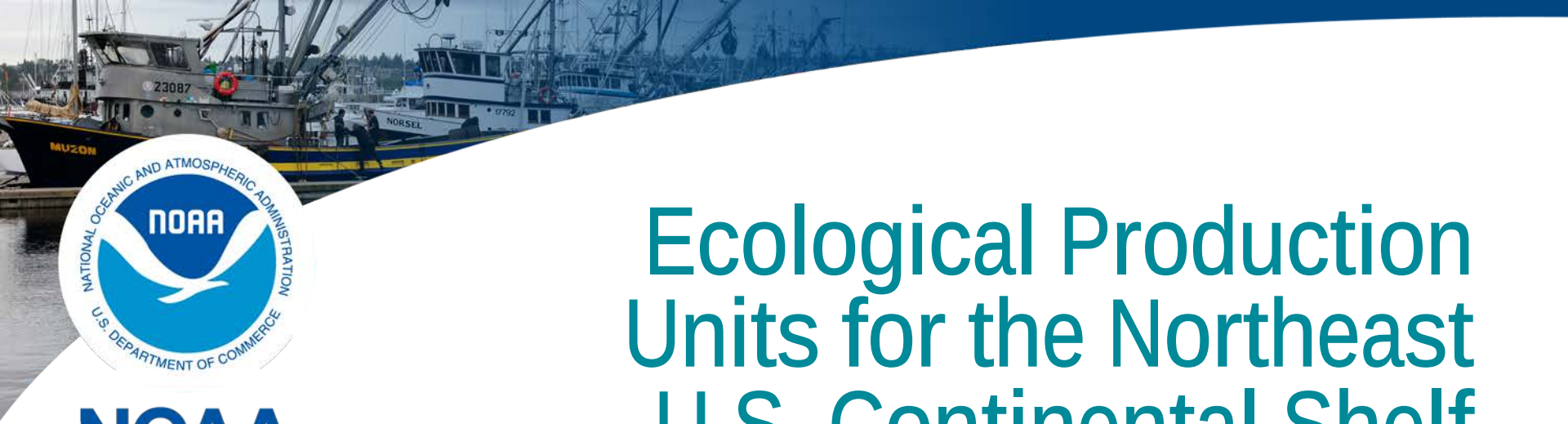


NOAA FISHERIES

NEFSC

Ecological Production Units for the Northeast U.S. Continental Shelf

Robert Gamble, Michael Fogarty,

Sean Lucey, Chad Keith

NEFSC Ecosystem and Climate Science Program Review

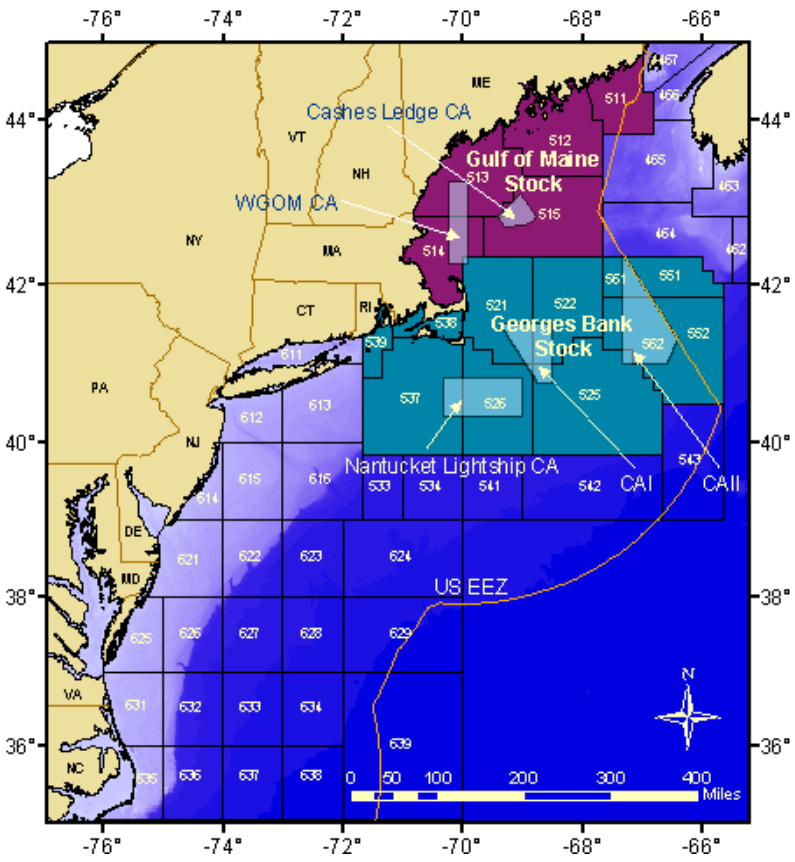
Ecosystem Delineation and Production Session

June 8, 2016

Why Geographical Management Units?

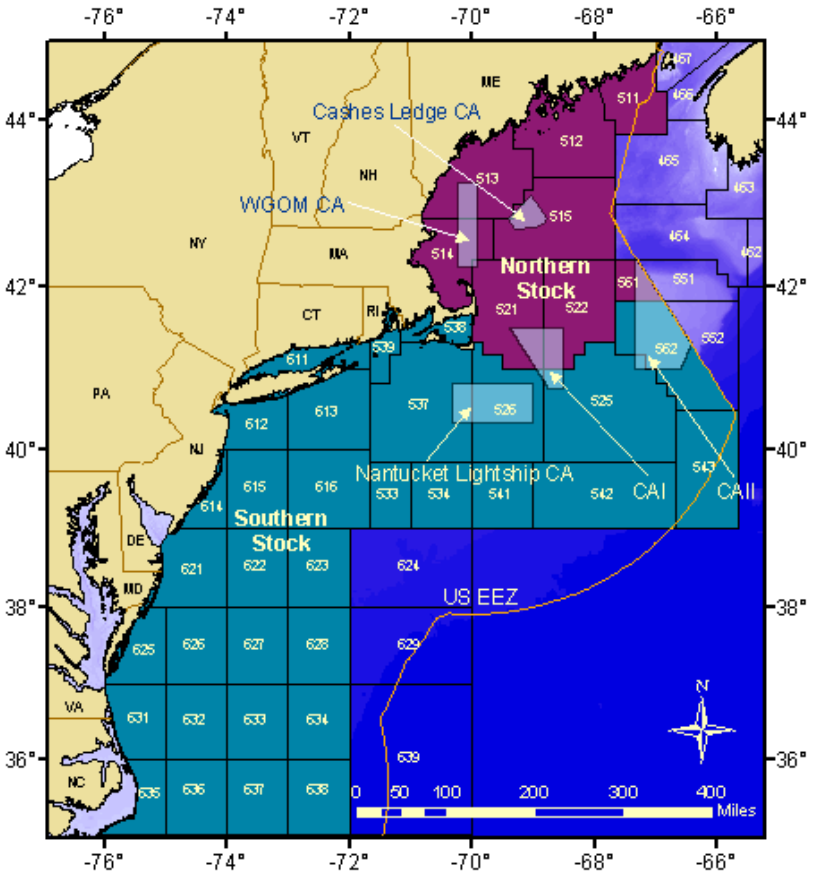
- Ecosystems are typically defined in terms of spatial extent and biogeophysical characteristics
- A New England Fishery Management Council white paper included the definition of Ecological Production Units as being an integral part of an EBFM implementation plan
- The single most important difference between Ecosystem-Based Management and Current Management will be the development of integrated management plans for ecological regions
- Coastal and Marine Spatial Planning is an integral part of the New Ocean Management Policy and we need to be ready to represent fishery interests
- We already do this with stock management areas (but have to deal with a large number of different spatial units)

Current Stock Boundary Units



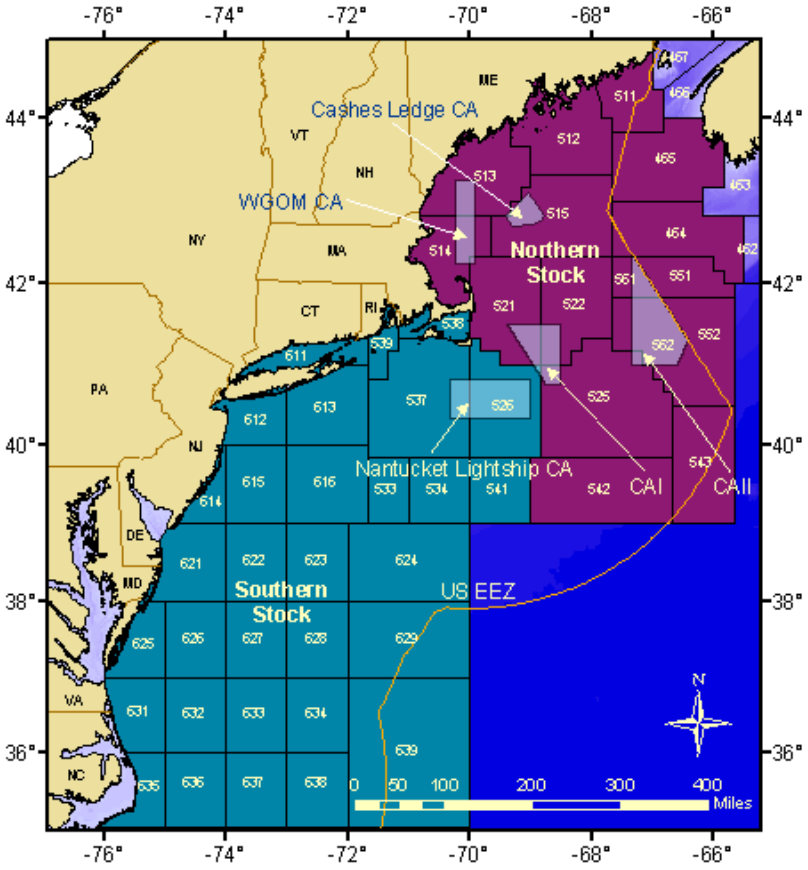
- Haddock

Current Stock Boundary Units



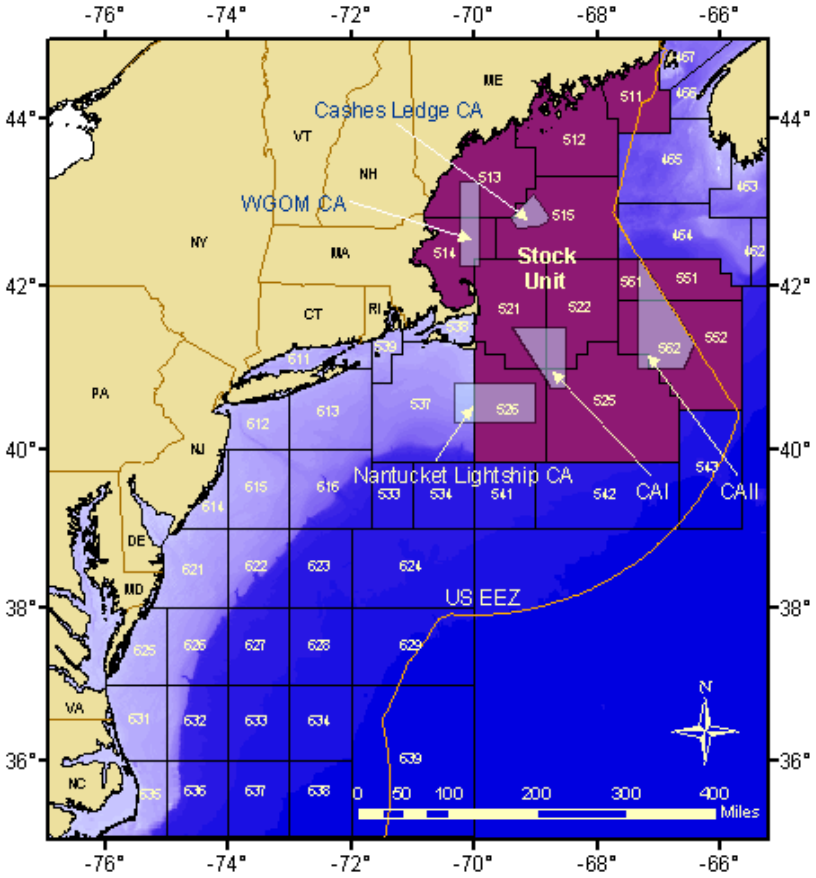
- Red hake

Current Stock Boundary Units



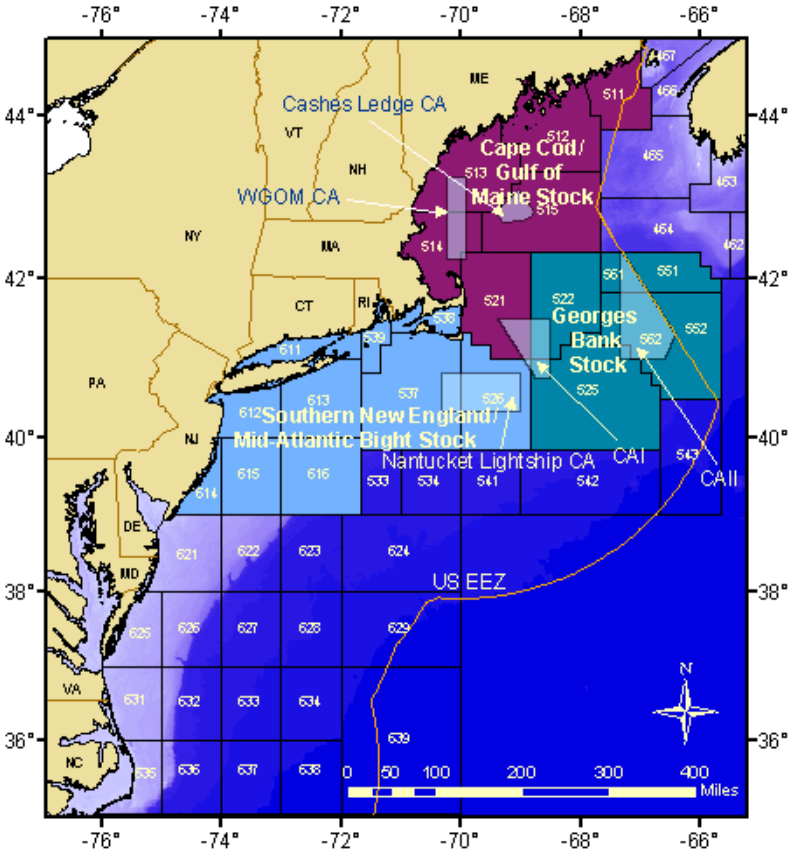
- Windowpane flounder

Current Stock Boundary Units



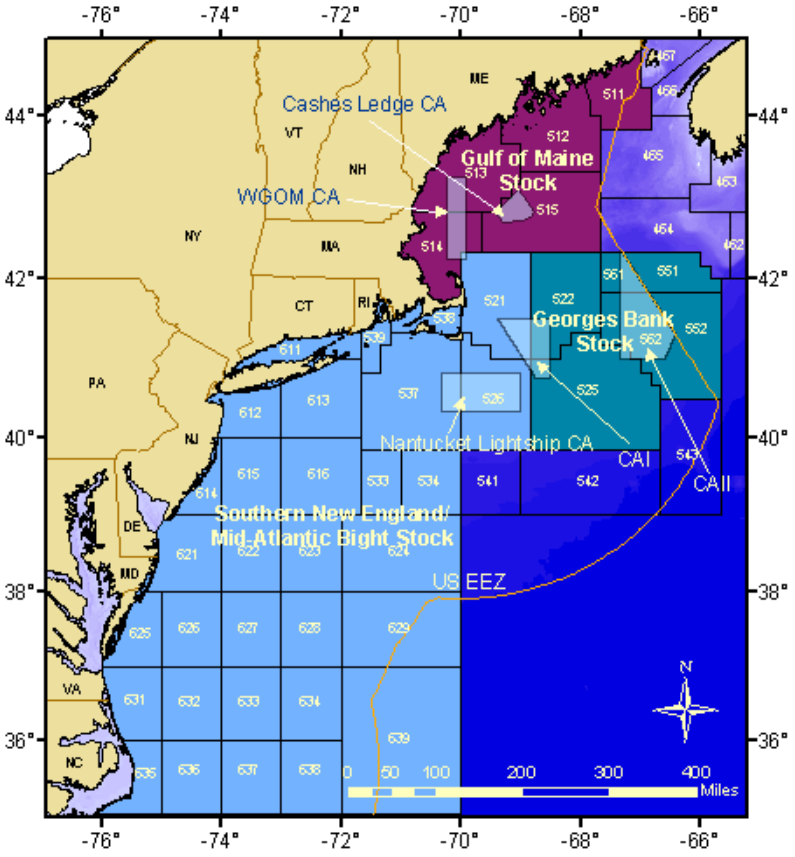
- Acadian redfish

Current Stock Boundary Units



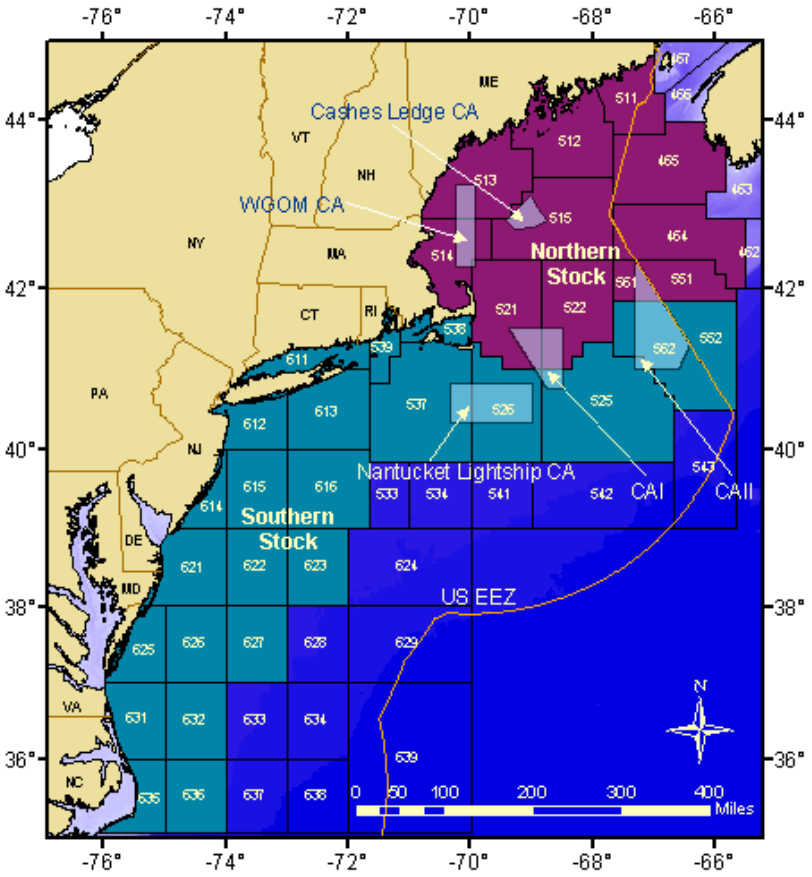
- Yellowtail flounder

Current Stock Boundary Units



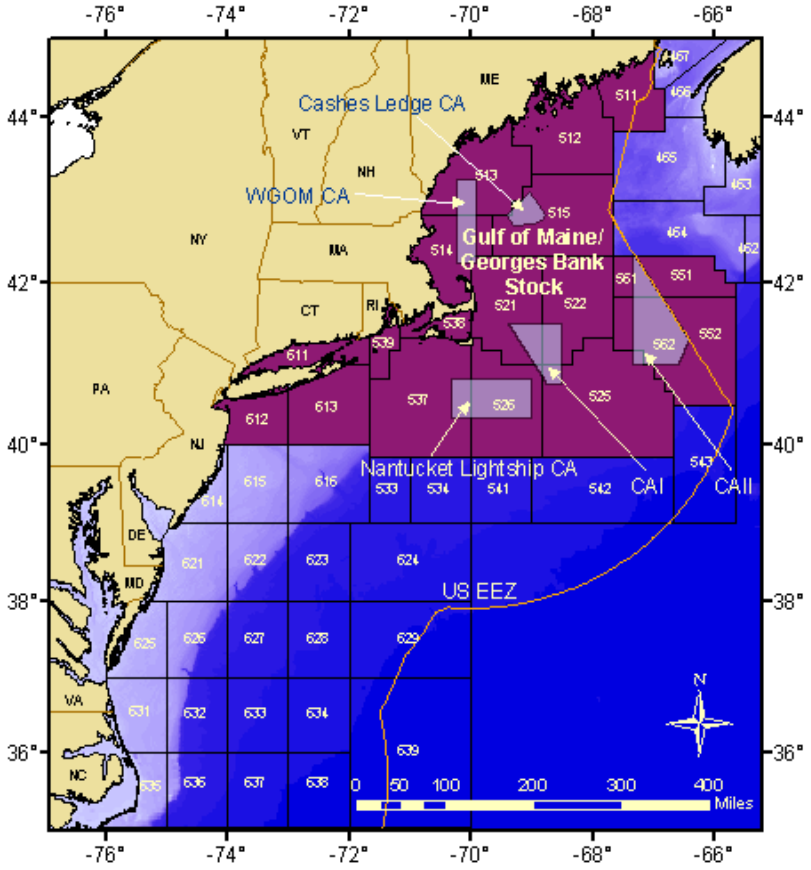
- Winter flounder

Current Stock Boundary Units



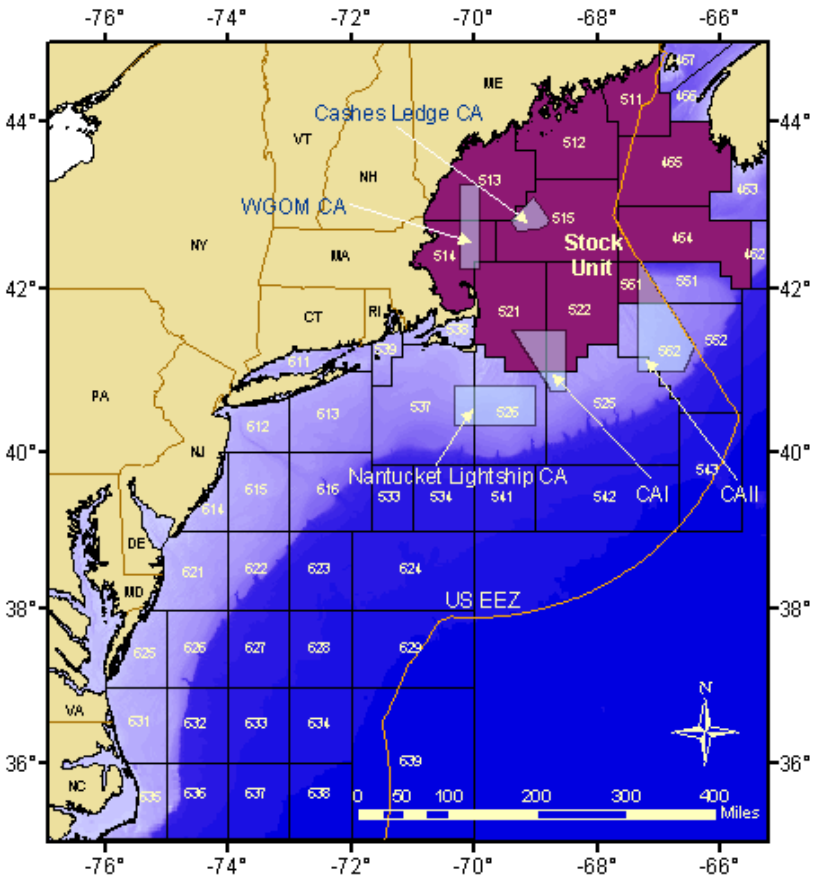
- Goosefish

Current Stock Boundary Units



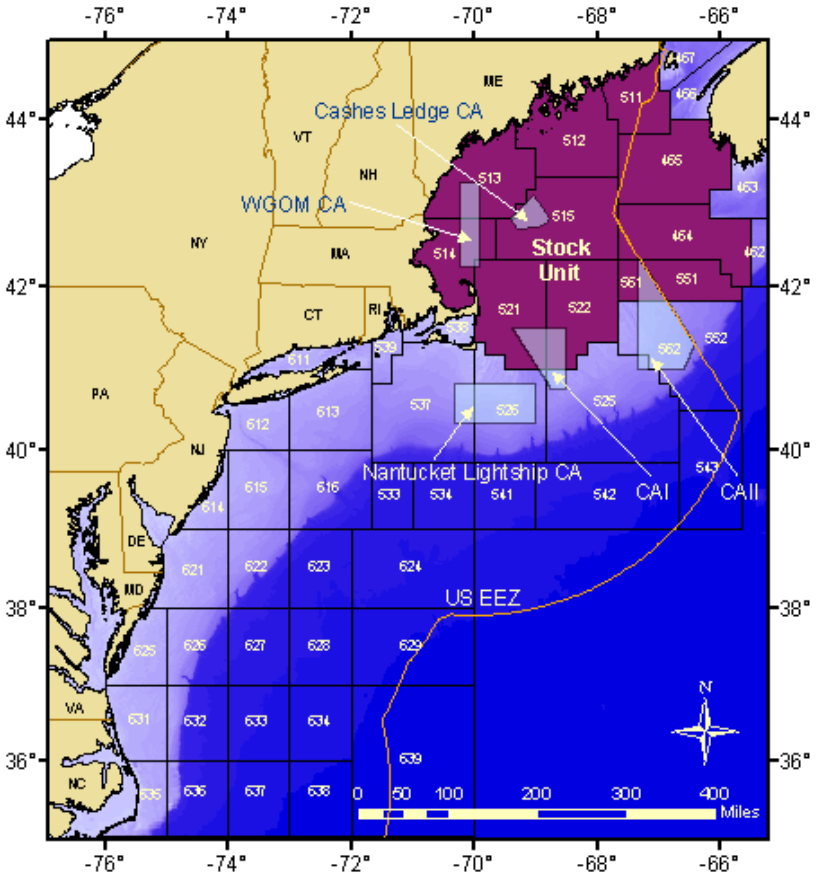
- Pollock

Current Stock Boundary Units



- Northern shrimp

Current Stock Boundary Units



- Cusk

Current Stock Boundary Units

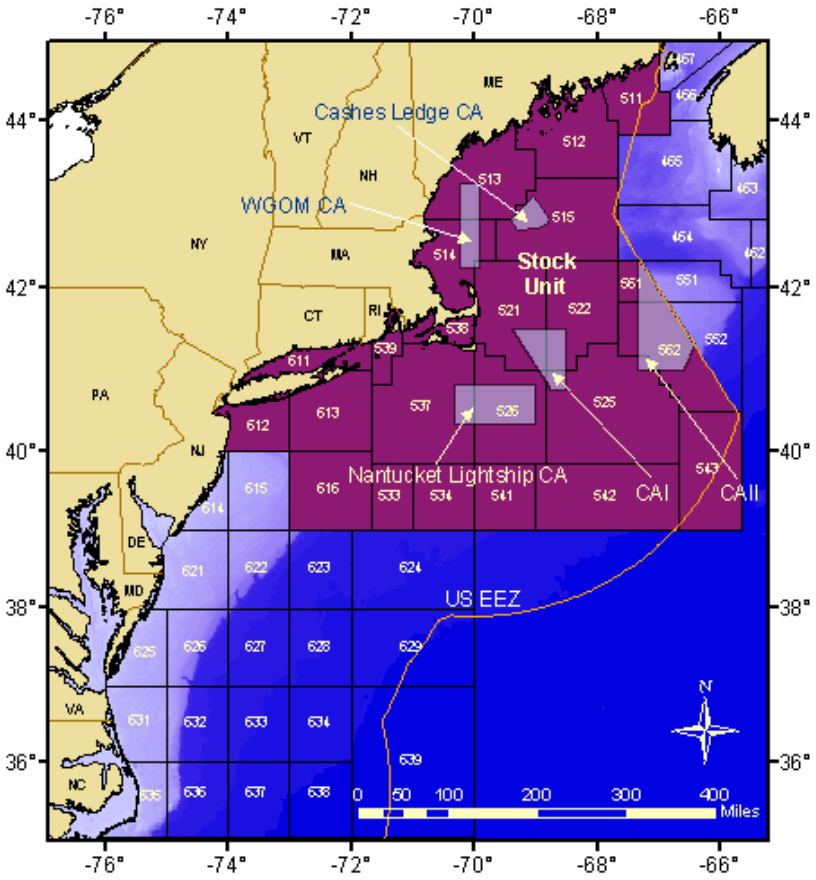
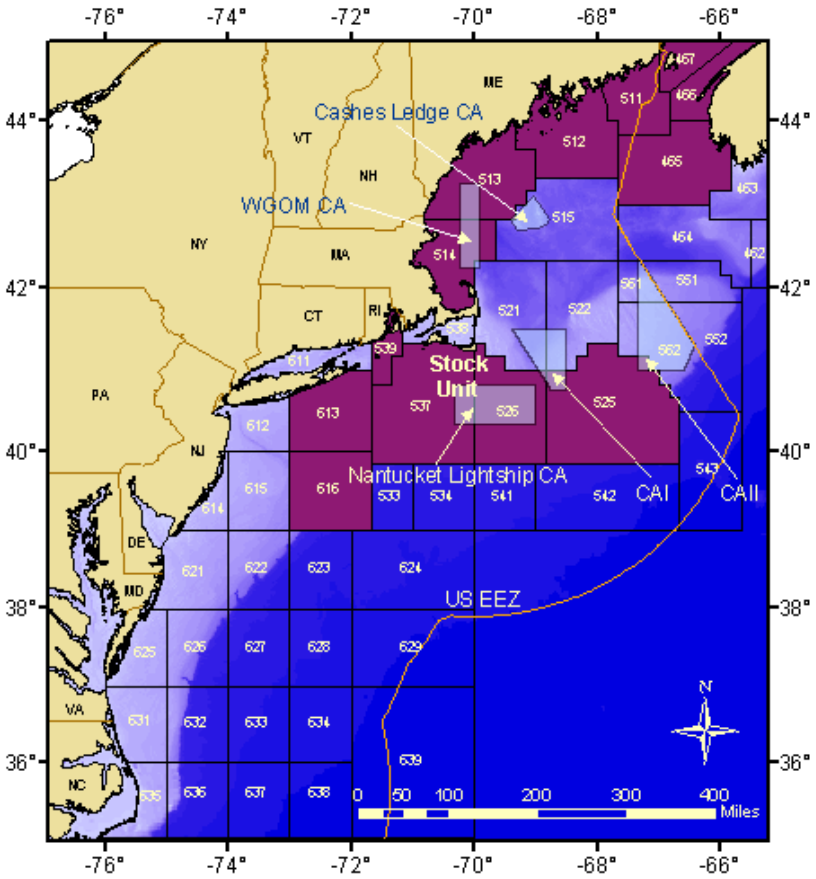


Figure 27.1. Statistical areas used to define the barndoor skate stock.

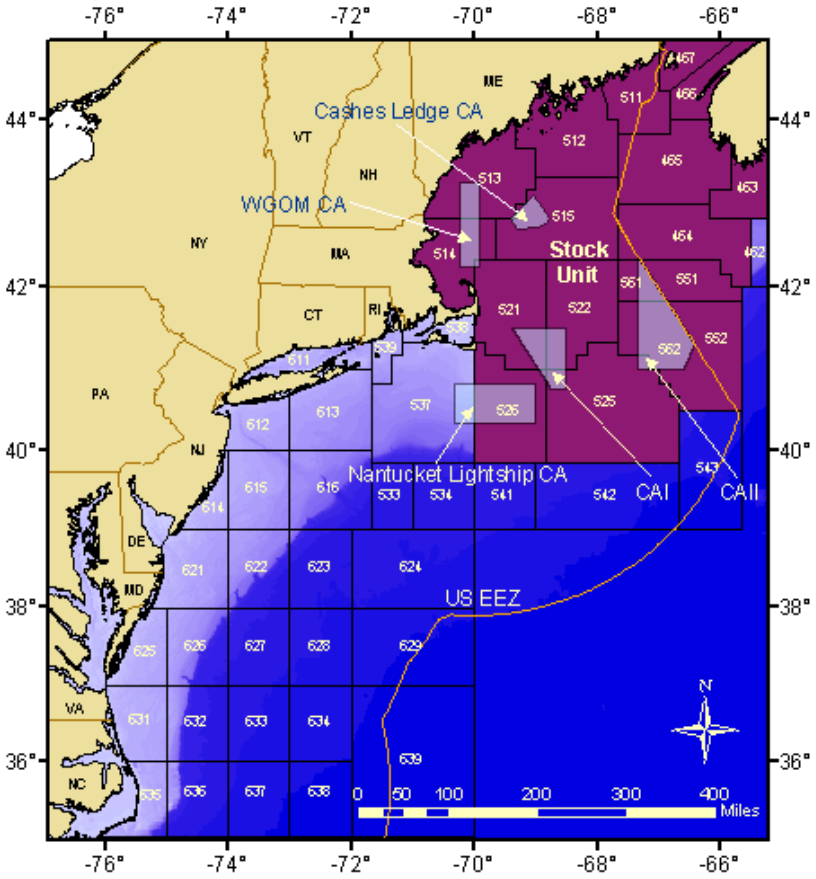
- Smooth skate

Current Stock Boundary Units



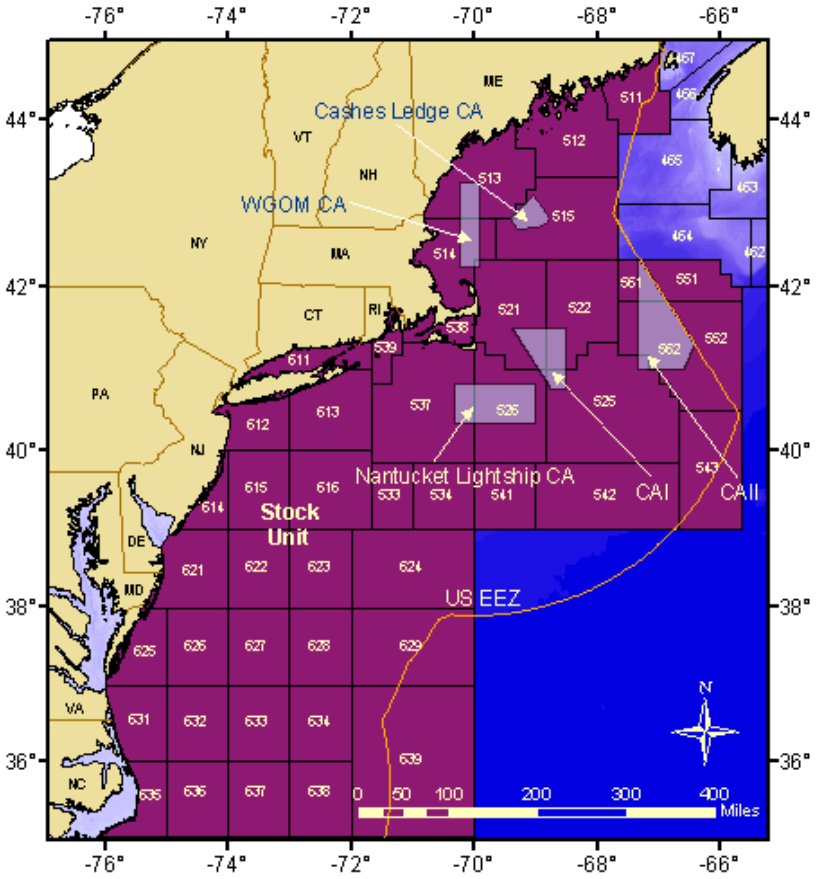
- American shad

Current Stock Boundary Units



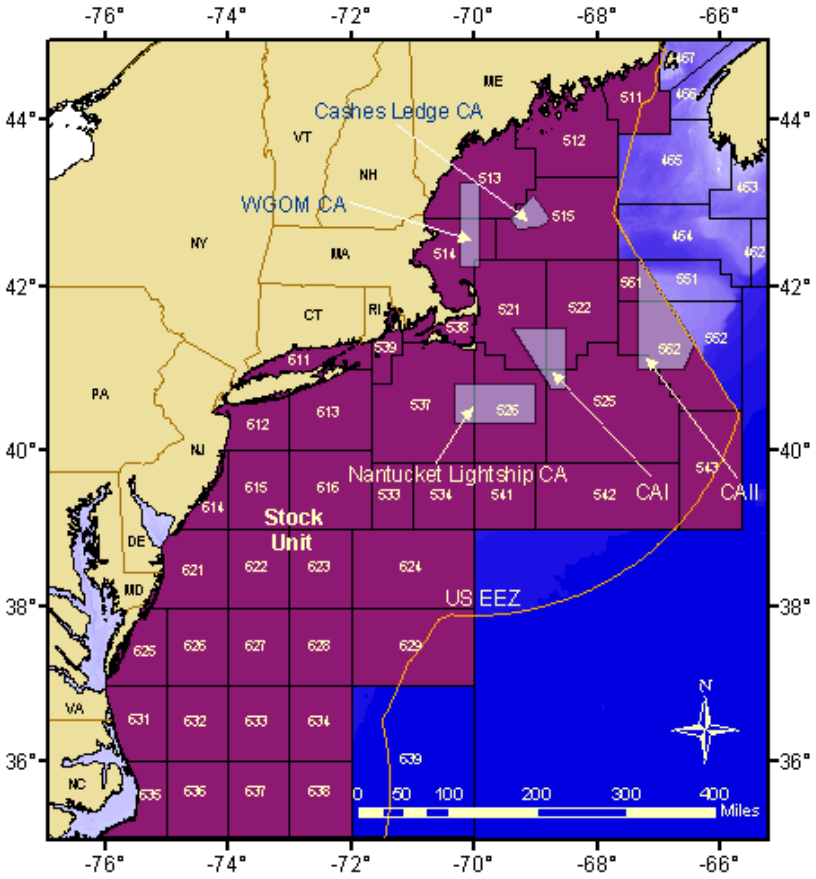
- Atlantic wolffish

Current Stock Boundary Units



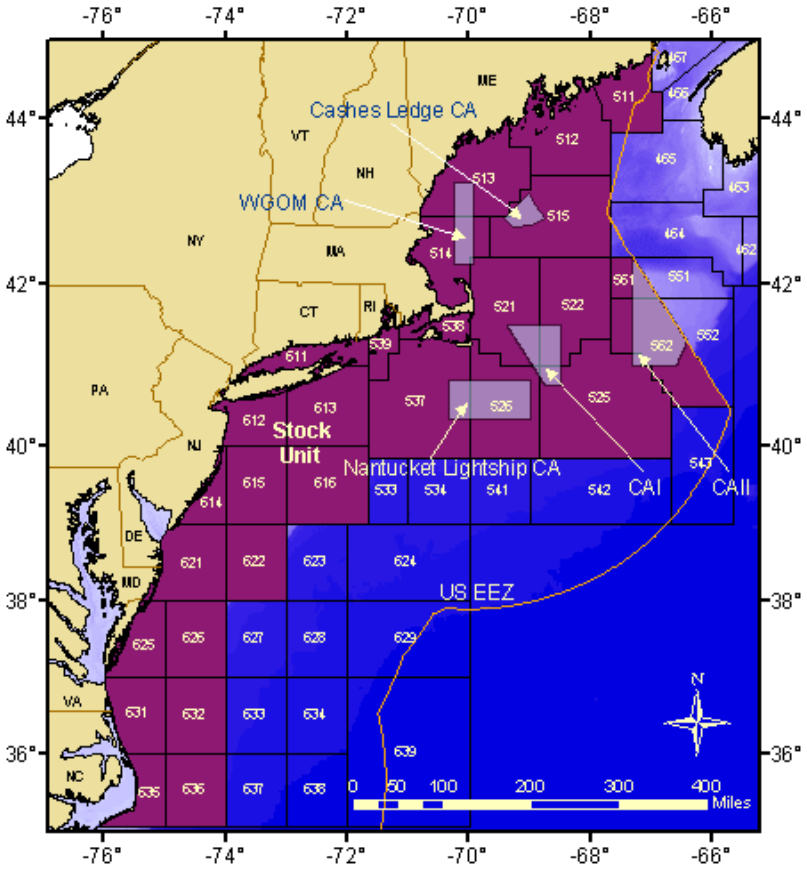
- Summer flounder

Current Stock Boundary Units



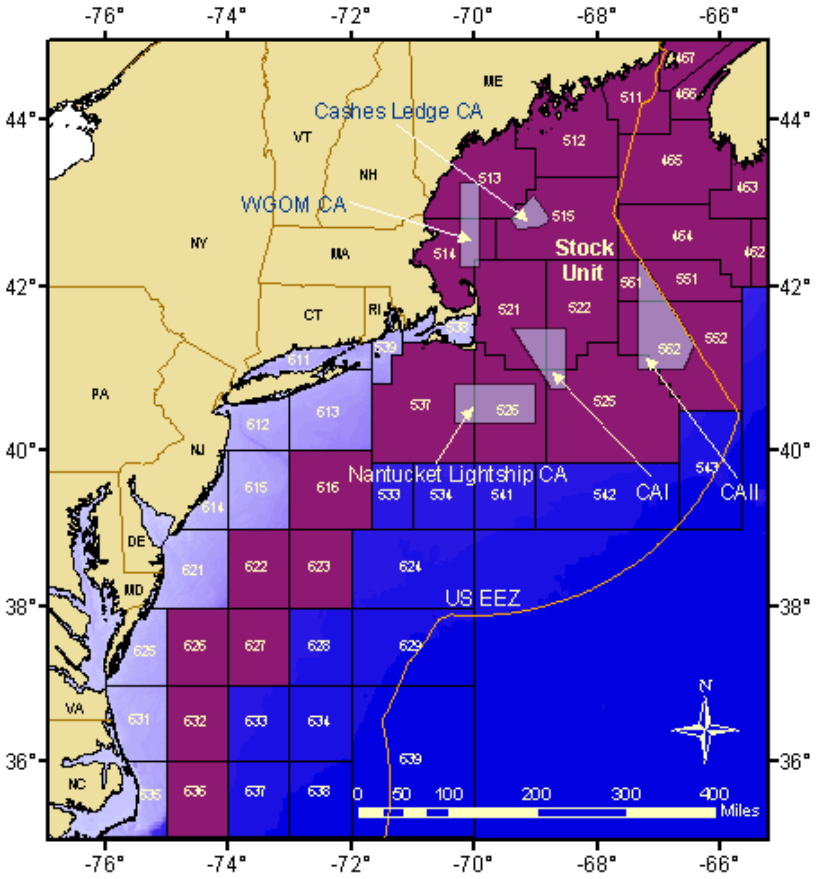
- Little skate
- Winter skate

Current Stock Boundary Units



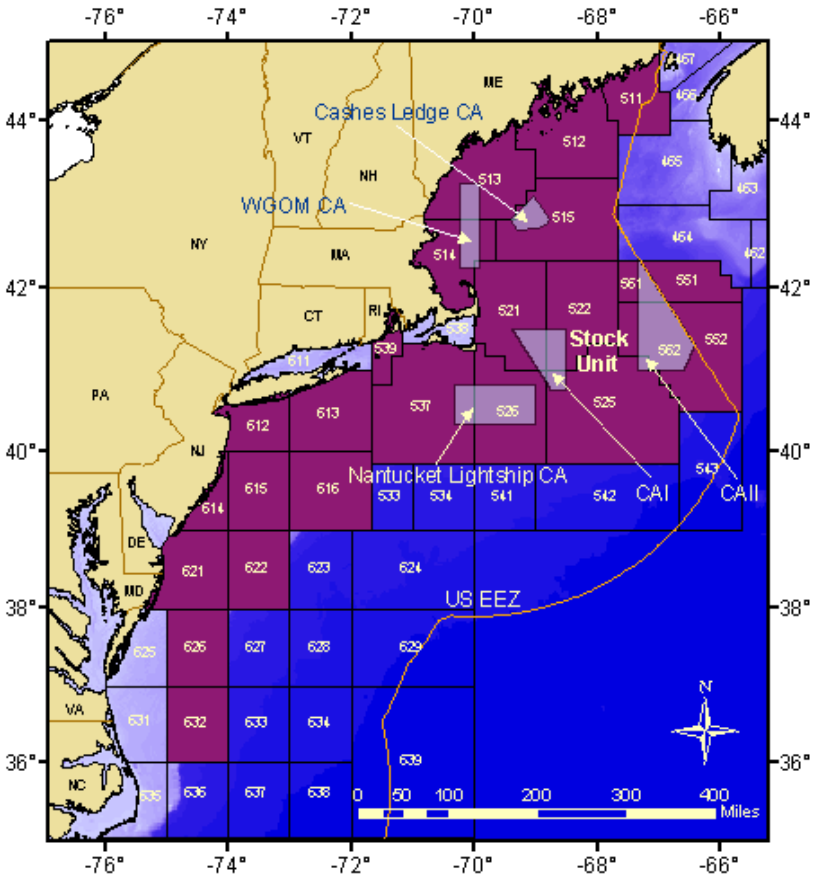
- Alewife
- Blueback herring

Current Stock Boundary Units



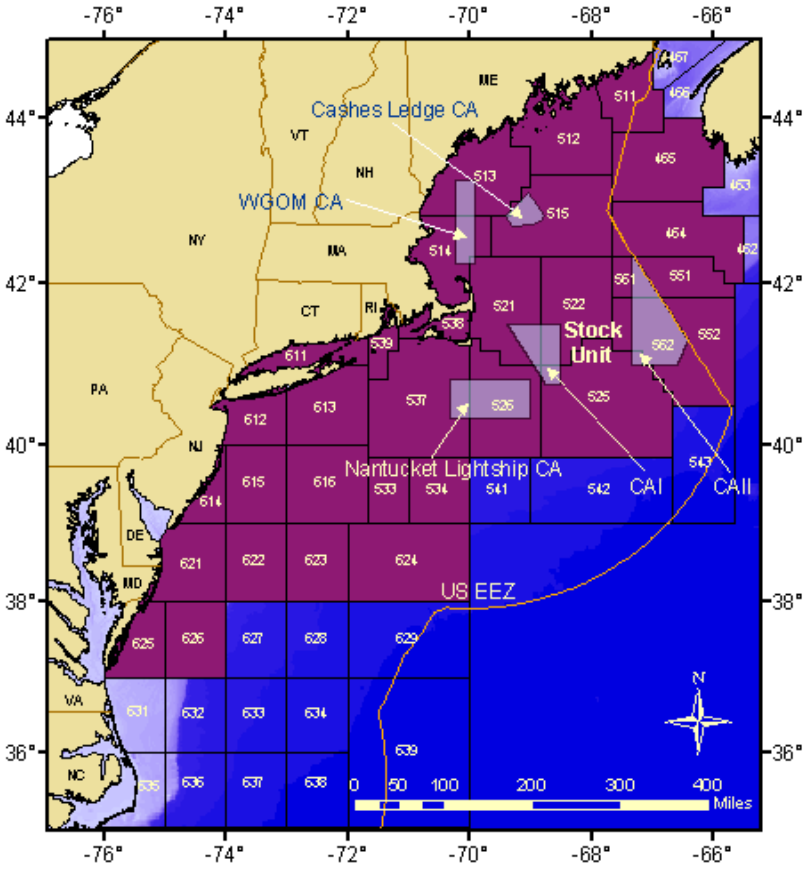
- Hagfish

Current Stock Boundary Units



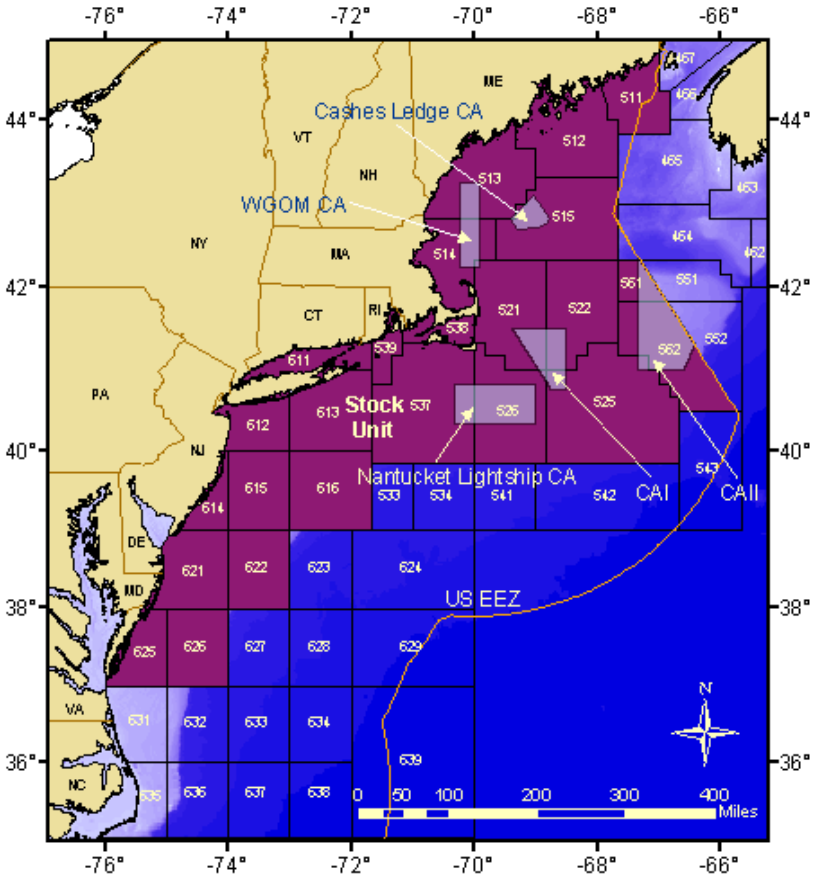
- Atlantic sea scallop

Current Stock Boundary Units



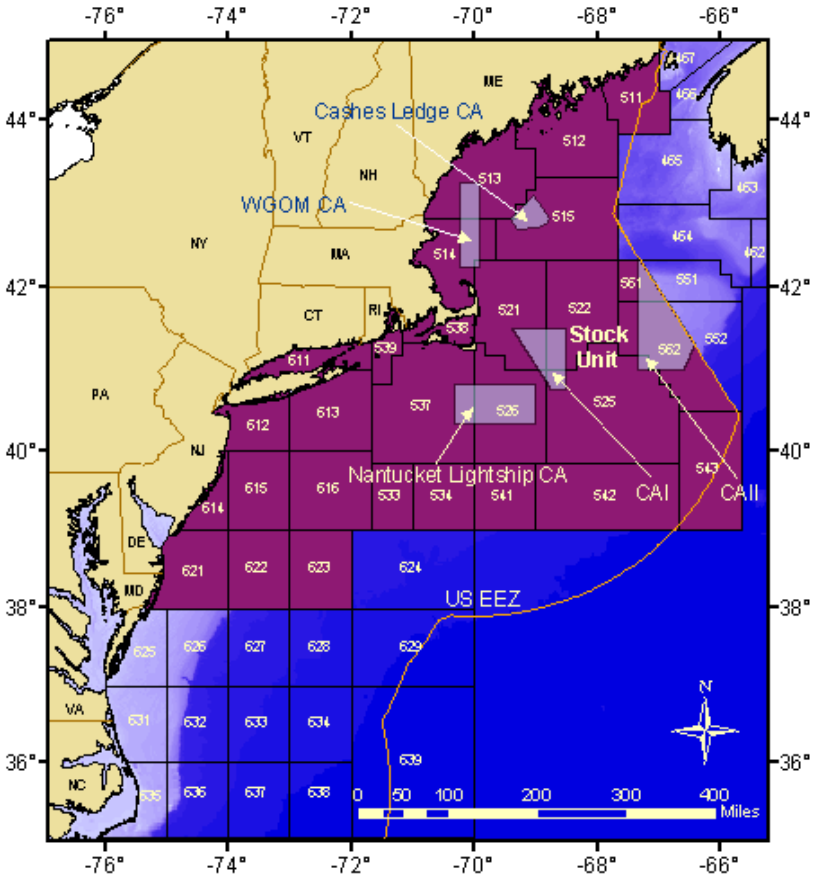
- White hake

Current Stock Boundary Units



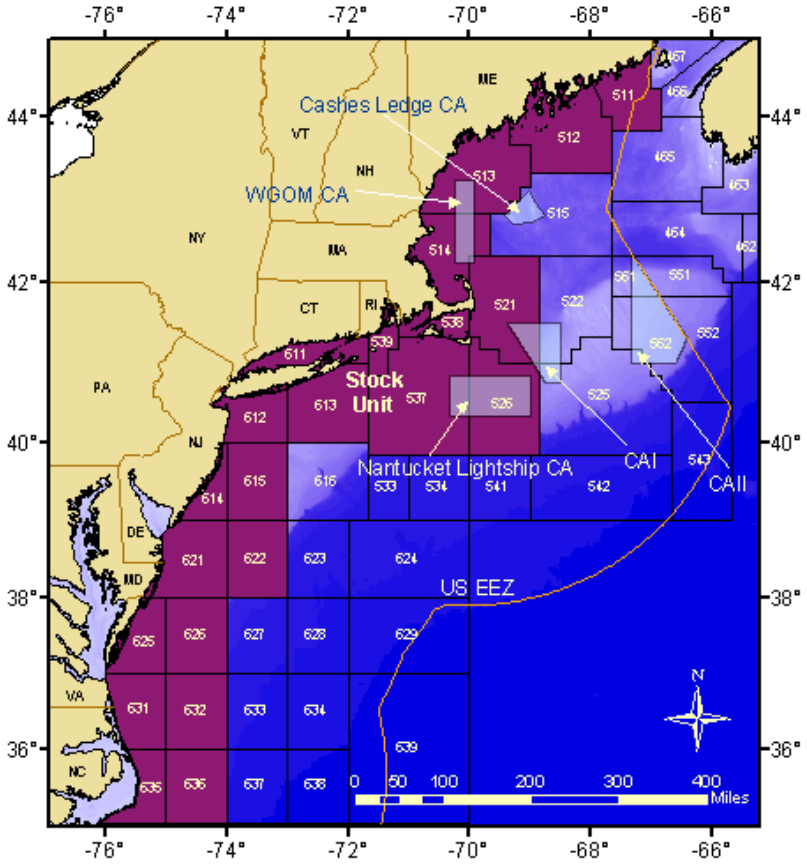
- Atlantic surfclam

Current Stock Boundary Units



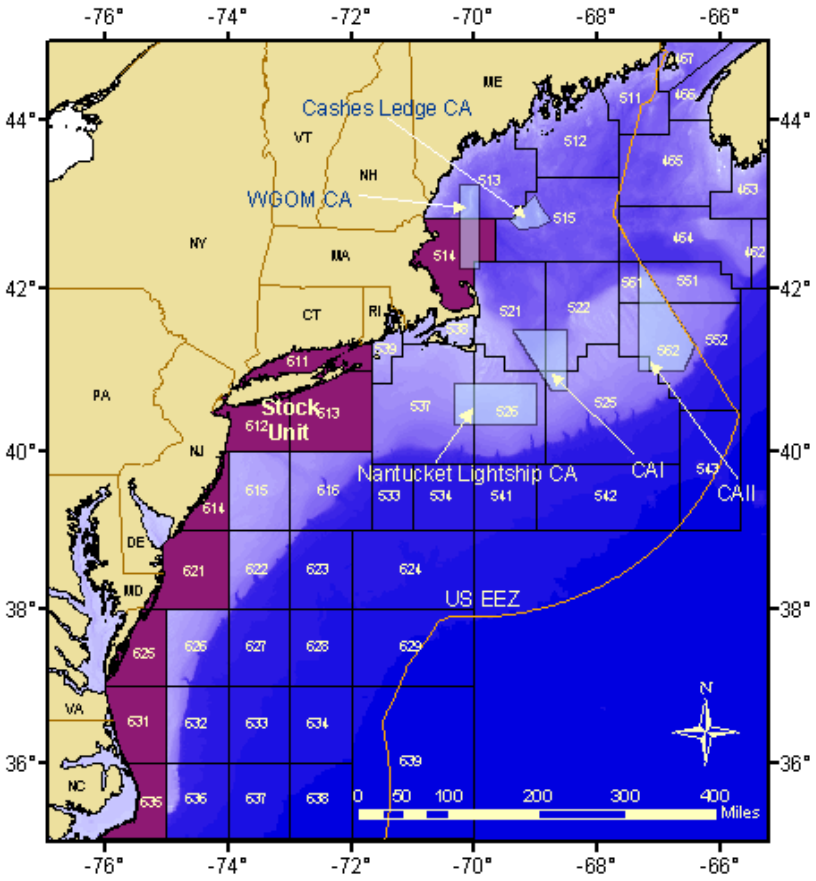
- Ocean pout

Current Stock Boundary Units



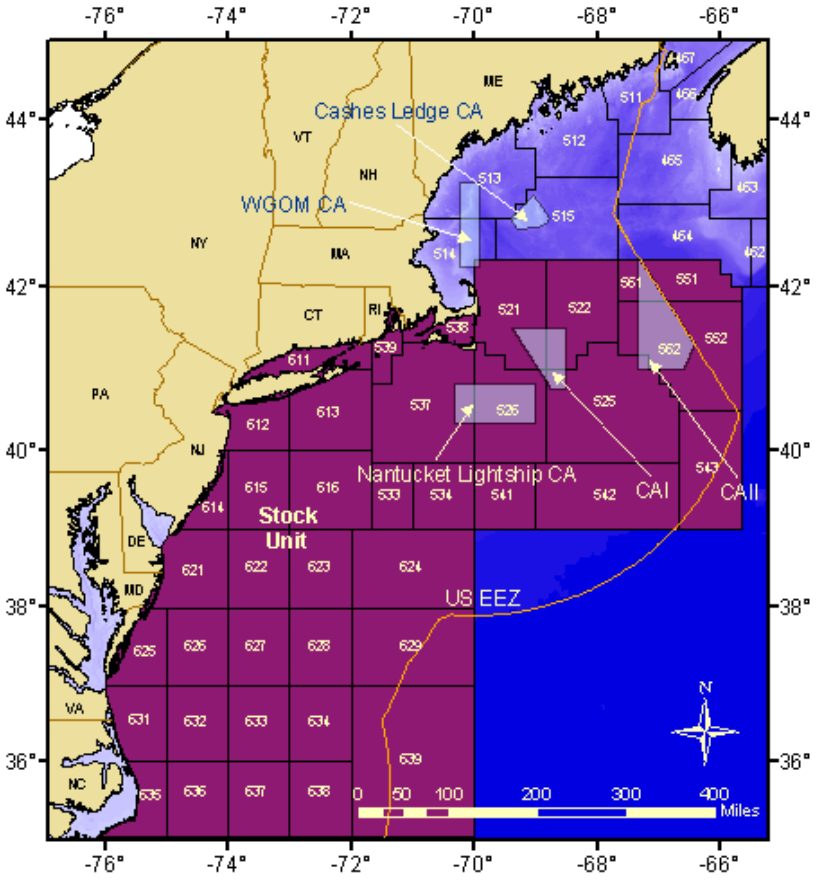
- American eel

Current Stock Boundary Units



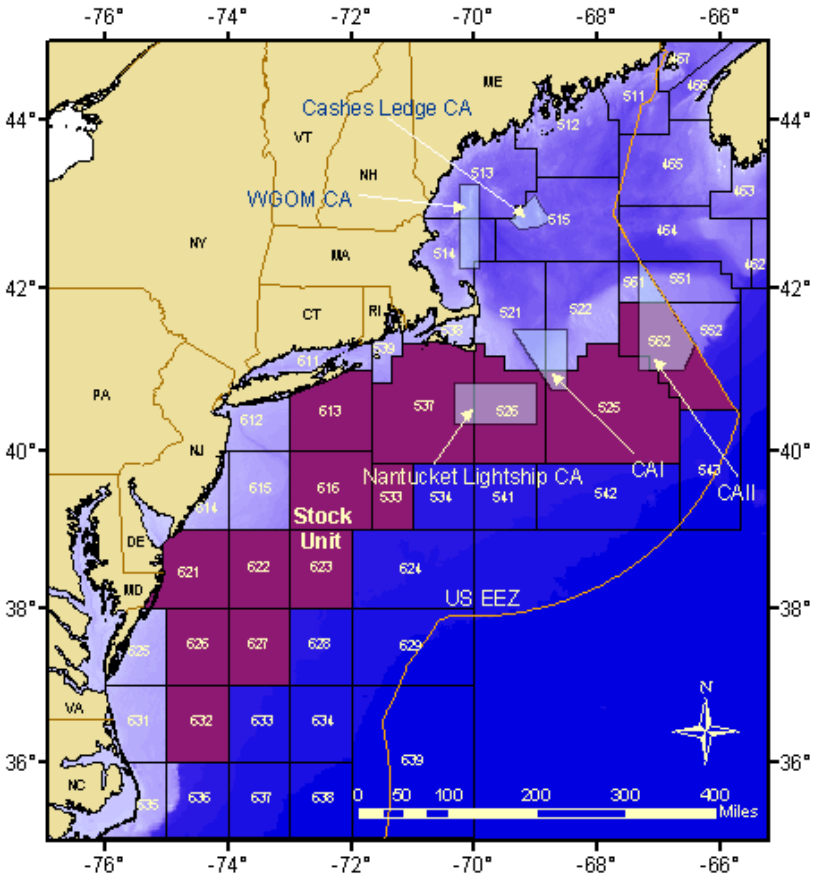
- Sturgeon

Current Stock Boundary Units



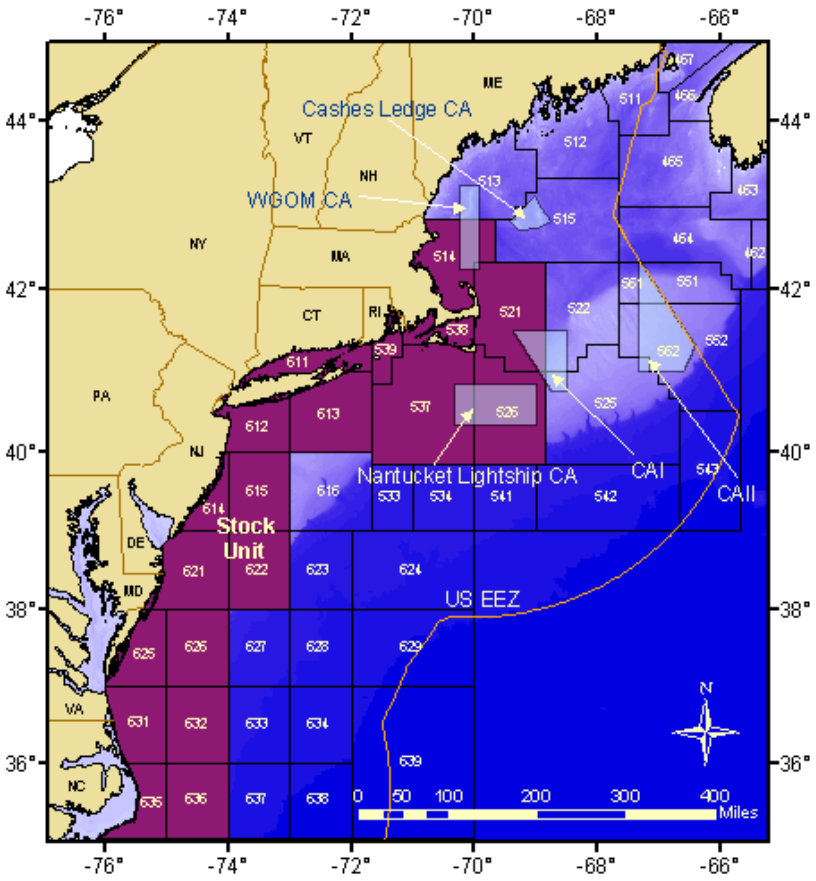
- Butterfish

Current Stock Boundary Units



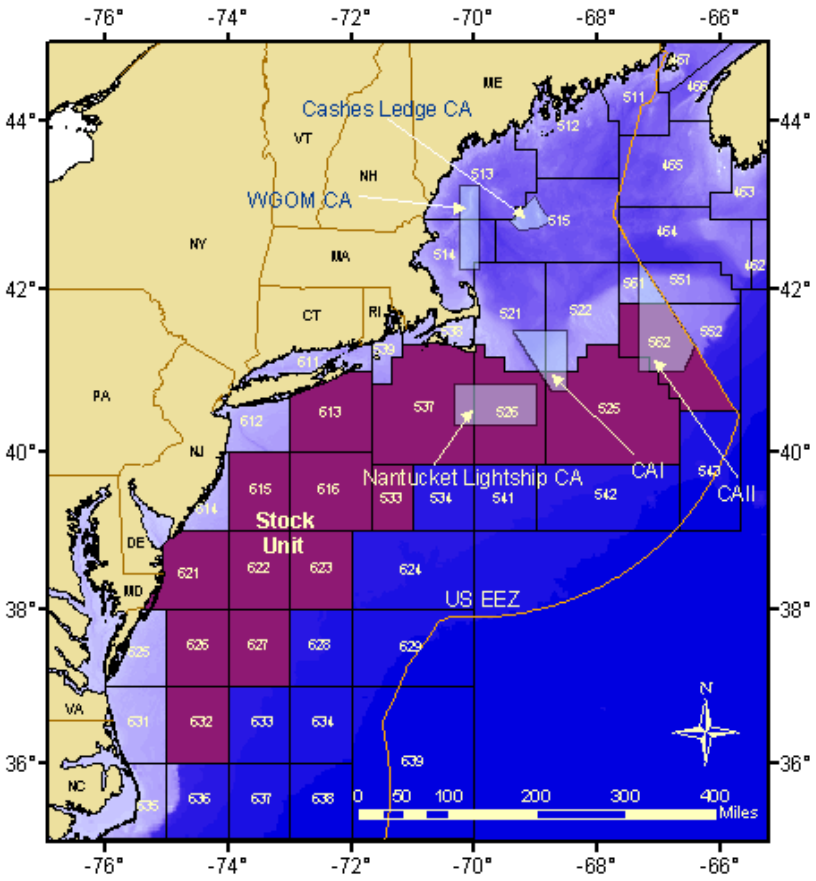
- Deepsea red crab

Current Stock Boundary Units



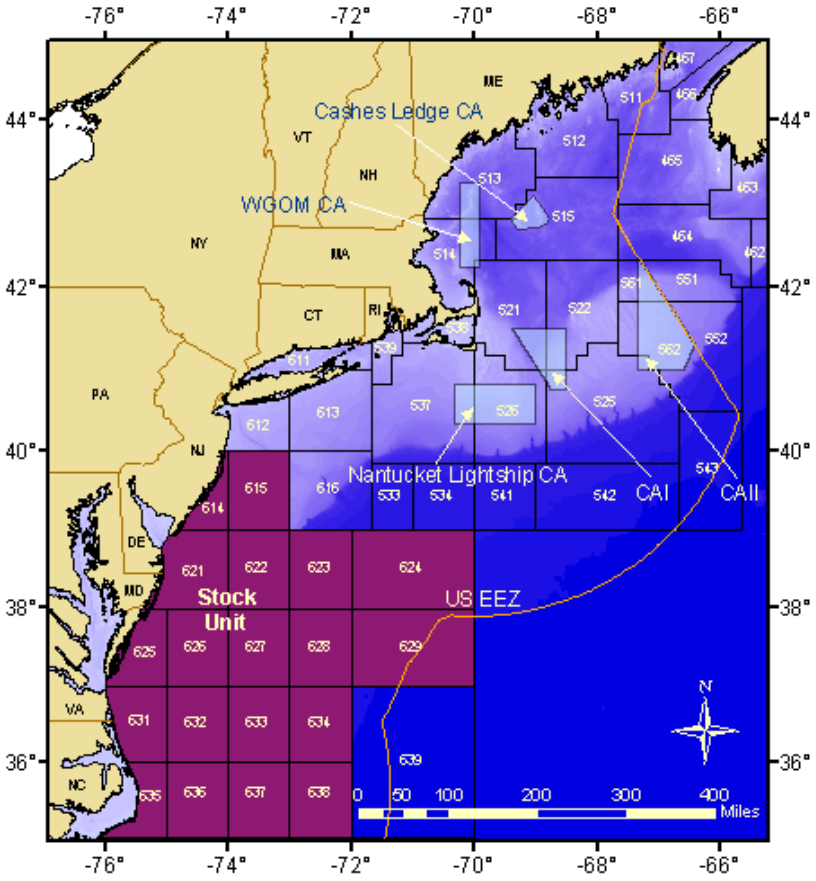
- Black sea bass

Current Stock Boundary Units



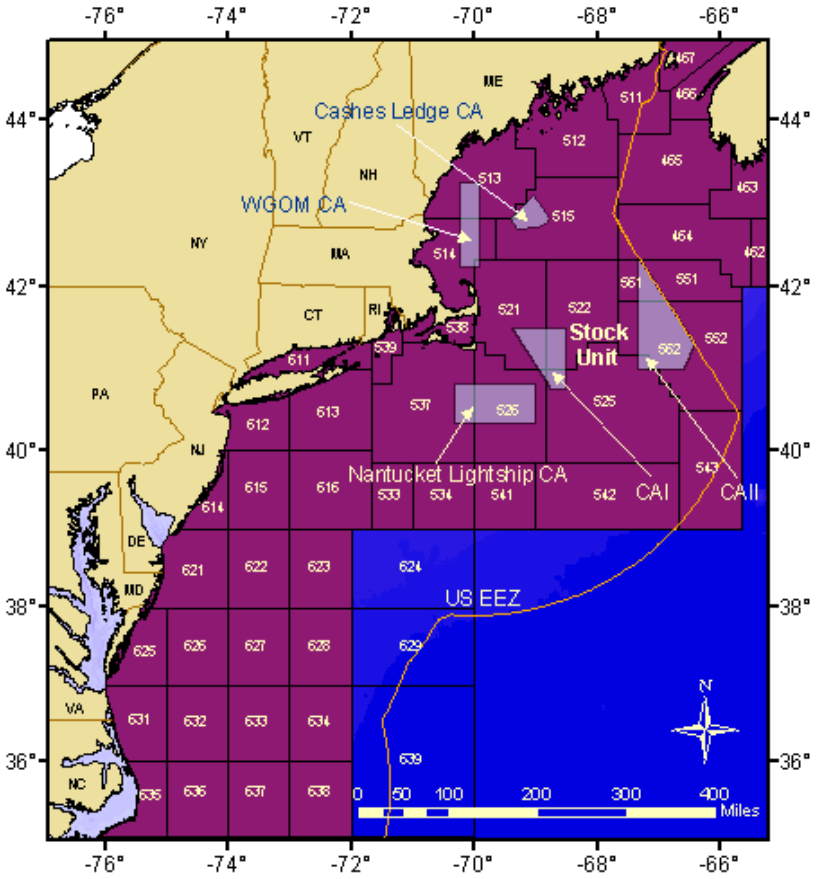
- Tilefish

Current Stock Boundary Units



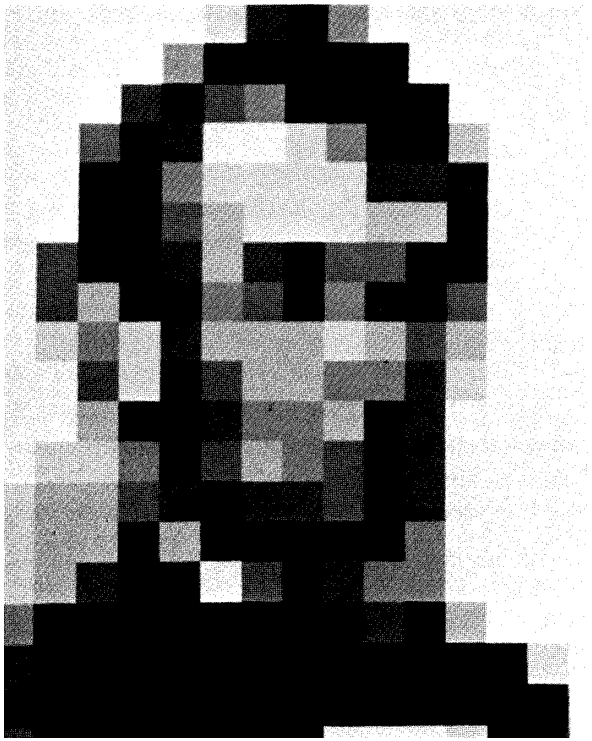
- Clearnose skate

Current Stock Boundary Units



- Spiny dogfish

Starting Point for Defining Ecological Production Units

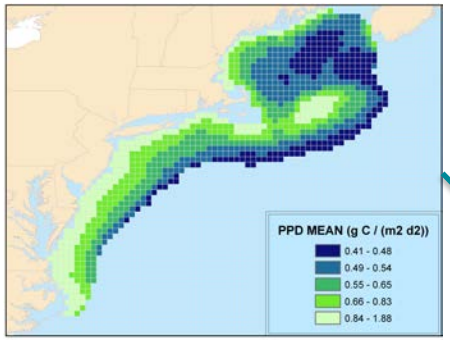


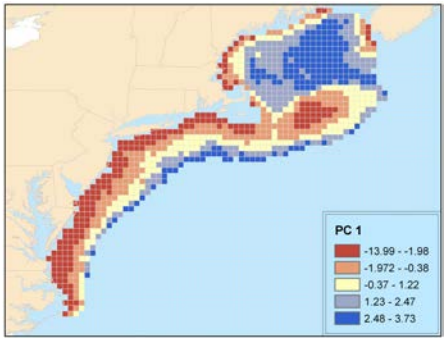
- Base on Physical Features, Oceanography, Productivity Patterns
- Define Common Spatial Frame of Reference (10 minute Rectangles – smallest unit for which historical catch data available ~1000 spatial cells)
- Determine statistical patterns of similarity within areas to define ecological subregions

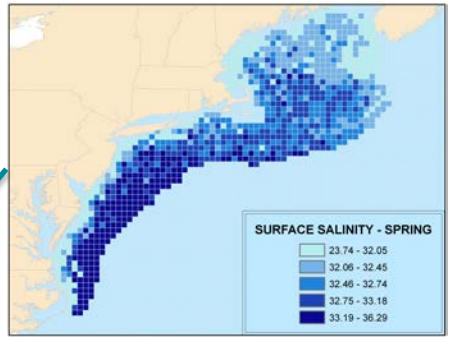
Define Ecological Production Units Based on Pelagic and Benthic Habitat Features and Primary Production

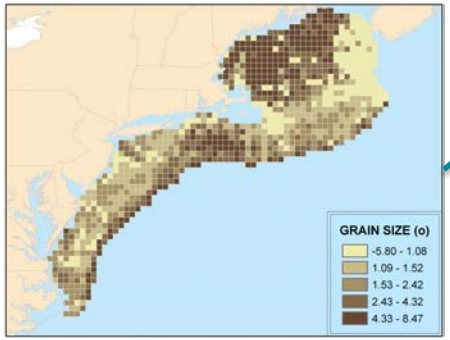
Bathymetry
Surficial Sediments
Mean Sea Surface Temperature (Satellite)
Annual Temperature Gradient (Satellite)
Annual Temperature Span (Satellite)
Temperature (Spring & Fall; Surface & Bottom)
Salinity (Spring & Fall; Surface & Bottom)
Chlorophyll a (Satellite)
Chlorophyll a gradient (Satellite)
Primary Production (Satellite)

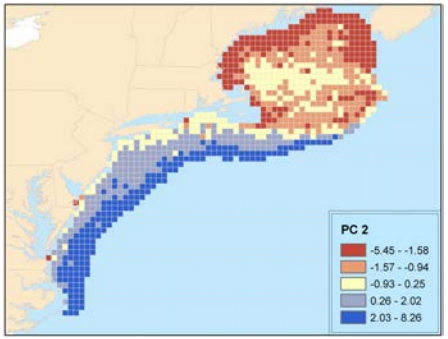
Analysis

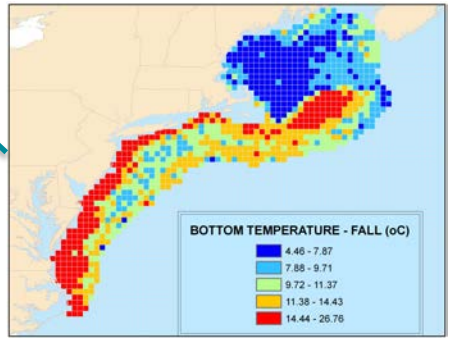

PPD MEAN (g C / (m2 d2))
0.41 - 0.48
0.49 - 0.54
0.55 - 0.65
0.66 - 0.83
0.84 - 1.88


PC 1
-13.99 - -1.98
-1.972 - -0.38
-0.37 - 1.22
1.23 - 2.47
2.48 - 3.73

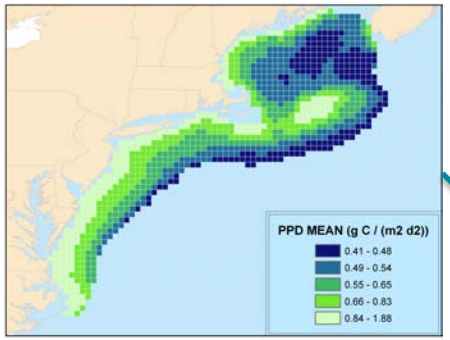

SURFACE SALINITY - SPRING
23.74 - 32.05
32.06 - 32.45
32.46 - 32.74
32.75 - 33.18
33.19 - 36.29

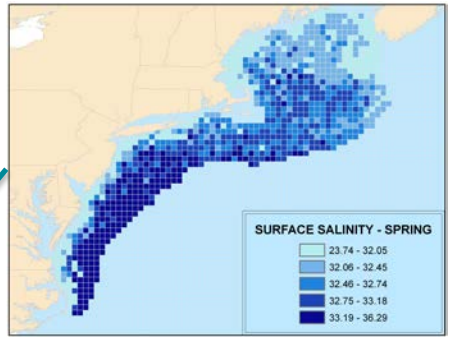

GRAIN SIZE (o)
-5.80 - 1.08
1.09 - 1.52
1.53 - 2.42
2.43 - 4.32
4.33 - 8.47

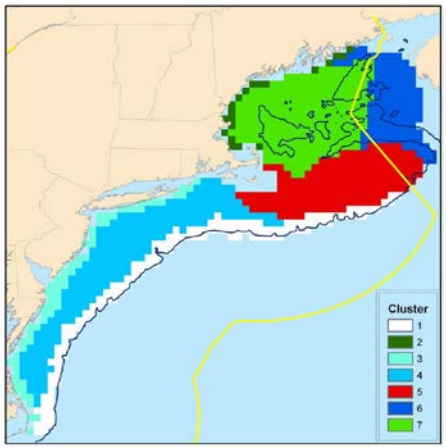

PC 2
-5.45 - -1.58
-1.57 - -0.94
-0.93 - 0.25
0.26 - 2.02
2.03 - 8.26

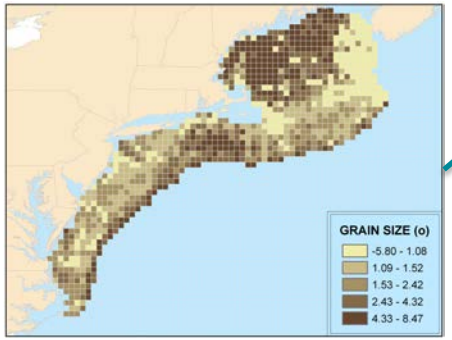

BOTTOM TEMPERATURE - FALL (oC)
4.46 - 7.87
7.88 - 9.71
9.72 - 11.37
11.38 - 14.43
14.44 - 26.76

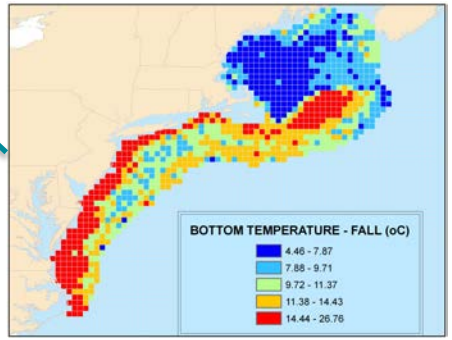
Analysis


PPD MEAN (g C / (m2 d2))
0.41 - 0.48
0.49 - 0.54
0.55 - 0.65
0.66 - 0.83
0.84 - 1.88

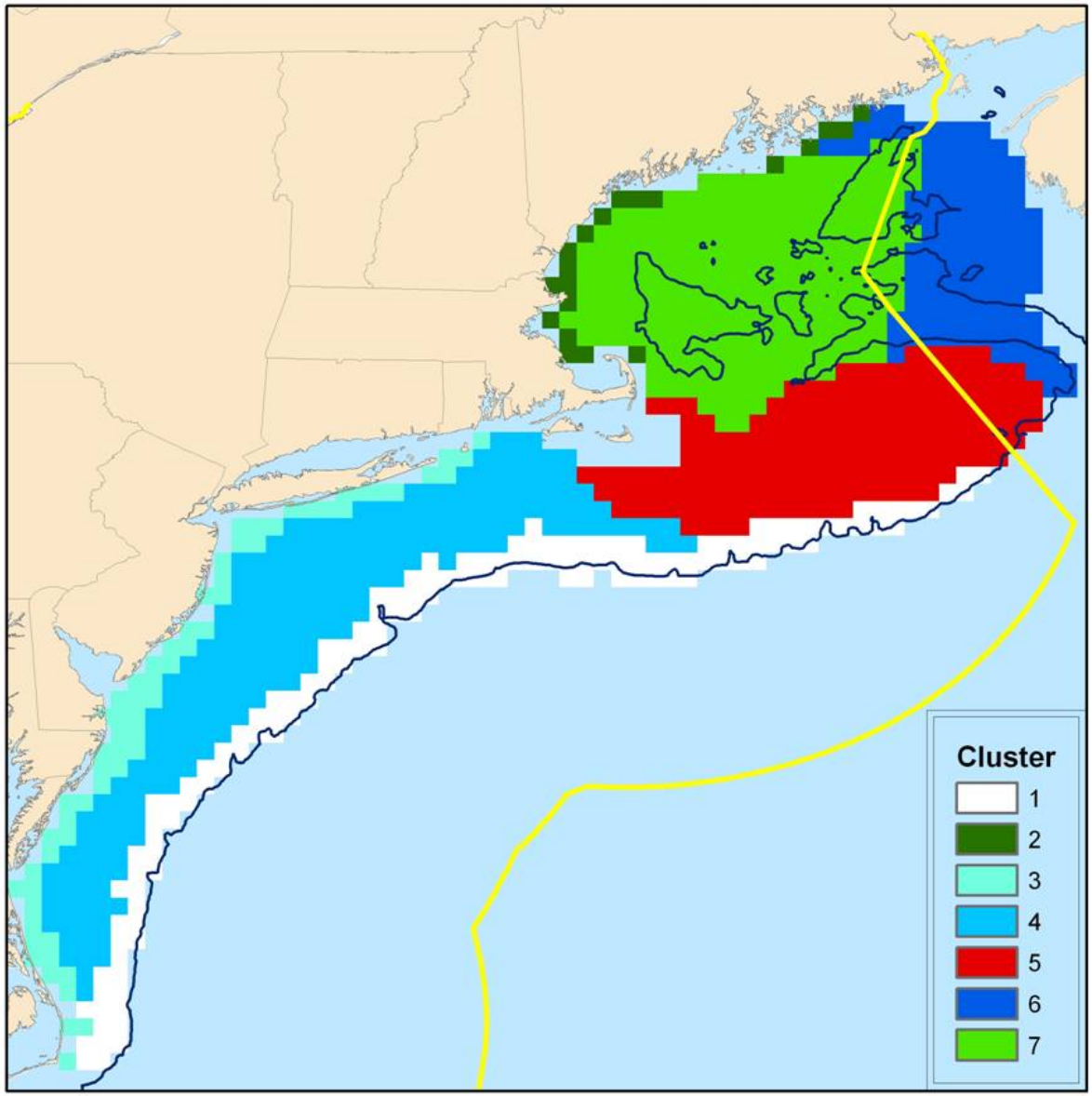

SURFACE SALINITY - SPRING
23.74 - 32.05
32.06 - 32.45
32.46 - 32.74
32.75 - 33.18
33.19 - 36.29


Cluster
1
2
3
4
5
6
7

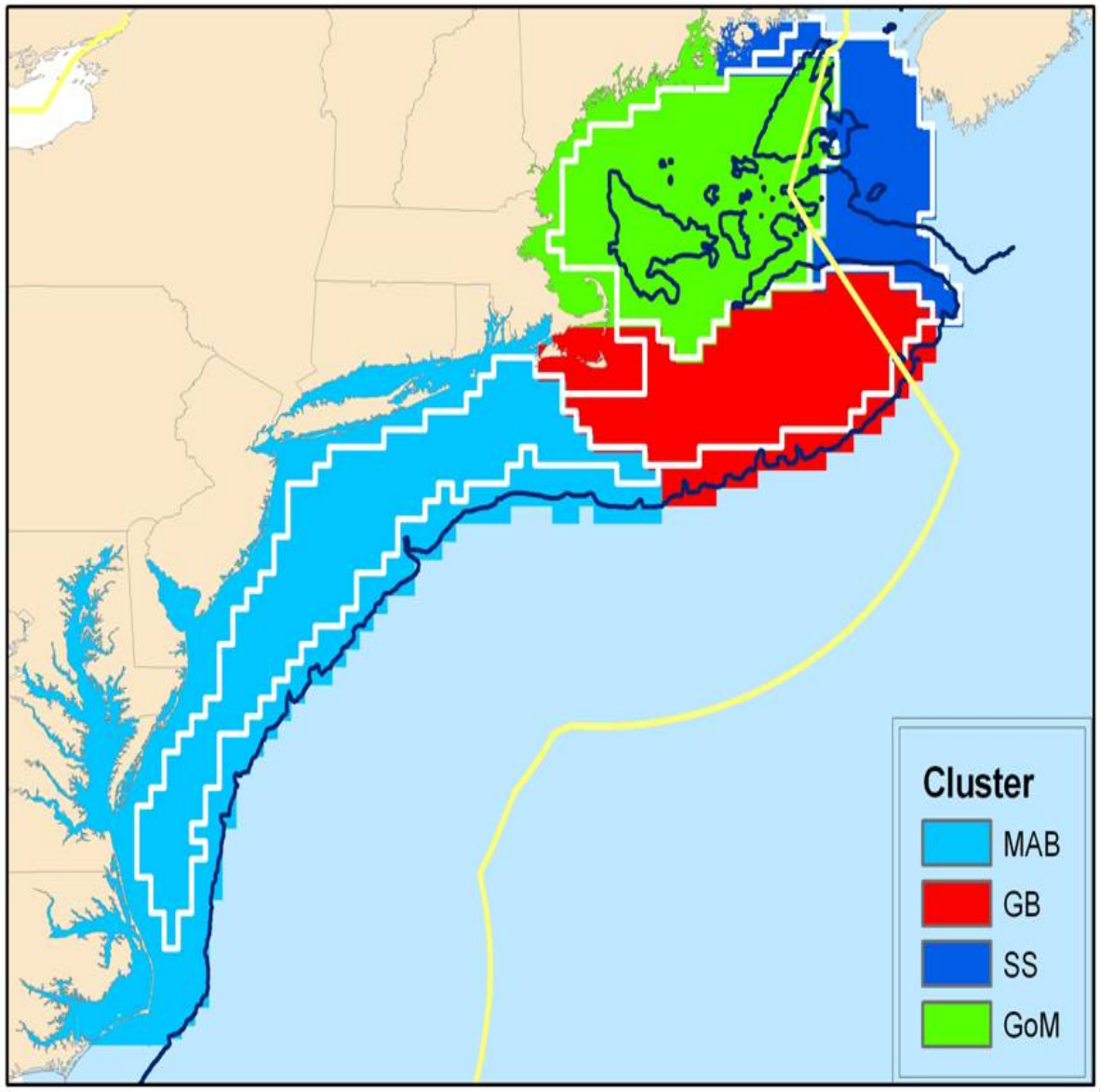

GRAIN SIZE (o)
-5.80 - 1.08
1.09 - 1.52
1.53 - 2.42
2.43 - 4.32
4.33 - 8.47


BOTTOM TEMPERATURE - FALL (oC)
4.46 - 7.87
7.88 - 9.71
9.72 - 11.37
11.38 - 14.43
14.44 - 26.76

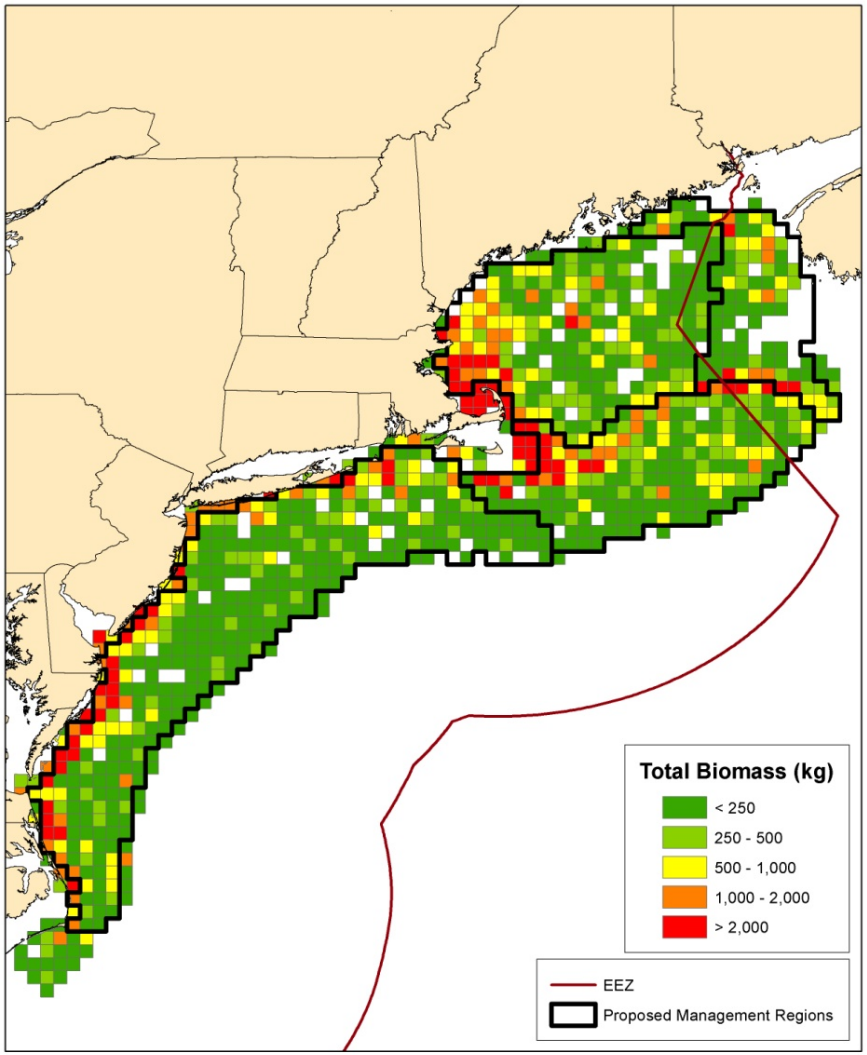
Ecological Production Units: Initial Clusters



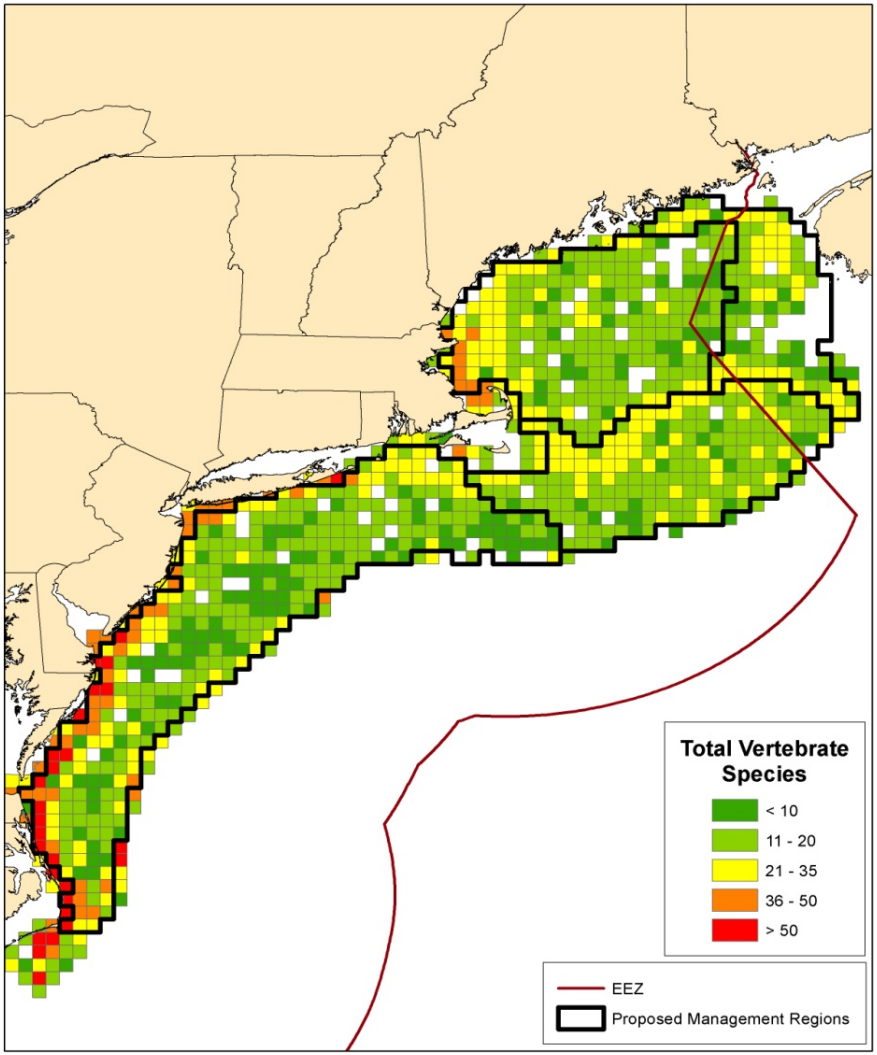
Ecological Production Units: Final Clusters



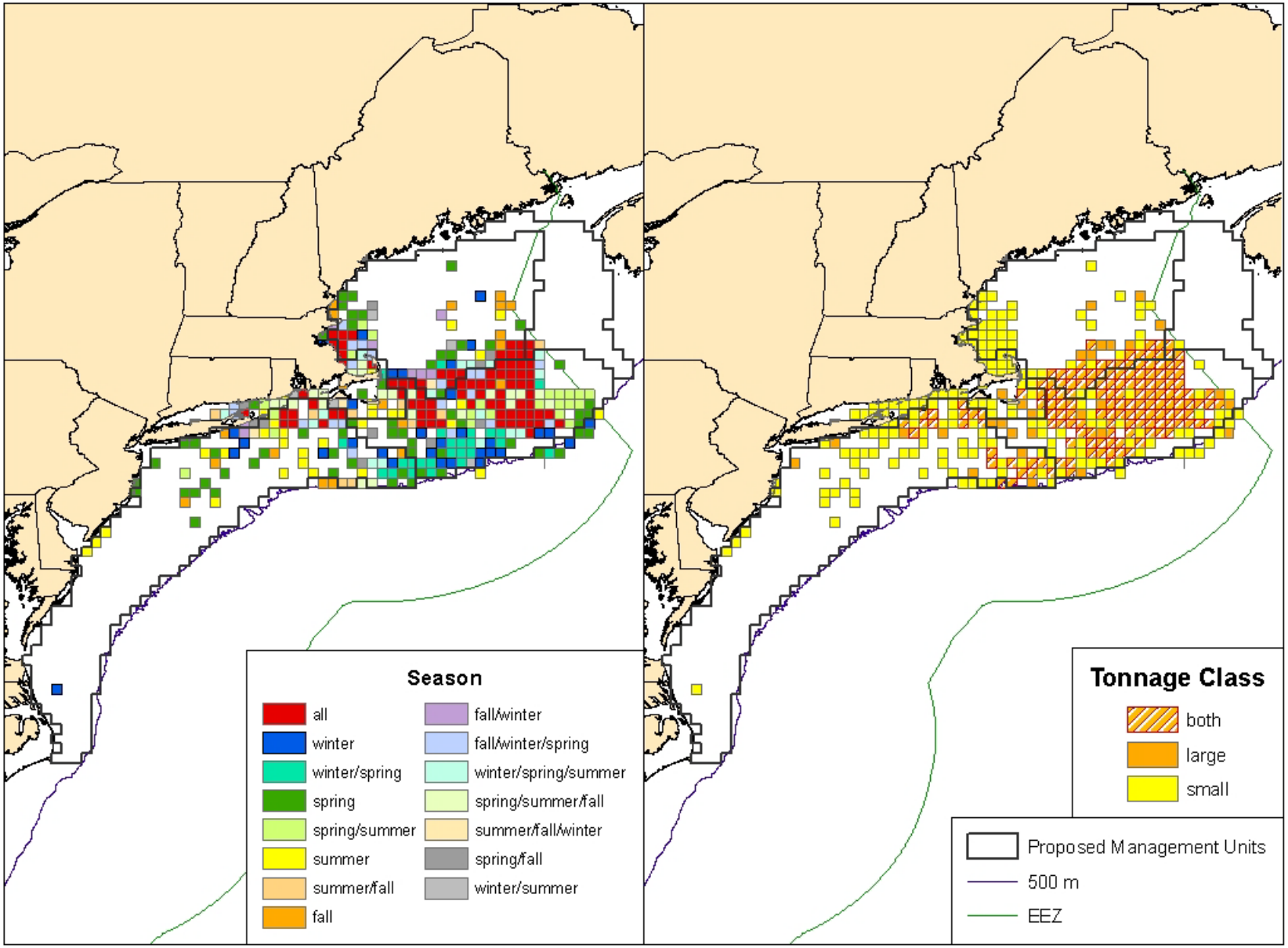
Biomass and Richness Patterns: Fish Species



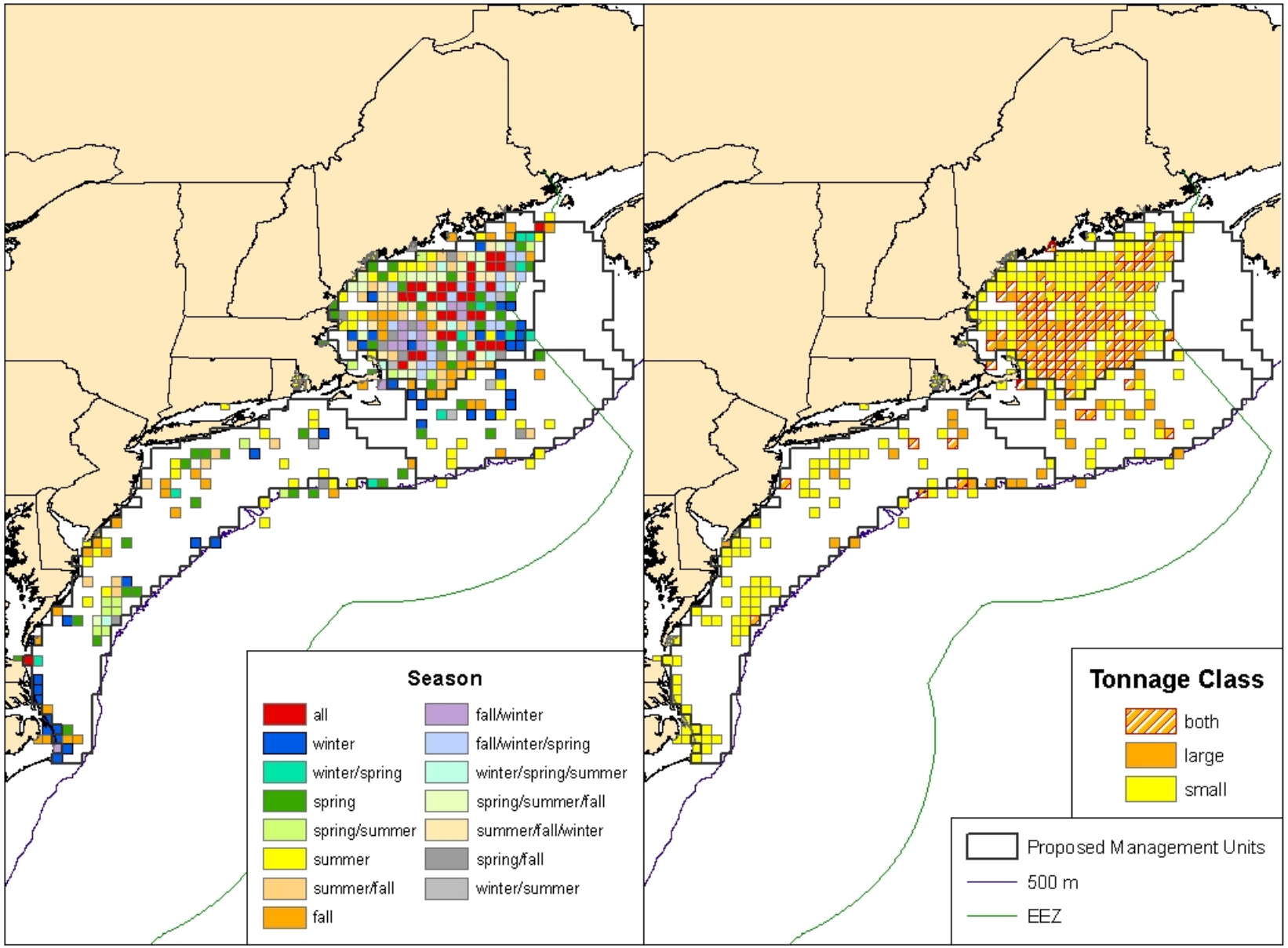
NEFSC Autumn Bottom Trawl Survey
(1998-2007)



NEFSC Autumn Bottom Trawl Survey
(1998-2007)

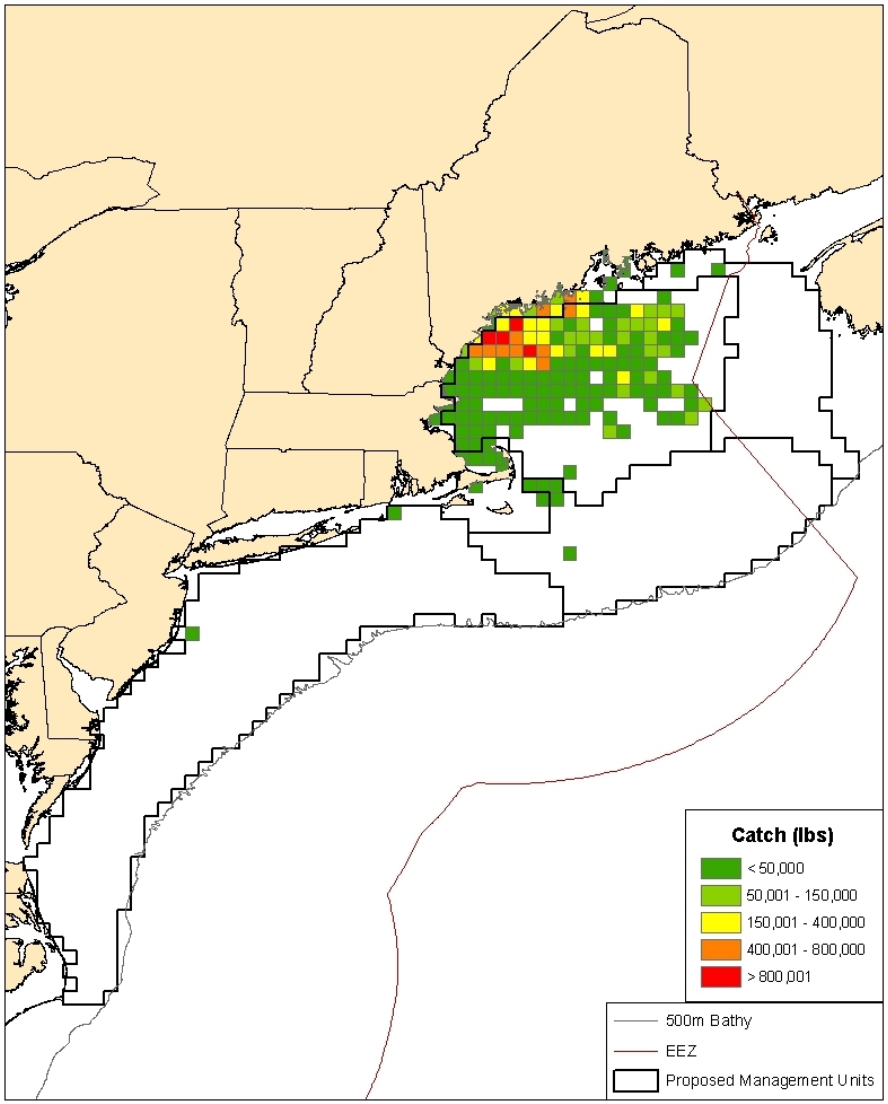


Otter Trawl Cluster 1



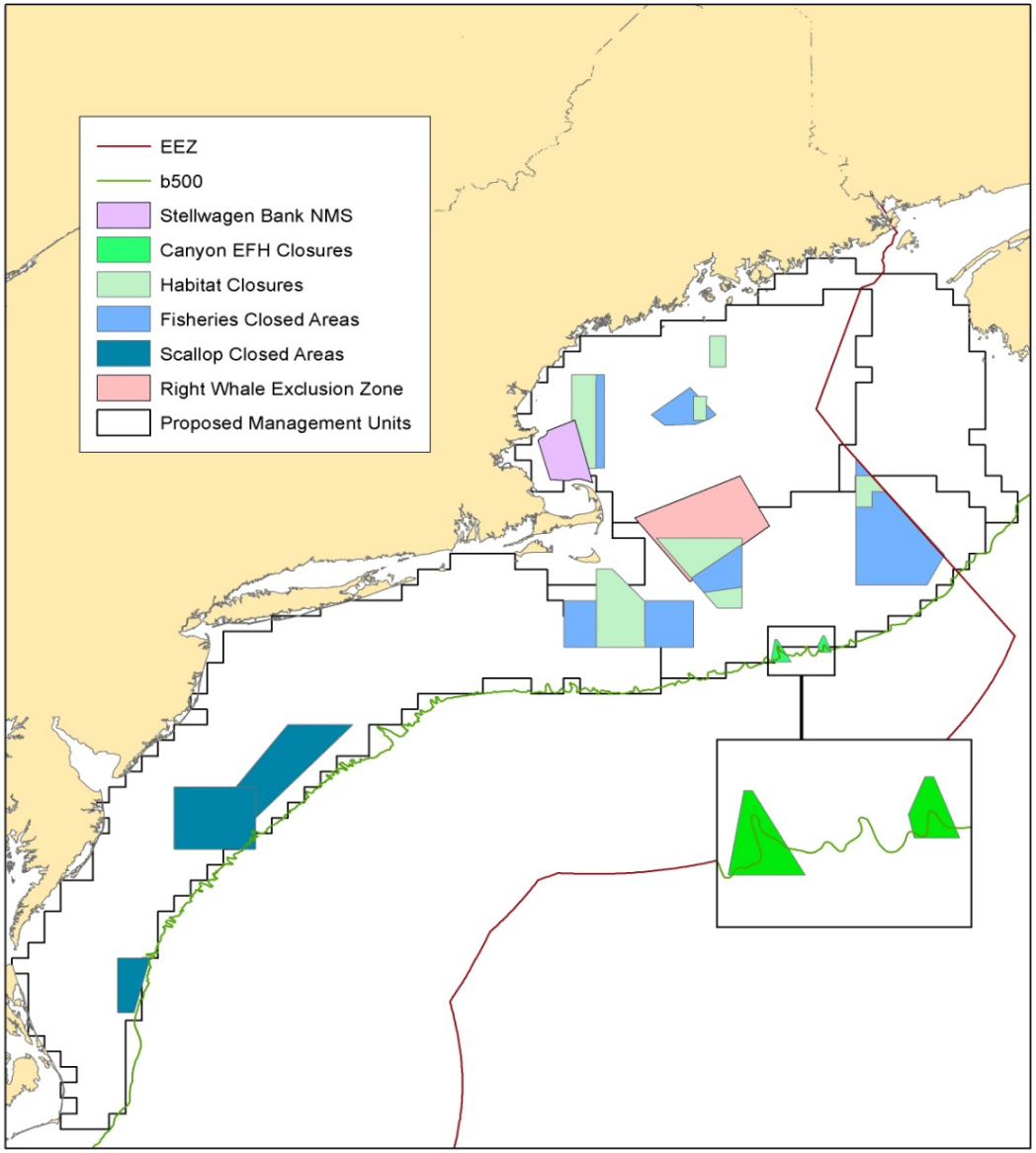
Otter Trawl Cluster 2

Prior Fishing Patterns of Vessels Now in Sectors



Port Clyde Community Sector (2005-2009)

Existing Large-Scale Management Areas



Conclusions

- Ecological subunits of the Northeast Continental shelf can be effectively defined based on physiographic, oceanographic, and lower trophic level variables
- The number and size of the major spatial management units ultimately chosen will involve tradeoffs involving interchange among areas (smaller units involve more interchange).
- These mapping exercises highlight areas of importance to fisheries and can be used to represent fisheries interests in marine spatial planning
- Hierarchical spatial management structures can be defined to reflect distribution of vulnerable species, biomass and biodiversity, human use patterns, and management requirements
- Choice of actual spatial management units is the prerogative of the management agencies

Strengths

- We have developed a framework for creating ecological subunits using reliably gathered physiographic and lower trophic level data
- These EPUs give us an opportunity to simplify the diverse set of stock unit boundaries in a more holistic, objective way
- As new data is collected, particularly climate data given the predicted changes in our region, these EPUs can be updated to reflect them

Challenges

- Management of species that move between EPUs needs to be addressed
  - Strategy: Models/analyses need to incorporate spatial structure (this is, of course, also a challenge).
  - Strategy: For long term movement due to climate change, triggers for dealing with changes in distribution patterns across EPUs are a possibility
- Exploration of how these subunits change over time is needed
  - Strategy: Sensitivity analyses to different number of years, and different time periods to determine appropriate time scale to reanalyze

Questions?