



**NOAA**  
**FISHERIES**

# Collaboration & crowd-sourcing applied seascape ecology to support of ecosystem based fisheries management

NEFSC Ecosystem Program Review

8 June 2016

John Manderson, John Hoey,  
Jon Hare & David Richardson

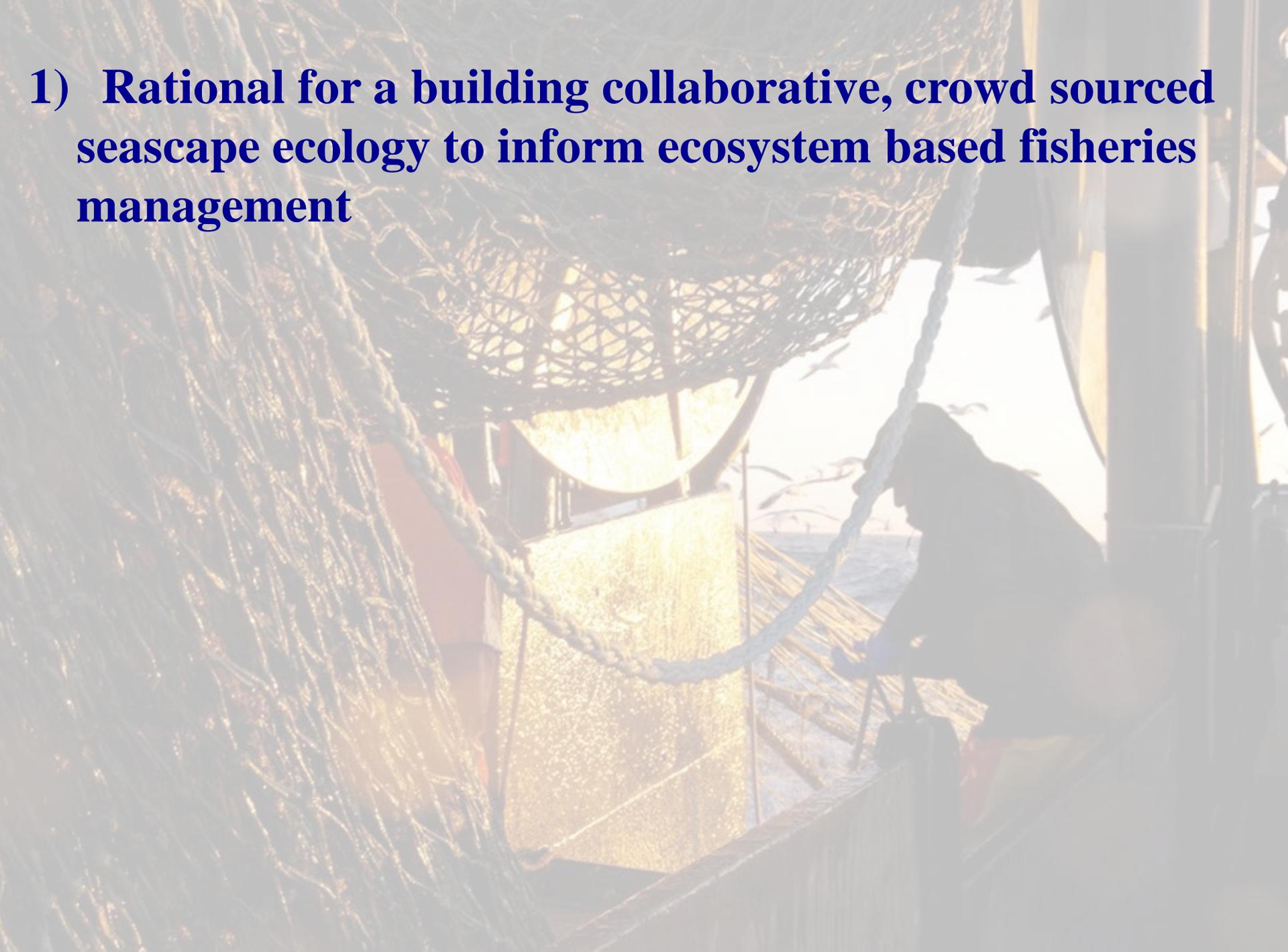
A fisherman is silhouetted against a bright sunset as he works with a large, glowing fishing net on a boat. The net is illuminated from within, creating a warm, golden glow. The background shows the sea and a few birds in flight.

**1) Rationale for a building collaborative, crowd sourced seascape ecology to inform ecosystem based fisheries management**

**2) Data available to inform collaborative seascape ecology**

**3) Building collaborative seascape ecology to support ecosystem based fisheries management**  
*(using of study fleet infrastructure)*

**1) Rational for a building collaborative, crowd sourced seascape ecology to inform ecosystem based fisheries management**



# "What's past is .. not .. prologue"

*Understanding the present & forecasting the future requires an understanding underlying mechanisms*

AGU PUBLICATIONS

JGR

Journal of Geophysical Research: Oceans

## RESEARCH ARTICLE

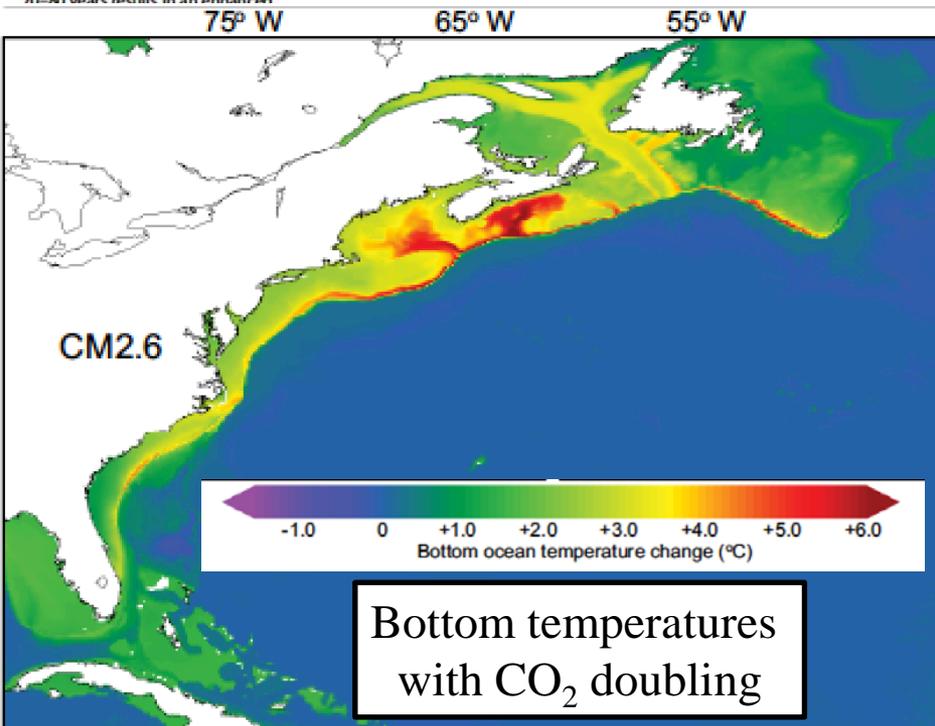
10.1002/2015JC011346

### Enhanced warming of the Northwest Atlantic Ocean under climate change

Vincent S. Saba<sup>1</sup>, Stephen M. Griffies<sup>2</sup>, Whit G. Anderson<sup>2</sup>, Michael Winton<sup>2</sup>, Michael A. Alexander<sup>3</sup>, Thomas L. Delworth<sup>2</sup>, Jonathan A. Hare<sup>4</sup>, Matthew J. Harrison<sup>2</sup>, Anthony Rosati<sup>2</sup>, Gabriel A. Vecchi<sup>2</sup>, and Rong Zhang<sup>2</sup>

#### Key Points:

- Northwest Atlantic circulation bias is reduced in a high-resolution global climate model
- Atmospheric CO<sub>2</sub> doubling over 70–80 years results in an enhanced



- Habitat locations & volumes are changing
- Habitat phenologies & durations are changing
- Stocks have & are shifting north &/or deeper
- Rates of growth, development & mortality underlying dynamics are changing

**We are in the sustainable food business**



**World bank: 1/3 of human population depends on fish for nutrition**

Ecosystems are weakly bounded complex adaptive systems  
Man embedded in complex, self (dis)organizing, natural ecosystems



The past is not prologue & we depend on ecosystems for subsistence

A photograph of a fisherman on a boat at sunset. The fisherman is silhouetted against the bright orange and yellow light of the setting sun. In the foreground, a large, intricate fishing net is draped over the side of the boat, its mesh catching the light. The background shows the sea and a few birds flying in the sky.

**1) Rational for a building collaborative, crowd sourced seascape ecology to inform ecosystem based fisheries management**

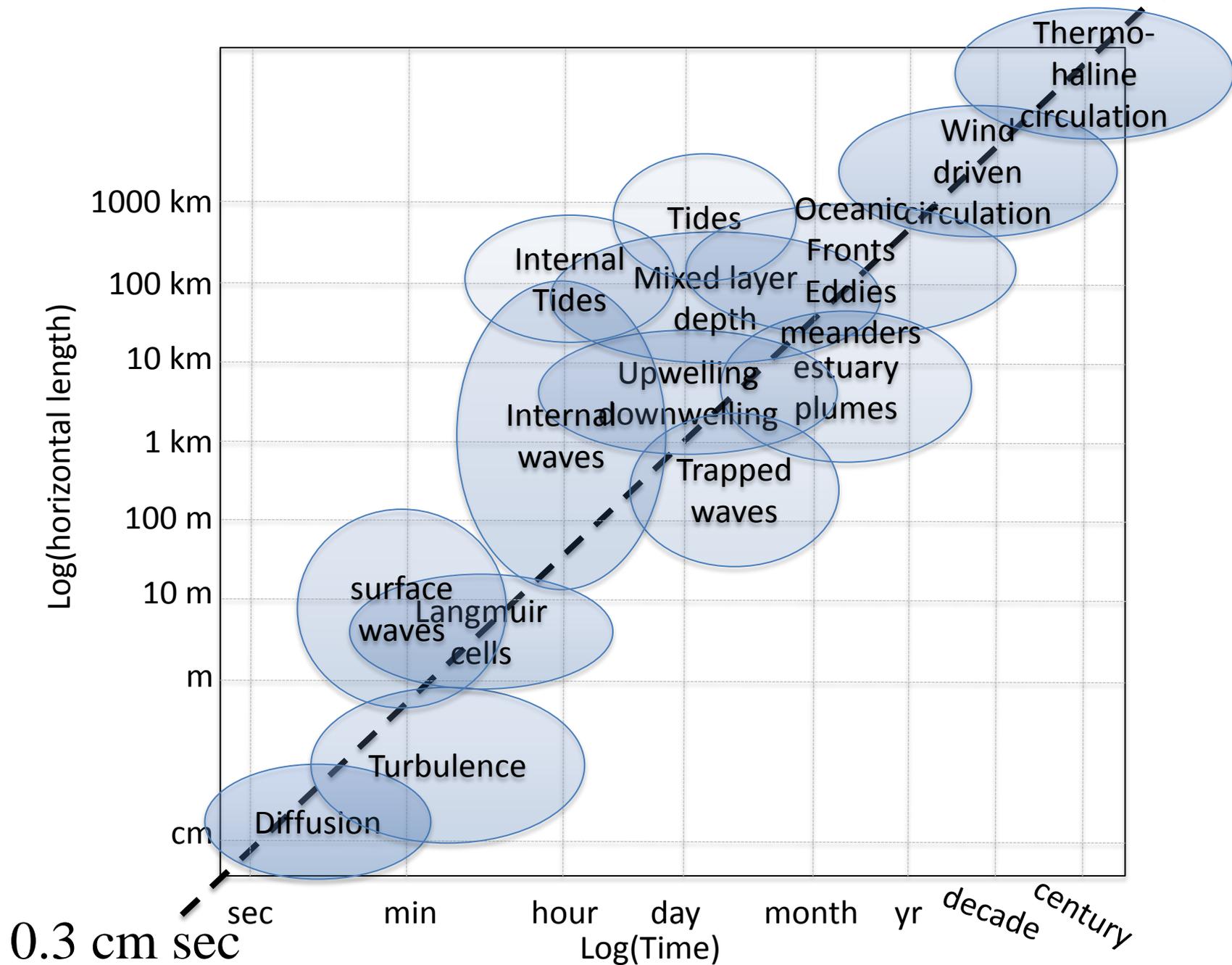
**2) Data available to inform collaborative seascape ecology**

Seascape ecology: The spatially & temporally explicit study of interactions between ocean processes, individuals, populations & ecosystems including human socioecological & economic activities

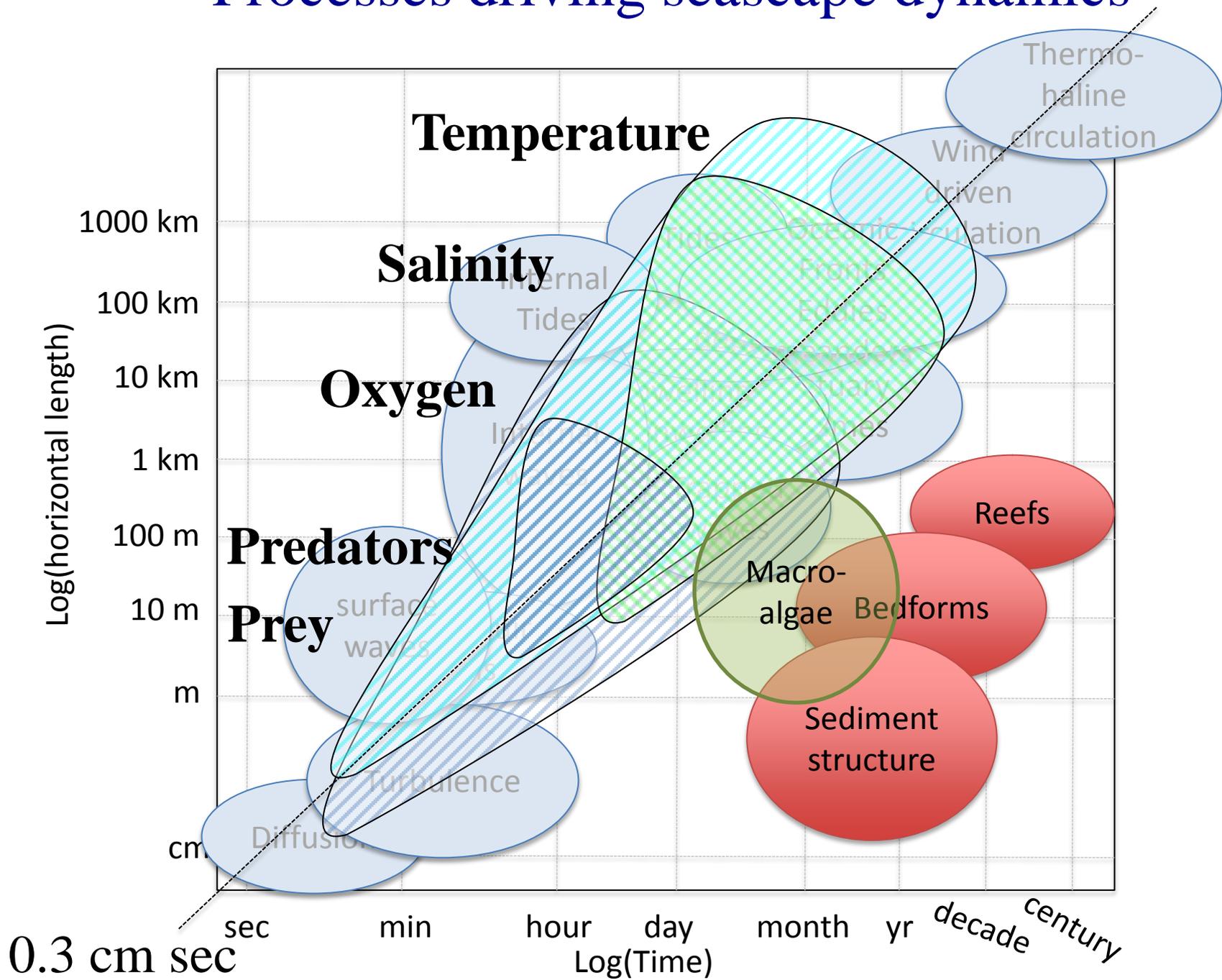


Dynamic hydrography lies at the foundation of seascape ecology  
*Living in a liquid is different from living in a gas*

# Processes driving seascape dynamics



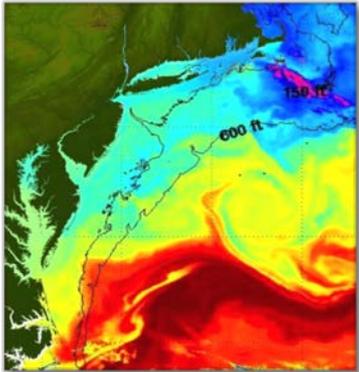
# Processes driving seascape dynamics



# Ocean Observing Systems

Measure & model physical & primary production dynamics  
in (*near*) real time

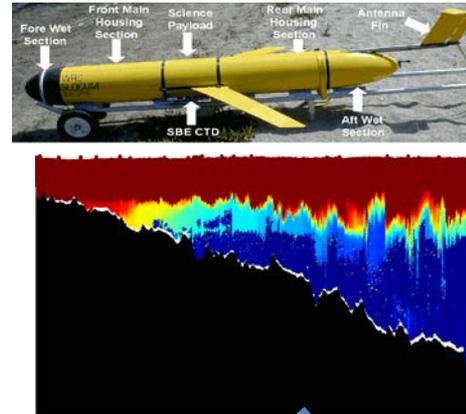
Satellites



HF radar



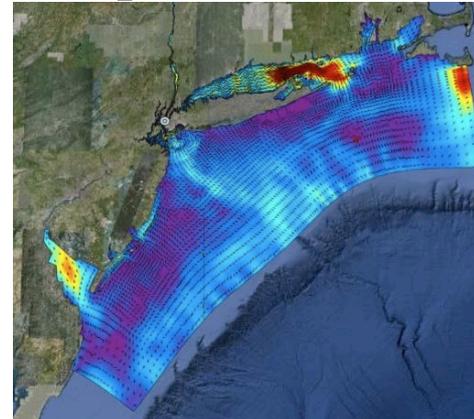
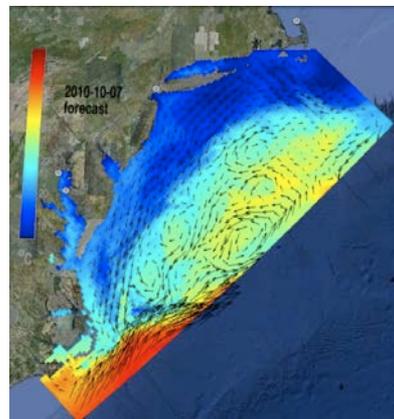
Gliders



Buoys



Ensemble of assimilative & operational Ocean Models

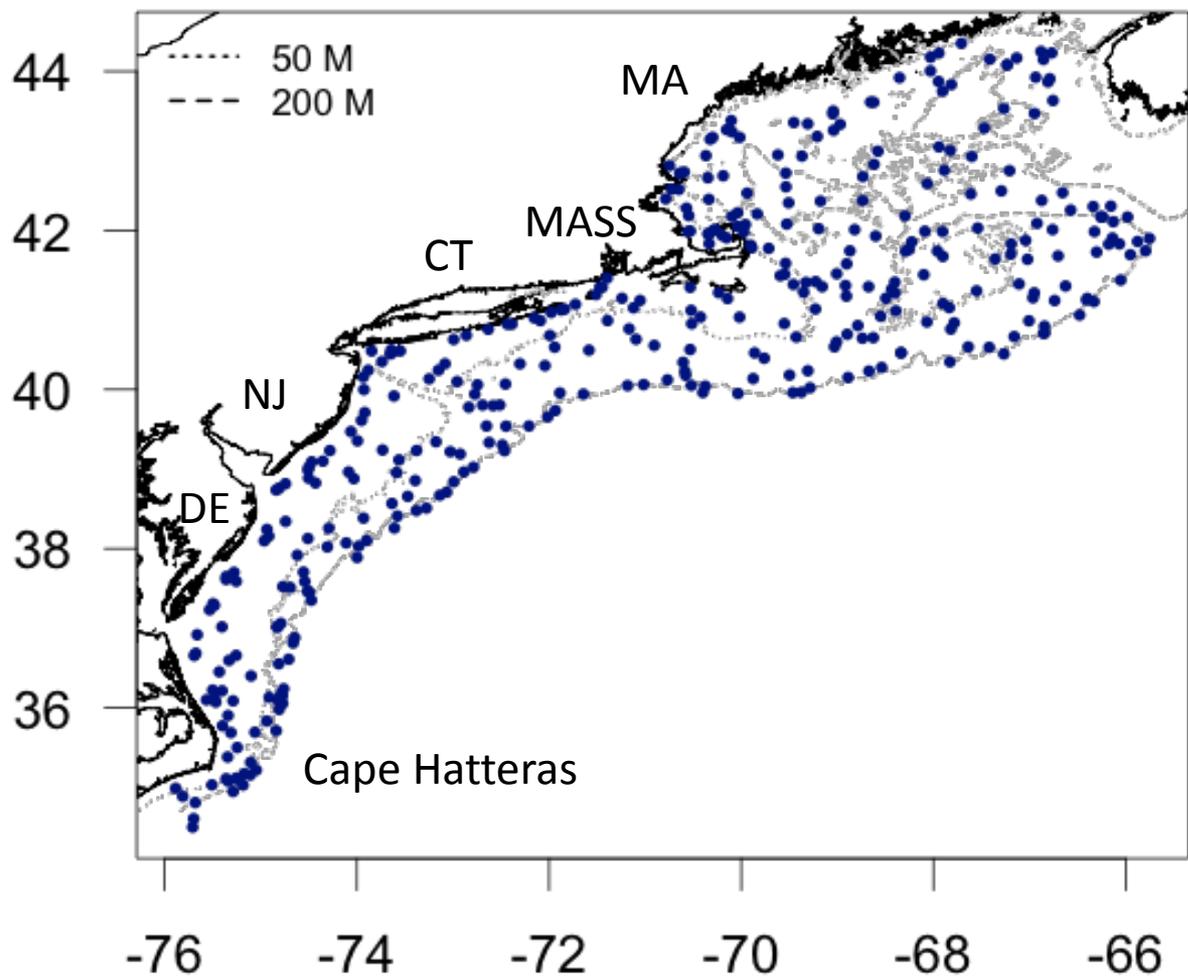


**MARACOOS**  
Ocean Information for a Changing World



# Biological data collected on regional surveys for population not habitat assessment

## 2013 NEFSC fall bottom trawl survey



### Space

Extent = 224,562 km<sup>2</sup>

Distance stations = 12 km

Depths = 20M-250M

### Time

Extent = 53 years

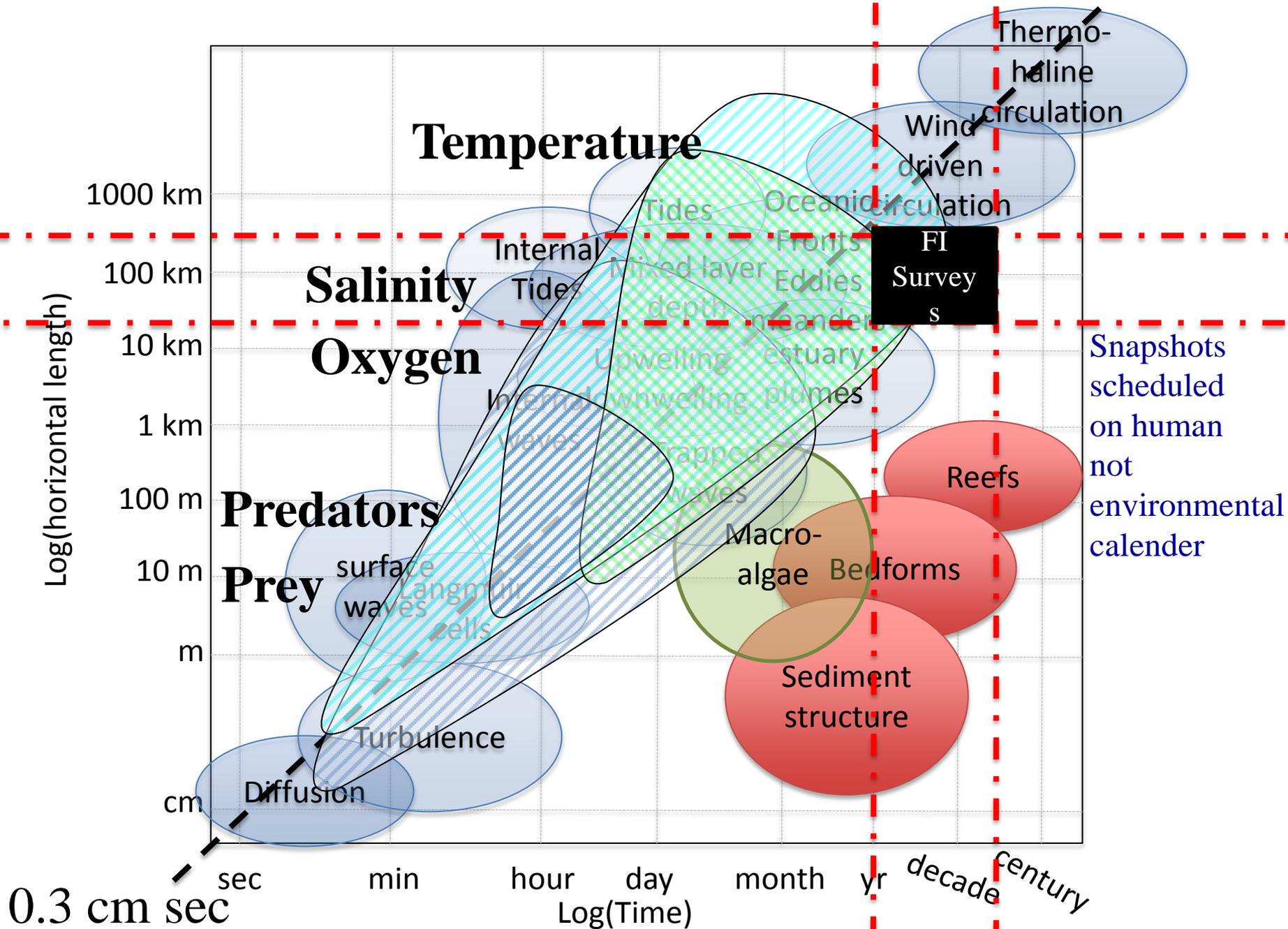
Spring & Fall Snapshots

(~ 53 days)



\* Longest dimension = 1210 km

# Survey space-time frame & seascape dynamics

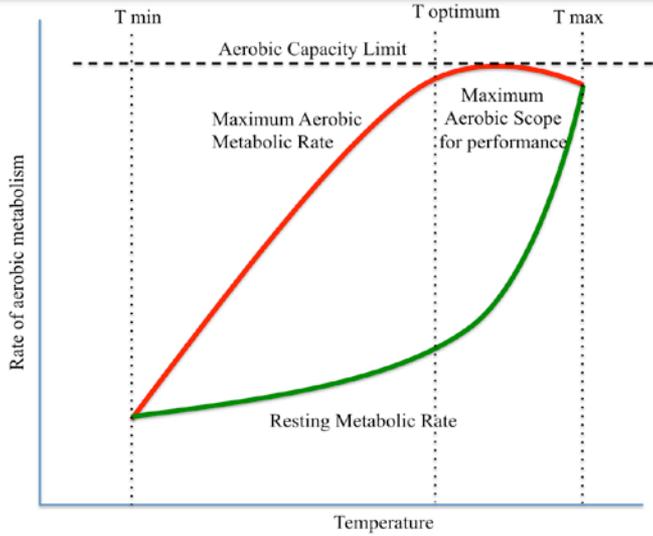
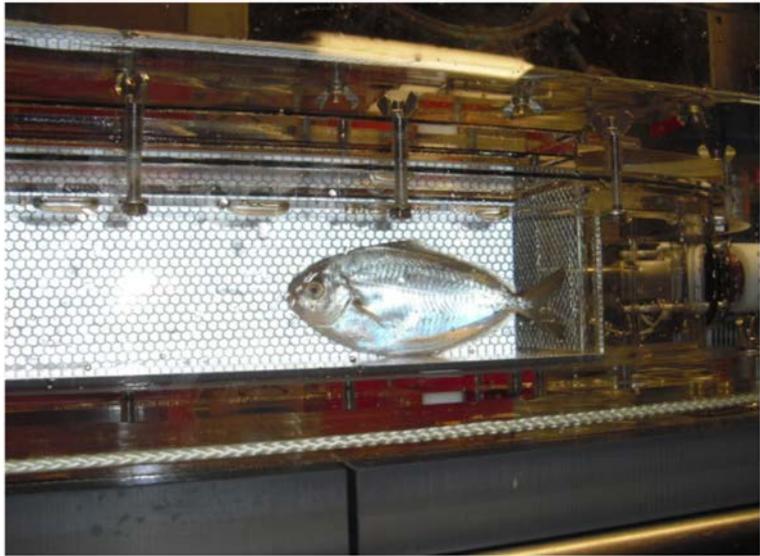


# Filling ecological data gaps? *(including ecology of humans)*



# Traditional scientific approaches

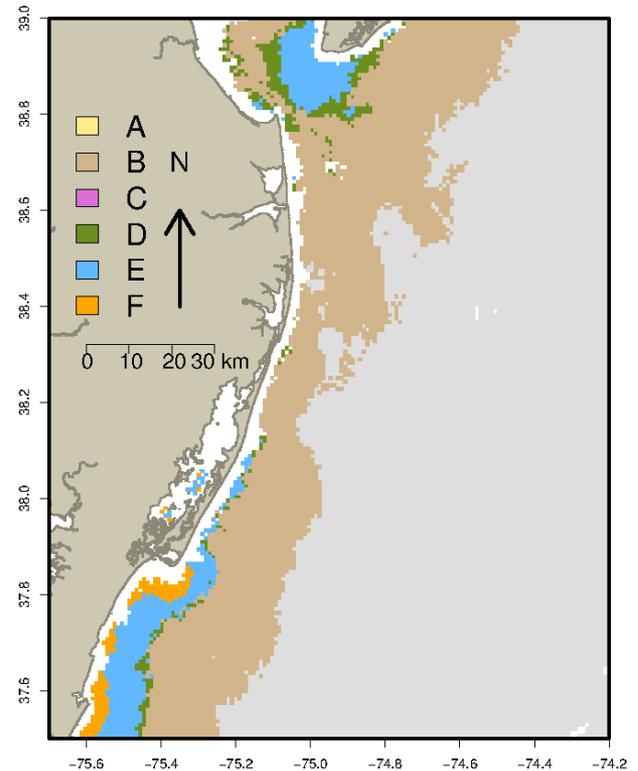
## Laboratory based



## Field based



2013-04-04

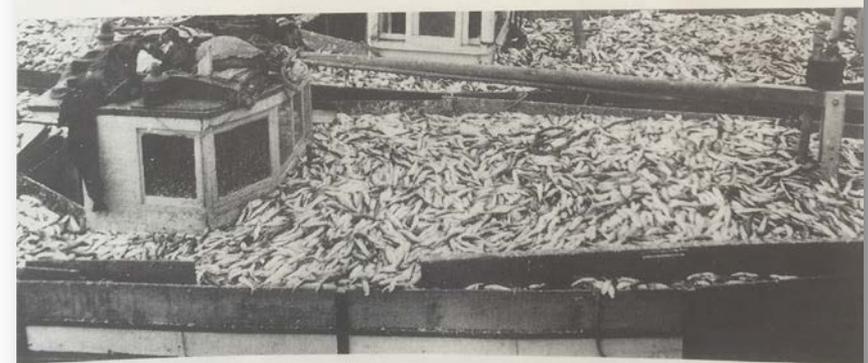


# *Why not perform fisheries science the old fashioned way?*

**William F Thompson**

Collaborative investigation  
with fishing industry  
continuously within ecosystem  
in real time

**Johan Hjort**



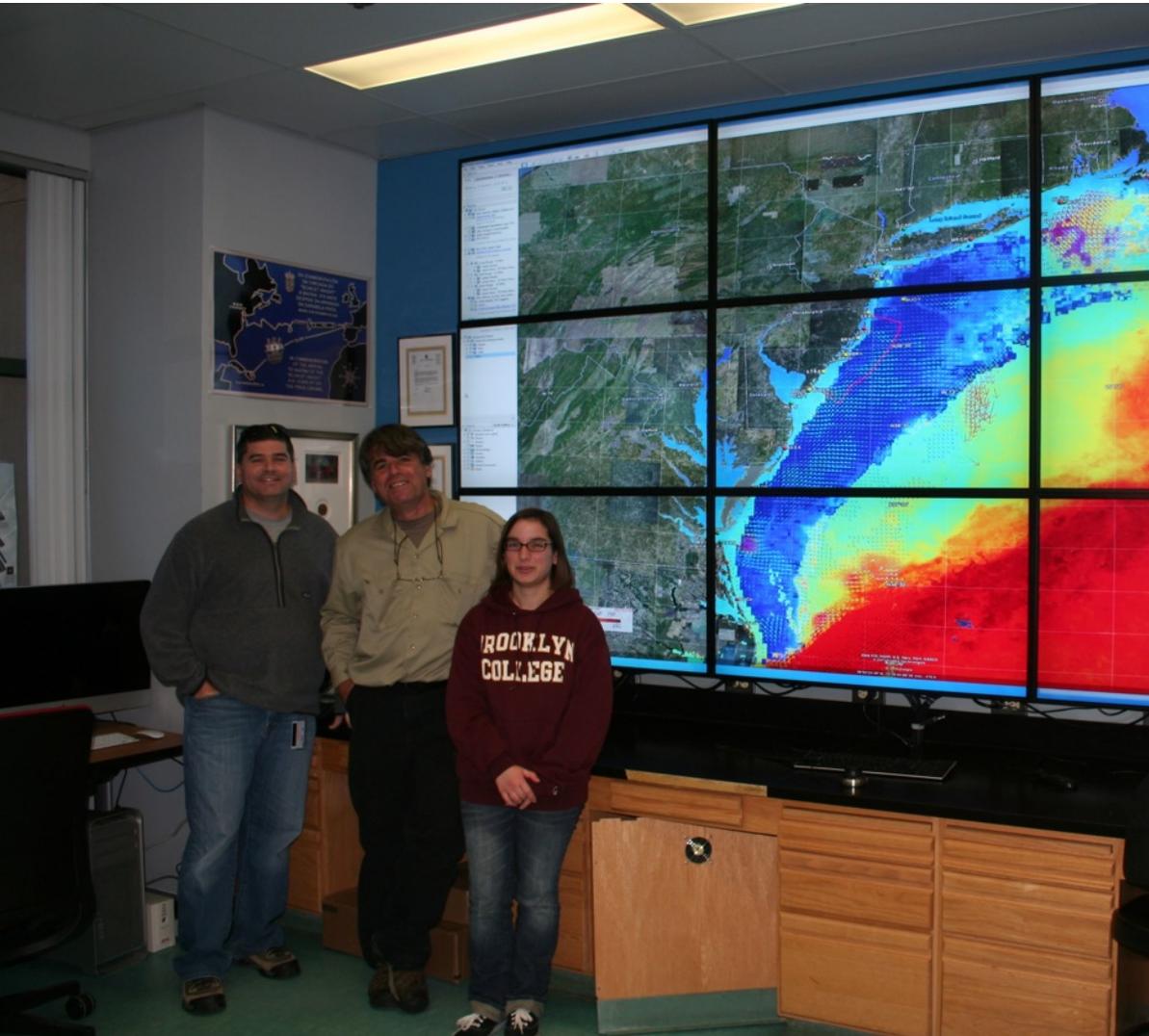
**Early 20th Century  
Fisheries Science**

# Why?

Fisherman: Operate continuously at space-time scales of  
species-habitat & species-species interactions  
(given economic incentives & regulatory constraints)  
& *provide insight into human dimensions*



### 3) Collaboration & crowd-sourcing operational seascape ecology

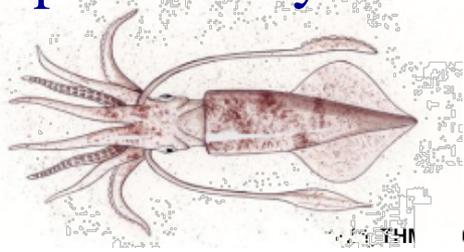


# Broadest scale of investigation:

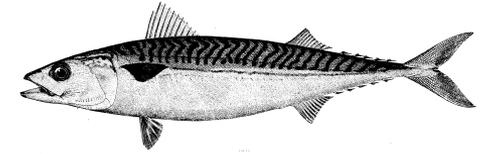
## Monitor dynamics of whole fleet & seascape in real time

(10-01-2015 to 05-01-2016)

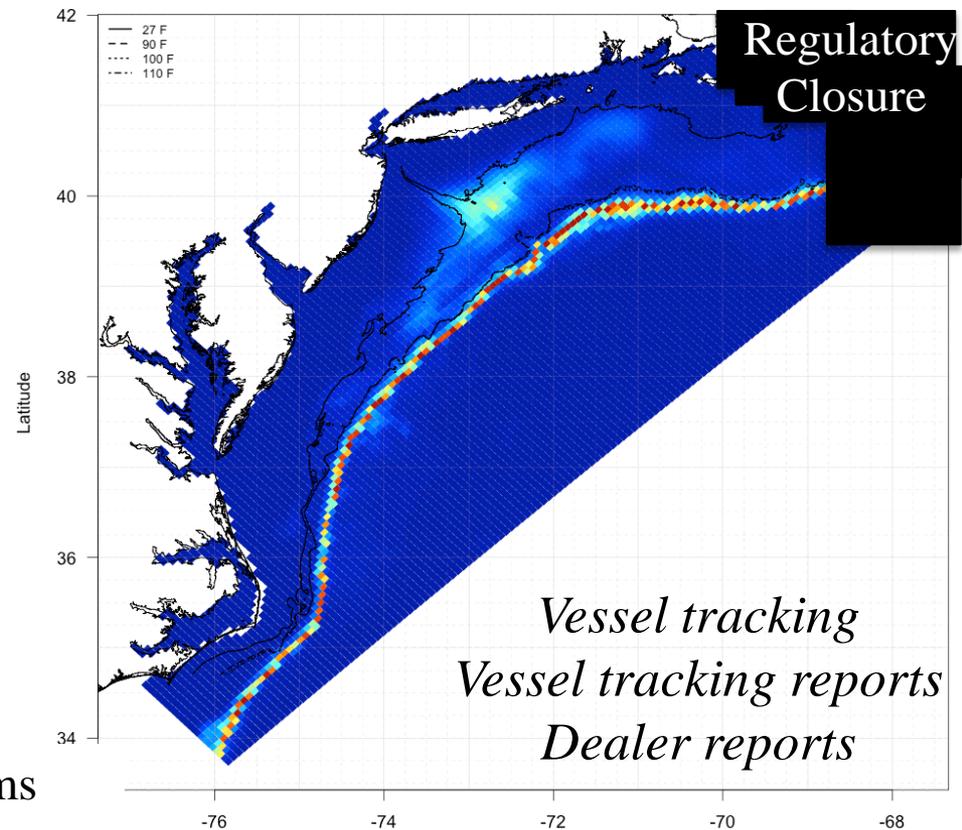
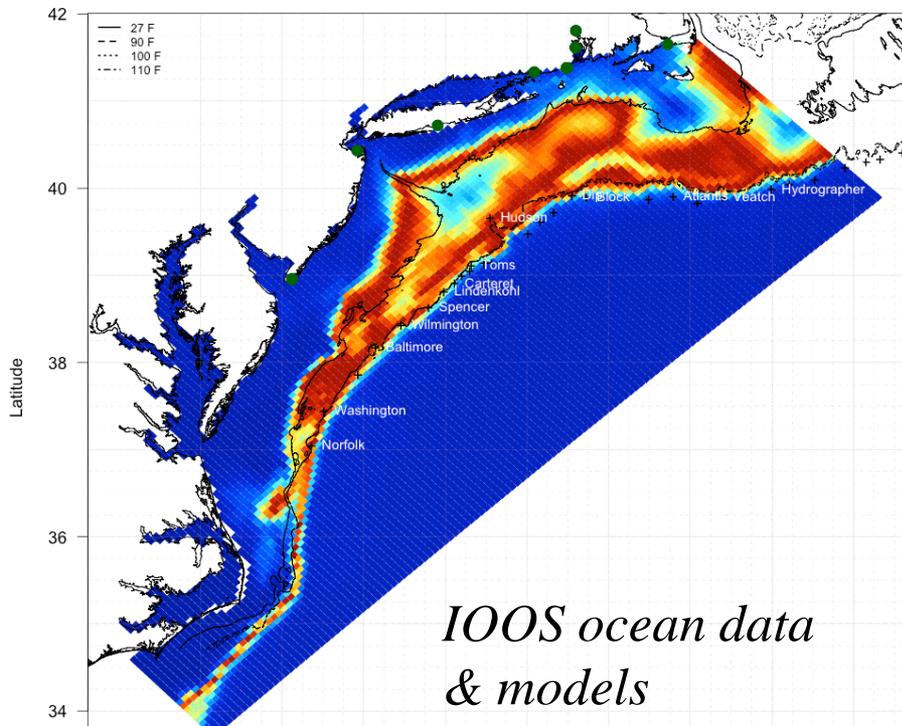
Fishing effort, availability & landings = f (seascape dynamics \* population dynamics \* global economics & economic alternatives \* management regulations)



15-10-01

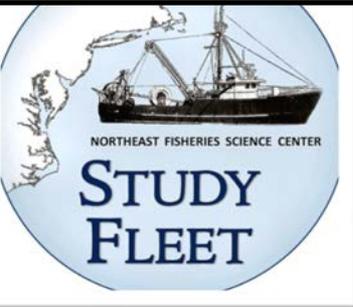


Dec:HER, Mackerel\_THM : 2015-10-01



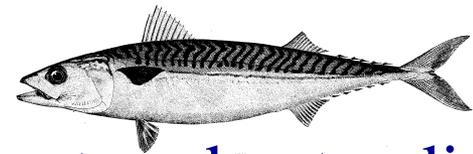
# Medium-scales:

## Collaborative development of seascape models with study fleets

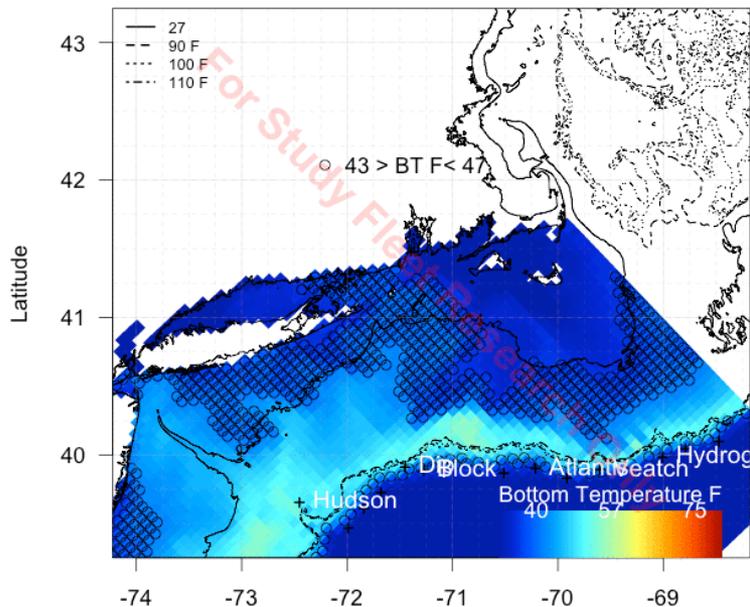


Products => co-developed models

Process => transfer of fishery dependent understanding

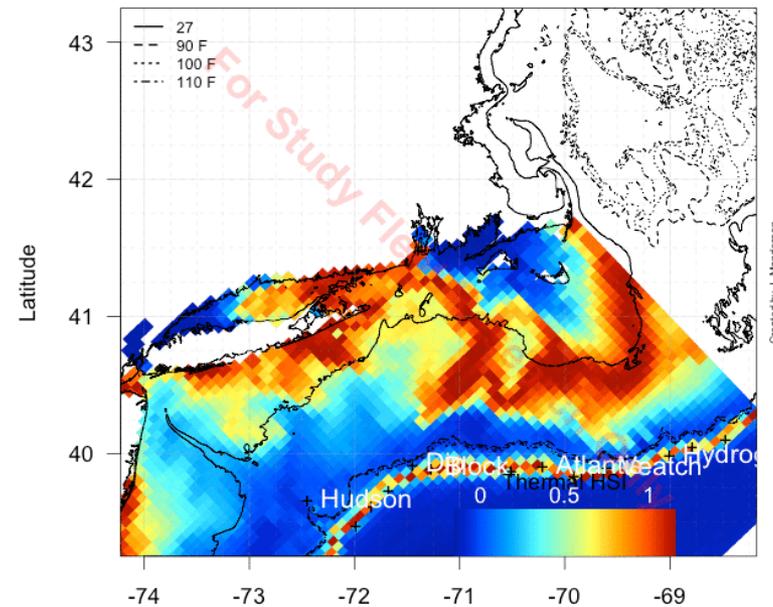


Bottom temperature F: 2016-02-03 13:00:00 GMT



Modeled bottom temperature

Atlantic Mackerel : 2016-02-03 13:00:00 GMT

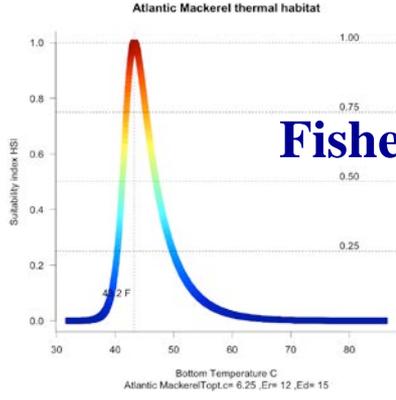


Thermal habitat suitability

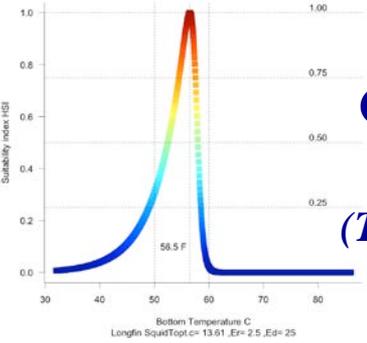
Created by J. Manríquez

# Niche model flavors

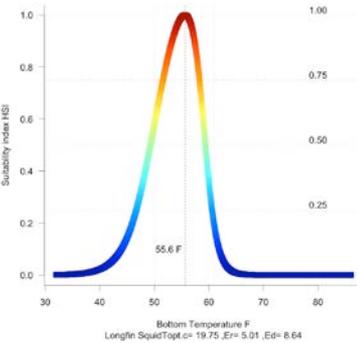
(Specific & proprietary to industry partners)



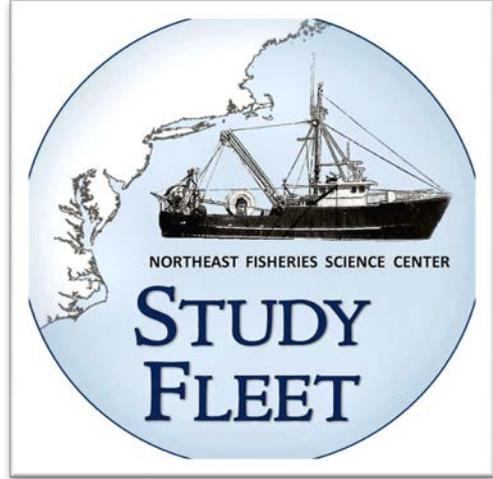
**Fisheries Independent surveys**



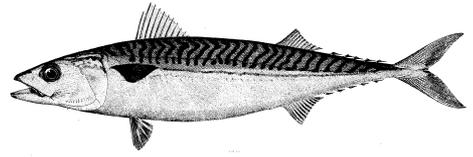
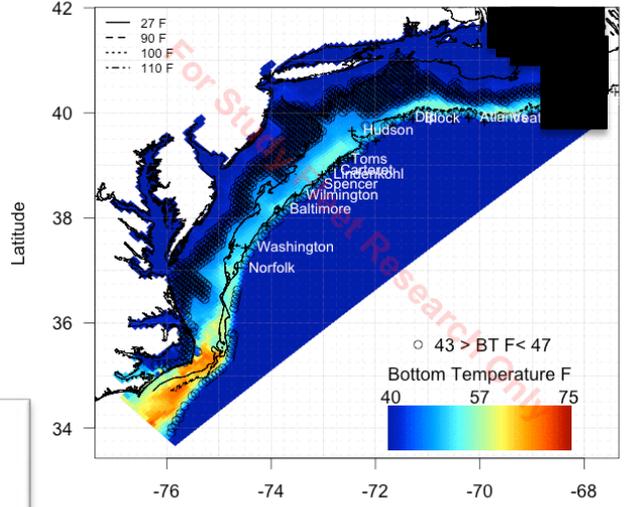
**Catch per hour by partner**  
(Tow by tow reporting & sensors)



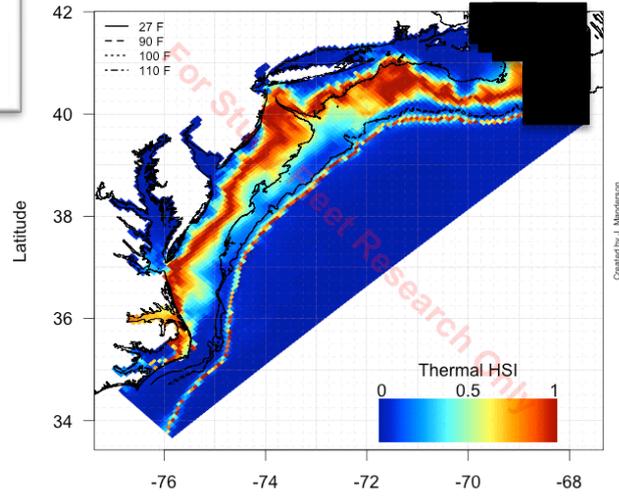
**Unique mental model of partner**



Bottom temperature F: 2016-02-19 13:00:00 GMT

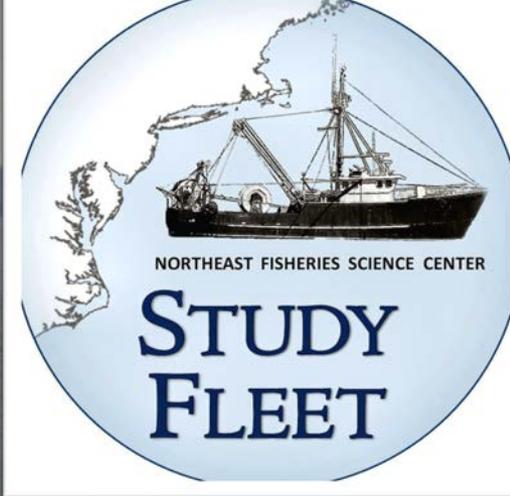
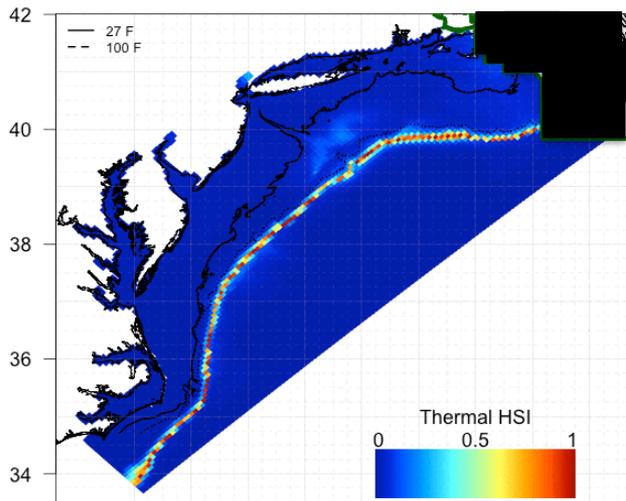


Atlantic Mackerel : 2016-02-19 13:00:00 GMT



2016-03-27 23:52:03 NL-BA model:(Er= 12 Ed= 15 Topt= 6.25 )

AtlanticMackerel : 2015-11-01

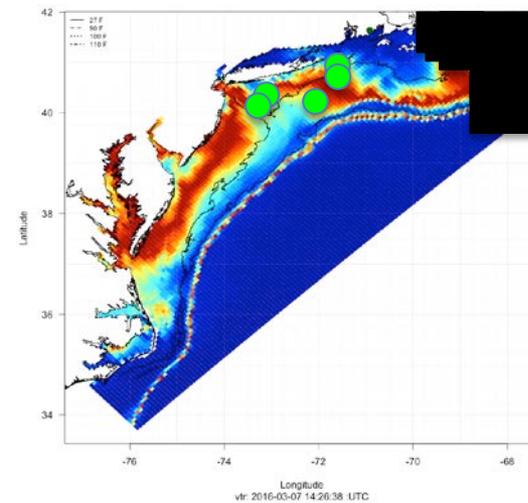
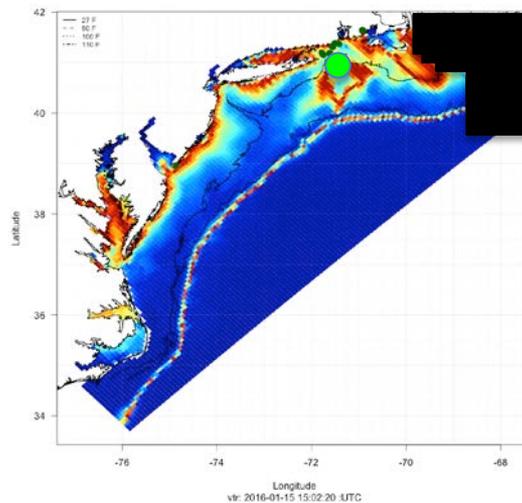
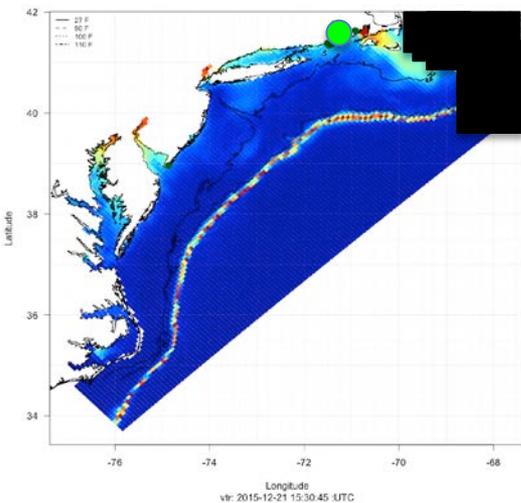


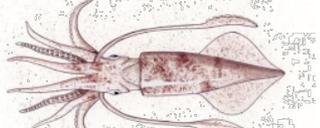
## Blind & transparent evaluations of crowd-sourced models with fleets & study fleets

Dec 21, 2015

Jan 15, 2016

Dec: H  
Feb 7, 2016



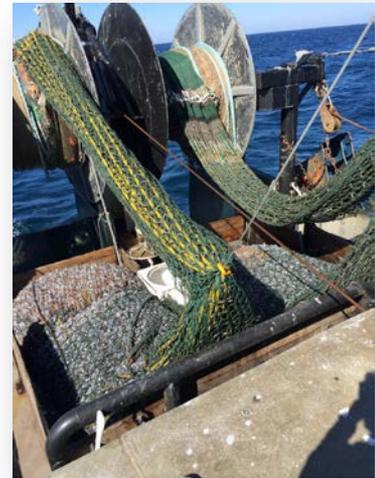
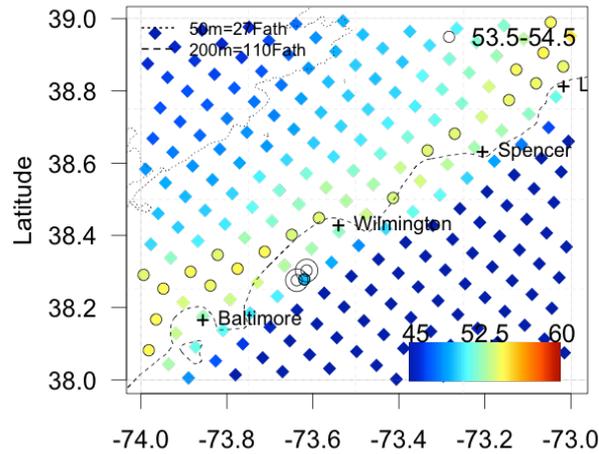


# Finest scales:

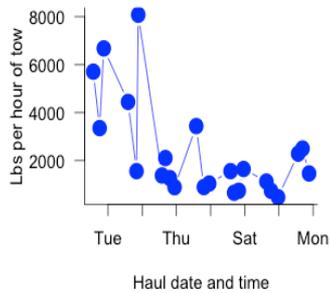
## Field investigations with individual collaborators

co-develop empirical understanding of seascape dynamics, catch, & bycatch avoidance to inform next generation models

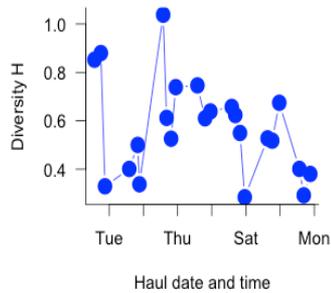
### Modeled hydrography



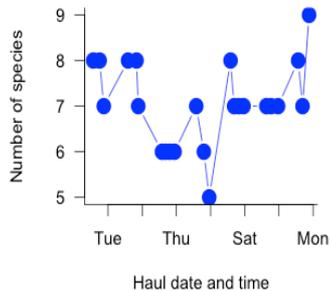
Longfin squid:2/12-2/23/14



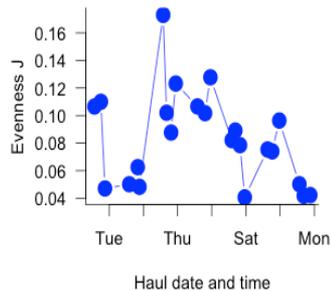
Diversity H:2/12-2/23/14



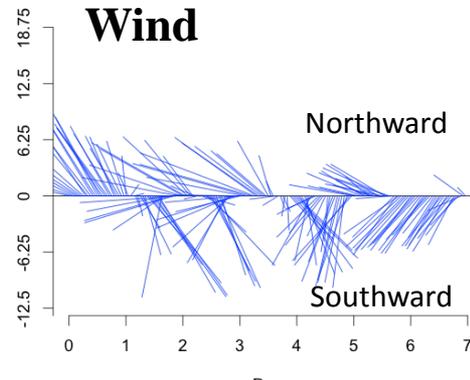
Number of species:2/12-2/23/14



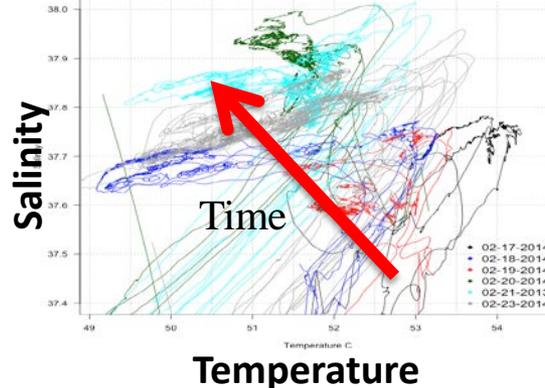
Evenness J:2/12-2/23/14



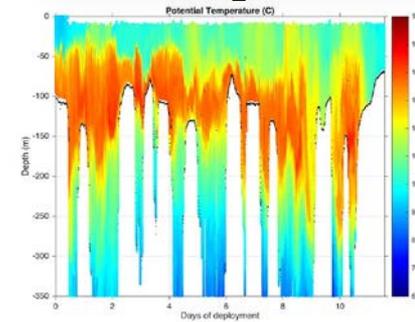
### Wind



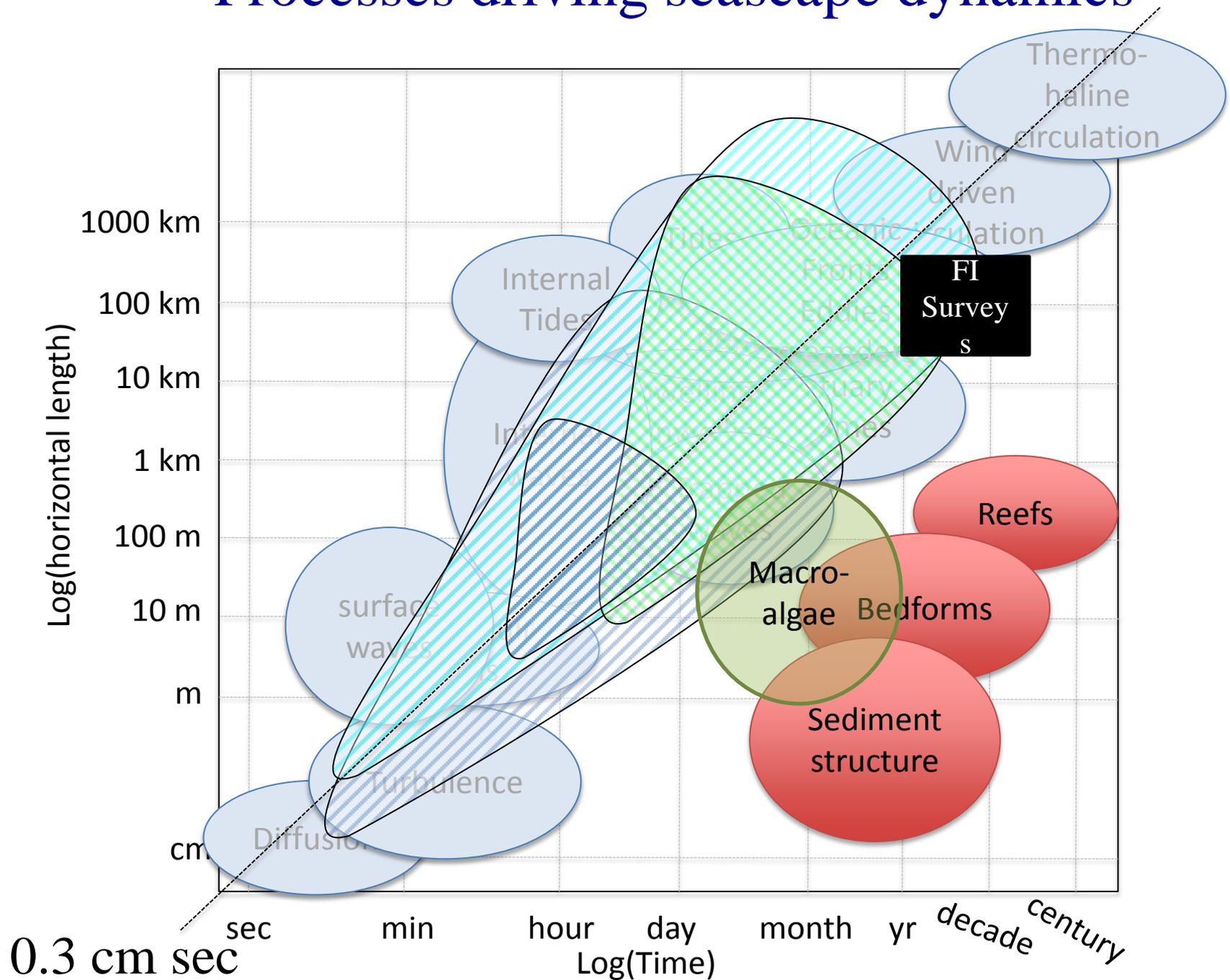
### Measured hydrography



### Glider profile

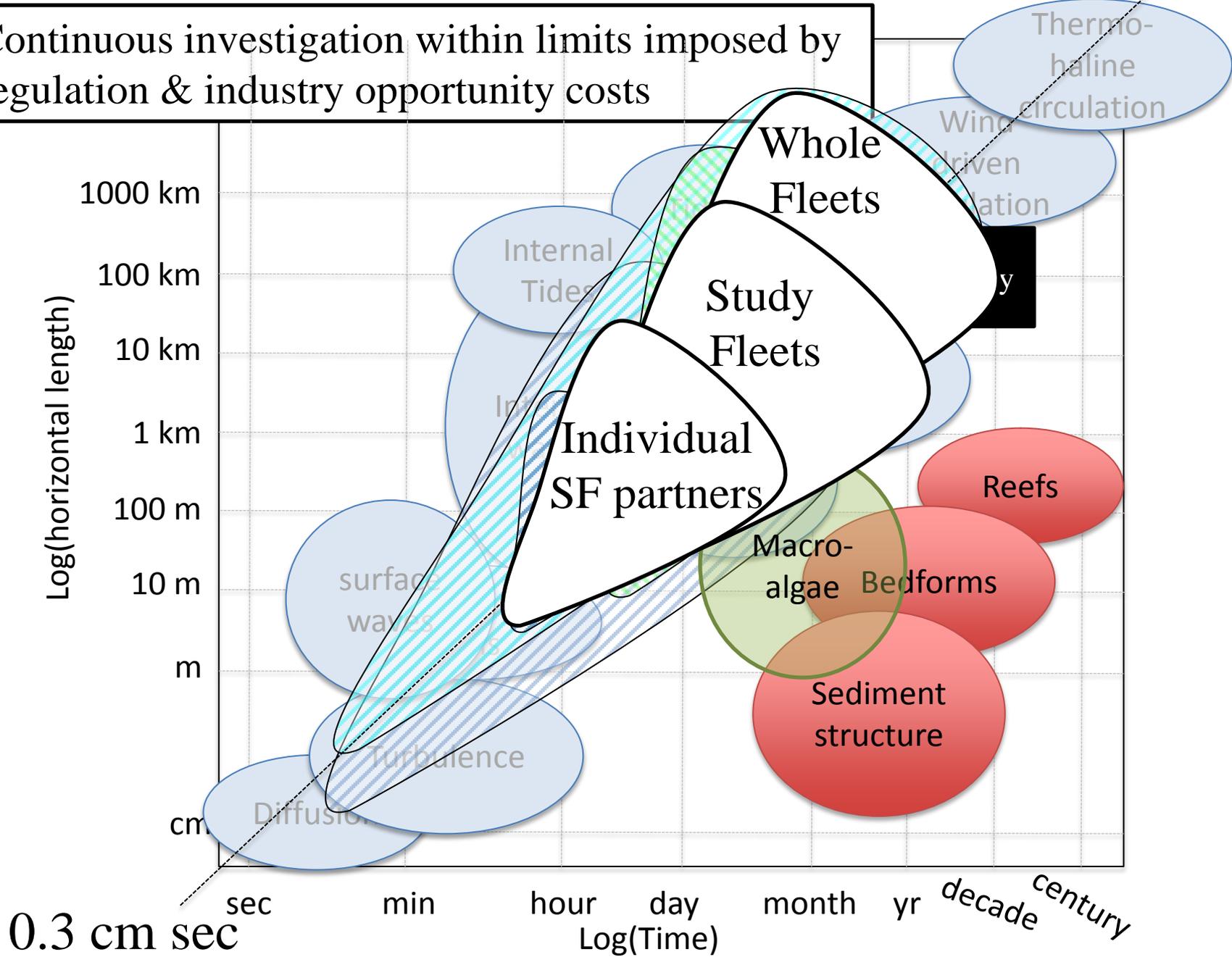


# Processes driving seascape dynamics



# Nested scales of collaborative investigation

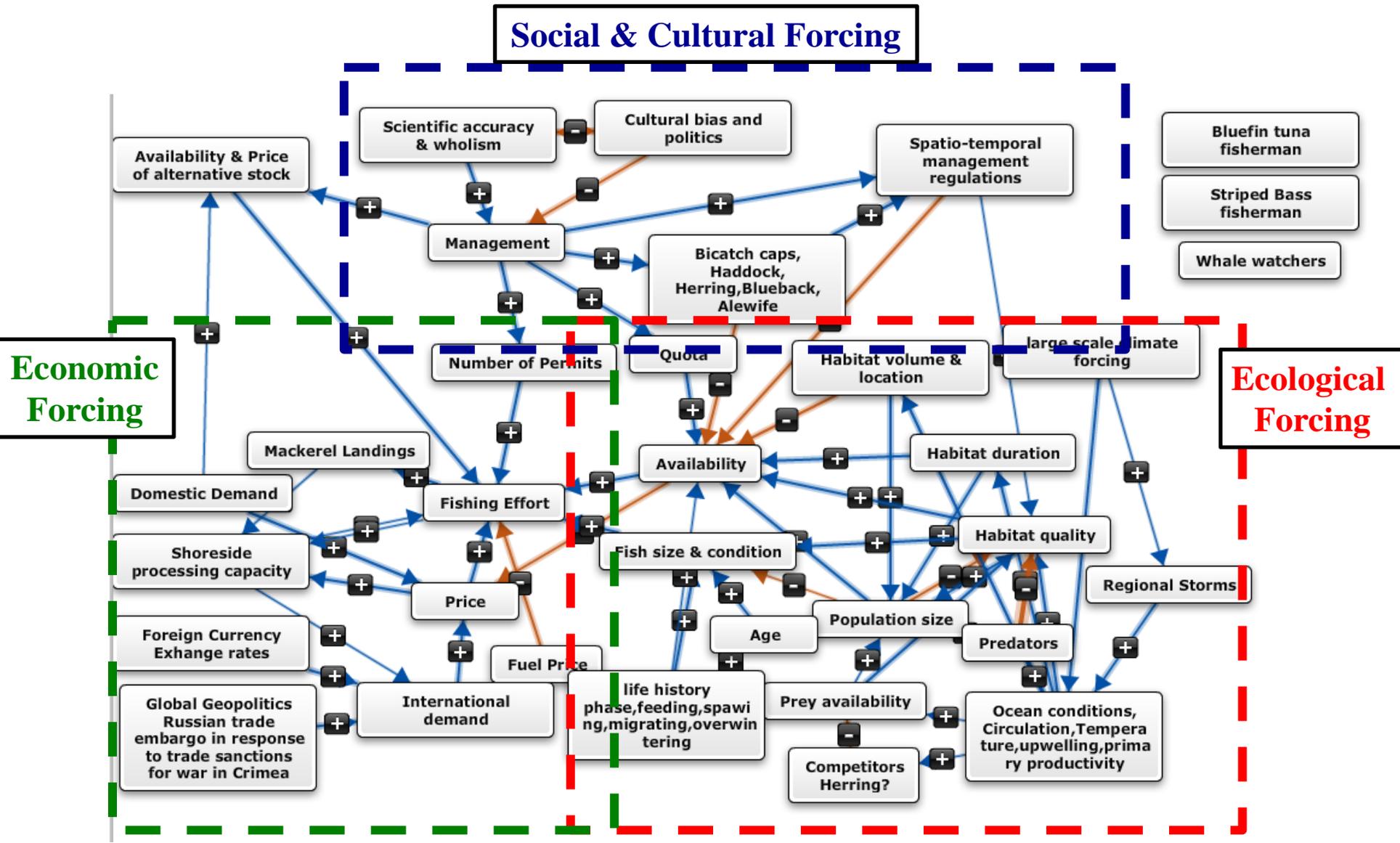
Continuous investigation within limits imposed by regulation & industry opportunity costs



At each scale of investigation talk to people.  
What's going on in the ecosystem & fishery in real time?  
(including human socio-ecological & economic components)



# “Horrendogram” of Atlantic Mackerel socio-ecological fishery system (preliminary mental model)

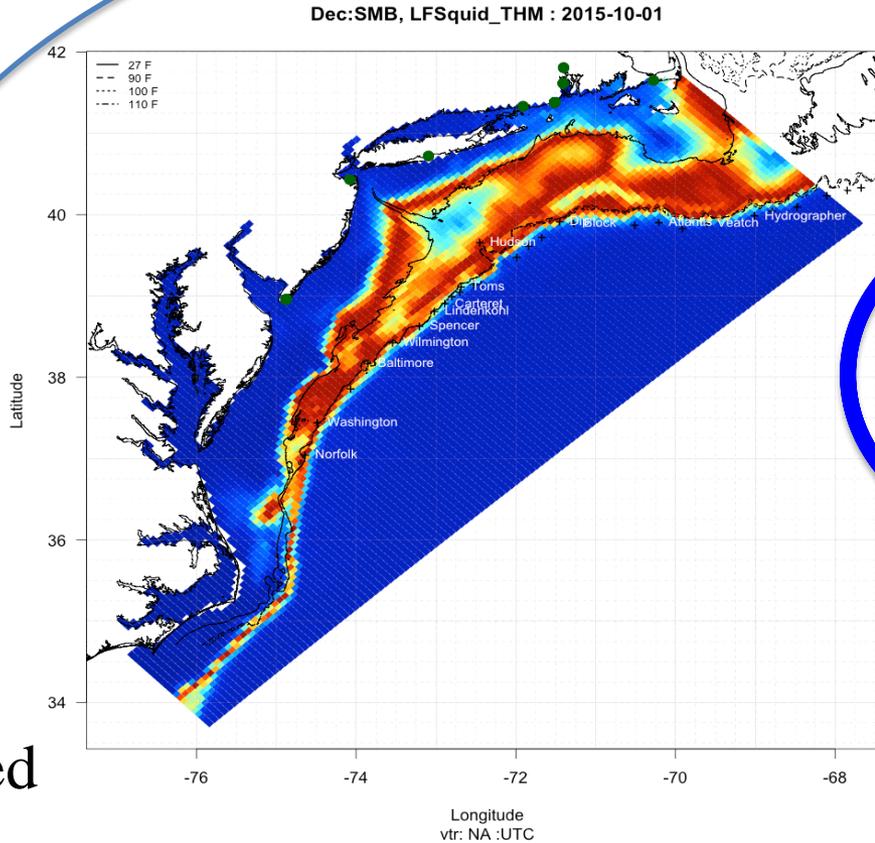


# Rapid climate, seascape & ecosystem change

Seascape ecology

Dynamic ocean management

Co-developed tools for sustainable use



Fishing Industry

Government

Academia

Ecosystem based population assessment

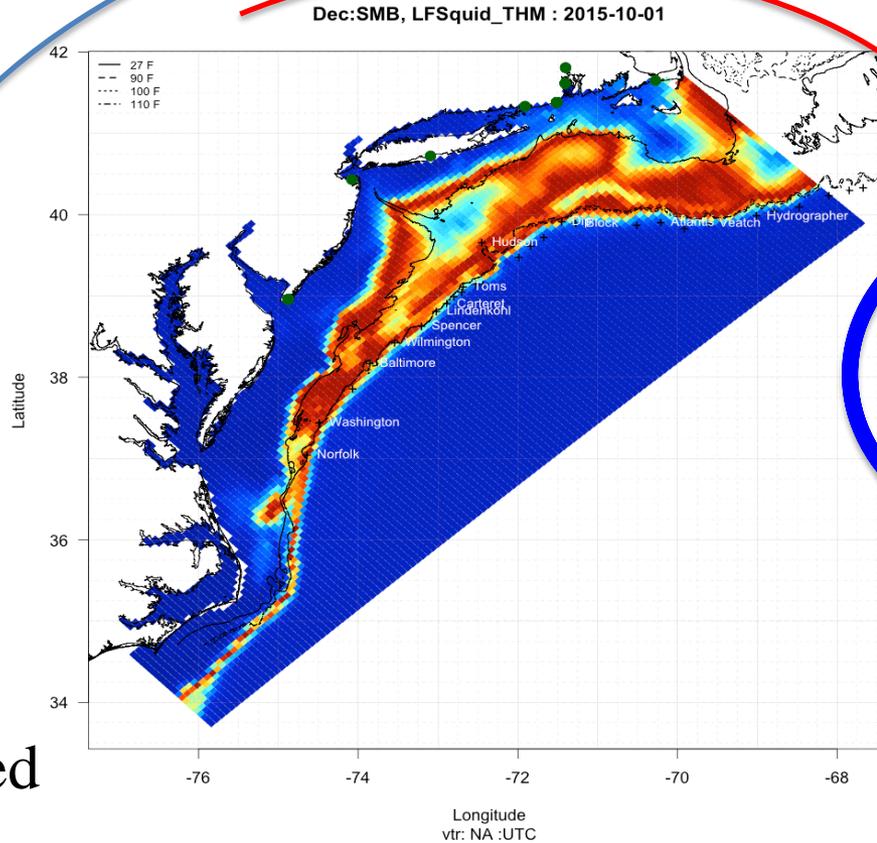
# Rapid climate, seascape & ecosystem change

Dynamic ocean management

Seascape ecology

Tactical regulations

Co-developed tools for sustainable use



Fishing Industry

Government

Academia

Ecosystem based population assessment

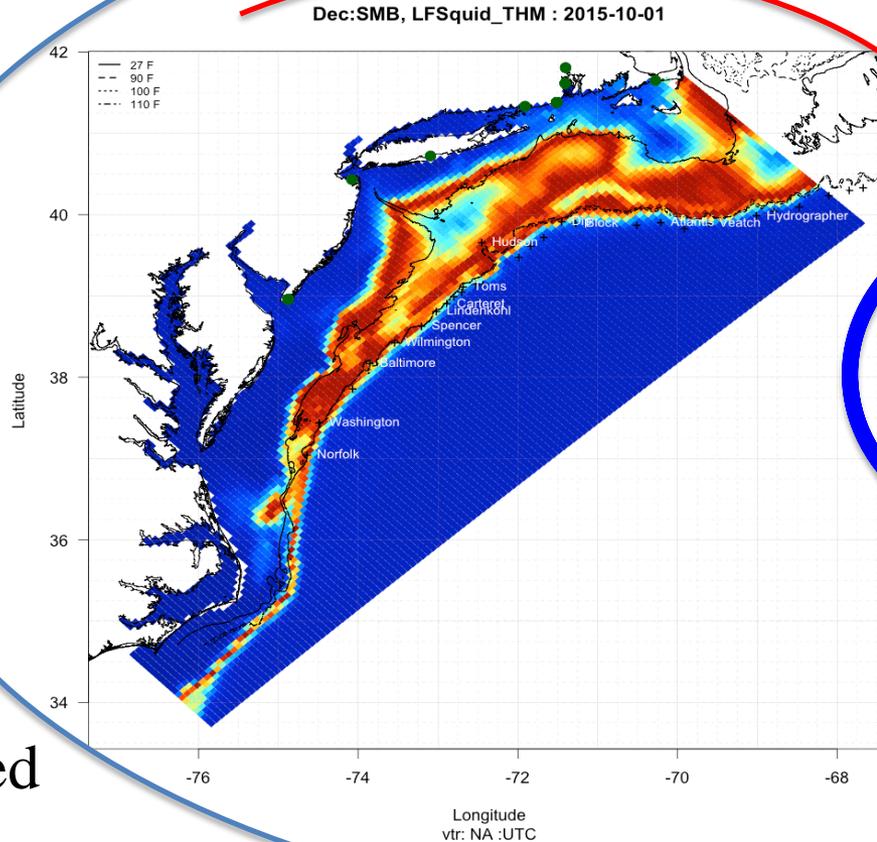
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Population ecology

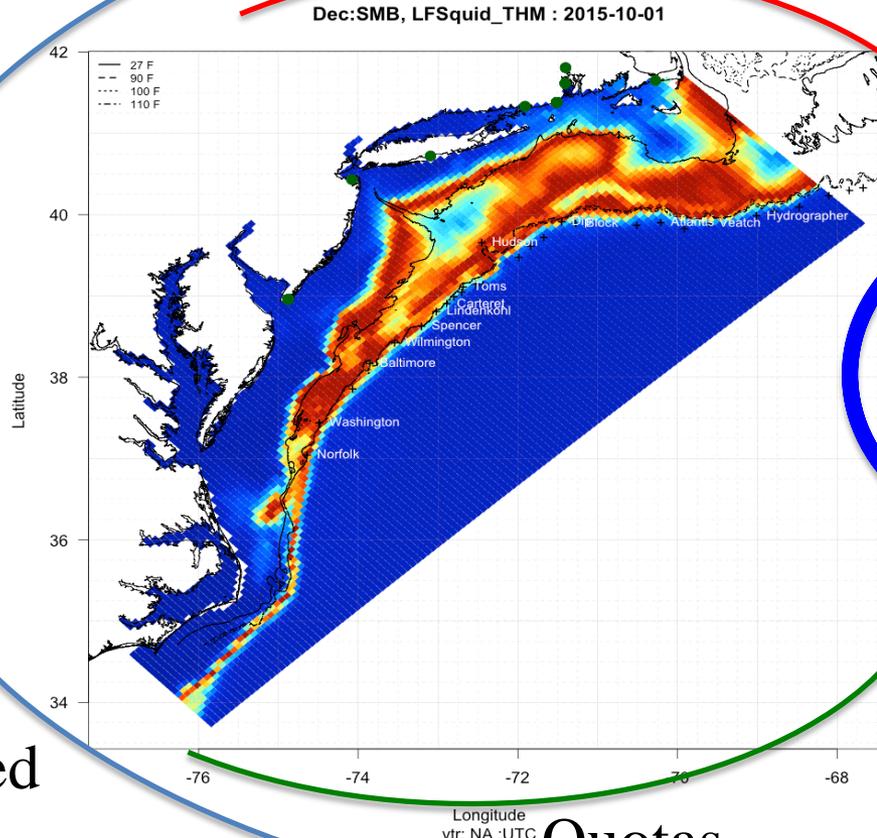
# Rapid climate, seascape & ecosystem change

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Fishing Industry

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Ecosystem based population assessment

Population ecology

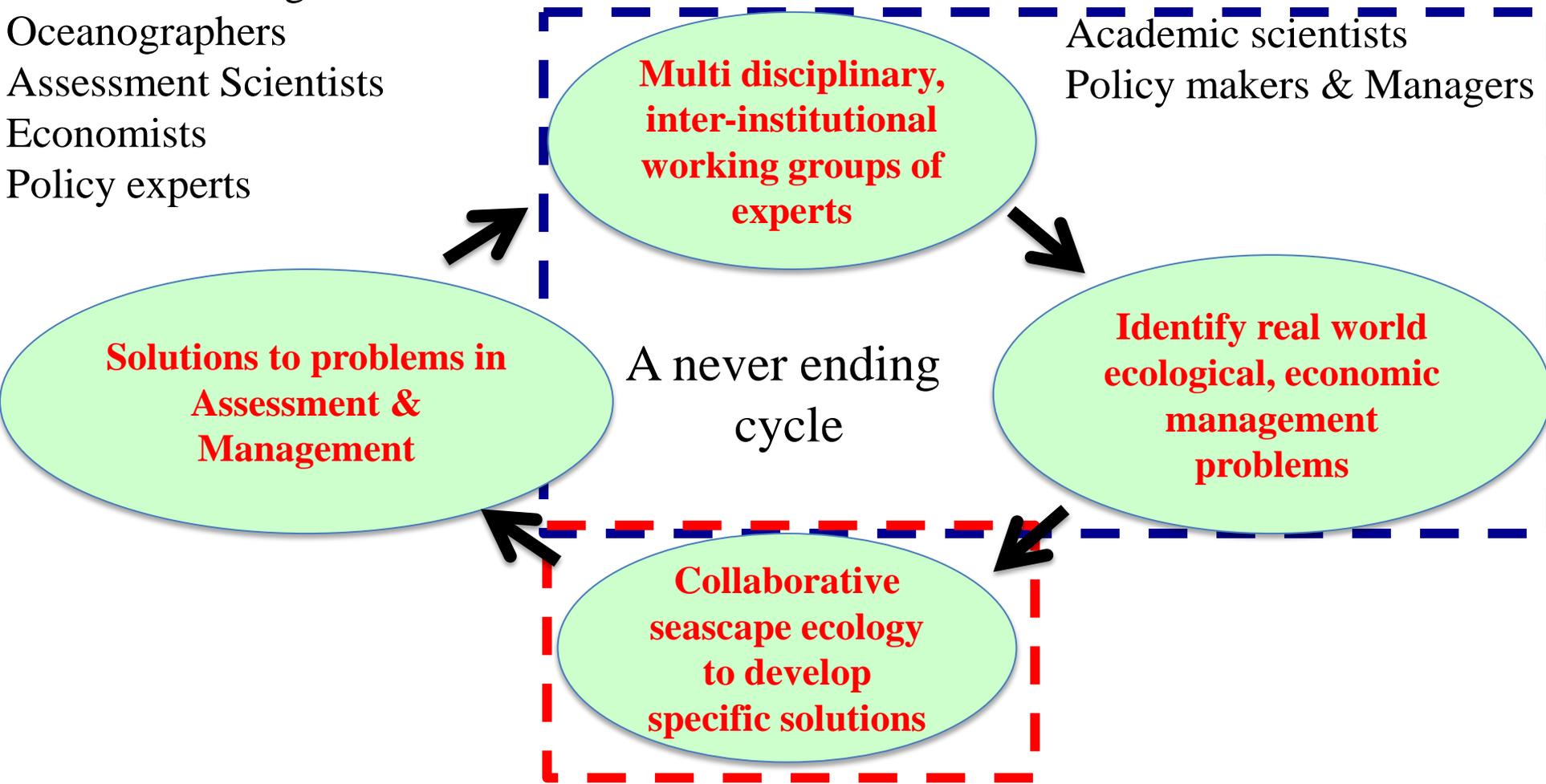
# Collaborative & crowd sourced seascape ecology a tool for inter-disciplinary working groups of experts integrating ecosystem considerations into assessment & management

## Disciplines

“Fisher” ecologists  
Academic ecologists  
Oceanographers  
Assessment Scientists  
Economists  
Policy experts

## Institutions

Fishing industry  
Government scientists  
Academic scientists  
Policy makers & Managers



# NEFSC CEHASG initiative

## Atlantic Mackerel Population Ecology & Fishery Workshop Industry & Science perspectives

December 2-3, 2015

Point Judith, Narragansett, Rhode Island

Funded by NEFSC COOP research, Salt Pond Fisheries, MAFMC

Adams, Chuck (Assessment)

Anderson, Emory (Assessment)

Axelson, Leif (Fisheries & Ecology)

Bari, Carly (Marine Policy)

Bright, Bill (Fisheries & Ecology)

Carter, Lauren (Assessment)

Curti, Kiersten (Assessment)

Didden, Jason (Marine Policy)

Gaiches, Sarah (Ecosystem science)

Goodwin, Glenn (Fisheries & Ecology)

Hare, Jon (Oceanography & Ecology)

Hoey, John (COOP research)

Jardine, Sunny (Fisheries Economics)

Kaelin, Jeff (Fisheries & Gov't relations)

Kohut, Josh (Ocean physics)

Lapp, Meghan (Fisheries & Gov't relations)

Lee, John (Journalist)

Manderson, John (Ecology & COOP research)

Martin, Mike (FI Surveys & COOP research)

McBride, Richard (Reproductive Ecology)

Miller, Alicia (Assessment Science)

Moore, Peter (Fisheries & Economics)

O'Neill, Gerry (Fisheries & Economics)

Redding, Gray (Ecology)

Rhule, Jim (Fisheries & Ecology)

Richardson, David (Oceanography & Ecology)

Roebuck, Chris (Fisheries & Ecology)

Sarro, Chris (COOP research)

Secor, David (Ecology)

Shepherd, Gary (Assessment)

**Discuss knowns, known unknowns & unknown unknowns  
about mackerel population ecology  
& ecological, economic, & regulatory drivers of fishery.**

Define steps required to integrating climate, ecosystem, habitat  
considerations into 2017 Mackerel Assessment



# Next steps developed at Dec, 2-3 2015 WG Meeting

- Investigate stock structure via ICES working group
- Survey catchability = Population availability to survey\*Net efficiency
- Unconfound model catchability estimates from uncertainties in  $M + F$
- Develop coast wide egg index
- Estimation of natural mortality (M)
  - Species displacement > Dogfish driving distributions?
  - Consumption > estimate for dogfish + other fish & mammals
- Estimation of fishing mortality (F)
  - What are the ecological, economic, regulatory drivers of availability & landings

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## UPCOMING EVENTS

List View

Calendar View

**Unmanaged Forage Amendment - Public Hearing #4**

Monday, May 23, 2016  
6:00pm – 7:30pm  
U. of Rhode Island Bay

# 2016

## LATEST NEWS

### Mid-Atlantic Council Announces Funded Collaborative Research Projects

The Mid-Atlantic Fishery Management Council announces that four research projects have been selected to receive a total of approximately \$610,000 in funding as part of the Council’s 2016-2017 Collaborative Fisheries Research Program. The four projects each address research priorities identified by the Mid-Atlantic Council in a Request for Proposals distributed in December 2015.

“Accurate information is the foundation of effective fisheries management,” said Council Chairman Rick Robins. “These research projects will help fill critical gaps in our understanding of Mid-Atlantic fisheries and ensure their continued sustainability.”

Details on the selected projects are provided below.

#### Changes in Availability of Mid-Atlantic Fish Stocks To Fisheries-Independent Surveys

*Principal Investigators: Janet Nye, Michael Frisk, and Skyler Sagarese.*

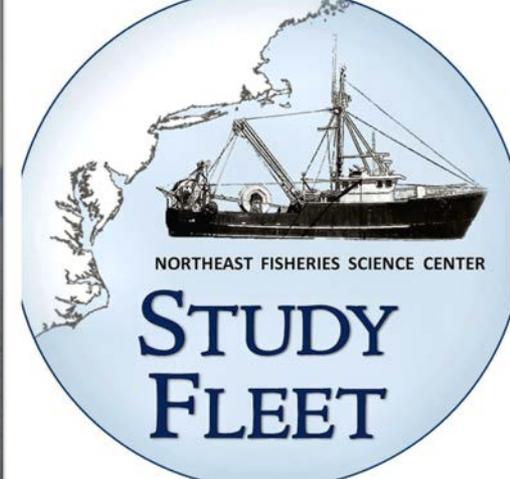
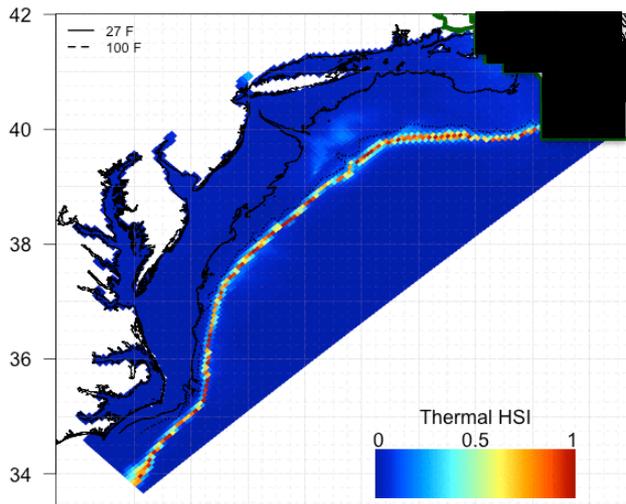
This project will investigate how habitat modifies the availability of summer flounder, black sea bass, and spiny dogfish to the NEFSC trawl survey. The focus of this research is on the relationship between the NEFSC trawl survey index and actual abundance of these species.

#### Collaborative Development Of A Winter Habitat Model For Atlantic Mackerel, “Version 2.0”; For The Identification Of “Cryptic” Habitats And Estimation Of Population Availability To Assessment Surveys And The Fishery

*Principal Investigator: Gregory DiDomenico; Co-Principal Investigators: William Bright; Peter Moore, Josh Kohut, Mitchell Roffer, and John Manderson.*

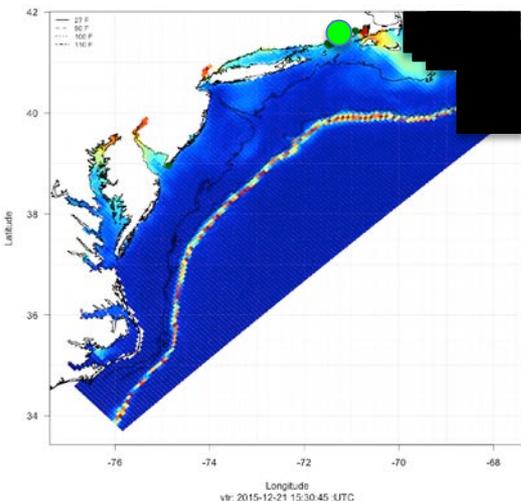
This project will synthesize existing information to develop and evaluate a quantitative model describing dynamic winter habitat distributions for Atlantic Mackerel. The goal of this study is to develop a model that can be used to accurately estimate the availability of the population to fishery independent surveys.

AtlanticMackerel : 2015-11-01

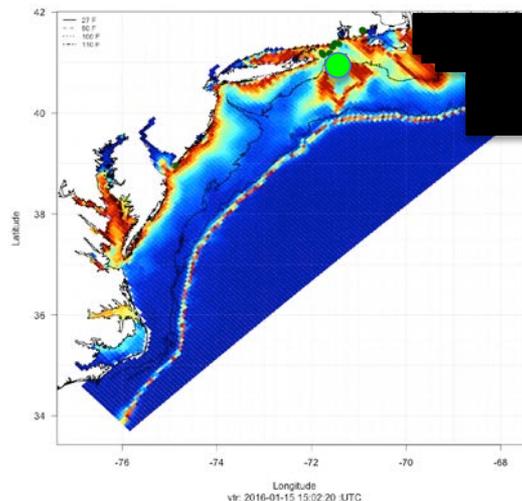


## Evaluated crowd-sourced model hindcasts can be used estimate availability to fishery dependent surveys & the fishery

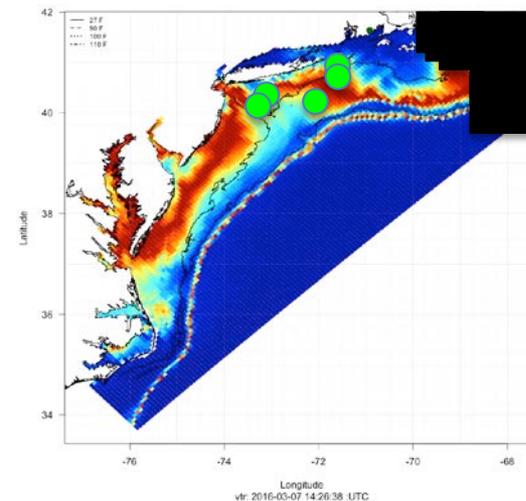
Dec 21, 2015



Jan 15, 2016



Feb 7, 2016



# NEFSC CEHASG

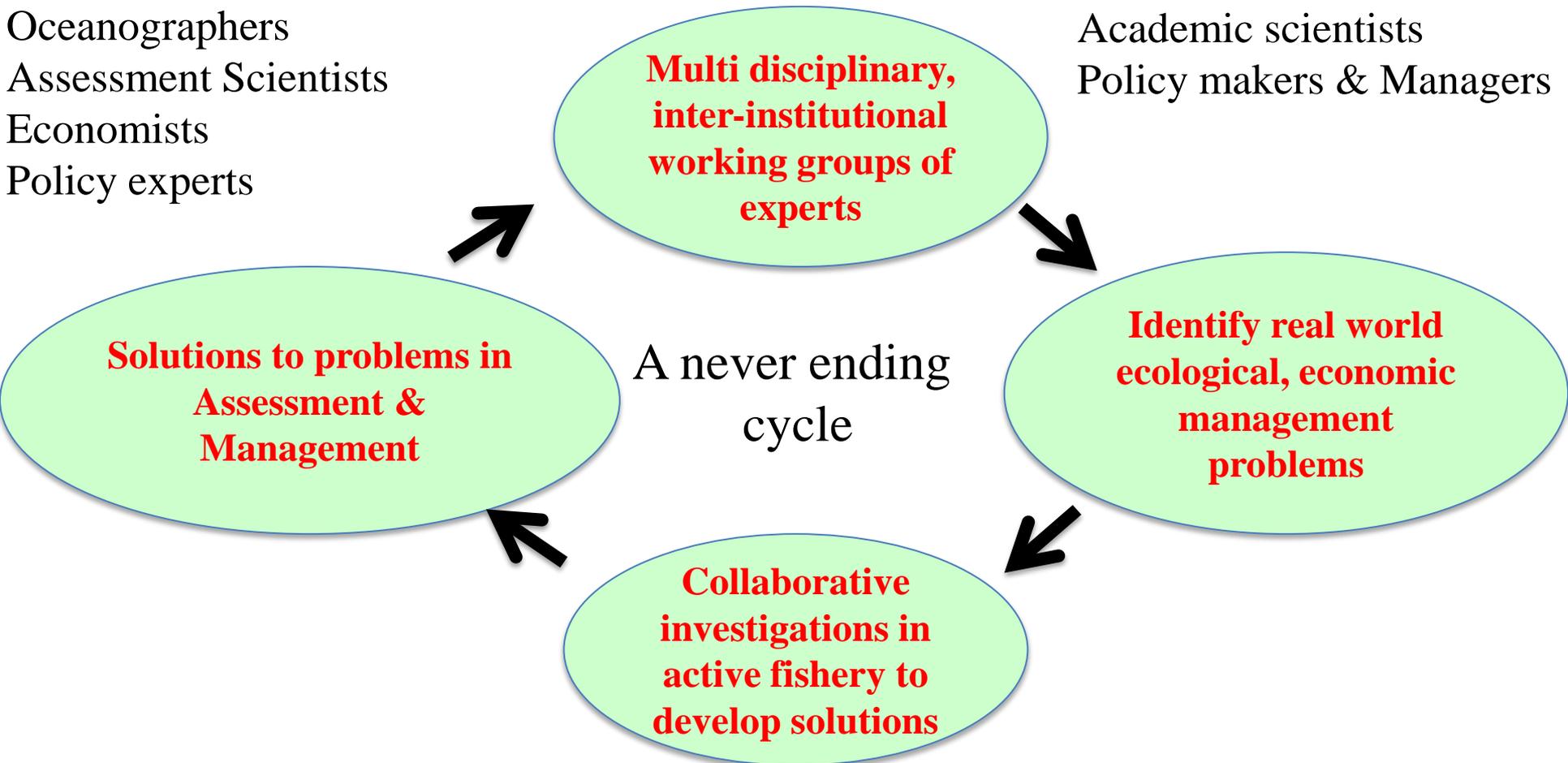
## Working group on Atlantic Mackerel

### Disciplines

“Fisher” ecologists  
Academic ecologists  
Oceanographers  
Assessment Scientists  
Economists  
Policy experts

### Institutions

Fishing industry  
Government scientists  
Academic scientists  
Policy makers & Managers



# Collaborative approach taken in 2014 butterfish assessment

## *Working with industry allowed us to identify the problem*



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### Butterfish—Little Fish Big Science

*The new stock assessment for butterfish accounted for the effects of ocean temperatures on the distribution of the stock, something that will become increasingly important as the climate changes and the oceans warm.*

By **Rich Press**, NOAA Fisheries Science Writer | Posted: October 29, 2014  
Follow Rich on Twitter: [@Rich\\_NOAAFish](#)



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## EDITORIAL – Butterfish: An assessment success story

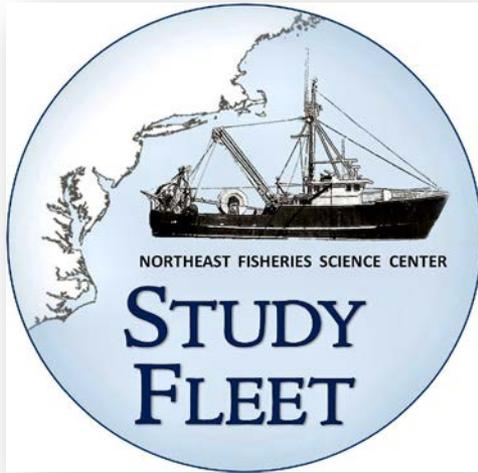
Editorial, May '14



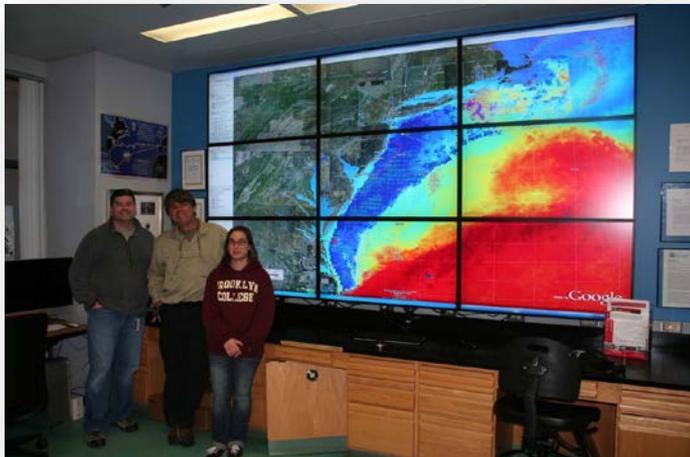
# Resources required?

Study fleet

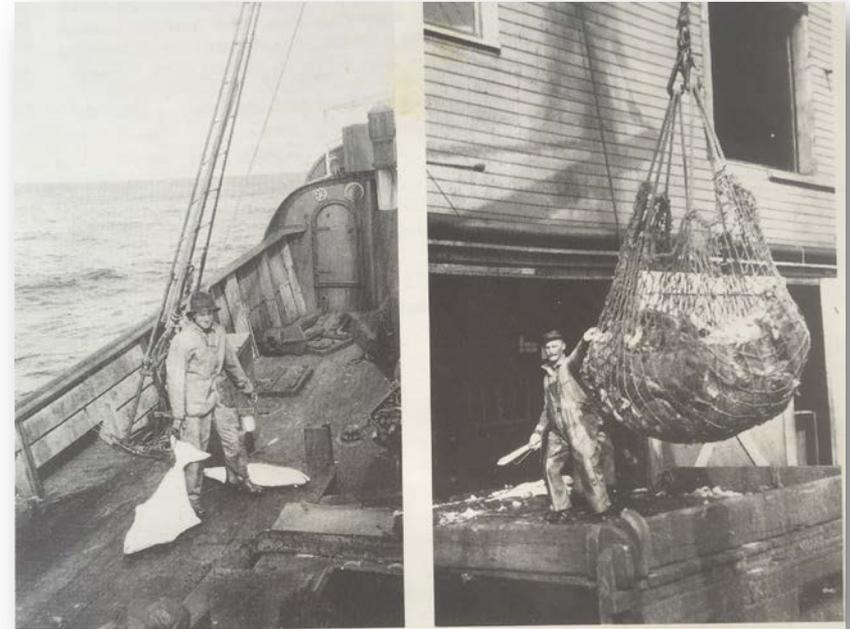
Infrastructure & collaborators



IOOS ocean data & collaborators



Ability to work with industry partners & develop fishery dependent understanding



*Result: better informed interpretations of real & near real time fishery dependent & fishery independent data*

Resource required

Mutual  
Trust

