Fishing Status of Vessels Using the AIS: A Big Data and Machine Learning Approach

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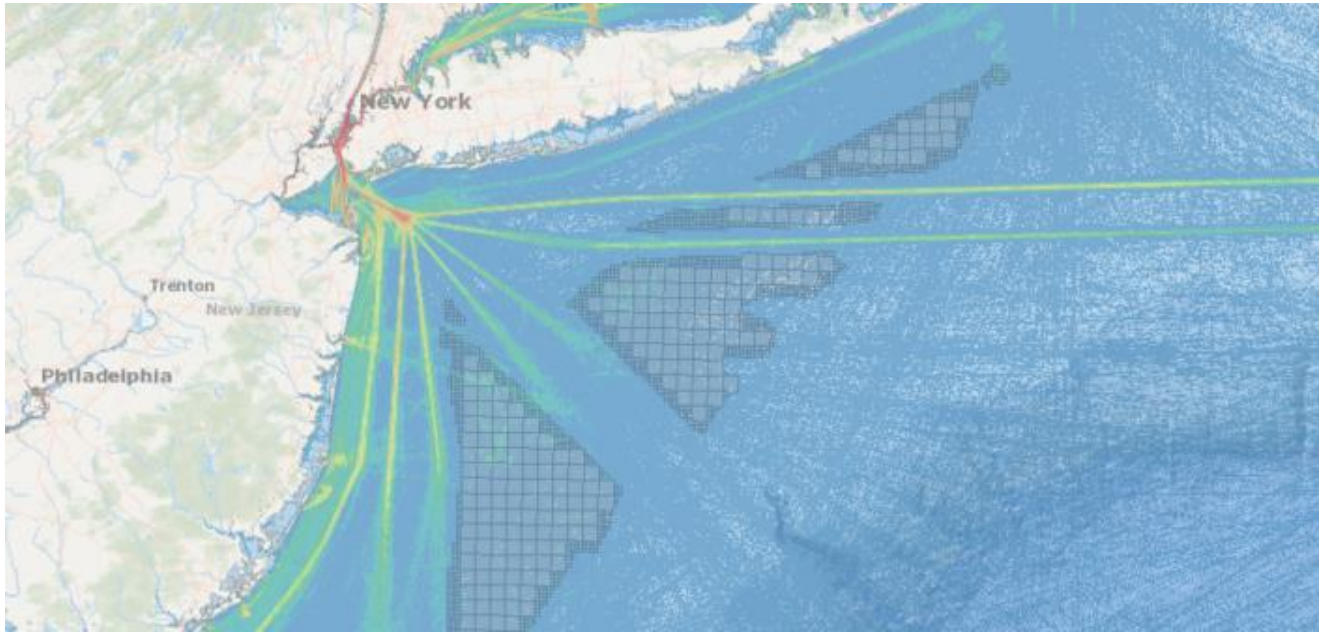
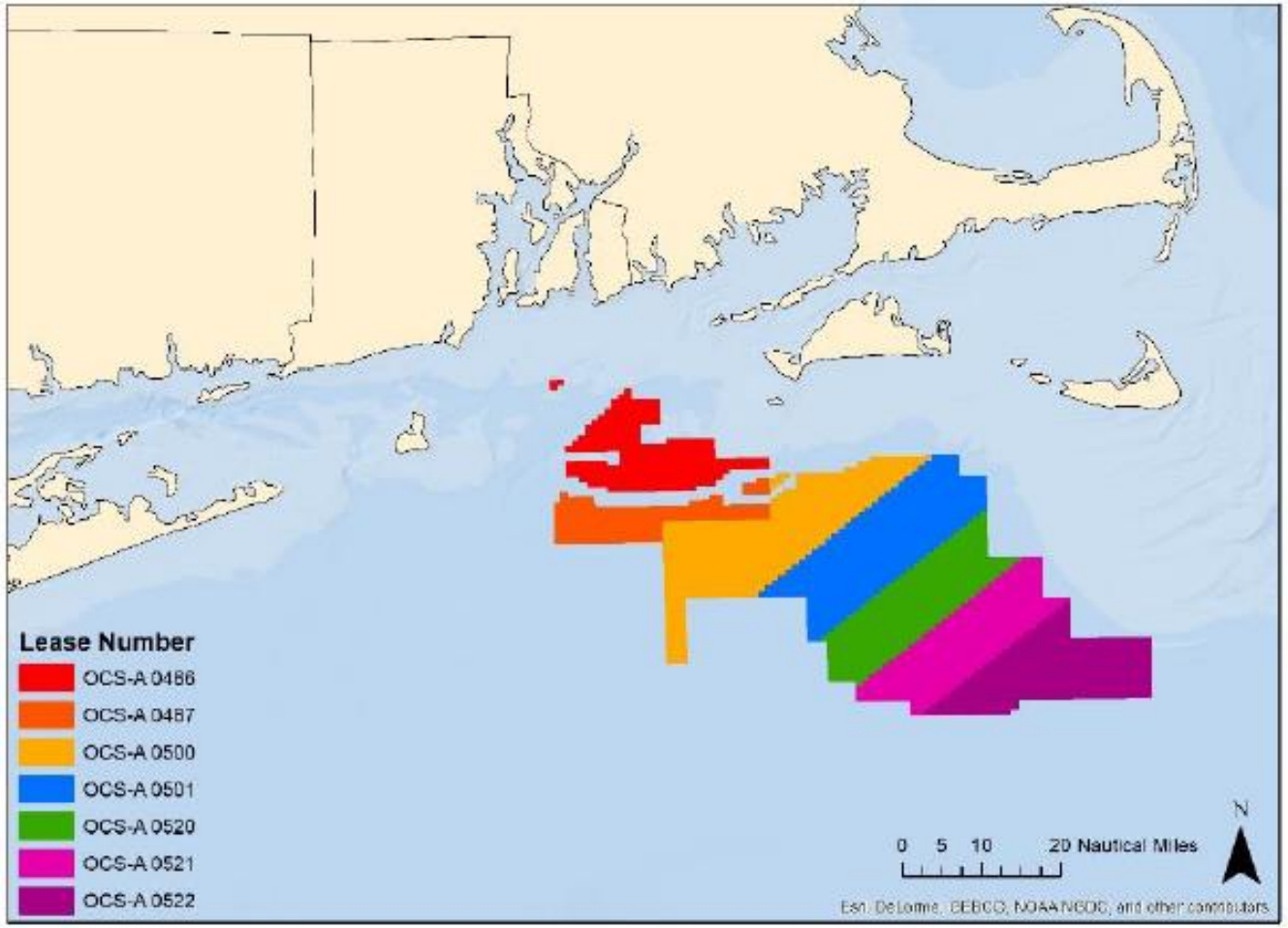


Background – Offshore Wind in SNE



- Block Island Wind Farm – 5 turbines, 30 MW
- Federal commercial scale farms proposed – hundreds of turbines, multiple GW
  - Vineyard Wind I is 800 MW
  - 7 federal lease areas in SNE
  - Possibly hundreds of turbines
- Social and biological impacts may be different

Problem Statement/Questions

- How will the commercial fishing industry be affected?
  - How will fishing pressure change inside or outside of wind farms areas?
  - If fishery displacement occurs, where will displaced fishermen go to fish, and how will increased pressure elsewhere affect non-wind farm displaced fishermen?
  - Will catch composition change in wind energy areas?
  - Will species composition of landings change in and around wind farms?
  - Do wind farms impact economic value and diversity of individual ports and will ports be affected disproportionately?

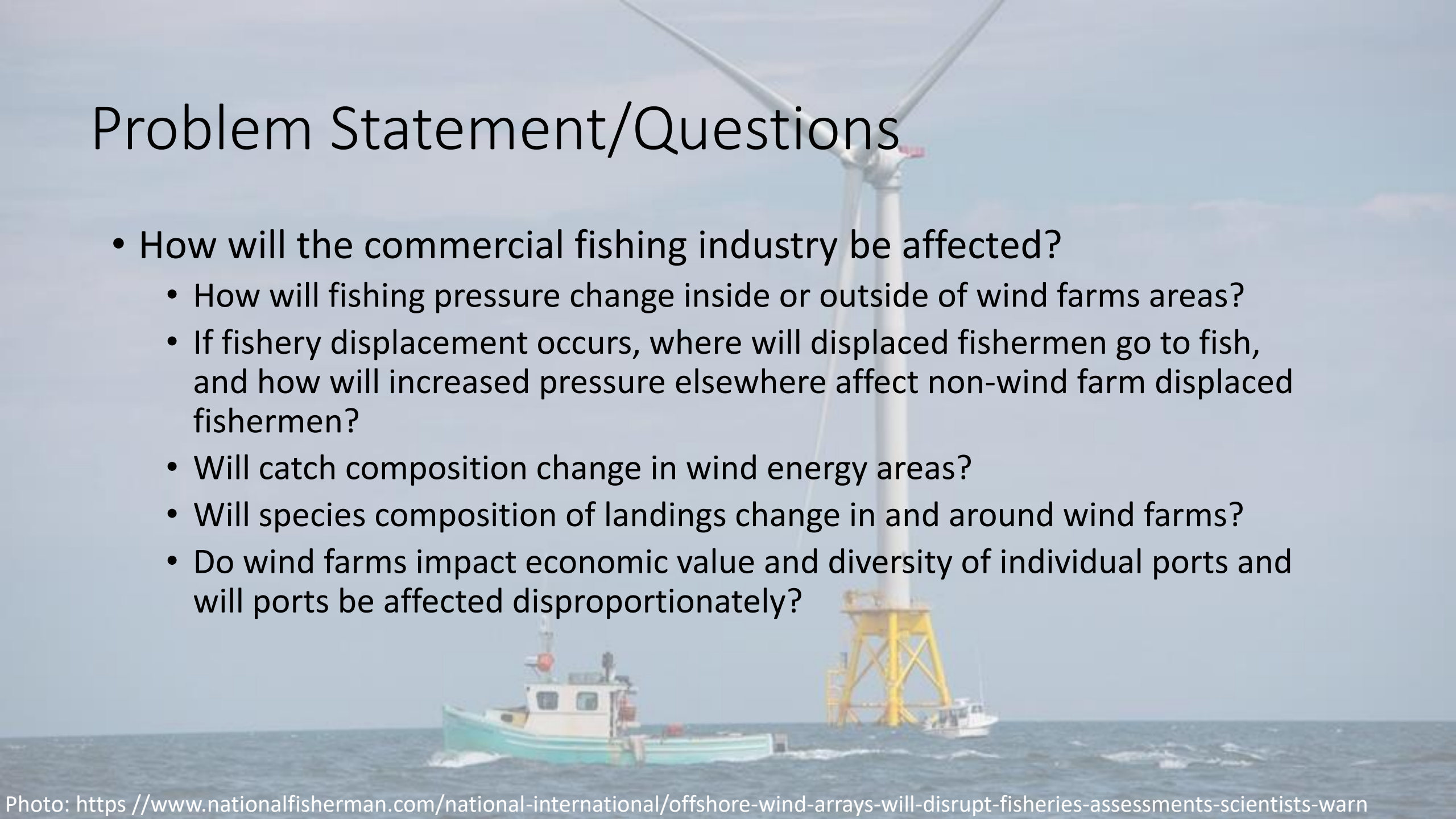


Photo: https //www.nationalfisherman.com/national-international/offshore-wind-arrays-will-disrupt-fisheries-assessments-scientists-warn

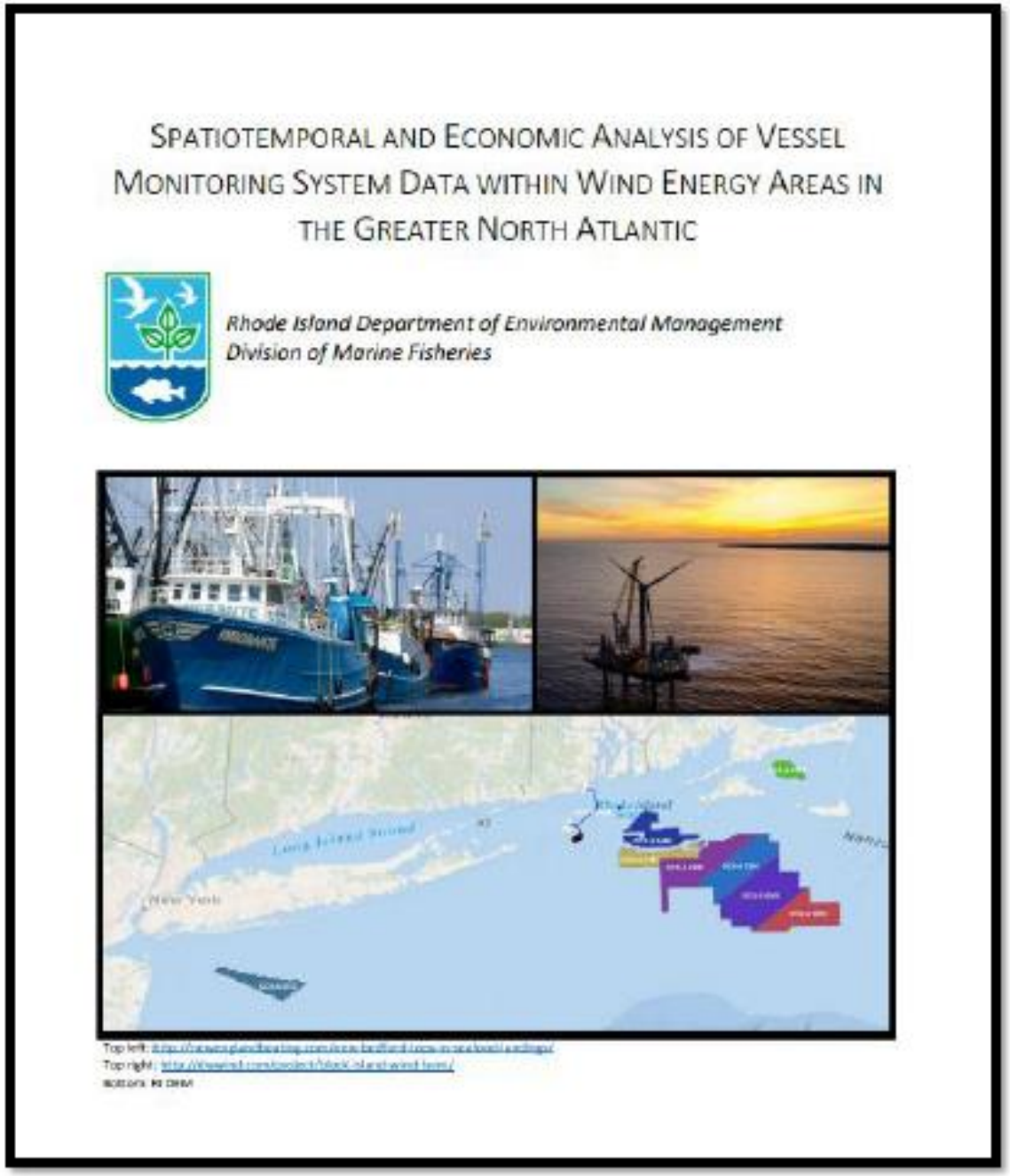
Fisheries Dependent Data

Dataset	Description	Challenges
Dealer Reports	Value, amount, and grade of seafood landed	No information about where seafood came from
Vessel Trip Reports/Logbooks	Self-reported effort info (location, gear used, catch, etc.)	Limited reporting based on statistical areas, poor resolution
Vessel Monitoring Systems	Location information for fishing vessels	Not all fisheries required to have, different reporting frequencies
Automatic Information System	High resolution location information for any vessel	Only required on vessels >65 ft.
NOAA Observer Reports	Highly reliable fisheries observer data on catch, bycatch, gear, location, etc.	Only certain fisheries have observer requirements and limited coverage by vessels

None designed for understanding where fishing is occurring – meant for enforcement or management

Existing Resources

- BOEM/NOAA VTR and Observer Revenue Data Model
- VMS Data on NROC/MARCO Data Portals
- RIDEM VMS/VTR/Dealer Revenue Analysis
- NOAA Predictive Displacement Modeling

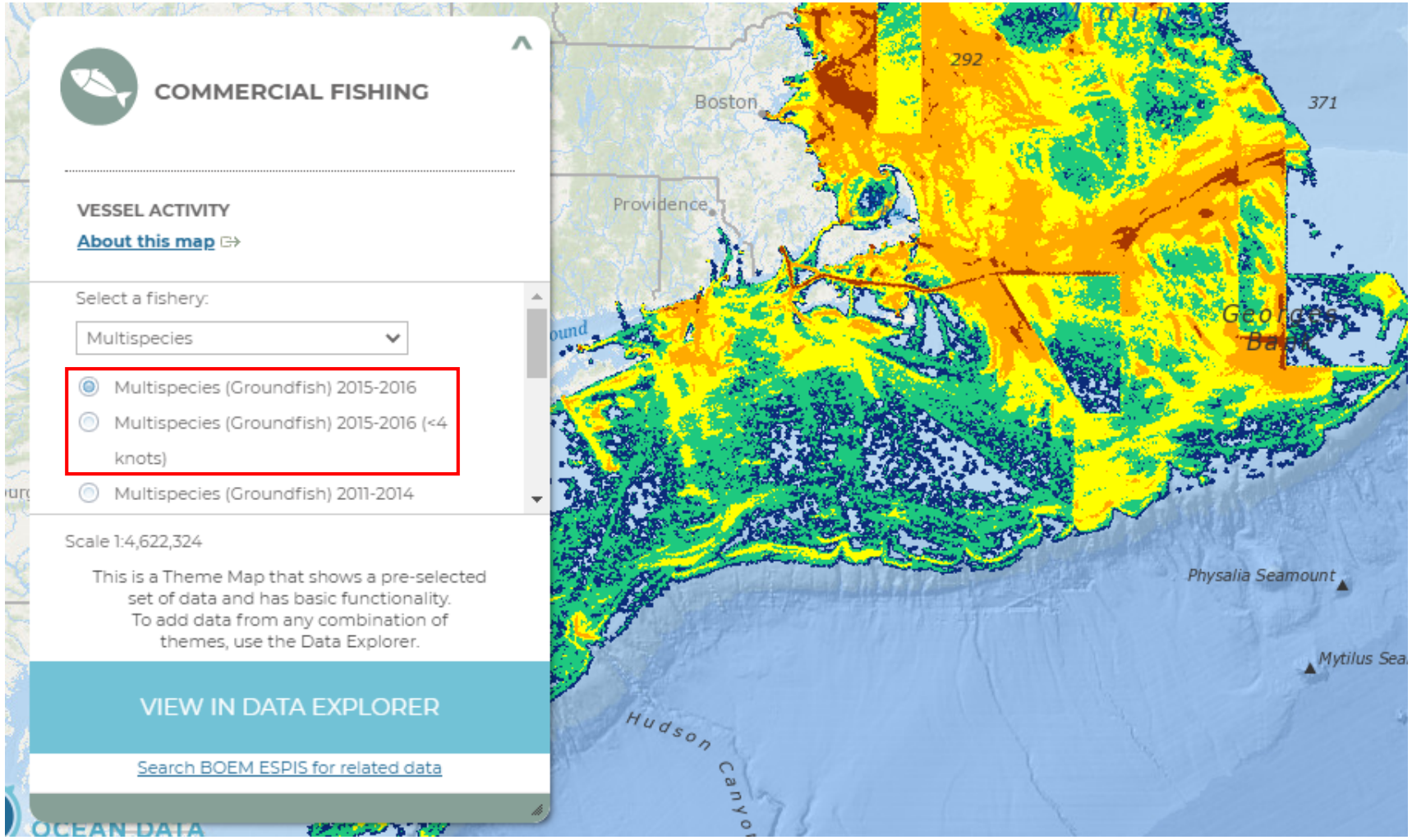


Problem with Existing Models

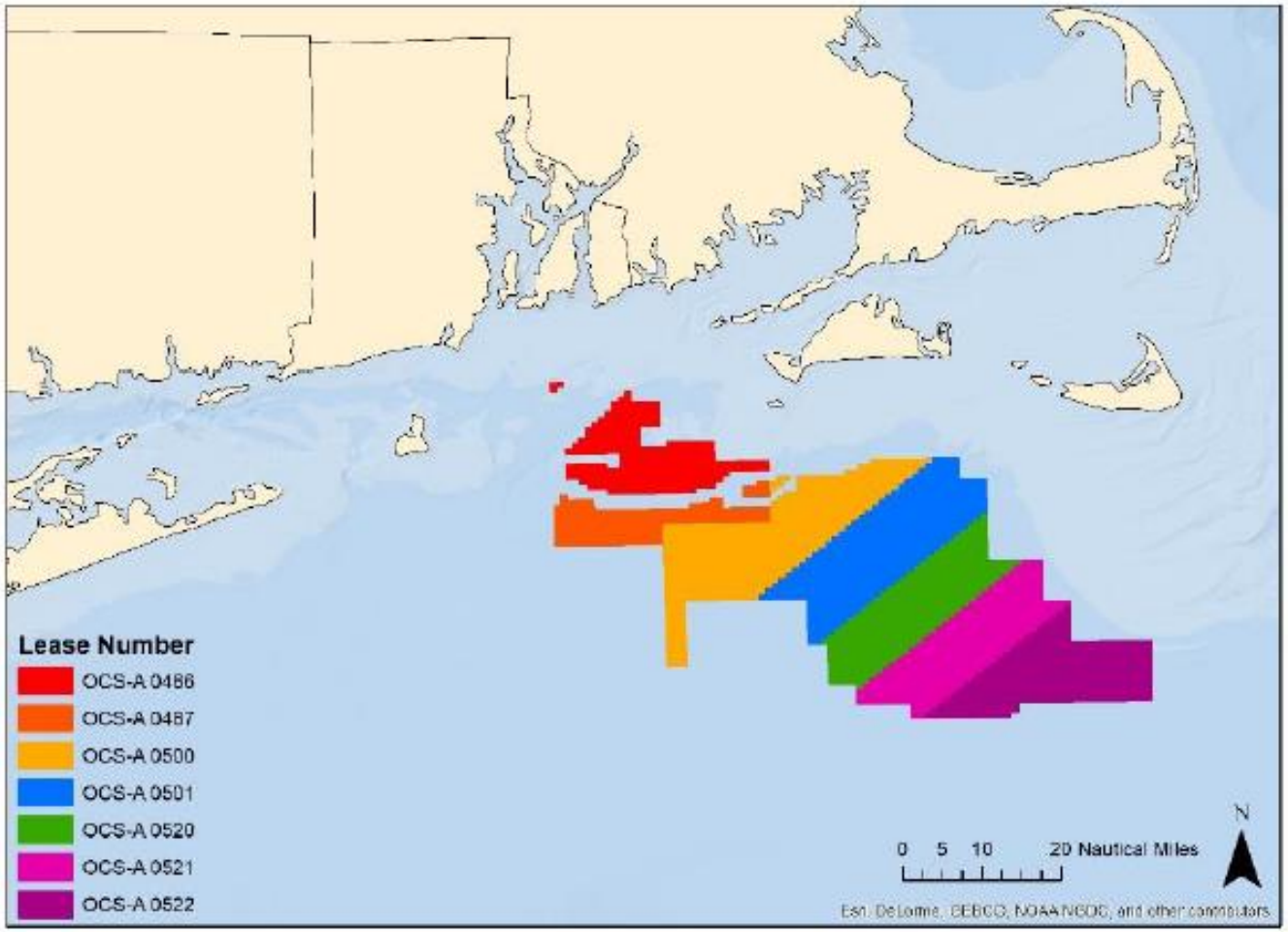
Muench et al. (2017) - On the precision of predicting fishing location using data from the Vessel Monitoring System (VMS)

- Using speed to separate fishing from non-fishing activity is not accurate for most gear types

This is the problem we're focused on addressing!



Scope of Study



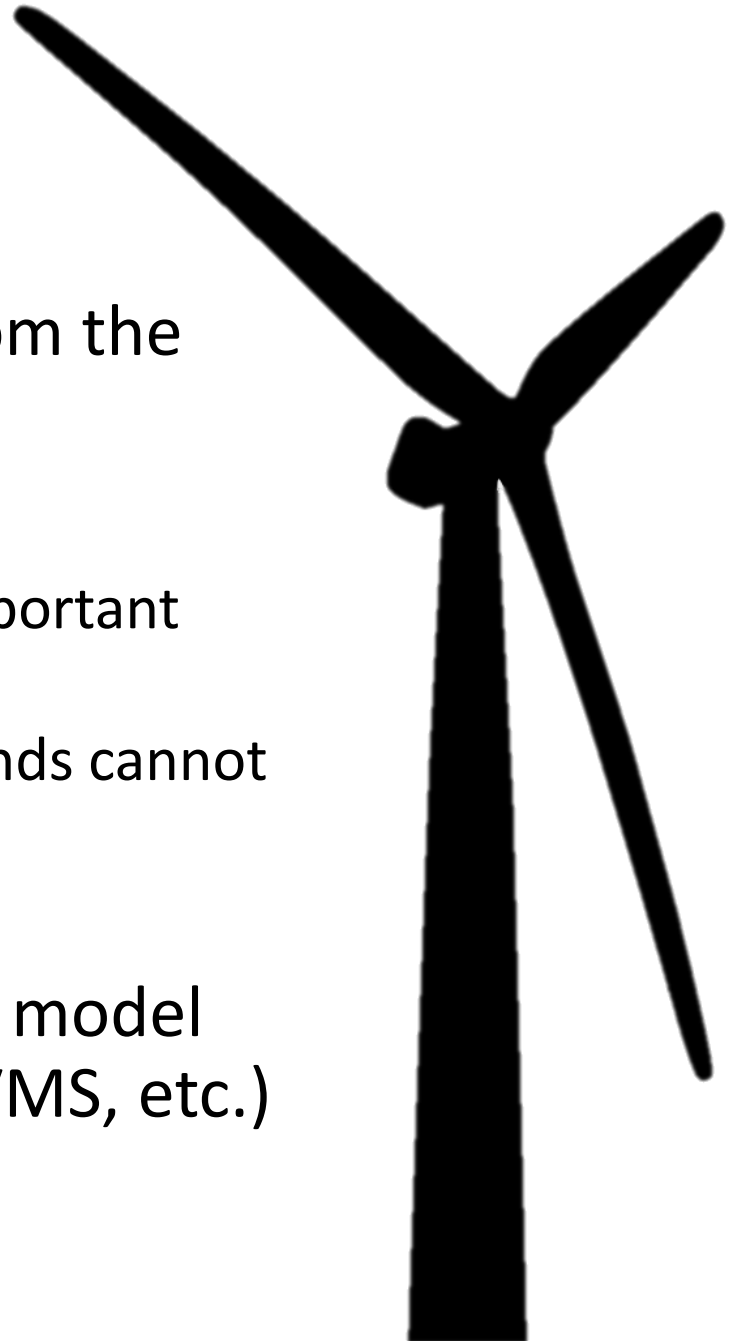
- 2013-2018 data
- Spatial extent defined at left
- Fishery Management Plans:
  - Atlantic Sea Scallop
  - Northeast Multispecies (groundfish): American plaice, Atlantic cod, Atlantic halibut, Atlantic pollock, haddock, redfish, white hake, winter flounder, witch flounder, yellowtail flounder, and ocean pout (currently prohibited)
  - Monkfish
  - Small-mesh Multispecies: offshore hake, red hake, silver hake
  - Surfclam and Ocean Quahog
  - Atlantic Mackerel, Squid, Butterfish

Methods

- Merge AIS, VMS, VTRs, dealer reports, United States Coast Guard registry records, and the NOAA Observer data
- Develop a machine learning approach to modeling the probability of fishing based on vessel activity at the FMP level
- Enhance “feature engineering” by obtaining information on key vessel behavior patterns (expert labeling) directly from the fishing industry and commercial fishing research organizations (CFCRI, Mass Fishermen’s Partnership, RI CFRF, and RODA)
- The model will then be trained using merged NOAA Observer Program data where fishing status of vessels is known, and fishing activity maps will be generated by extrapolating the fitted model to the full non- observer data set.

Project Deliverables Continued

- Maps by fishery indicating value of fish landed from the Study Area and in each offshore wind area
- Data can be used:
  - in the wind development process to avoid areas of important fishing grounds/and fish habitat (micrositing)
  - in mitigation discussions when important fishing grounds cannot be avoided
  - in measuring fishing displacement in the future
- We can also test the level of improvement on our model versus other previous data models (VTR, RIDEM VMS, etc.)



Progress

- AIS, VMS, VTRs, landings, observer data, and GARFO permit files all acquired
  - Have identified an issue with regular changes to landings database which can create challenges with replicability
  - Requested DMIS data from GARFO
  - Also have study fleet data which we may be able to use as another dataset to either train the machine learning model – or test output accuracy
- Developing visualizations of AIS vessel patterns for sharing with the fishing industry to train our machine learning feature engineering
  - Rethinking how to engage with fishing industry given COVID 19 constraints

Photo: https://www.ecori.org/aquaculture/2018/5/17/rhode-islands-commercial-fishing-industry-charts-future-path

Questions?

Thanks to the Regional Offshore Wind Science Pilot for funding this work!

References:
Muench A, DePiper GS, Demarest C (2017) On the precision of predicting fishing location using data from the vessel monitoring system (VMS). Can J Fish Aquat Sci 75:1036–1047. doi: 10.1139/cjfas-2016-0446