Fisheries & Wildlife Interactions with the Oceanographic Environment in the Mid-Atlantic Bight

June 17, 2025

Center for Ocean Observing Leadership
Department of Marine and Coastal Sciences
School of Environmental and Biological Sciences

Outline

- Thermal habitat relationships with fisheries
- Fisheries habitats defined by satellite data
- Potential applications from surface and/or bottom current measurements
  - Fronts, prey aggregation
  - Upwelling, divergence
  - Identifying source location of eDNA
  - Larval dispersion and settlement
  - Eddies
  - Sediment/benthic disturbance

Fish & The Environment

- Fish metabolism, distribution, abundance, is highly coupled to currents, salinity, plankton, predators, prey, temperature, …

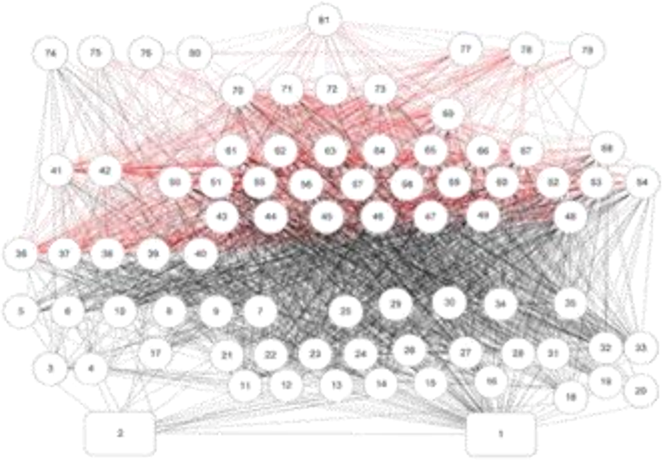
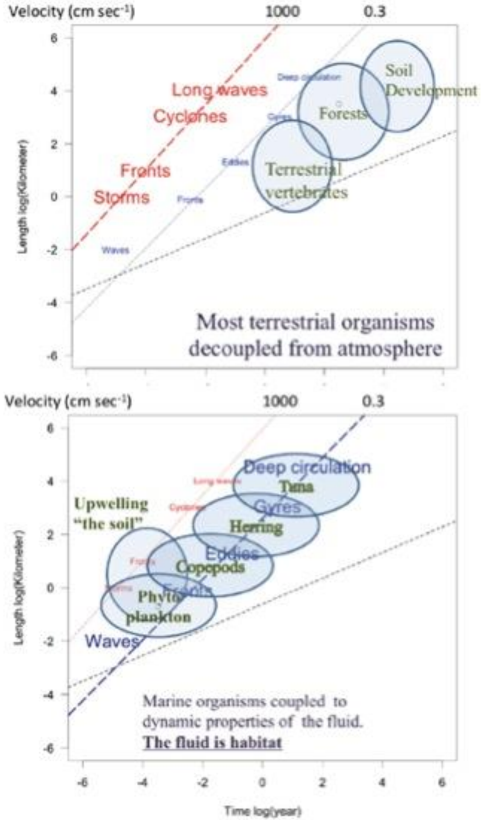
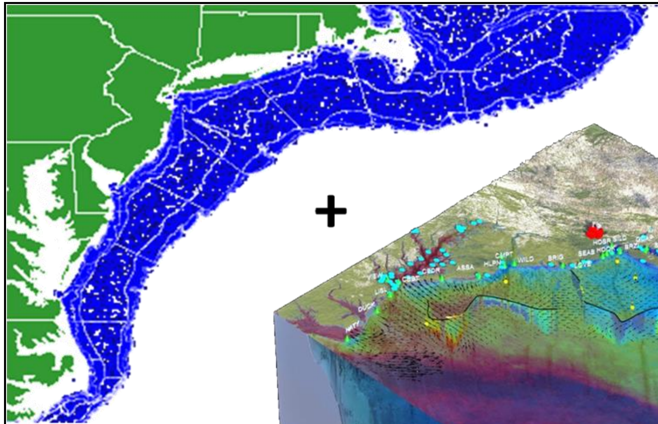


Figure 22. Food web of the northeast shelf large marine ecosystem (NES LME). Adapted from Link 2002.

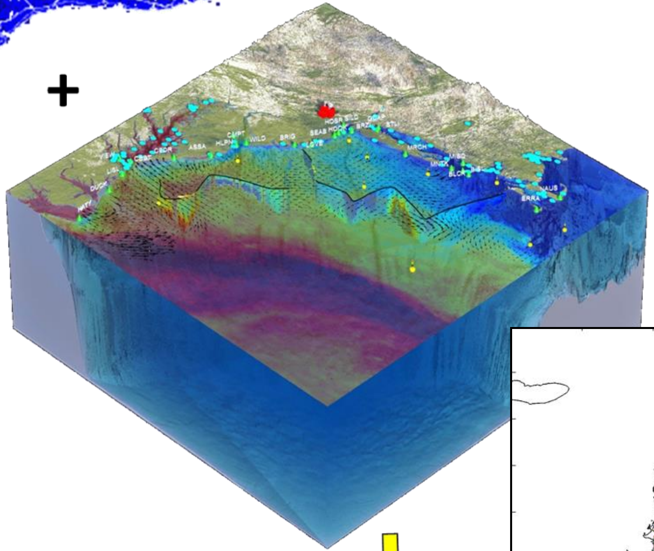


Approach: Regional Habitat Models



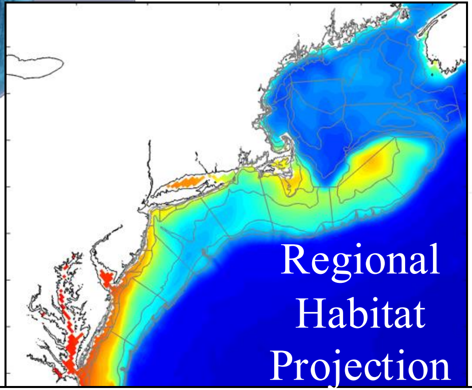
NOAA US Fishery Data
Spatial grain = 11km

+

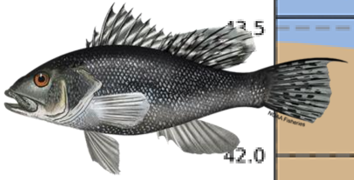


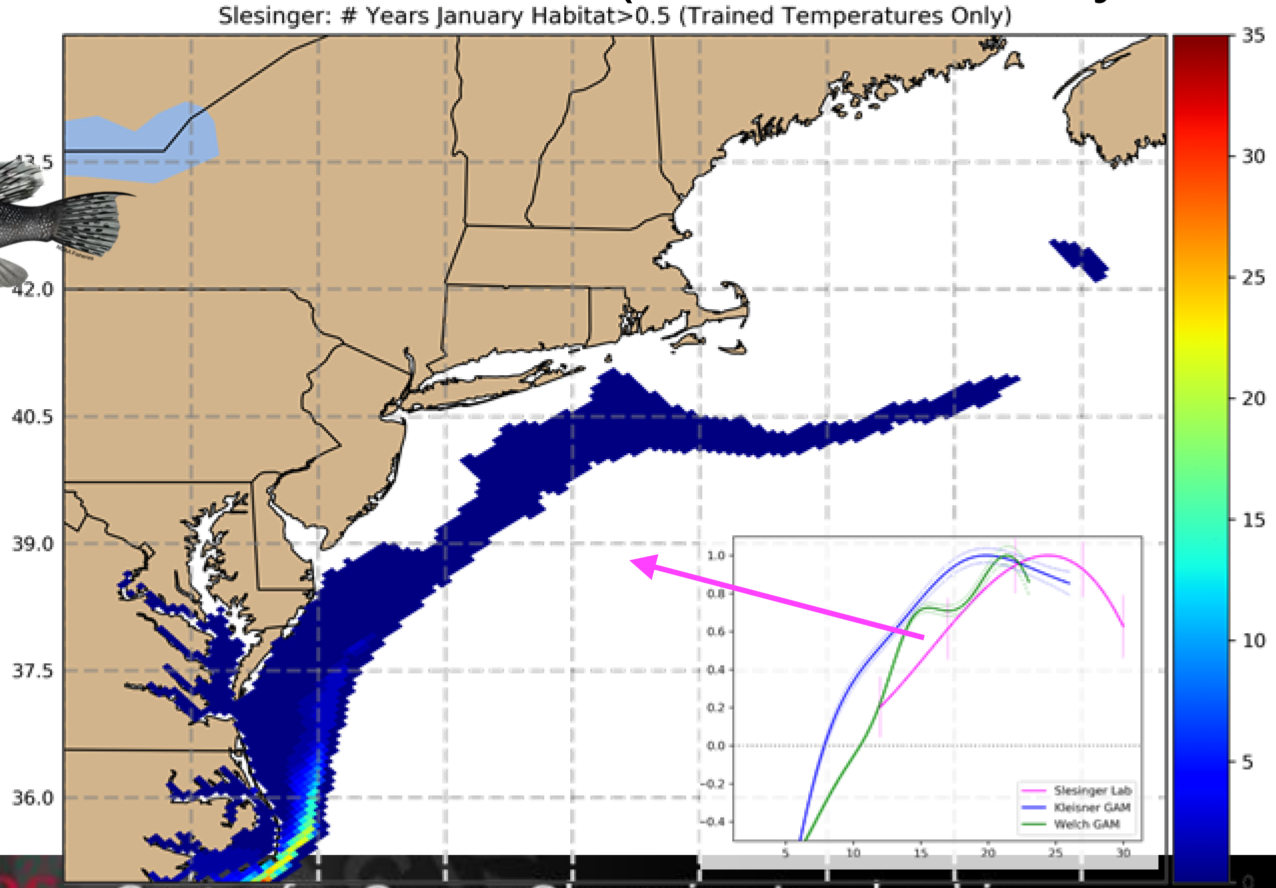
Ocean Observations
+
Models

Statistical, Mechanistic, and Physiological "niche" Models

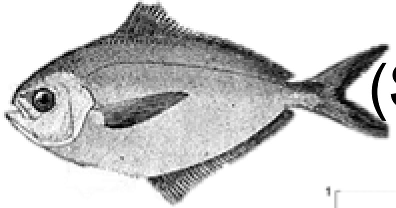


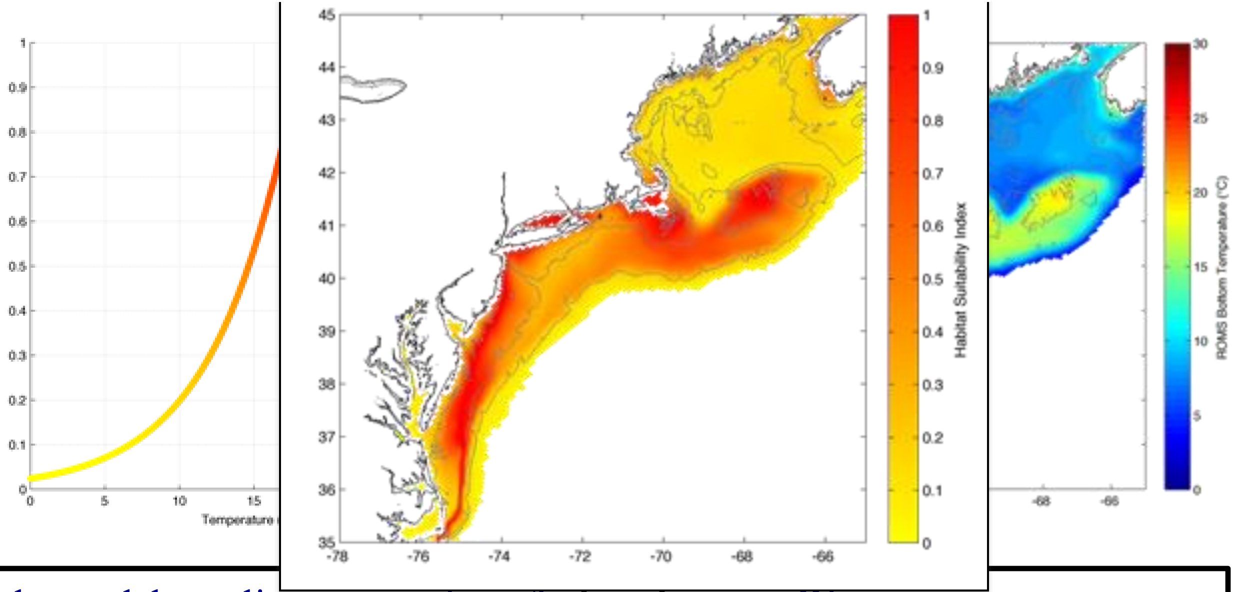
Black Sea Bass Habitat (Lab-Based Physiology)





Butterfish Habitat
(Statistical Curve fit to Physiological Curve)

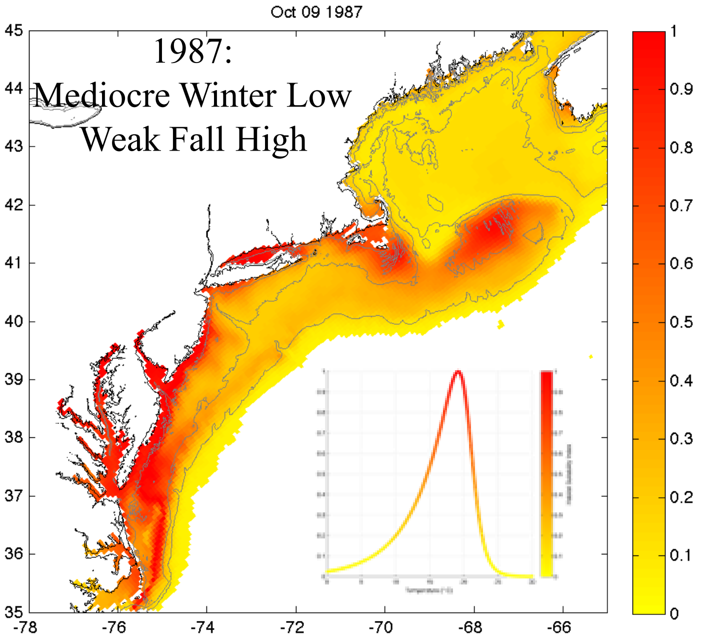


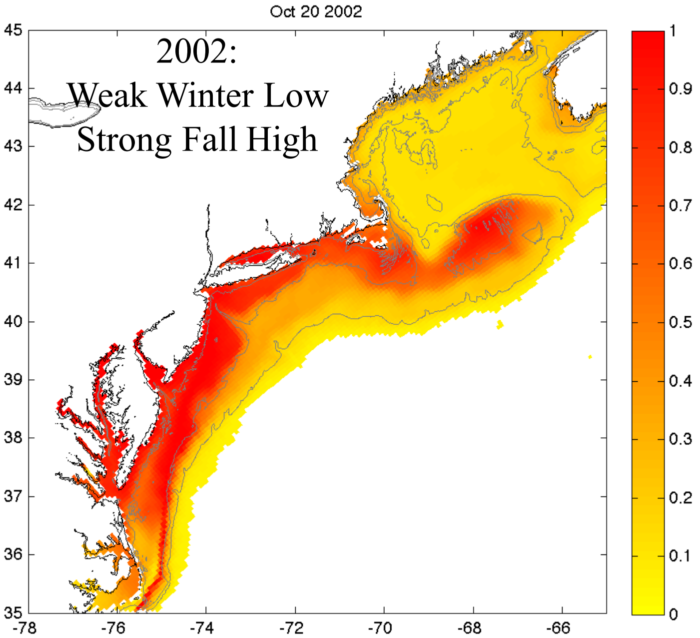


Niche model: nonlinear extension of Boltzmann-Arrhenius equation (mechanistic basis in enzyme kinetics)

Water temperature hindcast from oceanographic model (ROMS)

Butterfish Habitat
(Statistical Curve fit to Physiological Curve)





Accounting for variability in habitat available during the survey decreased uncertainty in the butterfish stock assessment and led to reopening the fishery.

Northeast Fisheries Science Center Reference Document 14-04
doi:10.7289/V5KP8043

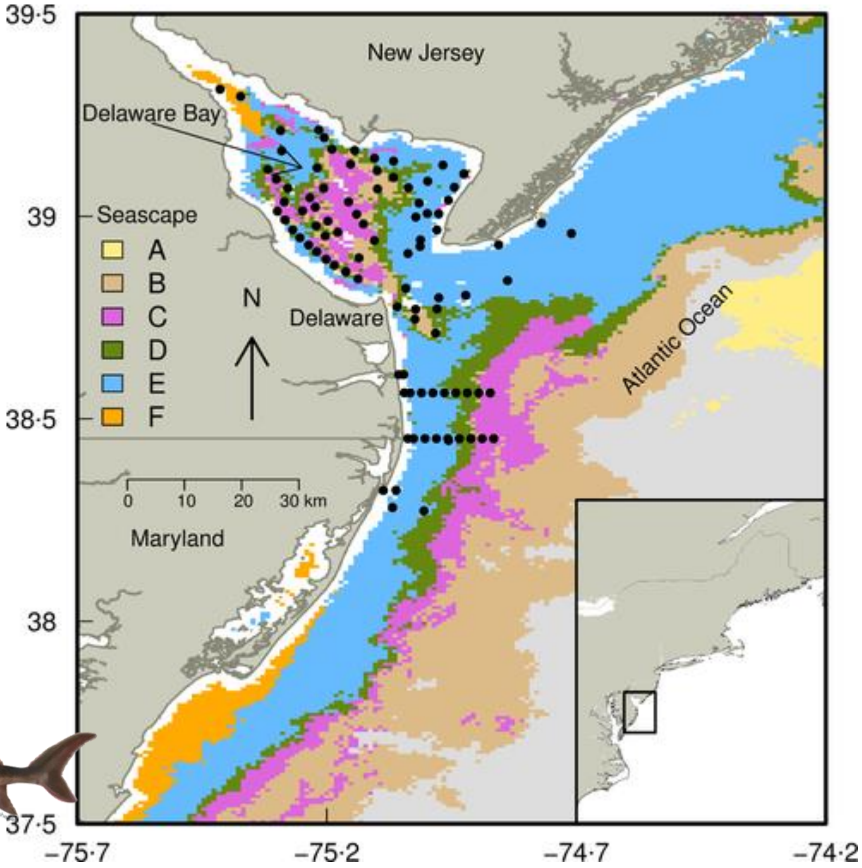
58th Northeast Regional Stock Assessment Workshop (58th SAW)

Assessment Report

by the Northeast Fisheries Science Center

TOR 3. Characterize oceanographic and habitat data as it pertains to butterfish distribution and availability. If possible, integrate the results into the stock assessment (TOR-5).

Sturgeon mapped to water masses classified based on satellite-based surface temperature and ocean color



BRITISH ECOLOGICAL SOCIETY | Methods in Ecology and Evolution

Research Article | Open Access

Dynamic seascapes predict the marine occurrence of an endangered species: Atlantic Sturgeon *Acipenser oxyrinchus oxyrinchus*

Matthew W. Breece, Dewayne A. Fox, Keith J. Dunton, Mike G. Frisk, Adrian Jordaan, Matthew J. Oliver

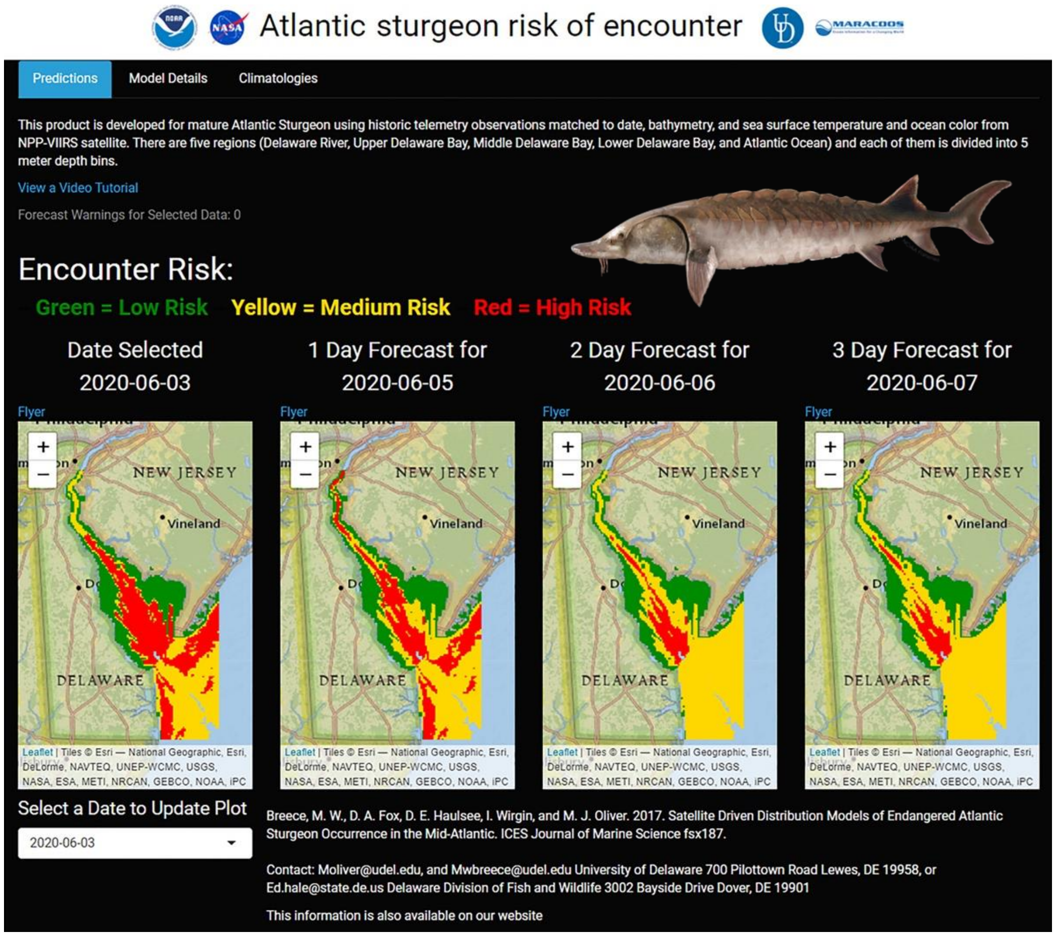
Daily risk map based on satellite data provided online and via text for endangered sturgeon

ECOLOGICAL APPLICATIONS
ECOLOGICAL SOCIETY OF AMERICA

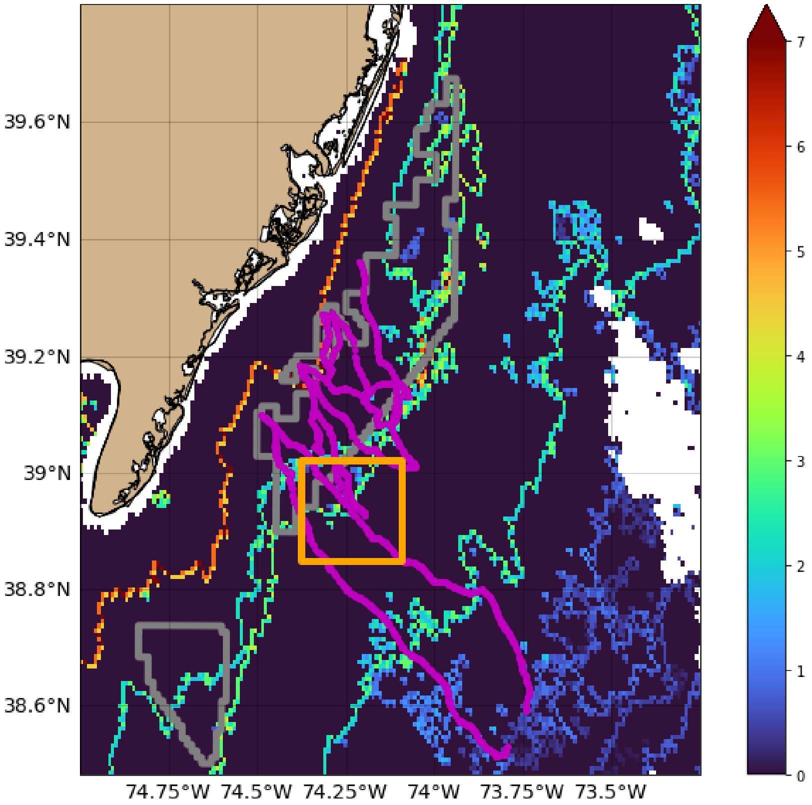
Article | Open Access

A satellite-based mobile warning system to reduce interactions with an endangered species

Matthew W. Breece, Matthew J. Oliver, Dewayne A. Fox, Edward A. Hale, Danielle E. Haulsee, Matthew Shatley, Steven J. Bograd, Elliott L. Hazen, Heather Welch



Critically endangered right whales may occur more frequently near strong fronts between water masses. Possible indicator of prey aggregations.



Vol. 438: 1–17, 2011
doi: 10.3354/meps09308
MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser
Published October 5

OPEN ACCESS

FEATURE ARTICLE

Ocean observatory data are useful for regional habitat modeling of species with different vertical habitat preferences

John Manderson[1,*], Laura Palamara[2], Josh Kohut[2], Matthew J. Oliver[3]

Vol. 447: 15–30, 2012
doi: 10.3354/meps09496
MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser
Published February 13

Improving habitat models by incorporating pelagic measurements from coastal ocean observatories

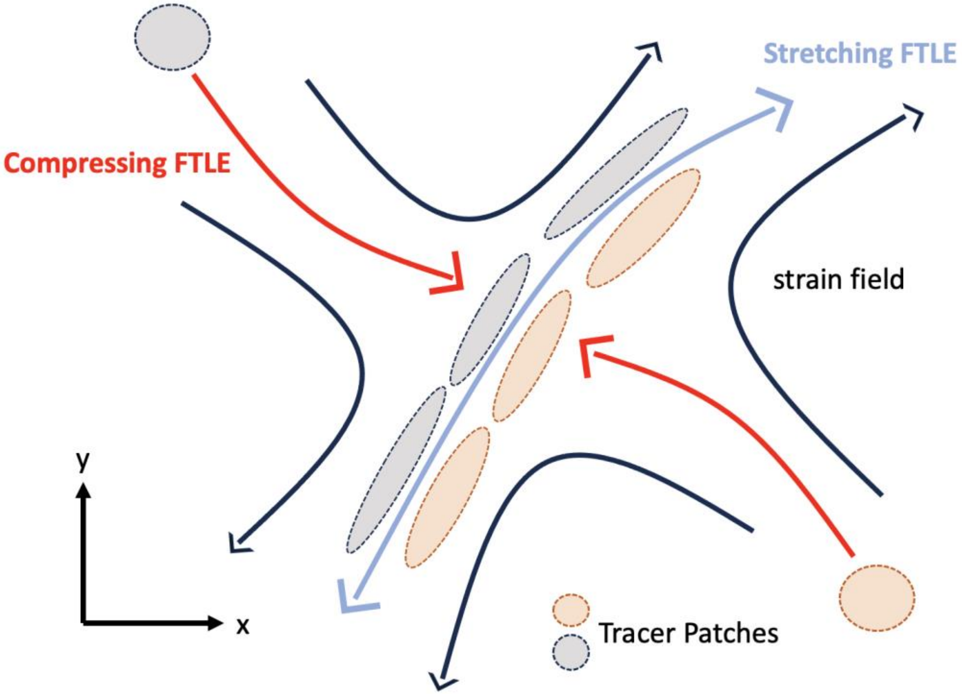
Laura Palamara[1,*], John Manderson[2], Josh Kohut[1], Matthew J. Oliver[3], Steven Gray[4], John Goff[5]

Variables	Spatial grain	Possible ecological effect	Data source
Sun's elevation	na	Vertical migration/catchability	Calculated for trawl locations & times
Geographic coordinates	2 km	Unknown spatial process	NEFSC bottom trawl survey
Benthic data			
Depth (μ, SD)	1.95 km (93 m)	Structural/spatial refuge	NGDC 93 m grid[a]
Slope (μ, SD)[d]	"	"	"
Aspect (SD)[d]	"	"	"
Profile curvature (μ, SD)[d]	"	"	"
Sediment grain size (μ)	2 km	Structural/spatial refuge/enrichment	US seabed data base[b]
Pelagic data			
***In situ* CTD measurements**			
Bottom temperature	1 m	Metabolic rate	NEFSC bottom trawl survey
Bottom salinity[d]	"	Alias proximity to freshwater source	"
Mixed layer depth	"	Mixing/1° productivity	"
Stratification index[d]	"		"
Simpson's PE (30 m)	"	"	"
OOS remote sensing			
High–frequency radar			
Cross shelf velocity	10 km	Advection/movement cost/mixing	MARACOOS HF radar[c]
Along shelf velocity	"	"	"
Variance in velocity	"	Tidal mixing/episodic forcing	"
Divergence potential	"	Upwelling/downwelling & mixing	"
Vorticity potential[d]	"	Eddy development/retention	"
Satellites			
Sea surface temperature	10 km	Metabolic rate/other seasonal factors	MODIS through MARACOOS[c]
Chlorophyll *a*	"	Primary production/organic matter	"
Normalized water leaving radiances (412, 443, 488, 531, 551, 667 nm)[d]	"	Surface organic matter	"
Water mass class	"	Various	"
Frontal index (distance to & strength of gradient between water masses)	"	Concentration/enrichment	"
Prey abundance			
Squid	2 km	Prey	NEFSC bottom trawl survey
Butterfish	"	"	"

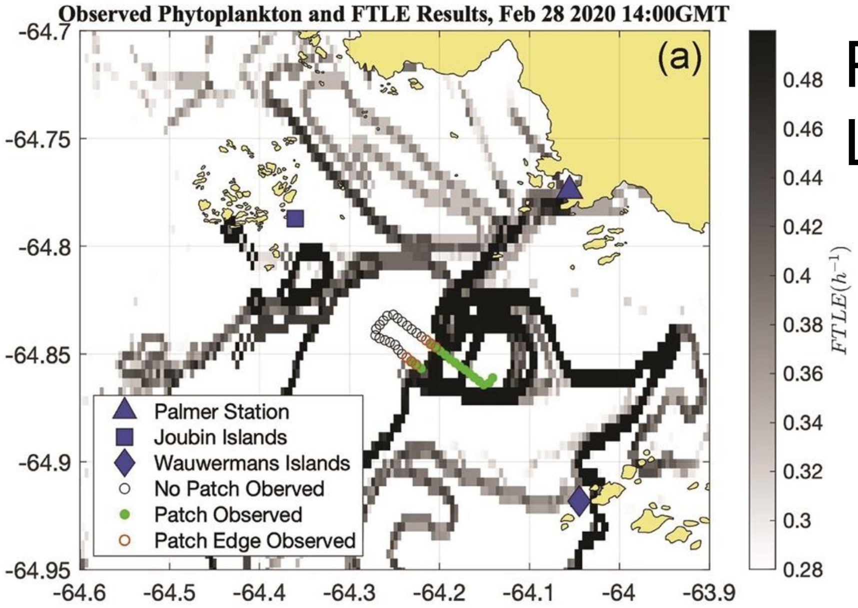
[a]www.ngdc.noaa.gov/mgg/coastal/coastal.html; [b]http://walrus.wr.usgs.gov/usseabed; [c]http://maracoos.org/data;
[d]variables that were redundant or not ecologically meaningful and therefore excluded in the final analysis

Rutgers Center for Ocean Observing Leadership

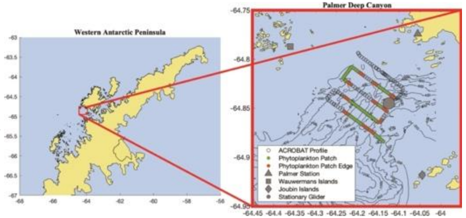
LCS

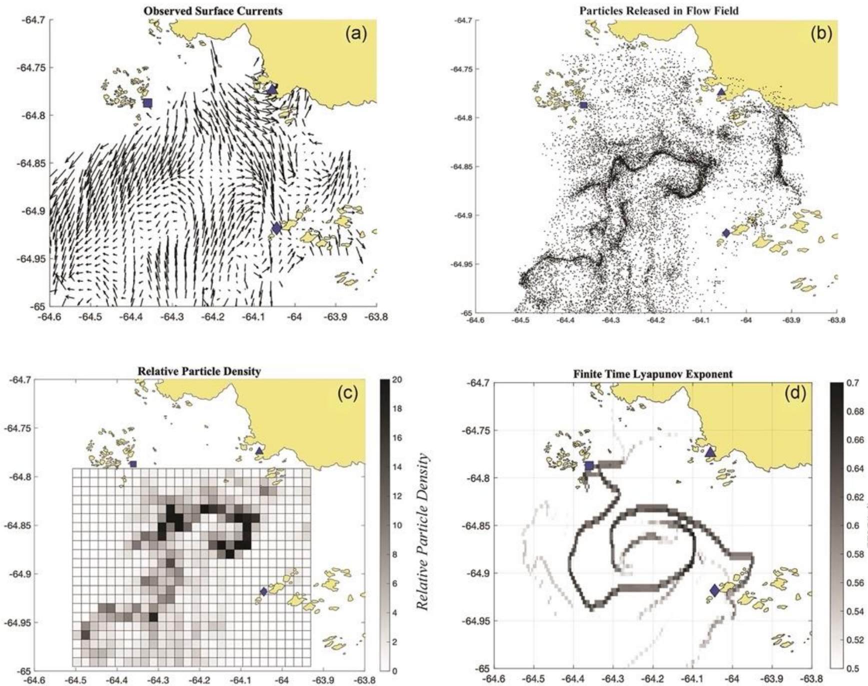


Finite Time Lyapunov Exponent is a type of Lagrangian Coherent Structure. Based on currents and can indicate areas passive particles (including prey species like zooplankton) may aggregate.



Palmer Deep LCS Case Study





Quantifying the role of submesoscale Lagrangian transport features in the concentration of phytoplankton in a coastal system

Jacquelyn M Veatch, Josh T Kohut, Matthew J Oliver, Hank Statscewich, Erick Fredj

ICES Journal of Marine Science, Volume 81, Issue 4, May 2024, Pages 760–773, https://doi.org/10.1093/icesjms/fsae036

Published: 22 March 2024 **Article history** ▾

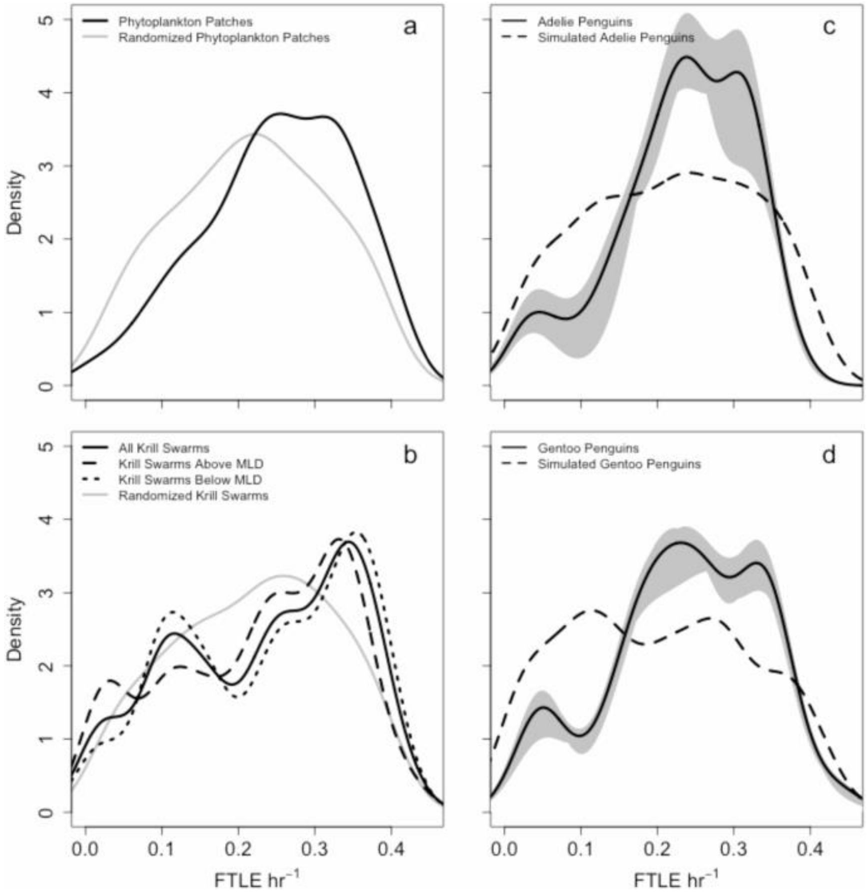
nature › communications earth & environment › articles › article

Article | Open access | Published: 20 February 2025

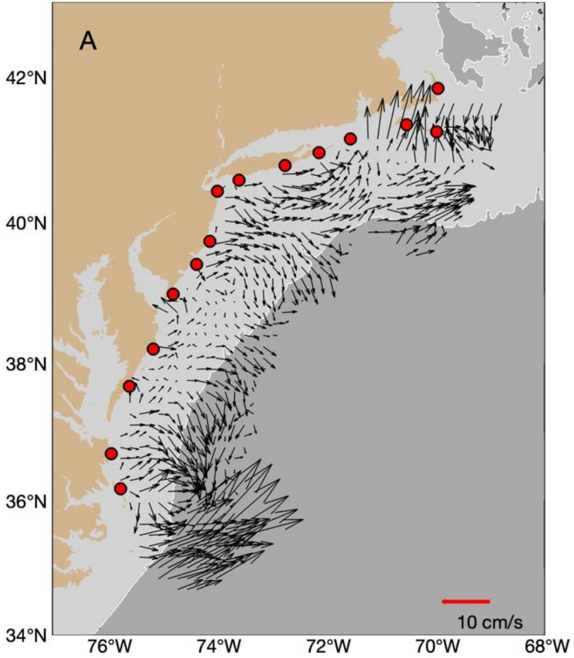
Lagrangian coherent structures influence the spatial structure of marine food webs

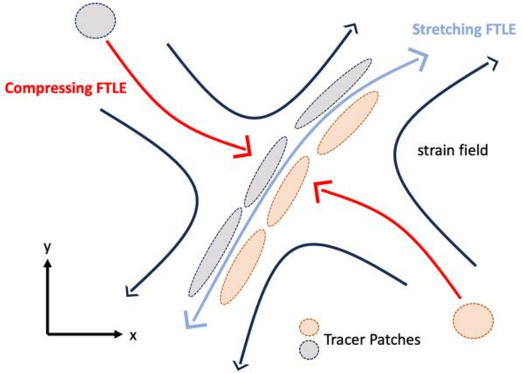
Jacquelyn M. Veatch, Matthew J. Oliver, Erick Fredj, Hank Statscewich, Kim Bernard, Ashley M. Hann, Grant Voirol, Heidi L. Fuchs, William R. Fraser & Josh T. Kohut

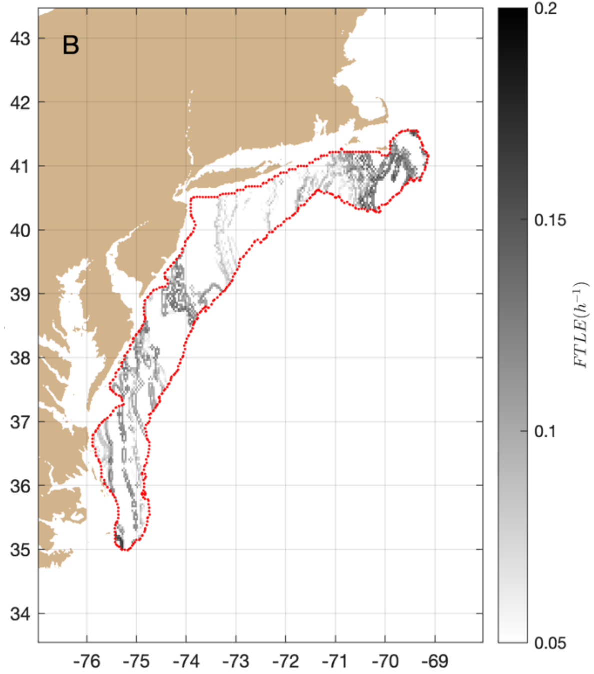
Communications Earth & Environment **6**, Article number: 127 (2025) | Cite this article

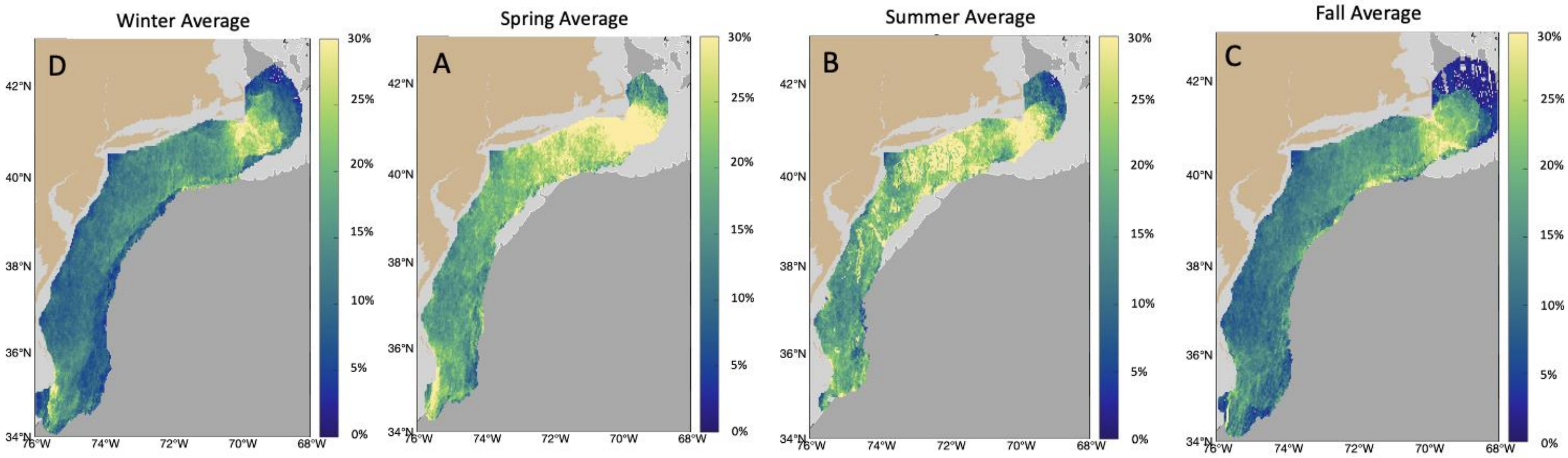


LCS in the Mid-Atlantic Bight

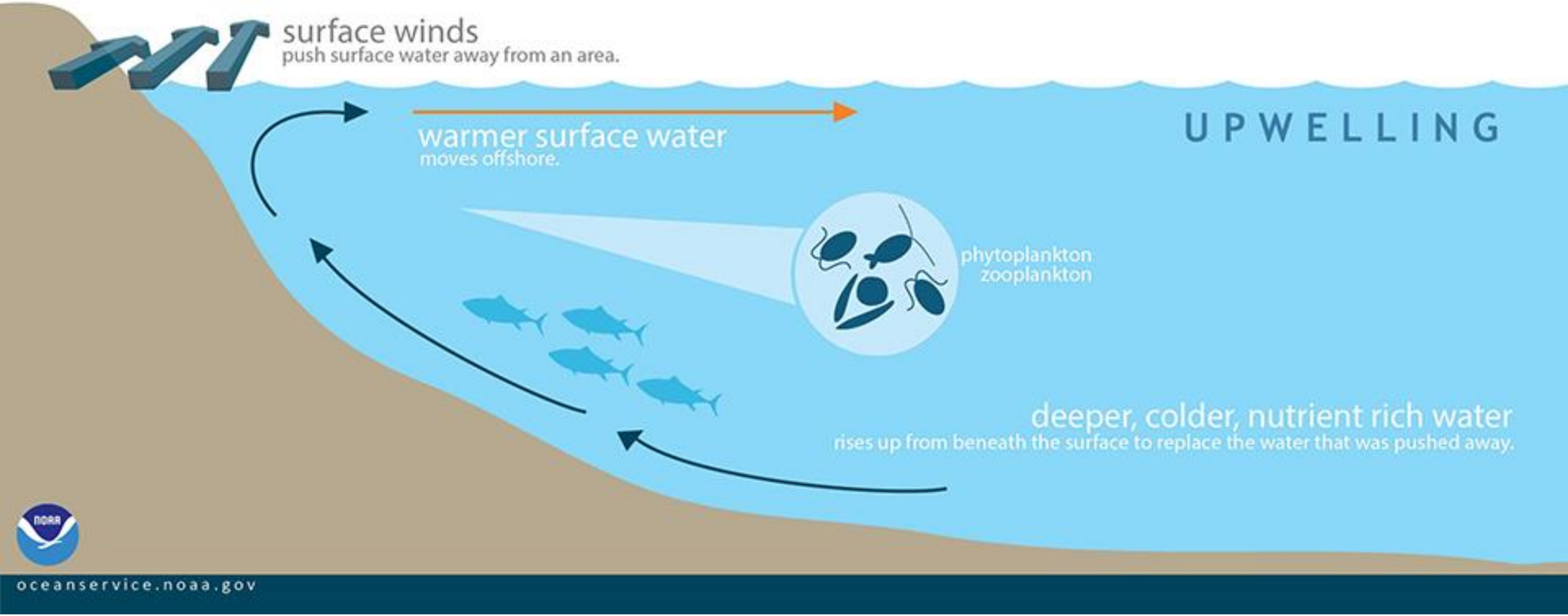


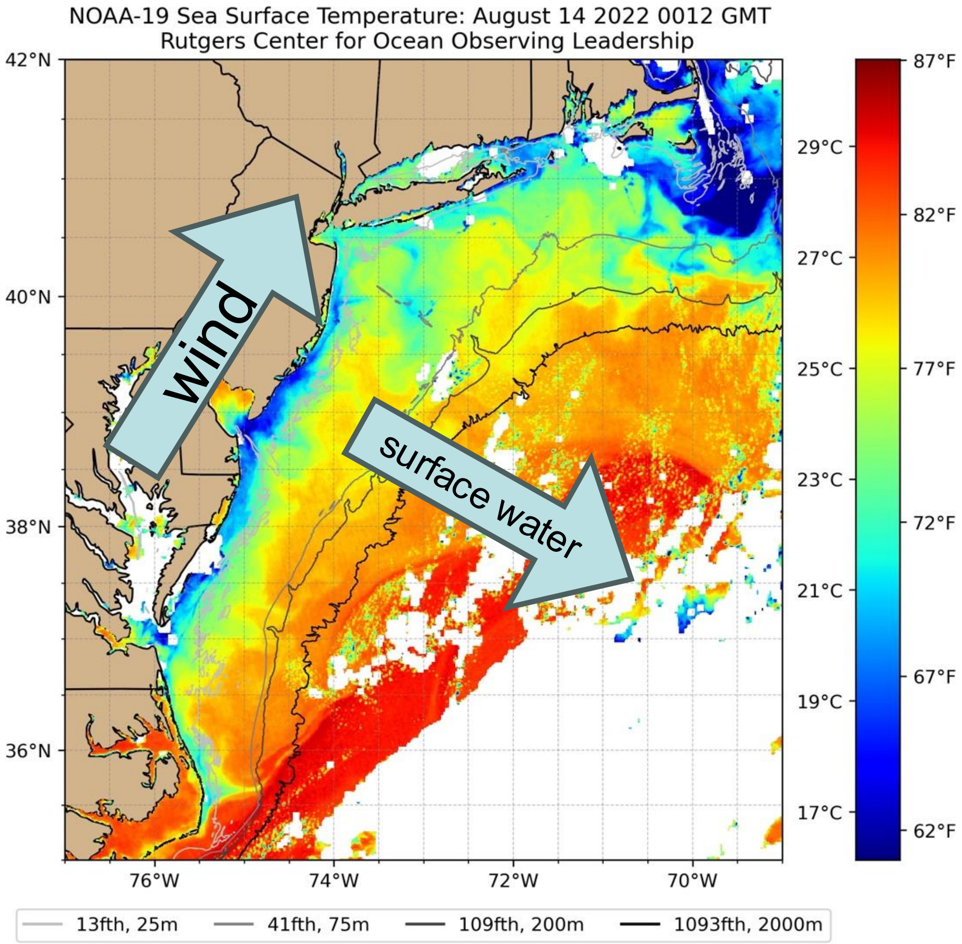





Winter Average
D
Spring Average
A
Summer Average
B
Fall Average
C
42°N
40°N
38°N
36°N
34°N
76°W
74°W
72°W
70°W
68°W
30%
25%
20%
15%
10%
5%
0%

Upwelling


surface winds
push surface water away from an area.
warmer surface water
moves offshore.
UPWELLING
phytoplankton
zooplankton
deeper, colder, nutrient rich water
rises up from beneath the surface to replace the water that was pushed away.
NOAA
oceanservice.noaa.gov



Persistent SW winds

↓

Ekman flow pushes warm surface water offshore

↓

Upwelled cold, nutrient-rich bottom water along coast

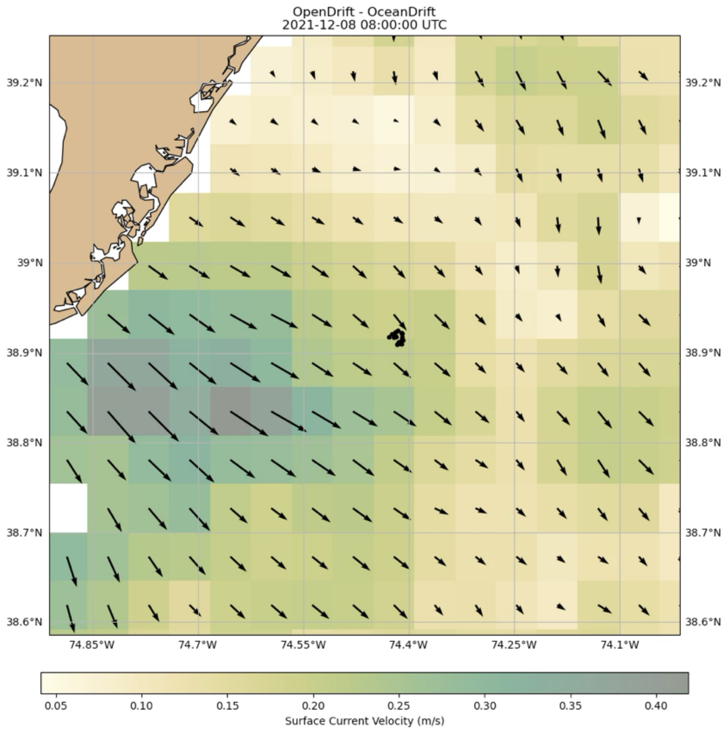
↓

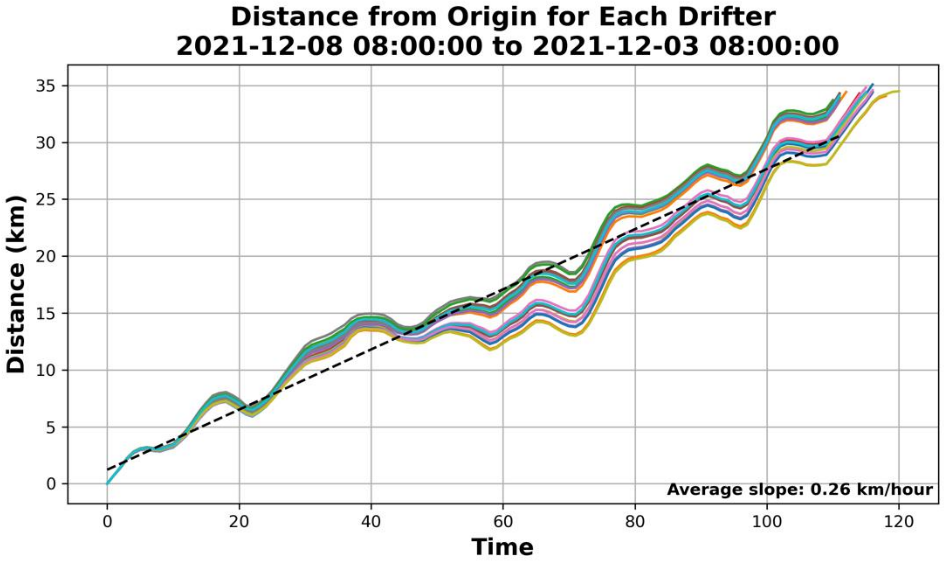
Possible phytoplankton bloom

↓

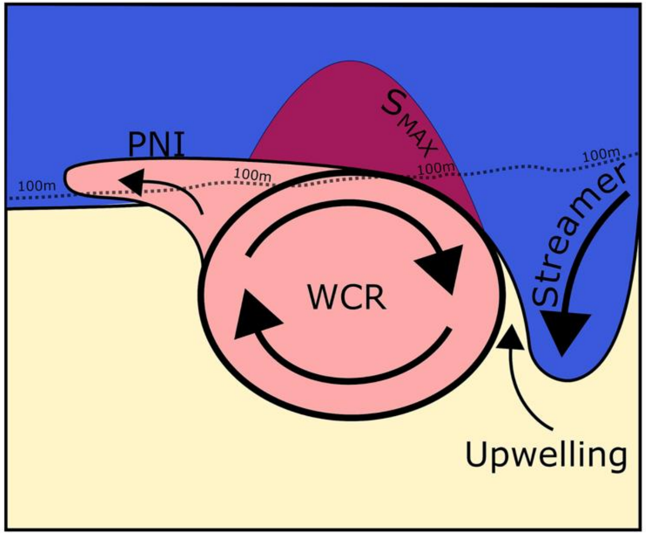
Possible zooplankton bloom

eDNA is becoming a common tool in the MAB. HFR can help identify where the source water is from.





Eddies and warm core rings may be related to some species distributions such as longfin squid.

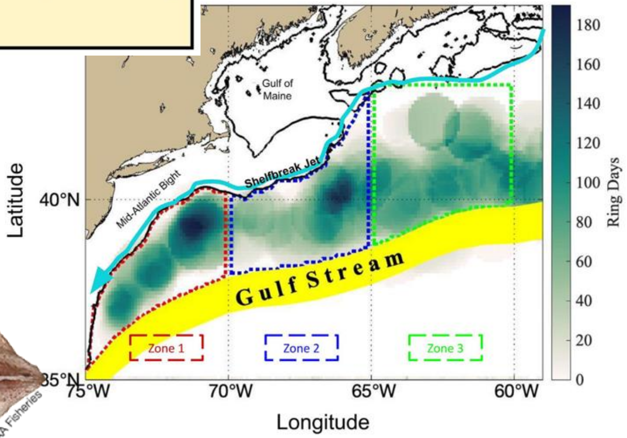


ORIGINAL ARTICLE

FISHERIES OCEANOGRAPHY WILEY

Shelf break exchange processes influence the availability of the northern shortfin squid, *Illex illecebrosus*, in the Northwest Atlantic

Sarah L. Salois[1] | Kimberly J. W. Hyde[1] | Adrienne Silver[2] | Brooke A. Lowman[3] | Avijit Gangopadhyay[4] | Glen Gawarkiewicz[2] | Anna J. M. Mercer[1] | John P. Manderson[5] | Sarah K. Gaichas[6] | Daniel J. Hocking[7] | Benjamin Galuardi[4,7] | Andrew W. Jones[1] | Jeff Kaelin[8] | Greg DiDomenico[8] | Katie Almeida[9] | Bill Bright[10] | Meghan Lapp[11,12]



Currents can affect larval dispersal and settlement success.

Oceanography / Vol. 20, No. 3, SEPTEMBER 2007 / Larval Transport and Dispersal in the Co...

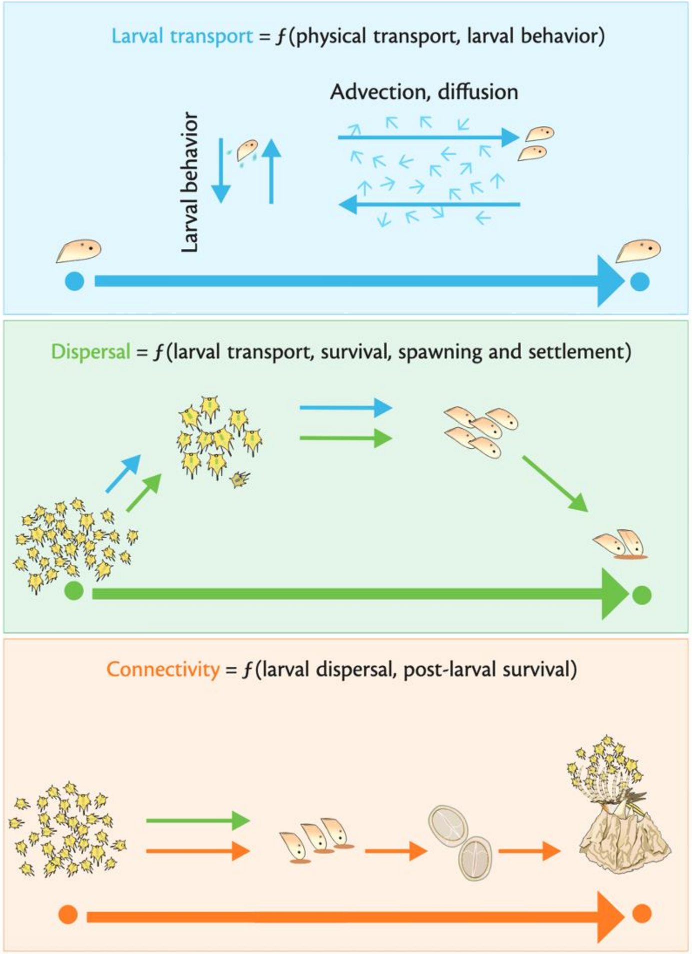
JOURNAL ARTICLE OPEN ACCESS

Larval Transport and Dispersal in the Coastal Ocean and Consequences for Population Connectivity

JESÚS PINEDA, JONATHAN A. HARE, SU SPONAUGLE

Oceanography, Vol. 20, No. 3, SPECIAL ISSUE ON Marine Population Connectivity (SEPTEMBER 2007), pp. 22-39 (18 pages)

https://www.jstor.org/stable/24860094

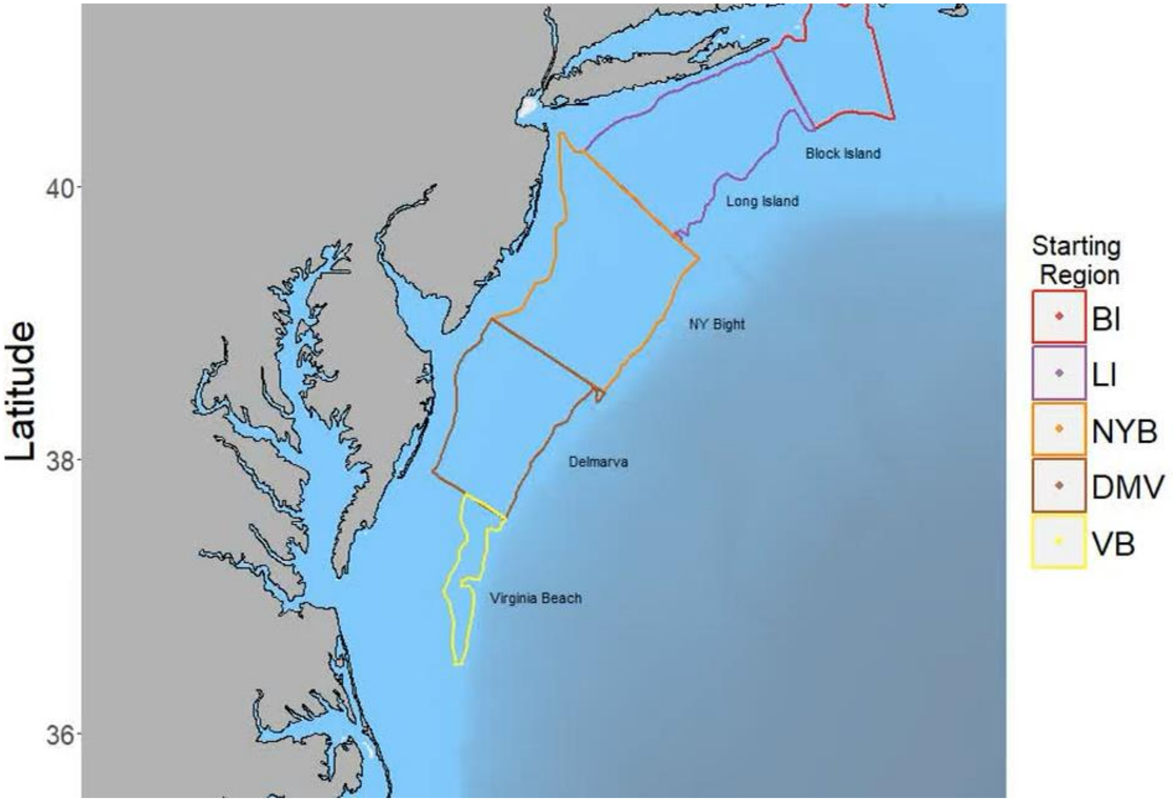


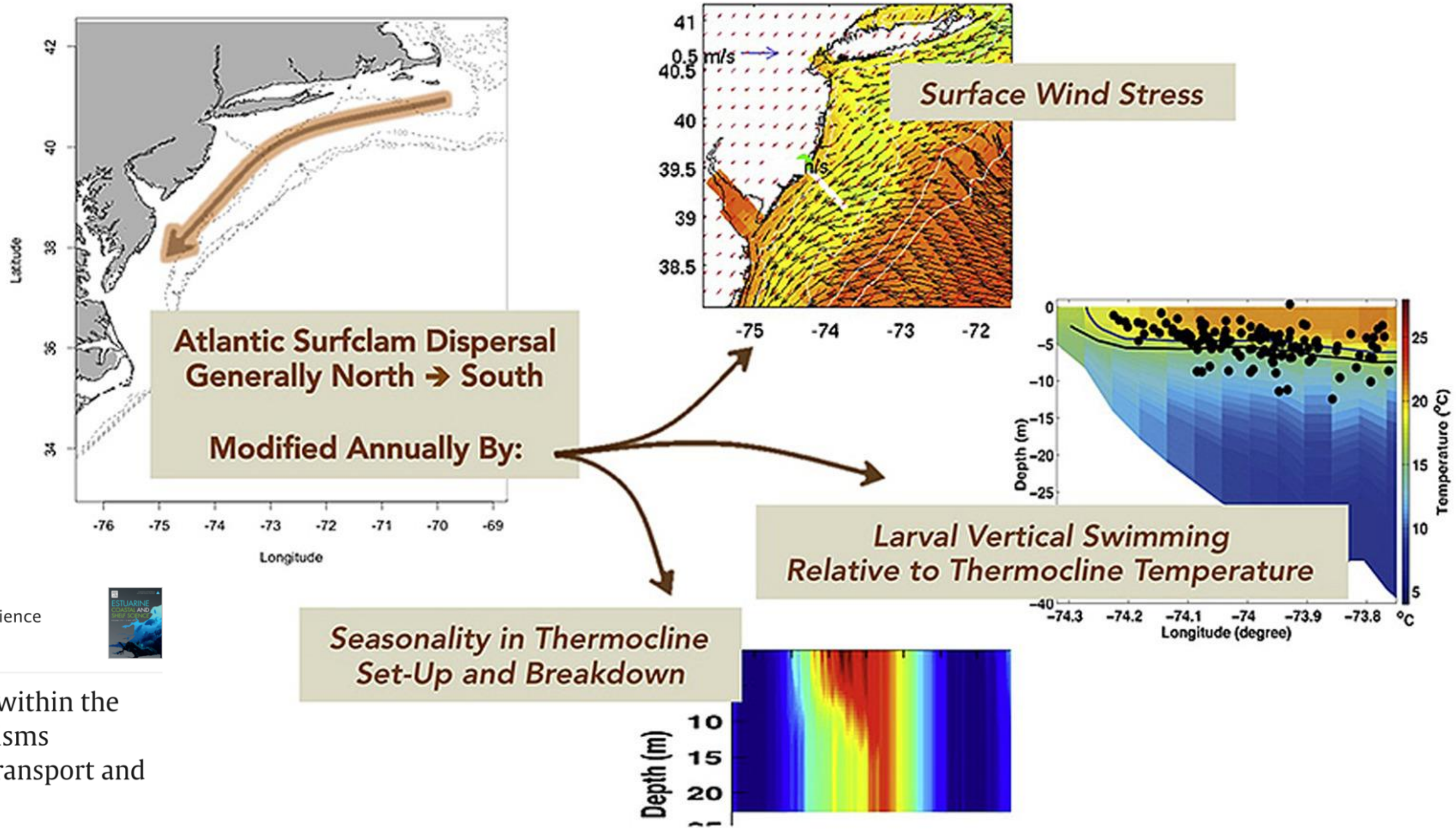
ELSEVIER

Fisheries Research
Volume 208, December 2018, Pages 7-15

Modeling larval dispersal and connectivity for Atlantic sea scallop (*Placopecten magellanicus*) in the Middle Atlantic Bight

Daphne M. Munroe [a b], Dale Haidvogel [b], Joseph C. Caracappa [a b], John M. Klinck [c], Eric N. Powell [d], Eileen E. Hofmann [c], Burton V. Shank [e], Deborah R. Hart [e]





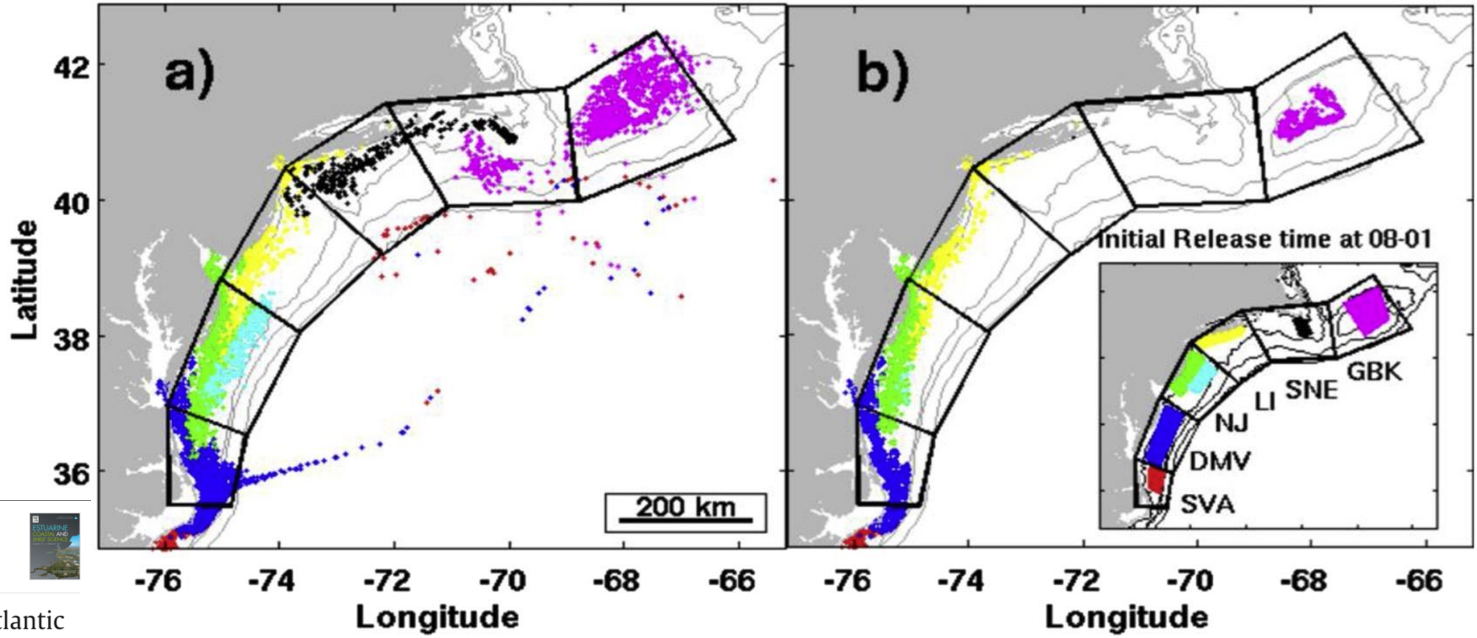
Estuarine, Coastal and Shelf Science
Volume 173, 5 May 2016, Pages 65-78

Atlantic surfclam connectivity within the Middle Atlantic Bight: Mechanisms underlying variation in larval transport and settlement

Xinzhong Zhang [a], Daphne Munroe [b], Dale Haidvogel [a], Eric N. Powell [c]

all larvae

successfully
settled larvae



ELSEVIER
Estuarine, Coastal and Shelf Science
Volume 153, 5 February 2015, Pages 38-53

Modeling larval connectivity of the Atlantic surfclams within the Middle Atlantic Bight: Model development, larval dispersal and metapopulation connectivity

Xinzhong Zhang [a], Dale Haidvogel [a], Daphne Munroe [b], Eric N. Powell [c], John Klinck [d], Roger Mann [e], Frederic S. Castruccio [a 1]

HFR data several potential applications to fisheries (and similar) data.

This data is also assimilated into regional models, which can improve coverage and allow for predictions.

Storms and strong currents can also cause benthic disturbance and temporary stress. To significantly affect a population’s distribution, these impacts are likely minimal compared to trawls, etc, or require prolonged strong currents due to tides.