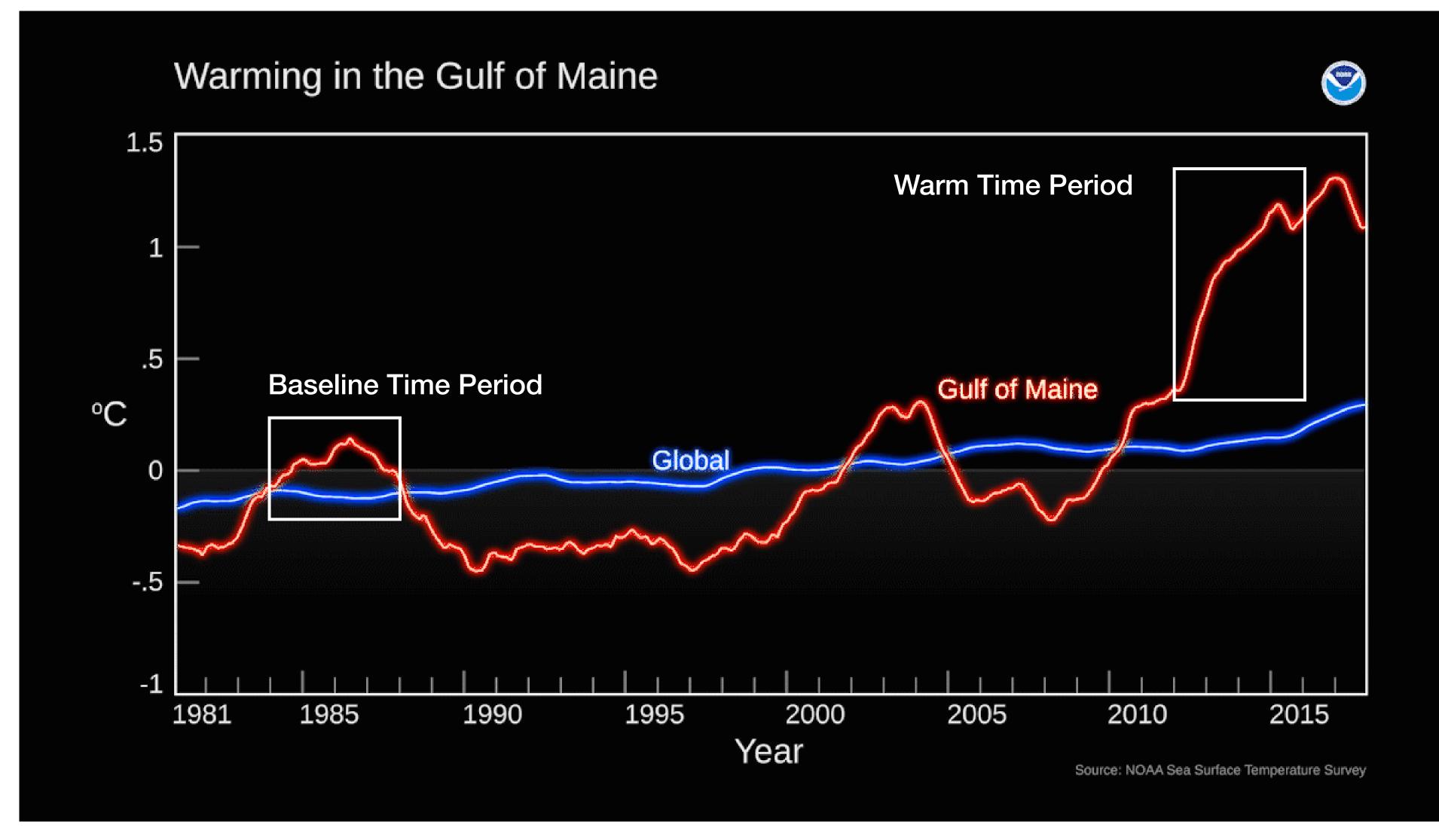
# Impacts of Changing Environmental Conditions on Larval Fish Dispersal and Population Connectivity on the NES



Joshua Zahner<sup>1</sup>, Donald Olson<sup>1</sup>, Elizabeth Babcock<sup>1</sup>, Joel Llopiz<sup>2</sup>, Rubao Ji<sup>2</sup> <sup>1</sup> Rosenstiel School of Marine and Atmopsheric Science, Miami, FL

## Warming on the Northeast US Shelf



 Ocean temperatures warming faster in NE Atlantic than global average

#### Warming is associated with significant changes in ocean circulation patterns and available reproductive habitat

 Changing population connectivity could have significanct impacts on population dynamics and management strategies

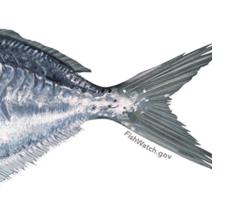
#### **Temperature Conditions**

**Baseline Period** 1984-1988 SSTA: +/- 0.25°C

	Vodel Wo	orkflow
<b>Atlantic cod</b> (Gadus morhua)	Haddock (Melanogrammus ae	
<b>Yellowtail flounder</b> (Limanda ferriguinea)	Atlantic mack (Scomber scom	
FintMath.com		5 Fish S N
Identify poten spawning regio General Additive Me	ns -	Seed larvae with spawning region
Temp   Depth   Sa	linity	Spawning Sease
Process larval transal   allow for larval sett   General Additive Mod   Temp   Depth   Salinity	lement - odel	Embed larvae in o model (FVCOM) dispersal tracki

#### Warm Period 2012-2016 $SSTA: > +0.75^{\circ}C$



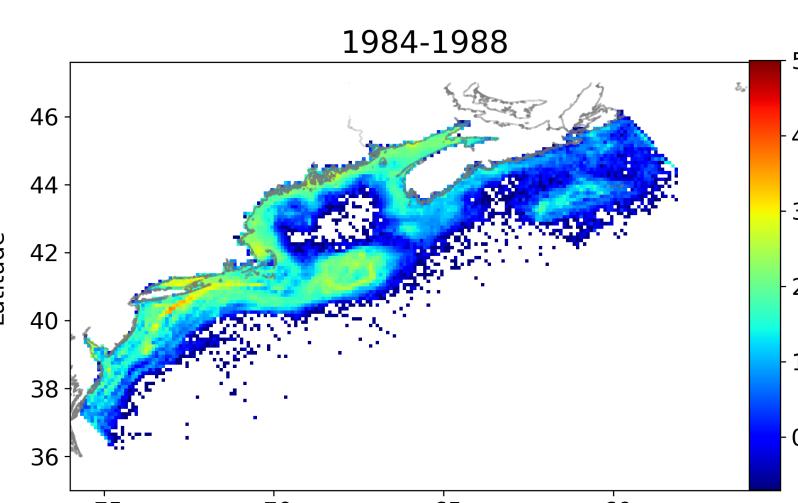


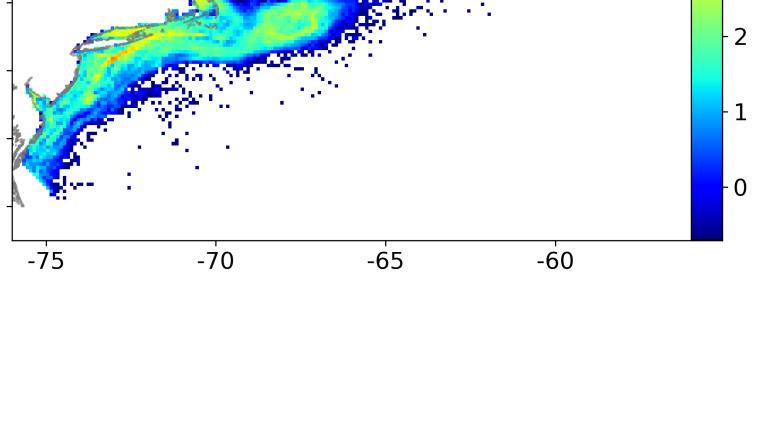
Species Modeled

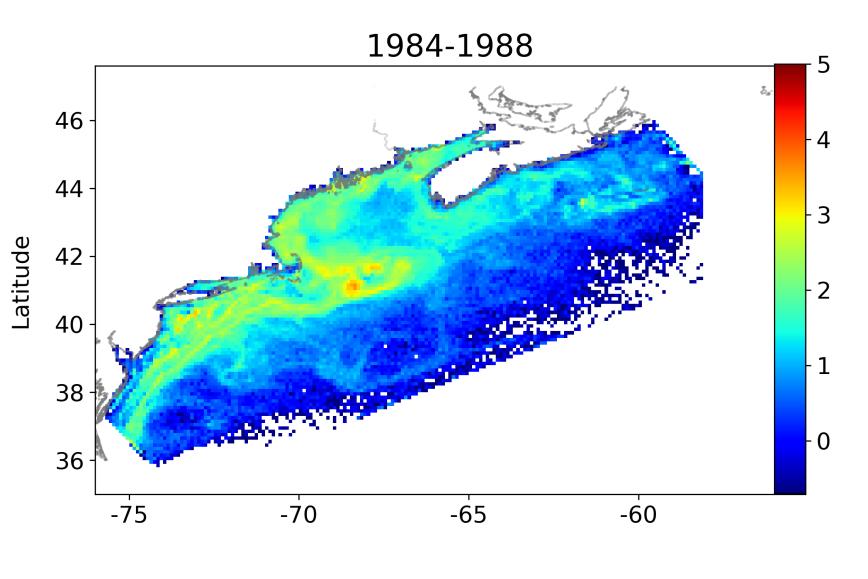
thin ons

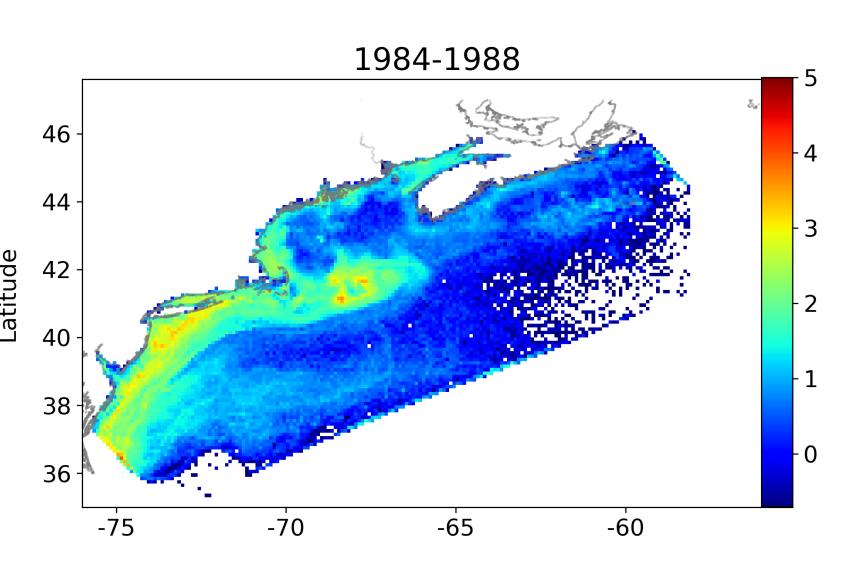
On

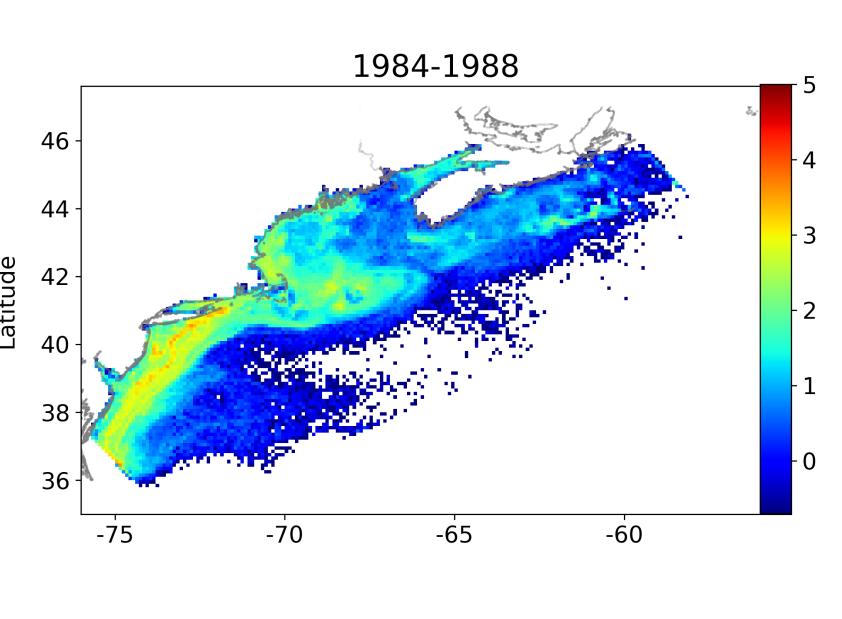
ocean for Ing



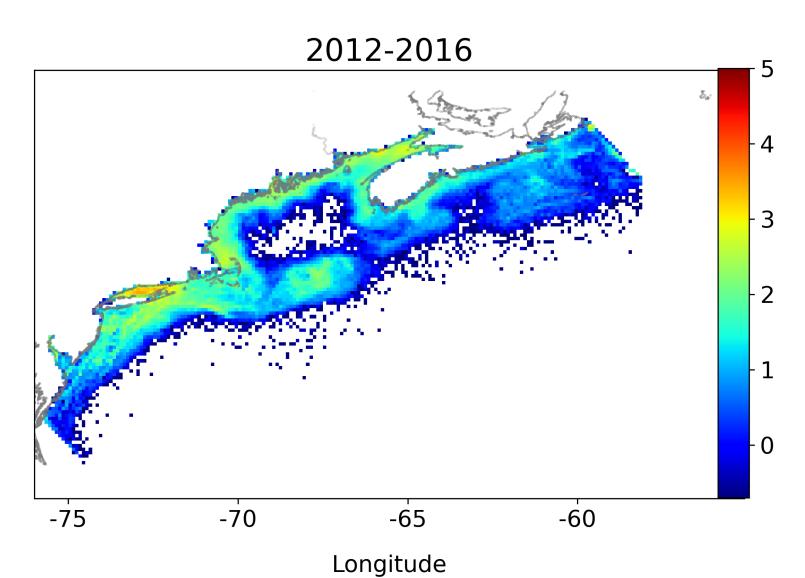




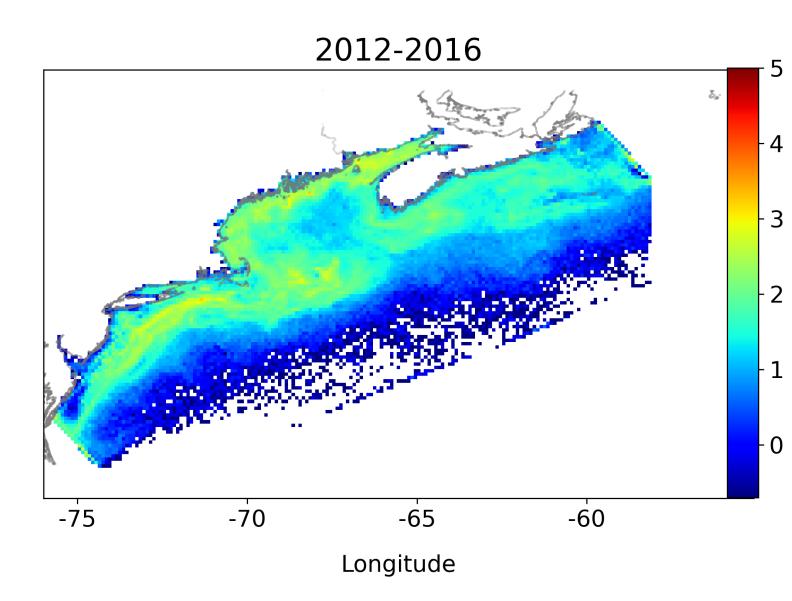




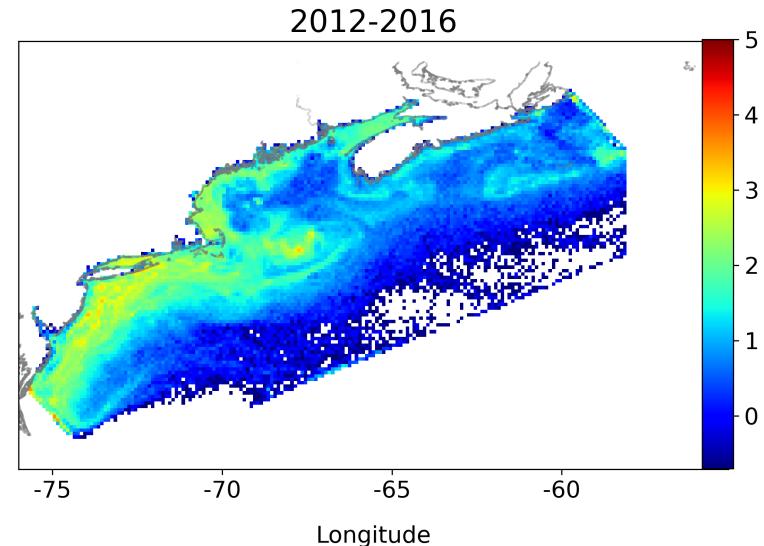
#### **Atlantic Cod Settlement Locations**



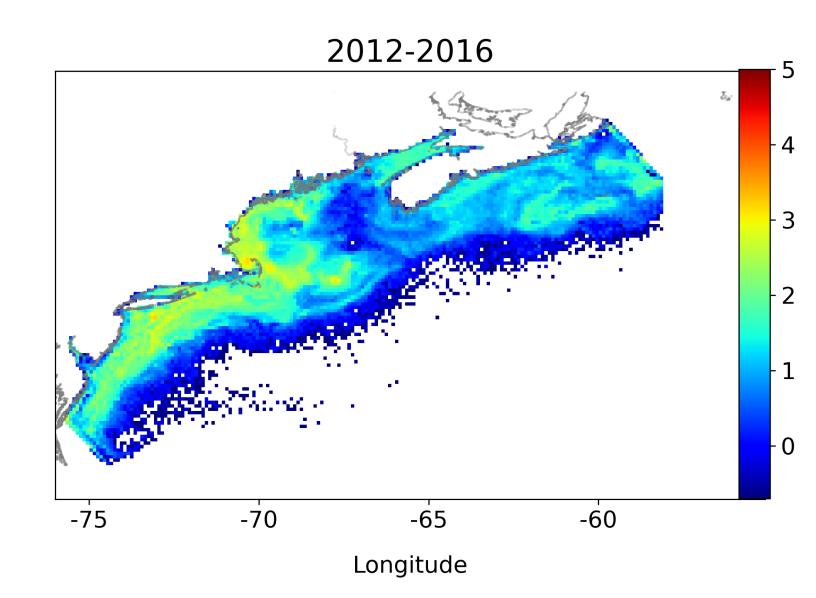
#### Haddock Settlement Locations



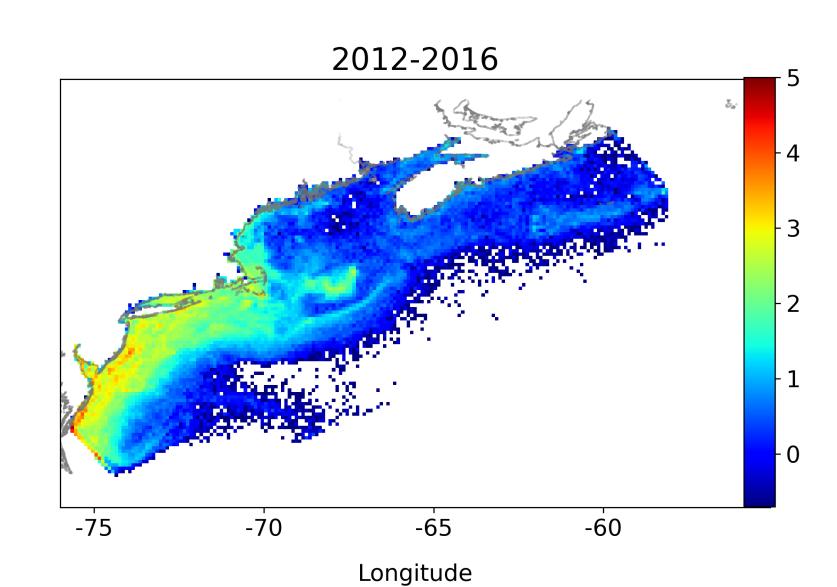
#### Yellowtail Flounder Settlement Locations

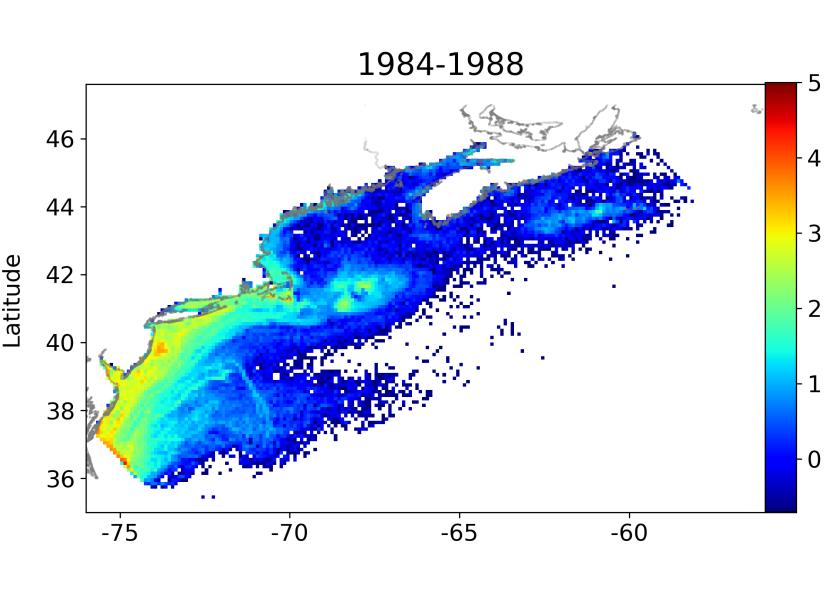


#### Atlantic Mackerel Settlement Locations



#### American Butterfish Settlement Locations



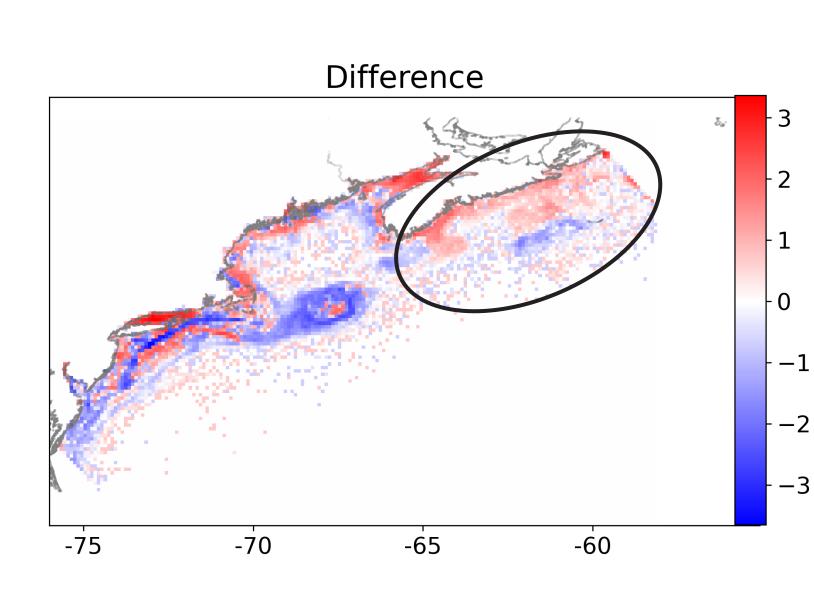


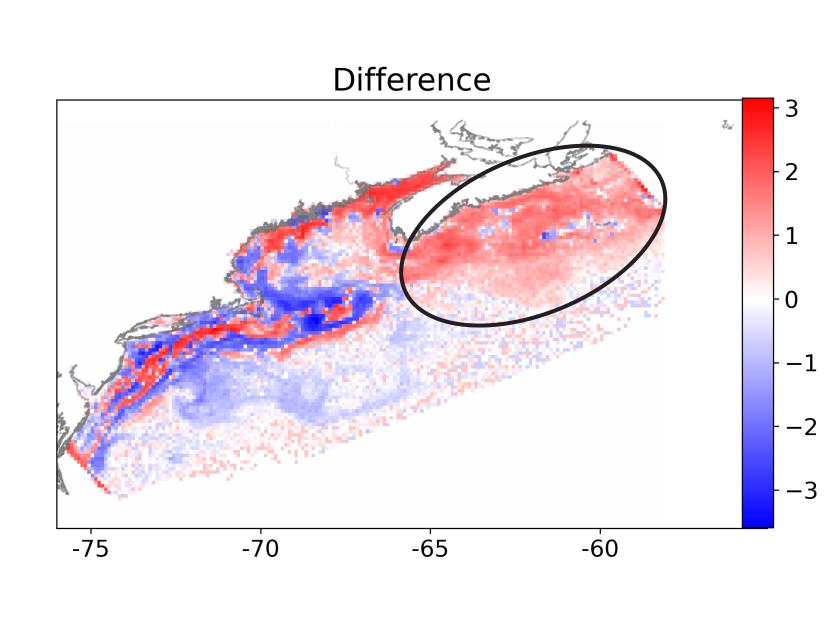
<sup>2</sup> Woods Hole Oceanographic Institution, Woods Hole, MA

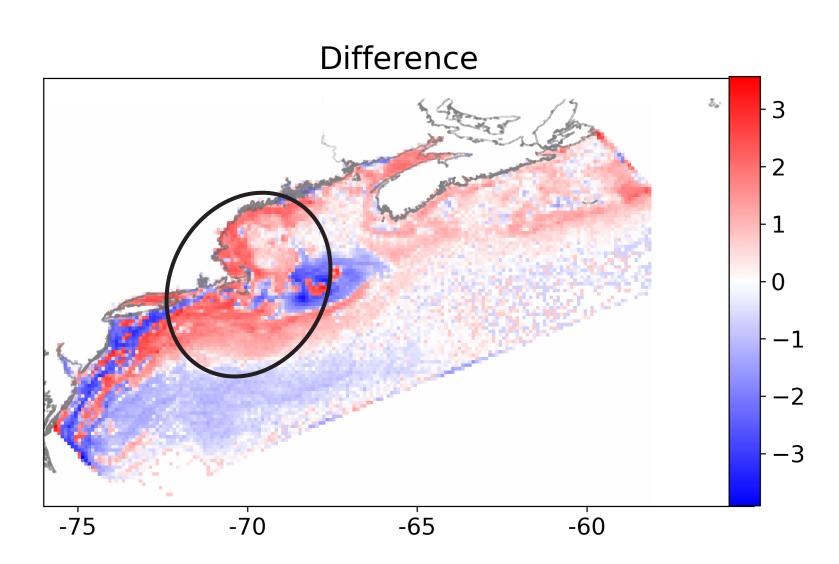
## **Results and Data**

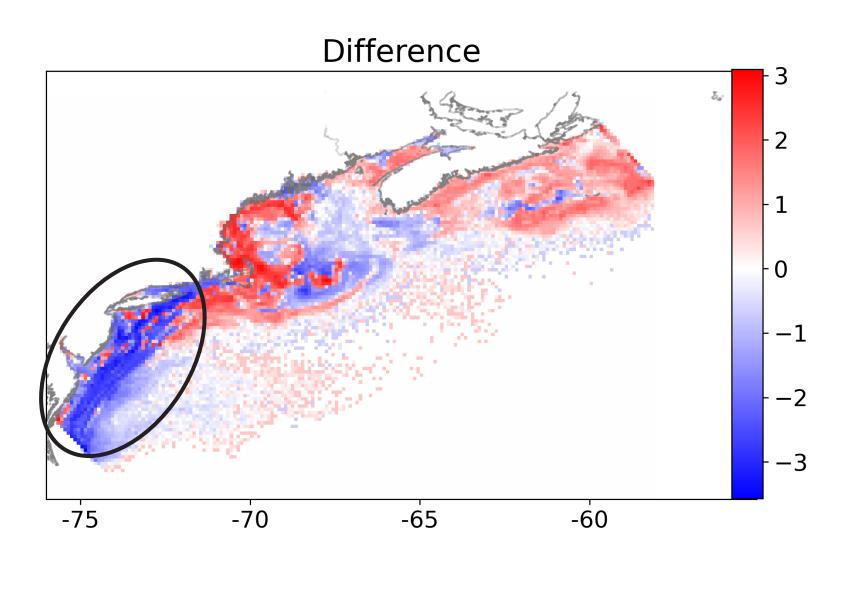


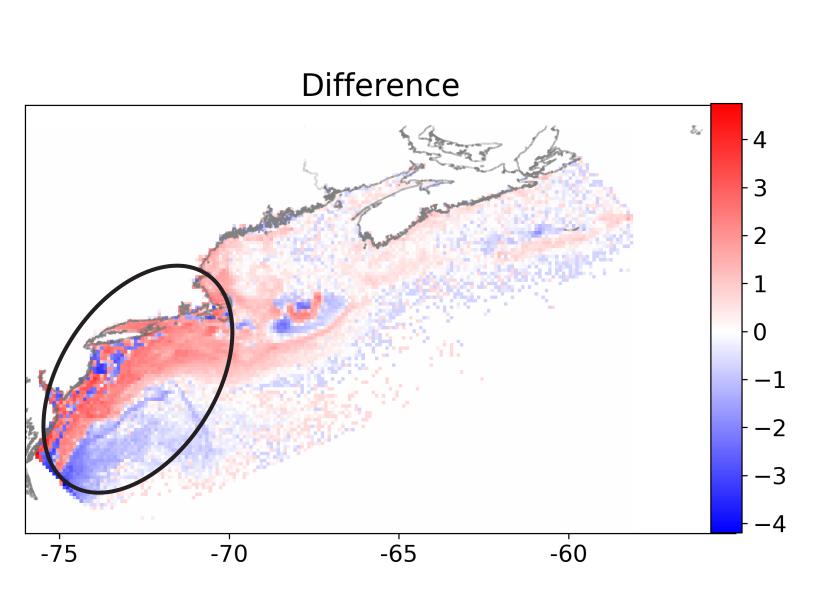


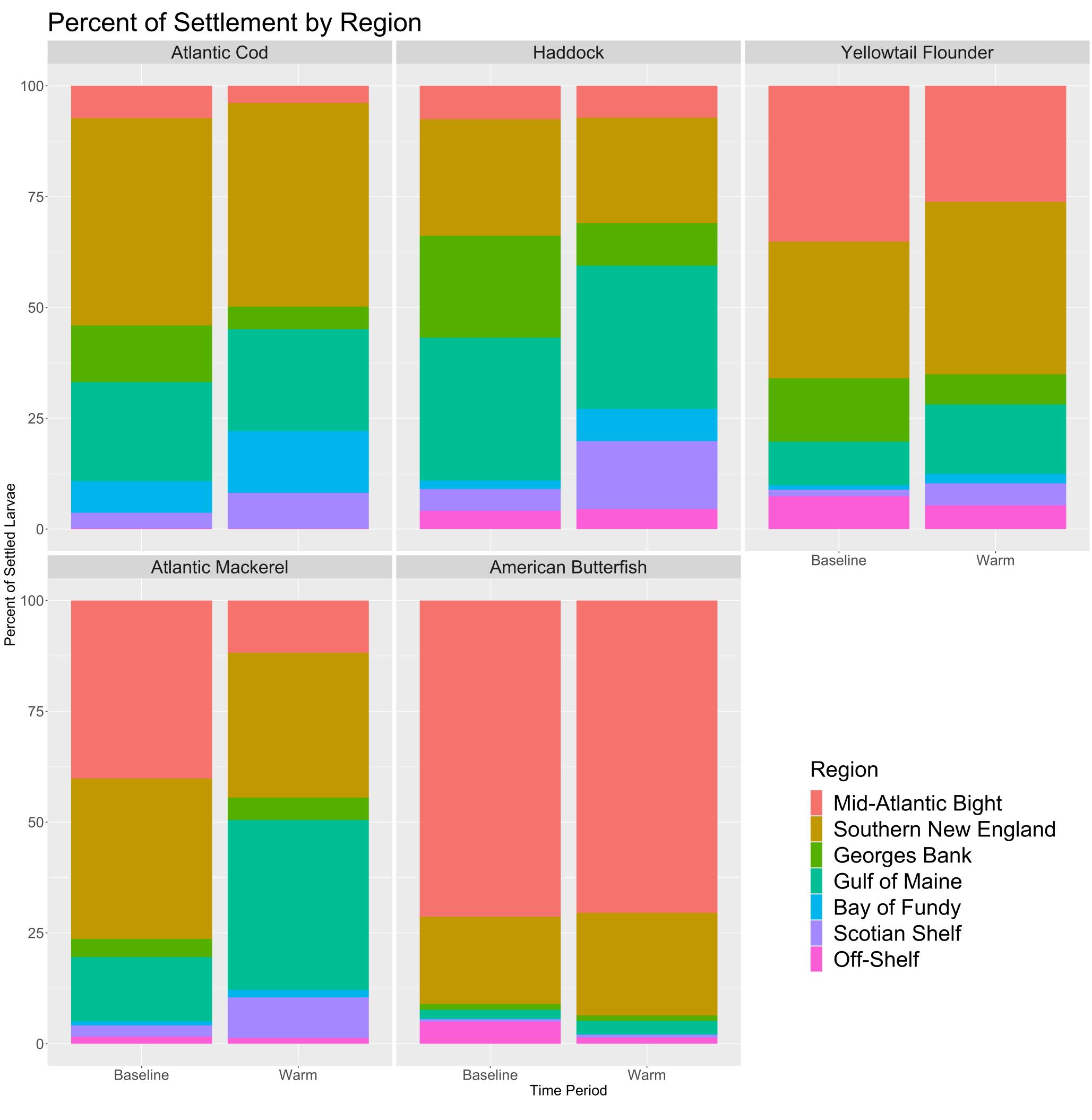












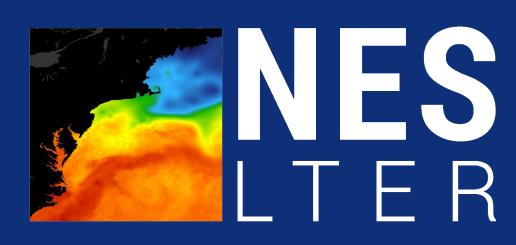
•Yellowtail flounder and Atlantic mack- •Connectivity data (not shown here) imerel are likely to make significant gains ply that exchange rates are likely to inin the Southern New England and west- crease for all species under warmer ern Gulf of Maine region as more south- conditions, though not enough to signifierly habitat becomes non viable. cantly impact population demographics.

We would like to acknowledge Dr. Harvey Walsh for pro-NES-LTER project (OCE# 1655686), and the WHOI HPC viding auxiliary data and an additional review of the support staff. We thank Dr. Changsheng Chen's team at University of Massachusetts - Dartmouth for the FVCOM study's methodology and data. We would also like to acknowledge the WHOI Summer Student Fellowship, the hindcast used for our tracking experiments









## Conclusions

- •Atlantic cod and haddock are likely to shift their distribution poleward in response to warming temperature in the ing significant gains on the Scotia Shelf. mal habitat expands.
- •American butterfish are likely to make significant gains throughout the Mid-Atlantic Bight, Southern New England, Gulf of Maine and George's Bank, mak- and George's Bank regions as their ther-

### Acknowledgements