Update on Northeast Regional Habitat Assessment (NRHA)

Michelle Bachman (NEFMC), *Jessica Coakley (MAFMC)*, Chris Haak (NOAA/Monmouth U), Tori Kentner (NOAA/Integrated Statistics), Laurel Smith (NOAA NMFS)

Presented to Fisheries GIT – June 23, 2021

Topics for today:

- Highlight ongoing activities and actions
- Describe types of products currently under development
- Convey status relative to workplan timelines
- Answer any questions

NRHA Goal: To describe and characterize estuarine, coastal, and offshore fish habitat distribution, abundance, and quality in the Northeast.

Four actions were identified as necessary to meet this goal which include

1) Inshore fish habitat assessment
    a) Fish distribution and abundance
    b) Habitat distribution, status, and trends
2) Habitat vulnerability including response to changes in climate,
3) Spatial descriptions of species habitat use in the offshore area, and,
4) Habitat Data Visualization and Decision Support Tools.

Focus Species (65+, important to managers)

- **Mid-Atlantic Council:** Atlantic and chub mackerel, butterfish, longfin and shortfin squid, surfclam, ocean quahog, summer flounder, scup, black sea bass, bluefish, golden and blueline tilefish, spiny dogfish
- **New England Council:** Cod, cusk, haddock, pollock, Acadian redfish, plaice, halibut, winter flounder, witch flounder, yellowtail flounder, wolffish, windowpane, ocean pout, offshore, red, and white hake, monkfish, Atlantic herring, salmon, skates (seven species), red crab, sea scallop
- **Additional Atlantic States Marine Fisheries Commission (ASMFC):** Eel, lobster, croaker, menhaden, striped bass, Atlantic sturgeon, black drum, cobia, horseshoe crab, Jonah crab, northern shrimp, red drum, shad and river herring, Spanish mackerel, spot, spotted seatrout, tautog, weakfish, coastal sharks
- **Highly migratory with Habitat Areas of Particular Concern (HAPC) designations:** Sandbar shark, dusky shark

Project teams

- **Project Coordinator:** Jessica Coakley
- **Team leads:** Jessica Coakley & Michelle Bachman (inshore); Laurel Smith (offshore)
- **Technical leads on GIS and modeling work:** Chris Haak, Tori Kentner
- **Inshore team members:** Bryan DeAngelis, Julie Devers, Stephen Faulkner, Zack Greenberg, AK Leight, Dave Packer, Mark Rousseau, Eric Schneider, Alison Verkade
- **Offshore team members:** Rich Bell, Kevin Friedland, Vince Guida, Donna Johnson, Rob Latour, Kathy Mills, Ryan Morse, Dave Packer, Marta Ribera, Vince Saba, David Stevenson, Marek Topolski, Harvey Walsh
- **Habitat Climate Vulnerability Assessment:** Jon Hare, Mike Johnson, Mark Nelson, Emily Farr, others

Inshore and Offshore Products

Data inventory (mostly complete)

- Data Inventory spreadsheet and metadata library of 1 page summaries for each dataset
- Compiled species data from state/federal fisheries-independent surveys, environmental datasets
- Conducted a comparison of trawl survey procedures and gears

Focus Species Profiles (mostly complete)

- Summarize life history and habitat use for each focus species
- Related Habitat Climate Vulnerability Species Narratives forthcoming

Habitat modeling (methods development/model testing underway)

- Joint and single species modeling efforts to determine species distributions and habitat use

GIS products (assembling data, identifying partners)

- Map locations and extent of habitat utilization by focus species including inshore habitat types (SAV, oyster reefs etc.), building on existing databases
- Species distribution maps and future predicted distribution

Habitat data visualization and decision support tools (identifying partners)

- Maintain, house, and updates every 5 years with portal partners

Inshore Products

- Create maps of inshore focus species distribution and abundance, by life history stage
  - Based on fishery-independent, state or regional trawl and seine surveys
  - Identify caveats and data gaps
  - Describe trends in species distribution and abundance
- Compile and summarize inshore habitat data from various sources
  - Coastal wetlands, seagrasses, oyster reefs, coastal inert substrates, hardbottom, etc.
    - Identify caveats and data gaps
    - Various existing efforts - summarize availability and possible uses
  - Describe trends in habitat abundance and quality
    - Quantitative, if possible
- Where possible given species and habitat data, develop habitat suitability models focusing on inshore areas
  - Products might be limited to specific regions, given available data

Habitat Climate Vulnerability Assessment/NHRA Crosswalk Project

- HCVA and NHRA teams will be working with a contractor starting this summer to:
  - Develop a matrix that identifies habitat climate vulnerabilities, species climate vulnerabilities, and the dependence of species on habitats
  - Write narratives describing these relationships and highlighting areas of particular interest/concern
- Matrix and narratives will build on NHRA species profiles, EFH designations, HCVA results, Fish and Shellfish CVA results, and ACFHP habitat matrix

Excerpt from draft summer flounder narrative:

Summer flounder were ranked moderately vulnerable to climate change due to very high exposure to both ocean surface and air temperature, but low sensitivity to all examined attributes. Broad dispersal of eggs and larvae and seasonal north-south migrations by adults lend the species a high potential for distribution shifts. Climate change is expected to have a neutral effect on the species, although there is high uncertainty surrounding this finding. The dispersal of eggs and larvae and the broad use of both estuarine and marine habitats could result in climate change having a positive effect, but uncertainty remains (Hare et al. 2016).

The habitats important to summer flounder, such as intertidal benthic habitats, submerged aquatic vegetation, and native salt marsh habitats, are vulnerable to projected changes in temperature as well as sea level rise. Subtidal benthic habitats are vulnerable to changes in sea surface temperature. The species itself is also vulnerable to such factors, as they are exposed to changes in conditions in both inshore and offshore habitats. The overlapping high importance of native salt marsh and submerged aquatic vegetation habitats to the species and the very high and high climate vulnerability of these habitats, respectively, show a potential critical nexus of climate vulnerability.

Data inventory compiled as spreadsheet and metadata library

Name	Region	Source	Type	Data	Data Category	Years
usSEABED	Entire Atlantic Coast	USGS	Point	Grain Size, %GSM	Sediment	1960-2003
CONMAP	US Atlantic Coast	USGS	Polygon	Categorial	Sediment	updated to 200
East Coast Sediment Texture Database (2014): ECST	US Atlantic Coast	USGS	Point	Grain Size, %GSM	Sediment	updated to 201
Loring and Nota 1973 Sediment Charts	Gulf of St. Lawrence	Loring and Nota 1973	Digitized poly	%GSM	Sediment	
Natural Resources Canada Expedition Database	Scotian Shelf, British Colu	Geological Survey of Canada	Point	Grain Size, %GSM	Sediment	
Sediment Thickness Database	Entire Atlantic Coast	NOAA NCEI	Polygon	Categorial	Sediment	updated 2019
Long Island Sound Sediment data	Long Island Sound	USGS	Point data	Categorial	Sediment	1931-2009
AMAPPS	Wind Energy Areas	NOAA	Point	%GSM and Grain size	Sediment	2 cruises in 201
SMAST	Northeast US Shelf	Umass Dartmouth	Point	annotated images	Sediment	
NAMERA_coastal_ecosystems	Northeast US Shelf	The Nature Conservancy	Polygon	Seabed Classification	Seabed Classification	1968-2008
NAMERA_benthic_habitats	Northeast US Shelf	The Nature Conservancy	Raster	Categorial	Sediment	

Sediment | Bathymetry | Temperature | Submerged Aquatic Vegetation | Species Data | Hydrodynamic data | Climate Models

usSEABED

Data Source
USGS, University of Colorado and partners

Data Type
Grainsize, Percent Gravel, Sand, Mud (GSM)

Date Range
1960-2002

Data Resolution
NA

Data available online?
Yes ☑ No ☐

Geographic Range
US Coast

Methodology
Data sources were compiled using the dbSEABED system to combine unique datasets into a standardized database. dbSEABED is a data-mining program that applies fuzzy set theory to marine geological and biological data. Sediments including core logs, sample descriptions, photos, and videos, as well as the more standard numeric data from a laboratory were classified using Folk and Shepard systems. Statistical comparisons are made between lab-based and word-based outputs as a ground truth to improve classification. The goal is accurate classification within one phi size.

Overview
usSEABED contains data from small and large marine research efforts by many entities—federal and state agencies, local authorities, universities, as well as private and public consortiums.

The usSEABED datasets currently hold georeferenced point data for more than 300,000 data sites in U.S. waters from the beach to the deep sea, rivers, lakes, and estuaries. In usSEABED, existing data from the USGS and other research groups are processed and extended to maximize their density and usability creating unified, comprehensive, relationally linked datasets for mapping and analysis. Source data include surficial and subbottom data from physical sampling equipment (grabs and cores) and virtual sampling such as descriptions from seafloor photographs and videos.

In addition to quantified lab-derived data, the datasets of usSEABED also include estimated numeric values for those typical seabed characteristics—noted above—based on the extensive accumulation of word-based data in U.S. waters. These data are rich in information, but were previously difficult to quantify, map, plot, or use in comparative analyses or models.

These descriptive data—from short sentences, small essays, or single phrases—are treated as a mathematical equation that is considered as a whole. Filters based on fuzzy set theory assign relative weight to each word in the description, and estimate the values of textural and other parameters. In addition, the textural implications of non-textural terms—such as 'broken shells' or Halimeda—are included in the calculation of grain-size parameters.

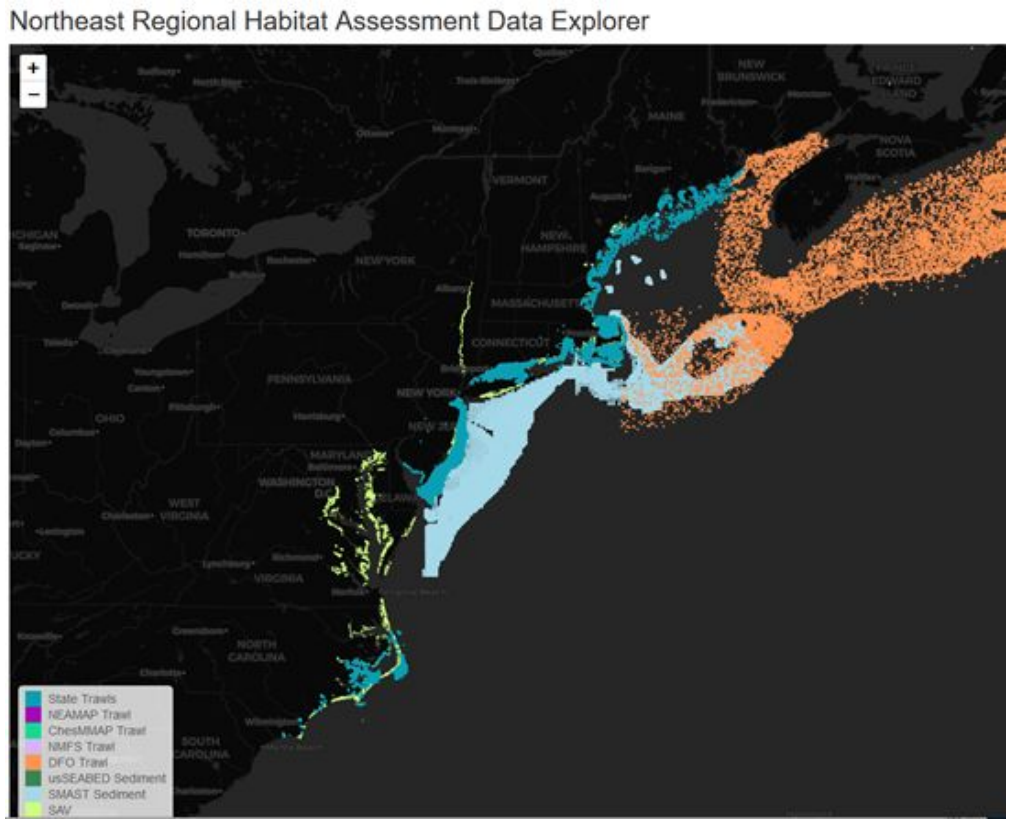
The resulting numeric data, now useable in a GIS or model, should be considered "fuzzy"; that is, they give an approximation—not a rigorous measurement—of the assessed values.

Data Caveats
Some small additions have been made but overall usSEABED has not been updated since 2002. Absences cannot be assumed because data is based on observation records. Additionally, much of the dataset is based on descriptive data so classifications are estimates and not exact measurements of grain size. Lastly, due to limitations in sample gear usSEABED does a poor job representing larger sediment such as cobbles, boulders and bedrock outcrops.

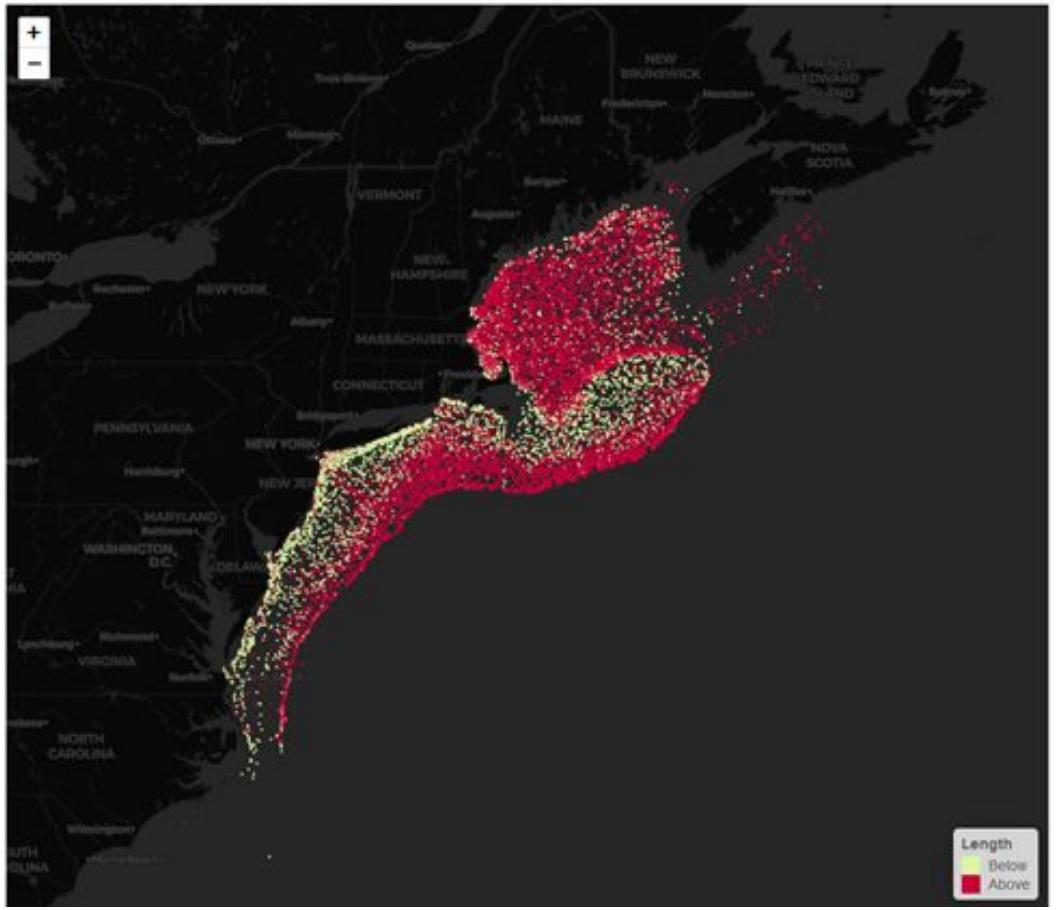
Data Access
usSEABED data is available for download and is broken into three regions, Pacific Coast, Gulf of Mexico and Caribbean and Atlantic Coast. Digital data catalog: https://coastalmap.marine.usgs.gov/national/usseabed/data.html
The sediment data sources included in usSEABED: https://www.usgs.gov/data-tools/usseabed-data-sources
Contact: Brian Buczkowski Woods Hole Coastal and Marine Science Center bbuczkowski@usgs.gov 508-457-2361

Citation
Buczkowski, B.J., Reid, J.A., Schweitzer, P.N., Cross, V.A., and Jenkins, C.J., 2020, usSEABED—Offshore surficial-sediment database for samples collected within the United States Exclusive Economic Zone: U.S. Geological Survey data release, https://doi.org/10.5066/P9H3LGWM.

R Shiny Apps built for data visualization, exploration and sharing among teams



https://nrha-data-viewer.shinyapps.io/data_inventory/



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Trawl Survey Comparison

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	State	Survey Name	Survey Location	Gear Type	Mesh Size	Survey Design	Headrope (ft)	Footrope (ft)	Tow Duration/Speed	Time of Year	Years Surveyed	NRHA Years	Strata & Stations
2	Maine	ME/NH Inshore Trawl Survey	ME/NH Coastal Waters	Bottom Trawl	2 inch with 1 inch cod end liner	Stratified random plus fixed stations	57	70	20 min @ 2.2-2.3kts	Bi-annual for 5 weeks starting first	2000-ongoing	2000-2019	20 total: 4 depth strata to 12 mile
3	Massachusetts	MA Inshore Trawl Survey	Coastal	Bottom Trawl	3.5 inch mesh wings 2..5 inch mesh belly, 0.25 inch	Stratified random	39	51	20 min @2.5kn	May (Spring) & Sept (Fall)	1978-ongoing	1978-2019	Since 1982, stations have been assigned
4	Rhode Island	Narragansett Bay Monthly Trawl	Narragansett Bay	Bottom Trawl	4.5 inch mesh 2" cod end, 0.25 inch liner	Fixed	40	55	20 min @2.5kn	Monthly	1990-ongoing	1990-2019	13 fixed stations chosen to represent
5	Rhode Island	Rhode Island Seasonal Trawl	Coastal	Bottom Trawl	4.5 inch mesh 2" cod end, 0.25 inch liner	Fixed and stratified random	40	55	20 min @2.5kn	Monthly & Seasonal Spring (April-May)	1979-ongoing	1979-2019	12 montly fixed stations & 14
6	Connecticut	CT Long Island Sound Trawl Survey	Long Island Sound	Bottom Trawl	4 inch with 2 inch cod end, no liner	Stratified random	30	46	30 min@ 3.5 kts	1984 -1991: Monthly April-November	1984-ongoing	1984–2019	40 random stations sampled monthly,
7	Connecticut	CT Small Mesh Trawl Survey	Long Island Sound	Bottom Trawl	2 inch with 0.25 inch cod end liner	Stratified random	30	46	30 min@ 3.5 kts	?	1991-93, 1996	-	-
8	New York	NY Raritan Bay Survey	Hudson-Raritan Bay	Bottom Trawl	1.75 inch cod end, 1.375 Liner	Stratified random	28	34	10 min @ 2kts	Monthly (except May, Sept)	1992-1997	-	-
9	New York	Peconic Estuary fishery trawl survey/	Peconic Bay	Bottom Trawl	.5 inch stretch mesh codend liner, 0.25 inch cod	Random	16	?	10 min @ 2.5 kts	Weekly, May-Oct	1985-ongoing	1987-2019	Allocation of stations is based on 77
10	New York	Nearshore Ocean Trawl Survey	Atlantic Ocean from Breezy Point to Block	Bottom Trawl	-	-	-	-	-	Year-round	2017-ongoing (10 year project)	-	-
11	New Jersey	NJ Delaware Bay Trawl Survey/ The	Delaware Bay	Bottom Trawl	1.5 inch with 0.5 inch liner	Fixed	16	N/A	20 min @ 2.1kts	Monthly April to October	1991-ongiong	1991-2019	11 stations within the bay for a yearly
12	New Jersey	NJ Trawl Survey/ New Jersey Ocean	Coastal Waters	Bottom Trawl	4.7 & 3 inches, 0.25 inch bar mesh cod end liner	Stratified random	82	100	20 min	1988/89 sampling was Feb, April, June,	1988-ongiong	1988-2019	To reduce potential sampling bias, each
13	Delaware (16ft Trawl)	DE 16ft Trawl Survey/ Delaware	Delaware Bay and Delaware River	Bottom Trawl	1.5 inch, 0.5 inch liner	Fixed	17	21	10 min @ minimum hp - tow against the	April - October (monthly)	1980-ongoing	1980–2019	The sampling design is a fixed site grid on
14	Delaware (30ft Trawl)	DE 30ft Trawl Survey	Delaware Bay	Bottom Trawl	3 inch wings & body, 2 inch cod end	Fixed	30	40	20-30 min @ minimum hp	March - December (monthly)	Since 1966 (1966-1971,	1966-2019	Nine fixed stations throughout the
15	Maryland	Coastal Bays Fisheries	Coastal Bay	Bottom Trawl	0.25 inch cod end	Fixed	?	16	6 min @ 2.5-2.8kts	April-Oct (monthly)	1972 - ongoing but standardized	1989-2019	Trawl sampling was conducted at 20
16	Virgina	VIMS Chesapeake Bay Juvenile Fish and	Lower Chesapeake Bay and major	Bottom Trawl	1.5-inch, 0.25 inch liner in cod end	Fixed and stratified random	20	?	5 min @ 2.5kts	Monthly April - Dec	1955-ongoing	-	Sampling in the Bay occurred monthly
17	Virginia	ChesMMAP:Chesapeake Bay Multispecies	Mainstem, Ches Bay (ChesMMAP)	Bottom Trawl	4.72 & 2.36 inch mesh with 1 inch cod end liner	Stratified random	32.7	36.5	20 min @ 3 kts	March, June, Sept & Nov	2002-ongoing	2002-2015	The coverage includes 80 stations
18	Virginia	NEAMAP: NorthEast Area Monitoring and	Coastal, RI to NC (NEAMAP)	Bottom Trawl	4.72 & 2.36 inch mesh with 1 inch cod end liner	Stratified random	80	88.6	20 min @ 2.9-3.3 kts	April-May and Sept-Oct	2007-ongoing	2007-2019	150 stations broken down into 15 regions
19	North Carolina	NCPamlico Sound Survey (Program	Pamlico Sound	Bottom Trawl	1.875 inch strech mesh, 1.5 inch cod end	Stratified random	31	34	20 min @ 2.5 kts	June and Sept (also March and Dec prior	1987-ongoing	1987-2019	Each trawl sweeps an area of approx.
20	North Carolina	NC Juvenile Trawl Survey (Juvenile	Albemarle Sound and tributaries	Bottom Trawl	4 inch in wings to 1/8 inch tail bag	Fixed	18	?	10 min @ ?	May and June (Feb-Nov prior to	1971-ongoing	-	Fixed. Some of the current stations
21	North Carolina	Estuarine Trawl Survey /Nursery	Estuarine	Bottom Trawl	.25 inch bar with .125 inch bar tail bag	Fixed	10ft	-	1 min calibrated to span 75 yards	Core stations: May and June	1971 - ongoing	1972-2019	105 stations in shallow water areas
22	Offshore/ Northeast U.S.	NMFS bottom trawl survey	Northeast U.S. Continental Shelf	Bottom Trawl	4.72 & 2.36 inch mesh, 1 inch cod end liner	Stratified Random	79.5	88.6	20 min @ 3 kts	Spring & Fall	1963-ongoing	1963-2019	Stratified random sampling design.

Modeling Framework

Characterizing Habitat Use

Characterizing habitat use: A comprehensive strategy

- **Stage-based approach** - partitioning spp. into distinct classes based on ontogeny (e.g., size or maturity)
  - Better resolution of habitat shifts?
  - Improved inferences about species interactions?
- **Single-species SDMs** using GAM and Random Forest (RF) methods
  - Time tested & proven (point of comparison for joint models)
  - Faster, can accommodate more covariates (RF)
- **Multi-species JSDMs** using a novel approach (CBFM)
  - Modeling groups of species that are likely to interact (i.e., functional groups)
  - Provide insights on species relationships/biotic interactions?

Northeast Regional Habitat Assessment

Actions to Meet Goals:

1) Inshore fish habitat assessment
   a) Fish distribution and abundance
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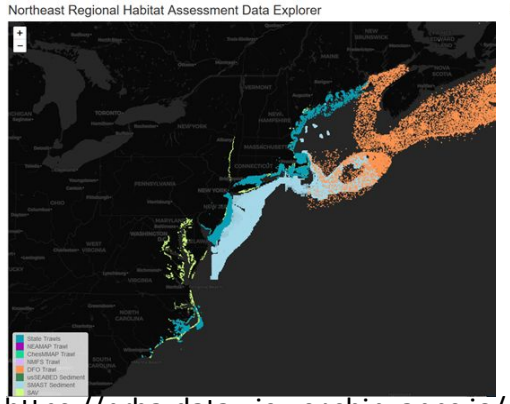
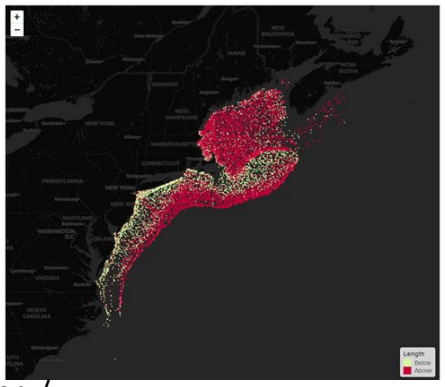
Data Visualization:





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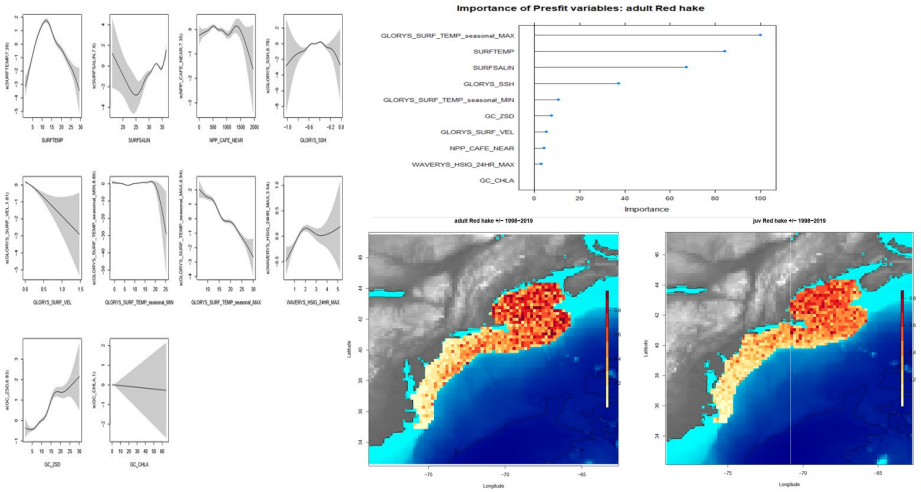
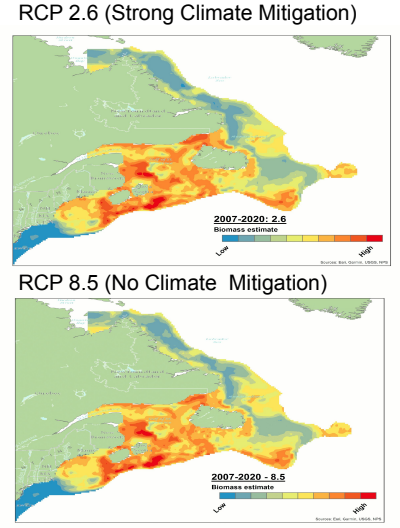
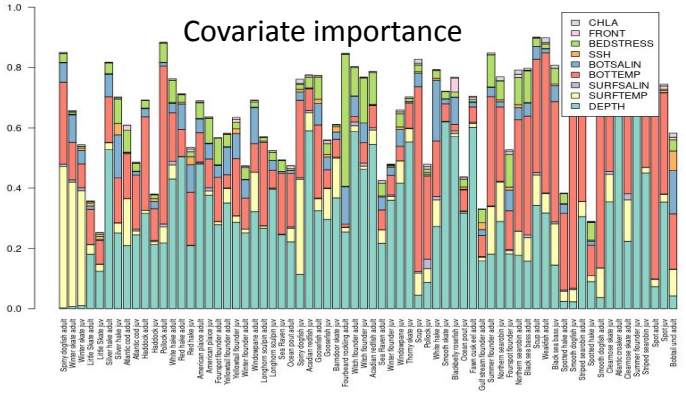
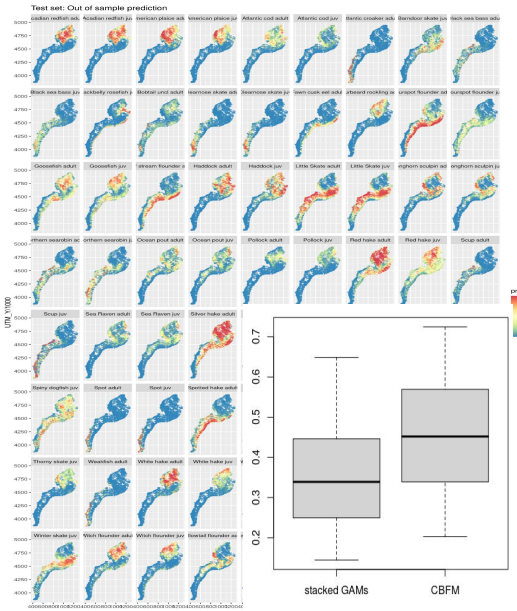
Species Distribution Models using Random Forest and GAMs:





Multispecies Joint Species Distribution Model using Community-Level Basis Function Model:





NRHA Timeline