<u>FUNDING SUPPORT FOR RENEWABLE ENERGY PROJECTS</u>

RI Department of Environmental Management
Division of Fish and Wildlife – Marine Section

Introduction

The following document is a culmination of all local research currently taking place in or in close proximity to the Ocean Special Area Management Plan (OSAMP) zone. The document also contains research ideas for projects that are not currently occurring in or near the OSAMP area, but would be considered important and valuable research for this area were it to be used for any number of projects including offshore wind energy projects. The document has three main sections. Each section describes major research survey categories, then describes any current research of this survey type that is occurring in the area, gives a description of the current analyses being conducted using data derived from the survey, and then concludes with some general comments on the main research survey type.

The first main section outlines research that is or should be occurring in the OSAMP zone as a way to characterize baseline information. Baseline information is critical to characterize the current and past conditions in the OSAMP area and crucial if future work is to assess changes in condition over time. The second main section provides information on survey types that would be conducive to monitoring effects of specific projects (i.e. offshore renewable energy projects) that could be proposed in the OSAMP area. These types of surveys provide techniques for colleting information to assess impacts of projects before, during, and after work has been completed, and rely heavily on the surveys identified in the baseline data collection section for underlying information from which to develop comparisons. The third and final section is an amalgamation of all of the research priorities that exist from many of the different natural resource agencies that have a vested interest in the OSAMP area. This section is an attempt to summarize the various research priorities that exist across agencies so that they can be compared to any new research priorities that may be developed in the future.

The three main sections provide a progression through existing research in the OSAMP area, research that would be needed for special use of this area, and concludes with a broad perspective on various agencies research priorities. This consolidation of marine fisheries information will be helpful as a comprehensive view of the OSAMP is developed and as special projects are proposed for this area.

1. Research focused on baseline data collection

LOBSTER TRAP SURVEYS

Introduction

Rhode Island Sound and Block Island Sound support a variety of commercial and recreational fishing activities producing over $40 million in seafood landings per year (Hasbrouk et al. 2011). In Rhode Island, American lobster is often the most valuable commercially harvested species, generating $13 million in revenue from 2.8 million tons of landings by 250 vessels (Hasbrouck et al., 2011).

The lobster resource and fishery in Lobster Conservation Management Area 2 (LCMA 2), which includes all Rhode Island state waters (0-3 miles), have experienced significant declines since the late 1990's. These declines were reflected in Rhode Island Division of Fish and Wildlife (RIDFW) trawl survey indices, RIDFW commercial lobster trap sea sampling catch per unit effort (CPUE) indices, RIDFW lobster settlement (young-of-the-year (YOY)) indices, and RI commercial lobster landings. The two most recent American lobster stock assessments concluded that the Southern New England lobster stock, which includes LCMA 2, is in poor condition based on the established biological reference points (ASMFC 2006, 2009).

Relative abundance indices generated from fishery-independent otter trawl survey gear have typically been used for lobster stock assessment purposes because of the random sampling design and non-selective nature of otter trawl gear. However, biases are introduced with the use of otter trawls due to their inability to access all types of bottom substrate (rocky and ledge areas) as well as being prevented from sampling areas where stationary gear types (traps and gillnets) are deployed. These two issues introduce bias because a large portion of the most productive lobster habitat is not accessible to the otter trawl survey gear.

Mandated management changes in lobster trap gear selectivity (increased escape vent size) have affected the ability of RIDFW's commercial lobster trap sea sampling program to adequately monitor the sublegal lobster population within the inshore portion of LCMA 2. Furthermore, fisheries-dependent commercial lobster trap sea sampling data historically have not been used to generate relative abundance indices for American lobster due to biases associated with the way these data are collected. The non-random, targeted manner in which lobster traps are commercially fished introduces a source of bias to lobster trap CPUE estimates.

Due to the limitations described above, the distribution and dynamics of the American lobster (Homarus americanus), one of the most valuable species in New England, is poorly understood (ASMFC 2009). With offshore development rapidly approaching, it is essential to evaluate the status of the lobster population in Rhode Island Block Island Sounds, in order to be able to assess the potential impacts of wind turbine construction.

RI DEM VENTLESS LOBSTER POT SURVEY

In July 2006, a northeast coast-wide cooperative random-stratified ventless trap survey was initiated by the Atlantic States Marine Fisheries Commission (ASMFC) to address the need to develop a robust coast-wide time-series of relative lobster abundance. The survey was designed to generate accurate estimates of lobster relative abundance and recruitment, while attempting to minimize or eliminate the biases identified in conventional surveys. In order to sample the American lobster population from Maine through New York, the overall sampling effort was divided into two regions: the Gulf of Maine and Southern New England. These regions were further subdivided based on National Marine Fisheries Service (NMFS) statistical areas. The Rhode Island portion of the coast-wide ventless trap survey was conducted within Rhode Island state waters (0-3 miles) located in NMFS Statistical Area 539 in LCMA 2.

The Rhode Island specific objectives of this study were to:

- Develop more precise estimates of relative abundance of legal-sized and sublegal-sized lobsters in the Rhode Island portion of LCMA 2.
- Document the relative importance of depth as it pertains to American lobster abundance and distribution.
- To monitor the status of the chronic shell disease epidemic in LCMA 2.
- To foster and maintain a strong relationship between the commercial lobster industry and fisheries scientists and managers in the interest of strengthening communication between science and industry.
- To foster confidence in the lobster stock assessment process.
- Develop a pilot project for a coast-wide fishery-dependent monitoring program for American lobster.

RI state waters were divided into grid cells based on 1 minute of latitude and longitude and categorized as falling within the 1-20 meter or 21-40 meter depth strata. Grid cells that could not be classified as containing at least 75% of one of these depth strata were removed from the sampling station random selection process. Grid cells that were identified to be located in areas of potential gear conflicts were also removed from the random selection process. For each year of the survey, a total of 24 survey sampling stations were randomly selected, with 12 sampling stations selected in each of the depth strata.

Each sampling station was sampled by one six-trap trawl, in which vented and unvented traps are alternated (3 of each trap type per trawl). In total, 144 survey lobster traps were deployed each year, consisting of 72 vented and 72 unvented survey lobster traps. All traps were sampled twice per month, with a 3 night soak time to standardize trap catchability and reduce the effects of trap saturation on total catch. The trap is a single parlor trap 16 inches high, 40 inches long and 21 inches wide with 5 inch entrance hoops and is constructed with 1 inch square rubber coated 12 gauge wire

Survey lobster traps were separated by 60 feet of ground line between traps and baited with locally available bait (typically skate). RIDFW survey personnel accompanied the contracted fishermen during each sampling event and used the standard RIDFW lobster trap sampling protocol, which records the following: sex, size (carapace length to the nearest millimeter (mm)), shell hardness (molt status), cement gland development and ovary maturity (sexual maturity), presence and developmental stage of extruded ova (ovigerous females), cull status, other shell/body damage, V-notch status (females only), mortality, incidence and severity of shell disease. Additional environmental parameters were recorded including depth, bottom/substrate type, surface water temperature and survey station locations (LORAN / GPS). Data regarding by-catch (finfish and other invertebrates) was also collected. The original sampling protocol called for survey sampling during the months of June-August, however, due to administrative delays encountered in some years, the survey sampling occurred during July-September in years 2006, 2009, 2010, and 2011.

Analytical Procedures:

General catch characteristics are generated for each stratum, including sex ratio, percent egg-bearing females, percent v-notched females, and percent of the catch with shell disease. Length frequency distributions are generated by sex, trap type (vented vs. ventless), and depth strata. Statistical comparisons of length frequency distributions were made using the Kolmogorov-Smirnof test with a Bonferroni adjustment to account for type II error biases associated with multiple comparisons.

Relative abundance was analyzed by pooling catch data from each trap within the six-trap trawl at each survey sampling station. CPUE data were calculated as mean catch per trawl-haul and mean catch per trap-haul. CPUE data presented as catch per trawl-haul was done to avoid biases associated with the lack of independence of traps within a trawl and to include the range of selectivity from both trap types (vented and ventless) into an independent sampling unit.

DEEPWATER WIND VENTLESS LOBSTER POT SURVEY

Deepwater Wind has committed to assess the impact of the proposed Block Island Wind Farm (BIWF) on lobster resources by conducting a lobster survey near the projects prior to and following construction.

The intent of this survey was to meet the following objectives:

- Determine the seasonal and spatial patterns of lobster abundance within the BIWF and the Block Island Transmission System Project Area;
- Provide site-specific information regarding lobster resources prior to construction; and
- Provide a baseline for monitoring effects after construction as part of a Before-After study design.
- Characterize changes in local lobster abundance, following a BACI study design for direct physical disturbance effects and a BA study design for indirect noise effects

The study will take place at two distance intervals (i.e., 0.2km and 2km near field) from the BIWF wind turbine array construction impact area and at two far field Reference Areas. The construction impact area is defined as the turbine foundations surrounded by the radial length of anchor chains and anchors used to stabilize the installation equipment (ca. 5000 ft radius). The study will occur 2 years before, one year after, and during the construction period for a total of four years. Sampling will take place twice per month from May through October for two (2) years prior to the start of construction and for one (1) year post construction. During the year of construction (2015), sampling will take place twice per month from May through October to track with the period of actual construction activities. The post construction monitoring period will begin during the first May following the end of construction.

Data will be collected at two sites within a far field Reference (or "control") area with similar habitat as the BIWF, to serve as a general index of lobster abundance in Block Island Sound in an area well outside of the direct influence of the Project. This sampling design will be used for the assessment of potential direct impacts due to the physical disturbance of seafloor habitats from installation and operation of the BIWF. Sampling in far field reference areas outside of the direct physical disturbance influence of the project will help identify potential regional trends in lobster abundance not associated with construction.

The survey protocol was modeled on the methods used by the ASMFC and RI DEM to conduct their coastwide ventless trap surveys with some exceptions. The sample design consists of sampling each of the four treatment blocks (2 nearfield, 2 farfield) with three trawl lines each. Each trawl line is composed of two trawl arrays of six trap. Each 6 trap trawl array will be composed of 5 ventless traps and one vented trap, with traps spaced 100' apart. The two arrays are then separated by 400' of groundline. The survey is also utilizing a 5 night soak time instead of the 3 night ASMFC standard.

Analytical Procedures:

Monthly data from the lobster surveys will be used to estimate catch per standard soak period per trap (CPUE) by month within each trawl. The traps, separated by 100' distance, are expected to be independent measures of local lobster abundance. Frequency diagrams will be constructed to compare the distributions before and after construction and among areas for any of the parameters measured (e.g., carapace length, sex ratio, incidence of shell disease).
A generalized linear model will be used to evaluate the data, using the most appropriate link function and error term (e.g., Poisson or zero-inflated Poisson for the catch data, or possibly a quasi-likelihood estimator if the catch data are highly skewed).

Utilizing the BACI design, there are two fixed factors: Year and Location, with three levels within the Year factor (two before and one after construction) and four levels within the Location factor (at 0.2km, 2km, and two farfield or reference locations). The basic BACI hypothesis is a test of the interaction effect, H_0: The year-to-year pattern in location means is identical for all locations.

BOEM/AMI VENTLESS LOBSTER POT SURVEY

The study area comprises the RI/MA Area of Mutual Interest and the northwest portion of the Massachusetts Wind Energy Area within Lobster Management Area 2. This project was designed to fill a data gap that exists between state ventless trap surveys, conducted within three miles of the coast, and federal trawl surveys conducted in deep waters offshore (>30 miles). Currently, the primary lobster fishing grounds are located 10-200 miles offshore therefore this survey will cover some of the most important fishing grounds.

The intent of this survey was to meet the following objectives:

- Establish a ventless trap survey protocol to assess the potential impacts of wind energy development in the RI/MA Area of Mutual Interest (AMI) and the northwestern portion of Massachusetts Wind Energy Area (WEA).
- Determine the seasonal and spatial patterns of lobster abundance within these development areas.
- Conduct two years of pre-development monitoring that will allow Before-After and Control-Impact (BACI) comparisons to be made.

Because no specific site has been identified for development, the sampling strategy will be to initiate random stratified sampling throughout the AMI. After a specific site is determined, the sampling design can be modified to increase the density of stations within the installation area and maintain some stations outside the installation area as control stations. The current sample design includes one station per lease block, which would equate to one station per 9 nm^2, but three of the lease blocks will not be able to be surveyed due to shipping or mobile gear fishing activity. Within each selected lease block, one of 16 sub-blocks will be selected randomly. New stations will be selected randomly in Year 2. The current study is for two-years, with monthly sampling from May through October. New stations will be selected randomly in Year 2.

The study will follow the Atlantic States Marine Fisheries Commission (ASMFC) protocol for ventless trap surveys to the extent possible. Three commercial boats will be used for the study and each boat will be responsible for 8 stations. A 5-day soak time will be used because of the logistics of sampling offshore. Traps will be deployed on ten-pot trawls with 100’ separation between traps with 6 ventless traps and 4 vented traps so that the data can be compared with commercial catch rates. Longer trawls are required offshore to provide more total weight and for ease of recovery in the case that buoys are lost. A total of 240 traps will be sampled each month.

Analytical Procedures:

The relative abundance of sublegal and legal lobsters will be calculated, stratified by depth and substrate. Length frequency distributions will be developed by month. The spatial extent of shell disease will be monitored.

Conclusion

Ventless pot surveys are essential to continue to monitor lobster populations in Rhode Island and Block Island Sounds. The surveys meet the need to estimate population sizes, sex ratios, fecundity, age structure, maturity schedules, natural and fishing mortality, and growth. The federal otter trawl surveys that are typically used to evaluate the stock are insufficient due to their inability to access all types of bottom substrate (rocky and ledge areas) as well as being prevented from sampling areas where stationary gear types (traps and gillnets) are deployed. The simple fact that the federal survey does not access waters where the fishery exists (where traps are set) indicates that this survey is not the best method of estimating lobster abundance. In addition, the targeted nature of the commercial fishery and gear design allowing small lobsters to escape create biases in data collected during sea sampling aboard commercial vessels.

There are some slight differences in the designs of the studies that seem to have evolved based upon evaluation of prior studies and goals of the particular study. The RI DEM study was developed to comply with protocols developed by the ASMFC. These guidelines were established so that the study would be effective throughout the range, from Maine to New Jersey and be directly comparable to commercial catch. The 3-day soak time was chosen to avoid pot saturation experienced in the high population areas in Maine with sets of more than 3 days. In addition, the 3 ventless, 3 vented configuration was decided upon to ensure that the results would be directly comparable to commercial harvest.

Analysis of the RI DEM survey indicated that 5 ventless traps per trawl with one vented trap would maximize sub-legal catch while not measurably reducing the catch of legal sized lobsters. This configuration is particularly useful for the studies designed to assess impacts of wind turbine construction as it more effectively samples all age classes of lobsters. In addition, it does not appear that traps become saturated in RI waters after a 3-day set so the other surveys have increased to a 5 day set to increase catches and make logistics easier. Also, spacing of traps per trawl was increased to 100' in order to maintain trap independence, enhance spatial resolution of collected data, and maximize the catch per unit effort. The traps, separated by 100' distance, are expected to be independent measures of local lobster abundance rather than grouped as done by RI DEM. Further analysis of these datasets will reveal if this is a valid assumption.

The spatial coverage of the 3 studies combined cover a large portion of the SAMP study area. The coverage of the Deepwater wind study is very limited and might have limited utility in stock assessment but the design meets the goal of assessing impacts from wind turbine construction. The temporal coverage in the near term appears to be sufficient but the continuation of two of the studies for only a single year after construction seems to be insufficient to assess impacts of wind farm construction.

TRAWL SURVEYS

<u>Introduction</u>

Bottom trawl surveys have long been conducted to document abundance, distribution, and composition of fish assemblages in a given area. Each of three long-term fishery independent surveys that occur within the SAMP area (NOAA NEFSC, NEAMAP, DEM) are described below.

NOAA NEFSC BOTTOM TRAWL SURVEY

The Ecosystems Surveys Branch of NOAA Fisheries collects fishery-independent data during their spring and fall bottom trawl surveys that extends from Cape Hatteras to the Scotian shelf. The survey uses a stratified random design, where stations are selected at random within strata that are delineated by depth and region. The autumn (September to October) and spring (February to April) surveys were initiated in 1963 and 1968, respectively, and presently attempt to sample 370 stations per seasonal component (Johnston 2012). Although these surveys offer the longest time-series of any fisheries independent survey conducted within the SAMP area, the sampling strata of this survey omits a large portion of the SAMP area.

In general, these surveys collect data on the abundance, distribution, feeding ecology, size and age composition of stocks of economically and ecologically important species (NOAA NEFSC 2013). More specifically the goals of these surveys are to: 1. Monitor trends in abundance, biomass and recruitment, 2.Monitor the geographic distribution of species, 3. Monitor ecosystem changes, 4. Monitor trends in biological parameters (growth, mortality and maturation rates) of the stocks, 5. Collect environmental data (Johnston 2012). Data from these surveys is used in and supports stock assessment, ecosystem based management, identification and assessment of Essential Fish Habitat (EFH), as well as general life history, and fisheries management.

Analytical Procedures:

Catch is typically reported as the weight per tow per species. Information from a given survey component, including tow data, will contain counts, lengths, sex, weight, and sometimes gut contents of individual fish. The data from this survey is used in a multitude of different stock assessments, but analyses are done as post survey research projects and are accomplished on a species specific basis by different groups of analysts. The dataset is large, comprehensive and has a long time series, and therefore can accommodate any number of analyses.

NEAMAP TRAWL SURVEY

Bottom trawling has been conducted as part of the Northeast Area Monitoring and Assessment Program (NEAMAP) survey since 2006 and is ongoing. In the Fall of 2010 and 2011 additional stations were chosen to include representative ranges of depths and habitat types in the SAMP area and in areas targeted for offshore renewable energy development. Trawling was conducted on the F/V Darana R, with the standard NEAMAP protocol of 20-minute tows at a speed of 2.9-3.3 knots. The biological data included numbers, weights, length-frequency, and sex composition.

For a set of key species, stomach contents for diet analysis and tissue samples for stable-isotope analysis were also collected in the SAMP area.
A random sub-sample of 5 fish (per size-class per target species per station) was selected for diet analysis following. All recovered prey items were identified to the lowest practical taxon and their contribution to overall diet measured as frequency of occurrence and percent of total stomach content weight.

To complement stomach-content data, nitrogen ($^{15}N/^{14}N$) stable isotope analysis was used to quantify the trophic level of important predator and prey species and to further define the time-integrated feeding history of each consumer (Piraino and Taylor 2009). Carbon ($^{13}C/^{12}C$)

stable isotope signatures were also used as indicators of the initial carbon source to the marine food web allowing for the differentiation between pelagic and benthic trophic pathways. Nitrogen and carbon stable isotope measurements of a sub-sample of fish tissue (~1 mg dry wt) were performed at the Boston University Stable Isotope Laboratory (Boston, MA) with an automated continuous-flow isotope ratio mass spectrometer (IRMS; Preston and Owens, 1983).

Analytical Procedures:

The diet composition of each of the predator species was unique and spatially variable. Spatial patterns were found in the diets of several fish species. For example, winter flounder diets contained a high percentage of amphipods in the Block Island Sound, whereas polychaetes dominated the diet in eastern Rhode Island Sound. Across species, broad-scale geographic patterns in fish diet were also observed. For example, squid were consistently present in the diet of all of its main predators (spiny dogfish, winter skate and summer flounder) in Rhode Island Sound, whereas in Block Island Sound squid were only present in the diet of spiny dogfish.

Nitrogen stable isotope analysis revealed three major trophic groups in the demersal fish and invertebrate community. Trophic level two consists of sea scallops and other phytoplanktivores, such as mussels and clams. Trophic level three consists of zooplanktivores, primary consumers and scavengers, including: herring, butterfish, squid, skates, dogfish, winter flounder, and scup. Trophic level four consists of secondary consumers and predators, such as black sea bass, monkfish, bluefish, and striped bass. Carbon stable isotope analysis suggests that there are two trophic pathways, a benthic pathway and a pelagic pathway. Macroalgae provide the foundation of the benthic trophic pathway, where as phytoplankton provide the foundation of the pelagic trophic pathway.

RIDEM TRAWL SURVEY

The RIDEM Fish and Wildlife Trawl Survey was initiated in 1979 to monitor recreationally important finfish stocks in Narragansett Bay, Rhode Island Sound, and Block Island Sound. Presently the survey is comprised of a seasonal component that samples 44 stations in the spring (April) and fall (September) and a monthly component that samples 12 stations in Narragansett Bay and 1 station in Rhode Island Sound. Together, both components of the survey aim to monitor trends in abundance and distribution, and produce data that is used to determine population size/age composition, and evaluate the biology and ecology of estuarine and marine finfish and invertebrate species occurring in RI waters. Over the years this survey has become an important component of fisheries resource assessment and management at the state and regional levels.

Like most fishery independent surveys, this survey was originally designed as a random stratified survey. Stations were selected at random based on a series of depth strata created for Narragansett Bay, Rhode Island Sound, and Block Island Sound. From 1979 until 1987 this approach was used to select stations for a spring (April) and fall (September) survey component. In 1998 the survey design was modified so that stations in Rhode Island Sound and Block Island Sound (12 and 6 stations, respectively) and 12 of the 26 stations in Narragansett Bay transitioned to fixed stations based on the frequency of their previous selection (per depth stratum) since 1979. The remaining 14 stations in Narragansett Bay continued to be randomly selected on a seasonal basis. Starting in 1990 a monthly component was added, which sampled the 12 fixed stations in Narragansett Bay and 1 station in Rhode Island Sound. In 2011 two fixed stations were added, both located around Block Island, to the seasonal component resulting in 44 stations being sampled each spring and fall. Since inception this survey has conducted over 5,500 tows and continues to add approximately 218 tows to that total annually.

At each station, an otter trawl equipped with a ¼ inch liner is towed for 20 minutes at 2.5 knots resulting in a sample unit of 1.3 km (0.83 miles) over ground per tow. The dimensions of the net have remained constant throughout the survey and using outputs from the current Notus net mensuration equipment an Area Swept per tow could be calculated. In addition to data collected by the Notus system, wind direction and speed, sea condition, air temperature, cloud cover as well as surface and bottom water temperatures, are recorded at each station. After each tow, the catch is sorted by species. All finfish, skates, squid, scallops, lobster and horseshoe crabs are enumerated, measured (cm/mm), and weighted (gm/kg). Anecdotal information is also recorded for incidental plant and animal species.

<u>Analytical Procedures:</u>

Catch statistics are quantified in a standardized unit of effort, such as the number and weight per tow per species, at monthly, seasonal, and annual time frames. This information has been included in several local and regional stock assessments conducted by RI DEM, as well by ASMFC and the NOAA NEFSC. Similarly, information regarding the length at weight of certain species has been considered in several stock assessments.

UNIVERSITY OF RHODE ISLAND GRADUATE SCHOOL OF OCEANOGRAPHY FISH TRAWL SURVEY

The URI-GSO Fish Trawl Survey is a state funded survey of the bottom fish and invertebrate community in Narragansett Bay, Rhode Island. Although not directly within the SAMP area this is the longest existing time series of record of fish and invertebrate relative abundance in Rhode Island and my provided insight into some of regional dynamics that our occurring. The Fish Trawl Survey was initiated in 1959 to quantify the seasonal occurrences of migratory fish populations but was continued to document and record long-term fluctuations in fish and invertebrate abundance.

Once per week throughout the entire year the trawl survey samples two locations, one at Fox Island in mid-Narragansett Bay and the other at Whale Rock at the mouth of the West Passage of Narragansett Bay. The Whale Rock site, which is closest to the SAMP area is in 20-25 meters of water and has a coarse mud/fine sand bottom type. Fish and invertebrates are collected during a single 30 minute tow at each station at a two speed of 2 knots. The net has a tickler chain footrope and floats attached to the headrope with a length of 11.9 meters. The mesh size of the net is 3 inches (7.6 cm). Data collection on the Graduate School of Oceanography Fish Trawl Survey has expanded over time and now includes: abundance and biomass of all fish and invertebrate species; surface and bottom temperature, dissolved oxygen, and salinity at each survey site; and total length measurements and sex determination of winter flounder. Live weight of each species captured has been recorded since 1994. The length and sex of winter flounder has been measured and recorded since 1986. Surface and bottom temperatures have been recorded since 1959 and salinity and dissolved oxygen were added in 2007.

Analytical Procedures:

More than a dozen publications have analyzed the long term data series from the URI-GSO Fish Trawl (partial list at http://www.gso.uri.edu/fishtrawl/publications.htm) In addition, the long term data is stored in a database at the lab of Jeremy Collie and can be requested by e-mailing the Graduate School of Oceanography Fish Trawl Survey graduate student assistant whose contact information is available at http://www.gso.uri.edu/fishtrawl/contact.htm.

DEEPWATER WIND TRAWL SURVEY

Deepwater Wind has committed to conduct a trawl survey in the vicinity of the proposed Block Island Wind Farm (BIWF) to assess the impact of the windfarm on demersal fisheries resources.

The intent of this survey was to meet the following objectives:

- Confirm the seasonal patterns of the demersal fish community gleaned from other sources;
- Provide agencies with site-specific information from which to regulatory decisions (e.g., seasonal restrictions on construction,); and
- Provide a basis for monitoring effects of the presence of the wind turbines.

The study will be conducted in the project area as well as two reference sites. At each site a 20-minute tow using a 412 x 12 cm, four-seam box whiting trawl with a 82 ft 10 inch (25.25m) footrope and 66 inch (167.6cm) Thyburon otter doors. A 1 inch (2.54 cm) knotless cod end liner is used to ensure that smaller fish are retained.

Scientists on board the vessel collect bottom water temperature, dissolved oxygen, and salinity data with a YSI model 650 water quality meter for each tow. Other observations such as sea state and weather condition are also recorded for each tow. Once on board the vessel, scientists process the entire catch including fish and mega-invertebrates. All species are identified, weighed and enumerated except in the case of large numbers of small forage fish which are sub-sampled according to the NEAMAP subsampling procedures which are adapted from NEFSC Bottom Trawl Survey protocols (Bonzek et al. 2008). A representative number of individuals for each species will be sampled in more detail by collecting individual weights, lengths, and reproductive status. Stomachs will also be removed and preserved for laboratory analysis.

Analytical Procedures:

A report will be prepared for each monthly survey and provided to stakeholders. For each species in a given tow, total number, weight and length range will be calculated. A monthly comparison for each site will be provided that will compare abundance, biomass, and species richness over the entirety of the survey.

The baseline data collected in this study can be compared to the data collected after the construction of the BIWF to determine impacts, if any, from the construction and/or operation of the BIWF.

MA DMF INSHORE BOTTOM TRAWL SURVEY

The Massachusetts Division of Marine Fisheries (MADMF) has conducted annual spring (May) and fall (September) trawl surveys from 1978 to the present day with the objectives of documenting the distribution, abundance, and size composition of finfish and select invertebrates in MA coastal waters including Nantucket Sound, an area adjacent to the RI Ocean SAMP. The spring survey is intended to target adult finfish in inshore waters while the fall targets juveniles prior to their migration out of state waters (King et al. 2010). Data collected from the surveys is used to inform decisions regarding fisheries management and incorporated into regional stock assessments where appropriate.

The survey is currently comprised of 103 stations stratified by 5 bio-geographic regions and 6 depth zones in MA coastal waters (King et al. 2010). In 2005, 2 stations were added to reflect improved stratum area estimates, creating the current 103 station total. Sampling intensity is 1 station per 19 nmi^2 with stations assigned in proportion to the area of each stratum, with a minimum of two stations per stratum. From 1978 until 1982 the survey utilized the F/V Frances Elizabeth. During this time frame, unfamiliarity with trawlable bottom habitats and time constraints to find suitable alternate sites led to a practical haphazard selection processes while at sea. (Post 1982), MADMF have utilized the NMFS R/V Gloria Michelle. Despite changes in vessels, trawl design was kept consistent. A ¾ size North Atlantic type two seam otter trawl (39' headrope/51' footrope) rigged with a 3" rubber disc sweep and ¼" knotless cod-end liner (1/2" stretched mesh) has been utilized through the entire survey. A 72" X 40" 325 lb pair of wooden trawl doors with 63', 3/8" chain bottom legs and 60', 3/8" wire top legs spread the net. Standard 20 minute tows are conducted during daylight hours at a speed of 2.5 knots after reconnaissance at each site insures a clear path.

Analytical Procedures:

Catch data from tows ≥ 13 minutes but less than 20 minutes are survey expanded to the 20 minute standard and coded as acceptable. Both standard and acceptable tows are considered representative. Tows of less than 13 minutes are considered non-representative and excluded from most indices with few exceptions such as short tows in areas of high spiny dogfish abundance. Standard bottom trawl techniques are used to process the catch and mostly mirror methods established by the NEFSC. Bottom temperature, total weights (nearest 0.1kg) and length frequencies are recorded for each species.

CT DEEP LI SOUND TRAWL SURVEY

The Connecticut Department of Energy & Environmental Protection (CTDEEP) has conducted the Long Island Sound trawl survey (LISTS) since 1984 with the primary goal of providing fishery independent monitoring of important recreational species in Long Island Sound (Esty et al. 2013).The survey has several more specific objectives outlined below:

1) Provide annual indices of counts and biomass per standard tow for 40 common species
2) Provide age specific indices of abundance for scup, summer flounder, tautog, and winter flounder
3) Provide recruitment index for age 0 bluefish and weakfish
4) Provide length frequency distributions of bluefish, scup, striped bass, summer flounder, tautog, weakfish, winter flounder, and other ecologically important species suitable for conversion to age using modal analysis, age-length keys or other techniques
5) Provide annual total counts and biomass for all finfish species taken
6) Provide annual total biomass for all invertebrate species taken
7) Provide a species list for Long Island Sound based on LISTS sampling noting the presence of additional species from other sampling conducted by the marine fisheries division

Since the initiation of the LISTS, there have been several changes to the survey. The original survey utilized a stratified-random design encompassing bottom type and depth intervals to sample 40 stations on a monthly basis from April through November. Bluefish, scup, striped bass, summer flounder, tautog, weakfish and winter flounder were of primary interest and lengths were recorded from every tow for each species as well as lobster. In addition, scup, tautog, and flounder were sampled for aging. In 1991, the sampling schedule was changed to the current spring/fall format. Aggregate weights using an onboard scale were taken beginning in 1992 to provide indices of biomass and more species were sampled for lengths including windowpane and fourspot flounders, butterfish, long-finned (loligo) squid and several herring species. American sand lance (1994), bay anchovy (1998) and striped anchovy (1996) were incorporated into the annual and seasonal totals. In 2003, the measured species list was expanded to 20 finfish species and 2 invertebrates (long-finned squid and lobster).

The LISTS encompasses the area from longitude 72° 03’ (New London, CT) to longitude 73° 39’ (Greenwich, CT). This area spans both Connecticut and New York waters at depths ranging from 5 to 46 m. The area is divided into 1 X 2 nmi sites with each site assigned to one of 12 strata defined by depth intervals (0 - 9.0 m, 9.1 - 18.2 m, 18.3 - 27.3

m or, 27.4+ m) and bottom type (mud, sand, transitional). Sites are selected randomly for each monthly cruise with a required minimum of 2 sites per strata. Before each tow, temperature (℃) and salinity (ppt) are measured 1 m below the surface and 0.5 m above the bottom. The R/V John Dempsey is used to haul a 14 m otter trawl with a 51 mm codend to sample stations during daylight hours only. Tows are conducted for 30 minutes at a speed of approximately 3.5 knots, tide dependent. Finfish total or fork lengths are recorded to the nearest cm and lobster carapace lengths are measured to the nearest 0.1 mm. Squid mantle lengths (cm) and horseshoe crab prosomal widths (cm) are also recorded.

Analytical Procedures:

Annual spring and fall geometric mean number per tow and weight per tow (biomass, kg) is calculated for the common finfish and invertebrate species to gauge relative abundance. The geometric mean is calculated by taking the $\log_e$ to normalize the data due to the highly skewed nature of length frequencies from trawl surveys.

Transformed variable = ln(variable+1).
Means are computed on the log scale and then retransformed to the geometric mean:
geometric mean = exp(mean)-1.

Bluefish, scup, summer flounder, tautog, weakfish and winter flounder are sampled for age determination using a variety of procedures outlined by Esty et al. (2013) in the most recent technical report.

NEW YORK PECONIC BAY SMALL MESH BOTTOM TRAWL SURVEY

This survey is designed to achieve long-term monitoring and assessment of annual recruitment of important marine finfish species in New York waters, including weakfish, winter flounder, scup, tautog, bluefish and northern puffer. The survey also monitors trends in abundance of important forage species such as the bay anchovy (Anchoa mitchilli) and the Atlantic silversides (Menidia menidia)

Survey gear used in this project was designed to target YOY and juvenile finfish species.

Sampling station locations for the survey were selected based on a block grid design superimposed over a map of the Peconic estuary sampling area. The sampling area was divided into 77 sampling blocks, each of which measured 1’ latitude by 1’ longitude.

From May through October of each year, 16 stations are randomly chosen each week and sampled by otter trawl weekdays during daylight hours only.

The research vessel used throughout the survey was the David H. Wallace, a 10.7m lobster-style workboat. At each location, a 4.9m semi-balloon shrimp trawl with a small mesh liner was towed for 10 minutes at ~2.5 knots. From 1987-1990, nets were rigged using nylon scissors and tow ropes set by hand and retrieved using a hydraulic lobster pot hauler. Following 1990, the research vessel was re-outfitted to include an A-frame, wire cable and hydraulic trawl winches.

At the beginning and end of each tow, location and depth are recorded. At each station the time clock is started when the gear is fully deployed. If a tow is abandoned due to hangs and/or debris, a nearby site within the sampling grid is chosen and the tow is redone.

Temperature, salinity, and dissolved oxygen have been recorded at each station. Some gaps in the environmental data exist due to equipment malfunction.

Analytical Procedures:

Fish collected in each tow are sorted, identified, counted and measured to the nearest mm (fork or total length). Large catches are subsampled, with length measurement taken on a minimum of 30 randomly selected individual fish of each species. Some samples are stratified by length group such that all large individuals are measured and only a subsample of small (YOY or yearlings) specimens are measured. Subsampled counts are then expanded by length group for each tow. In addition to finfish, catch data was also recorded for several macroinvertebrate species ("New York Peconic Bay Small Mesh Trawl Survey").

Conclusions

Several different long-term bottom trawl surveys are being conducted within or near the SAMP area. However the spatial and temporal coverage of these surveys are likely not adequate to monitor and assess long-term shifts in fish distribution, abundance, or species composition across the SAMP area. Similarly, these surveys cannot sample hard bottom habitat and thus additional techniques such as beam-trawl surveys and ventless pot surveys should be incorporated with bottom trawl surveys to adequately sample the SAMP area.

VENTLESS FISH POT SURVEYS

Introduction

There have been several fish pot surveys that have occurred in and around the SAMP area. Some of these surveys are limited spatially and temporally, but some are ongoing and there is one survey that is just beginning implementation. The main focus of these surveys has been to assess and monitor species that are difficult to assess with other measures such as trawl surveys due to their utilization of and dependence on structured habitats. These species are of recreational and commercial importance to RI as well as the Atlantic coastal states in general. The main species of focus are scup, black sea bass, and tautog.

LONG ISLAND SOUND VENTLESS POT SURVEY

The state of NY has been running a ventless pot survey for tautog since 2010. This survey does not take place in the SAMP, but does reside in waters immediately adjacent to the SAMP and probably has overlap with populations of fish, in particular tautog, that inhabit the SAMP area. Thirty-five fish traps were deployed in the spring of each year between Mattituck Inlet, Mattituck NY, and Rocky Point in East Marion, NY. Efforts were made to deploy the traps near submerged rocks where tautog would be expected to be found. The traps were checked weekly, weather permitting, and all fish were counted and measured. The traps were removed for the season in the late fall of each year. Tautog were the most numerous (3,730) fish species followed by black sea bass (477) and cunner (186). Nine-spine spider crabs were the most abundant invertebrate species captured followed by lobsters and flat clawed hermit crabs.

This survey dataset is being examined for use in the 2014 benchmark assessment for tautog. Tautog is a species that is difficult to assess and monitor, but is an important resource to consider given its recreational importance to local fisheries. It is also important to assess this species given its limited migratory nature, so local impacts can have significant effects ("Long Island Sound Ventless Pot Survey").

<u>Analytical Procedures:</u>

Catch rates (catch per unit effort) and catch frequencies (abundance) were compiled for each species captured. The size distribution of target species, including tautog, scup, and black sea bass were compiled for the pot survey dataset. Further analysis may be performed on the dataset to prepare it for use in the 2014 tautog benchmark assessment, which could include use for estimating growth, age characteristics, or modeled abundance estimates using GLMs ("Long Island Sound Ventless Pot Survey").

SEAGRANT VENTLESS SCUP POT SURVEY

Seagrant in cooperation with the University of Rhode Island and fishing industry members have been running a ventless pot survey for scup from 2004 through 2012. The scope of work is separated into eastern, mid-western, and far-western sampling zones, with identical sampling sites. Scup and black sea bass were collected from each site utilizing standard fish pots (2 x 2 x 2 foot) made with 1½ x 1½ inch coated wire mesh. Pots were unvented and therefore have the capability to retain all size classes of scup. The sampling protocol required that the commercial vessels take 30 pots to each sampling site once during each month for five months (June to October). Pots were baited with clams, which fish very quickly, and were allowed to fish for one to two days at each site. Sampling occurred six days per month (one to set the gear and 5 to haul and move gear) for five months or 90 days for the three sites for the year. The date, area, depth, set over days, and catch was recorded and fish were measured utilizing the standard NMFS sea sampling protocols. The same sampling format was followed every four weeks from June 15 through October 15 for five complete cycles. Data collected as part of the project was formatted in a manner consistent with the NMFS and Atlantic

Coastal Cooperative Statistics Program (ACCSP) formats. The data was screened for errors in recording and data input.

This survey dataset has been used in the assessment updates for scup. Scup is a species that is difficult to assess and monitor given its propensity for structure, but they are more routinely captured in trawl surveys than other structure oriented species. The main reason and justification for the ventless pot survey was to do a better job of characterizing the age structure of the stock. Trawl surveys tend to select for smaller sizes and therefore younger ages. The pot surveys were designed to better represent the older segments of the population, which are believed to do a better job accessing the optimal structured habitat, thereby making them less susceptible to trawl gear ("Sea Grant Ventless Scup Pot Survey").

Analytical Procedures:

Catch rates and catch frequencies between stations and between areas were compared for each species (scup and black sea bass). The size distribution from the unvented pots and the fall and spring surveys of the NMFS and the RIDEM trawl survey were then compared to the pot survey dataset. Further comparisons were made between catch composition of the unvented pot survey and trawl surveys. Performance of the survey was evaluated using five criteria: 1) internal consistency across annual cohorts; 2) consistency between URI ventless trap survey and other available surveys; 3) the ability to track the cohort effect, age effect and year effect within URI survey index; 4) evaluating parameters that are derived from the survey-based analysis; and 5) evaluating performance of survey data as a tuning index in the scup stock assessment model.

There were only a few years of data on black sea bass which had been collected as part of the project. To the extent practicable, the analysis of the black sea bass data generally complied with the description above for scup ("Sea Grant Ventless Scup Pot Survey").

SEAGRANT INDUSTRY BASED VENTLESS BLACK SEA BASS POT SURVEY

Seagrant in cooperation with the University of Rhode Island and fishing industry members have been running a ventless pot survey for black sea bass beginning in 2012 with a proposal to extend in to 2013. This survey takes place in part in the SAMP. Black sea bass were collected from four general zones along the coast utilizing black sea bass pots (43½” long, 23” wide, and 16” high) made with 1½ x 1½ inch coated wire mesh, single mesh entry head, and single mesh inverted parlor nozzle. The pots were unvented and therefore have the capability to retain all size classes of black sea bass.

The four general zones included one in Massachusetts, one south of Rhode Island, one south of New Jersey, and one south of Virginia; the southern RI survey being the segment applicable to the SAMP area. The configuration generally corresponds to the northern and southern core range of the species, and each is an area in which a major black sea bass fishery takes place. In each general zone, four individual sampling sites were selected, each of which was one square mile in size. Each individual sampling site was separated by at least four miles in order to provide adequate spatial coverage. Each one square mile sampling site was further partitioned into quarter mile sub-blocks, with numbers assigned to each sub-block. Specific sampling sites within each square mile sampling site were randomly selected from the sub-blocks each month. The traps were set at the center of each sampling site each month.

The sampling protocol required that a commercial vessel take 30 pots (3 ten pot trawls) to each of the randomly selected hard bottom sampling sites. This procedure continued each month during the sampling season for five months. Thus, 16 locations were sampled monthly. Pots were un-baited and allowed to remain in place for a minimum of four days. The date, area, depth, set over days, and catch was recorded and fish measured utilizing the standard NMFS sea sampling protocols. Fish were measured excluding tendril, which is the NMFS/ASMFC standard. This same sampling format was followed every four weeks for five complete cycles. Data was transported to NMFS via an electronic portal in an ACCSP format. The sampling period for the general zone located in RI was May through September. This timeline provided five continuous months of sampling beginning with the start of the fishery. The four stations south of Rhode Island were at the following general locations; South of Newport (14365 43975), South Elisha Ledge (14325 43955), Churches Ledge (14315 43920), and west of Normans' Island (14260 43855).

This survey dataset has not yet been used in the assessment for black sea bass, but the hope is that in future benchmark assessments this dataset could be considered. Black sea bass is a species that is difficult to assess and monitor given its propensity for structure. The main reason and justification for the ventless pot survey was to do a better job of characterizing both the age structure and abundance of the stock. Trawl surveys do catch black sea bass but the variability from year to year can be high. It is believed this occurs because black sea bass tend to be more susceptible to trawl gear when they are migrating, so survey timing can have a significant impact on abundance ("Sea Grant Industry Based Ventless Black Sea Bass Pot Survey").

Analytical Procedures:

Catch rates and catch frequencies between stations and between areas were compared for each species. The overall length frequency distribution for catches of black sea bass in the pots at each study site were compared to each of the other collection sites, to finfish trawl data collected by the NMFS and state agencies, and data collected on black sea bass retained as bycatch in the other ventless trap studies. The data were also aggregated and analyzed by Northern and Mid-Atlantic areas with appropriate lags for age and growth.

A Kolmogorov Smirnov (KS) two sample test ($\alpha = 0.05$) was used to determine whether the observed length frequency distributions were significantly different (Steel et al. 1997). The tests were based on the unsigned differences between the relative cumulative frequency distributions of the two samples.

Comparisons between the values lead to decisions on whether the maximum difference between the two cumulative frequency distributions is significant (Sokal and Rohlf 1995).

A one way ANOVA was also performed to test for differences among the mean length and number of black sea bass between the collection sites, as well as the NMFS finfish trawl survey. Tukey HSD tests were applied to determine where significant differences are observed if in fact differences were detected in the ANOVA. Published information of growth rates (Mercer 1978, Shepherd & Idoine 1993) were used to derive length-based estimates of mortality (Beverton & Holt 1957, Ehrhardt & Ault 1992) ("Sea Grant Industry Based Ventless Black Sea Bass Pot Survey").

RIDEM VENTLESS FISH POT SURVEY

The Rhode Island Division of Fish and Wildlife is implementing a ventless pot survey for scup, black sea bass, and tautog beginning in 2013. The survey is located in RI state waters, mainly occurring in Narragansett Bay. This survey takes place in part in the SAMP. A monthly ventless black sea bass and scup pot survey will be conducted in the Narragansett Bay, North of the colregs line from April through November.
Sampling will be conducted aboard a 26ft research vessel purchased for a previous pelagic finfish monitoring project (F-64-R). The scup pots and black sea bass pots used in this survey are identical to those used by the URI/Sea Grant for the last several years under “2013 Fisheries independent Scup Survey of Hard Bottom Areas in Southern New England Waters” and “2013 Industry Based Survey on Black Sea Bass Utilizing Ventless Traps” (see descriptions above. The scup pots (2'x2'x2') will be constructed of 1.5” x 1.5” coated wire mesh and unvented. Black Sea Bass Pots (43.5” L, 23” W, and16” H) will be also be constructed of 1.5” x 1.5” coated wire mesh, single mesh entry head, and single mesh inverted parlor nozzle. All pots will be covered with vexar in August and September in an attempt to capture age 1 sea bass. Narragansett Bay is divided into six sampling areas, The Providence/lower Seekonk River, Upper Bay/Greenwich Bay, West Passage, East Passage, Mount Hope Bay, and the Sakonnet River. Each area is then subdivided into 0.5 deg of latitude and longitude and numbered. These numbered boxes are referred to as stations. Investigators will then locate areas of hard bottom, shipwreck, major bridge abutments, or pilings, etc, in each station. The areas of structure are noted in the stations and the goal for each month will be to randomly sample half of the replicates (see below for a description of replicates) in areas of known structure and half in areas without known structure. All sampling stations are randomly selected. In order to maintain a consistent methodology with the URI/Sea Grant projects, investigators adopted the following sampling schedule which they anticipate will take approximately two weeks. Week one, day one: two unvented scup pots will be set at five (5) randomly selected stations in one of the six sampling areas and left to soak for 48+/- 1 hrs. One pot will be baited with sea clams while the second will remain unbaited. Day two: the process will be repeated in a second sampling area and again the pots will be left to soak for 48+/- 1 hrs. Day three: the pots set on day one will be hauled, the catch processed, and the pots moved to an unsampled area for 48+/- 1 hrs. Day four: the pots set on day two will be hauled, the catch processed, and the pots removed from

the water. Day five: the pots set on day three will be hauled, the catch processed, and the pots removed from the water. Week two activities mirrors those of week one in order to sample the remaining sampling areas. Given previous research performed by the Division of Fish and Wildlife, it is believed that the scup pots will be the preferred gear type for capturing tautog, but this will be examined at the completion of the first year's survey and the methodology may be altered if this is not found to be the case. Simultaneously on the same setting and hauling schedule as above, investigators will set unvented black sea bass pots in five (5) pot trawls at five (5) randomly selected stations in the same sampling area as above. Pots will remain unbaited as was the methodology in the Sea Grant experiment and allowed to fish for 48+/- 1 hrs. Upon hauling all gear types, the catch is sorted by species. Finfish are measured to the nearest centimeter, fork length (FL) or total length (TL), and weighed. Invertebrates are measured using a species specific appropriate metric or counted. Individual length frequency data and weights are recorded for all species. When individual fish weights are not manageable, aggregate weights will be taken. Scales, otoliths, and opercula are taken from a percentage of the catch for the eventual aging of species caught as appropriate. Project personnel collect data on water temperatures, salinities, dissolved oxygen, air temperature, and meteorological data and sea conditions at each sampling station. Scales and otoliths will be prepared according to NOAA Technical Report NMFS 72 (1988). A matrix of needed sizes was developed for tracking the numbers needed for each size/age category. The aging structure for each species was determined by the existing convention for aging species.

This survey dataset has not yet been used in any analyses as it is a brand new survey, but the hope is that in future benchmark assessments this dataset could be considered. The main reason and justification for the ventless pot survey was to do a better job of characterizing both the age structure and abundance of these recreationally important species. Trawl surveys do catch these species but the variability from year to year can be high and the selectivity of the trawl gear can be problematic for assessment purposes, in particular when the stock assessment models are age or length structured, which is the case for the three target species ("RIDEM Ventless Fish Pot Survey").

Analytical Procedures:

After completion of the first years research, an analysis will be undertaken to test whether the presence of crustaceans, such as lobsters, has a statistically significant effect on the abundance of the target species to further support the sampling methodology, and the methodology may be altered in subsequent years if significant effects are detected. In addition, power analyses will be conducted to determine the effects of variables such as baiting of pots and proximity to structure. Indices of relative abundance and biomass will be developed for each species. All data will be stored at the Rhode Island Division of Fish and Wildlife and analysis will be performed by Division staff. Data analysis will conform to standards of the National Marine Fisheries Service and the Atlantic States Marine Fisheries Commission ("RIDEM Ventless Fish Pot Survey").

Conclusion

Fish pot surveys are available in and near the SAMP area. This type of survey is important for the assessment and analysis of three important structure oriented species that inhabit the SAMP area for a significant portion of the year. These species are difficult to assess with other fisheries assessment techniques, so the use of existing datasets and the possibility of continuing similar work is important. The datasets that are not currently running and do not take place in the SAMP itself can be used to inform survey design for any proposed survey that might be considered in the future. Expanding the new RIDFW survey would be a useful and beneficial project to consider.

BEAM TRAWL SURVEYS

Introduction

Hard bottom habitat is often difficult to sample by traditional trawl gear and is subsequently inadequately sampled, particularly in the SAMP area. A beam trawl survey allows for the collection of data and characterization of hard bottom habitat that would otherwise be unattainable.

URI BEAM TRAWL SURVEY

The University of Rhode Island under the Southern New England Collaborative Research Initiative (SNECRI), initiated a beam trawl survey in the SAMP area in 2010 that ran through 2012 with plans to continue in 2013. The main objective of this work was to conduct a beam trawl survey that would supplement an ongoing otter trawl survey in the SAMP area to characterize the fish communities and allow for sound management decisions. The survey design was to sample over the course of 3 to 4 days in either the fall or summer of each year of the survey. To allow for direct comparison to the ongoing otter trawl survey, ten of the otter trawl stations were sampled with the beam trawl each year of the survey. Additional hard bottom stations were selected each year to supplement the otter trawl stations. The beam trawl was equipped with a ten foot beam, two tickler chains and a net with a cod-end mesh equivalent to that of the otter trawl. From 2010-2012, a total of 52 stations were sampled with numbers, weights, and length-frequencies being collected at each station. Temperature, salinity and dissolved oxygen were also collected at each station with a YSI sensor (Collie et al. 2013).

Analytical approach:

Characteristics such as total abundance, biomass, and number of species were collected for each tow conducted throughout the project period. Non-metric multi-dimensional scaling (MDS) analysis was used on the abundance data to look for specific groupings of species within the SAMP area. Species assemblage groups were identified from MDS plots and stations were compared for differences in habitat/environmental factors between species assemblages.

To allow for direct comparison to the otter trawl catch, macro invertebrates were removed from the beam trawl data set and pelagic species were removed from the otter trawl data set. This was done due to the fact that the beam trawl over samples invertebrates and under samples pelagics in comparison to the otter trawl. After standardizing the datasets for area swept, pooled beam trawl and otter trawl data was then used to look at trends in diversity, length frequencies, biomass and abundance.

***Conclusion*:**

Beam trawl surveys are very useful in the SAMP area as they allow for sampling of hard bottom habitat that is otherwise inadequately sampled by traditional otter trawl gear. This data can be used as stand alone or in conjunction with other otter trawl survey data to characterize the fish and invertebrate community in the SAMP area. The continuation of the aforementioned baseline study would be beneficial to create a larger dataset over time. Researchers should not only look for trends in the observed data, but consider some additional statistical analyses to be conducted that would investigate statistically significant relationships. Lastly, the aforementioned research fits into the research priorities identified by Atlantic States Marine Fisheries Commission (ASMFC), New England Fishery Management Council (NEFMC), the Mid-Atlantic Fishery Management Council (MAFMC), the Northeast Fisheries Science Center (NEFSC), the RI Bays, Rivers, & Watersheds Coordination Team (RI BRWCT), the Atlantic Coastal Fish Habitat Partnership (ACFHP).

MAPPING HABITAT

Introduction

The importance of marine benthic habitat (i.e. fish habitat) to the sustainability of healthy fisheries was formally recognized with the advent of the Essential Fish Habitat (EFH) component of the Sustainable Fisheries Act (1996). Site specific baseline information detailing the benthic habitat and fish assemblages present, as well as an understanding of fish-habitat relationships is needed to asses change over time and minimize impacts from development activities. Benthic habitat maps are useful tools for understanding the distribution and extent of seafloor habitat (Collie et al. 2013). They are often created by coupling high-resolution acoustic surveys with underwater video or photographic surveys. In this approach the underwater video and photography provide information to assess habit type and ground truth the acoustic data. Habitat mapping can also be combined with fishery survey techniques, such as bottom and beam trawling, to examine relationships between benthic habitat and demersal fish communities.

The following habitat mapping projects sought to document the benthic environment and demersal fish community within the SAMP area to better understand the relationship between benthic habitat and the fish assemblages they support, as well as determine the functional role of different habitat types and the importance of benthic-pelagic coupling in supporting fish production.

FISHERIES ECOLOGY IN RHODE ISLAND AND BLOCK ISLAND SOUND FOR THE RI OCEAN SAMP

The goals of this study were to develop a base map of the fisheries resources in Rhode Island and Block Island Sounds and investigate the relationship between the benthic environment and the demersal fish community (Malek et al 2010). The general approach was to use acoustic mapping and bottom trawling to classify fisheries habitats based on benthic habitat characteristics and site-specific fisheries data. Study locations were chosen based on existing maps of bottom sediment composition, side-scan sonar data, interpretation of NOAA hydrographic surveys, and fishing location maps prepared during the RI Ocean SAMP process (see Malek et al. 2013 for more details). A bottom trawl was used to sample 15 sites, and twelve of these sites were also acoustically surveyed. The “NEAMAP Trawl Survey” section above contains more details on general methods used during the bottom trawl survey work. The corresponding acoustic data was collected using an interferometric sonar system that simultaneously collected swath bathymetric and side-scan sonar data (Malek et al. 2013). Raw data were continuously recorded, monitored in real time with a top-side monitor, and corrected for vessel heading, pitch and roll. All survey lines were logged using Hypack navigation software and data were processed using OIC CleanSweep software (Malek et al. 2010).

<u>Analytical approach:</u>

Acoustic side-scan and bathymetry data were processed using OIC CleanSweep software. After processing the final side-scan backscatter and bathymetry mosaics were exported as geo-referenced tiff files and ArcGrid files, respectively (see Malek et al. 2010 for further details). A suite of benthic habitat parameters were derived from the acoustic data and rugosity was used as a measure of benthic habitat complexity.

Univariate regressions and graphical analysis were used to investigate the relationship between depth and fish community metrics (i.e. abundance, biomass, diversity and evenness), testing the hypothesis that fish abundance and biomass would be positively correlated with depth (Malek et al 2010). Relationships between acoustically-derived benthic habitat parameters and fish community metrics were also assessed with univariate regressions. Malek et al. (2010) hypothesized that fish diversity would be positively correlated with measures of bottom complexity (i.e. rugosity, number of bottom types, number of bottom type borders) (Salomon et al. 2010).

Malek et al. (2010) used PRIMER 6.0 to conduct multivariate analysis including, an analysis of similarity (ANOSIM) on the Bray-Curtis similarity matrix of the species-specific fish abundance using location and depth strata as factors, and draftsman plots to assess the correlation between the benthic habitat variables. The BIOENV procedure, in PRIMER 6.0, was used to determine the relationship between the non-correlated benthic habitat parameters and species-specific demersal fish community data.

MAPPING AND CHARACTERIZING FISH HABITAT IN RHODE ISLAND AND BLOCK ISLAND SOUNDS

The primary objective of this project (Collie et al. 2013) was to obtain up-to-date site-specific data on benthic habitats and the fish communities they support in Rhode Island's coastal waters to support sound management decisions. This was addressed by mapping and classifying fisheries habitats based on benthic habitat characteristics and site-specific fisheries data. This study also assessed the functional importance of fish habitat to rebuilding fisheries stocks important to Southern New England.

The study area for this project was the RI Ocean SAMP area. Station selection was based on existing maps of bathymetry, sediment composition, backscatter, and fishing locations. Acoustic mapping was conducted to supplement previously mapped areas in the SAMP (e.g. Malek et al. 2010). Specifically, acoustic mapping was conducted using an interferometric sonar system to simultaneously collect high-resolution side-scan sonar and swath bathymetry data with 2 and 10 meter resolution, respectively (Collie et al. 2013). Raw data were continuously recorded, monitored in real time with a top-side monitor, and corrected for vessel heading, pitch and roll. All survey lines were logged using Hypack navigation software and data were processed using OIC CleanSweep software (Collie et al. 2013). The resulting habitat maps were used to guide bottom trawling (see "NEAMAP Trawl Survey" above) and to obtain site-specific benthic habitat information.

Video and photographic surveys of benthic habitats were conducted on the F/V Mister G, in summer 2012. Video surveys were conducted at all the otter-trawl and beam-trawl stations that were sampled as part of this project (see the aforementioned "NEAMAP Trawl Survey" and "URI Beam Trawl Survey" for more details). Additional station locations were chosen to include the complete range of bottom types. Along each transect 5 minutes of continuous video footage was recorded and photographs were taken one meter off the seafloor, giving a field of view of approximately 1 m^2. The objective was to obtain at least 20 clear and useable still images for quantitative analysis from each transect to supplement the video surveys (Collie et al. 2013).

Analytical approach:

The acoustic side-scan and bathymetry data were processed using OIC CleanSweep software. The final products were water depth maps and classification maps of seafloor bottom types based on acoustic characteristics. The bottom classification maps were ground-truthed with grab samples and underwater images from the same areas.

This study is ongoing and image processing has yet to be completed. It's expected that benthic habitat parameters will be derived from the side-scan and bathymetry data at two and ten-meter resolution, respectively (Collie et al. 2013). Side-scan, which measures acoustic backscatter intensity, will be used to infer bottom type and bathymetry data will be used to calculate rugosity, which is a measure of the roughness of the bottom and benthic habitat complexity.

A total of 106 video transects and eight photographic transects were conducted throughout Rhode Island Sound and Block Island Sound from all major habitat types, including: mud, sand, pebble, cobble, and boulder (Collie et al. 2013). Bottom photos will be analyzed with a point-count program written in Matlab (Lengyel et al. 2009). Data extracted from each photo will include the major and minor sediment types, the percent cover of colonial epifauna, and the frequencies of free-living animals (Collie et al. 2013). Sediment data will be used to further ground-truth the acoustic mapping.

Conclusion

Benthic habitat maps are useful tools for understanding the distribution and extent of seafloor habitat (Collie et al. 2013). Coupling habitat mapping with fishery survey techniques, such as bottom and beam trawling, can be used to examine relationships between benthic habitat and demersal fish communities. For example, Malek et al. (2010) found a distinct relationship between fish community and depth, with larger, more evenly distributed fish communities in deep water habitats and smaller, more diverse communities in shallow water habitats. Similarly, both Malek at al. (2010) and Collie et al. (2013) found that spatial patterns in the diversity of the demersal fish community coincide with major benthic habitat features, meaning more diverse fish communities occupy more complex habitats, such as hard bottom habitat.

Overall, these studies showed that the distinct distribution of fish assemblages found in Rhode Island coastal waters can be explained by a subset of benthic habitat and oceanographic features, which include surface and bottom temperature, surface salinity, bottom type, depth and rugosity (Collie et al. 2013). They also provide a basic understanding of fish-habitat relationships in a temperate marine ecosystem and begin to elucidate the importance of benthic-pelagic coupling in supporting fish production (Malek et al. 2010). Results from these and future studies will also provide a baseline for measuring the cumulative effects of offshore development projects, and a basis for protecting important benthic habitats.

TAGGING AND ACOUSTIC STUDIES

Introduction

Tagging and acoustic data can provide important information on the movement, distribution, and abundance of ecologically and economically important species of pelagic finfish that are otherwise difficult to sample due to their close association with hard bottom habitats. Many tagging and acoustic programs have occurred along the Atlantic coast that may have data applicable to the SAMP area with some of these programs presently ongoing.

ASMFC COOPERATIVE TAGGING PROGRAM AND REGISTRY

To improve the use of tagging data for stock assessments and fisheries management, ASMFC initiated the ASMFC cooperative tagging program and registry ("ASMFC Cooperative Tagging Website and Registry"). Several tagging programs are discussed in more detail below; however the ASMFC tagging program and registry website provides a comprehensive list of programs that already exist along the east coast that may have data applicable to the Ocean SAMP area for several of the target species which include herring, shad, menhaden, bluefish, and striped bass.

AMERICAN LITTORAL SOCIETY FISH TAGGING PROGRAM

Started in 1965, the ALS tagging program is the largest volunteer, saltwater fish tagging program in the United States. The ALS program has over 1,000 participants tagging nearly 25,000 fish annually with the top three species being striped bass, summer flounder and bluefish. Additional species that are tagged include winter flounder, black sea bass, tautog, axe, cod, croakers, scup and weakfish ("Fish Tagging"). The ALS tagging data is a large repository of data that has many applications to fisheries management. In 2005, the National Marine Fisheries Service in partnership with ALS, used the bluefish tagging data from ALS to publish a paper on the migratory patterns of bluefish along the Atlantic coast (Shepherd et al. 2006). While the ALS tagging data covers a broad geographic range it is highly likely that data applicable to the SAMP area exists and could utilized for several of the target species.

MADMF TAGGING PROGRAM

The Massachusetts Division of Marine Fisheries (MA DMF) tagging program employs charter boat captains to collect striped bass around Cape Cod, MA. The program started in 1991 and has tagged and released over 5,000 fish that have been found as far north as New Brunswick, Canada and as far south as Georgia ("Tagging Studies"). Striped bass tagging data can be especially useful as it can provide important information regarding spawning and movement. Atlantic striped bass have three distinct stocks, the Hudson, Chesapeake, and Roanoke, that migrate along the east coast during the summer months. Tagging data on striped bass can provide important information on spawning and migratory patterns as well as overall condition of the three distinct stocks.

NEFSC BLACK SEA BASS TAGGING STUDY

Beginning in 2002 over 13,000 black sea bass were tagged and released over four distinct seasons. The objectives of this project were to estimate the population size, exploitation rate, and movement of black sea bass ("Cooperative Black Sea Bass Tagging Project"). Although this study is currently not on-going, it does have useful data on black sea bass movement in the SAMP area that could be utilized.

ATLANTIC COOPERATIVE TELEMETRY NETWORK

Underwater ultrasonic biotelemetry, more commonly referred to as telemetry, can be used to investigate a tagged animal's behavior, site occupancy and fidelity, habitat use, migratory behavior and patterns, spawning ecology, as well as to produce specie specific estimates of abundance and mortality when combined with conventional tagging efforts. Recent technological advances have greatly reduced the cost and size of ultrasonic acoustic transmitters (i.e. tags) and hydrophones (i.e. receivers), resulting in more fish carrying acoustic tags and a more arrays of receivers being deployed and maintained along the East Coast. As the use of acoustic tags increased, collaborations were formed in order gain a more complete representation of species' movements, as well as to identify gaps in coverage.

The Atlantic Cooperative Telemetry (ACT) Network began in 2006 when 15 researchers working on Atlantic and shortnose sturgeon decided to collaborate and share telemetry data from existing acoustic arrays beyond those within their own system ("Atlantic Cooperative Telemetry Network"). The ACT Network has expanded to include more than 65 researchers and 5,000 acoustic receivers from Maine to Florida focusing on more than 45 different species, including American Lobster, Atlantic Cod, Atlantic Sturgeon, Sand Tiger Shark, Sandbar Shark, Shortnose Sturgeon, Spiny Dogfish, Striped Bass, Summer flounder, Weakfish, and White Shark (for more details see "Atlantic Cooperative Telemetry Network").

ACOUSTIC SURVEYS

Several research efforts currently exist in both the United States and Canada for estimating the biomass of Atlantic herring in the Northwest Atlantic. Even with these large efforts however, the data in the SAMP area is very limited. An alternative source of data for looking at the distribution of Atlantic herring in the SAMP area is the NEFSC Fall Bottom Trawl Survey Data. This survey constitutes a long time series of data that encompasses the SAMP area (Figure X) ("Atlantic herring").

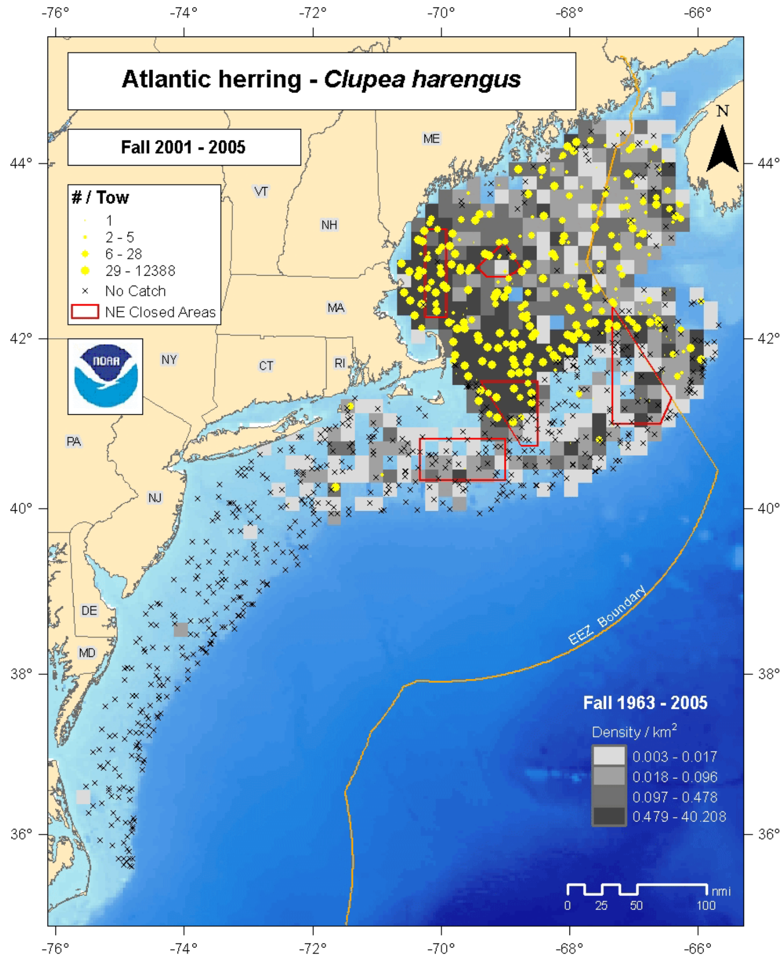

Figure 1. Relative species abundance and distribution from NEFSC bottom trawl survey by time block and relative species density for the full time series ("Atlantic herring").

SUGGESTED RESEARCH

Despite the ever growing number of acoustic arrays maintained along the East Coast, there are currently no known acoustic receivers deployed in the RI Ocean SAMP study area. Information gained from acoustic telemetry can be used to gain baseline information regarding where, when, and how areas within the SAMP are used by different species annually and over time. More specifically, acoustic arrays can be sited to identify migratory corridors, important spawning areas, and when appropriately combined with conventional tagging studies can produce specie specific estimates of abundance and mortality. Despite the number of species that currently carry acoustic tags, there are several species where this technique is not practical and thus, other techniques are likely more appropriate.

For example, improving our knowledge of Atlantic menhaden movement and distribution in the SAMP area would prove useful; however, tagging and acoustic studies may not be the most practical approach for obtaining this data. The state of Rhode Island has a

Narragansett Bay Menhaden Management program that manages the harvest of menhaden annually through possession limits, reporting requirements, and opening/closure of the fishery based on biomass estimates. In addition to commercial purse seine operations, the state of RI contracts spotter pilots to locate schools and estimate biomass for their management plan. Many spotter pilots keep detailed records on school counts and biomass estimates. Additionally, several pilots will operate in more than one state, essentially following the fish through their migration along the coast. As a result, the use of spotter pilot logs may provide informative information regarding the movement and distribution of Atlantic menhaden in the SAMP study area. If historical data does not avail itself useful for the study area, an alternative study could be the contracting of a spotter pilot to document the location, number and biomass of schools in the study area throughout the year. This type of study will not only provide movement and distribution patterns, but will also provide estimates of biomass.

Suggested Analytical Approach:

The aforementioned programs that may have data applicable to the study area for the target species should be contacted for available data. Data will be compiled for each species and used to develop maps including but not limited to distribution, movement/migration patterns, and abundance. The completed map products should then be reviewed to identify any existing data gaps. Once data gaps are identified, additional research should be proposed that address/fulfill those data gaps.

Conclusion

The suggested approach will not only provide useful baseline data on pelagic species for the study area, but additionally, this research fits within the research priorities identified by ASMFC, MAFMC, NEFMC, NEFSC, RI BRWCT, ACFHP, and the Bureau of Ocean Energy Management (BOEM).

FISHERY DEPENDENT DATA ANALYSIS

Introduction

One underutilized source of data is data derived from fishermen themselves. Surveys conducted on the fishing industry and/or use of VMS and vessel logbook information from the commercial fishing industry can be used to characterize fishery demographics, important usage areas, and the species specific to those usage areas which may provide insight into important habitats for those species. To create a more comprehensive fisheries characterization, a deep analysis of the data that already exists from these sources, as well as the development of comprehensive surveys to better characterize segments of the fishing community that do not record in logbooks or use VMS, should be conducted.

CFRF LOBSTER RESEARCH FLEET PILOT PROJECT

The CFRF Lobster Research Fleet Pilot Project is a collaborative endeavor among lobstermen, and state/regional/federal scientists with a Project Steering Committee comprised of representatives from the lobstermen who fish in Lobster Management Areas 2 and 3, state managers from the RI Department of Environmental Management and the MA Division of Marine Fisheries, and staff from the Atlantic States Marine Fisheries Commission (ASMFC) and NMFS Northeast Fisheries Science Center. The project focuses on testing methods to improve the collection and management of fishery dependent data. Specifically, the pilot program is designed to test new technologies that will enable lobstermen fishing in Lobster Management Areas 2 and 3 to collect and relay biological data to managers and scientists monitoring the lobster stock in these areas. The technologies being piloted in this project include the use of onboard waterproof tablets, electronic calipers, and internet relay of data.

The project uses a lobster research fleet approach that includes six lobster fishing vessels in each management area, with vessels strategically chosen to provide area coverage. Carapace length, sex, presence of shell disease, and egg bearing status/V-notch are recorded for a sub-sample of both retained and discarded lobsters. The goal for each vessel is to conduct at-sea sampling during three trips per month. Fishermen enter the number of trawls that will be hauled in a day and how many trawls they intend to sample. The tablet will randomly choose which trawl(s) to sample. While processing a trawl, the crew ceases data collection after 100 lobsters or 20 traps are sampled. Each vessel will sample a minimum of 300 lobsters or 60 traps per month. Data for lobsters caught in a subset of ventless traps is also reported. Each vessel will be given three ventless traps to use during the course of this project. Ventless traps will be deployed as the lobstermen see fit and all data is reported to the CFRF. Ventless trap sampling will not be associated with commercial trap sampling, and thus will be recorded in a different database. A specific lat/long, depth, soak time, and date/time will be recorded for each ventless trap. Lobstermen also have the option of entering notes regarding general observations e.g. tides, weather conditions, other species in traps, etc.

<u>Analytical Procedures:</u>

Collection of field data began in June 2013 and is being stored in an access database maintained by the project manager at CFRF. The database was designed to make the incorporation of the demographic data into the ASMFC stock assessment as easy as possible. Data collection will continue through at least May of 2014.

VESSEL MONITORING SYSTEM (VMS) DATA

Several fisheries in the offshore commercial fishing community require the use of a VMS on board the vessel. These devices record a vessel’s movements as they prosecute the various fisheries that they are active in. This information is a valuable source of fishing information and can be used to look at demographic, fishing strategy, and species specific information when used in conjunction with other available fishery dependent datasets.

This source of data can provide detailed maps that can be used for both demographic and biological information, and would be a valuable asset to other existing sources of data in the Ocean SAMP area.

FISHERMEN LOGBOOK INFORMATION

In addition to the VMS data source mentioned above, fishermen also record data in paper logbooks. Logbooks can take the form of state catch and effort logbooks, federal vessel trip reports (VTRs), and federal charter boat VTRs. The logbooks record a number of useful fields like species landed, species discarded, weight of species captured, area fished, gear used, and many other useful pieces of information. This system is used by a large segment of the commercial fishing community as well as certain segments of the recreational party and charter community, thereby creating a more demographically comprehensive dataset than that given by VMS alone. When used in conjunction with VMS data, logbooks may provide even more comprehensive information that can be used to characterize the ocean SAMP area, and it can provide pieces of information unavailable from any other data source.

SUGGESTED RESEARCH

While VMS and logbook information are important to analyze for their fishing biological and demographic information, additional information will be need to characterize the fishing public using this area in its entirety. Gathering this information could be accomplished through the use of a comprehensive fishing demographic survey. One of the major areas missing from the existing fishery dependent datasets would be a thorough characterization of the recreational fishery, most importantly the shore and private boat modes. The development of a thorough fishery survey is suggested as a critical area of research for the ocean SAMP.

<u>Suggested Analytical Approach:</u>

The aforementioned programs that may have data applicable to the study area. Data could be compiled and used to develop maps including but not limited to distribution, movement/migration patterns of fish species, demographic usage information, and fishing economic information. The completed map products could then be reviewed to identify any existing data gaps or could identify areas of greatest importance to the fishing community. Once data gaps are identified, additional research should be proposed that address/fulfill those data gaps. Fishery dependent data is particularly difficult to quantify, but techniques have been developed to help with the quantification process. Things like Jaccard indices can be used to collect information on effort which can then be used to quantify the other pieces of information in the fishery dependent dataset. The South Atlantic Region in particular has to rely on fishery dependent data for many analyses, therefore research the techniques used for their fisheries may be warranted.

Conclusion

The suggested approach will not only provide useful baseline data on both biological and demographic information for the study area, but additionally, this research fits within the research priorities identified by ASMFC, MAFMC, NEFMC, NEFSC, RI BRWCT, ACFHP, and the Bureau of Ocean Energy Management (BOEM).

2 Research focused on impact assessment

BEAM TRAWL/GILLNET (TRAMMEL NET)

Introduction

Traditional otter trawl surveys are often used to characterize fisheries spatially and temporally. To create a more comprehensive fisheries characterization, otter trawl surveys may be supplemented by beam trawl and/or gillnet/trammel surveys. Having a comprehensive dataset becomes especially important when trying to determine project-scale changes in an area such as those related to the installation of offshore renewable energy (ORE) devices. Supplementing otter trawl data by using gillnet/trammel surveys to investigate project scale impacts from ORE devices may not be the most practical approach for in the SAMP area. Gillnet/trammel surveys require daily maintenance and monitoring which may not possible for some portions of the SAMP area which are farther offshore. A better approach would be to conduct post-monitoring beam trawl surveys mirroring the methods used by Collie et al. (2013) for the baseline characterization of the SAMP area.

SUGGESTED RESEARCH

Conduct seasonal beam trawl surveys in the SAMP area after the installation of ORE devices (post-monitoring) following the methodology of Collie et al. (2013). Using the baseline data collected by Collie et al. (2013) as well as the post-monitoring data, conduct analyses including but not limited to analysis of variance (ANOVA) and non-metric multi-dimensional scaling (MDS) to look at before/after changes in abundance, biomass, and species composition. Environmental parameters and natural population fluctuation should be considered as well in the analysis to ensure that observed significant changes are in fact related to the installation of ORE devices.

Conclusion

The suggested approach will incorporate baseline and post-monitoring data to investigate the potential impacts of ORE device installation in the SAMP area. Additionally, the proposed research fits within the research priorities identified by the ASMFC, NEFSC, ACFHP, US Fish & Wildlife Southern New England & New York Bight Program (USFW SNEP), RI BRWCT, BOEM, and the Northeast Regional Ocean Council (NROC).

VENTLESS TRAPS

Introduction

Ventless pot surveys are used to characterize species that are difficult to measure through other techniques given the species specific propensity for use of structured habitat. To create a more comprehensive fisheries characterization, ventless pot surveys may be used to characterize species such as tautog, scup, black sea bass, lobsters, and crabs. Having a comprehensive dataset becomes especially important when trying to determine project-scale changes in an area such as those related to the installation of offshore renewable energy (ORE) devices. Supplementing other sources of data by using ventless pot surveys to investigate project scale impacts from ORE devices are a practical approach for use in the SAMP area.

SUGGESTED RESEARCH

Conduct a suite of random stratified surveys in the SAMP area occurring before, during and after the installation of ORE devices. These surveys can be conducted in such a manner as to determine impacts not only before and after an ORE project is conducted, but can also determine impacts with regard to proximity to the project area by setting up ventless pot arrays around the project zone. Using potential baseline data collected prior to the project as well as the post-project data, analyses can be constructed that include (but are not limited to) analysis of variance (ANOVA) and non-metric multi-dimensional scaling (MDS) to look at before/after changes in abundance, biomass, and species composition. In addition, spatial analyses can be conducted to determine scope of impacts in relation to the project zone, which could then be data used in any additional projects proposed for the area. Environmental parameters and natural population fluctuation should be considered as well in the analysis through both frequentist and Bayesian approaches to ensure that observed changes are in fact related to the installation of ORE devices.

Conclusion

The suggested approach will incorporate baseline and post-monitoring data to investigate the potential impacts of ORE device installation in the SAMP area. Additionally, the proposed research fits within the research priorities identified by the ASMFC, NEFSC, ACFHP, US Fish & Wildlife Southern New England & New York Bight Program (USFW SNEP), RI BRWCT, BOEM, and the Northeast Regional Ocean Council (NROC).

INDUSTRY DEPENDENT VESSEL AND FISHING INFORMATION

Introduction

Surveys conducted on the fishing industry and/or use of VMS and vessel logbook information from the commercial fishing industry can be used to characterize fishery demographics and important usage areas. To create a more comprehensive fisheries characterization, VMS data, logbook data, and fishing industry surveys may be used to characterize high use areas by fishermen, demographic information about what segments of the industry are using a particular area (i.e. commercial trawlers, recreational party boats, etc), as well as the species of importance to fishermen in those areas. Having a comprehensive dataset becomes especially important when trying to determine project-scale changes in an area such as those related to the installation of offshore renewable energy (ORE) devices. Supplementing other sources of data by using fishery dependent data sources such as VMS data, logbook data, or fishermen usage surveys is important to investigate project scale impacts from ORE devices. The use of these techniques is a practical approach for use in the SAMP area.

SUGGESTED RESEARCH

One approach would be to conduct a review of existing VMS and logbook data to map important usage areas in the SAMP and then compare this information to that collected after the installation of ORE devices. This analysis can be conducted in such a manner as to determine impacts not only before and after an ORE project is conducted, but can also determine impacts with regard to proximity to the project area. In addition to VMS and logbook data, surveying of fishermen can also be conducted in an effort to map out their usage areas. This would capture other segments of the fishing industry that would not be captured by VMS data, like smaller state waters commercial vessels and recreational fishermen. Again these surveys could be conducted periodically and compared prior to and post ORE projects. Using potential baseline data collected prior to the project as well as the post-project data, analyses can be constructed that include (but are not limited to) spatial analyses can be conducted to determine area usage by industry including the scope of impacts in relation to the project zone, which could then be data used in any additional projects proposed for the area. Mapping strategies and techniques would be a critical element of these types of analyses.

<u>Conclusion</u>

The suggested approach will incorporate baseline and post-monitoring data to investigate the potential impacts of ORE device installation in the SAMP area. Additionally, the proposed research fits within the research priorities identified by the ASMFC, NEFSC, ACFHP, US Fish & Wildlife Southern New England & New York Bight Program (USFW SNEP), RI BRWCT, BOEM, and the Northeast Regional Ocean Council (NROC).

VIDEO AND SCUBA SURVEYS

<u>Introduction</u>

In-water foundations that support ORE devices, such as wind turbines, are essentially de facto artificial reefs and provide opportunities for epiphytes and other marine organisms to colonize and create new communities. These communities have potential to both positively and negatively affect the composition and ecological function of surrounding benthic and fish communities. For example, foundations like artificial reefs often attract fish (Reubens et al. 2011); however whether these structures actually increase habitat value or fisheries production (Brickhill et al. 2005, Wilhelmsson 2012, Reubens et al. 2013) or offset possible gains due to increases in nonnative species (Bulleri et al. 2005, Glasby et al. 2007) requires further investigation. Considering these potential positive and negative impacts foundations will require monitoring and assessment. Video recording techniques, including drop or cable-controlled camera and remotely operated underwater vehicle (ROV's), and dive surveys using SCUBA are applicable approaches to monitor and assess impacts from foundations that support ORE devices.

SUGGESTED RESEARCH

Evaluation of impacts from foundations that support ORE devices will require detailed ecological assessments of communities before and after the installation of foundations at both development and non-development sites (i.e. control). The general goal of such research should be to assess impacts to and changes in the composition and ecological function of the on-site and surrounding benthic, "reef", and fish communities. Specific methods to conduct these ecological assessments in the SAMP area will need to be developed so that observations captured by video and SCUBA dives can be used to compliment work done by Malek et al. (2010) and Collie et al (2013). Monitoring both development and non-development sites over time will allow assessments to separate fluctuations influenced by natural processes and climate changes from impacts due to installation and long-term presence of ORE devices.

Conclusion

The suggested approach will incorporate baseline and post-monitoring data to investigate the potential impacts of ORE device installation in the SAMP area. Additionally, the proposed research fits within the research priorities identified by the ASMFC, NEFSC, ACFHP, US Fish & Wildlife Southern New England & New York Bight Program (USFW SNEP), RI BRWCT, BOEM, and the Northeast Regional Ocean Council (NROC).

VIDEO AND SONAR SURVEYS

Introduction

Video cameras and sonar systems can be used to characterize the abundance, temporal and spatial location, density, behavior, and species composition of fish in the vicinity of and within hydrokinetic power sites (i.e. tidal turbines). Some traditional survey gears (e.g. gill nets, otter trawls) can be difficult to use in deep water and strong currents, or when there are bottom obstructions; however, video and sonar systems can be used under such situations (Hightower et al. 2008). In addition, these approaches allow the documentation of fish in immediate vicinity of tidal turbines as well those approaching or passing through the turbine itself, thereby assessing potential and observed mortality from blade strikes.

SUGGESTED RESEARCH

Using baseline information collected prior to the installation of tidal turbines or other hydrokinetic power sources, monitoring and assessment of potential impacts can be focused on specific times of the year and tidal situations when species of interest are known to be present in the site area. Future studies should consider using multiple techniques in order to accurately assess and observe fish movement and behavior in and near operating turbines. For example, recent work conducted at tidal turbine sites in the East River, NY (see Smith and Adonizio 2011) coupled Dual-frequency Identification Sonar (DIDSON) and Split beam Biosonic transducer (SBT) with video recoding. This work shows promising results and suggests that when calibrated correctly, these techniques can be used to measure abundance, movement, and behavior of fish in and near operating turbines and assess impacts from hydrokinetic energy activities (Smith and Adonizio 2011).

Future studies must account for potential errors in species identification, length estimates of individual fish, and estimates of abundance that may stem from the size class (small fish are more difficult to estimate length) and azimuthal angle (the fish's angle could be off-axis within the view-field) of fish swimming at these sites (Hightower et al. 2008, Smith and Adonizio 2011). Research has shown that these sources of bias are apparent when files are processed manually and can be filtered out using automated software, providing that sonar sensors and video sources have been properly configured and adequate ground truthing has been completed (Maxwell and Gove 2007, Hightower et al. 2008). Ground truthing studies can include verifying sonar estimates with stationary fish netting (e.g. gillnets) or video arrays (Maxwell and Gove 2007, Smith and Adonizio 2011).

Conclusion

The suggested approach will incorporate baseline and post-monitoring data to investigate the potential impacts of ORE device installation in the SAMP area. Additionally, the proposed research fits within the research priorities identified by the ASMFC, NEFSC, ACFHP, US Fish & Wildlife Southern New England & New York Bight Program (USFW SNEP), RI BRWCT, BOEM, and the Northeast Regional Ocean Council (NROC).

3. General Research Priorities from Natural Resource Agencies Pertinent to the SAMP

Introduction

A table outlining the research priorities of all major agencies involved in the Ocean SAMP area is included in this section. In each row of the table , there is a brief description of a specific research priority and then an indicator of the agencies that have priorities related to the subject. Some points have overlap between many agencies; some are unique to one agency. The table is ordered by the subjects that have the most agencies with interest in that specific topic.

Agencies included and acronym definitions:

ASMFC – Atlantic States Marine Fisheries Council
NEFMC – New England Fisheries Management Council
MAFMC – Mid Atlantic Fisheries Management Council
NEFSC – NOAA Northeast Fisheries Science Center
NERO – NOAA North East Regional Office
ACFHP – Atlantic Coastal Fish Habitat Partnership
CFRF – Commercial Fisheries Research Foundation
BOEM – Bureau of Ocean Energy Management
USFW – US Fish & Wildlife Southern New England & New York Bight Program

Information from the below agencies are more goal oriented and what the specific agency or office does in general, not as much specific research agendas as were indicated for the agencies above, but are included as they are still relevant.

RIBRWCT – RI Bays, Rivers, & Watersheds Coordination Team
USGS – United States Geologic Survey
NROC – Northeast Regional Ocean Council
RISG – Rhode Island Sea Grant
EPA– Environmental Protection Agency Atlantic Ecology Division

Discussion

This document accumulated all local research currently taking place in or in close proximity to the Ocean Special Area Management Plan (OSAMP) zone. The document also indicated research ideas for projects that are not currently occurring in or near the OSAMP area, but would be considered important and valuable research for this area were it to be used for any number of projects including offshore wind energy projects. The document was meant to be a comprehensive examination of current and needed research, but research needs and priorities are a dynamic process, so re-evaluation should occur periodically. This document will serve as a good starting point for any subsequent re-evaluation of the OSAMP zone as it relates to marine fisheries.

The document provided a progression through existing research in the OSAMP area, research that would be needed for special use of this area, and concludes with a broad perspective on various agencies' research priorities. This consolidation of marine fisheries information should be helpful as a comprehensive view of the OSAMP area as it relates to marine fisheries resources and as special projects are proposed for this area now and in to the future.

The last perspective yet to be included is a vetting of the document through Rhode Island's marine fisheries community. The community is diverse and compromises both recreational and commercial users. They may lend additional research types to be considered and could also lend a valuable perspective to the research priorities beyond what is included in section 3 of this document. This vetting should take place before this document is finalized and the Rhode Island Department of Environmental Management could shepherd this process through the fishing community if deemed appropriate.

Table 1 – Research Priorities with agencies interested in each priority

Priorities	ACFHP	ASMFC	BOEM	CFRF	EPA	MAFMC	NEFMC	NEFSC	NERO	NROC	RI DFW/CT	RISG	USFW	USGS	COUNT
Monitor catch/effort, gear type and its effects on habitat and ecosystems, bycatch and bycatch reduction devices, and natural and fishing mortality with efforts to improve estimates and understanding where feasible	X	X				X	X	X	X						6
Consider the need for and develop ecosystem-based assessment/management methods by incorporating phenomena such as multispecies interactions and environmental effects, fisheries oceanography, trophic dynamics, essential habitat and spatial and temporal dynamics		X				X	X	X	X		X				6
Research, develop, and implement techniques for idetifying sources, causes, effects, magintudes and diversity of anthropogenic impacts such as fishing, pollution, and introduced substances on species, habitats, ecosystems, communities and economies and techniques for identifying pollutants, their sources, and impacts		X			X			X					X	X	5
Investigate, understand and attempt to mitigate influence of environmental factors and climate change on communities, coasts, economies, ecosystems, stock distributions, persistence, growth on various life stages, etc.		X				X	X	X			X				5
ID vulnerable, underutilized, spawning, nursery and/or essential habitats with using a variety of methods such as acoustic trawls, photo and video, and dredge transects	X	X					X	X	X						5
Investigate novel and improve existing methods to reduce bycatch across gear types and fisheries, especially highly migratory and protected species		X		X		X	X		X						5
Continue life history studies to estimate population sizes/abundances, sex ratios, fecundity, age structure, maturity schedules and maturity at age, natural and fishing mortality, growth, recruitment etc.		X				X	X	X							4
Develop a better understanding of ecosystem dynamics and threats as related to rebuilding important stocks and in terms of healthy habitats and changing ecosystem parameters and ecosystem goods and services provided by habitats in varying conditions (damaged, restored, alternative)				X		X	X	X							4
Develop indicators and examine trends of coastal community, habitat, population, and/or ecosystem vulnerability and resilience in response to climate change					X			X		X				X	4
Conduct research on stock definitions examining range, structure, mixing, and migratory patterns through tagging, DNA markers, morphological characteristics & other methods seen fit		X				X	X								3
Implement varying-scale (coastwide or regional) tagging/telemetry studies at different life stages to study factors such as growth, habitat usage, passage mortality, movement/migration, validated aging methods, reporting rates and tag loss/damage rates, stock mixing with possibility of incorporation into spatial and temporal models		X					X	X							3
Improve understanding of predator-prey relationships across life stages, general diets, ecological roles/niches, and effects on growth and mortality		X				X	X								3
Evaluate barriers to migration and movement, synthesize info to identify & prioritize fragmentation of barriers that have the potential to be critical threats, develop methods to quantify and improve fish passage efficiency and restore connections between previously fragmented habitats	X	X											X		3
Develop, implement, continue and/or expand dockside, port sampling and/or intercept surveys for commercial and recreational fisheries to quantify/collect mortality sources (natural, fishing, discard), fishing locations, catch rates, size distributions, sex stages & ratios, biological samples		X					X		X						3
Continue and improve, enhance, or expand fish, invertebrate, sea turtle, and/or marine mammal stock assessments, impact analyses, and biological and socioeconomic data collections to meet regulatory requirements and to implement an integrated ecosystem monitoring program		X		X				X							3
Develop programs to collect data on and evaluate socioeconomic/cultural aspects of fisheries using methods such as conducting surveys, gather oral histories, ethnological interviews, focus groups, etc.		X		X				X							3
Investigate social and economic impacts and effectiveness of area closures to enhance productivity and yield, and investigate new/modified measures as appropriate		X					X		X						3
Evaluate interspecies stock interactions - i.e one species slowing or preventing rebuilding of others							X	X							2
Improve our understanding of the short- and long-term effects of an increasingly noisy ocean environment on marine mammals and other species			X					X							2
Assess and evaluate the importance of specific habitat types for marine species by conducting habitat assessments, continuing to develop habitat suitability models to predict distributions (pelagic and benthic) in near-real time at sea, and participating in activities under the National Fish Habitat Action Plan	X							X							2
Link habitat types and respective functions with fishery productivity/health					X		X								2
Assess consequences of habitat loss, alteration and degradation, particularly for early life stages of fish and inverts with attempts to mitigate effects		X						X							2
Monitor, prevent and/or mitigate the introduction and establishment of invasive species and their impacts upon habitat quality, native species, and biodiversity.											X		X		2

Table 1 cont. – Research Priorities with agencies interested in each priority

Priorities	ACFHP	ASMFC	BOEM	CFRF	EPA	MAFMC	NEFMC	NEFSC	NERO	NROC	RI BRWCT	RISG	USFW	USGS	COUNT
Conduct scientific surveys to collect info to be used for stock assessments and ecological status and trends of important commercial fisheries								X			X				2
Develop industry-based data collection systems to improve information used for groundfish management							X	X							2
Collect spatial info to determine potential localized depletion effects		X						X							2
Estimate biomasses and reference points of less studied species		X				X									2
Develop, assess, and/or improve aging techniques using new hard parts or building on existing catalogues		x													1
Reseach the distribution & abundance of marine mammals in wind farm development areas			X												1
Characterize population-level mechanisms and develop predictive models of population responses and ecological condition under varying combinations of stresses					X										1
Carry out or take advantage of research that allows investigation of impacts of stressors on particular ecosystem components or processes								X							1
ID critical structural & functional components that determine population viability					X										1
Investigate patterns in disease (i.e. variation in biogeographic and population succeptibility)								X							1
Develop & verify population models for use in ecological risk assessments					X										1
Synthesize the structure of physical properties and circulation above the continental shelf in response to forcing caused by climate change								X							1
Determine the role of increased acidity in the ocean on structure and function of the ecosystem								X							1
Develop/validate models predicting the future state of ecosystems, changes in fish pops, and resulting effects on regional economies and social structures								X							1
Conduct research using multiple environmental variables to evaluate cumulative effects of disturbances on species reproduction, behavior, and other physiological processes								X							1
Continue investigation of harmful algal blooms and other pathogens								X							1
Develop a framework for interdisciplinary research that provides a better understanding of how sea-level rise, flooding of coastal embayments, and loss of wetlands will affect economically important fish populations.														X	1
Develop numerical relationships between environmental conditions & human well-being					X										1
Assess using hydro acoustics to repel from obstructions or pheromones to attract to passages		X													1
Identify priority areas in each subregion where priority habitats have been degraded or eliminated by past alterations to hydrology, and where conditions for restoration of habitats exist and restore those priority habitats in locations where threats have been removed	X														1
Minimize or reduce adverse impacts to priority habitats associated with coastal development and water dependent activities, e.g. rec boating & marine transport	X														1
Quantify effects of land-based activities on critical ocean habitats with possibility of designating essential fish habitat based on metrics including condition indices and habitat quality							X								1
ID nursery and overwintering habitats vulnerable to alteration by scallop fishery							X								1
Long-term chronic effects of scallop fishing on marine resource productivity, other ecosystem effects, habitat recovery potential, and fine scale fishing effort in fine scale relation to fine scale habitat distribution							X								1
Projects to assess whether preset Essential Fish Habitat and Habitat Areas of Particular Concern are accomplishing their stated purposes and better define complex ecosystem processes occurring in these areas							X								1
Detailed habitat mapping in areas of operation							X								1
Evaluate contribution of benthic habitat to prey survivability							X								1
Establish a comprehensive set of indicators for coastal habitats to assess habitat changes, impacts, and conservation and restoration progress.											X				1
Develop ecosystem indicators that will help determine which, and at what scale, observations should to be made								X							1
Develop decision support models that utilize web technology, spatial data, and visualization to identify areas at risk from coastal hazards.														X	1

Table 1 cont. – Research Priorities with agencies interested in each priority

Priorities	ACFHP	ASMFC	BOEM	CFRF	EPA	MAFMC	NEFMC	NEFSC	NERO	NROC	RI BRWCT	RISG	USFW	USGS	COUNT
Identify ecologically significant areas considering issues related to geographical scale, climate change effects and shifts in habitat, protection of biodiversity, vulnerability of species/habitats to particular human uses, understanding of and ability to map significant oceanographic processes and geologic features, and state of scientific understanding of the ecosystem										X					1
Gather baseline information on fish habitat affinities at the scale of individual wind farms			X												1
Environmental assessments with emphasis on significant impacts of wind farm development on the environment (effects of pile installation, vessel discharges, anchoring, noise, electromagnetic fields etc.)			X												1
Determine how predicted changes in climate and climatic variability may affect coastal habitat restoration efforts and how these impacts can be mitigated.														X	1
Monitor and assess ecological condition of coastal ecosystems					X										1
Identify areas that are significant for commercial and recreational fishing, considering geographic scale, temporal shifts in effort, and state of scientific understanding										X					1
Characterize demographics of fishing fleets by area and seasons		X													1
Develop more effective species ID methods for fishers, dealers, and port samplers							X								1
Promote improvements in quality of info provided by the industry through direct interaction with industry members									X						1
Evaluate the potential for new technologies -- including animal telemetry systems, passive acoustic arrays, autonomous underwater vehicles, and gliders-- to serve as research, assessment and/or monitoring tools and implement them if seen fit								X							1
Conduct research to determine whether fishing vessels can use oceanographic conditions as indicators to reduce bycatch								X							1
Develop and verify multispecies models to better understand interactions among species								X							1
Evaluate fishery monitoring strategies relative to science, management, & compliance, implementing improvements as appropriate							X								1
Develop models that allow us to better evaluate the consequences of multiple environmental change impacts, evaluate potential mitigations, and assess cumulative effects on both organisms and the environment								X							1
Develop assessment models to support fishery management control rules for data poor stocks using fishery dependent data						X									1
Maintain and where feasible, improve collection of the data required for stock and socioeconomic assessments								X							1
Implement novel supplemental surveys to derive fishery independent indices of abundance						X									1
Incorporate the use of fishery dependent data for improved stock assessments				X											1
Develop understandings of product flow through marketplaces		X													1
Develop/improve models for various life history stages and biological benchmarks incorporating relevant environmental, socioeconomic, anthropogenic and/or biological parameters to examine mortality rates, recruitment, effects of density dependent/independent interactions, interspecies interactions, etc.		X													1
Determine optimum utilization of long term fluctuating populations		X													1
Examine cause for retrospective patterns in New England multi-species groundfish assessments and resolve using appropriately identified adjustments							X								1
Develop bio-economic models to support fishery management							X								1
Establish a framework for risk analysis of alternative harvest policies						X									1
Conduct integrated ecosystem assessments (IEA) and support ecosystem-based management within the Northeast LME to meet emerging management needs and mandates								X							1
Develop an integrated ecosystem assessment for the NE Continental Shelf directly and through partnerships								X							1
Develop and improve ecosystem indicators of fishing and climate impacts necessary for advancing multispecies and ecosystem assessments for fish, invertebrate, and marine mammal populations and providing a means for assessing management efficacy								X							1
Use the contemporary tools of biotechnology and the biomedical field, including DNA technology, to applied research on the health of organisms and their interactions with the ecosystem								X							1
Conduct research that contrasts managed and non-managed areas to evaluate the impacts of management actions on ecosystem components								X							1
Develop baseline characterization of ecological, social and economic conditions for planning areas										X					1

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