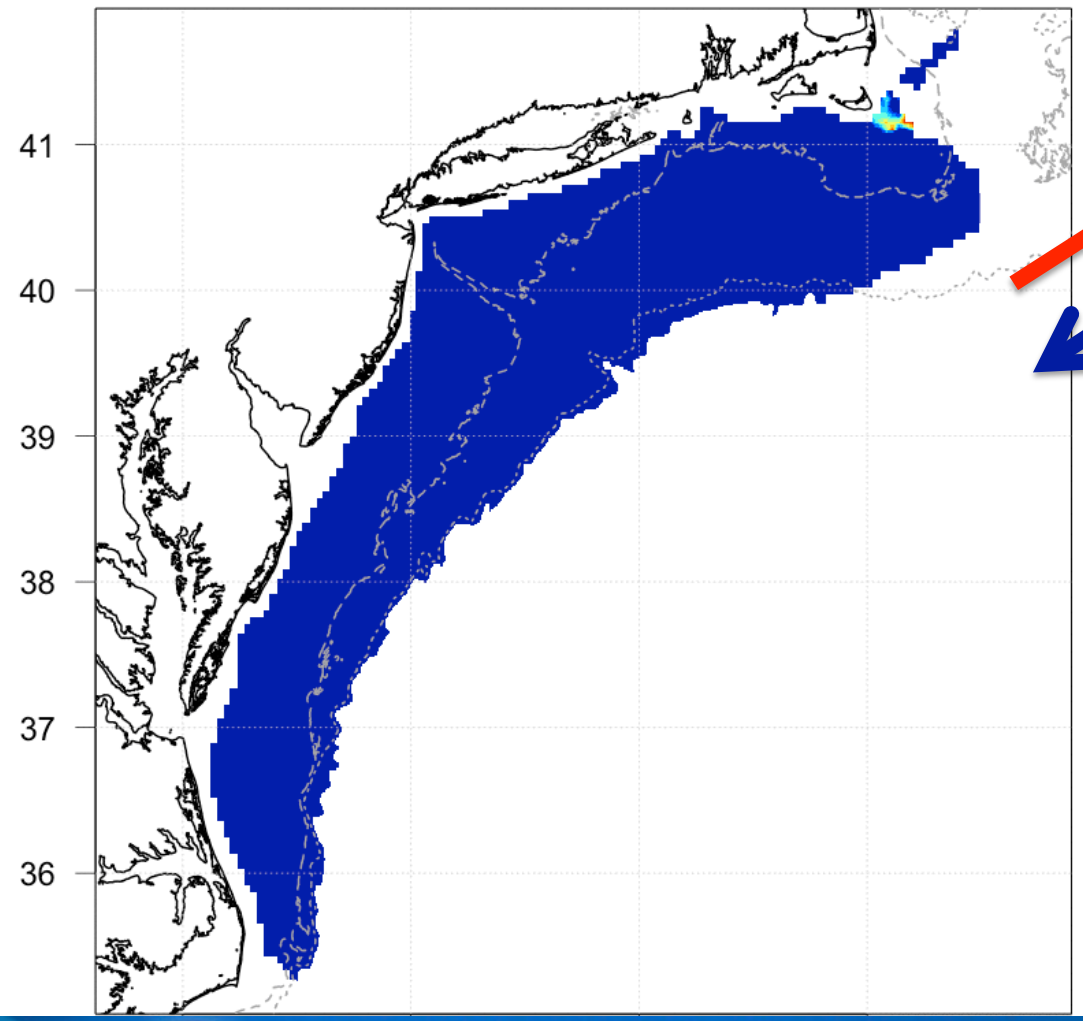
Surface fronts

Bottom complexity

Bottom depth

Mixed layer depth

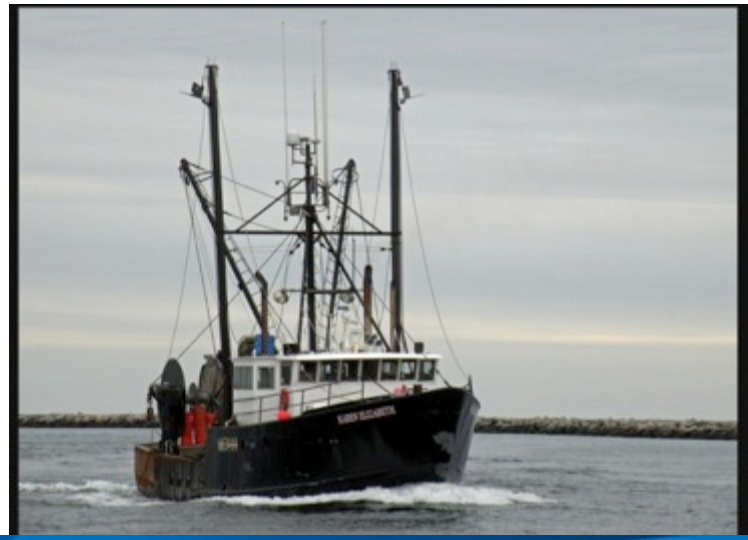
Test of prototype operational habitat model (v. 2.0)



Model "now cast" based on IOOS observations

Catch data & analysis

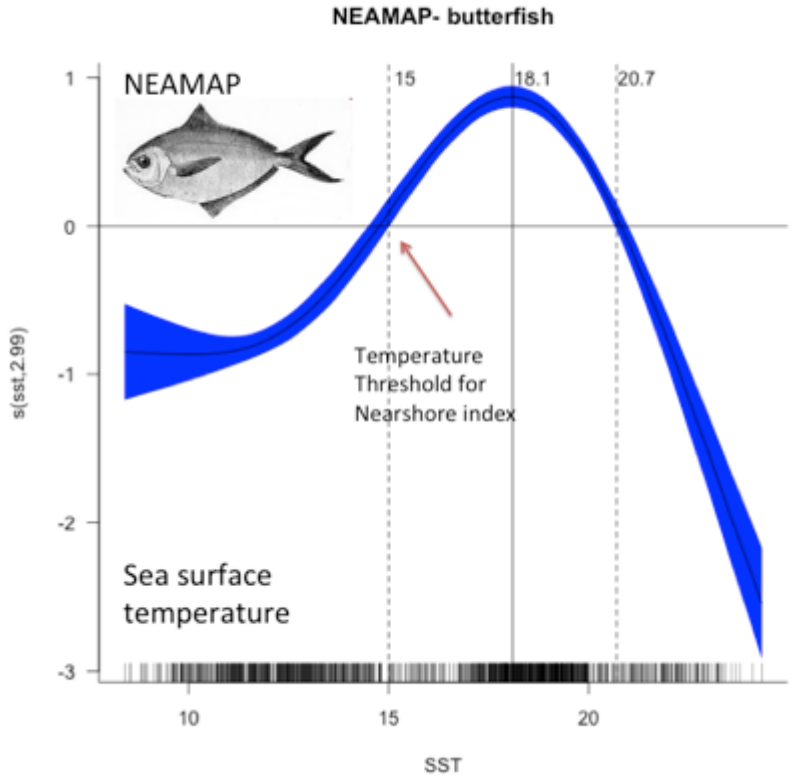
F/V Karen Elizabeth

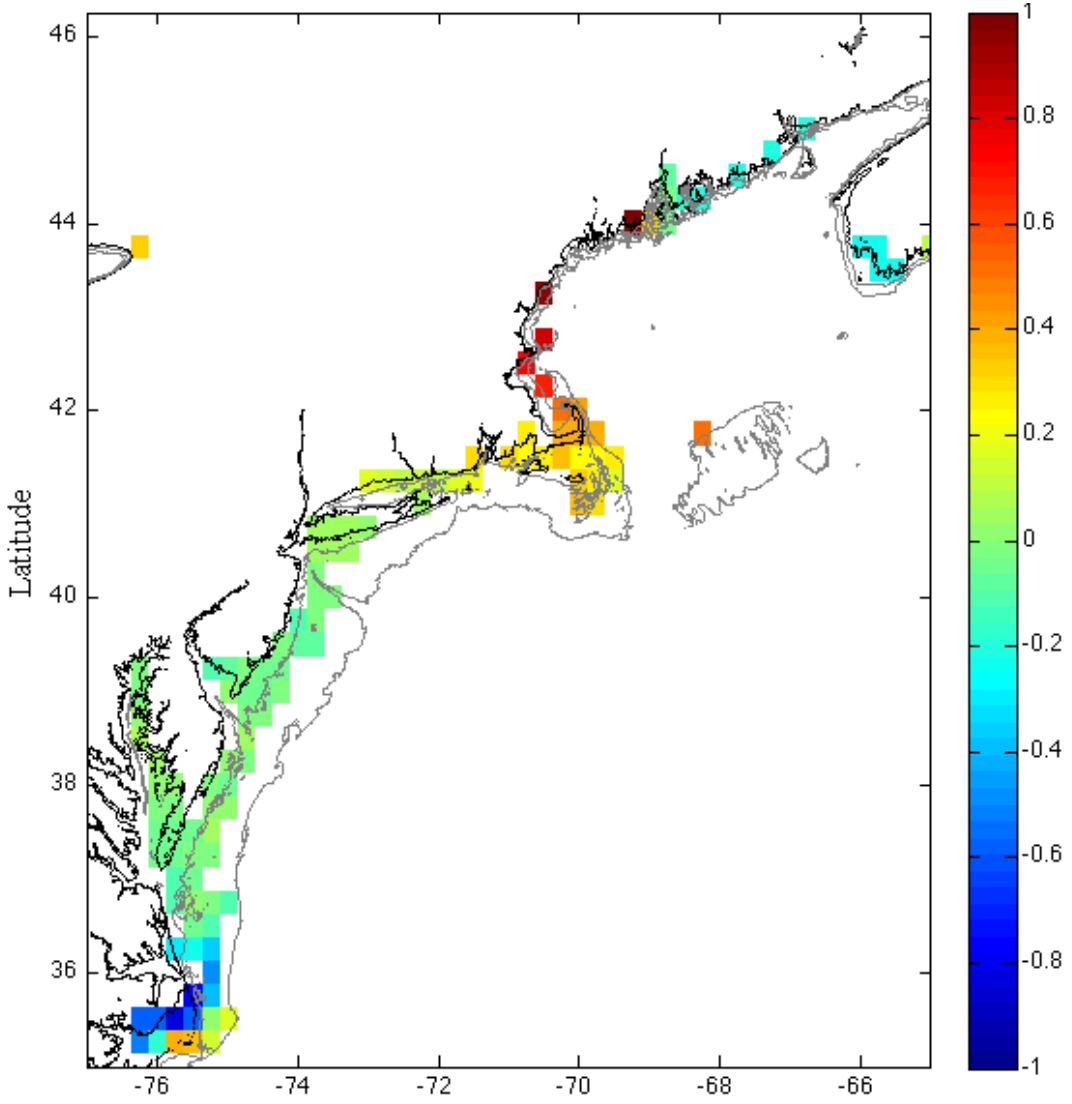


What we learned
Lower limits to scale & extent of data & models

- Spatial resolution of statistical habitat model ~ 40 km
  - Nyquist frequency: 2 x interstation distance
- Animals & fisherman respond to fine scale habitat variation nested within meso-scale variation:
  - Dynamic gradients in temperature, prey, predation
- Animals may occupy habitats under sampled in assessment surveys
  - Diel time scales
    - vertical migration
  - Seasonal time scales
    - Shallow near-shore in summer-fall
    - Continental slope in late fall, winter-early spring

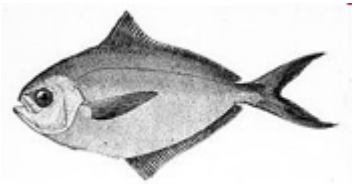
Possible trend in survey strata within preferred bottom habitat (1981 - 2011)





Enlist assessment experts in model application

Ask the assessment scientists how best to apply the models to butterfish stock assessment



- Physical oceanographers
- Fisheries oceanographers
- Habitat ecologists
- Assessment Scientists
- Managers
- Fishing industry

- Reviewed the stock assessment process
- Reviewed the habitat model development
- Prioritized steps for habitat model input into the butterfish stock assessment scheduled in 2013

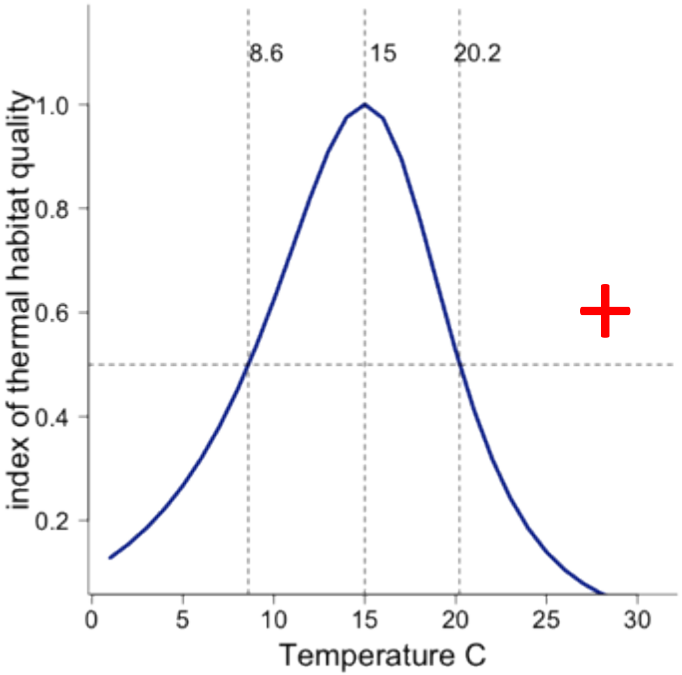
Mechanistic Habitat Model 3.0

Metabolic basis to thermal habitat

Unimodal Boltzmann-Arrhenius Function

NOAA.NMFS/NEFSC Trawl Survey CTD

Inter-annual variability of survey strata within preferred bottom habitat



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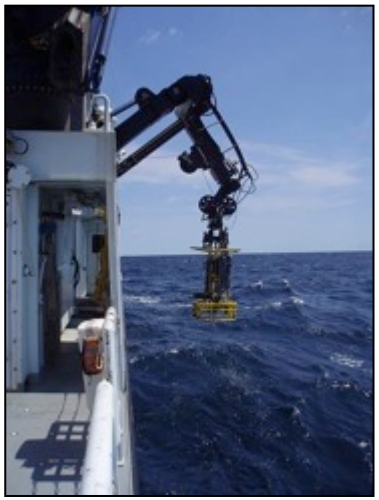

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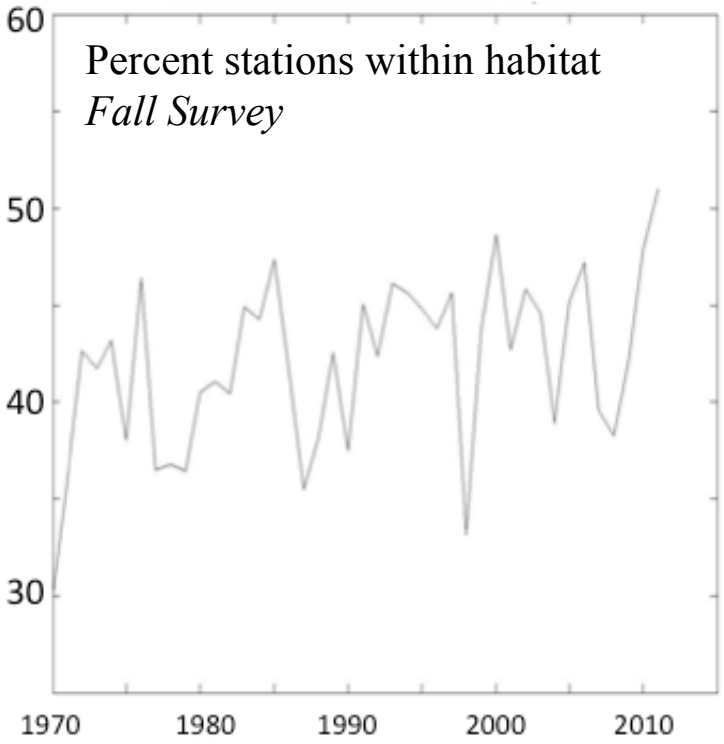
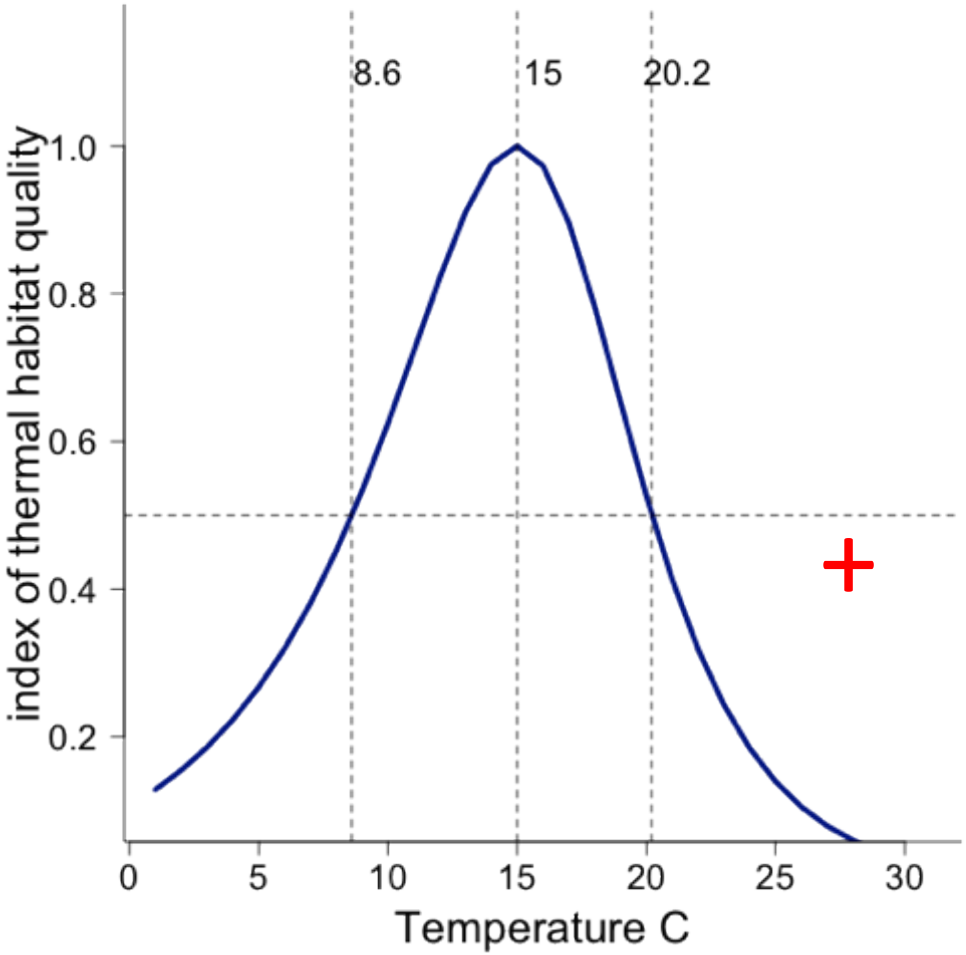
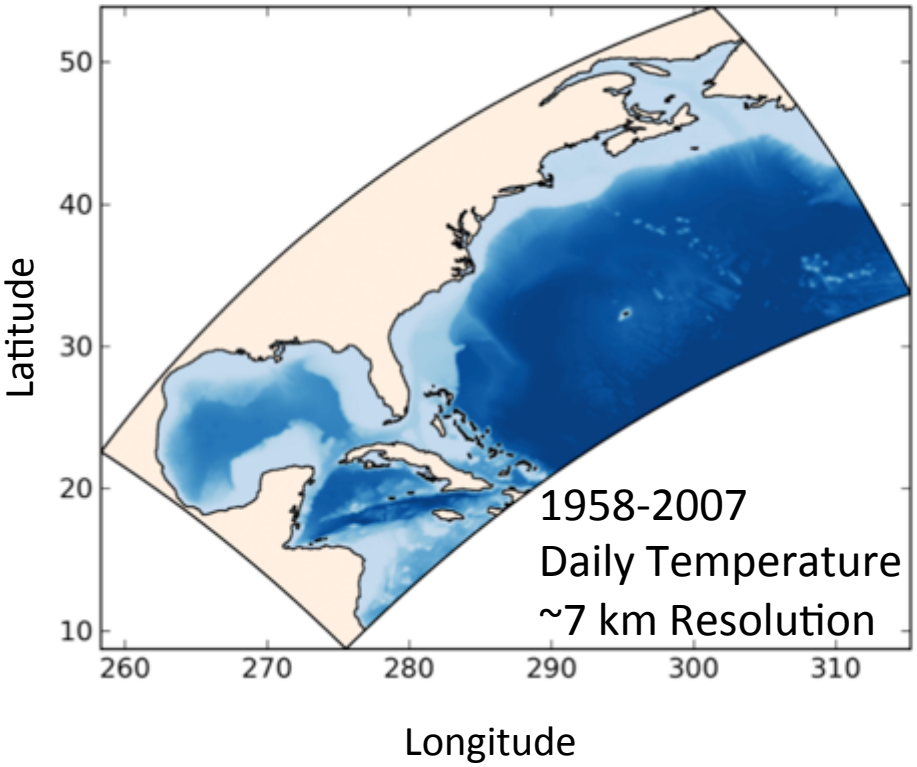


Mechanistic Habitat Model 3.0

Unimodal Boltzmann-Arrhenius function
Metabolic basis to thermal habitat



Bottom temperatures from ROMS model hindcasts
Enrique Curchitser

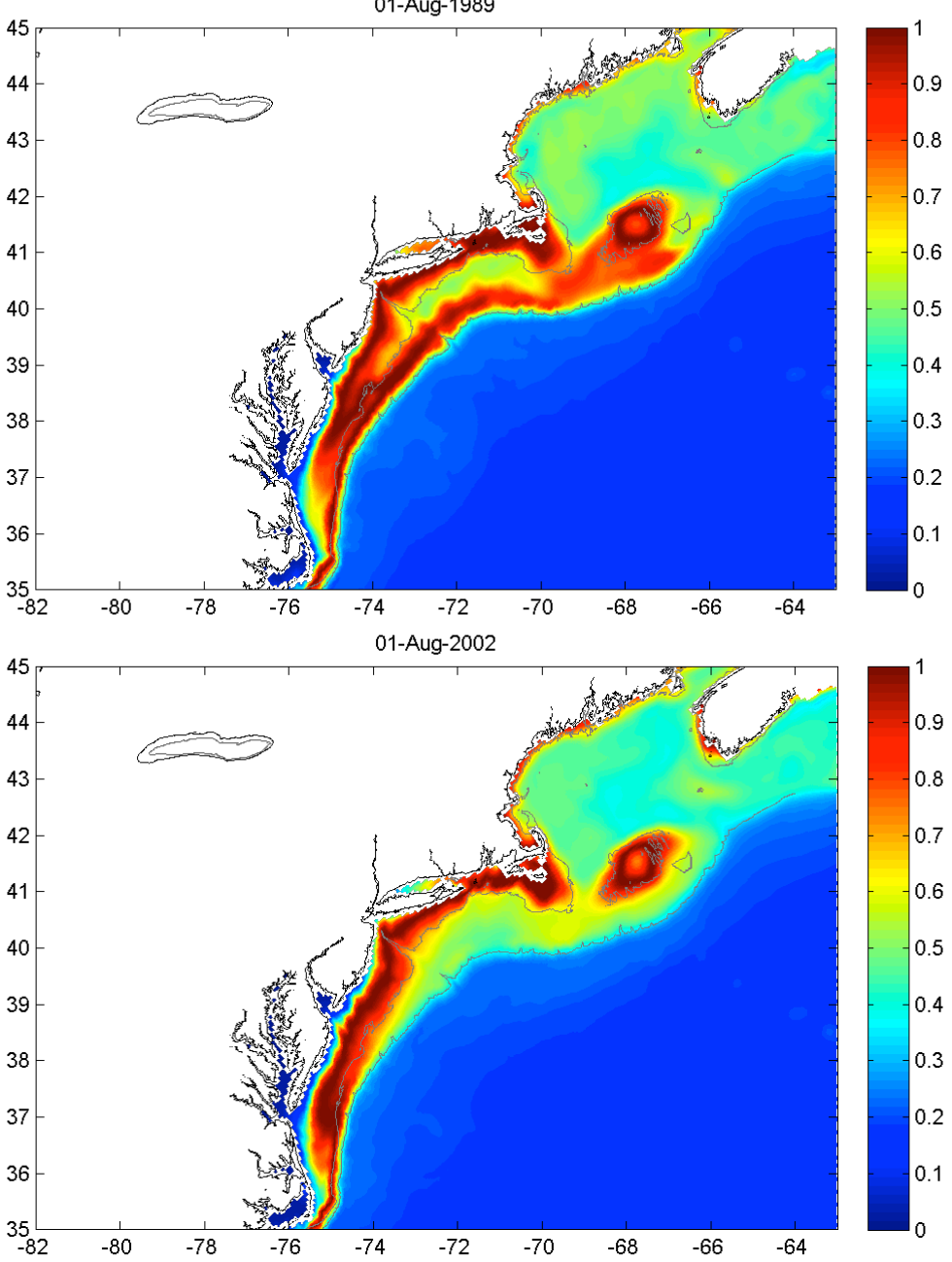


Mechanistic Habitat Model 3.0

Daily: 1958-2007

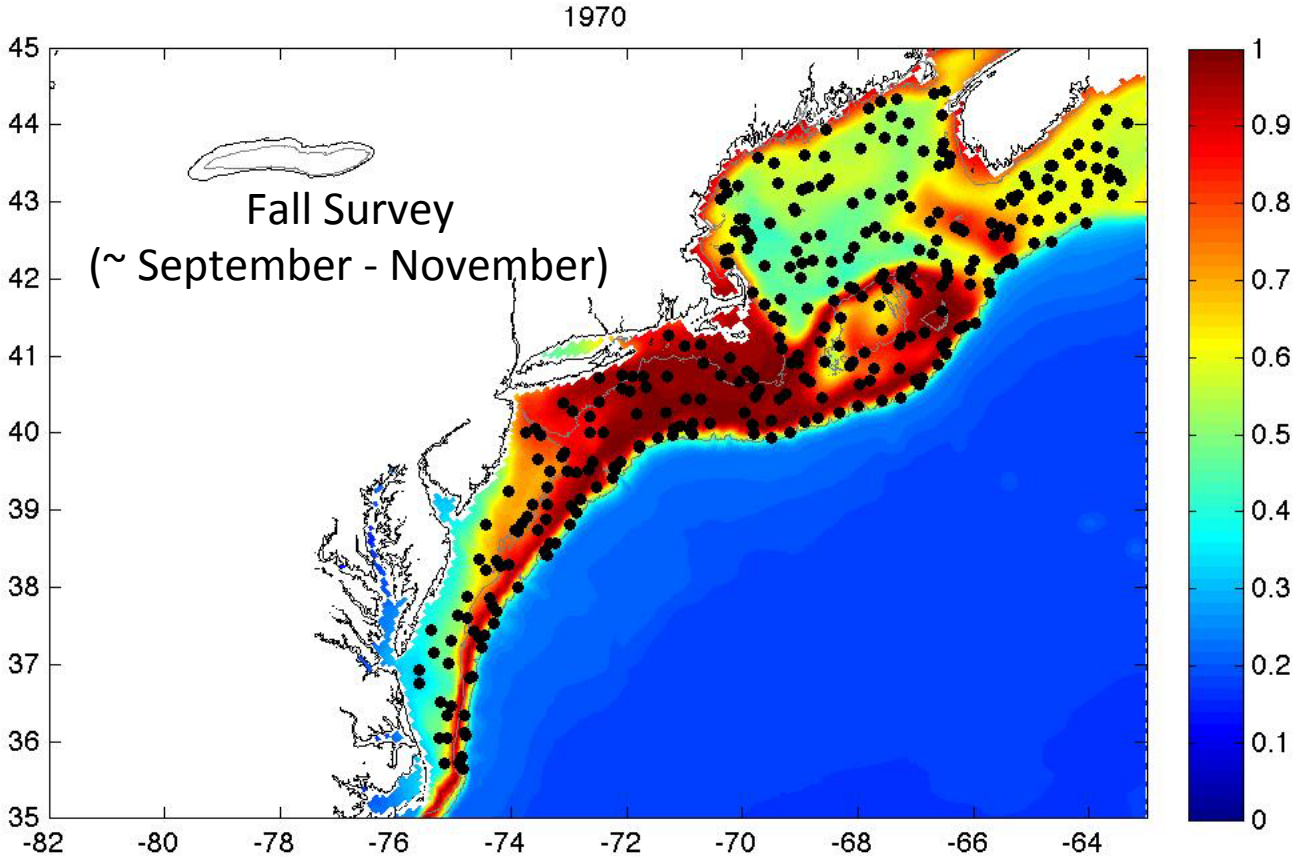
1989-1992

2002-2004



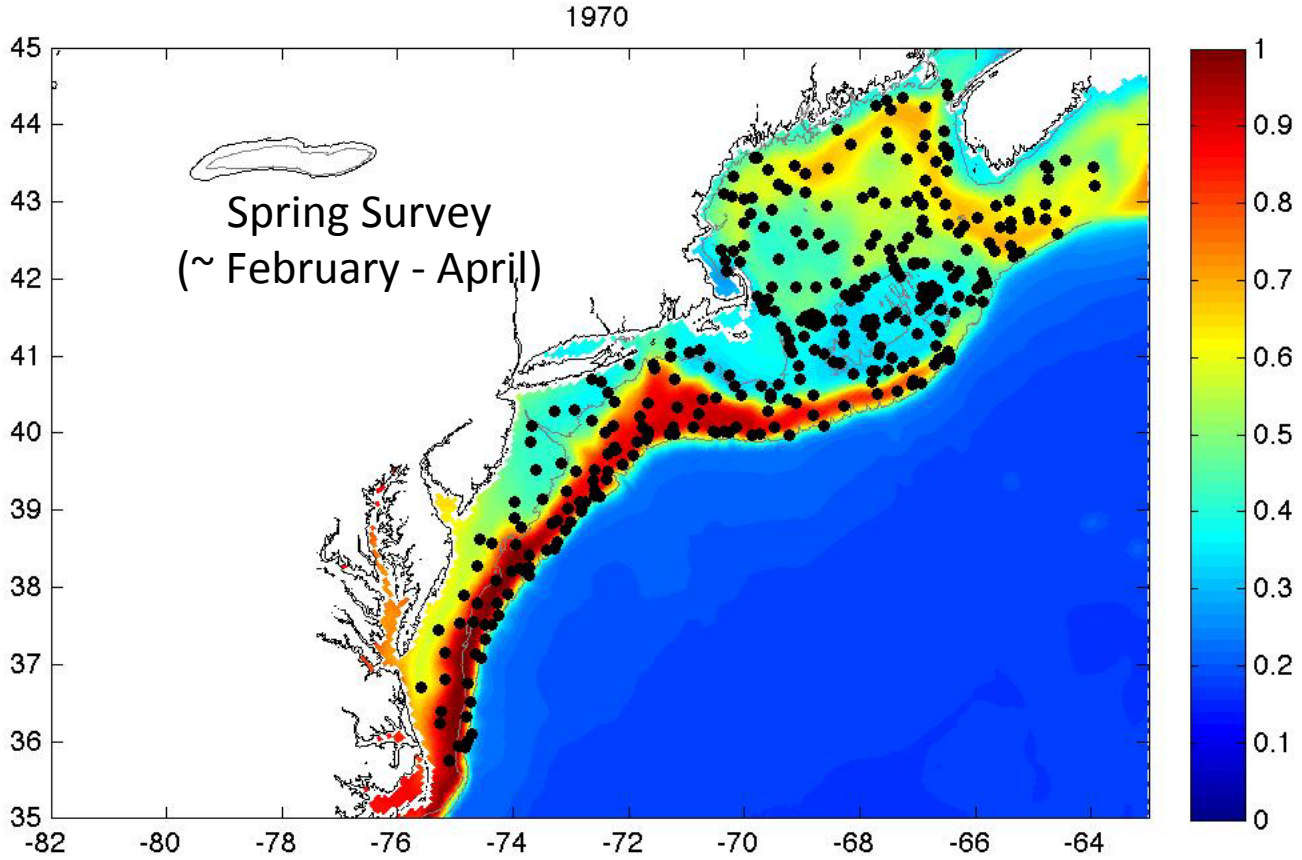
Index of thermal habitat quality

Can we improve stock assessments by using dynamic habitat models and fishery-dependent surveys as a supplement to current fishery-independent surveys?



1. **Recalibration of indices of population trend based upon the amount of habitat actually sampled in fisheries independent surveys**

Can we improve stock assessments by using dynamic habitat models and fishery-dependent surveys as a supplement to current fishery-independent surveys?



1. **Recalibration of indices of population trend based upon the amount of habitat actually sampled in fisheries independent surveys**

2. **Guide industry based population surveys of dynamic habitat intended to supplement fishery-independent surveys.**

Summary

- Ocean observatories capture the dynamics of marine habitats
- Mechanistic models linked to physical models **co-developed with scientists, managers, and the industry** may support fisheries assessment and management through:

1) the recalibration of existing surveys given CPUE within modeled habitat and the extent of that habitat.

2) guided supplemental surveys with the industry stratified on the modeled habitat

Butterfish habitat model 3.0

(resolution~40 km 22 nm)