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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Olaf Jensen (Rutgers)
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Physical and Biological Oceanographers
Josh Kohut (Rutgers)
Matt Oliver (U. Delaware)

Human Dimensions
Steven Gray (U Hawaii)
Fisheries Management
Jason Didden (MAFMC)
Length-time scales of turbulent structures in the atmosphere & ocean & ecosystem processes

Terrestrial ecosystem processes 1000 – 10,000 x “slower” than the atmosphere

“Velocities” of marine ecosystem processes match the fluid & faster than in terrestrial ecosystems
Mid-Atlantic Regional Association Coastal Ocean Observing System: From Observations to Forecasts

MANY MANY MANY MANY PEOPLE
Regional Ocean Observing System

Data:
- Satellites
- HF radar
- Gliders
- Buoys

Ensemble of Assimilation Models

ROMS
HOPS

MARACOOS
Ocean Information for a Changing World
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)
**HF radar data**

**Satellite data**

**Response models**

**Divergence index**

- **Downwelling**
- **Upwelling**

**Frontal index**

- **Distance**: Far, Close
- **Strength**: Weak, Strong

**Graphs**

- Color scales for divergence and frontal index.
- Graphs showing response models.
Sometimes a management problem finds you
Butterfish by-catch mortality cap in the longfin inshore squid fishery

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**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
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

Percent stations within habitat
Fall Survey

![Graph showing inter-annual variability of survey strata within preferred bottom habitat.](image-url)
Mechanistic Habitat Model 3.0

Unimodal Boltzmann-Arrhenius function
Metabolic basis to thermal habitat

Bottom temperatures from ROMS model hindcasts
Enrique Curchitser

1958-2007
Daily Temperature
~7 km Resolution
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)
Backward stepwise CV (N iterations=999)