MA DMF recommended fisheries studies for offshore wind development –Draft for public review

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Kathryn Ford, Cate O'Keefe, and Michael Pol with contributions from Michael Armstrong, Erin Burke, Todd Callaghan, Greg DeCelles, Robert Glenn, Melanie Griffin, John Logan, Daniel McKiernan, Gary Nelson, David Pierce, Tracy Pugh, Tom Shields, Greg Skomal, Anna Webb, and Kelly Whitmore

Background

The Massachusetts Division of Marine Fisheries (MA DMF) has been participating in science panels and forums related to fisheries science related to offshore wind since September 2017. There are currently five nearshore wind turbines off of Block Island, and we are anticipating the addition of hundreds of wind turbines in the next 5-10 years between the Hudson Canyon and Nantucket Shoals, as well as further south on the U.S. Atlantic continental shelf in waters ranging from about 50-100 feet deep. Development in the Gulf of Maine has been proposed as well, but is further behind in planning and implementation.

The Bureau of Ocean Energy Management (BOEM) requires wind farm developers to conduct fisheries studies, but the guidance does not specify what studies or methods should be done or used in a given area (https://www.boem.gov/Fishery-Survey-Guidelines/). In contrast, the geophysical and benthic infaunal studies guidelines specify variables to measure, they identify the types of instruments that should be used, and they identify the minimum scale of the work (e.g., how many samples over an area).

To assess impacts of the Block Island Wind Farm (BIWF), Deepwater Wind designed baseline fisheries studies with feedback from the Rhode Island Fisheries Advisory Board (RI FAB), these studies are currently underway. Deepwater also partnered with BOEM to do the Real-time Opportunity for Development Environmental Observations (RODEO) program which had a benthic impact component. Deepwater also did additional work to inform planning for the South Fork and Revolution Wind projects, which are wind developments in federal waters in the RI-MA Wind Energy Area. The fisheries work that was done by Deepwater across the BIWF, South Fork, and Revolution Wind projects has the following components:

1. Trawl survey
2. Ventless lobster trap survey
3. Cod spawning survey (gillnet and hook and line)

4. Surveys of sound in the water

In meetings of various groups including the Rhode Island Fisheries Advisory Board (RI FAB), the Massachusetts Offshore Wind Fisheries Working Group (MA FWG), and the National Academies Atlantic Offshore Renewable Energy Development and Fisheries Steering Committee, a consistent concern has been how to address regional-scale or cumulative impacts. For example, a single wind farm may not be enough to alter current flow to affect sea scallop settlement at the population-level, but wind farms across the shelf may.

This memorandum identifies the studies recommended by MA DMF to address wind farm specific and regional scale fisheries information needs.

Methodology

To address the challenge of defining wind-farm specific studies that can then be integrated into regional-scale questions, or defining stand-alone regional scale studies, our first step was to define the specific management concerns that studies should address. This we did in a document titled "Management Objectives and Research Priorities for Fisheries in the Massachusetts and Rhode Island-Massachusetts Offshore Wind Energy Area" (MA DMF 2018). The document was drafted and edited by several MA DMF staff and had feedback from Rhode Island Department of Environmental Management (RIDEM), NOAA-NMFS, and was disseminated for public comment to the RI FAB, MA FWG, and NYSERDA Fisheries Technical Working Group (NY F-TWG). The document built a framework by identifying why we would want to study something and it organized the recommended questions and study topics that have emerged over the past several years of wind energy area planning. The document also established and clarified management objectives such as "Maximize compatibility of the offshore wind industry with the recreational and commercial fishing industries." This document was similar to a BOEM-funded study which accumulated study ideas via surveys of fishermen and other stakeholders and identified species of concern that were mentioned by all stakeholders (Petruny-Parker et al. 2015). The key differences were that in MA DMF (2018), studies were grouped by how they addressed the specific management concerns, and a process was developed to be more discriminatory with respect to what the species of concern are.

After completing the framework document, MA DMF held an internal meeting to further discuss staff's primary management and research concerns and consider how to define studies that can be accomplished at multiple scales. In preparation for the meeting, staff was asked to consider the following questions:

1. What are the potential changes you are worried about as a manager – are there species that you think will be affected (adversely or beneficially) that might change management needs?
2. Are there areas where very important fishing, natural resource events, or oceanographic events are occurring that could be disrupted by construction or operation of wind farms?
3. Can fishermen (including rec) fish if the turbines are a mile apart? How would that be assessed?
4. If you had to do a before-after study here, what species or other variables would you prioritize?
5. How concerned are you about cables, especially long term?

6. What are we missing, what should we prioritize?
7. What are the key species and/or ecosystem questions and why are they key? (Consider vulnerability and management interest, ecosystem role; focus on state interests.)
8. What are the key fishing industry concerns we have at DMF?
9. Consider statistics and reporting too.

During the meeting, a discussion was launched by asking the question, "If you had $400,000, what would you study?" Other guiding questions over the timeframe of developing our research priorities were, "If we do nothing else, what should we do?" and "If we do nothing, what will we most kick ourselves for not doing?"

After the meeting, minutes were disseminated to the group and then used to assemble a full list of potential studies. This list was augmented with studies recommended in the regional research framework document and in public comments to the Notice of Intent to Prepare an EIS from MA DMF, NMFS GARFO, and RIDEM for South Fork and from MA DMF and NMFS GARFO for Vineyard Wind. The full list was then split into items that are best management practice recommendations (e.g., distributing compensatory mitigation fairly or measuring cable burial routinely) and items that are study recommendations (e.g., developing a hydrodynamic model or conducting a trawl survey).

Each study recommendation was then assigned a methodology, and then the studies were consolidated based on the methodology. In other words, we started with the "why" of a study, then determined the "how," and ultimately established the "what" – the actual study that could be released for a request for proposal (RFP). In developing the list, the scalability of the study was considered. We considered it likely that studies would be done at individual wind farms/lease areas and then "ganged together" for a regional perspective. In the regional research framework document, it was recommended that studies "define the spatial and temporal scales for the metric or question being asked and use appropriate study designs." This document is viewed as a next step in defining RFPs for specific studies that can be applied to research questions that are relevant at either the wind farm specific or the regional scale. We anticipate that more detail about scale and study design will be part of the RFP process. However, some guidance/commentary is provided for each proposed study.

A draft list was generated that covered a broader range of studies, and then this list was reviewed by MA DMF staff and informed by meetings and fisheries survey plan reviews conducted in the late fall of 2018. The following factors were considered in preparing a final list of high priority regional studies and high priority wind- farm specific studies: is there a clear question, a feasible method, and a clear use of the results; will the study potentially cause more impact through mortality or habitat impacts; does the study address major concerns we have. Our goal was to get the list of potential studies down to 2-3 studies that could be released for a Request for Proposal (RFP). Studies that were mentioned by many MA DMF staff covering multiple areas of interest (e.g. finfish, invertebrates, and habitat) or multiple major categories of interest (e.g. Fisheries Resources & Habitat, Fishing Industry, and Fisheries Management) were prioritized.

We were unable to select the top 2-3 studies primarily because further discussion with additional stakeholders, the developer, and the funding agencies is needed to elucidate what components of these studies are the responsibility of an individual developer (e.g., benthic monitoring) and what should be covered by other parties.

Results

The proposed studies are listed below in three groups: high, medium, and low priority. The prioritization approach was based on MA DMF staff's best professional judgment as informed by their individual expertise. Factors that weighed into the prioritization included:

- How consistently mentioned various themes or studies were by biologists or other stakeholders in working group meetings.
- Studies that address multiple functional groups ranked more highly.
- The appropriateness of the study for Mass CEC funding was an important consideration.

Some of the studies below are relatively straightforward additions to existing research programs, and some are unique and costly new research efforts. We ultimately would like all of the studies to be funded in one way or another.

High Priority

Define and map the seafloor habitats in the region via multiple methods

Assess impact of wind farms on benthic biomass, species composition, and spatial distribution of benthic organisms. Use multibeam, grab and high resolution seafloor photos. Map regional geoforms, bathymetry, and sediment texture; identify features that are unique and/or vulnerable and/or sensitive. Needs to use a common classification system (CMECS).

The research efforts should collect data that can be used to answer the following specific questions:

a. What is the location and relative abundance of squid mops and scallops? [Use the data to inform location and timing of construction activities and detect changes over time.]

b. What is the location of structure-forming infauna and epifauna? [Use the data to inform location and timing of construction activities and detect changes over time.]

c. What is the location of special, sensitive, or unique benthic features and how persistent are those features? [Use the data to inform location and timing of construction activities and detect changes over time.]

d. Does benthic biomass and species composition change after a wind farm is built? Do some wind farms have less of an effect than others? Changes to prey species, ecosystem-level changes. [Use the data to assess wind farm adverse and beneficial impacts, determine if certain structures or construction timing or other variables are associated with changes in order to mitigate for impacts.]

e. What is the distance of detectable benthic habitat changes away from a turbine and cables? Does this change based on foundation type, cable burial depth, etc?

f. Do some wind farms have more invasives than others?

g. Compare colonization at different structures, different scour protections, different seasons to further our knowledge of impacts of aggregation/artificial reef effect; How does timing of construction relate to colonization and long-term species composition and biomass?

h. Is one scour protection design better than another? Determine scour patterns. Compare biomass and species composition on different scour protection designs.

i. Do the cables stay buried? (Cable burial monitoring is also mentioned below.)

Other comments: Inclusion of grabs for grain size and benthic infauna drives up cost significantly and the value of these metrics should be discussed further. These should be done in every wind energy area and in inter wind-farm areas studies for context and controls. However, the priority is within a wind energy area, and a lot of questions can be addressed by examining the gradient of change from an individual turbine. The photo surveys should be done seasonally for a period of time (5 years) and then can be done less often. Frequency of multibeam surveys needs further discussion. This data is also relevant to ecosystem models; more discussion is needed to ensure it can be built into the models. Much of this data collection is expected to be collected directly by wind companies but there is concern that the data will not be collected at the correct time steps, at a high enough resolution, or with the appropriate methods.

Measure Atlantic cod spawning timing and spatial distribution via tagging and hook and line

a. Determine the spawning season for cod to inform construction timing

b. Determine spatial distribution of cod; assess if they expand into the turbine array from Cox Ledge.

c. Measure fish condition (length, stomach content, isotopic ratios) to determine food web changes.

Other comments: will also need to measure Cox Ledge cod, try and determine if they're moving or expanding. This is a regional study but subcomponents can be done at individual wind farms (e.g., South Fork/Revolution, Bay State, and Vineyard Wind) if timing of wind farm studies and development coincides.

Assess changes to current flow and larval transport via a calibrated oceanographic model

a. Develop a calibrated oceanographic model to explore local and regional effects of the turbine structures. Model should resolve particle distribution for zooplankton and phytoplankton and assess potential for impact on larval patterns and settlement of scallops and longfin squid or food patch dynamics for marine mammals. Scallop, longfin squid, clam, and flounder pelagic eggs and larvae could be affected by current changes; lobster and scallop settlement might be enhanced. What is relationship to Gulf Stream rings -- do they break up differently once wind farms are in?

b. Groundtruth the model – ADCP, water quality measurements, and plankton tows.

c. Use improved oceanographic model to update sediment transport models and predict construction turbidity, cable exposure potential, and scour.

d. Use improved oceanographic model and benthic information from #1 to model scallop habitat suitability.

Other comments: Hydrodynamic studies are currently required of wind farm companies, but we have concerns regarding the adequacy of sampling and quality of data to answer the specific questions identified above. A review of the existing guidelines is also a worthwhile project. Scale should resolve oceanographic impact of individual turbines. Apply from North Carolina to Georges Bank. Ideally develop as a management tool where turbines can be added and moved to explore different outcomes.

Measure fish spatial distribution via satellite, acoustic, and conventional tagging

a. Tag cod, monkfish, black sea bass, bluefin tuna, blue shark, mako shark and track where they go. Do black sea bass stay offshore, or do they continue to migrate inshore? Do pelagics spend more time in wind farms?

b. Deploy a listening array to opportunistically study fish already tagged and newly tagged fish. Use data to characterize what species use the area.

c. Measure avoidance behavior during construction. Use data to inform potential impact and time of year recommendations.

d. Measure time spent over energized cables, specifically for flounders and skates.

Other comments: RFP needs to include survey design goals with respect to scale and how close the receivers should be. How will wind farm construction affect receivers and final receiver locations (are receivers on turbines or between them?). The individual studies a and c may require separate designs. Consider overlap with proposed cod study. Tagging inverts is not out of the question but is limited by the molt.

Medium Priority

Measure fish and invertebrate spatial distribution, abundance, and condition via pots

a. Study relative abundance and spatial distribution of black sea bass, lobster, and Jonah crab to examine aggregation/artificial reef effects and scour impacts.

b. Measure fish condition (length, stomach content, isotopic ratios) to determine food web changes.

c. Determine if black sea bass congregate in wind farm areas and if this coincides with abundance declines inshore.

d. Compare biomass and species composition on different scour protection designs. Is one design better than another?

Other comments: use a random stratified ventless trap, fall only due to whale impact concerns. Use gradient studies from select turbines. Stratify by depth and wind farm presence. Scale should be fine enough to define species composition of an individual wind farm. Look at state surveys for comparison. Inter wind-farm areas may need to be sampled by a regional consortium. Still some though needed with respect to fixed, random, and transect/gradient designs.

Measure spatial distribution and abundance of longfin squid via multiple methods

a. Determine spatial distribution of squid mops.

b. Model potential larval squid spatial distribution.

c. Improve squid habitat suitability model.

d. Monitor changes in the distribution and CPUE of the fishery.

Other comments: Squid is a major resource in the Southern New England area and has several clear, potential vulnerabilities to offshore wind. Squid mops are demersal and adhesive, adult, juvenile, and larval squid are impacted by oceanographic changes, and there is concern about how sound and light affect squid. A study combining a squid mop distribution analysis with habitat suitability modeling and assessments of the squid fishery might yield insight on how wind farms affect this resource.

The relative abundance and spatial distribution of squid is notoriously difficult to measure due to the interannual variability of this species. A squid focused study using a squid trawl may be appropriate, but may also result in needing more sampling intensity than is practicable. There have been strides in improving the habitat suitability modeling for squid and it may be a reasonable approach to improve the habitat modeling as a mitigative approach for expected impacts that will be hard to measure.

We focused on longfin squid, and not mackerel/butterfish/whiting. All have high interannual variability. Also, Atlantic herring has demersal eggs. Should look at NMFS or NEAMAP survey data to see spatial distribution of these species in recent years. Possibly a needed study for wind farm development further south.

Measure spatial distribution and abundance of monkfish via gillnet or fisheries dependent sampling

a. Study relative abundance and spatial distribution of monkfish to examine aggregation/artificial reef effects and scour impacts.

b. Measure fish condition (length, stomach content, isotopic ratios) to determine food web changes.

c. Compare biomass and species composition on different scour protection designs. Is one design better than another?

Other notes: monkfish might be an excellent indicator of how much the wind farms act as barriers to fish movement because of their current distribution and seasonal movements. Monkfish tagging isn't successful so a gillnet study is more feasible. A driving question is what are the best indicator species and how will the information be used to make future wind farm siting/operation decisions and/or fisheries management decisions.

It might be easier to track fishing effort and location as an indicator of changes in fish distribution. This could work, but would need to make sure that fishermen aren't changing locations for other reasons beyond fish distribution (don't want to/cannot fish in turbine array).

Assess changes to prey species

Use benthic biomass, ecological modeling, and studies that include a focus on stomach contents to address prey species.

Study recreational boating effort and methods via aerial surveys (new or existing aerial surveys)

a. Recreational and charter boat fishing spatial distribution of effort will change. Effort will move west.

b. Recreational and charter boat fishing methods will change. They won't fish as they do now (drifting, trolling, 150 boats in one spot) in the turbine areas.

c. These surveys are also being used for marine mammal, turtle, and bird work; impact of turbine presence on survey design and flight height is needed.

Other comments: survey scale is at least NY to Nantucket and should include inter-wind farm areas such as southwestern Rhode Island Sound. Linkages with intercept and/or other interview studies of recreational fishermen should be made.

Measure spatial distribution, abundance, and condition of shellfish via hydraulic clam dredge

a. Study relative abundance, spatial distribution, and size of surf clams and ocean quahogs. Identify persistent hot spots. Use data to inform siting, mitigation.

b. Measure fish condition (length, stomach content, isotopic ratios) to determine food web changes.

Low Priority

The studies below are also very important. However, we characterize them as having a lower priority *for Mass CEC funding* than the studies included above. Some of these studies can wait until construction has begun or should be exclusively funded by other funding sources.

Conservation engineering & fisheries development

Each of the major regions that have unique fishing practices should be assessed individually (VA-NJ, NY, RI-MA, and MA), assessments should be wind-farm specific unless multiple wind farms are using exact same equipment (turbine spacing, foundation type, size).

a. Examine effective fishing techniques in wind farms in Europe.

b. Examine question of fishability, including impact of turbine spacing and orientation on safety and gear interactions between fixed and mobile gear fisheries. (In 30 years will we reorient them?)

c. Consider how to more effectively fish in wind farms in the U.S.

Reason for lower priority: These are very high priority. Our understanding is that the CEC funding will be targeted toward resource studies rather than studies that will improve compatibility between fisheries and wind. These studies should be a critical component of permitting wind farms and assessing impact to the fishing industries.

Measure fish and invertebrate spatial distribution, abundance, and condition via otter trawl

Annually conduct a seasonal (winter-spring-summer-fall) random stratified survey using a trawl with standard definition such as the NEAMAP trawl. Stratify by depth and wind farm presence. Scale should be fine enough to define species composition of an individual wind farm. Look at state surveys for comparison. Inter wind-farm areas may need to be sampled by a regional consortium. Needs a power analysis to assess change detection thresholds and refine the study design. Consideration needs to be given to incorporating areas that are too rough for trawling.

a. Measure species composition, pelagic-demersal ratio, biomass, and relative abundance of target species to determine do they change compared to baseline, do some wind farms have less of an effect than others.

b. Analyze fish length, stomach contents, isotopes of target species (winter and summer flounder, winter and little skates, scup) to determine does fish condition change compared to baseline, do some wind farms have less of an affect than others.

c. Determine spawning areas of cod, winter flounder, ocean pout, red hake, and squid. If these species are persistent in specific areas at specific times, they might require time of year or sequencing avoidance.

d. Determine if black sea bass congregate in wind farm areas and if this coincides with abundance declines inshore.

Reason for lower priority: Trawl surveys require a relatively large number of samples to address short-term change, which could put these surveys at risk of exceeding allowable catch limits in FMPs. Trawls may not be able to operate within wind farms or catchability of species could change as a result of the wind farm and associated habitat being introduced. Strata that are set up prior to construction will need to be adjusted post construction, limiting the power of the sampling design. In sum, the use of trawl surveys needs a collaborative design approach.

A better approach: At a wind-farm specific scale (thus, funded by the developer) specify questions to ask, for example, are skates and flounder found in greater or lesser abundance over energized cables. A similar approach to the question is to use tagging to observe movements over energized cables. We also wonder if fixed ROV/AUV transect surveys is an alternative.

Measure water quality and eDNA via water sampling

a. Examine dissolved oxygen concentrations in a gradient from turbines. Does biomass at turbine result in decreased oxygen at the seafloor?

b. Create an eDNA baseline and compare species composition over space and time.

Other comments: Study (a) should be done by wind developers. Study (b) should be done in every wind energy area and in inter wind-farm areas studies would be useful for context and controls.

Reason for lower priority: eDNA methods might not be sufficiently advanced to design meaningful before-after-control-impact studies, but water samples should be collected and preserved properly at the very least.

Routine mapping of vulnerable resources in Nantucket Sound.

It is possible that lease holders to the east of Vineyard Wind will consider laying cables across Nantucket Sound. The information available in Nantucket Sound with respect to the location and timing of vulnerable resources including squid and squid mops, winter flounder and their eggs, and conch, is insufficient to assess optimal locations and timing for cable laying. We recommend that a mapping program be initiated to more holistically assess the various benthic habitats and vulnerable resources in Nantucket Sound.

Reason for lower priority: This work can be initiated over the next two years.

Cable burial monitoring

The electromagnetic field strength will be limited by burial. In permitting documents, proponents are relying on that physical reality to argue that EMF impacts will be minimal. It is a high priority for companies to monitor cable burial on a routine basis (at least annually and after storm events including hurricanes and nor'easters). This is a high priority to limit adverse effects to benthic and pelagic organisms.

Reason for lower priority: We do not recommend this be funded by a regional monitoring cooperative. Instead, it should be funded by individual wind energy developers.

Add observer coverage/new protocols to commercial fisheries to address specific wind farm-related questions.

a. Compare fishing practices pre and post wind farm construction

b. Compare interactions with non-target species pre and post wind farm construction

c. Compare catch composition in commercial and recreational catch before and after wind farm construction. Would require observers, landings data at a higher spatial resolution. Need to consider if baseline data is sufficient. Consider use of electronic monitoring.

Reason for lower priority: Haven't assessed if existing coverage can answer the same questions. It may be that needed information can be collected under the current observer coverage, but with new protocols.

Desktop studies, multiple topics

a. Assess impacts to the federal trawl survey—can it operate in wind farms, if not which stations will be affected, how does this affect the precision of the survey? *NOAA needs to do this or wind developers hire a consultant.*

b. Walk through wind farm construction and consider impacts to affected fishermen. What areas will be closed for what length of time? Turbines, cables. *This is part of the permitting process/COP development. Developers should do this.*

c. Are there specific changes to FMPs that will mitigate wind farm construction and operation impacts? What changes to fisheries management could enhance fishability in wind farms? (License conditions, flexibility in gear types, multi-species fishing, changes to days at sea rules?) Assess potential for changes to rotational management criteria. *CEC isn't the right funding mechanism for these questions; these are less of concern right now than resource surveys.*

d. Develop a stoplight approach to integrate various indicators; develop specific tipping points/thresholds to limit expansion of wind development. What is carrying capacity for offshore wind? What actions should be taken in the face of adverse impact? *CEC isn't the right funding mechanism for these questions; these are less of concern right now than resource surveys*

e. Develop compensatory mitigation framework including reporting mechanism to the Councils. Include a review of mitigation frameworks for telecommunication cables and offshore oil & gas development. Determine whether or not fishermen submitting under a compensation framework need to have VMS. *This is part of the permitting process/COP development. Developers should do this.*

f. VMS data studies: use scales as defined in the northeast ocean data portal or other baseline studies.

   i. Does squid, scallop, groundfish, small mesh, or surf clam fleet have different spatial footprint before/after wind farms? Assess fishery displacement. Determine linkages to compensatory mitigation framework, fisheries management.

   ii. Do fishermen travel further to fish?

   iii. Monkfish fishery might be a good focus here – it's directed, has VMS, strong baseline.

   Because these data are being collected already and changes should be assessed during and after construction (not before), these studies can be done later.

g. Propose how to handle data management and ensure metadata standards are adhered to. Assess existing data management systems like ACCSP, SAFIS, Northeast Ocean Data Portal, BOEM Environmental Studies Program/federal portals, etc. Determine needs and how to ensure access to data. *BOEM and other regulatory agencies should include this in permit conditions. Where does funding come to develop the system and/or what existing system will be used?*

h. Deliberately track insurance issues for fishermen and wind farms. *This is a good regional study that should be funded in a year or two. Developers should include information regarding insurance in the COPs and in how they're assessing socioeconomic impacts to fishermen.*

i. Do landings change? Does economic value of fishing change from one port to another? See RIDEM and Kirkpatrick reports. Redo these annually/every few years. Determine linkages to compensatory mitigation framework, fisheries management. *This is part of the permitting process/COP development. Developers should do this.*

j. Track emergence of gear conflicts. *NOAA? Council? This is regional—does it require a database or hotline to be set up—is there money needed?*

k. Define and assess cultural identity of ports, track how it changes over time relative to the emergence of wind farms. Consider linkages to harbor development plans. *This is a good regional study that should be funded in a year or two.*

l. Develop simulators that can be used by fishermen and other maritime users to practice driving vessels through the wind farms. We're thinking along the lines of the simulators at Mass Maritime, not just 3D goggles or a PC simulation. *Our understanding is that the CEC funding will be targeted toward resource studies. This would be a good community benefit for a developer to support/initiate.*

m. Provide recommendations to improve BOEM guidance documents. *Not sure if this will require funding.*

n. Run EcoPath with EcoSim or Atlantis for annual snapshots of the Eastern Seaboard to explore changes over time. *These are ecosystem models that allow simulations for different management decisions such as amount of fishing pressure or placement of protected areas. These are valuable simulation tools that are regional and approximate. Hold meeting with EcoPath experts to determine what data collection can inform these models. Northeast Fisheries Science Center Ecosystems Dynamics & Assessment Branch could do this.*

o. Meta-analysis on all wind farms from NC to Georges Bank.

   i. Do certain wind farms have less of an impact than others? For which indicators? Why?

   ii. Compare various construction methods, mitigation techniques, and timing across wind farms. For example, do bubble curtains work? Do fish deterrence mechanisms work? Are time of year restrictions needed?

   This is a good regional study that should be funded in a few years. Consider how this data gets collected (BOEM?) so the meta-analysis can be done.

Reason for lower priority (summary): These are high priority, but needed later or not consistent with how we think the CEC money should be spent. Ideally we could be sure of which indicators we are using for a future meta-analysis, to be certain we are collecting the appropriate data now.

Laboratory studies, EMF and vibration

a. Look at electromagnetic field sensitivity for multiple life stages for winter, summer, and yellowtail flounder, longfin inshore squid, Jonah crab, lobster, little skate, winter skate, Atlantic cod, and smooth and spiny dogfish.

b. Conduct focused research to further our knowledge of impacts of vibration

Reason for lower priority: There are many studies demonstrating that benthic organisms and elasmobranchs can detect EMF. Many migratory animals are already exposed to magnetic and electromagnetic fields from existing cables and bridges. While additional work is certainly warranted and needed for cables of the size being used for the offshore wind export cables and in the configurations within wind farms, we think it is a higher priority to ensure that cables remain buried.

Best Management Practices

In the course of developing research recommendations, several best practices and consistent conservation recommendations emerged.

Communication	Communication with recreational and commercial fishermen is needed
Communication	Have cables visible in plotters at the helm (e.g., WinPlot)
Communication	Use existing communications pathways for realtime updates
Communication	Have a "one stop shop" for fishermen communication -- snags, construction issues -- each company supports a central system
Communication	Update charts
Communication	Track incidents that occur between wind farms and other user groups, as well as user groups within the wind farms (e.g. fixed and mobile gear fishing) to assess effectiveness of BMPs and propose new ones.
Compensatory mitigation	Consider if boats need VMS to submit/VMS in lobster?
Compensatory mitigation	Put cell towers on turbines
Compensatory mitigation	Distribute compensatory mitigation fairly
Environment	Use natural cover for cables
Environment	Use a mix of grain sizes for scour protection and cable protection
Environment	Cod spawning Nov-Apr
Environment	Winter flounder spawns and eggs are demersal in WEAs
General	All data should be public
General	Integrate lessons learned from studies and update BOEM guidelines.
Safety	Visual aids on turbines
Safety	AIS on turbines
Safety	Address radar concerns (radar repeaters?)
Safety, Environment	Monitor cable burial
Safety, Environment	Bury cables 1.2 meters is a priority

References

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