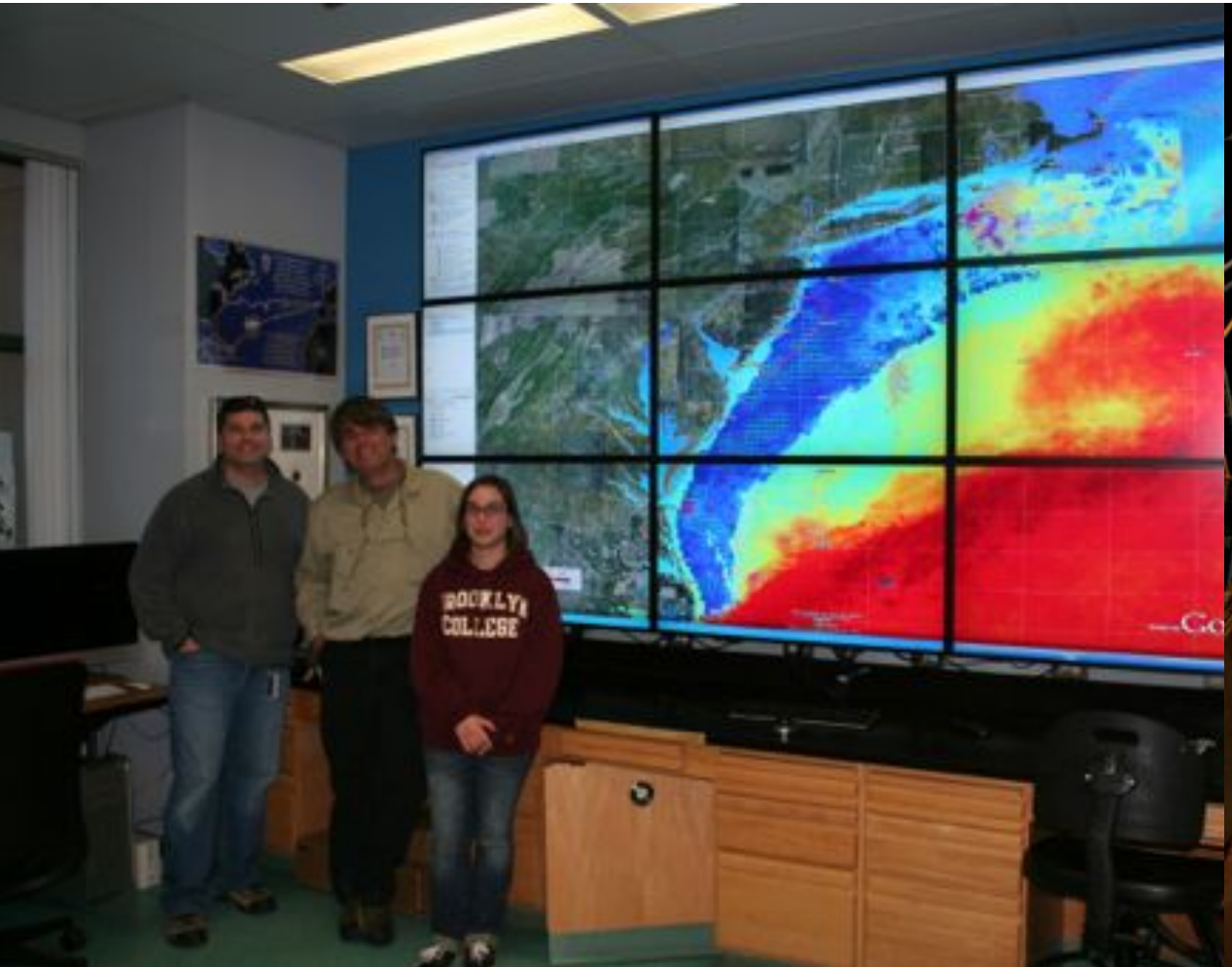
Nowcasting seascape dynamics to better estimate past & future species-habitat distributions



1) Seascapes are not landscapes

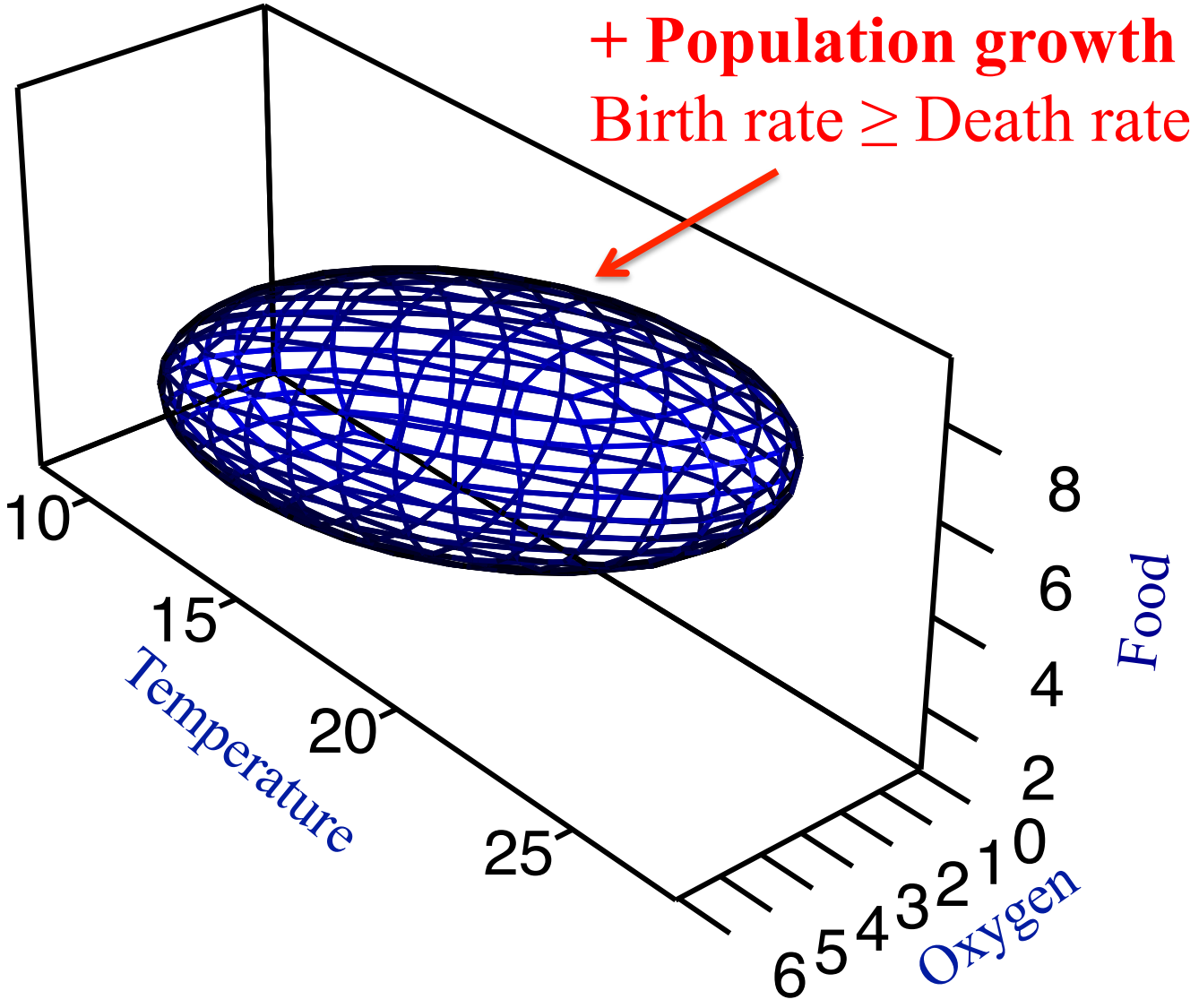
2) Data required for applied seascape ecology

3) Collaboration & crowd-sourcing an operational seascape ecology

What is habitat?

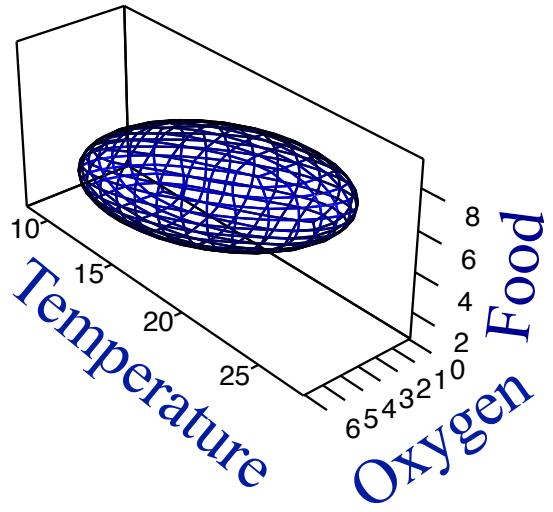
Niches defined by environmental variables affecting population growth

GE Hutchinson



Habitat => Projection of niche onto environmental variation

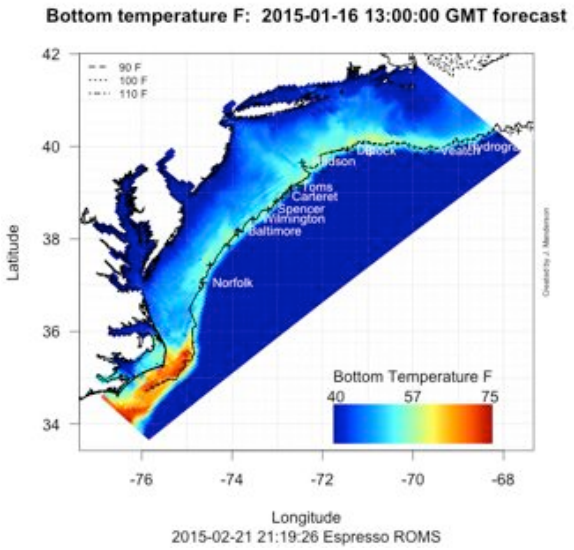
Species niche

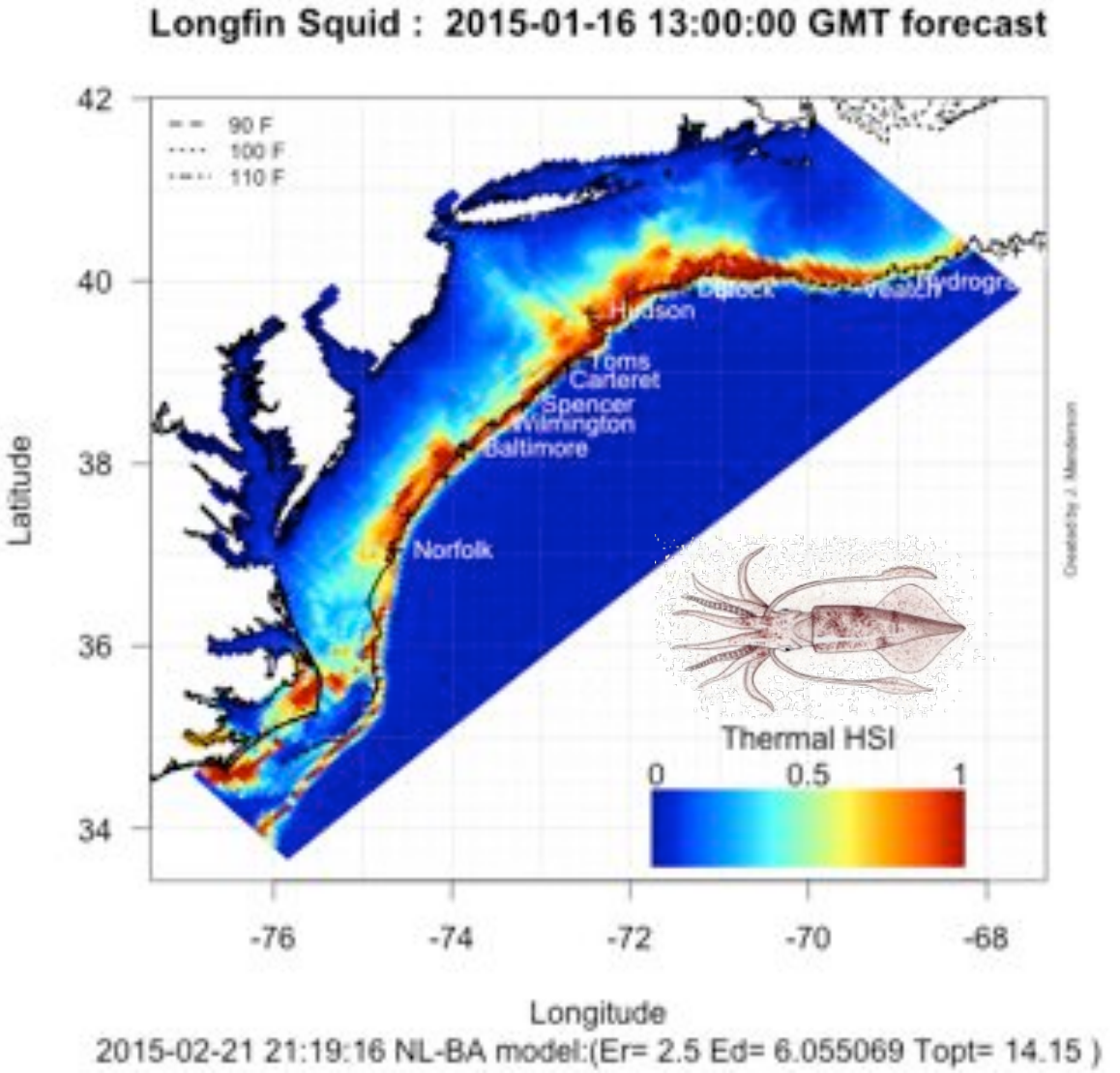


+

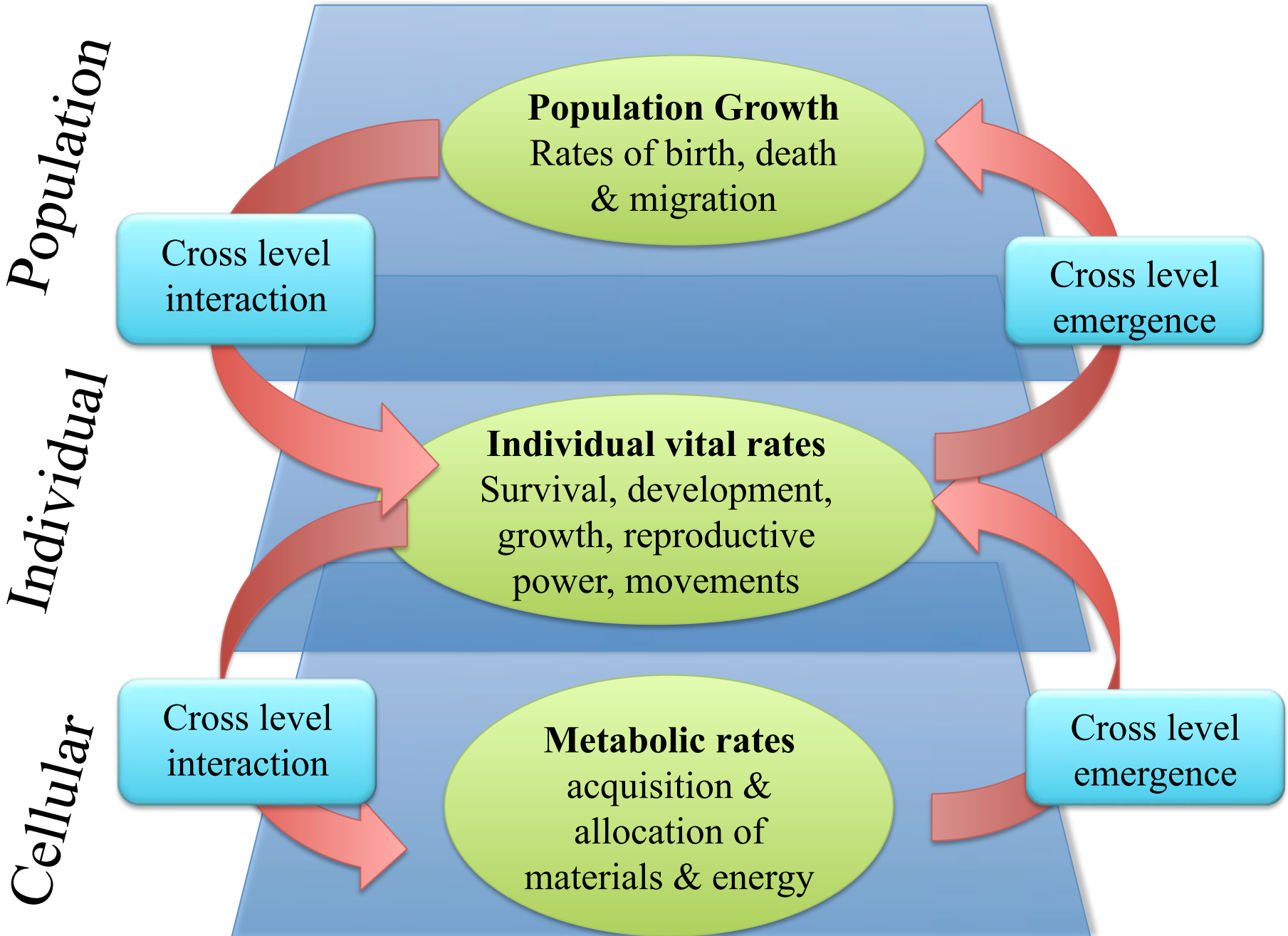
Environment

=





Habitat & niche fundamentally linked to metabolism

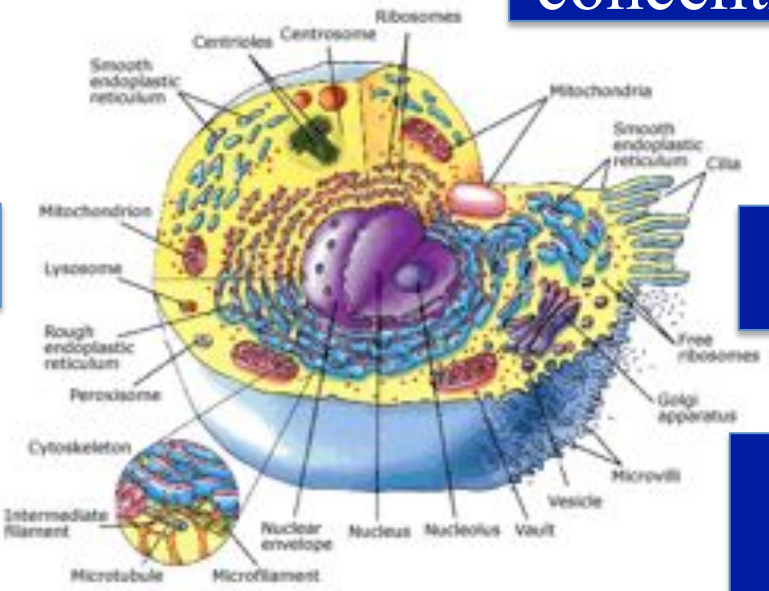


Optimizing metabolism requires specific, conservative & universal conditions in tissues

Water

Solute concentrations

Oxygen



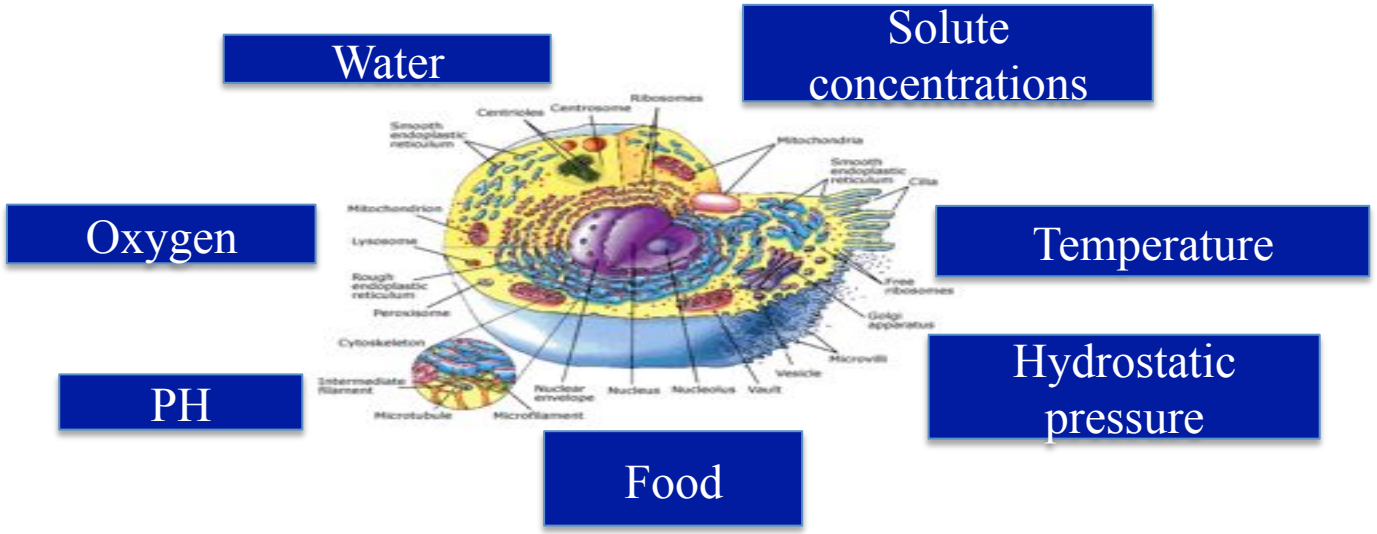
Temperature

PH

Hydrostatic pressure

Food

How do organisms meet core requirements optimizing metabolism



Habitat selection: Select external environment most closely matching specific internal conditions required for optimal metabolism

Physiological regulation: control internal environment so it matches conditions required by optimal metabolism independently of external environment

Physical properties of water in the ocean & air in atmosphere

determining degree to which organisms can use habitat selection to optimize metabolic performance

Property	Ocean	Atmosphere	Ocean/Atmosphere
% water by weight	high	low	**40:1**
Solute concentration	high	low	**32:1**
Oxygen concentration	low	high	**1:38**
Oxygen diffusion	low	high	**1:10**
Heat capacity	high	low	**4:1**
Heat transfer by conduction	high	low	**23:1**
Density	high	low	**850:1**
Viscosity (resistance to stretching)	high	low	**14:1**
Drag (Reynolds #)	high	low	**12:1**
Speed of sound	fast	slow	**4:1**
Light penetration	low	high	**1:100-1mill**
Electrical conductivity	high	low	**20 bill:1**

Property of ocean liquid- habitat selection

Property of ocean liquid- habitat selection

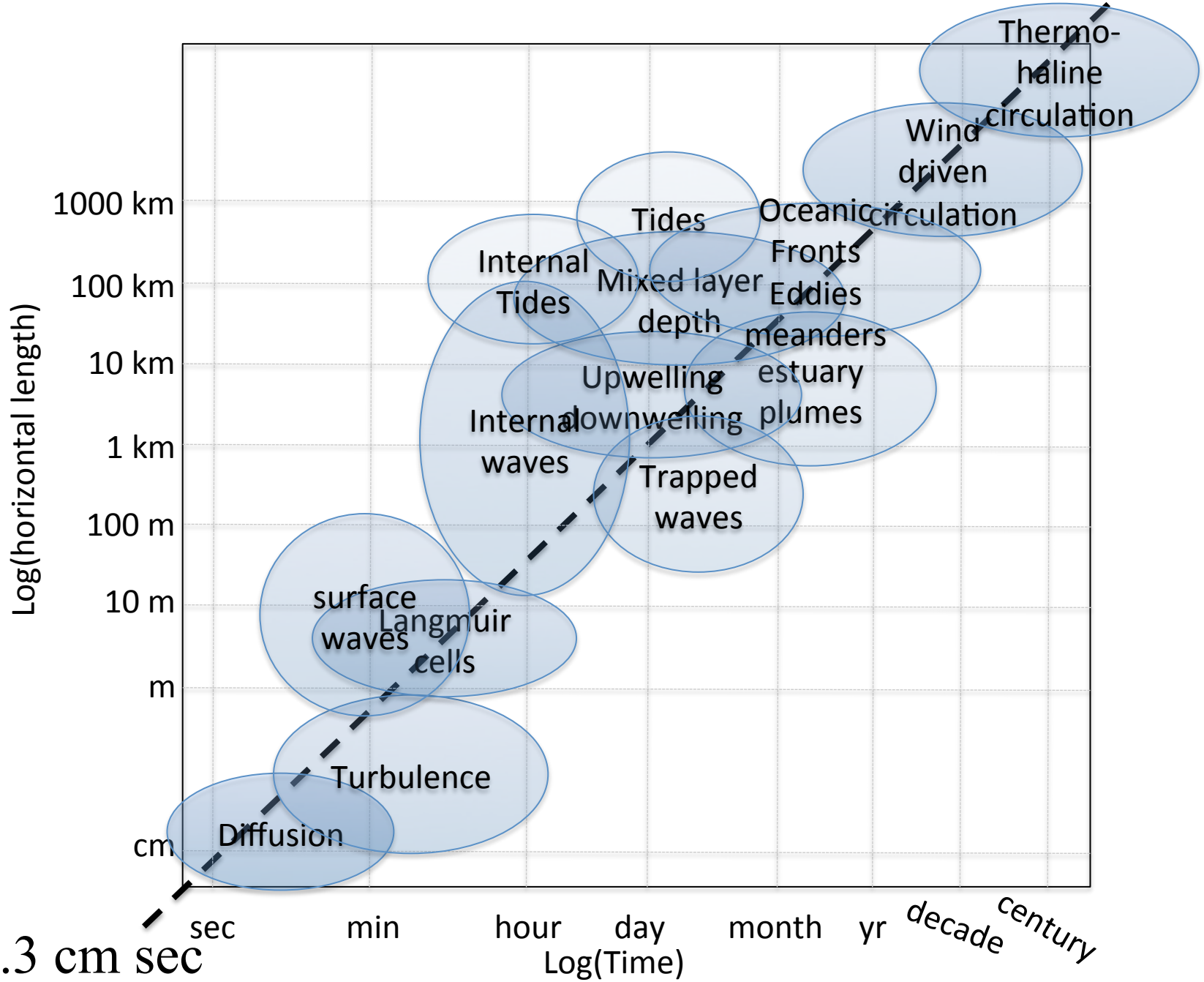
Property of ocean liquid- habitat selection

Drag dominant force controlling movement. turbulence & transport by currents crucial foodweb dynamics and movements

Seascapes are not landscapes
Living in a liquid is different from living in a gas

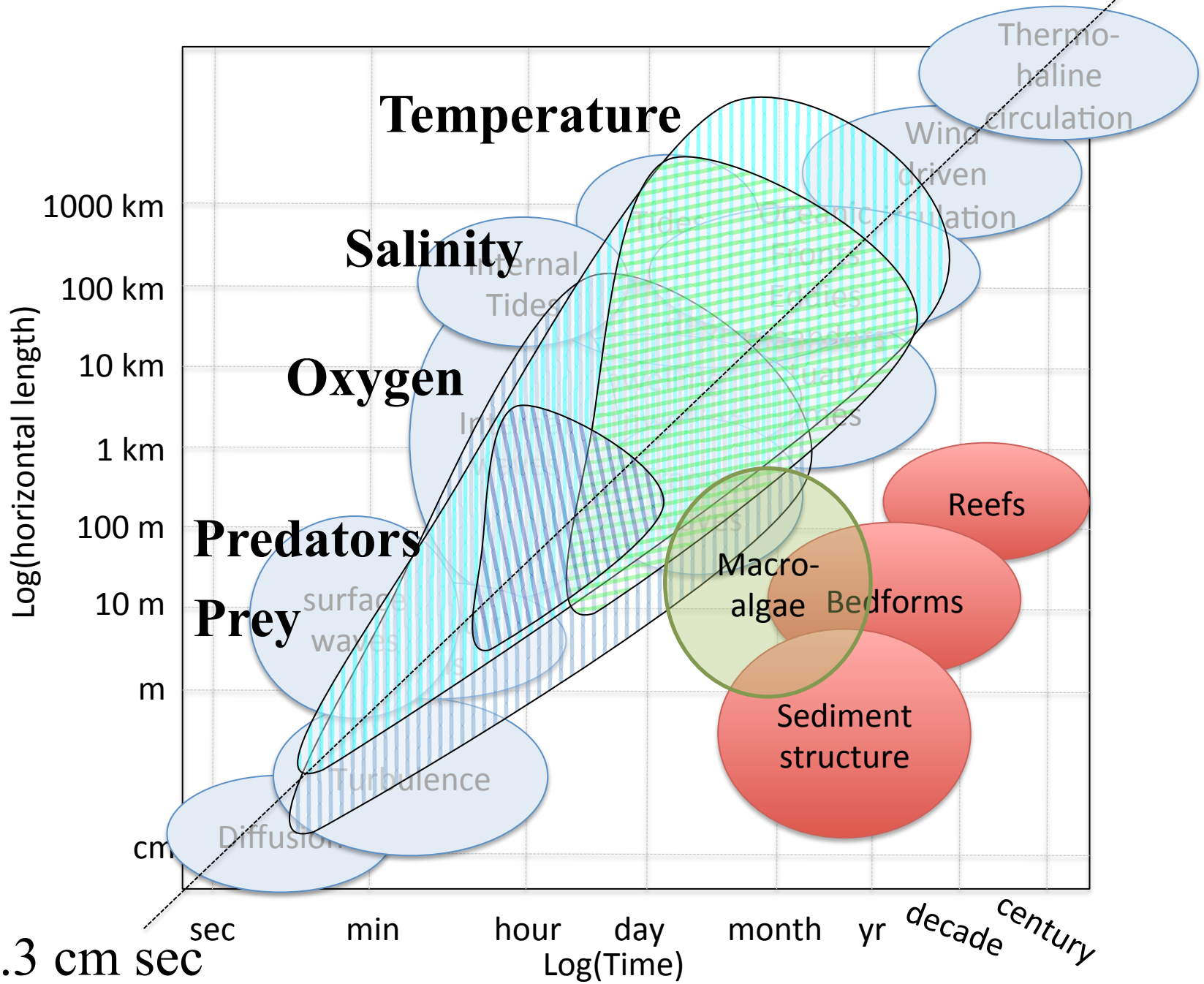
Dynamic hydrography including circulation & mixing
lie at the foundation of marine habitat & seascape ecology

Processes driving seascape dynamics



0.3 cm sec

Processes driving seascape dynamics



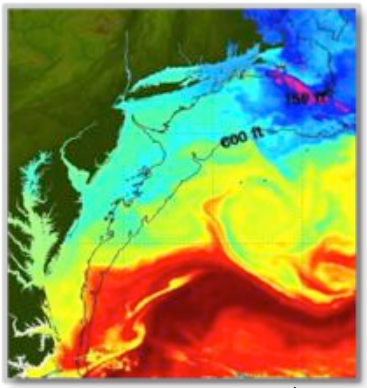
0.3 cm sec

1) Seascapes are not landscapes

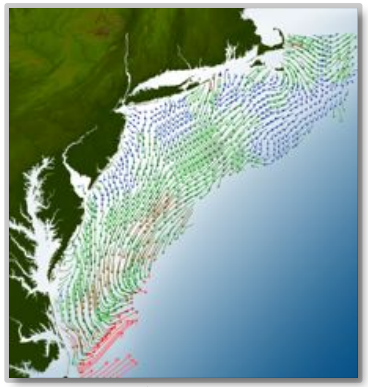
2) Data required for applied seascape ecology

Ocean Observing Systems measure & model physical & primary production dynamics in the ocean

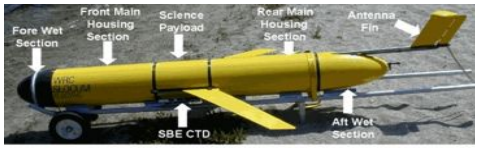
Satellites

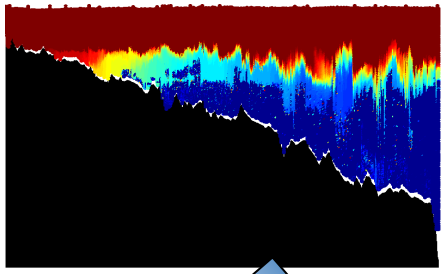


HF radar



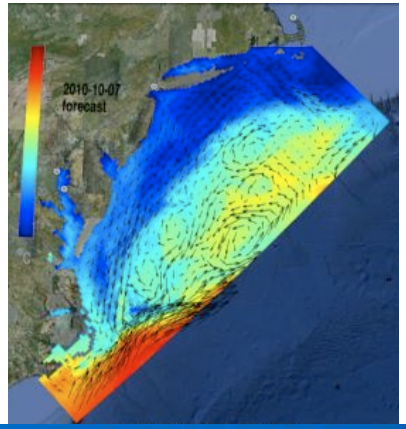
Gliders

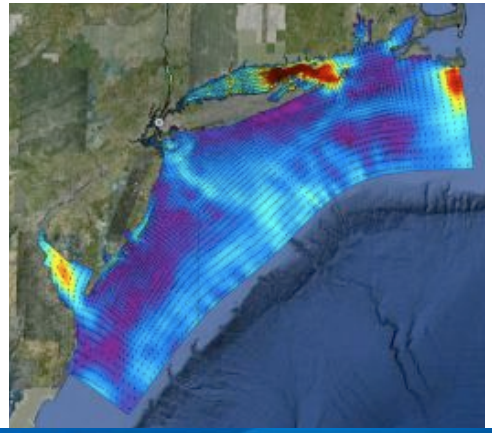




Buoys

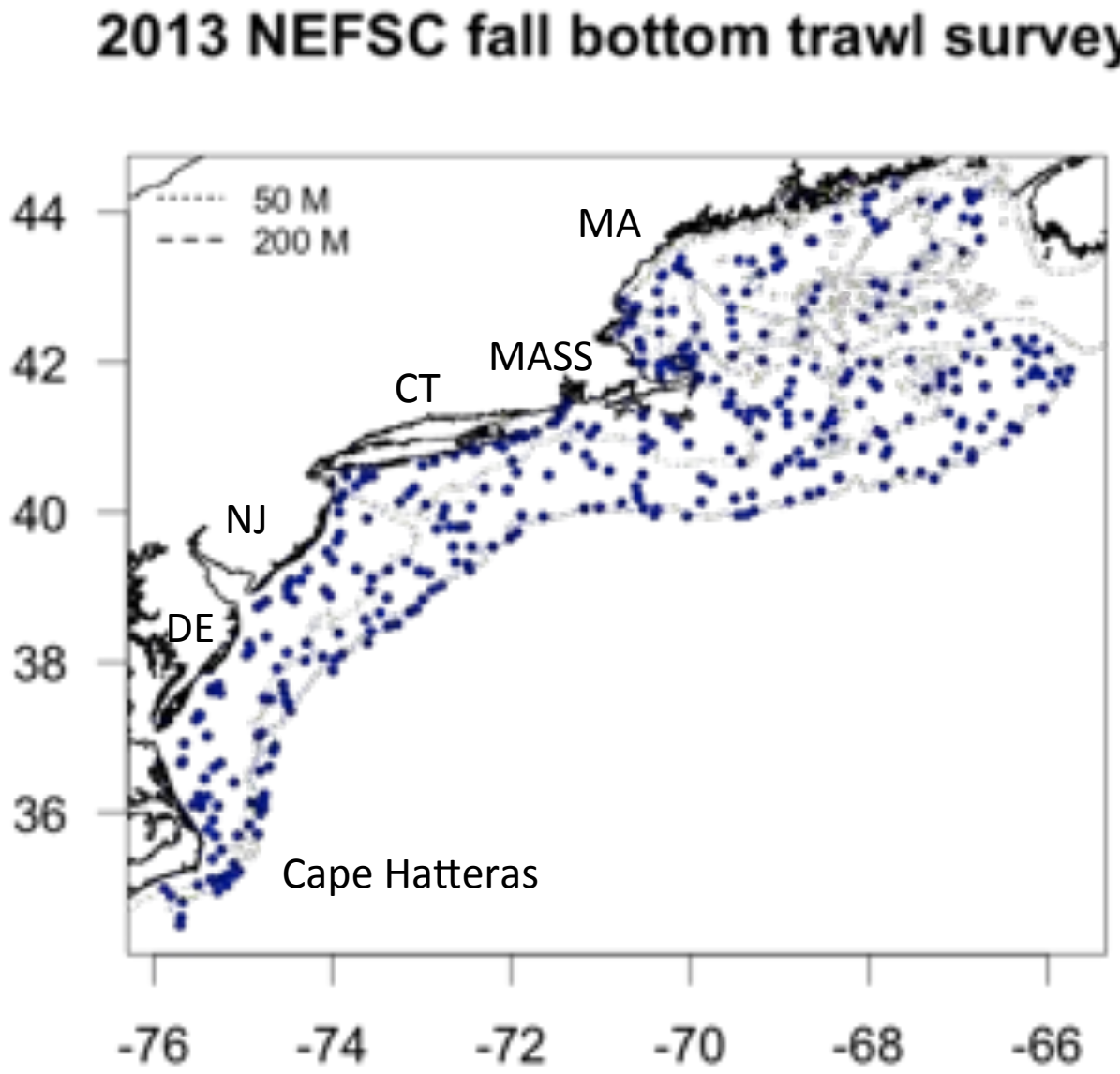
Ensemble of Operational Assimilative Ocean Models





But what about the biology?

Biological data collected on regional sea scale surveys designed for population not habitat assessment



Space

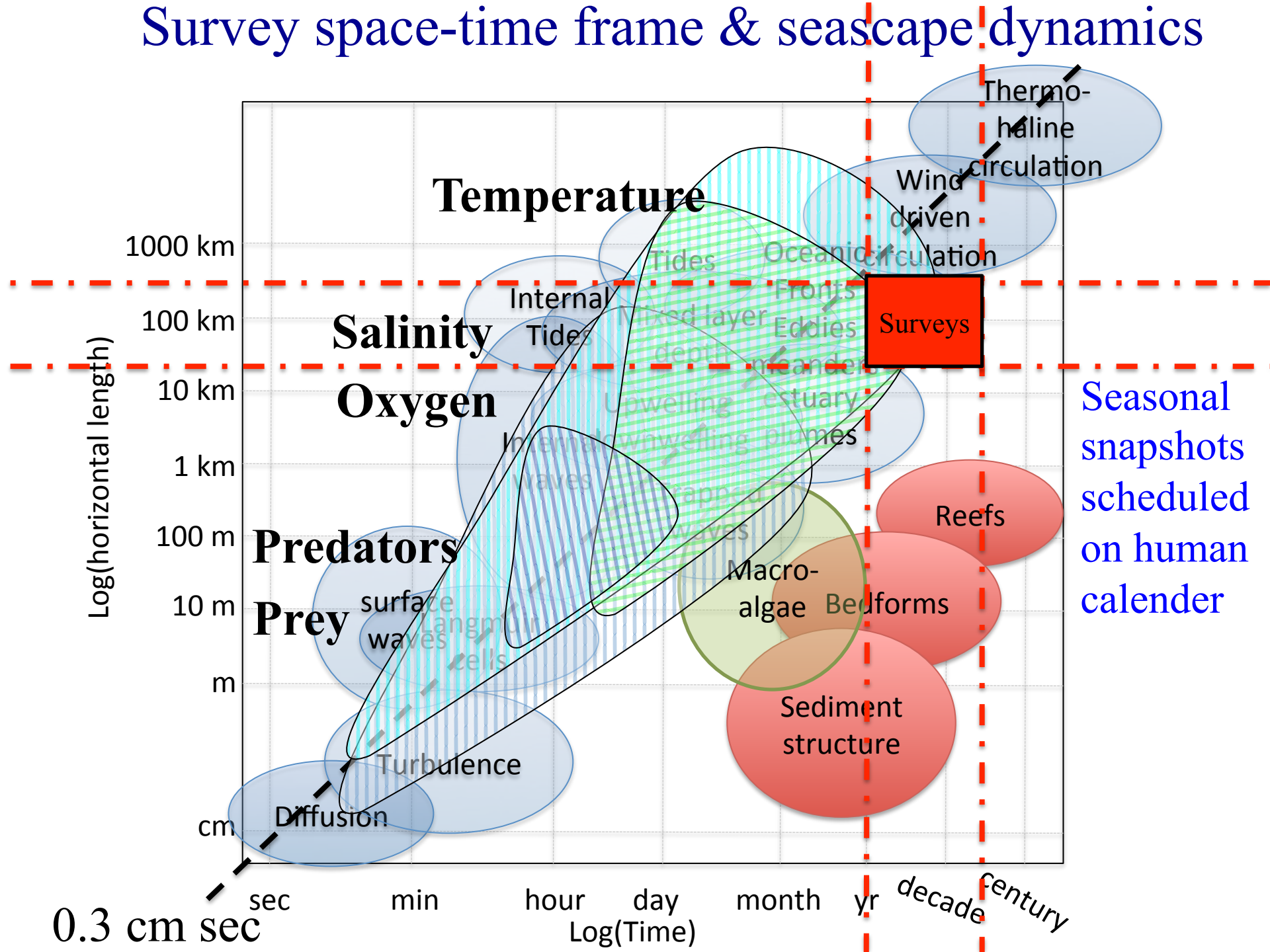
Extent = 224,562 km^2
Distance stations =12 km
Depths = 20M-250M

Time

Extent = 53 years
Snapshots Spring & Fall
(~ 53 days)

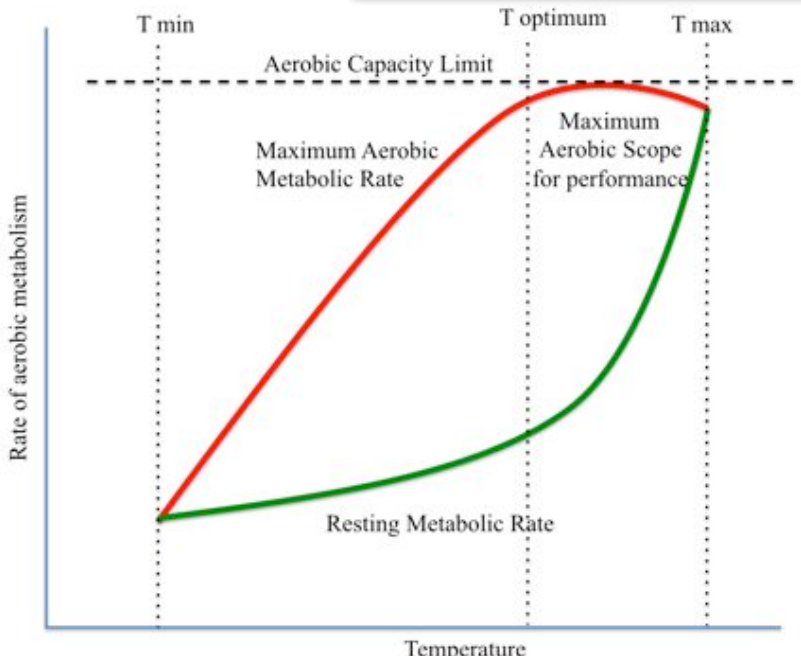
* Longest dimension = 1210 km

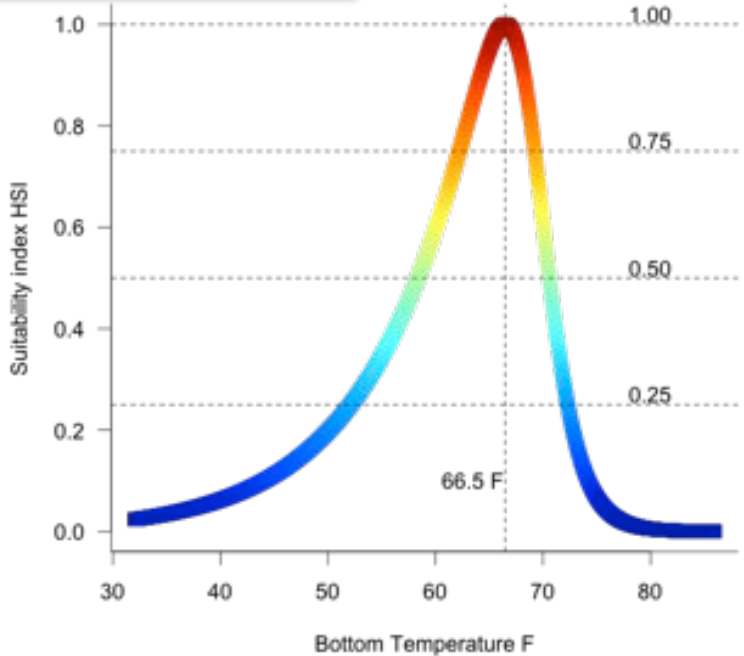
Survey space-time frame & seascape dynamics



Seasonal snapshots scheduled on human calender

Laboratory studies of physiological performance to inform eco-physiological models



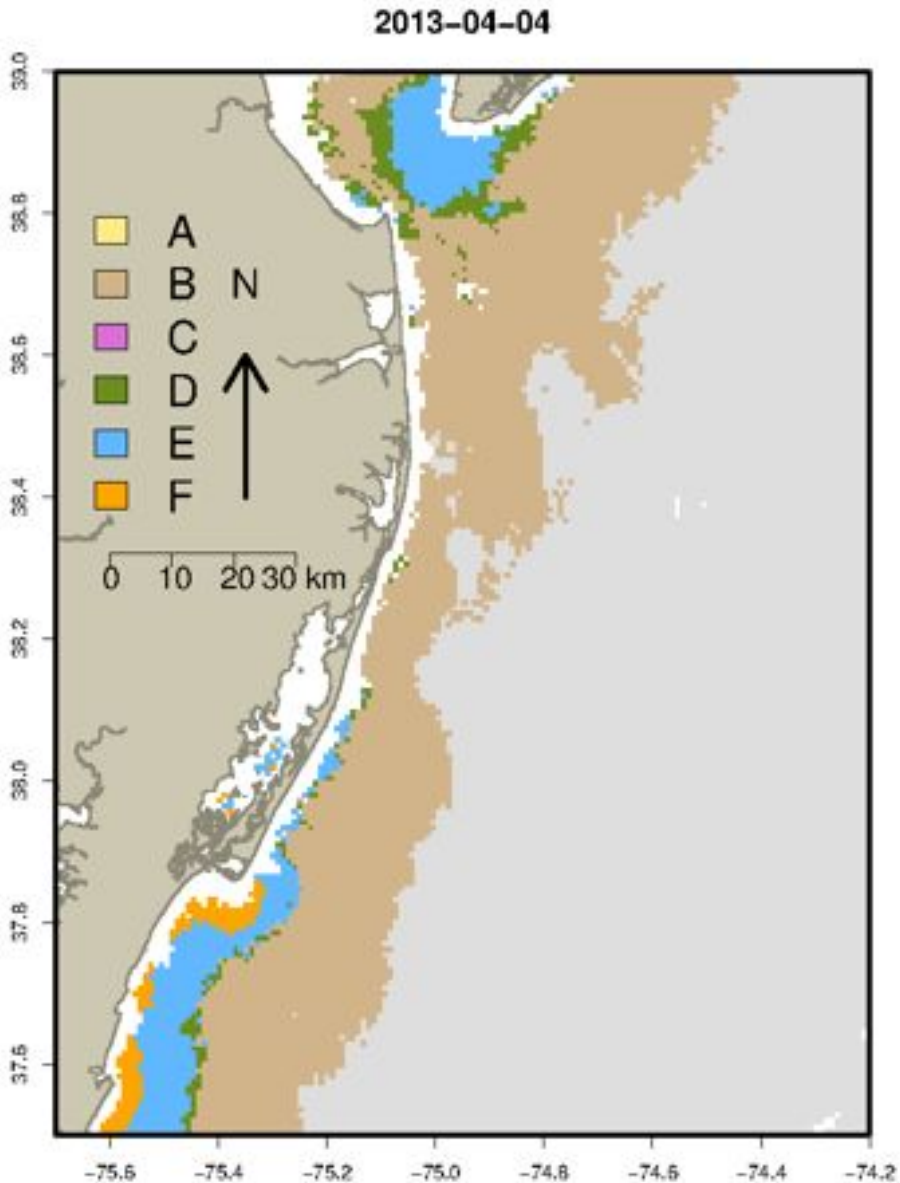


Studies of *insitu* habitat selection

Glider detections of telemetered sturgeon on seascape classified by satellite optics

Satellite data: **http://thredds.demac.udel.edu/thredds/catalog.html**

Matt Breece, Matt Oliver (U Delaware)
Dewayne Fox (Delaware State U)
Kevin Waark (FV Dana Christine II)



From Breece et al., 2016. Meth Ecol & Evol
Doi: 10.1111/2041-210X.12532

What about doing fisheries science the old fashioned way?

Perform fisheries science collaboratively with industry continuously in the ecosystem in real time

Johan Hjort

Why?

Fisherman: Operate at space-time scales of species-habitat & species-species interactions

(given economic incentives & regulatory constraints)

1) Seascapes are not landscapes

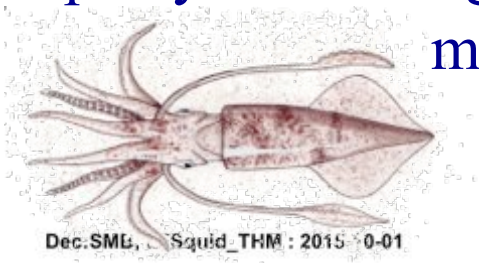
2) Data required for applied seascape ecology

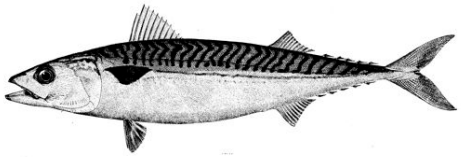
3) Collaboration & crowd-sourcing an operational seascape ecology

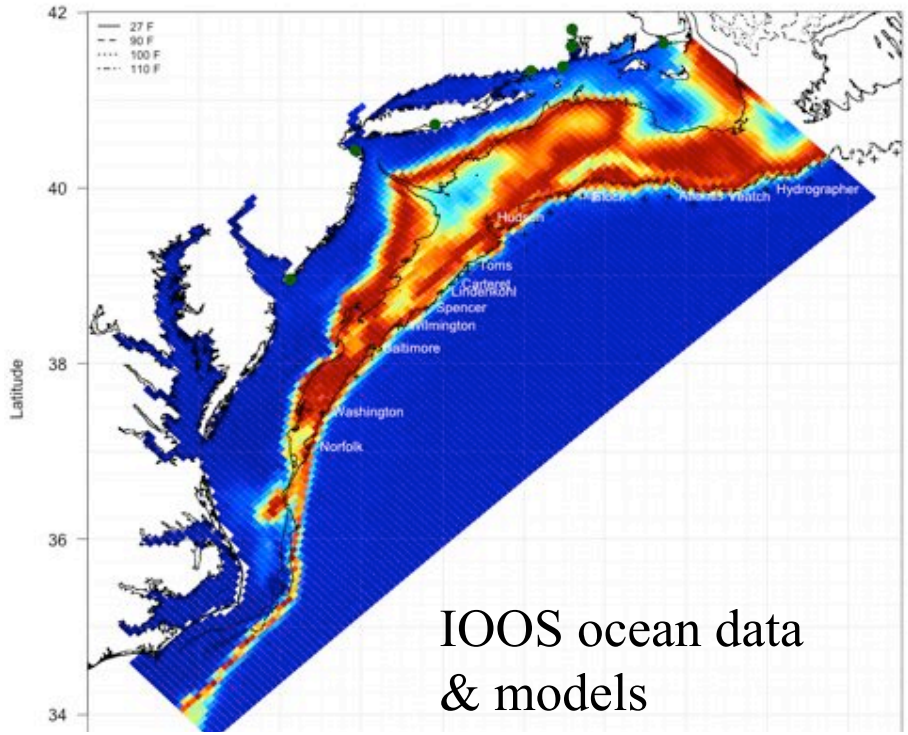
Whole fleet dynamics & nowcast seascape habitat dynamics (*Expresso ROMS*)

10-01-2015 to 05-01- 2016

Effort & population availability to fishery = population dynamics * seascape dynamics * global economics * economic alternatives * management regulations

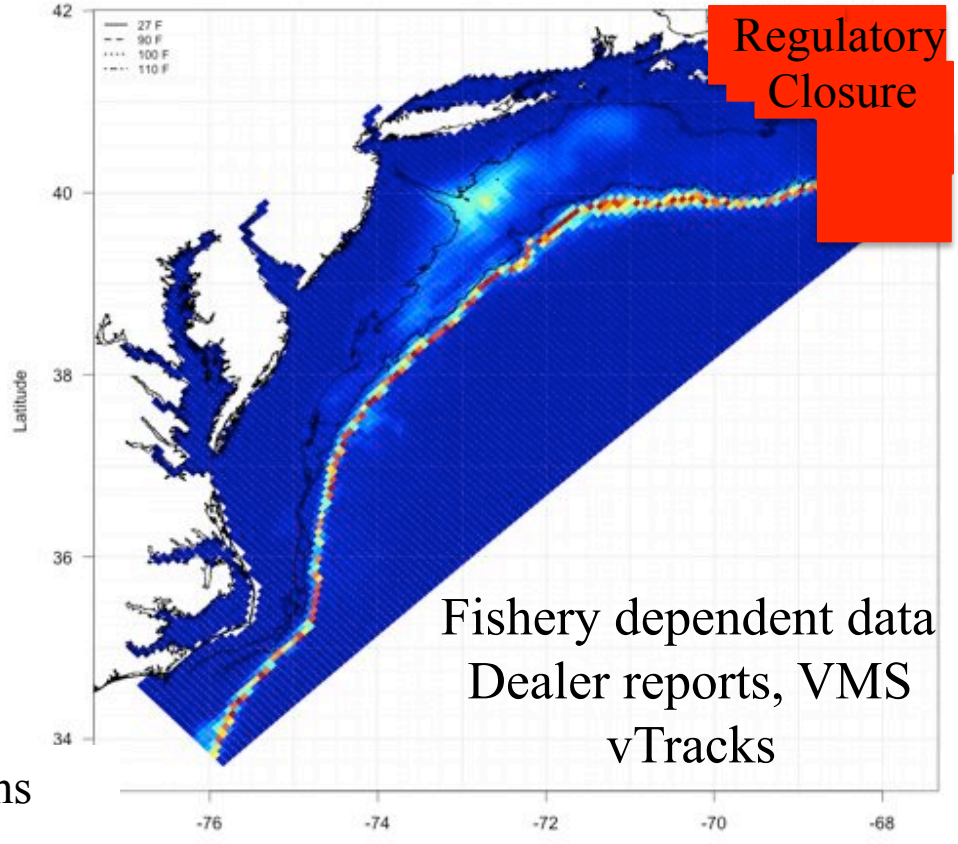






IOOS ocean data & models

http://tds.marine.rutgers.edu/thredds/dodsC/roms

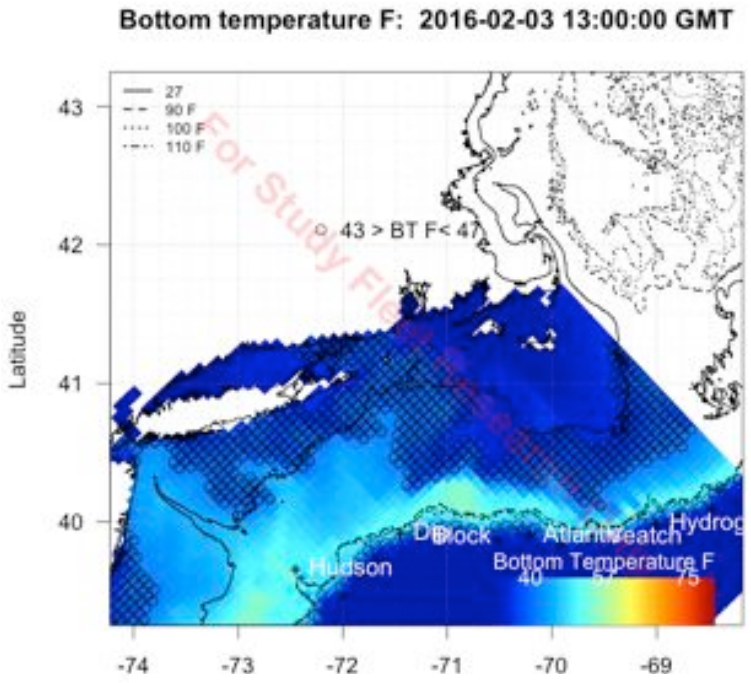


Fishery dependent data
Dealer reports, VMS
vTracks

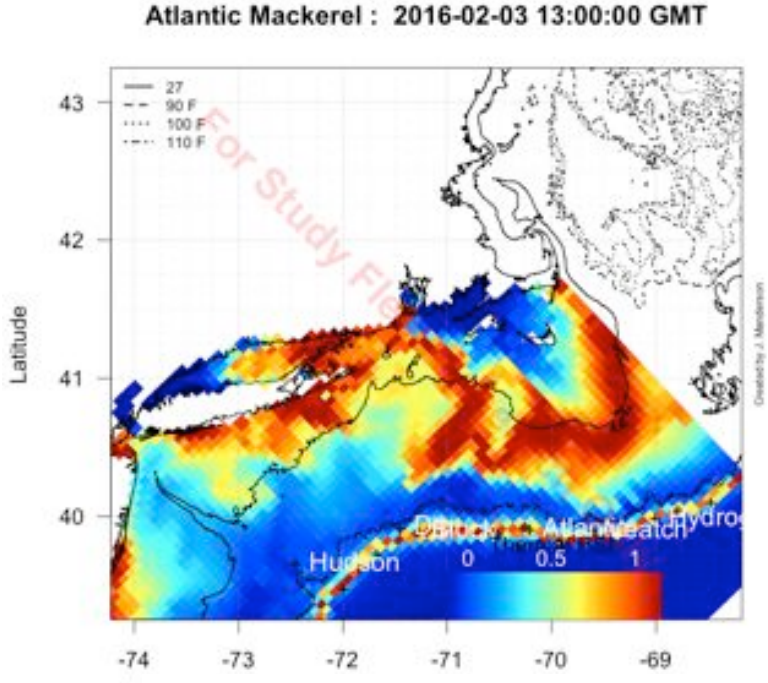
Collaborative development of seascape models with study fleets

Products => co-developed models

Process => transfer of fishery dependent understanding



Modeled bottom temperature

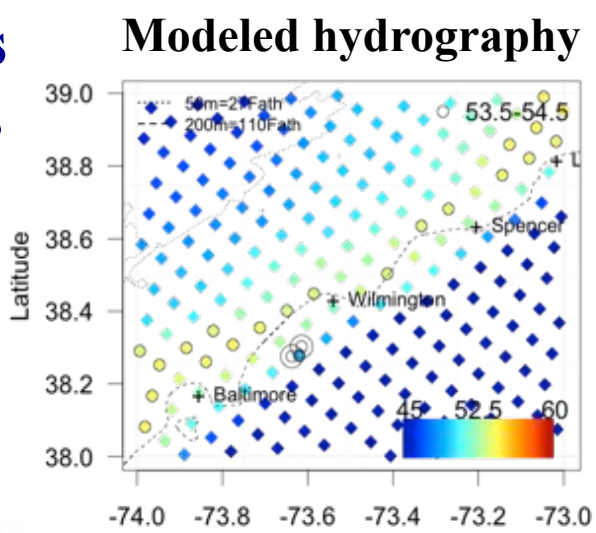


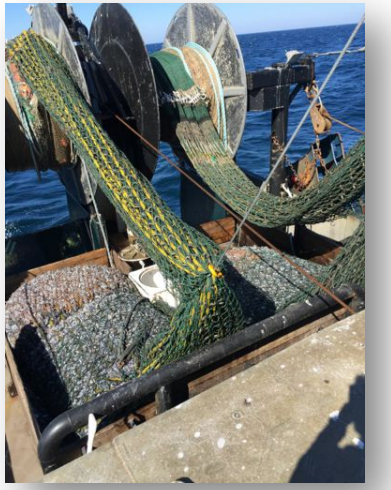
Thermal habitat suitability

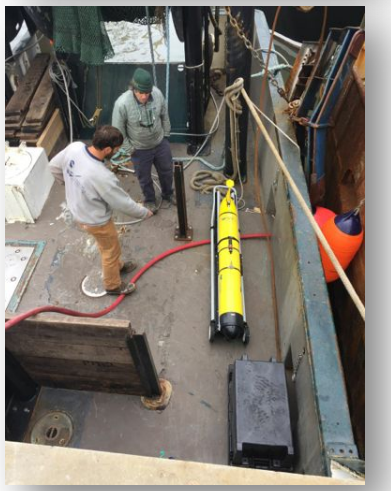
Empirical field investigations with individual collaborators

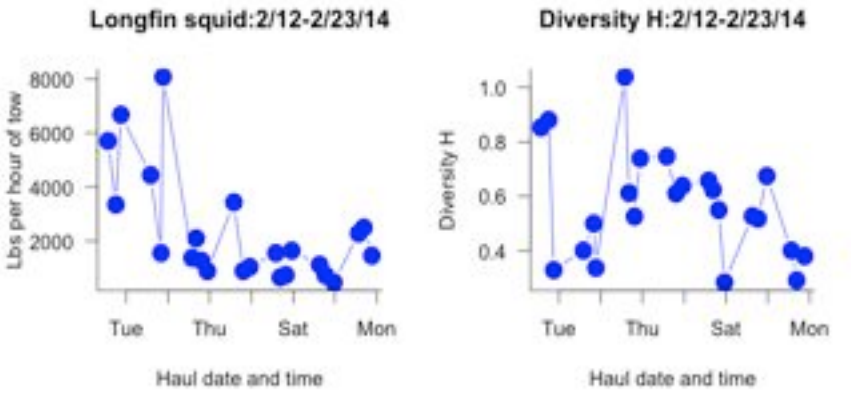
to inform next generation Seascape models

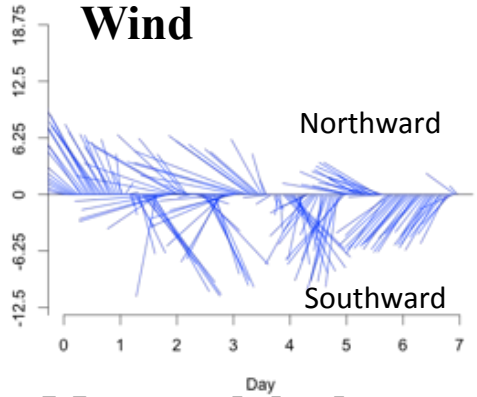
Models of habitat
catch & bi-catch avoidance

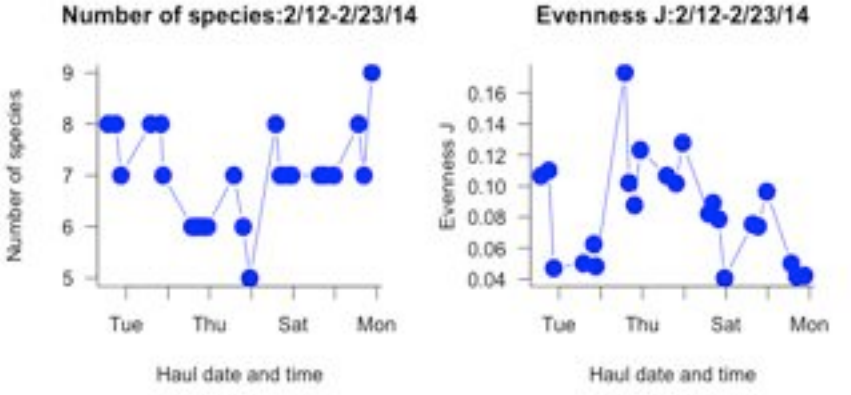


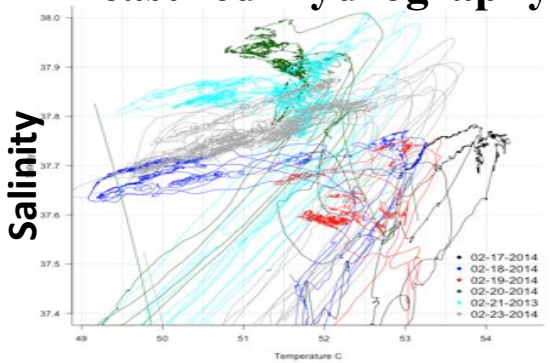






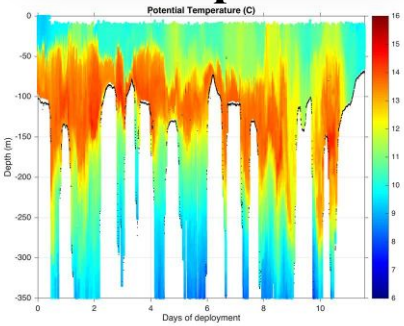






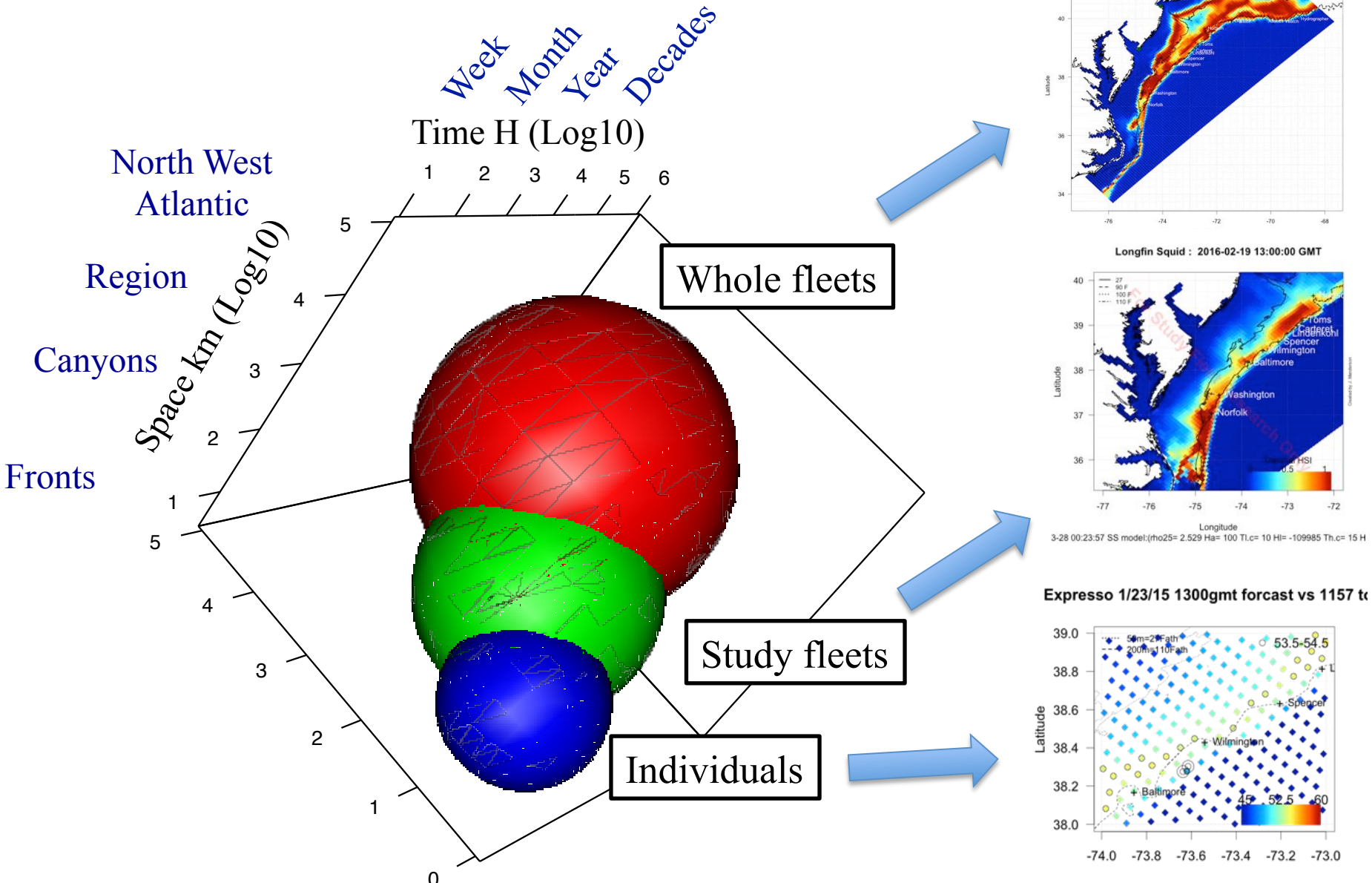
Temperature

Glider profile



Applied seascape ecology

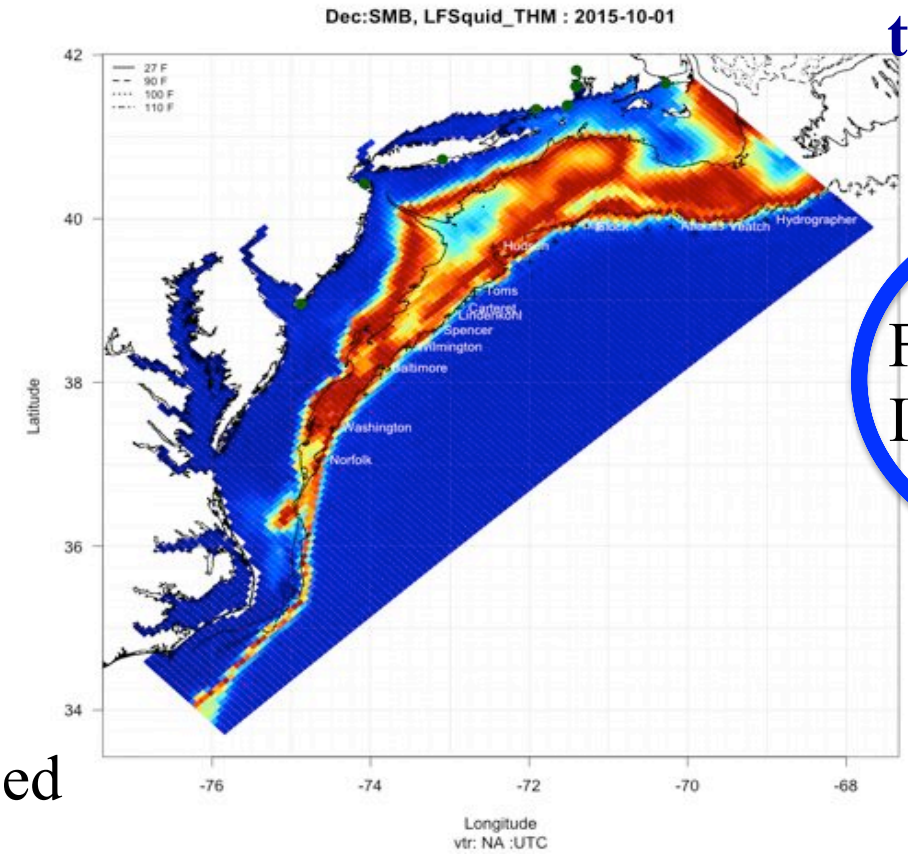
nested hierarchy of modeling & collaborative investigation



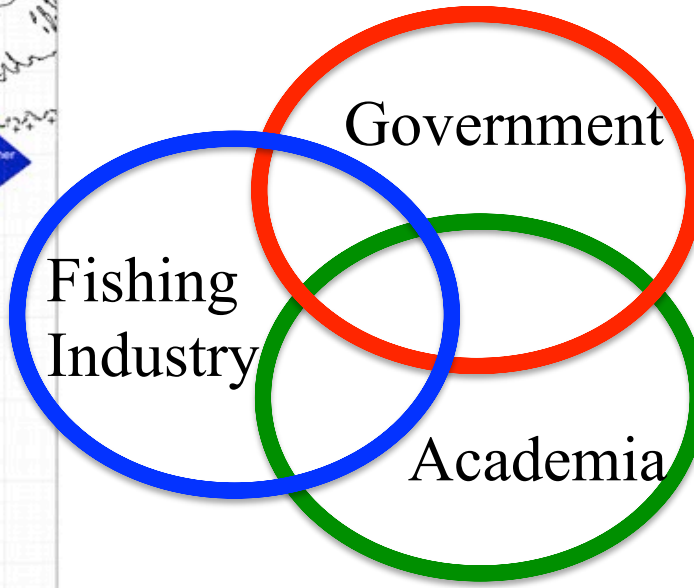
Rapid Climate, Seascape & Ecosystem change

Dynamic ocean management

Ecosystem based population assessment



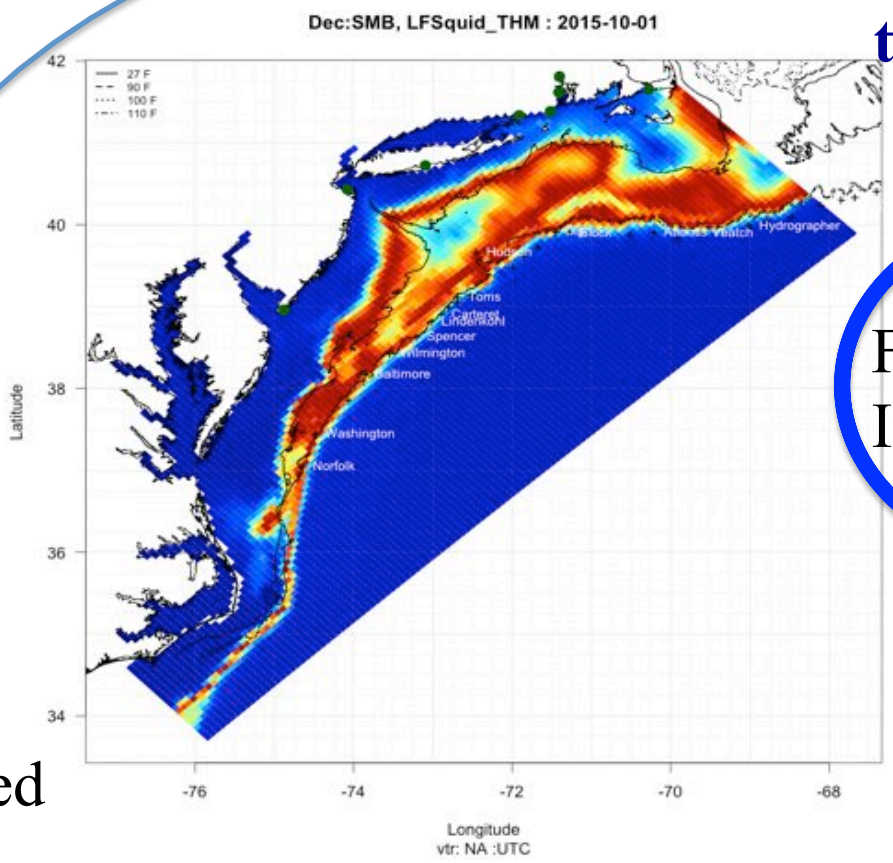
Co-developed tools for sustainable use



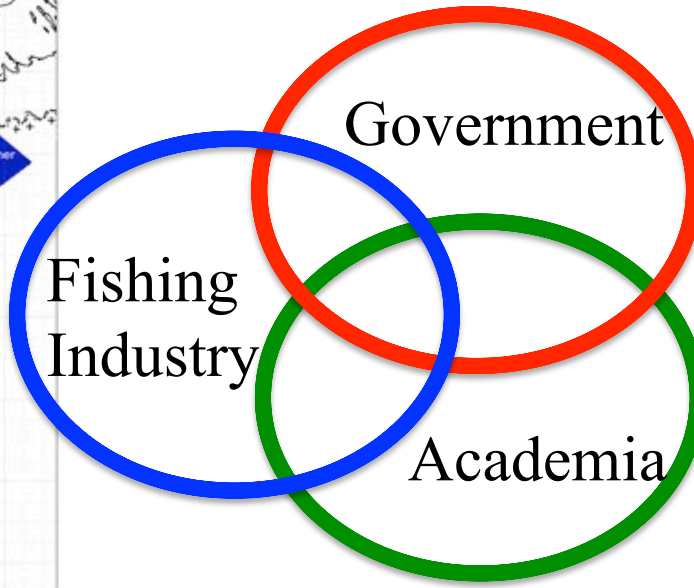
Rapid Climate, Seascape & Ecosystem change

Seascape ecology

Dynamic ocean management



Co-developed tools for sustainable use



Ecosystem based population assessment

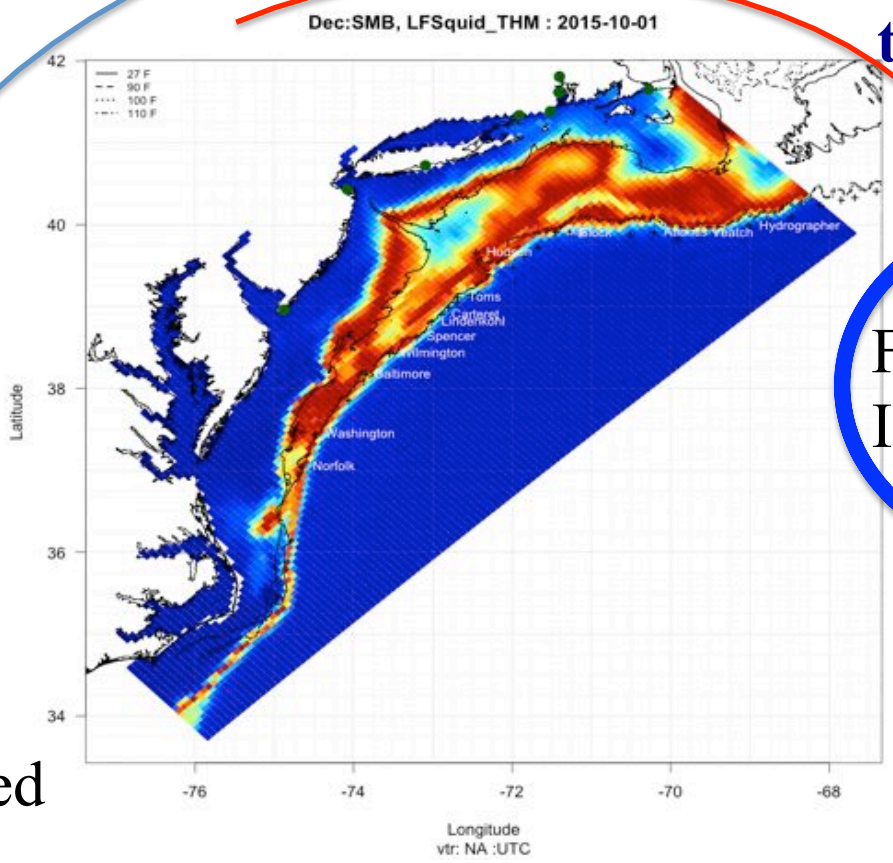
Rapid Climate, Seascape & Ecosystem change

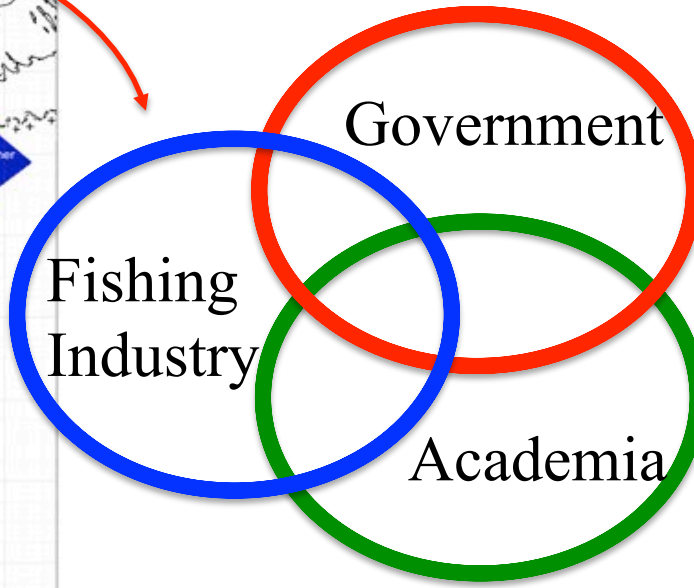
Seascape ecology

Dynamic ocean management

Tactical regulations

Co-developed tools for sustainable use





Ecosystem based population assessment

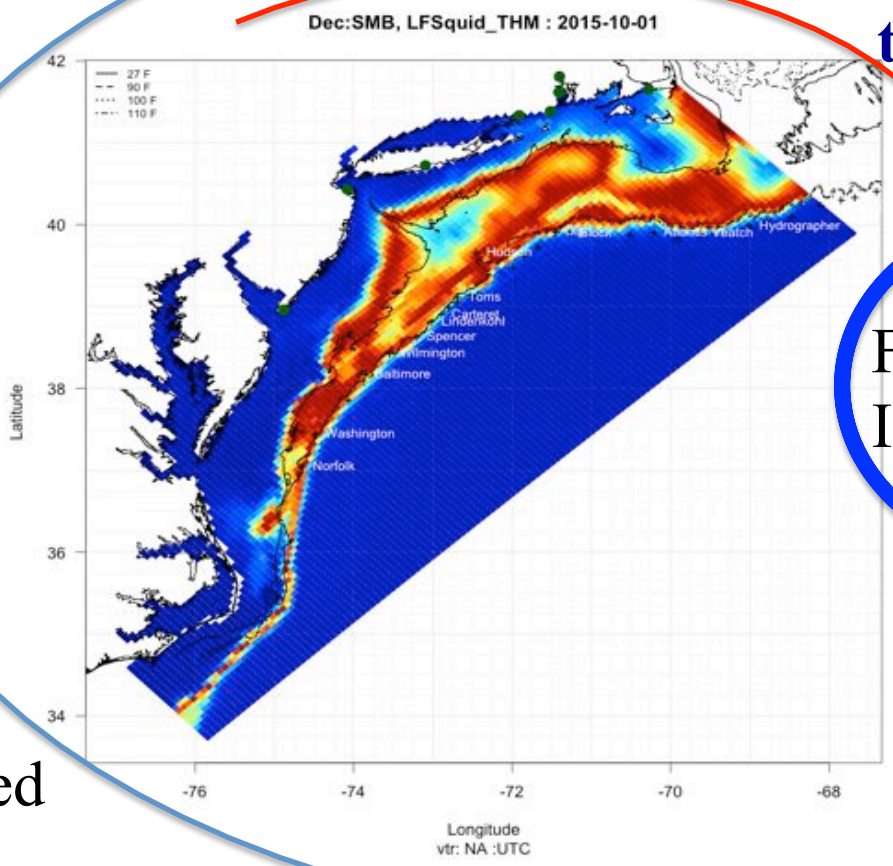
Rapid Climate, Seascape & Ecosystem change

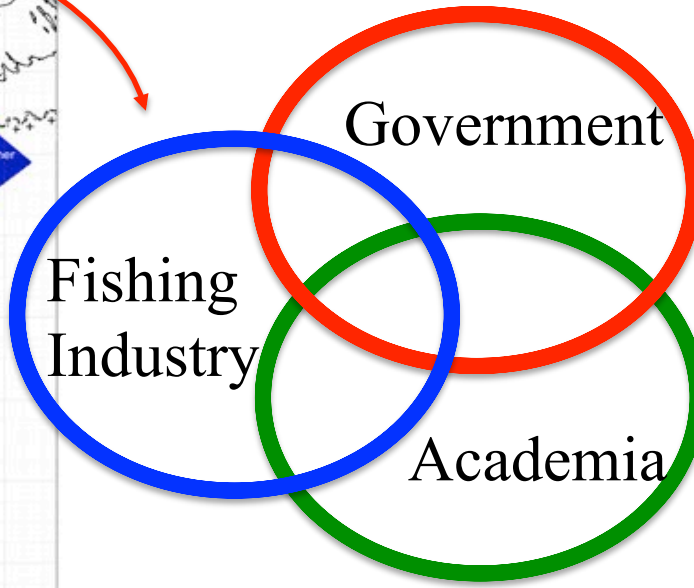
Seascape ecology

Dynamic ocean management

Tactical regulations

Co-developed tools for sustainable use





Ecosystem based population assessment

Population ecology

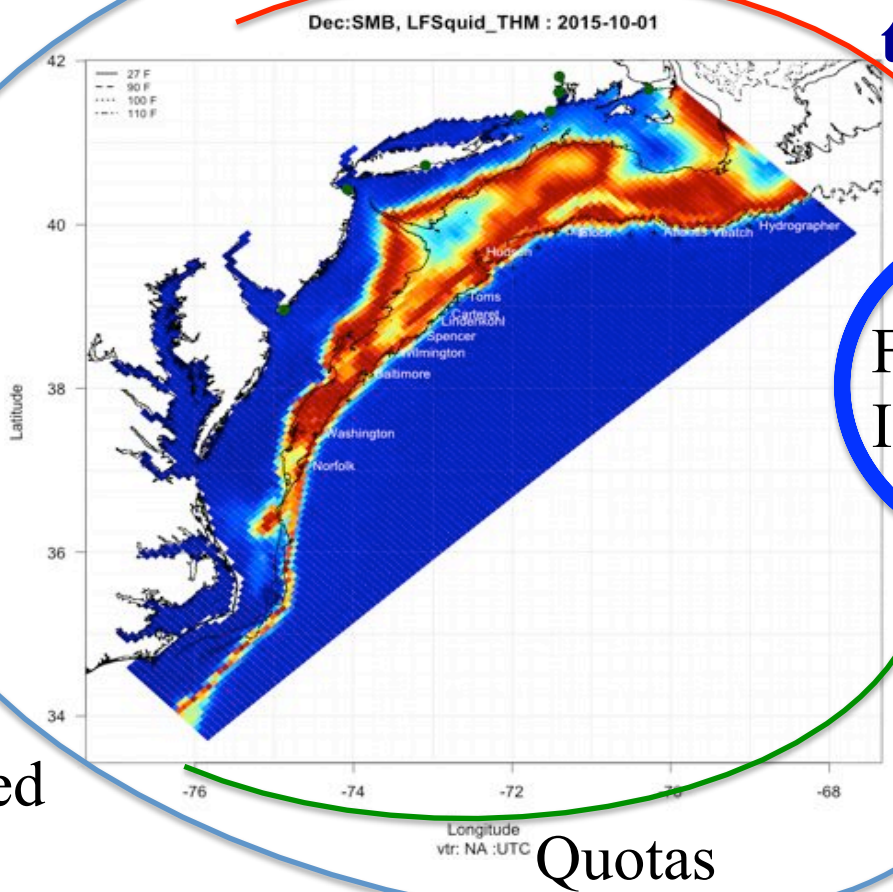
Rapid Climate, Seascape & Ecosystem change

Seascape ecology

Dynamic ocean management

Tactical regulations

Co-developed tools for sustainable use



Government

Fishing Industry

Academia

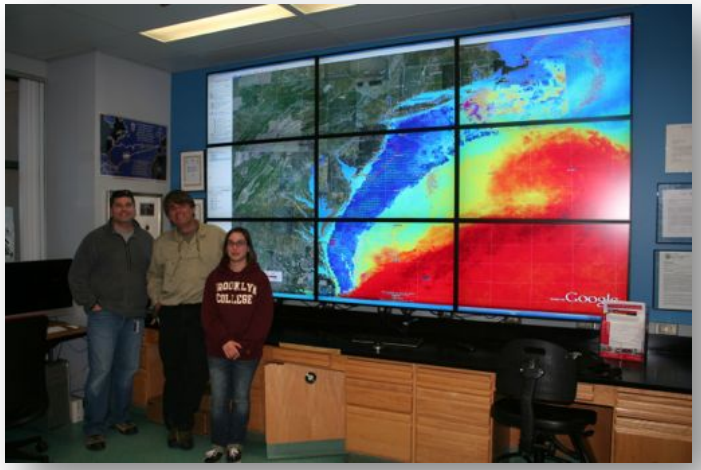
Ecosystem based population assessment

Quotas

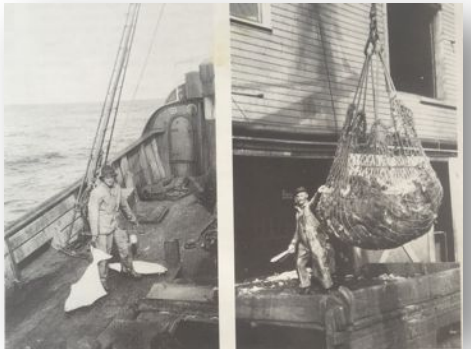
Population ecology

Resources required?

Access to IOOS ocean data & collaborators



Real & near real time
Fishery independent &
Fishery dependent data
Fishery dependent understanding



A laptop, a wireless hotspot processing & file sharing freeware

Dropbox

R

Resource required