OCS Study
BOEM 2017-016

ATLANTIC OCEAN ENERGY AND MINERAL SCIENCE FORUM

NOVEMBER 16-17, 2016

US Department of the Interior
Bureau of Ocean Energy Management
Atlantic OCS Region

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The Bureau of Ocean Energy Management thanks all the attendees at the *Atlantic Ocean Energy and Mineral Science Forum* for their enthusiasm and valuable participation. We especially thank the panel presenters for their time in preparing the presentations and providing excellent discussions. The panelists are identified along with a brief summary of their presentations in this publication. Brian Kinlan, we will miss you.

We thank the panel leads, Amy Stillings, Desray Reeb, Mary Boatman, David Bigger, Brian Hooker, Jennifer Bucatari, and Brad Blythe for organizing their panel sessions and gathering the presentation summaries.

Many others contributed to the success of this Forum, including Kyle Baker, Ann Bull, Algene Byrum, Andrea Heckman, Willie Hoffman, Jennifer Kilanski, Mark Mueller, Donna Schroeder, Ian Slayton, Christine Taylor, and Josh Wadlington. A special thank you to Meghan Winands Araiza who calmly and competently managed the registration and all attendee concerns throughout the Forum.

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Overview

The Bureau of Ocean Energy Management (BOEM) is funding studies to address environmental questions and collect scientific data in support of expansion of energy and non-energy related activities on the Atlantic Outer Continental Shelf. On November 16 and 17, 2016, in Sterling, Virginia, BOEM hosted the *Atlantic Ocean Energy and Mineral Science Forum* (Forum) to present BOEM's ongoing and recently completed studies, particularly those in support of BOEM's Renewable Energy and Marine Minerals Programs. The Forum objectives were to: 1) share with the public information from BOEM's and other recently completed studies and ongoing science activities in the Atlantic region; 2) identify research needs/information gaps for the development of new studies through BOEM's Environmental Studies Program; and 3) provide the public an opportunity to learn how BOEM utilizes the best available scientific information to support our decision-making processes.

The Forum was conducted over two days and followed an interdisciplinary format to provide the public updates for selected social and environmental science subject areas. The Forum included technical presentations by BOEM funded researchers and other Atlantic region experts in each subject area. Topic areas covered included fish and fisheries, marine mammals, coastal and marine birds, social and cultural resources, environmental stressors, sound propagation, and an update on the marine minerals program resource evaluation efforts.

Generally, the presentations took the form of panel discussions with one hour devoted to approximately four presentations, followed by 30 minutes of guided discussion to allow the audience an opportunity to ask questions about the presented research. Throughout the two days and during a special session at the end, the Forum participants were asked to provide input for emerging issues and future directions of the studies program. More information about the BOEM studies program is available on the BOEM website.

In all, there were 34 presentations, which are available at the end of this Forum summary.

Welcoming Remarks

Dr. Rodney Cluck welcomed the participants and provided an overview of BOEM's Environmental Studies Program. BOEM's mission is to manage ocean energy and mineral resources on the Outer Continental Shelf (OCS) in a safe and environmentally sound manner. BOEM has three program areas active on the Atlantic OCS: renewable energy, marine minerals, and oil and gas. The Environmental Studies Program supports all three program areas. At this Forum, BOEM is inviting the participants to provide input for future emerging issues and directions of the studies program.

Atlantic Activities Overview

Regional Ocean Planning Update

Bob LaBelle, Senior Advisor to the Director of BOEM, provided an update on the regional ocean plans, which are the Northeast Ocean Plan and Mid-Atlantic Regional Ocean Action Plan, that were developed as part of the National Ocean Policy. These plans will be finalized by the end of 2016. Each plan is linked to a regional ocean data portal that provides a synthesis of information about marine life and human use in each of the regions. This will lead to more regional input to the BOEM studies planning process and research efforts.

Renewable Energy Program

Michelle Morin, Chief of the Environment Branch for Renewable Energy, BOEM, described recent activities in support of the Renewable Energy Program along the Atlantic coast. Currently, there are thirteen active leases from Massachusetts to Georgia. BOEM has a four stage authorization process for renewable energy, and BOEM's environmental studies provide information that is used for each step. Recently, the Department of the Interior and the Department of Energy released the *2016 National Offshore Wind Strategy* that commits BOEM to improve communication about studies, provide data collection guidance, and continue to collect regional baseline data.

Marine Minerals Program

Dr. Jeff Reidenauer, Chief of the Marine Minerals Branch of the Office of Strategic Resources, BOEM, described the roles and responsibilities of the Marine Minerals Program. To date, the program has issued leases and agreements for OCS sand offshore six Atlantic coast states, with Florida having the most activity. He described the methodology for dredging and the potential impacts to the environment. BOEM collects scientific information to inform the leasing decisions, which include sand resource inventories, habitat characterization, and borrow area monitoring. In response to Hurricane Sandy, BOEM has also gathered additional information on the potential locations of new sand resources in Federal waters, particularly in the Northeast, where most of the coastal erosion occurred.

Conventional Energy Program

Matthew Frye, Chief of the Resource Evaluation Methodology Branch, BOEM, discussed the application of science to assess conventional energy on the Atlantic OCS. BOEM leasing for oil and gas was initiated in 1976 and ended in 1983 with no commercial production, however, data were collected in several locations. The 5-year Program for 2017 to 2022 does not include leasing for oil and gas on the Atlantic OCS, but assessments are required as part of the program development process. The assessments are prepared based on a variety of sources of data and through examination of similar areas around the world.

Social and Cultural Resources

Using Socioeconomic Data to Support BOEM's NEPA Assessments

Presented by: Amy Stillings, Industry Economist, Office of Renewable Energy, BOEM (Session Chair)

BOEM has a focused mission and our research needs are directed toward our responsibilities under the National Environmental Policy Act—providing information to allow officials to make informed decisions about the consequences of those decisions. Ms. Stillings highlighted recently completed and on-going studies. Areas she anticipates future studies include: 1) knowledge gaps needed for NEPA assessments as BOEM anticipates construction and operation plans from several offshore wind energy leases; 2) projects that help BOEM meet its commitments within Regional Ocean Action Plans; and 3) pilot project that more explicitly integrates ecosystem services into the decision making process.

Ms. Stillings is looking for collaborators in these areas: 1) Public perception – which is a difficult area for regulators –how should BOEM address concerns?; 2) Impact of offshore wind on the value of housing; 3) Commercial and recreational fishing—need more refined analysis of revenue and identification of important areas for fishing; Also continue dialogue regarding mitigations (e.g., best management practices); and 4) Ocean planning—examples include navigational concerns and refined analysis of vessel data and fishing.

More about BOEM's social sciences is available in the April-June 2016 *BOEM Ocean Science*.

The Effects of Offshore Wind Power on Recreational Beach Use on the East Coast of the U.S. Public

Presented by: George Parsons, Professor, University of Delaware

With BOEM funding, University of Delaware surveyed more than 2,000 of the east coast population to collect their response to simulations of offshore wind turbines. An objective was to understand whether offshore wind energy development would cause changes in the likelihood of tourists to visit beaches and what activities they engaged in while visiting. The results found that people were most concerned with the impact of the viewscape when turbines were closer to shore and 29 percent of the sample was concerned about impacts to marine life. The researchers then examined if the person's trip plans would change and looked at what factors influenced the probability of canceling a trip. Seven percent of the sample said they'd take a special trip to the beach to see the wind turbines. The final report will be available in 2017.

Comment: An attendee from Rhode Island mentioned that Block Island, which had a 5 turbine wind energy facility constructed off its shores, had a record number of tourism this year and hotels were full. Fishermen and others created new tours to bring visitors to view the offshore wind facility. Ms. Stillings indicated that BOEM funded the next study, which Dr. Bidwell will present on, to analyze the tourism and recreation impacts from this first U.S. offshore wind project.

Analysis of the Effects of the Block Island Wind Farm on Rhode Island Recreation and Tourism

Presented by: David Bidwell, University of Rhode Island

University of Rhode formed a multidisciplinary team to collect the first empirical data on the effects of an offshore wind farm on the local tourism and recreation. An objective is to identify indicators that can be used to measure effects of other projects on tourism. The research team will solicit input from community members to ensure that the data collected aligns with what the business community believes is important to the Block Island tourism and recreation sectors. Another aspect of the project is to capture people's experience while at the coast and on the water. For example, younger people may find a wind turbine a positive aspect because they associate it with clean energy.

Introduction to BOEM Archeological Research

Presented by: James Moore, BOEM

Dr. Moore outlined the relevant laws and regulations (such as the National Historic Preservation Act) that require BOEM to identify and consider effects to historic properties and which underlie the archaeological studies conducted by the Bureau. Various survey methods and technologies used to identify submerged archaeological sites were discussed followed by an overview of recent archaeological studies in the Atlantic. These case studies highlight BOEM's collaboration with other Federal agencies that create efficiencies and provide needed data to inform the bureau's decision-making. Through collaboration with NOAA, Monitor National Marine Sanctuary, BOEM has gathered baseline archaeological survey data for areas under consideration for wind energy activities offshore Maryland, Virginia, and North Carolina. These surveys have included direct investigation of potential targets by scientific divers to determine if they are significant archaeological resources that should be avoided during development or if they are not archaeological sites and therefore should not prevent development in a specific location. Additionally, BOEM and NOAA are conducting a multi-year project to document the Battle of the Atlantic by conducting archaeological investigation of both Axis and Allied losses during World War II offshore North Carolina.

Panel Discussion:

A comment was made that the survey of attitudes toward wind farm perception were being conducted in isolation of other important information, such as an understanding of energy use and climate change impacts. This thought was echoed by another audience member that indicated a greater need for social science studies. What do people think about energy? The United States is in an energy transition.

We're also at the point where we can start to collect baseline data to help answer if stakeholder positions before a facility hold up after a project is completed. For example, impacts of offshore wind energy facilities and coastal property values. Examining the impact of oil and gas platforms off of California may be an interesting aspect to explore since over time, attitudes change as the public became used to them. Another suggestion was to examine how on-shore wind facilities have been accepted. Dr. Bidwell said they will look at on-shore, but tourism and recreation is different on water and the potential symbolic feelings of the ocean need to be explored. An audience member suggested sociocultural studies are needed to help understand a person's attachment to a place.

Paleochannels are submerged remnants of former river channels and drainages on the outer continental shelf in areas that were once exposed as dry land during the last ice age. During subsidence from rising sea levels these channel features are often filled with younger sediments making them ideal targets for sand resource extraction. These features, however, are also often considered to be archaeologically sensitive as the former inhabitants of this landscape often lived, hunted, and conducted other activities near water sources. An attendee encouraged that there be more formal coordination between BOEM programs to ensure that potential archaeological sites are properly identified and protected during the designation of sand borrow areas. BOEM acknowledged this comment and agreed to continue efforts to improve internal coordination between program areas. Another attendee asked if BOEM coordinates with NOAA given the wealth of ocean industry data they have. Dr. Brad Blyth, Branch Chief within BOEM's Environmental Studies Program that OCLSA requires coordination with NOAA and USGS. Greater effort has been made in the last few years to improve coordination.

Marine Mammals

The Atlantic Marine Assessment Program for Protected Species (AMAPPS)

Presented by: Dr. Debra Palka, NOAA

The Atlantic Marine Assessment Program for Protected Species (AMAPPS) is a collaborative effort between NOAA Fisheries (the Northeast and Southeast Fisheries Science Centers), US Fish and Wildlife (USFWS), Bureau of Ocean Energy Management, and the US Navy. The objectives are to collect data on abundance and distribution of marine mammals, sea turtles and sea birds in the US Atlantic waters using a variety of methods: line and strip transect shipboard and aerial surveys; passive acoustic hydrophones towed behind ships and mounted to the ocean bottom; and tagging individuals with telemetry tags. Then, use these data to develop broad scale abundance estimates and fine scale seasonal, spatially-explicit density maps (and estimates) that incorporate habitat characteristics which put the distribution and abundance of the animals within an ecosystem context. The goal is that these results are in a format that can be used for management purposes and by the general public.

Since 2010, NOAA Fisheries conducted over 165,000 km of abundance line transect surveys using ships and planes and identified nearly 20,000 harbor seals in photographed haul out sites, and USFWS conducted over 104,000 km of abundance strip transect aerial surveys. Hundreds of hours of towed passive acoustic data were collected during the visual surveys and at night on the ships. Physical and biological characteristics were sampled using bongo nets, visual plankton recorders, mid-water trawls, and conductivity-temperature-depth probes at several hundred locations, and the surface water characteristics were recorded nearly continuously while the EK60 recorded backscatter of fauna in the water column. Other field efforts have attached various types of telemetry tags to harbor seals (29) and loggerhead sea turtles (about 200). In addition, static (e.g., bottom depth and slope) and dynamic (e.g., sea surface temperature, primary productivity, and mixed layer depth) habitat information was downloaded via satellite to update the ocean models along with field collected data.

As a result of integrating these newly collected data and applying distance sampling methods, generalized additive models and hierarchical Bayesian models (draft seasonally spatially-explicit density models) have been developed for 17 species of cetaceans. These data will be available via a public website where a user can outline a region of interest, and derive the density and abundance within this region along with being able to download the data. In addition, broad scale abundance estimates of cetaceans and seals have been published. The acoustic signatures of two beaked whale species have been characterized for the first time. New spawning grounds of bluefin tuna have been discovered. New information on the distribution and diversity of salps has also been discovered. Ongoing research includes documenting the spatial-temporal distribution of loggerhead turtles using tag, visual survey and bycatch data; integrating shipboard acoustic and visual data of deep diving species like sperm whales to develop a more precise and accurate abundance estimate; improving and expanding spatial-temporal distribution models of marine mammals, sea turtles, and sea birds; and integrating these distributions with the distributions of the physical and biological characteristics of the ocean.

Field Studies of Whales, Dolphins, and Sea Turtles for Offshore Alternative Energy Planning in Massachusetts

Presented by: Scott Kraus, New England Aquarium

The Bureau of Ocean and Energy Management (BOEM) designated two wind energy areas (WEAs) in New England: one offshore of Massachusetts (MA WEA) and the other offshore of both Rhode Island and Massachusetts (RIMA WEA). Under the National Environmental Policy Act of 1969 (42 U.S.C. 4371 et seq.), BOEM and other relevant federal agencies are required to conduct environmental assessments of offshore development and construction plans. Offshore wind-energy planning and development is new in the United States and comprehensive assessments of biological resources within wind energy areas are needed to identify and mitigate potential effects of development on marine species.

The main objective of this study was to collect visual and acoustic baseline data on distribution, abundance, and temporal occurrence patterns of marine mammals, in particular endangered whales and sea turtles, in the MA WEA and RIMA WEA. Secondary objectives were: 1) to assess the degree of inter-annual variability in animal distributions, and 2) to integrate aerial survey, acoustic, and photographic survey data on endangered large whales and sea turtles to provide an overview of habitat-use patterns.

A notable finding of this study was the consistent spring and summer presence of the relatively large numbers and diversity of marine mammals in the area corroborated by both survey methods. The aerial surveys collected a total of nearly a thousand records comprised of twelve different species, representing both odontocetes and mysticetes, in all seasons of the year during the study period. Six species of large whale and six species of delphinoids were observed during the study. Sixteen species of cetaceans and sea turtles were categorized as common to abundant, and another six as regular.

This study has made a major advance of marine mammal and sea turtle distribution and abundance in a broad area south of Cape Cod and Rhode Island, in what was previously a largely unsurveyed and uncharacterized habitat. In particular, it has revealed new information on right whale habitat-use patterns, demonstrating consistent winter and spring use of portions of the SA. However, given recent changing patterns of oceanography due to a changing climate, it is likely that future marine mammal and sea turtle seasonal distribution and abundance patterns may shift. Over the last five years, changes in right whale distribution and occurrence have occurred throughout the Northwestern Atlantic. These ongoing changes argue for continued monitoring of the WEAs' marine fauna.

Determining Offshore use by Marine Mammals and Ambient Noise Levels using Passive Acoustic Monitoring Offshore of Maryland

Presented by: Helen Bailey, University of Maryland Center for Environmental Science

As the focus of renewable energy in the United States turns to offshore wind facility development, there is an increasing need for an understanding of potential noise impacts on marine mammals. Pile-driving of offshore wind turbines produces loud, low frequency sound that can travel great distances and could potentially harm or disturb marine mammals. As a result, a critical first step is to understand the current baseline ambient noise levels and the spatiotemporal distribution of marine species that could potentially be impacted. Little is known about the year-round distribution of cetaceans offshore of Maryland, U.S.A. There is particular concern regarding the potential overlap with the migratory routes of endangered whale species, such as North Atlantic right whales (Eubalaena glacialis). We used passive acoustic monitoring to characterize the soundscape and determine the seasonal occurrence of cetaceans in and around the Maryland Offshore Wind Energy Area (WEA). We deployed Cornell University's Marine Autonomous Recording Units (MARUs) to detect whales at ten sites and C-PODs (Cetacean PODs, click detectors) to detect small cetaceans (dolphins and porpoises) at four sites ranging from approximately 10 to 60 km offshore. Acoustic data were analyzed for the period November 2014 to February 2016.

The large whale species most frequently detected was the fin whale (Balaenoptera physalus), followed by right, humpback (Megaptera novaeangliae), and minke (Balaenoptera acutorostrata) whale. These whale species were all detected more frequently within and offshore of the Maryland WEA compared to inshore of the WEA. There was a strong seasonal pattern with whale calls being most frequently detected in the winter and spring, although fin and right whales were detected year-round. The occurrence of right whales was highest during November to March and peaked in February. From May to September, dolphins were detected during 99% of days at the site closest to shore, predominantly during dawn and dusk, switching to increased presence offshore in the winter months. Harbour porpoises (Phocoena phocoena) were mainly detected in the Maryland WEA in November – May, and the occurrence of feeding buzzes (inter-click interval <10 ms) indicated they were foraging 30-60% of the time they were there. Limiting construction to periods when North Atlantic right whales are less likely to occur in the vicinity of the WEA could reduce the potential impacts of wind facility development. However, the year-round presence of cetaceans within the area indicates that at least some individuals may be within the audible range of pile-driving sounds. Continued monitoring during wind facility construction would help to determine the response of cetaceans to these sounds.

Passive Acoustic Surveys for Baleen Whales in the Virginia Offshore Wind Area

Presented by: Aaron Rice, Bioacoustics Research Program, Cornell University

Similar to many Mid-Atlantic States, little is known about the seasonal and spatial occurrence of marine mammals off the coast of Virginia. This data gap presents a challenge for effective marine spatial planning in the context of offshore wind energy development in the Virginia Wind Energy Area. As with other forms of human activity in the ocean, wind energy development has the potential to negatively affect marine mammals through increased ship traffic, construction and operational noise. Consequently, collecting baseline data on spatial and temporal trends of whale occurrence in these wind development areas is critical to minimize or mitigate risk to protected species.

We deployed ten bottom mounted passive acoustic recorders off the coast of Virginia in two spatial configurations. One series was deployed as a linear transect extending east from Norfolk across the continental shelf. The other series was deployed as a synchronized localization array within the wind energy area to acoustically localize calling marine mammals. We used a combination of human and automated acoustic analysis approaches to describe occurrence of four baleen whale species: fin whales (Balaenoptera physalus), humpback whales (Megaptera novaeangliae), minke whales (Balaenoptera acutorostrata), and North Atlantic right whales (Eubalaena glacialis).

Here, we report initial findings from the July 2014-May 2015 recording season. Right whales were most common in the area in January through March, with low levels of presence from October through April. Fin whales maintained a presence of greater than 50% of days of the month in October, November, and January and February. Humpback whales had low levels of presence in the fall, with some moderate (>30% of days) occurrence in January and April. Minke whales were detected only on <10% of days in November. Preliminary analysis of whale locations shows that whales are calling across the continental shelf, with no immediate signs of habitat preference or association.

As we continue with the project and ongoing data analysis, the large geographic and temporal scale of our study allows us to compare seasonal trends in whale presence in Virginia, as well as inter-annual variability for this region. Our goals are to: 1) use these data to identify periods of time with low whale occurrence to minimize any influence of construction behavior on their occurrence and 2) collect baseline data to compare against changes in during and post-construction occurrence to evaluate changes in whale ecology associated with wind farm construction and operation. These results will help inform regulators and developers of highly active seasonal periods, high-use regions or corridors, and frequency of off-season whale presence so that adequate protection may be provided.

Large Scale Monitoring of Acoustic Soundscapes and Species Distribution Patterns across the Western Atlantic Ocean

Presented by: Sofie Van Parijs, Northeast Fisheries Science Center, NOAA

Long term patterns and changes in distribution and movement throughout the Western Atlantic Ocean of baleen whales and odontocetes are being monitored using a variety of passive acoustic recorders. Historical data compiled from a large scale collaborative project examining data from 2006 to 2014 shows that North Atlantic right whales can be tracked throughout their migration northward in the spring and southward in the winter. Additionally, they are widely distributed throughout their entire range in winter months. Recent distributional changes in their use of certain areas since late 2010 show an increased acoustic presence in the mid-Atlantic region. Current efforts, funded primarily by BOEM, will continue to monitor the movement patterns of right whales, as well as sei, fin, humpback and blue whales from 2014 to late 2018. The BOEM funded shelf break acoustic ecology program which focuses on recording the entire frequency band used by marine animals started in 2015 with 3 High Frequency Recording Packages (HARPs) being deployed on the shelf break along Georges Bank. A further deployment of 8 HARPs stretching from Georges Bank in the Northeast US to the shelf break off Florida in the Southeast US aim to collect baseline information on the soundscape and species composition in these areas until 2019. Preliminary data from Georges Bank shows clear differences in beaked whale species composition in each shelf break canyon and variation in sperm whale occurrence. Ambient noise curves show how there are clear variations in the level of anthropogenic noise, biological noise (such as currents and weather) and presence of “clouds” of low frequency species, such as fin whales, between sites. The final analyses of the shelf break acoustic ecology program will allow an understanding of how the species composition and sound field in this region changes over time as well as whether there are changes resulting from the introduction of new anthropogenic noise sources or activities. This long term big picture view of species presence and movements is aimed at being able to improve our capacity to infer whether observed changes are a result of ecological, climatological or anthropogenic factors. In addition this big picture view is only possible through data sharing of multiple smaller scale projects funded by many federal agencies.

Panel Discussion:

Q: Will online data from ocean data web portals have been used or integrated in the studies being done regarding marine mammals?

A: They are looking at how to pull that data together, along with data from Duke University and AMAPPS, and it is a work in progress. Duke’s data is older, which is providing some challenges. NMFS and Duke are looking at how to best incorporate the Duke data with AMAPPS data, and then continue to update their data collection format to be compatible. Some of this data is “presence-only” data, and it is really “presence-absence” data that helps inform and train models. These represent three different model approaches and that there is an effort to ultimately compare and contrast these approaches.

Q: How are surveys timed, regarding North Atlantic right whale, and whether passive acoustic monitors should be incorporated during all survey operations to allow for the detection of North Atlantic right whales?

A: Including passive acoustic monitoring during daylight operations has been considered, but it is important to keep in mind that these animals are inherently cryptic, both visually and acoustically. NARWs vocalize mostly during dusk and dawn, so passive acoustic techniques are not very helpful during the day, and have already been incorporated as a requirement for any night time survey operations. The siting of the WEAs and BOEM’s standard operating conditions aim to avoid high densities of animals during sensitive times, since avoiding the potential of ever coming across any individual NARW at any time is practically impossible.

Q: Is the entire population of North Atlantic right whales moving, or are there sub-movements of distinct genetic or geographic groups?

A: There are no detailed genetic studies on North Atlantic right whales, but from what we do know, there are no subgroups. The entire population is related. Our understanding of North Atlantic right whale distribution assumes historical pastures, and assumes their distribution is mostly related to food. It may be more climatological or otherwise complex, and as such, is not an area of certainty.

Q: Does this data provide some information about where best to have wind development activities? How many single installed turbines it would take before one could reasonably determine if there is a change from the background level of distribution shifts, or otherwise be able to pick out the specific level of effect/impact from such structures?

A: The siting of the WEAs and BOEM’s standard operating conditions aim to avoid high densities of animals during sensitive times; other than that, there is currently no data that relates how NARWs respond to wind development activities. To answer the second question, this was an excellent question, and recommended attending a planned BOEM workshop in 2017 where BOEM is hoping to work with stakeholders to design a biological research framework to collect pre, during and post wind facility construction data to inform this question. At this stage, no one is sure of the answer, but in her opinion, the number is greater than 5, the current number offshore wind turbines installed on the Atlantic OCS. This is also about cumulative effects over distance. Most likely there will not be a mortality issue with marine mammals, but there could be a behavioral response, and if so, it could perhaps go beyond 20 km for a few days. Artificial reef effects could increase marine mammal activity later. She noted that there is more than one stressor, i.e., there could potentially be more than one wind farm in the range of a marine mammal in many scenarios of wind development on the Atlantic OCS, and that these need to be considered.

Q: Regarding modeling North Atlantic right whale distribution during G & G surveying, monitors are required. Does information from the monitoring feed into any of these studies and current modeling efforts?

A: Not yet, but that it has been talked about and that they have reached a point in time in which to start pulling that sort of data together.

Environmental Stressors

Overview of BOEM's Real-Time Opportunity for Development of Environmental Observations (RODEO) Program

Presented by: Anwar Khan, HDR Engineering; Jamey Elliot, HDR Engineering, James Miller, URI; and Kevin Smith, Fugro

The program Real-Time Opportunity for Development of Environmental Observations (RODEO) is designed to assess direct, real-time measurements of the nature, intensity, and duration of potential stressors during the construction and initial operations of proposed offshore wind facilities. The program also includes recording of direct observations during testing of monitoring equipment that may be used during future offshore development to measure or monitor activities and their impact producing factors. Data collected will be used to support analysis and modeling to evaluate effects or impacts from future offshore activities.

Three separate phases of environmental monitoring in and around the Block Island Wind Farm (BWIF) Project area were conducted under the RODEO Program. First, the installation of the foundations was observed in summer/fall of 2015. Cable installation between the mainland and Block Island was observed in June 2016. The installation of the towers was observed in August 2016. Monitoring of the activities includes visual, turbine foundation scour, seafloor disturbance and recovery, airborne noise, and underwater sound. Monitoring data will be used to support assessment of short-, mid-, and long-term environmental impacts.

Visual monitoring involved recording the type and duration of activities that occurred during jacket installation, wind turbine construction, and cable laying activities. The observations included the type of construction and duration, support vessels, weather, and other impact producing factors. Monitoring of the submarine cable laying from mainland to Block Island included the cable pull at each end and the cable laying. Visual observations were collected for the construction wind turbine generator 2 through completion of wind turbine generator 4.

Aerial and underwater acoustic monitoring was conducted during pile driving operations associated with the installation of the foundations in 2015. Pile driving generates intense sound, pulsating in nature at close range, which radiates into the surrounding air, water and sediment. Our team collected acoustic and seismic data ranging from 500 m to 15 km using moored vertical arrays of hydrophones, a towed array, tetrahedral array near the seafloor, 3-axis geophone on the seafloor, and air noise measurement systems.

Sediment disturbance and seafloor recovery is currently being evaluated through measuring seafloor disturbance from construction, monitoring seafloor recovery rates, observing seafloor disturbance during cable installation, and scour monitoring sensor testing.

The newly installed turbines are expected to start operations in December 2016. Under the RODEO Program, visual, airborne noise, underwater sound, benthic monitoring data will be collected. Marine mammal monitoring and evaluation of acoustic data is also planned.

Electromagnetic Field Impacts on Elasmobranch and American Lobster Movement and Migration from Direct Current Cables

Presented by: John King, University of Rhode Island

Electromagnetic fields are a concern for species that may use magnetic fields for migration. In the study, electromagnetic field effects on elasmobranch and American lobster movement, and by inference possible impacts on migration from Direct Current cables, were examined. We studied the effects of a high voltage direct current cable (HVDC) on lobster and skates. The field emitted by the Cross Sound cable outside of New Haven Harbor in Connecticut was surveyed using a "SEMLA" sensor consisting of a 3-axis electrode and fluxgate magnetometer. Based on the survey data we selected a study site on the cable and an adjacent control site off the cable. For this project, we built two mesh-lined cages and deployed one on the cable and one at the reference site in August/September 2016. Acoustic telemetry tags that generated a unique signal were attached to individual lobsters and skates. Their movements were tracked by using hydrophone receivers placed on the frame of the cage. The accuracy of the recorded movements was ~10cm. We are currently analyzing this data for evidence of effects on behavior due to EMF generated by the DC cable. In addition, the measurements of electric and magnetic fields are being incorporated into a predictive model (COMSOL) to evaluate and predict emissions from other cables.

Panel Discussion:

During the panel discussion, the audience asked several clarifying questions about the technology including how much energy is being produced, safety concerns, what type of pile driving system was monitored, and details as to the foundation type at Block Island Wind Farm.

In general, the focus of this forum was on the science and not policy or engineering, so some questions could not be directly answered. The Block Island Wind Farm used a jacket structure with four legs and the piles driven are of comparable size to those used in Europe, e.g., 60 inch diameter. As part of the underwater acoustic analyses, the effect of depth on sound levels is being examined. During collection of the acoustic data, measurements were not taken within 500 meters due to restrictions by the US Coast Guard. In the future, measurements closer to the sound source should be collected.

Clarifying questions were asked about the electromagnetic field study including the choice of species, whether other species could be considered for study, and whether the cage had effects on behavior. Skates are known to be sensitive to EMF and thus were selected, and lobsters were selected because fishermen were most concerned with them due to their economic importance and known migratory behavior on the sea bottom. Generally, behavior did not seem to be affected, but there was one hypoxic event that killed some lobster. The animals were subjected to acclimation periods in tanks after being tagged. Scallops were suggested as a potential species for future study.

An audience member suggested that these experiments be conducted on the cable between Block Island and the mainland. In response, measurements of the electric and magnetic fields are planned. Whether more detailed experiments will be performed depends on these measurements.

An audience member asked why these EMF studies were being done, and for how long, since Europe did a lot of EMF studies without finding anything conclusive, with uncertainty in both humans and animals. In response, while those studies found no impacts, effects have been measured. Here in the US, fishermen are immensely concerned about this and fear effects on lobster migration. All of the European research on this topic was on alternating current cables, and that this was the first study with a direct current cable. In addition, it takes many repetitions to be able to statistically determine that there are "no effects" and if you have a species that is not sensitive; it is still harder to do enough repetitions to come to the conclusion of no response.

The panel discussed what more data they would like to have collected. James Miller regretted not getting acoustic readings from 30 km and perhaps even 50 km from the pile-driving, with hydrophones. Kevin Smith would like to develop better backscatter multibeam surveys, more technology testing, and refine the collecting and interpreting of data.

Marine and Coastal Birds

Introduction to BOEM's Avian Research Strategy

Presented by: David Bigger, BOEM

Discussions during the USFWS Marine Bird Science and Offshore Wind Workshop and the BOEM Atlantic Wind Energy Workshop in 2011 identified several information gaps and needs to inform BOEM's process for offshore wind energy development on the Atlantic OCS. Soon after those workshops, BOEM developed an avian research strategy that includes identifying which species populations on the Atlantic OCS are vulnerable to collision and displacement by offshore wind facilities; finding out where they are and where they are not; describing how they move through the area; and understanding how individuals respond to development. In this session, our expert panel shares findings from BOEM funded research aimed at filling information gaps. The panelists Brian Kinlan, Tim White, Andrew Gilbert, and Julia Robinson Willmott, will give a short presentation. Afterwards, there will be a discussion of future avenues of research with the panelists.

Mapping and Modelling Distribution and Abundance of Seabirds

Presented by: Brian Kinlan, NOAA

Environmental assessments of ocean energy projects must consider different types of potential impacts (e.g., collision, displacement), different phases of construction and operation, differing technologies, and differing ecological and oceanographic contexts, leading to a complex planning problem. Moreover, since ocean energy facilities remain in operation for several decades or more, careful spatial planning is essential to minimize conflicts between these installations and seabird habitat. In the last 5 years, statistical models of seabirds have emerged as critical spatial planning tools for ocean energy siting and environmental assessment. We show how spatial models of seabird distribution and abundance have been, or are anticipated to be, incorporated into planning processes in these diverse contexts. We compare and contrast development and application of seabird models for ocean renewable energy spatial planning on the US Atlantic coast. This synthesis includes maps and data showing predicted occurrence and abundance for over 40 seabird species on the Atlantic OCS. These maps and data are available on Mid-Atlantic Regional Council on the Ocean (MARCO) Ocean Planning Data Portal and Northeast Regional Ocean Council (NROC) Ocean Planning Data Portal, NOAA NCCOS and BOEM's websites. Data this study used is in the USFWS Information and Planning and Conservation (IPaC) tool to show potential presence of migratory birds on the Atlantic OCS. We also developed an approach to estimate the statistical power of discrete survey events to identify species-specific hotspots and coldspots of long-term seabird abundance in marine environments. Using 30 years of seabird data collected of the Atlantic, we developed a practical approach to estimate the amount of sampling effort required for sufficient statistical power to identify species-specific hotspots and coldspots. In addition, we developed a method for testing the statistical significance of possible hotspots and coldspots. We show how this power analysis approach would fit in a general framework for avian survey design, and discuss implications of model assumptions and results.

Surveys off Massachusetts

Presented by: Tim White, BOEM

We conducted thirty-eight (38) aerial surveys of seabirds south of the islands of Nantucket and Martha's Vineyard, Massachusetts between 22 November 2011 and 14 January, 2015. The study area, which extends approximately 85 km offshore to the 60-m depth contour, has been designated as a "Wind Energy Area" (WEA) by the federal Bureau of Ocean Energy Management. We sampled approximately 23,000 linear km of transect over the three years. We mapped the distribution of all birds from data sampled along standardized strip transects. One of our goals was to detect the presence of persistent "Hotspots" of seabird activity; that is, locations where larger than average aggregations of seabirds occurred on a regular or repeated basis. We identified two Hotspots of seabird abundance: one near the western edge of the Nantucket Shoals, consisting mainly of Long-tailed Ducks and White-winged Scoters during winter, and Common and Roseate Terns during spring, and a second one in the Muskeget Channel area, consisting of scoters, eiders, loons, and terns.

Spatial use of the Atlantic OCS by Vulnerable Marine Birds

Presented by: Andrew Gilbert, Biodiversity Research Institute

Offshore wind energy is one of the fastest-growing sectors of world energy development, offering a clean abundant source of electricity to meet power demands. Offshore wind facilities, however, may impact many bird species via increased mortality due to turbine collisions, effective habitat loss through avoidance/displacement, and increased energetic costs by altering behavior and flight pathways. To evaluate the potential for effects on marine birds posed by wind turbines in Federal waters (>5.6 km from shore), there is a need to collect information on the distribution and movements of a broad suite of birds in these areas. Our project evaluated the fine-scale occurrence and movement patterns of three potentially vulnerable diving bird species with different flight and foraging characteristics in the near-coastal federal waters of the U.S. mid-Atlantic area (North Carolina to New York). We used satellite transmitters to track the winter movements of Northern Gannets (n=75) and Red-throated Loons (n=86) during 2012-2016, and Surf Scoters (n=186) during 2011-2016 in mid-Atlantic waters, and their migrations to and from their northern breeding areas. We used dynamic Brownian bridge movement analysis to estimate the use of winter and migration habitat. All three species made heavy use of the major bays of the mid-Atlantic (Chesapeake, Delaware, and Pamlico Sound) in winter. Northern Gannets ranged much wider than the other two species, with their distribution including nearly all coastal areas of the Atlantic coast and Gulf of Mexico. Red-throated Loons and Surf Scoters were more tied to bays, with some additional core use along Long Island and Cape Cod. Spring and fall migrations were different among all three species, and even within species, with some apparent differences in movements between sexes. Data derived from this project are designed to inform the permitting process, and regulation of future offshore wind development in the Atlantic region and provide important information on key habitat use and migration of a suite of species with different ecological niches.

New Technologies and Approaches for Characterizing Bird Exposure to Offshore Energy on the OCS

Presented by: Julia Robinson Willmott, Normandeau

Normandeau Associates has a long history in developing effective methods for collecting and interpreting data on animal presence, abundance, and behavior in the offshore environment. Many research projects have been directly funded by BOEM and three such studies are represented within this presentation.

High resolution aerial digital imagery is a broad-scale survey method widely used in Europe, but at the time of our study it was untested in the USA. We used high altitude aerial digital surveys to collect data on birds, marine mammals and turtles. Surveys were carried out in synchrony with traditional visual survey methods from boats and aircraft, providing the first direct comparison of resulting density estimates and success in species identification across all three methods. We found that the only method not to significantly underestimate turtle abundance was high resolution digital imagery, which found four times more turtles than aerial visual surveys and ten times more turtles than boat-based surveys. The study also highlighted the effects of attraction and repulsion on density and behavior caused by the proximity of visual survey vessels, key information to interpret data and assess impacts.

The second study presented here is the development of an acoustic and thermographic monitoring system to collect data on bird and bat presence and activity in the offshore environment. The system was first tested at a terrestrial wind facility, and then moved 29 miles offshore of North Carolina. The resulting data, collected over more than a year, show seasonal and weather-related bird and bat presence and activity, a unique insight into migrant passerine activity and important variation in weather-related bird flight behavior regarding timing, altitude, bearing and speed.

Making the best use of existing data on the diverse ecological and biological traits of birds in the offshore environment improves our understanding for the potential of population-level impacts from collision or displacement and helps to inform responsible siting of offshore wind projects. We therefore collected published information on 177 bird species found in the Atlantic Outer Continental Shelf (AOCS) to develop novel indices of sensitivity to developments within three categories. The population sensitivity index depended on the proportion of global range within the AOCS, abundance, and reproductive rate. The collision sensitivity index considered behavioral traits that contribute to collision risk, such as the amount of time spent in flight and within the rotor swept zone, and evidence for macro-avoidance behavior. The displacement sensitivity index distinguished habitat generalists from specialists and likely impact of displacement on foraging success. A combined sensitivity index shows that bird species differ by orders of magnitude in their likely sensitivity to offshore wind developments and provides an objective means for assessing and comparing impact across sites and designing mitigation measures.

Panel Discussion:

Q: For the distribution and relative abundance models, do you check the accuracy of the models through a verification process, like looking at subsequent data? Does your model take into account anomalous range extension like the razor bills we heard about, which may be due to climate change?

A: The methodology uses an iterative fitting method that holds some data back for verification, and for each iteration, we used statistics for verification. We have not used actual ground-truth verification through additional survey work, but we may in the future. Comparison with telemetry data may be used for verification too. For climate change, should look at the climatological pattern and predict future changes for the long range risk assessment such as wind facility siting. There is the potential for episodic events that should be taken into consideration for risk assessment, but the model does not include these. Some year-to-year effects and climate oscillations show variability and we can use this data to diagnose effects on some species that seem to be affected by climate and these species may warrant more study.

Q: Have you controlled for some of the biases in data collection in the modeling? Did you examine the effects of different parameters when modeling your data?

A: We used a hierarchy of effects starting with platform, then survey, and then transects, which includes things like observer difference and sea state differences. We do see effects such as some species are more likely to flush for a boat survey rather than an aerial survey. We are not able to take advantage of more modern techniques such as resurveying to understand availability and detectability which is needed to get absolute abundance. We report results as relative abundance rather than absolute abundance, so results need to be evaluated in a relative way.

Q: What are your thoughts about survey designs that examine pre-, during, and post-construction avian assessments?

A: Europe has gone to high-definition aerial surveys that fly at altitude above the turbines so you can do pre- and post-construction surveys and results are comparable. Boat surveys still have utility because you can capture behavior information. High resolution surveys also need to extend beyond one or two years after construction. For example, it may take a while for mussel beds to recover, you may need 4-5 years or more of data to fully understand the effects and recovery.

Q: What is the image resolution and could we use it to look at human activities?

A: Our resolution is 1.5 cm and the footprint of the image is 650 meters. We've observed human activities along the coast, but we did not record those observations.

Q: One action in the Mid-Atlantic Ocean Action plan is to increase understanding of shifting patterns of distribution in response to climate change. What can we do, looking into the future, to understand past shifts and to look to the future?

A: Temporal shifts can be looked at through taking time slices and making comparisons of hot spots for example. Modeling reveals hypotheses as to mechanisms and could form the basis for forward looking models. There is good work going on to downscale global climate models and to look at historical time series to look at fine scale oceanography and changes since 1900-1950. We may be able to predict a hot spot location 50 years from now using the climate information.

In Europe, in the year 2000, a project was initiated to predict habitat shifts from climate change and to identify future areas for habitat conservation before the shift in a species occurred. For some, you cannot help and there is a potential catastrophic result.

It is an incredibly complex question. Hotspots of birds track prey distribution and shifts in fish stocks including forage fish can be used to predict shifts for birds. There are recognized shifts in the core abundance of species. Telemetry may be used to track the shift in movements.

Fish Acoustics Panel

The fish acoustics panel was centered around the theme of trying to better communicate and understand what BOEM has done and what BOEM should be doing to better understand not only what fish species may be affected by noise generated by offshore wind energy development activities, but also how the various fish species may be impacted.

Brian Hooker gave a brief overview of BOEM's Renewable Energy Program's fisheries studies to date which include fish telemetry studies as well as lobster surveys. Potential impact producing factors from activities in support of site characterization, site assessment, and construction and operations were also presented. Lastly, a study idea regarding fish acoustics was presented.

Following Mr. Hooker's presentation, Dr. David Zeddies presented an overview of hearing in fish and invertebrates. The presentation explained the various pathways that fish and invertebrates experience sound in the marine environment. Dr. Aaron Rice then explained how fish could be impacted by anthropogenic noise in the marine environment. He explained the frequencies of soniferous fish communication and physical trauma that could occur under some sound pressure levels and frequencies. Dr. Rice also presented some of the results of baseline acoustic measurements that Cornell Cooperative Extension completed for BOEM in 2015. Dr. Rice also then presented some data gaps regarding impacts to marine fish and invertebrates from sound.

Lastly, Dr. Vince Guida and Dr. Beth Phelan presented information that they've collected regarding the biogeography of fish susceptible to noise from renewable energy activities and research that they have done with black sea bass. Dr. Guida showed the overlap of renewable energy lease areas with cod, haddock, black sea bass, weakfish, and croaker. The conclusion was that black sea bass were present in wind energy areas (highest occurrence offshore New Jersey, Delaware, and Maryland) in the warm season (summer/fall) and the weakfish and croaker were prevalent in wind energy areas on the warm season from New Jersey south. Dr. Phelan then presented on the work of auditory thresholds for black sea bass, weakfish, and croaker as well as the capabilities of the JJ Howard Marine Lab's ability to study black sea bass (and other fish behavior) when exposed to different stimuli.

The presentations clearly showed what studies BOEM and others have done to date, the identification of fish species that might be susceptible to noise impacts from renewable energy development, and studies that are necessary for better understanding the impacts.

The panel discussion was lead by Mr. Hooker and began by asking each of the panelists what BOEM needed to know about fish and acoustics. The responses included:

- Directional masking is important to understand and is completely unknown,
- There is an immediate potential for harm during construction and potential behavior response during operation.
- Ecology and ecological consequences is important to know.
- Are fish adaptable?
- To what degree is masking going to be a population impact?
- Need to know construction noise versus operational noise.
- Speculation is all very interesting but pile driving is the biggest concern for fish auditory harm.
- Initial mortality is not the biggest issue. The biggest issue is behavioral change, feeding, spawning etc.
- An aquarium is at least a place to start experiments

The audience was then brought into the discussion. A summary of questions and answers from audience members included:

Q: Big difference between acute impacts versus initial or long-term displacement from construction activities. Has science been done on "displacement" and "return?" Has science been done on locational response and recovery?

A: Some recent European studies have shown cod returned and increased at an installation site. It was a snapshot study that likely did not consider all possible questions. It's a question of whether we are willing to take a short-term decrease in abundance or chance a long-term impact. European studies were not necessary designed to help answer this question. They generally found that fish increased within 20 m around foundation, but less conclusive outside this area.

Q: For Block Island installation is operational noise at industry scale stressful to fish?

A: No studies have been completed yet. BOEM is looking at that question through the acoustic monitoring with the RODEO program. The physics work to be able to look at this question in a lab that can reproduce particle motion measured in the field. Producing a sound field that you want is difficult and involves questions of lab versus field experiments.

Q: Does masking occur from pile driving or from operational noise?

A: Injury is fairly easy to predict. Behavior changes and their consequence are unknown. There is some operational overlap of low frequency with hearing ability of certain species such as cod.

Q: What about decommissioning? Explosives will kill fish.

A: Decommissioning will take place twenty years in the future and may not require explosives. There are a number of cutting techniques currently being used so explosive removal may not be necessary.

Q: Is BOEM evaluating noise abatement for fish during construction?

A: Although there are a few possible techniques, e.g. bubble curtains or air space, no abatement was used during Block Island installation and there were no observed fish kills and fishing is active in the area.

The audience was thanked for their participation and the panel was concluded.

Marine Minerals Program

A Review of Marine Minerals Science Strategy and Studies

Presented by: Jennifer Bucatari, BOEM

This presentation outlined the structure and participants within the Bureau's Marine Minerals Program (MMP). The employees involved with the program are spread out over various Divisions at the Headquarters level along with the Regions (GOM and Pacific). BOEM has spent over $40 million on non-energy OCS resources since 1992. This funding includes more than 40 site-specific and programmatic studies in various topical areas relevant to the MMP. Historically there was a heavy focus on physical oceanography studies however more recently this has shifted to expanded resource evaluations, benthic assessment and recovery and endangered species. Jennifer discussed several ongoing studies including:

- Natural Habitat Associations and the Effects of Dredging on Fish at the Canaveral Shoals, East-central Florida. Navy Interagency Agreement; Glider-based fish tracking
- Sediment sorting during coastal restoration projects: implications for resource management, environmental impacts, and multiple use conflicts
- Discerning behavioral patterns of sea turtles in the Northern Gulf of Mexico to inform management decisions
- Development of a Decision Support Tool To Reduce Sea Turtle Dredging Entrainment Risk (find storyboard for this project here: http://arcg.is/298s5BO)

Jennifer concluded her presentation with the mention of several new starts for FY17 and a request for ideas/input from stakeholders for consideration in future MMP science strategies.

Preliminary Results of BOEM's Atlantic Sand Assessment Project, Location and Quantity of Coastal Restoration Mineral Resources on the Atlantic OCS

Presented by: Beau Southard, CB&I

This presentation described the goals, planning, execution, and preliminary results of the Atlantic Sand Assessment Project (ASAP). The ASAP project is funded through appropriations resulting from the impacts of Hurricane Sandy. $13.6 million of Hurricane Sandy funding was allocated to the MMP. The ASAP project consists of a desktop research and stakeholder engagement phase, a reconnaissance-level offshore mineral resource investigation, and a design-level offshore mineral resource investigation that began in winter 2014. A total of 6,177 km of geophysical surveys (interferometric sonar, sub-bottom, sidescan and magnetometer surveys) and 350 geological surveys (cores and surface) have been completed. This project has identified tens of millions of cubic yards of Atlantic OCS mineral resources for use in future shore protection and coastal restoration projects. This is an ongoing effort with more collection of design-level geophysical and geological data to occur. This project is crucial to BOEM's ability to manage OCS resources on a regional scale for future renourishment efforts and emergency response.

A National Outer Continental Shelf Sand / Sediment Inventory - Marine Minerals Geospatial and Information System

Presented by: Leighann Brandt, BOEM

A summary of MMP's Geospatial Information System (GIS) efforts and the status of its current data repository were presented. BOEM's geodatabase is still a prototype, and the data are still being developed. The database focuses on the Atlantic and Gulf OCS resources. Primarily, BOEM is seeking to incorporate data from all of their cooperative agreements and derived datasets from resource evaluation projects like the Atlantic Sand Assessment Project into a relational database system. Specifically, the geodatabase will include digitally-derived data sets linked to source data documentation. In addition to data collected and maintained by BOEM, the geodatabase will also leverage other agency datasets, including those from the U.S. Geological Survey (USGS), NOAA and USACE. The database is meant to assist BOEM and other potential users with information on where compatible sand / sediment resources are located on the OCS to support coastal restoration and marine spatial planning.

Characteristics of Sounds Emitted During High-Resolution Marine Geophysical Surveys

Presented by: Steven E. Crocker, Naval Undersea Warfare Center, Underwater Sound Reference Division

Scientific questions regarding the impact of noise in the marine environment have resulted in an increasing number of regulatory requirements and precautionary mitigation strategies to reduce the risk associated with high-resolution marine geophysical surveys performed in U.S. waters. However, data to estimate the ecological risk associated with the operation of a given high resolution survey system are frequently lacking. The Naval Undersea Warfare Center Division Newport (NUWCDIVNPT) conducted a study to quantity characteristics of sounds radiated by a variety of commercial marine geophysical survey systems including boomers, sparkers, airguns, chirp profilers, side-scan sonars, and multibeam bathymetric echosounders. Calibrated acoustic data including source levels, intensity spectra, and beam patterns were acquired for a total of 18 different marine survey systems. This presentation presented the analysis of a calibrated acoustic dataset collected to support future permit applications and in situ measurements in coastal U.S. waters. The report referenced in this presentation is available here: https://www.data.boem.gov/PI/PDFImages/ESPIS/5/5551.pdf. In addition, a database of calibrated acoustic waveform data was delivered to BOEM to aid in future studies to understand the potential ecological risks posed by the operation of certain high-resolution marine geophysical survey systems.

Ecological Function and Recovery of Biological Communities within Dredged Ridge-Swale Habitats in the South-Atlantic Bight

Presented by: D. J. Murie, University of Florida, School of Forest Resources and Conservation Program of Fisheries and Aquatic Sciences

The effects and recovery of sand dredging operations on biological communities of submerged ridge-swale habitats in coastal waters, and the recovery of these communities through time, are being examined off the east coast of Florida during 2013-2019. The study goals are: 1) to quantify the unique functional ecosystem services of submerged ridge-swale habitats in the South Atlantic Bight; 2) to determine the functional, biological services that are potentially compromised by dredging of sand from these habitats and determine the degree of impact; and 3) to investigate the mechanisms of recovery of invertebrate and fish communities associated with ridge-swale habitats post-dredging. Biological assemblages from plankton to predatory fishes are being sampled on an annual, seasonal, and diel (day-night) basis to aid our understanding of key functions and processes. Our approach is to examine trophic interactions among biota with a focus on the dynamics of prey availability, patterns of habitat use, changes in carbon assimilation, and isotopic and bioenergetic coupling. Fish use of these habitats is being assessed using bottom trawling, along with acoustic telemetry, which allows tracking of fish movement and habitat occupancy in ridge-swale areas. Potential prey are being sampled using the trawls, as well as plankton tows and benthic grabs. Effects of water characteristics, currents, and sediment type are being incorporated into fish distribution models. Functional components of the biological communities are being integrated into a ridge-swale ecosystem model using Ecopath with Ecosim, using Ecospace to assess the perturbation to the system due to dredging. This study is ongoing.

Panel Discussion: There was no panel discussion due to time constraints.

Future Needs

The final session of the Forum focused on gathering feedback from the participants, particularly seeking future science directions. Dr. Brad Blythe introduced the session and reviewed the mission and goals of the Environmental Studies Program. He then gave a brief synopsis of BOEM studies proposed for FY 2017 and FY 2018 in the Atlantic Region. Participants broke out into four groups and shared their thoughts about future directions for BOEM research. Following is a synthesis of the comments received, grouped by themes.

General

BOEM should use regulations and policy as a framework to identify critical areas of uncertainty and guide research. BOEM should consider what the need is in the scientific community. Population consequences of disturbance should be used as well as ecological functions of species. BOEM should identify useful indicator taxa. Baseline gaps should be identified and filled. Data collection should consider using drones for survey work. Resources should be ranked based on risk (can it recover) and understanding trade-offs, which can be used to assist in micrositing, for example, the onshore wind tool.

BOEM should consider subsistence activities in the Atlantic and Gulf of Mexico, paleochannels for their potential historic resources, and appropriate buffers for cultural and hardbottom resources.

Renewable Energy Program

Some areas that BOEM should consider are ship traffic, particularly indirect impacts from projects, especially during construction; infrastructure and supply chain, such as availability and capacity and consequences to construction times; and compatibilities and competition between offshore energy programs in the USA/International, e.g., availability of large vessels. Studies should be undertaken that focus on gravity-based foundations of offshore wind farms, for example how they interact with sediment types. Decommissioning of marine infrastructure and impacts to other OCS uses should be examined.

To improve our understanding of the effects of wind development, we need to recognize the difference between short-term vs. long-term impacts, for example construction noise vs. operational noise. Also, immediate effects may lessen over time; therefore, we should conduct longer term post construction monitoring to see if there is recovery of species that left the area, for example. We should also improve our risk assessments; some animals identified as high risk because of a lack of information rather than an actual risk. Lessons can be learned from studying Block Island, including monitoring results and best practices.

Additional areas of study of marine birds were identified including underwater sound impacts to diving birds, expanding telemetry studies into the South Atlantic for multiple species such as the Sheerwater, attaching tags on birds with altimeters to understand flight height or diving depth, and perhaps testing fish tags on sea bird legs to take advantage of the existing telemetry network.

Marine Minerals Program

Some comments were focused on the Marine Minerals Program. Some areas for future study included additional sand resource evaluation studies, understanding the economics of sand resources and the return on investment. The interactions between offshore dredging and commercial fisheries, especially Rhode Island, should include fishing stakeholders, including fisheries working groups and advisory committees in the study design and implementation. Another area of interest is how sand shoals change from south to north along the Atlantic Coast and investigations should not focus on individual shoals in isolation.

Conventional Energy Program

For conventional energy, the deepwater canyons are of particular interest and additional study of the connectivity between canyons is needed.

Climate Change

BOEM along with other Federal agencies should acquire long term biological data on breeding, wintering, or migratory stopover locations to understand changes due to climate. This applies to coastal and marine birds, as well as cetaceans like the sperm whale. For social science, the community benefits of renewable energy as well as detriments including climate change should be considered.

Sound

Soundscape should be considered as a habitat and BOEM can use marine spatial planning and the International Maritime Organization classification of ships to help identify effects of sound. BOEM should us a broader approach to address issues like sound; rather than focusing on short term impacts should evaluate the stressor in terms of the larger context in both space and time, e.g., shipping getting louder. In addition to putting sound into this larger context, work should be done to find trends in this context in order to develop a better and more predictive understanding of possible future scenarios. Science in support of EA/EIS, e.g., sound sources (propagation) should include what is being mitigated and impacts to resources. Mitigation should be evaluated as to how effective and did it impact the activity (e.g., spreading surveys out).

Fish

A comparative risk framework should be considered, for example, what are the stressors to fish and uncertainties in risk? BOEM should include a focus on listed species such as Sturgeon. Forage fish are also important to study. Functionally comparable species should be examined such as those dependent on hard bottom, is there a seasonal need? BOEM should consider the cumulative dynamic, for example fish and the effects of BOEM activities in conjunction with NOAA responsibilities for fisheries. BOEM should develop standardized methods and measurement capabilities of particle motion to evaluate impacts on fish from sound.

Communication

There is a disconnect between the public and the available knowledge; increased communication and outreach efforts are necessary. Outreach should include working with stakeholders to address issues, such as the fishermen. In the Northeast, additional fisheries outreach is needed, and could be modeled after the Deepwater Wind outreach program. Data collection can be combined with outreach, such as collecting fishing data directly from fishing activity. BOEM should connect more with states to facilitate Coastal Zone Management determinations. For the renewable energy program, BOEM should debrief project proponents on information related to operational activities (e.g., temporal constraints) and focus study ideas to assist the project proponent and help BOEM to understand issues. BOEM should also consider engaging the general public about OCS resources and issues, as most of the general public is completely unaware of BOEM until something (wind turbines, OCS sand) directly affects them.

Data/Data Sharing

BOEM should establish a data clearinghouse and provide available baseline data in on place for all to use, and require end product data be submitted to a publically available website. By having all the data in one place, it is easier to see where the gaps are, and set up an information exchange forum to generate ideas and proposals. Surveys required of industry should be incorporated into density models.

Lots of data already exists and BOEM should leverage other programs for BOEM use – interdisciplinary approach, e.g., biogeographic assessment on a regional approach; use current monitoring programs; bird surveys to inform fish distribution and abundance as well as observer reports, developer data, and BOEM institutional knowledge. In addition, BOEM should mine data already collected, for example, aerial imagery may be used to look at water color or human uses (e.g., lobster/crab pot distribution), data in existing portals and Europe, identifying the links between newer datasets and older ones. BOEM should also set data and metadata standards as is done with SeaScribe for avian data.

Agenda

ATLANTIC OCEAN ENERGY AND MINERAL SCIENCE FORUM

November 16-17, 2016

Agenda

Wednesday, November 16

7:30 – 8:30 am	Complimentary Breakfast and Registration	
	Welcome	
8:30-8:45 am	Welcoming Remarks	Rodney Cluck Chief, Division of Environmental Sciences, BOEM
	Atlantic Activities Overview	
8:45-10:00 am	Regional Ocean Planning Update	Bob LaBelle Senior Advisor to the BOEM Director
	Renewable Energy Program	Michelle Morin Chief, Environment Branch for Renewable Energy, BOEM
	Marine Minerals Program	Jeff Reidenauer Chief, Marine Minerals Branch, BOEM
	Conventional Energy Program	Matt Frye Chief, Resource Evaluation Division Methodologies Branch, BOEM
10:00-10:15 am	**Coffee Break**	
	Social and Cultural Resources	
10:15-11:30 am	Using Socioeconomic Data to Support BOEM's National Environmental Policy Act Assessments	Amy Stillings Industrial Economist, BOEM
	Public Attitudes, Values for Offshore Wind and Implications for Recreation and Tourism	George Parsons Professor, University of Delaware
	Analysis of the Effects of the Block Island Wind Farm on Rhode Island Recreation and Tourism Activities	David Bidwell Professor, University of Rhode Island
	Introduction to BOEM Archaeological Research	James Moore Archaeologist, BOEM
11:30-12:00 pm	Discussion with Panel and Audience - BOEM's Research Priorities in Social Science	
12:00-1:30 pm	**Lunch**	
	Marine Mammals	
1:30-2:45 pm	Atlantic Marine Assessment Program for Protected Species (AMAPPS)	Debra Palka Project Manager, NOAA
	Field Studies of Whales, Dolphins, and Sea Turtles for Offshore Alternative Energy Planning in Massachusetts	Scott Kraus New England Aquarium
	Determining Offshore Use by Marine Mammals and Ambient Noise Levels using Passive Acoustic Monitoring offshore Maryland	Helen Bailey University of Maryland
	Understanding Whale Presence in the Virginia Offshore Wind Energy Area	Aaron Rice Cornell University
	Large Scale Monitoring of Acoustic Soundscapes and	Sofie Van Parijs

	Species Distribution Patterns across the Western Atlantic Ocean	NOAA
2:45-3:00 pm	Discussion with Panel and Audience – Future Directions for Marine Mammal Research	
3:00-3:30 pm	**Networking Break**	
	Environmental Stressors	
3:30-4:30 pm	Overview of BOEM's Real-Time Opportunity for Development of Environmental Observations (RODEO) Program	Anwar Khan HDR Engineering
	RODEO Program – Aerial and Underwater Acoustic Monitoring	James Miller Professor, University of Rhode Island
	RODEO Program – Sediment Disturbance and Seafloor Recovery Monitoring	Kevin Smith Fugro Group
	Overview and initial results from a study of Electromagnetic Field Effects on Marine Organisms (Lobsters and Skates) from a submerged DC power transmission cable in Long Island Sound	John King Professor, University of Rhode Island
4:30-5:00 pm	Discussion with Panel and Audience: Future Directions for Research	

Thursday, November 17

7:30 – 8:30 am	Complimentary Breakfast and Registration	
	Welcome	
8:30-8:45 am	Review of Previous Day	
	Marine and Coastal Birds	
8:45-9:45 am	Mapping and Modelling Distribution and Abundance of Seabirds	Brian Kinlan Marine Ecologist, NOAA
	Surveys off Massachusetts	Tim White Avian Biologist, BOEM
	Spatial use of the Atlantic OCS by vulnerable marine birds	Andrew Gilbert Data Management Director, Biodiversity Research Institute
	New Technologies and Approaches for Characterizing Bird Exposure t Offshore Energy on the OCS	Julia Robinson Willmott Senior Scientist, Normandeau
9:45-10:15 am	Discussion with Panel and Audience: Further Avenues of Study including Avian Responses to Turbines	
10:15-10:30 am	**Coffee Break**	
	Fisheries	
10:30-11:15 am	Overview of BOEM's Fisheries Science Strategy	Brian Hooker Fisheries Biologist, BOEM
	Fish and Invertebrate Hearing Physiology	David Zeddies JASCO Applied Science
	Potential Effects of Offshore Wind Development on Fish and Invertebrates	Aaron Rice Cornell
	Fisheries/Offshore Wind Co-Occurrence and Focus on Black Sea Bass	Vince Guida/Beth Phelan NOAA Fisheries
11:15-12:00 pm	Panel Discussion: Important Outstanding Research Questions Regarding Anthropogenic Sound and Fish	

12:00-1:30 pm	**Lunch**	
	Marine Minerals Program	
1:30-2:40 pm	A Review of Marine Minerals Science Strategy and Studies	Jennifer Bucatari Oceanographer, BOEM
	A National Outer Continental Shelf Sand / Sediment Inventory - Marine Minerals Geospatial and Information System	Leighann Brandt Geologist, BOEM
	Characteristics of Sounds Emitted during High-Resolution Marine Geophysical Surveys	Steven Crocker US Navy
	Preliminary Results of BOEM's Atlantic Sand Assessment Project, Location and Quantity of Coastal Restoration Mineral Resources on the Atlantic OCS	Beau Southard CB&I
	Ecological Function and Recovery of Biological Communities within Dredged Ridge-Swale Habitats in the South-Atlantic Bight	Debra Murie Professor, University of Florida
2:40-3:00 pm	Discussion with Panel and Audience - BOEM MMP's Future Research Priorities	
3:00-3:30 pm	**Networking Break**	
	Future Needs	
3:30-4:45 pm	Panel Discussion: Future directions for Atlantic Environmental Studies and seeking participant suggestions	BOEM Staff
4:45 – 5:00 pm	Closing Remarks	

Presentations

Science-Informed Decisions from Use-Inspired Research

BOEM's Environmental Studies Program

Dr. Rodney E. Cluck

Chief, Environmental Studies Program

BOEM | Office of Environmental Programs

BOEM MISSION

Manage ocean energy and mineral resources on the Outer Continental Shelf in a safe and environmentally sound manner.

PURPOSE OF MEETING

- To Inform the Public on ESP Science

- To Hear Your Ideas on Important Emerging Issues

PROGRAM AREAS

Oil & Gas

5-year leasing plan

Regional lease sales

Renewable Energy

Site identification through stakeholder input and state task forces

Marine Minerals

Through negotiated agreement with state and local entities

ENVIRONMENTAL PROGRAMS MISSION

To study and prevent environmental harm from energy development and minerals extraction on the Outer Continental Shelf

ENVIRONMENTAL STUDIES PROGRAM PRINCIPLES

Remain **use-inspired** to apply results towards management decisions

Adhere to the utmost levels of **scientific integrity** and credibility

Seek partnerships to leverage funds and maximize utility of results

Engage regularly with stakeholders and public educational outreach for quality assurance, peer-review planning, and data dissemination

ESP Use-Inspired Model

"There is not pure science and applied science but only science and the application of science." Louis Pasteur 1863

ESP Business Model

Maintain

Core Expertise

in numerous scientific disciplines

BOEM Scientists

Develop, Oversee, and Manage

Research Projects

Engage the Scientific Community

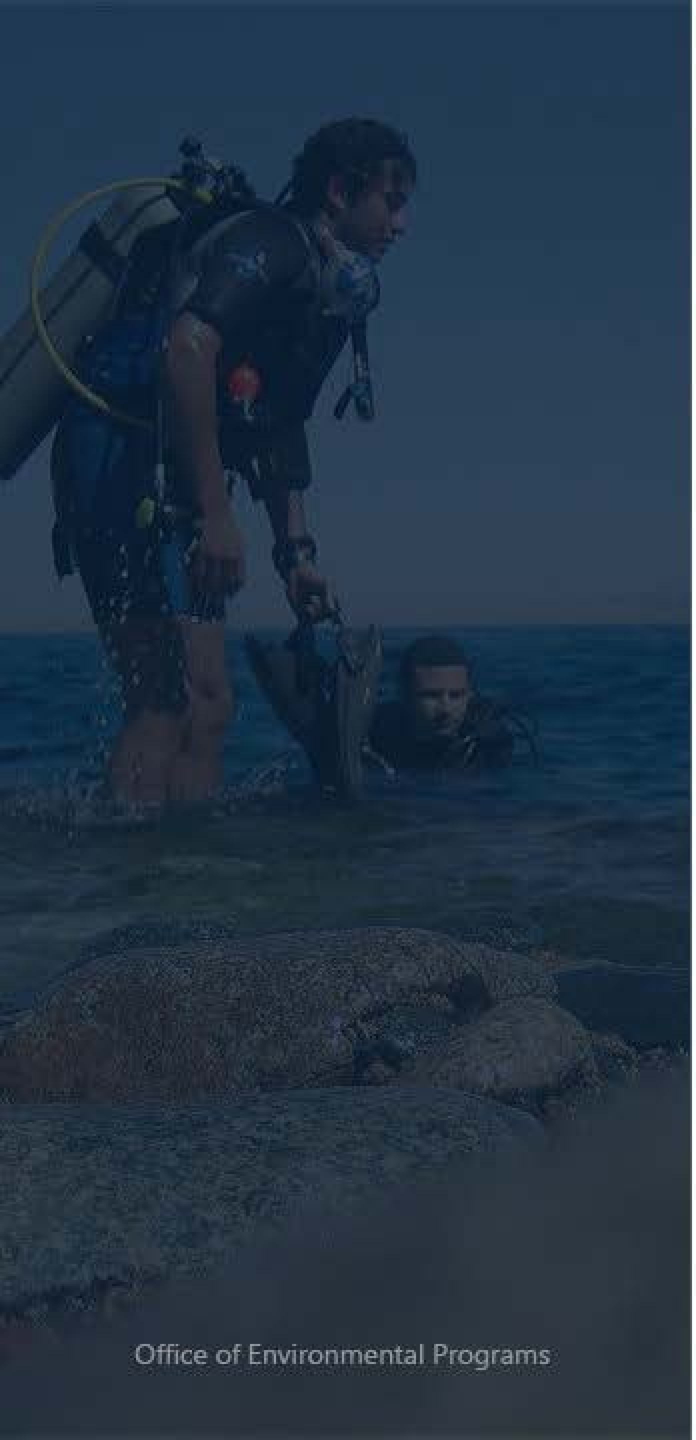
(academic, government and private sector)

to

Conduct the Science.

Seek Stakeholder Input

- Science Forums
- Annual Request for Study Ideas
- Regional and Office Engagement
- Public Meetings Task forces



STUDY DEVELOPMENT PLAN

Allows **ideas to flow**
with a look toward the future

SCIENCE/ASSESSMENT INFLUENCE

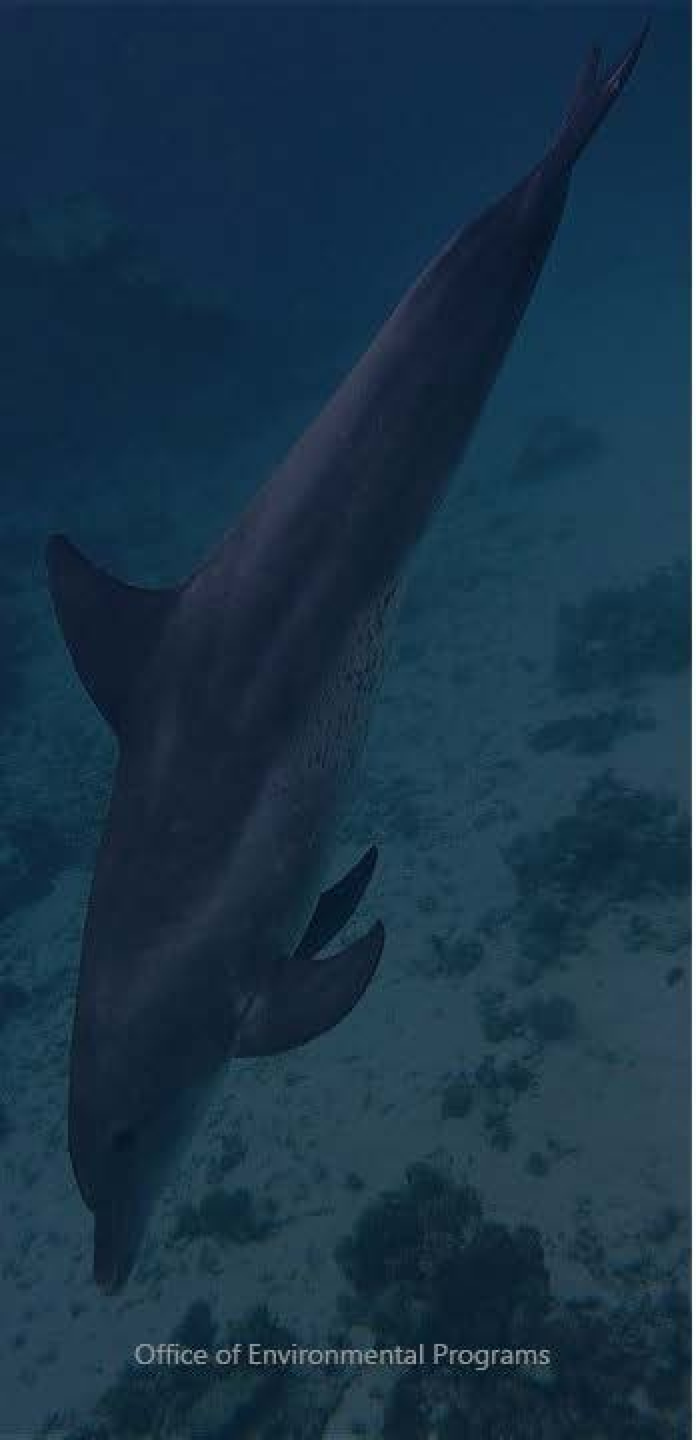
Clean Air Act	**Clean Water Act**	**Coastal Zone Management**	**Endangered Species Act**	**Magnuson-Stevens Fishery Conser. & Manag. Act**
Marine Mammal Protection Act	**Migratory Bird Treaty Act** E.O. 13186	**National Historic Preservation Act**	**Tribal Consultation** E.O. 11593	**Environmental Justice** E.O. 12898

↓

NEPA (National Environmental Policy Act)

↓

Science-Informed Decision



ESP RESEARCH AREAS

avian biology
marine mammals
sea turtles
fish
invertebrates
corals
benthic ecology
chemical and physical oceanography
marine and coastal ecology
marine acoustics
marine archaeology
data management
meteorology, air quality
economics
sociology and anthropology

Environmental Studies Program Information System (ESPIS)

"Science for Informed Decisions"

Dr. Rodney Cluck

Chief, Environmental Studies Program

BOEM | Office of Environmental Programs

rodney.cluck@boem.gov

Regional Ocean Plans – New Users for ESP Info

…. and ….

New Commitments

Bob LaBelle, DOI/BOEM

November 16, 2016

OCEAN PLANS

Ocean Plans Now Being Certified by NOC

Northeast Ocean Plan

- **September 28, 2016:** Northeast Regional Planning Body public webinar
- **October 19, 2016:** **NE RPB submitted the Plan** and response to public comments document to the National Ocean Council; certification possible after at least 30 days

Mid-Atlantic Regional Ocean Action Plan

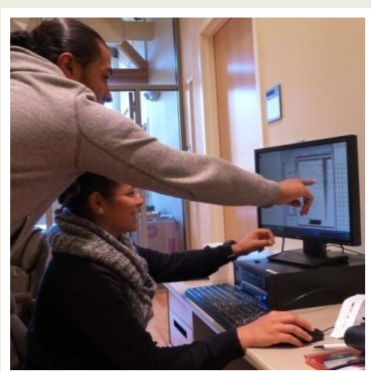
- **October 28, 2016:** **Mid-Atlantic RPB submitted the Plan** and response to public comments document to the NOC; certification possible after at least 30 days
- **December 8, 2016:** MidA RPB public webinar to update stakeholders

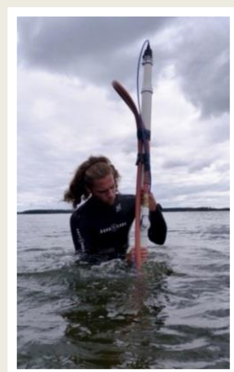
Next steps

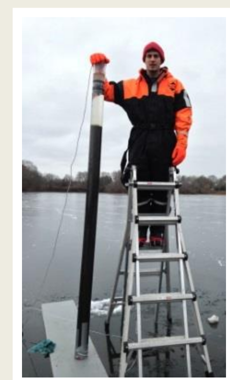
- **NE and MidA RPBs** sign implementation agreements
- RPBs begin implementing Ocean Plans; meetings; develop internal work plans

Regional Science & Research Priorities

1. Improve understanding of **marine life and habitats**
2. Improve understanding of **tribal cultural resources** (e.g., paleocultural reconstruction mapping)
3. Improve understanding of human activities, coastal communities, socioeconomics, and **interactions** between uses
4. Characterize the **vulnerability** of marine resources to specific stressors
5. Characterize **changing environmental conditions**, particularly resulting from climate change, and characterize resulting impacts to existing resources and uses
6. **Advance ecosystem-based management** (EBM) by building on the previous priorities and also including cumulative impacts and ecosystem services







BOEM Ocean Plan Commitments on Studies

- ***Partner in on-going and planned studies, identify knowledge gaps, and increase access to research planning cycles***

- **Northeast Ocean Plan offshore wind energy and sand management efforts:**
  - Identify R&D gaps
  - Link BOEM's Geospatial Information System to Data Portal
  - Create sand resources theme on Data Portal
  - Sand resource assessment areas
  - Geological and biological studies on sediments

- **Mid-Atlantic Ocean Plan offshore wind energy and sand management efforts:**
  - Use Data Portal
  - Increase access to study planning
  - Link BOEM's Environmental Studies Program Information System to Data Portal
  - Create offshore sand inventory
  - Continue studies and research

For more information:

OCEAN PLANS

- **Northeast Ocean Plan**: http://neoceanplanning.org/plan/
- **Northeast Ocean Data Portal**: http://www.northeastoceandata.org/
- **Mid-Atlantic Regional Ocean Action Plan**: http://www.boem.gov/Ocean-Action-Plan/
- **Mid-Atlantic Ocean Data Portal**: http://midatlanticocean.org/data-portal/

DOI Northeast RPB Member and Mid-Atlantic RPB Federal Co-Lead:

Bob LaBelle, Sr. Advisor to Director, BOEM
robert.labelle@boem.gov
703-787-1700

BOEM
Bureau of Ocean Energy Management

Offshore Renewable Energy Program

Michelle Morin, Chief, Environment Branch

Office of Renewable Energy Programs

Atlantic Ocean Energy and Mineral Science Forum | *Sterling, VA*

November 16, 2016

OFFSHORE RENEWABLE ENERGY

"… may grant a lease [for] energy from sources other than oil and gas … in a manner that provides for safety and **protection of the environment**."

- Energy Policy Act of 2005, Sec. 388

OFFICE OF RENEWABLE ENERGY PROGRAMS
ENVIRONMENT BRANCH

Physical
Air Quality
Water Quality

Biological
Marine Mammals
Sea Turtles
Fish & Essential Fish Habitat
Coastal Habitats
Benthic Resources
Avian & Bat Species

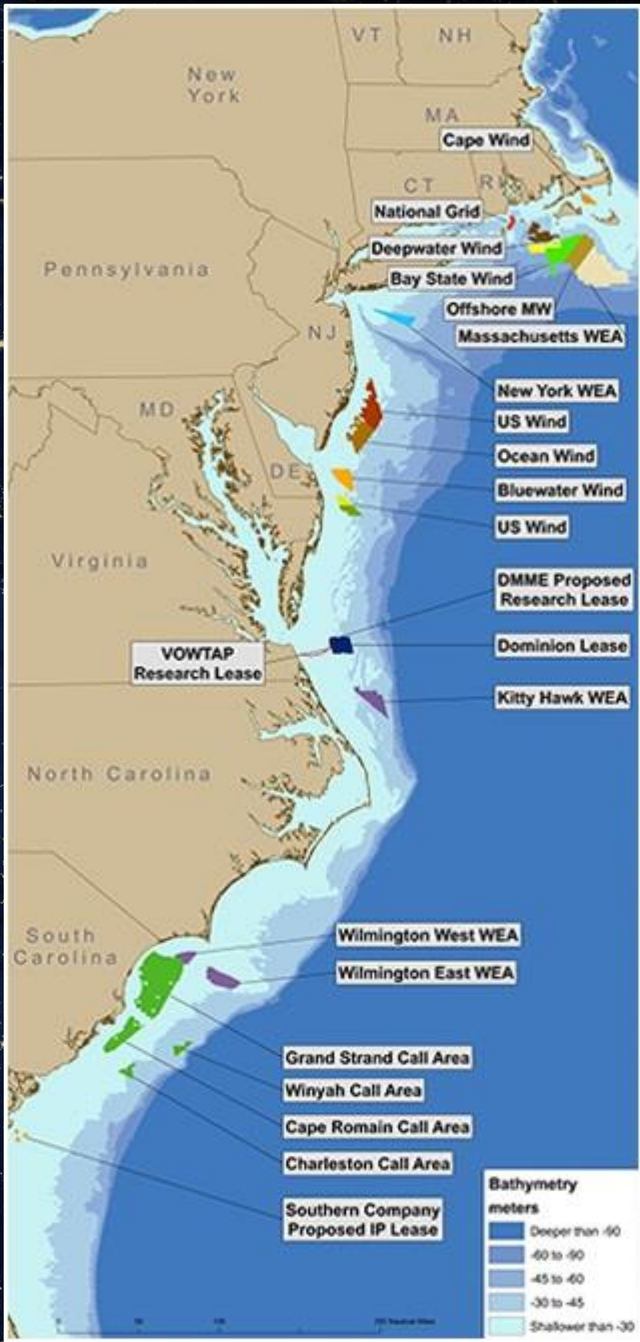
Socioeconomic
Aesthetics & Visual Resources
Commercial & Recreational Fishing
Cultural Resources
Military Uses
Environmental Justice
Land Use & Coastal Infrastructure
Tourism & Recreation
Demographics & Employment

NEPA Compliance

Consultations

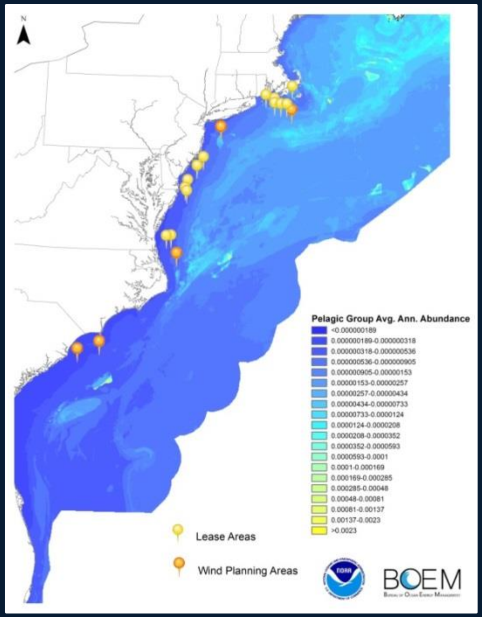
Studies

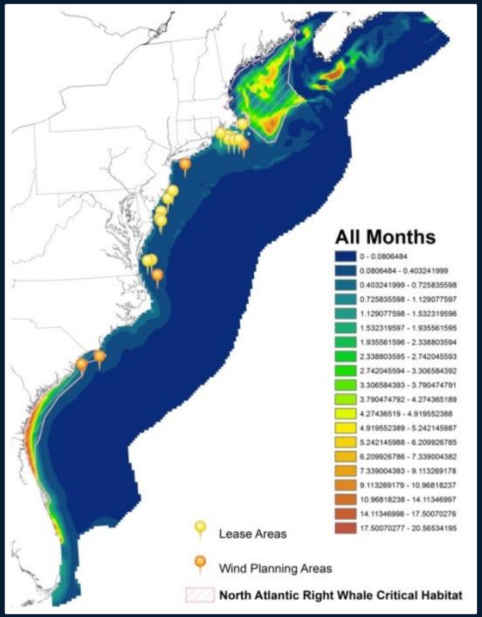
ATLANTIC
OUTER CONTINENTAL SHELF



4-STAGE AUTHORIZATION PROCESS

PLANNING & ANALYSIS





Planning & Analysis

4-STAGE AUTHORIZATION PROCESS

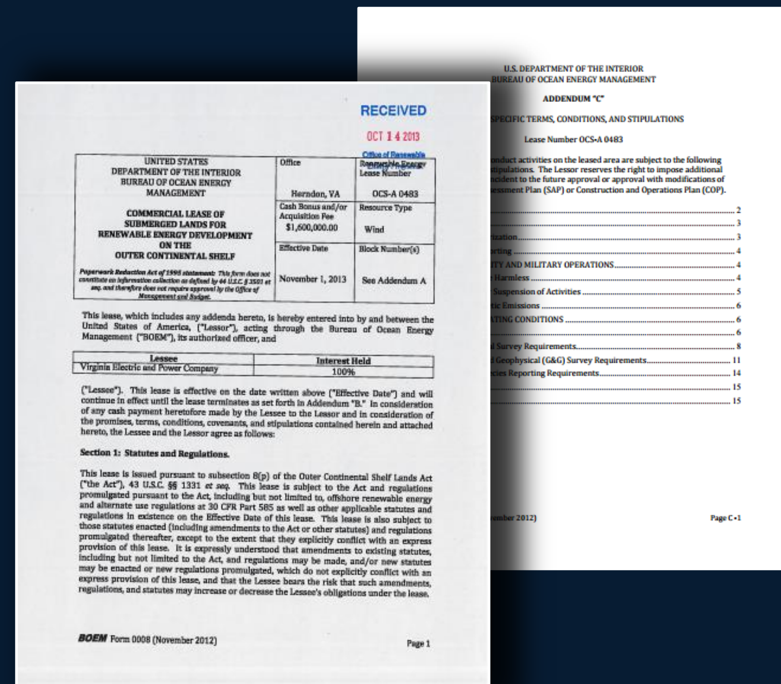
LEASING

44150 Federal Register / Vol. 78, No. 141 / Tuesday, July 23, 2013 / Notices

DEPARTMENT OF THE INTERIOR

Bureau of Ocean Energy Management

Atlantic Wind Lease Sale 1 (ATLW1) Commercial Leasing for Wind Power on the Outer Continental Shelf Offshore Virginia—Final Sale Notice



RECEIVED

OCT 14 2013

UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF OCEAN ENERGY MANAGEMENT COMMERCIAL LEASE OF SUBMERGED LANDS FOR RENEWABLE ENERGY DEVELOPMENT ON THE OUTER CONTINENTAL SHELF	Office Herndon, VA	Renewable Energy Lease Number OCS-A 0483
	Cash Bonus and/or Acquisition Fee $1,600,000.00	Resource Type Wind
Paperwork Reduction Act of 1995 statement: This form does not constitute an information collection as defined by 44 U.S.C. § 3501 et seq. and therefore does not require approval by the Office of Management and Budget.	Effective Date November 1, 2013	Block Number(s) See Addendum A

This lease, which includes any addenda hereto, is hereby entered into by and between the United States of America, ("Lessor"), acting through the Bureau of Ocean Energy Management ("BOEM"), its authorized officer, and

Lessee	Interest Held
Virginia Electric and Power Company	100%

("Lessee"). This lease is effective on the date written above ("Effective Date") and will continue in effect until the lease terminates as set forth in Addendum "B." In consideration of any cash payment heretofore made by the Lessee to the Lessor and in consideration of the promises, terms, conditions, covenants, and stipulations contained herein and attached hereto, the Lessee and the Lessor agree as follows:

Section 1: Statutes and Regulations.

This lease is issued pursuant to subsection 8(p) of the Outer Continental Shelf Lands Act ("the Act"), 43 U.S.C. §§ 1331 *et seq.* This lease is subject to the Act and regulations promulgated pursuant to the Act, including but not limited to, offshore renewable energy and alternate use regulations at 30 CFR Part 585 as well as other applicable statutes and regulations in existence on the Effective Date of this lease. This lease is also subject to those statutes enacted (including amendments to the Act or other statutes) and regulations promulgated thereafter, except to the extent that they explicitly conflict with an express provision of this lease. It is expressly understood that amendments to existing statutes, including but not limited to the Act, and regulations may be made, and/or new statutes may be enacted or new regulations promulgated, which do not explicitly conflict with an express provision of this lease, and that the Lessee bears the risk that such amendments, regulations, and statutes may increase or decrease the Lessee's obligations under the lease.

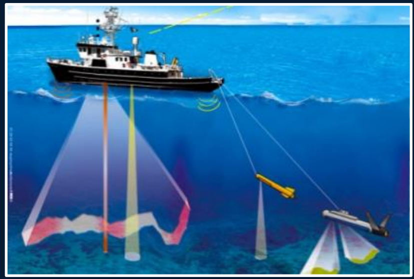
BOEM Form 0008 (November 2012) Page 1

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF OCEAN ENERGY MANAGEMENT

ADDENDUM "C"

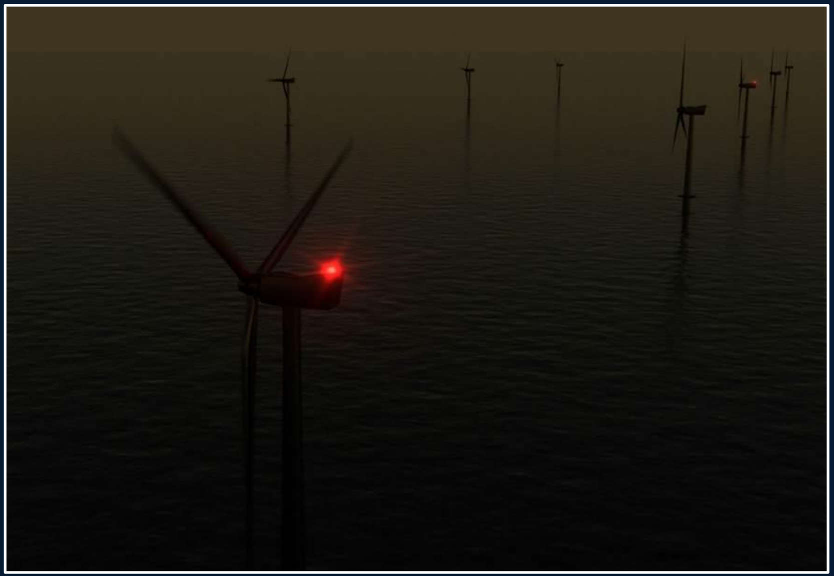
Lease Number OCS-A 0483

4-STAGE AUTHORIZATION PROCESS
SITE CHARACTERIZATION & ASSESSMENT



Planning & Analysis | Leasing | Site Assessment

4-STAGE AUTHORIZATION PROCESS
CONSTRUCTION & OPERATIONS



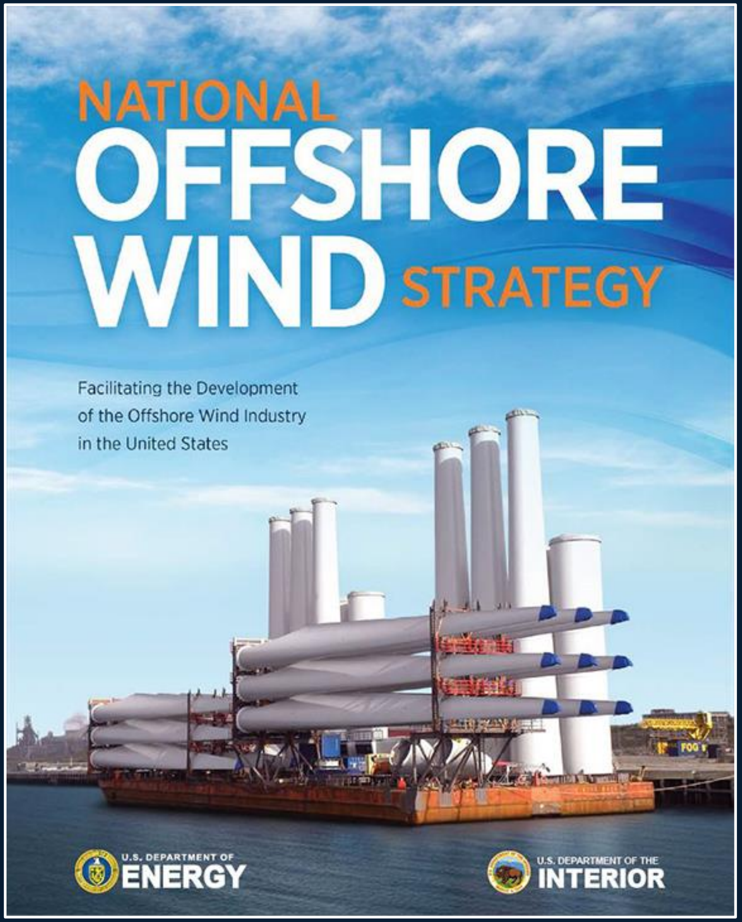
Planning & Analysis | Leasing | Site Assessment | Construction & Operations

ACTION AREA 2.2: MANAGING KEY ENVIRONMENTAL & HUMAN-USE CONCERNS

Action 2.2.6: **Improve Communication** of BOEM's Offshore Wind Energy Studies & Research with All Stakeholders

Action 2.2.7: Provide Guidance to Clarify Information Needs & **Data Collection Requirements**

Action 2.2.8: More Comprehensive **Baseline Data Collection** to Support Regional Spatial Planning



MID-ATLANTIC & NORTHEAST

REGIONAL OCEAN ACTION PLANS

Partner in on-going and planned studies

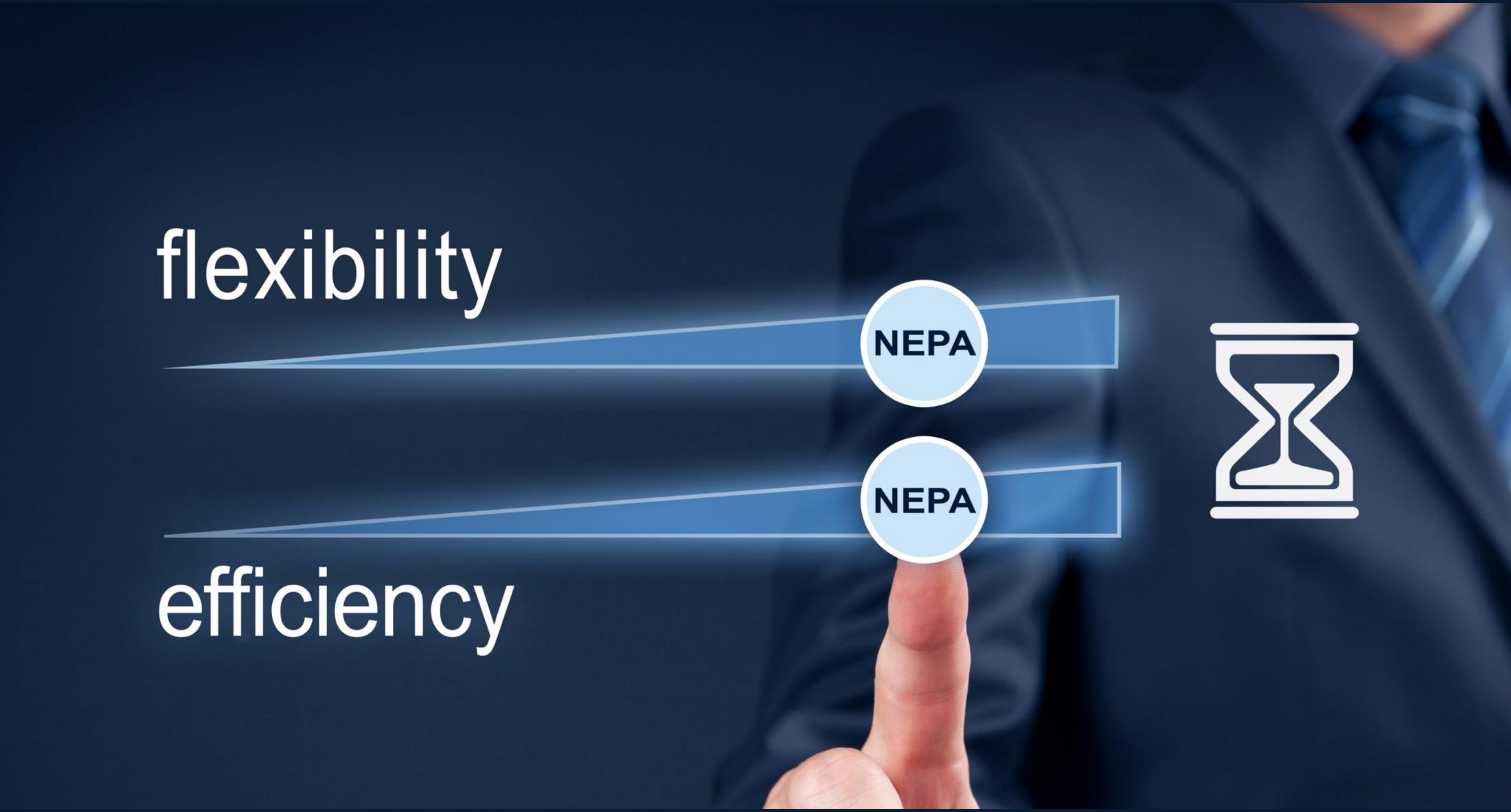
Identify knowledge **gaps**

Increase **access** to research planning cycles related to ocean energy

Provide additional **regional data**

Maintain and use **data portals**

ENVIRONMENTAL ASSESSMENT



ENVIRONMENTAL STUDIES

BOEM
Bureau of Ocean Energy Management

Michelle Morin

michelle.morin@boem.gov

703-787-1722

For more information visit
www.boem.gov/Renewable-Energy

BOEM
Bureau of Ocean Energy Management

Marine Minerals Program



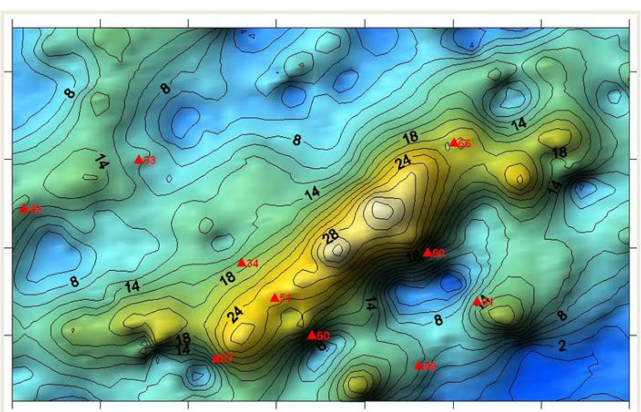
Jeff Reidenauer, PhD
Chief, Marine Minerals Branch
Leasing Division
Office of Strategic Resources

Atlantic Ocean Energy and Mineral Science Forum

16 November 2016

Roles and Responsibilities

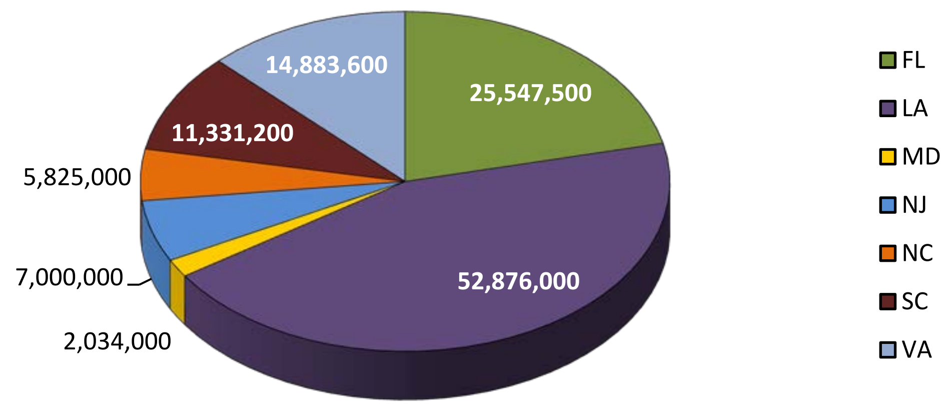
- Manage non-energy marine minerals in Federal waters
- Identify and evaluate OCS sand resources
- Respond to requests for use of OCS sand through issuances of leases/agreements
- Promote environmental stewardship of these finite resources
- Conduct environmental reviews (e.g., NEPA) and consultations (e.g., ESA) for proposed actions
- Use stakeholder outreach and coordination in decision-making process



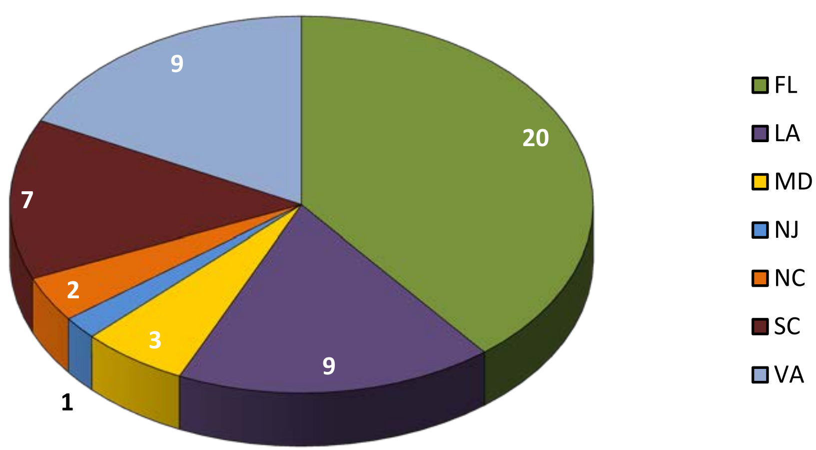
Program Activity by State

NASA Flight Facility, Wallops Island, VA

Cu Yd Allocated

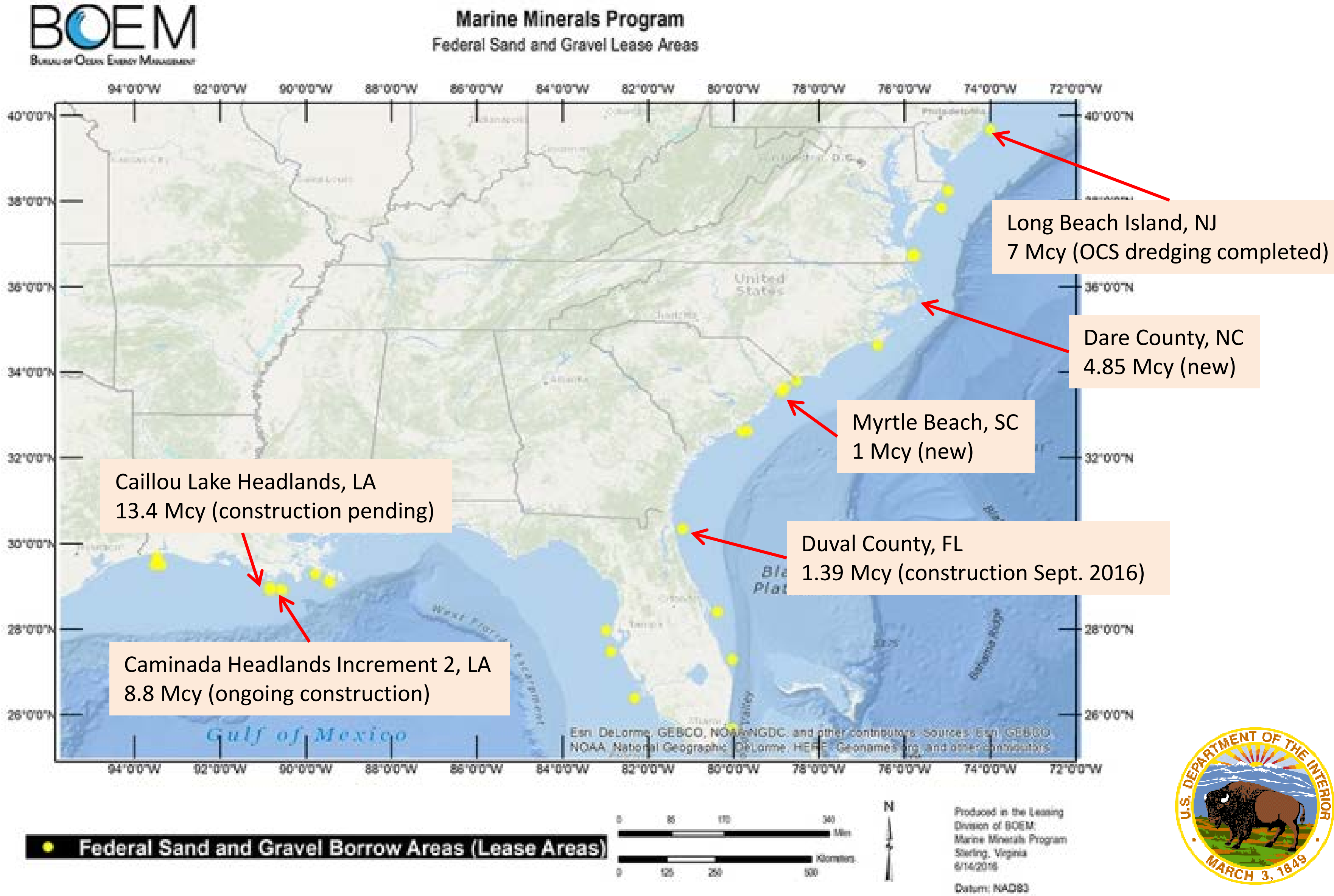


Number of Leases



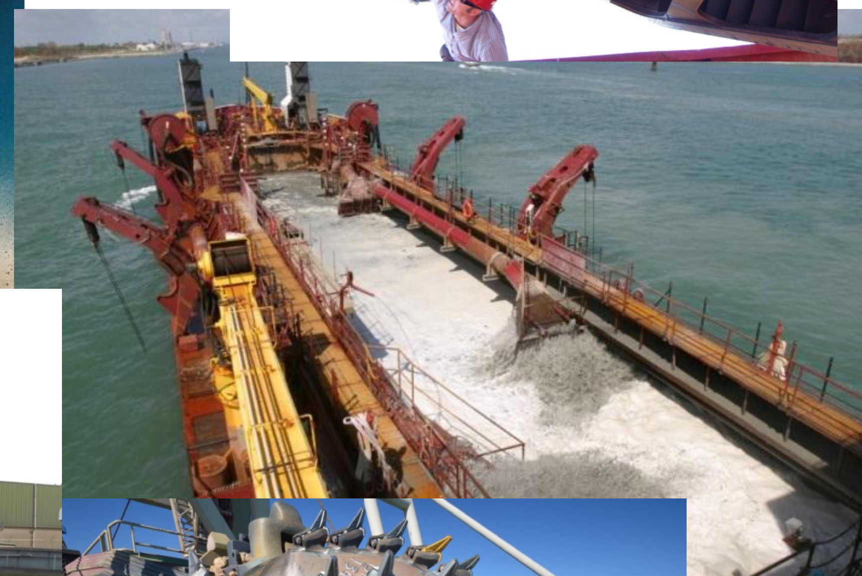
Long Beach Island, NJ

Recent Leases and Agreements



Bureau of Ocean Energy Management

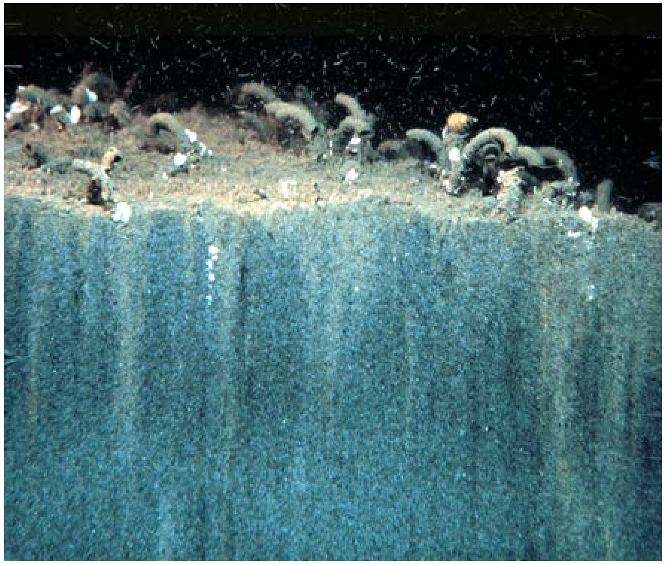
Offshore Dredging

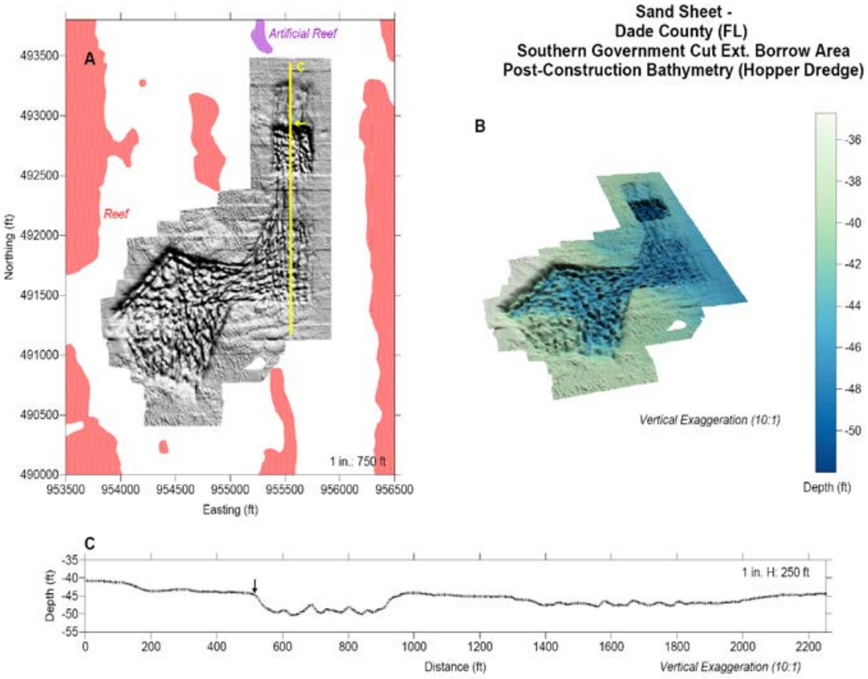


BOEM
BUREAU OF OCEAN ENERGY MANAGEMENT

Potential Dredging Impacts

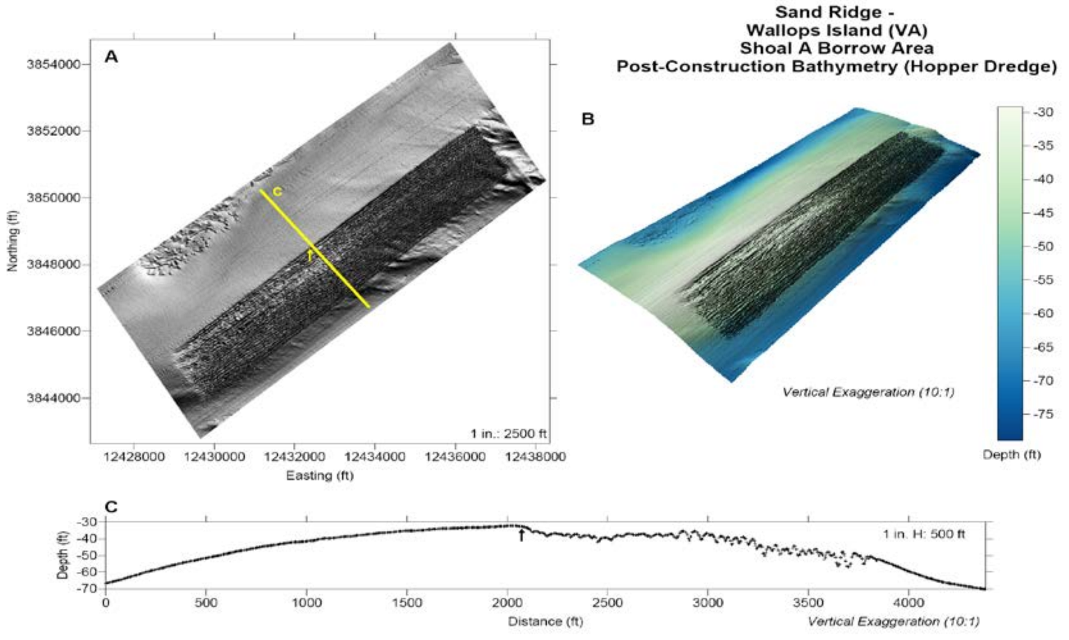
- Protected species
- Substrate characteristics and bathymetry
- Near-field currents and sediment transport
- Submerged cultural resources
- Benthic habitat and species diversity
- Essential Fish Habitat (EFH)





Marine Minerals Program Science

- Sand Resource Inventory
- Habitat Characterization (biological, physical, geological)
- Environmental Assessment and Review = NEPA, Environmental Consultations
- Mitigation – Avoid and Minimize Impacts
- Borrow Area Monitoring



Marine Minerals Program Studies

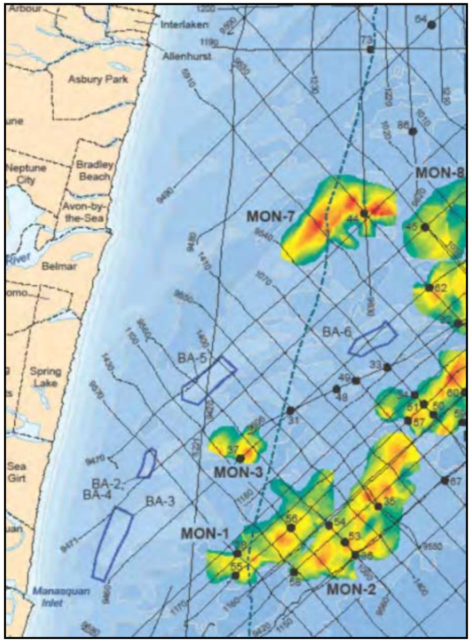
- Underwater Sounds Produced by Hopper Dredges (completed)
- Sounds Emitted by High Resolution Marine Geophysical Studies (completed)
- Review of Biological and Biophysical Impacts from Dredging (completed)
- Decision Tool To Reduce Sea Turtle Entrainment Risk (ongoing)
- Function and Recovery of Biological Communities within Dredge-Swale Habitats in South Atlantic Bight (ongoing)
- Regional EFH Geospatial Assessment and Framework of Offshore Features (new)
- Assessing Biological Processes that Drive Fisheries Productivity on New England Sand Shoals (new)

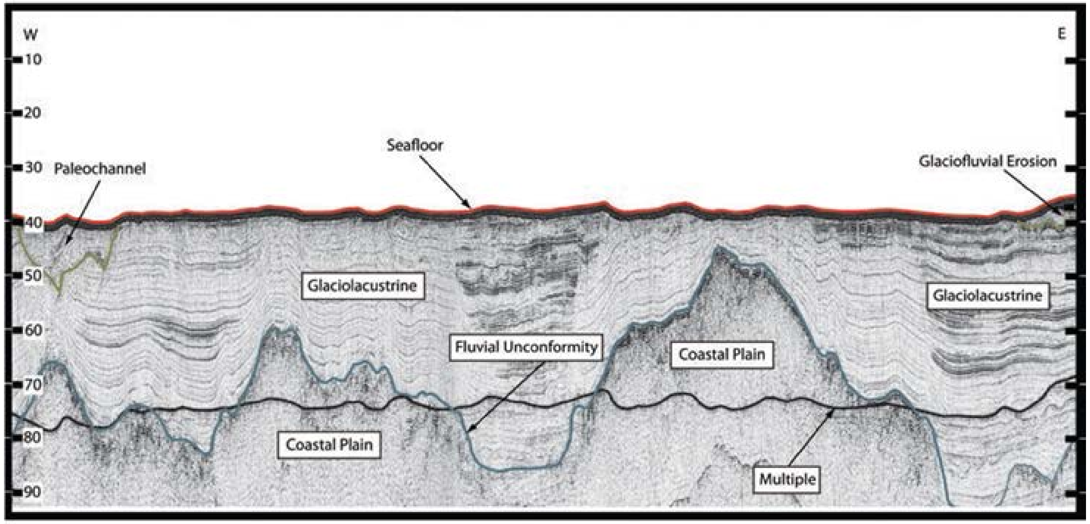
Atlantic Sand Resources

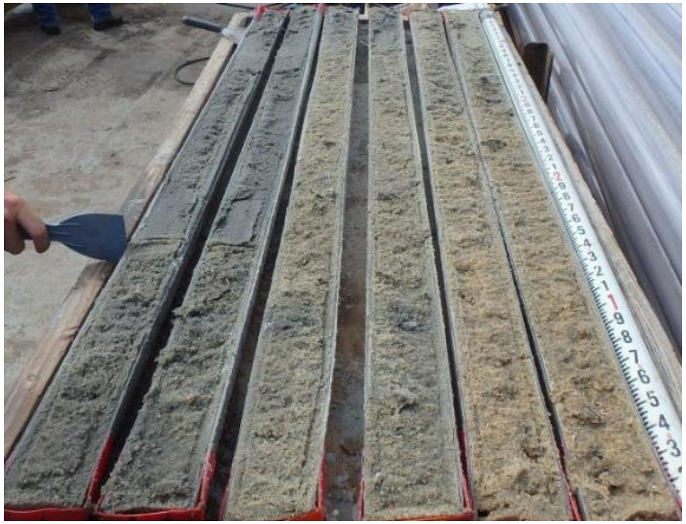
- Atlantic Sand Assessment Project (ASAP)
- State Cooperative Agreements (13)

  https://www.boem.gov/MMP-State-and-Regional-Activities/

- Regional Studies (Mid- and SE- Atlantic)
- MMP GIS







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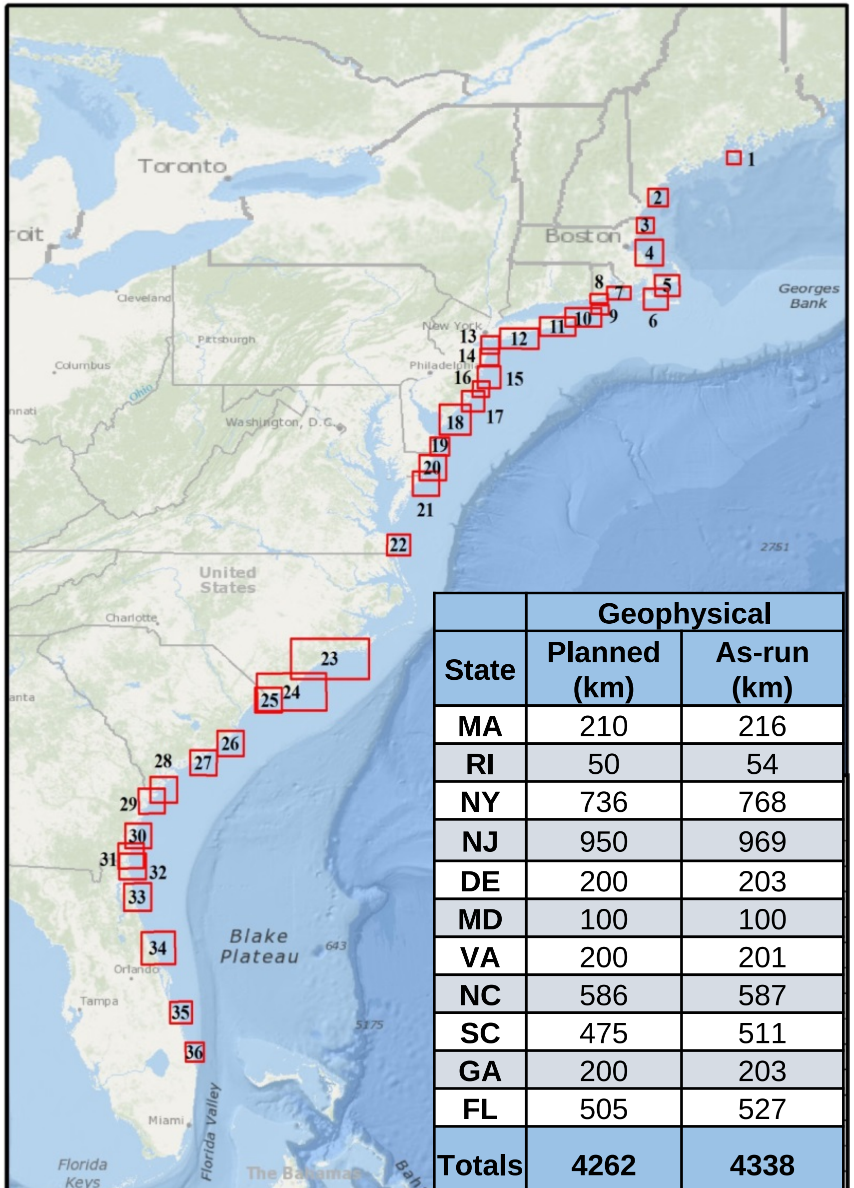
Atlantic Sand Assessment Project



State	Geophysical	
	Planned (km)	As-run (km)
MA	210	216
RI	50	54
NY	736	768
NJ	950	969
DE	200	203
MD	100	100
VA	200	201
NC	586	587
SC	475	511
GA	200	203
FL	505	527
Totals	**4262**	**4338**

State	Geologic		
	Vibracores	Surface Samples	Total Samples
MA	7	7	14
RI	6	4	10
NY	31	18	49
NJ	32	20	52
DE	5	3	8
MD	5	3	8
VA	6	4	10
NC	23	14	37
SC	19	11	30
GA	7	5	12
FL	19	11	30
Totals	**160**	**100**	**260**

Vibracore

Sub-Bottom

Bathymetry and Backscatter

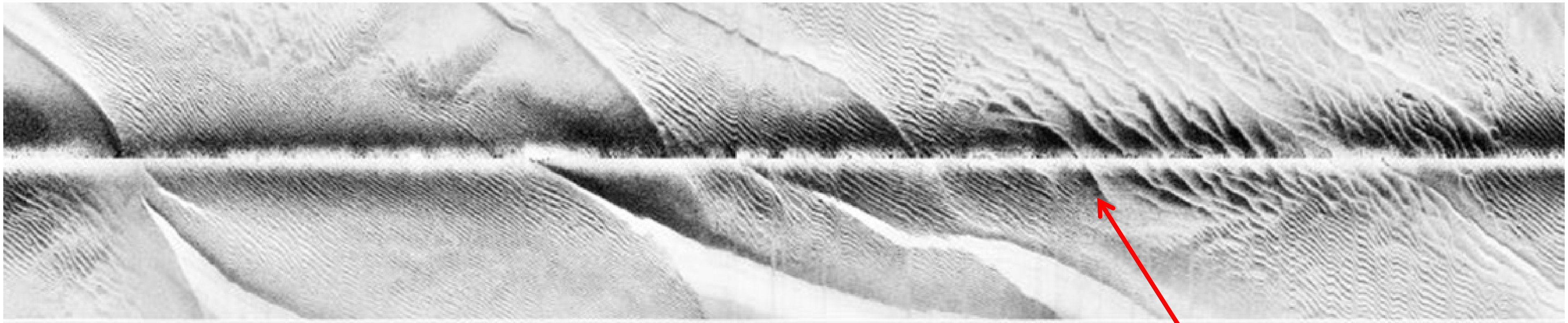
Sidescan Sonar

Magnetometer

BOEM
Bureau of Ocean Energy Management

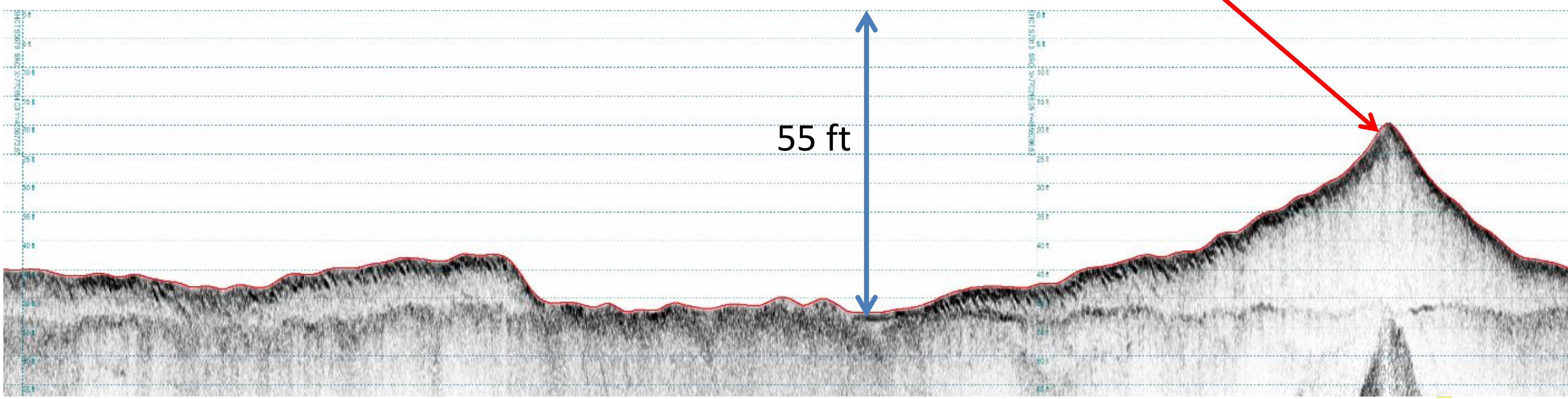
Example Sidescan and Sub-Bottom Images

BOEM_Line_NY_107



BOEM_Line_NY_102: East Montauk

Sand ridges



Lamont Doherty Core Repository

- BOEM Collection
- 190 vibracores archived
- Future cores

- Available for researchers
- Lamont's System for Earth Sample Registration (SESAR) http://www.geosamples.org/

Questions/Further Information

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Leasing Division
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703-787-1851

http://www.boem.gov/Marine-Minerals-Program/
http://www.boem.gov/BOEM-Fact-Sheets/

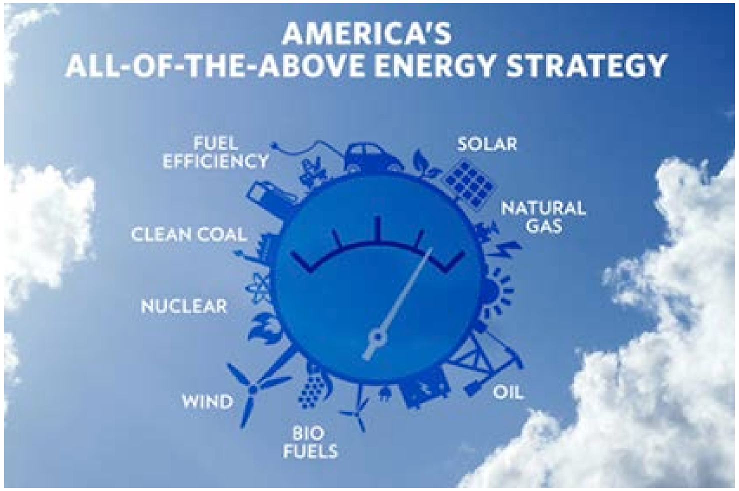
The Application of Science to Assess Conventional Energy on the Atlantic OCS

Matthew Frye
Chief, Resource Evaluation Methodologies Branch
Office of Strategic Resources
U.S. Bureau of Ocean Energy Management

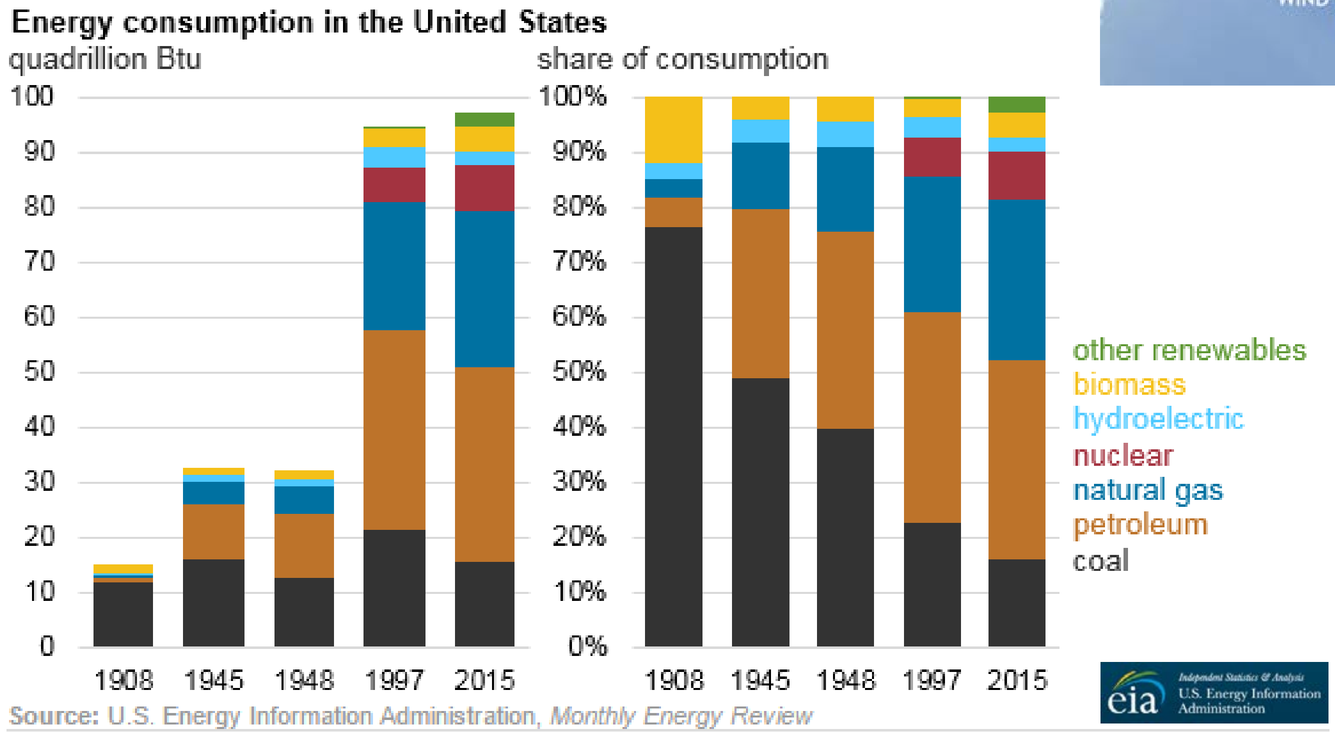
FPSO Sea Rose

BOEM
Bureau of Ocean Energy Management

All-of-the-Above Energy Strategy



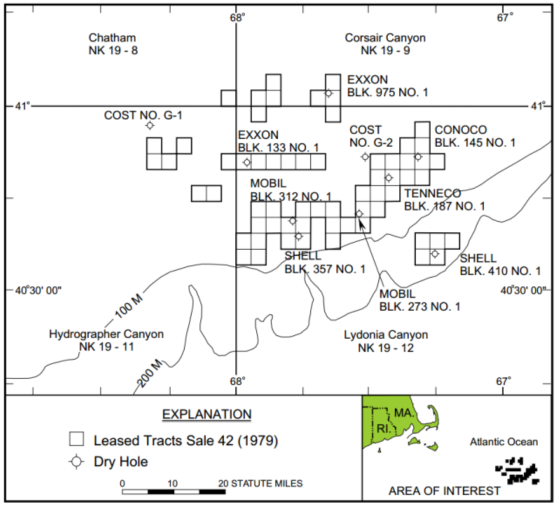
"……..We need an energy strategy for the future – an all-of-the-above strategy for the 21st century that develops every source of American-made energy." –
President Barack Obama, March 15, 2012



2015 U.S. production & OCS contribution:

- ~ 16% of oil
- ~ 4% of gas

Atlantic OCS - BOEM Historical O/G Leasing Perspective



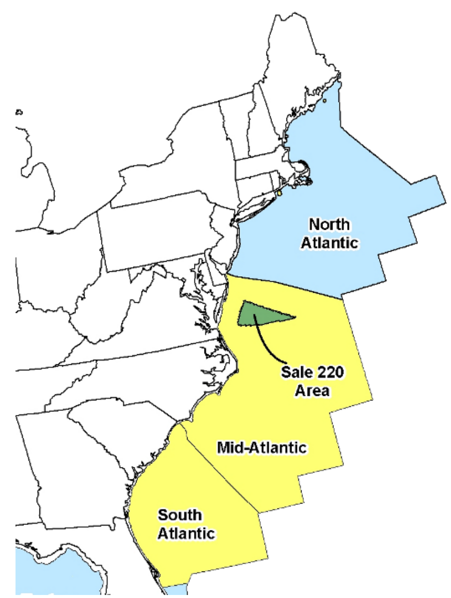
- Nine Lease Sales were held on the Atlantic OCS from 1976 to 1983 - no active leases remain;

Historical Atlantic Lease Sale Information**					
Tracts Offered	Tracts Leased	Bids Received	Acres Bid On	Acres Leased *Active and Inactive*	Total Bonus High Bid
9,240 tracts	433	1,248	3,013,106	2,334,089	$2.99 billion

- No commercial production of oil and gas resources;

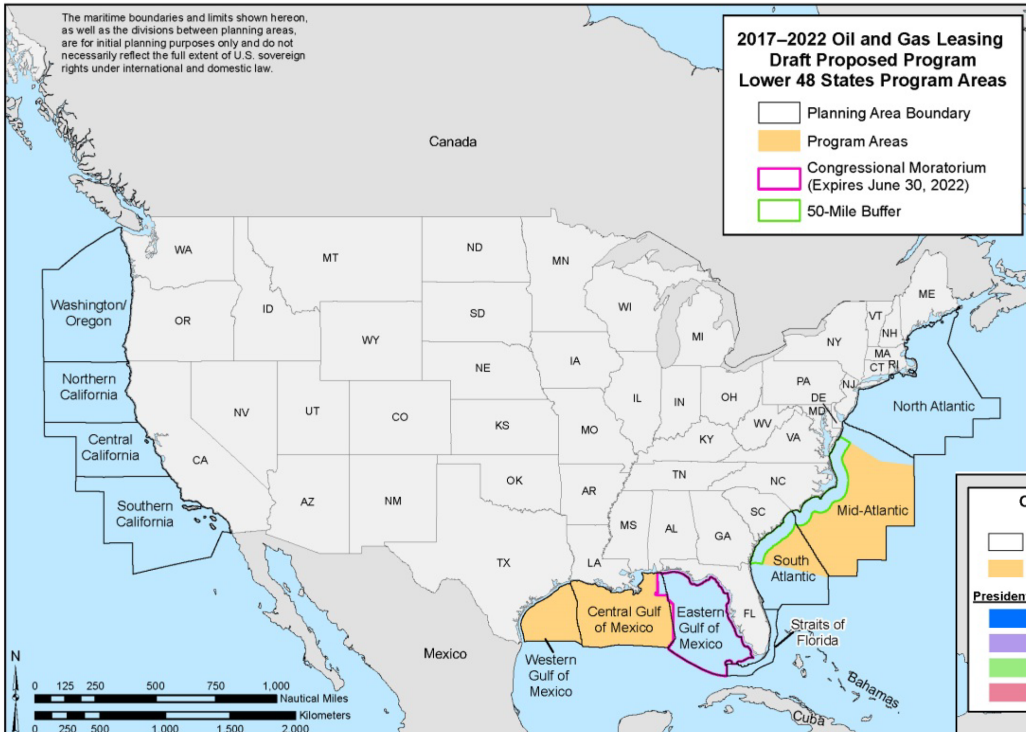
- Virginia Lease Sale 220 area was included in the 2007-2012 Program (scheduled for 2011), but was cancelled on May 27, 2010;

- The Atlantic OCS Region is <u>not</u> included in the current Five-Year Program (2012-2017);



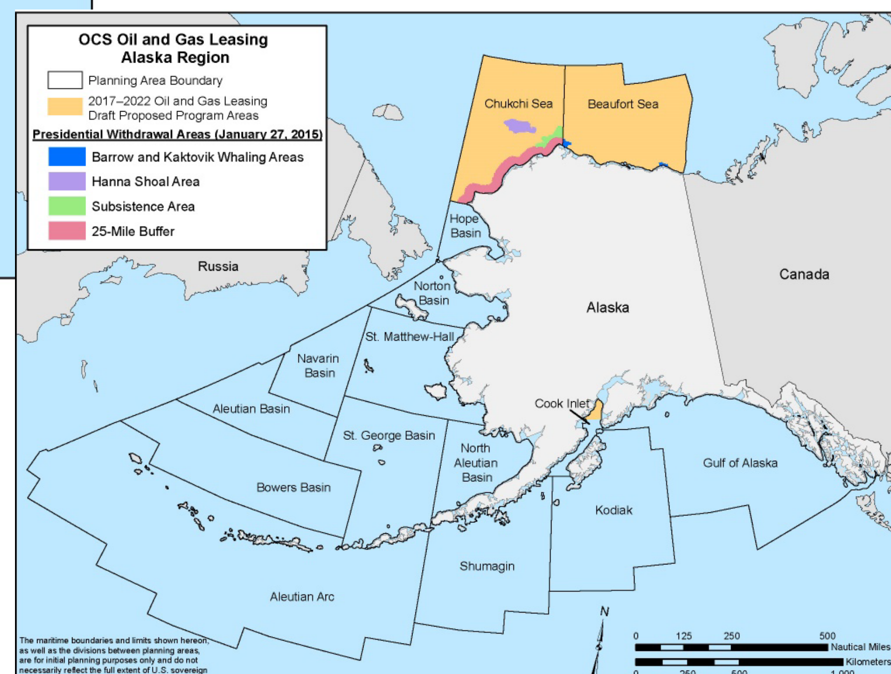
BUREAU OF OCEAN ENERGY MANAGEMENT

2017 – 2022 Oil and Gas Leasing Program



Section 18 of OCSLA mandates consideration of eight factors:

1. Oil and gas **Resource Estimates** and Net Social Value
2. Equitable Sharing of Benefits and Environmental Risks
3. Regional and National Energy Needs
4. Other Uses of the OCS
5. Industry Interest and **Resource Distribution**
6. Environmental Sensitivity and Marine Productivity
7. Geographical, Geological and Ecological Characteristics
8. Laws, Goals, and Policies of Affected States



- For the 2017-2022 Program, BOEM evaluated all 26 OCS planning areas for oil and gas leasing consideration, as required under OCSLA.
- Multi-step process, beginning with publication of "Draft Proposed Program (DPP)"

BUREAU OF OCEAN ENERGY MANAGEMENT

Five Year Program Development (2017 – 2022)

January 27, 2015 - Draft Proposed Program (DPP):

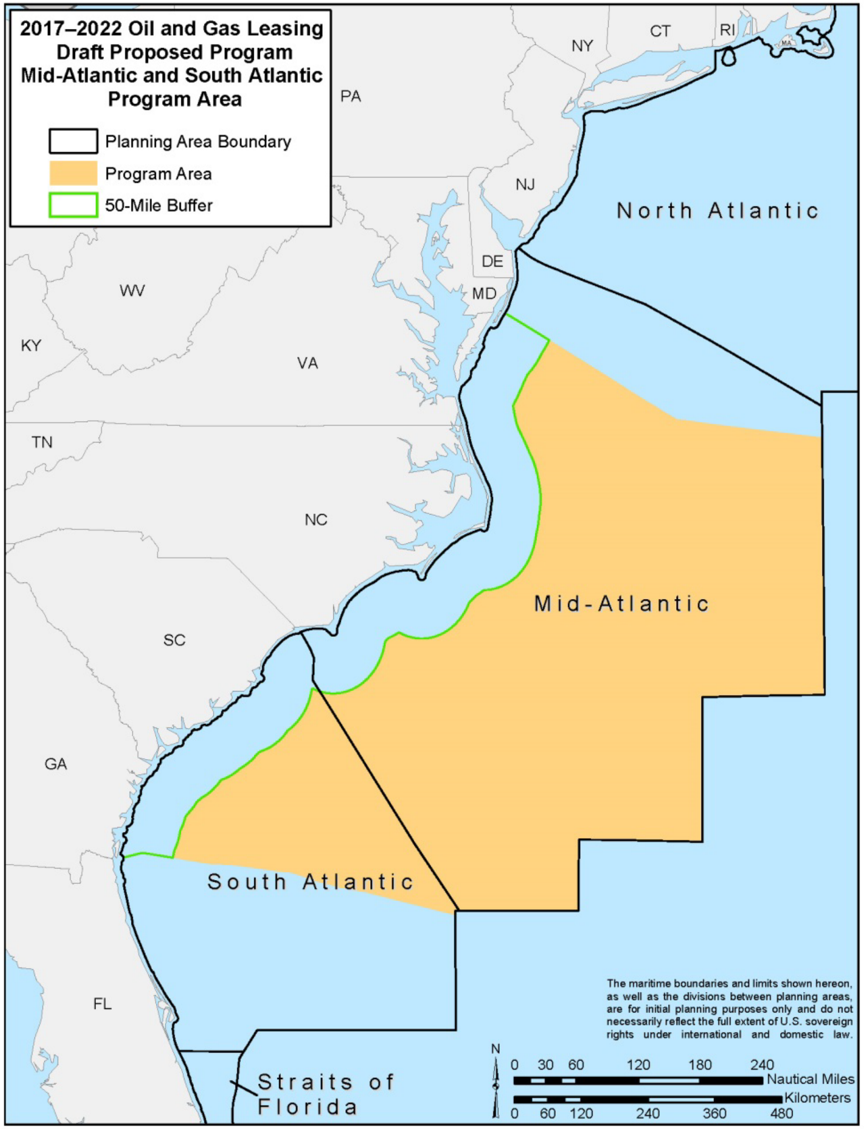
- Includes one sale in 2021 in a portion of the combined Mid-Atlantic and South Atlantic Planning Areas, offshore the Commonwealth of Virginia and the States of North Carolina, South Carolina, and Georgia, with a 50-statute-mile, no-leasing buffer from the coastline.
- No sales proposed in the North Atlantic or Straits of Florida Planning Areas.

March 15, 2016 – Proposed Program (PP):

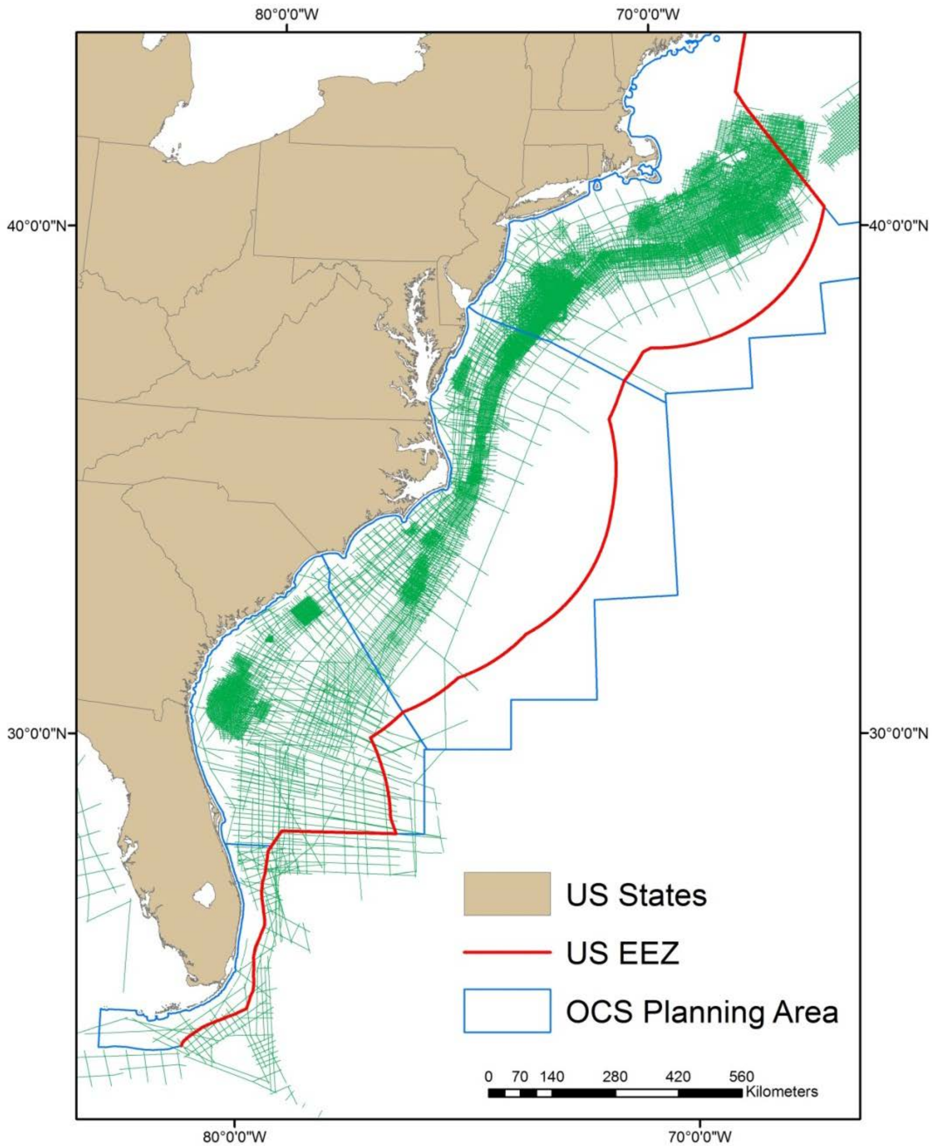
- Atlantic OCS removed from consideration for leasing in the 2017-2022 Program.
- Informed by Draft Programmatic EIS.

~ EOY 2016 – Proposed Final Program (PFP):

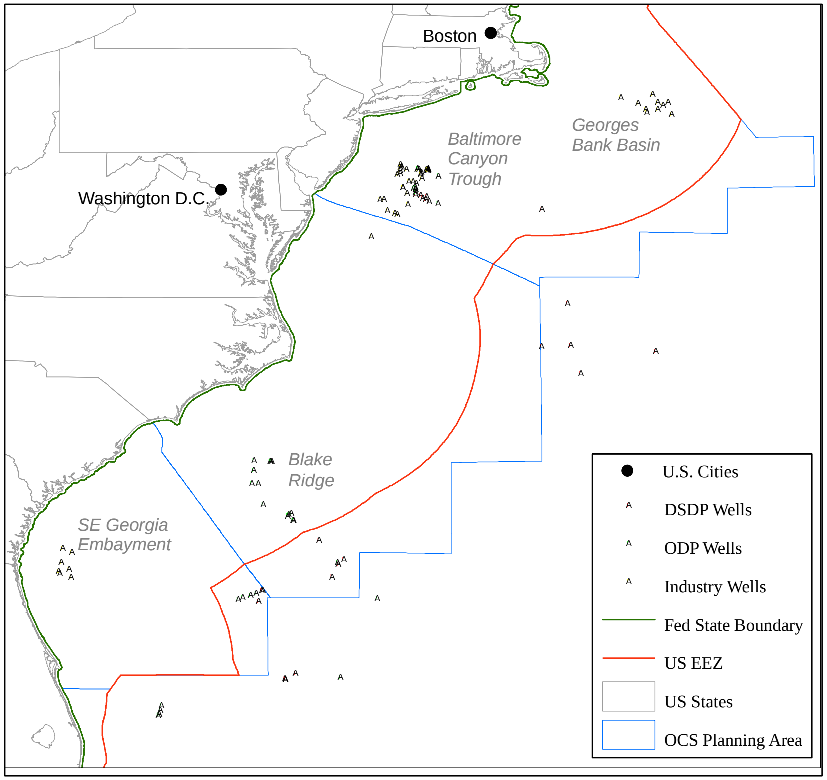
- Atlantic is not included in the 2017 – 2022 Program.



Geological and Geophysical Data



- > 200,000 line miles of 2D MCS deep penetration data
- 51 industry wells, including five COST wells
- DSDP/ODP/IODP wells



Assessment of Undiscovered Oil and Gas Resources

Assessment of Undiscovered Oil and Gas Resources of the Nation's Outer Continental Shelf, 2016

Using a play based assessment methodology, the Bureau of Ocean Energy Management estimates a mean of 89.87 billion barrels of undiscovered technically recoverable oil and a mean of 327.49 trillion cubic feet of undiscovered technically recoverable natural gas in the Federal Outer Continental Shelf of the United States.

Figure 1. Federal Outer Continental Shelf areas of the United States.

Introduction

This report summarizes the results of the Bureau of Ocean Energy Management (BOEM) 2016 assessment of the undiscovered oil and gas resources for the U.S. Outer Continental Shelf (OCS). The OCS comprises the portion of the submerged seabed whose mineral estate is subject to Federal jurisdiction (Figure 1). The 2016 assessment represents a comprehensive appraisal that considers relevant data and information available as of January 1, 2014, and builds upon previous assessment efforts on the OCS.

This assessment provides estimates of undiscovered, technically and economically recoverable oil and natural gas resources located outside of known oil and gas fields on the OCS. It considers recent geophysical, geological, technological, and economic information and utilizes a probabilistic play-based approach to estimate the undiscovered technically recoverable resources of oil and gas for individual geologic plays. This methodology is suitable for both conceptual plays where there is little specific information available and for developed plays where considerable information from discovered oil and gas fields is available. Individual geologic play results are aggregated to larger areas including Basins, Planning Areas, and Regions. Estimates of the quantities of historical production, remaining reserves, contingent resources, and future reserves appreciation are presented as components of total endowment to provide a frame of reference. More detailed information about the geology, assessment methodology, and economics will be made available in separate play-specific regional assessment reports.

Commodities Assessed

Commodities assessed include crude oil, natural gas liquids (condensate), and natural gas that exist in conventional reservoirs and are producible with conventional recovery techniques. Crude oil and condensate are reported jointly as oil; associated and nonassociated gas are reported as gas. Oil volumes are reported as billions of stock tank barrels of oil (Bbo) and gas as trillion standard cubic feet of gas (Tcfg). Oil-equivalent gas is a volume of gas (associated and/or nonassociated) expressed in terms of its energy equivalence to oil (i.e., 5,620 cubic feet of gas per barrel of oil). The combined volume of oil and oil-equivalent gas resources is referred to as barrel of oil-equivalent (BOE) and is reported in billions of barrels (Bbo).

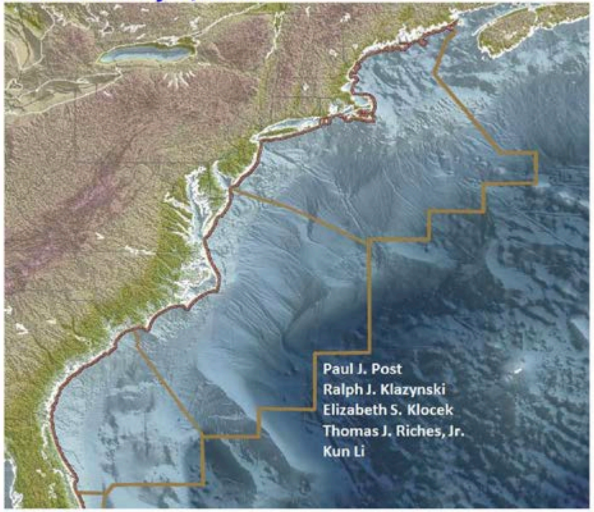
To ensure consistency in reporting recoverable resources across all OCS regions, this assessment does not include quantities of hydrocarbon resources that could be recovered from known and future fields by enhanced recovery techniques. It also does not consider methane hydrates, gas in geopressured brines, or oil and natural gas that may be present in insufficient quantities or quality (low permeability "tight" reservoirs) to be produced by conventional recovery techniques.

Estimates of undiscovered recoverable resources are presented in two categories; undiscovered technically recoverable resources (UTRR), and undiscovered economically recoverable resources (UERR). UTRR estimates are generated stochastically and are reported here at the mean value and at the 95th and 5th percentile values. This range of estimates corresponds to a 95 percent probability (a 19 in 20 chance) and a 5 percent probability (a 1 in 20 chance) of there being more than those amounts present, respectively. The 95 and 5 percent probabilities are considered reasonable minimum and maximum values, and the mean is the average or expected value. UERR results are presented as price-

BOEM (March, 2016)

OCS Report
BOEM 2016-xxx

Inventory of Technically and Economically Recoverable Hydrocarbon Resources of the Atlantic Outer Continental Shelf as of January 1, 2014



Paul J. Post
Ralph J. Klazynski
Elizabeth S. Klocek
Thomas J. Riches, Jr.
Kun Li

Published by

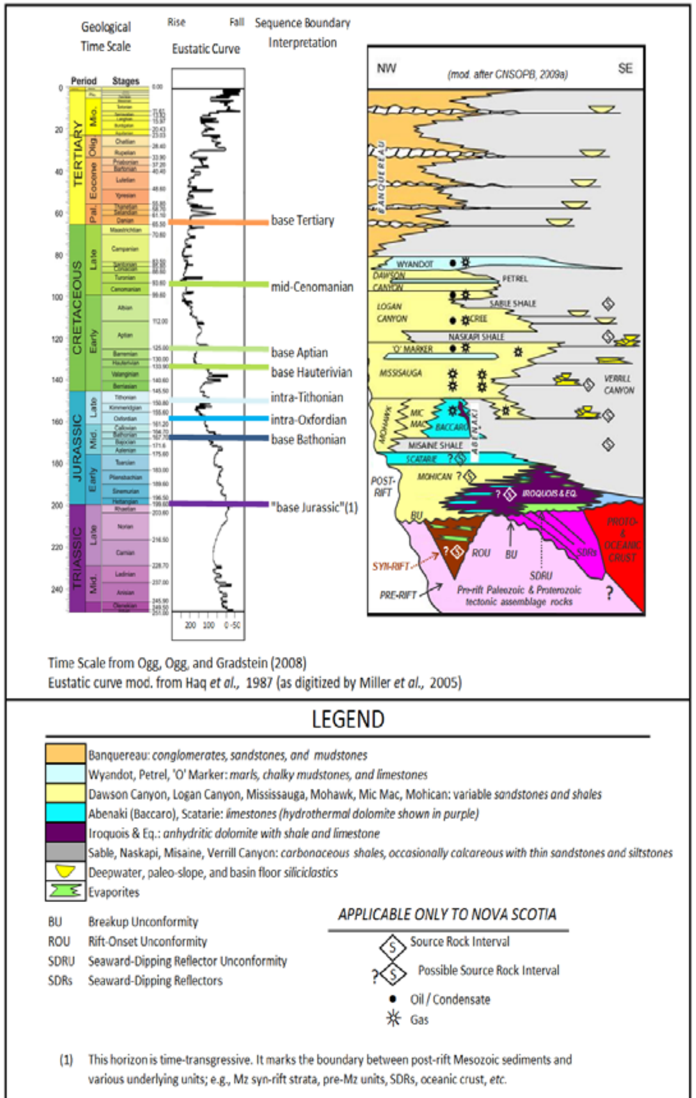
**U.S. Department of the Interior
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region
Office of Resource Evaluation**

**New Orleans
August 2016**

BOEM (*in press*)

BOEM
Bureau of Ocean Energy Management

Atlantic Geology & Petroleum System Elements

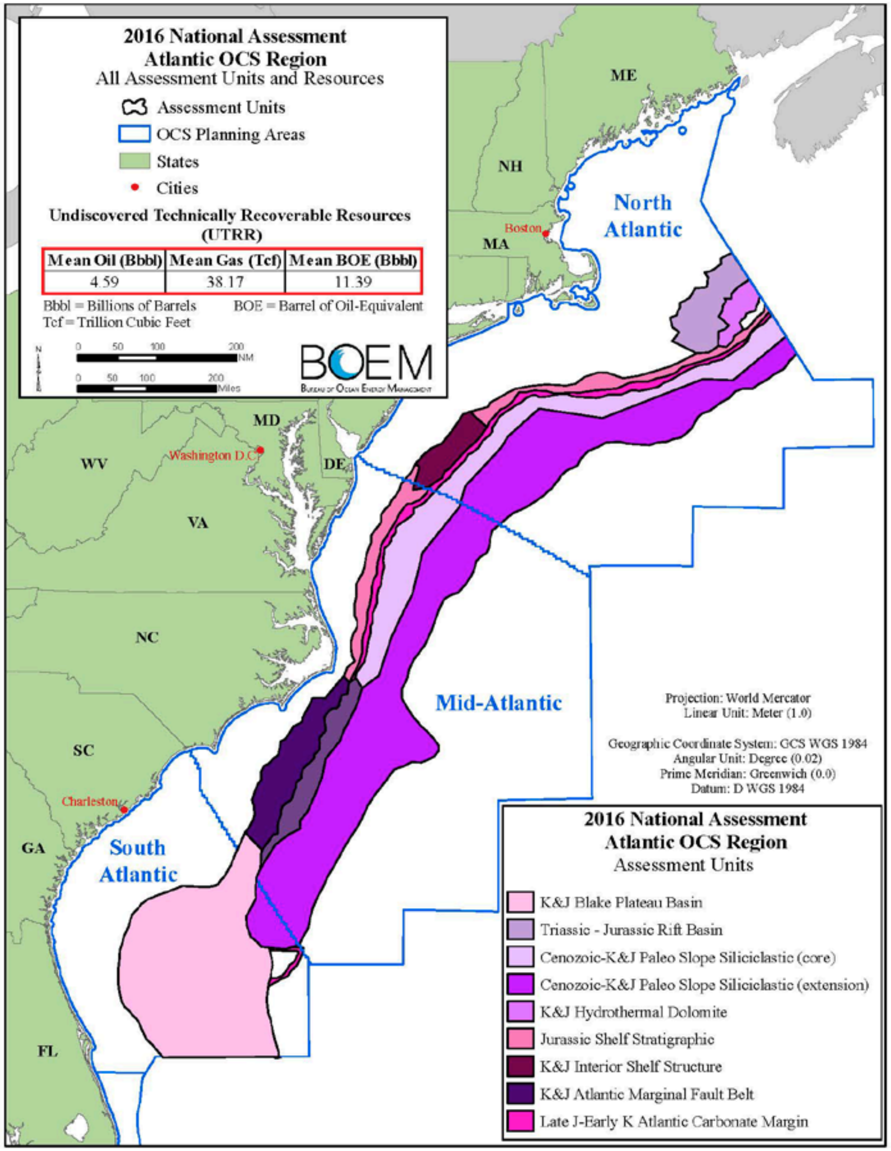


"Forensic Petroleum Systems Analysis"

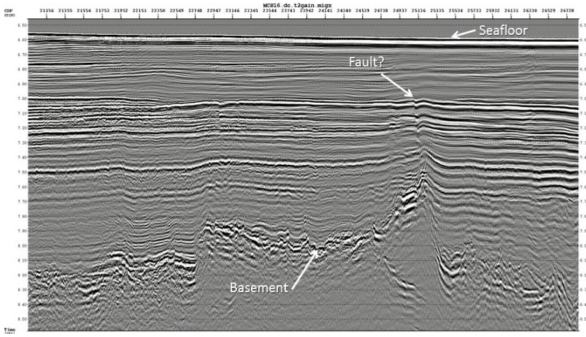
- Geochemical analysis of source rocks
- Petrophysical characteristics of reservoirs
- Lithologic conditions for trap seal
- Geophysical analysis of seismic data
- Geological timing of critical elements

Due to the paucity of detailed reservoir-performance data and information, we look globally for analogous fields/pools/reservoirs

Assessment Unit Extent and Resources



- Nine conceptual and one proven AU identified
- WD > 3 kilometers
- Target depths > 6 km
- Monte Carlo approach to incorporate uncertainty
- Mean undiscovered technically recoverable resource = 11.39 BBOE



Hutchinson et al. (2015)

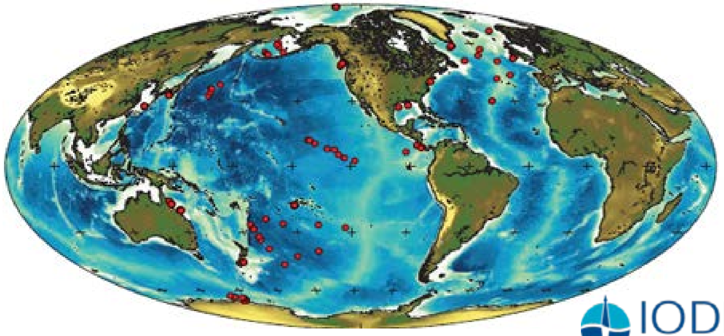
BOEM
Bureau of Ocean Energy Management

Ocean Drilling

International Ocean Discovery Program (2013-)

(last update June 2016)

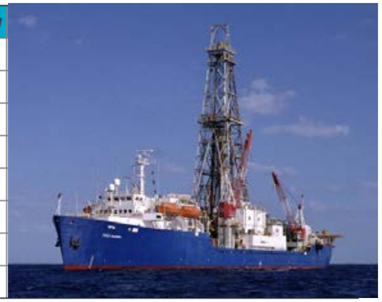
	JOIDES Resolution	*Chikyu*
Expeditions Completed	10	1
Sites Visited	43	1
Holes Drilled	118	5
Cores Recovered	4,167	18
Deepest Hole Penetrated (m)	1,806	654
Shallowest Water Depth (m)	87	2,525
Deepest Water Depth (m)	4,775	2,538
Core Recovery (m)	21,230	60

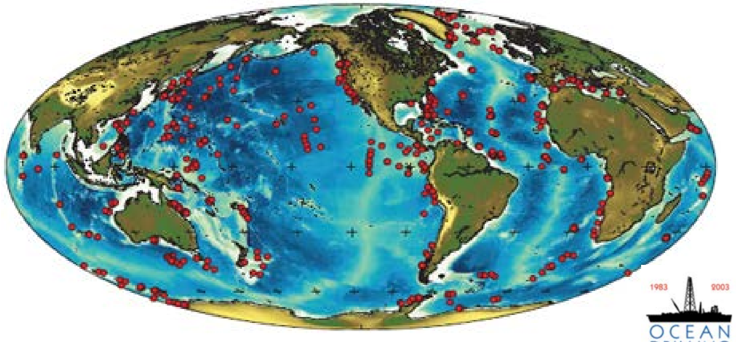


IODP
INTERNATIONAL OCEAN DISCOVERY PROGRAM

Integrated Ocean Drilling Program (2003-2013)

	JOIDES Resolution	*Chikyu*
Expeditions Completed	35	14
Sites Visited	145	38
Holes Drilled	439	95
Cores Recovered	8,491	927
Deepest Hole Penetrated (m)	1,928	3,059
Shallowest Water Depth (m)	95.5	885
Deepest Water Depth (m)	5,708	6,929
Core Recovery (m)	57,289	4,886





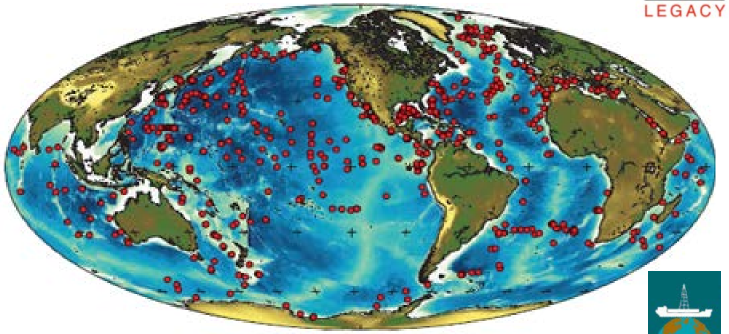
1983 2003
OCEAN DRILLING PROGRAM LEGACY

Ocean Drilling Program (1985-2003)

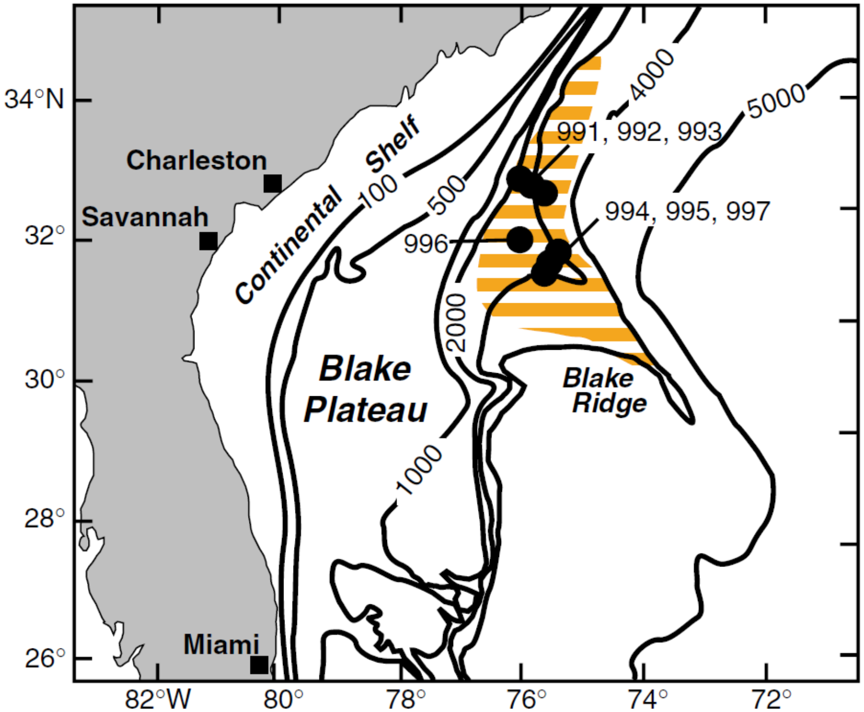
	JOIDES Resolution
Expeditions Completed	111
Sites Visited	669
Holes Drilled	1,797
Cores Recovered	35,772
Deepest Hole Penetrated (m)	2,111
Shallowest Water Depth (m)	37.5
Deepest Water Depth (m)	5,980
Core Recovery (m)	222,704

Deep Sea Drilling Project (1968-1983)

	Glomar Challenger
Expeditions Completed	96
Sites Visited	624
Holes Drilled	1,053
Cores Recovered	19,119
Deepest Hole Penetrated (m)	1,741
Deepest Water Depth (m)	7,044
Core Recovery (m)	97,056



Blake Outer Ridge – Gas Hydrate

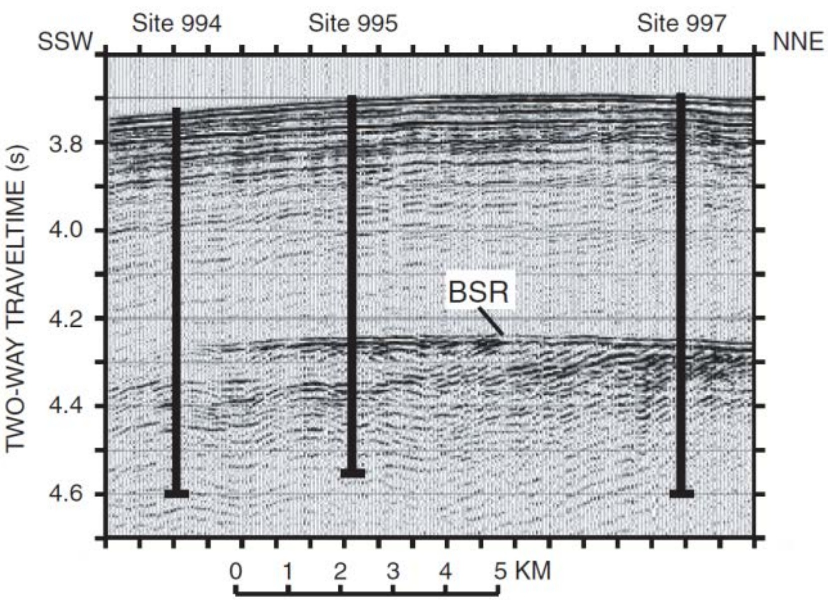


Collett & Ladd (2000)

Paull & Matsumoto (2000)

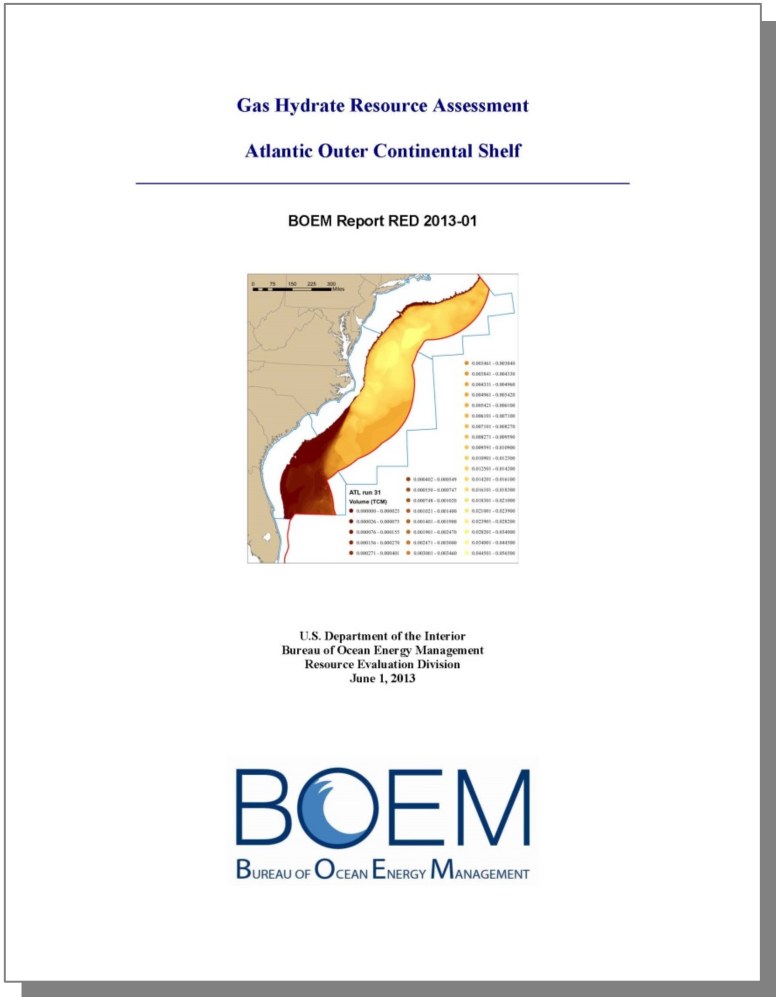
Ocean Drilling Program Leg 164 (1995)

- Confirmed Methane Hydrate accumulation on Blake Outer Ridge
- World class site characterization
- ~ 26,000 km^2
- Very large accumulations of in-place gas (up to 10^3 Tcfg)



Collett & Ladd (2000)

BOEM Assessment - Gas Hydrate


Gas Hydrate Resource Assessment

Atlantic Outer Continental Shelf

BOEM Report RED 2013-01

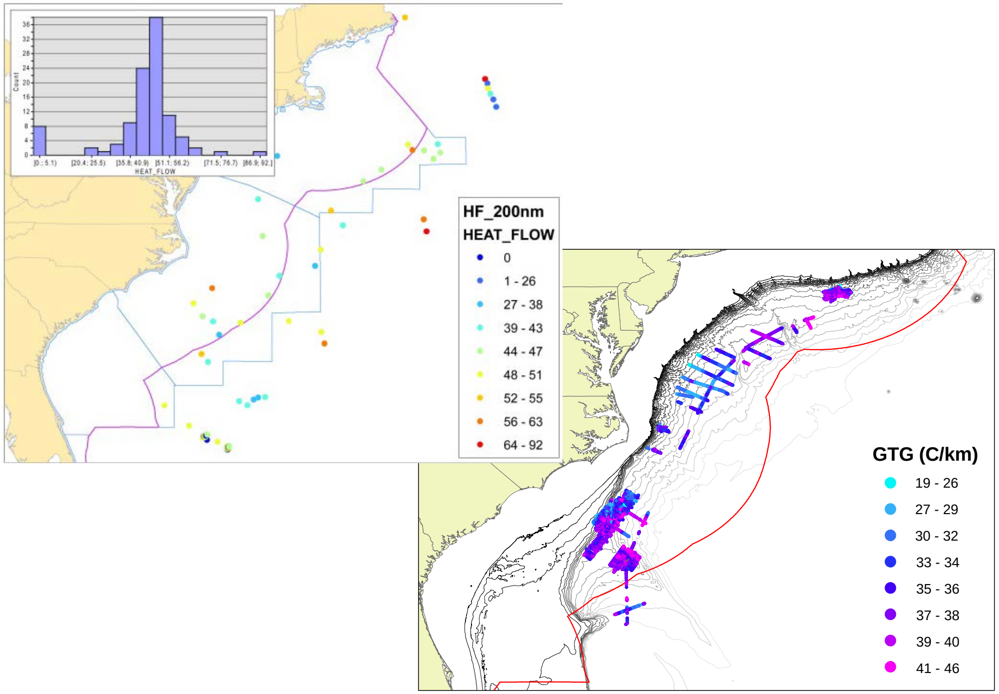
U.S. Department of the Interior
Bureau of Ocean Energy Management
Resource Evaluation Division
June 1, 2013

BOEM
BUREAU OF OCEAN ENERGY MANAGEMENT

BOEM (2013)

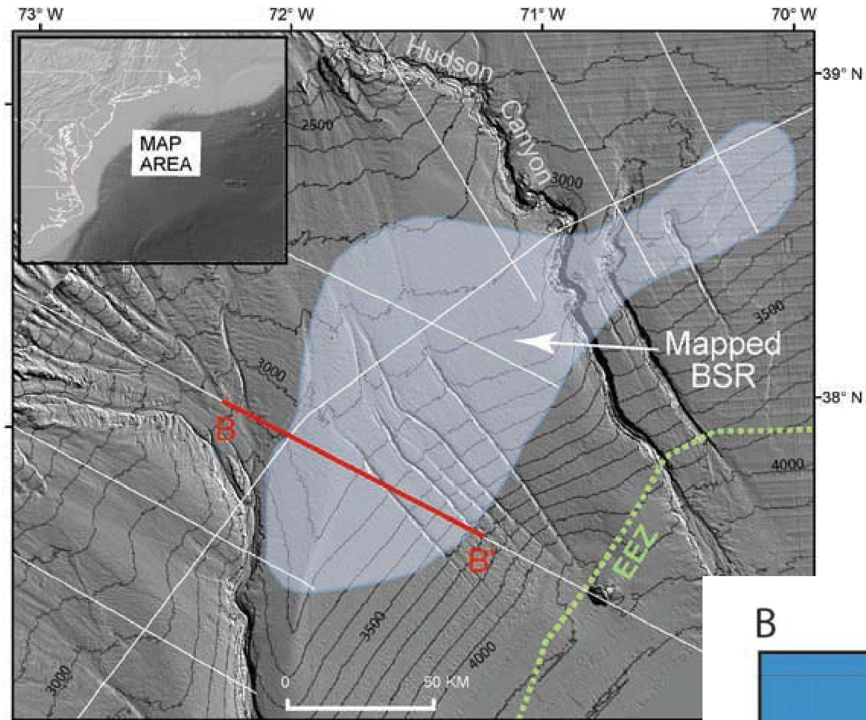
Informed by all available scientific data:

- DSDP/ODP/IODP very valuable
- Global Heat Flow database
- TOC, GTG, Hydrous Pyrolysis
- All available geophysics



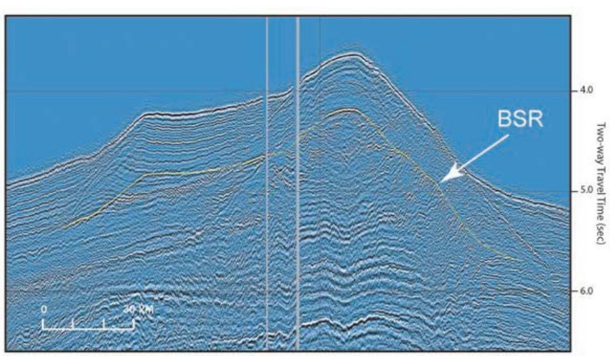
BOEM Assessment - Gas Hydrate

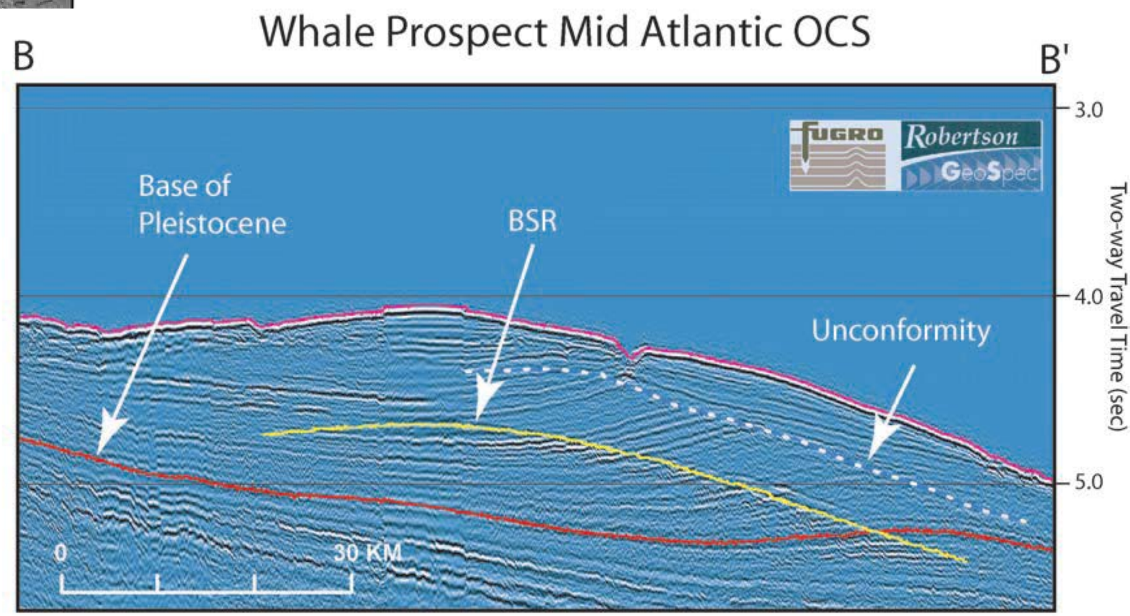
BOEM
Bureau of Ocean Energy Management



Shedd & Hutchinson (2006)

- The Whale prospect
- approximately 12,000 km^2 (3 million acres)
- Uncertainties: litho-facies, saturation, lateral and vertical connectivity





Shedd & Hutchinson (2006)

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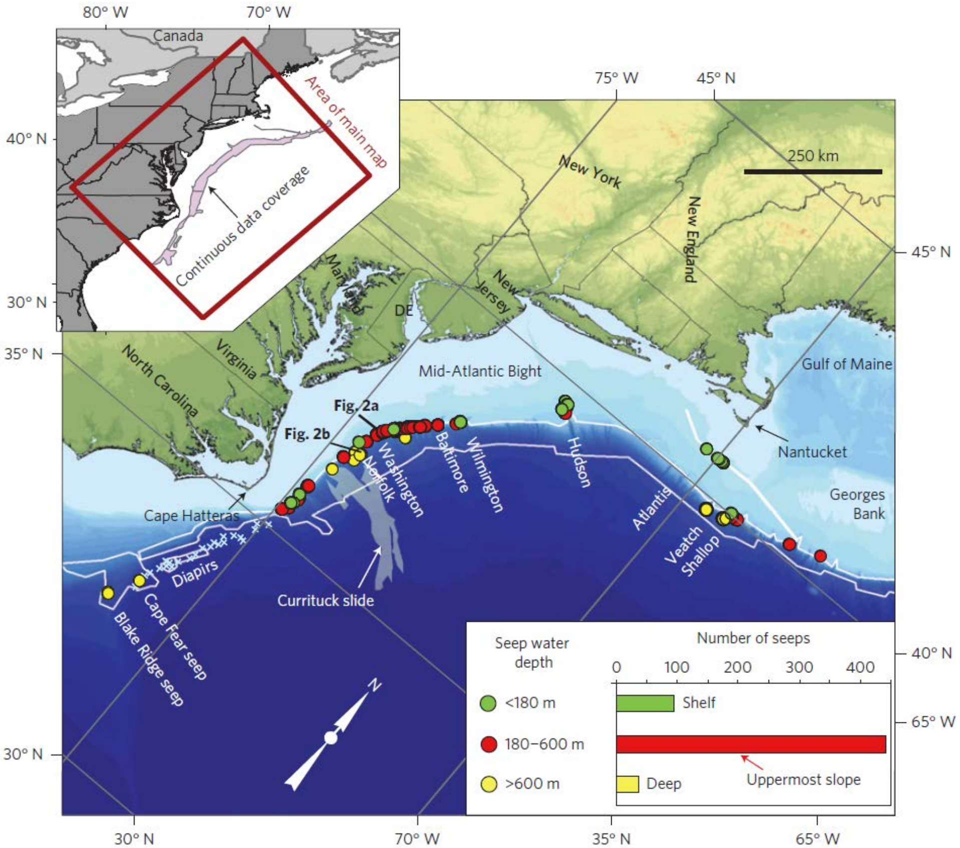
Active Gas Seeps – Atlantic Margin



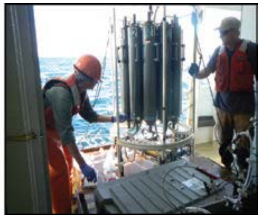
Skarke et al., 2014

- > 600 seep sites in variable water depths;
- Dozens of cruises contributing information, including '11, '12, '13 work funded through BOEM M10PC00100 ("Canyons")

2015 Field Work – USGS and others:

- High-resolution multichannel seismic cruise in ~550 km of MCS data acquisition
- 72-channel streamer
- Sparker source (~100-700 Hz)
- Coincident water column data (EK60)
- Real-time sea-air methane flux measurements
- Piston coring, some with heat flow data
- Chirp high-resolution imaging
- EK60 water column imaging





Ruppel et al., 2015

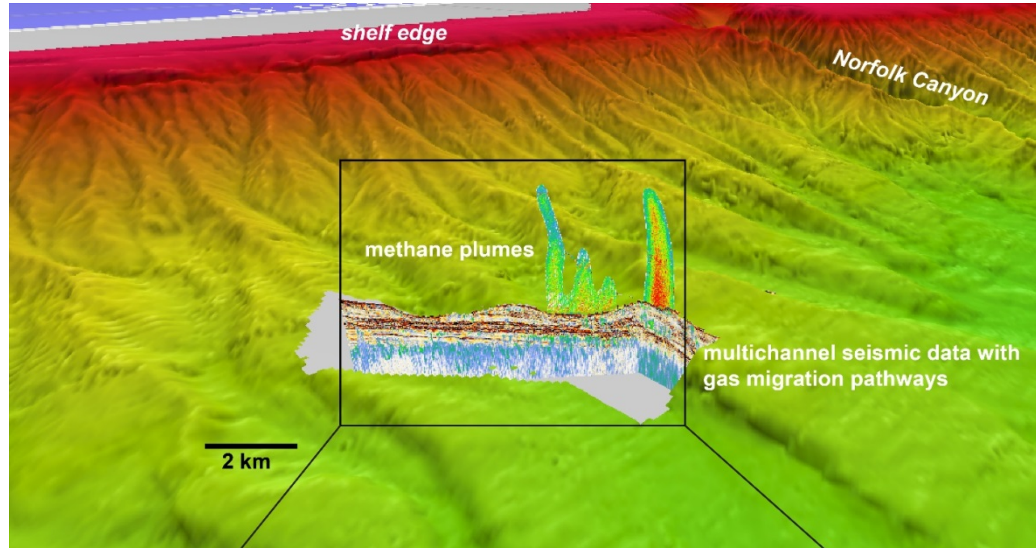
Active Gas Seeps – Atlantic Margin

Questions to ask:

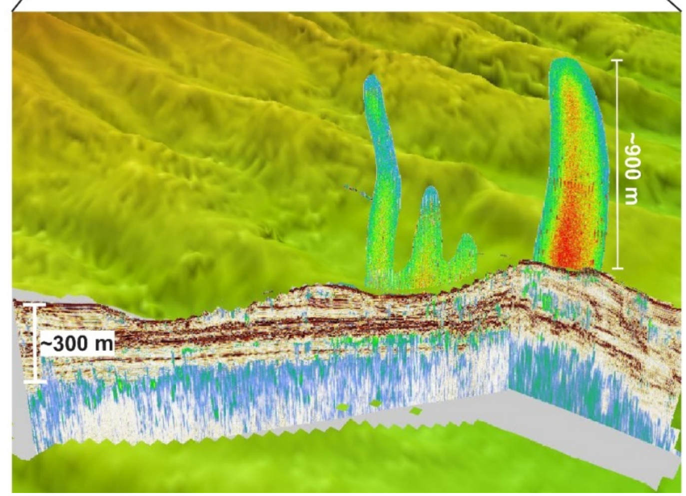
Source of gas? Prouty et al. (2016) indicate microbial methane;

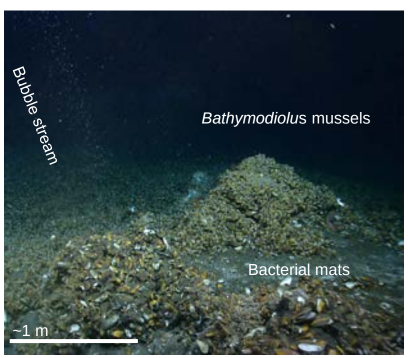
Controls? Lithology, sedimentary characteristics, fractures, pressure/overpressure;

Gas hydrate stability? BWT warming, updip edge of stability zone, timing.

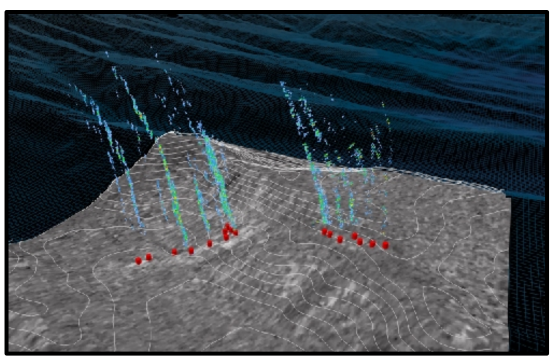


Ruppel et al., 2015





after Skarke et al., 2014



Skarke et al., 2014

Atlantic Ocean Energy and Mineral Science Forum

November 16, 2016 Sterling, VA

- Assessment of undiscovered oil and gas resources on OCS informs Sec. 18 OCSLA decisions;
- BOEM analysis of resource distribution enabled by best available science and information;
- Consumers of field-based foundational investigations, including IODP/predecessors, at the component level.

FPSO Sea Rose

Thank You !

matt.frye@boem.gov

Using Socioeconomic Data

to Support BOEM's

National Environmental Policy

Act Assessments

Amy Stillings | Industry Economist

Focused Mission

Stewardship of U.S. Outer Continental Shelf **energy and mineral resources**

Protecting the environment that development of those resources may impact

Focused Mission

Social and cultural resources include:

- Archaeology
- Demographics & Employment
- Tourism and Recreation
  - Visual Impacts
- Environmental Justice
- Land Use & Coastal Infrastructure
- Commercial & Recreational Fishing
- Other Uses of OCS:
  - Navigation
  - Military

BOEM Efforts: Completed

- Port Infrastructure
- Visual Simulations
- Tourism & Recreation Baseline

BOEM Efforts: Ongoing | Spatially Explicit Social Values

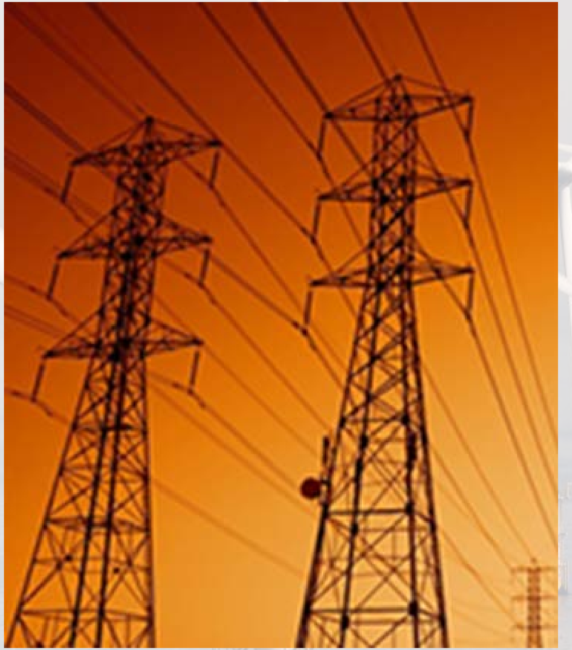
Wbur News

2016 Survey development and OMB approval

2017 Survey implementation and analysis

2018 Final report

BOEM Efforts: Ongoing | Benefits of Offshore Wind



The Effect of Offshore Wind Power on Recreational Beach Use on the East Coast of the United States

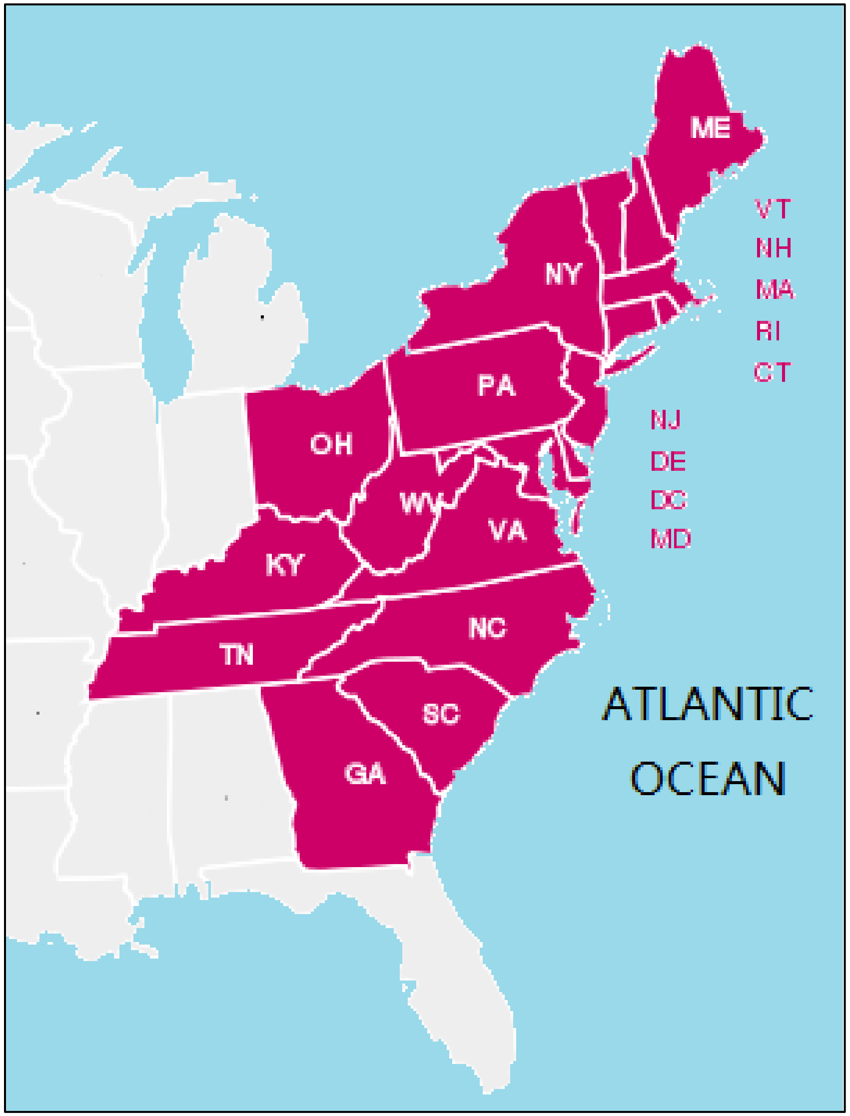
George Parsons, Jenna Toussaint, Kate Efimova & Jeremy Firestone

November 16
BOEM Atlantic Ocean Energy
& Mineral Science Forum

Study Design

- Internet-Based Survey (Jan - Feb)
- Showing Beach Users and Nonusers Simulations of Offshore Wind Projects to Judge Behavioral Response
- Three Core Questions
  - Effect on Experience/Enjoyment?
  - Change Trip Plans?
  - Special Trip?

Sample



- Internet-Based Survey
- GfK International – Knowledge Panel
- Two Samples
  - General Pop N = 500
  - Beach-Goer N = 1551
- Visuals from 2.5 to 20
- In-Person Validity-Check Surveys

Beaches

- Ocean Beaches in 9 States
- N = 275
- Day, Short Overnight, and Long Overnight Trips
- Characteristics Data

Summary Data

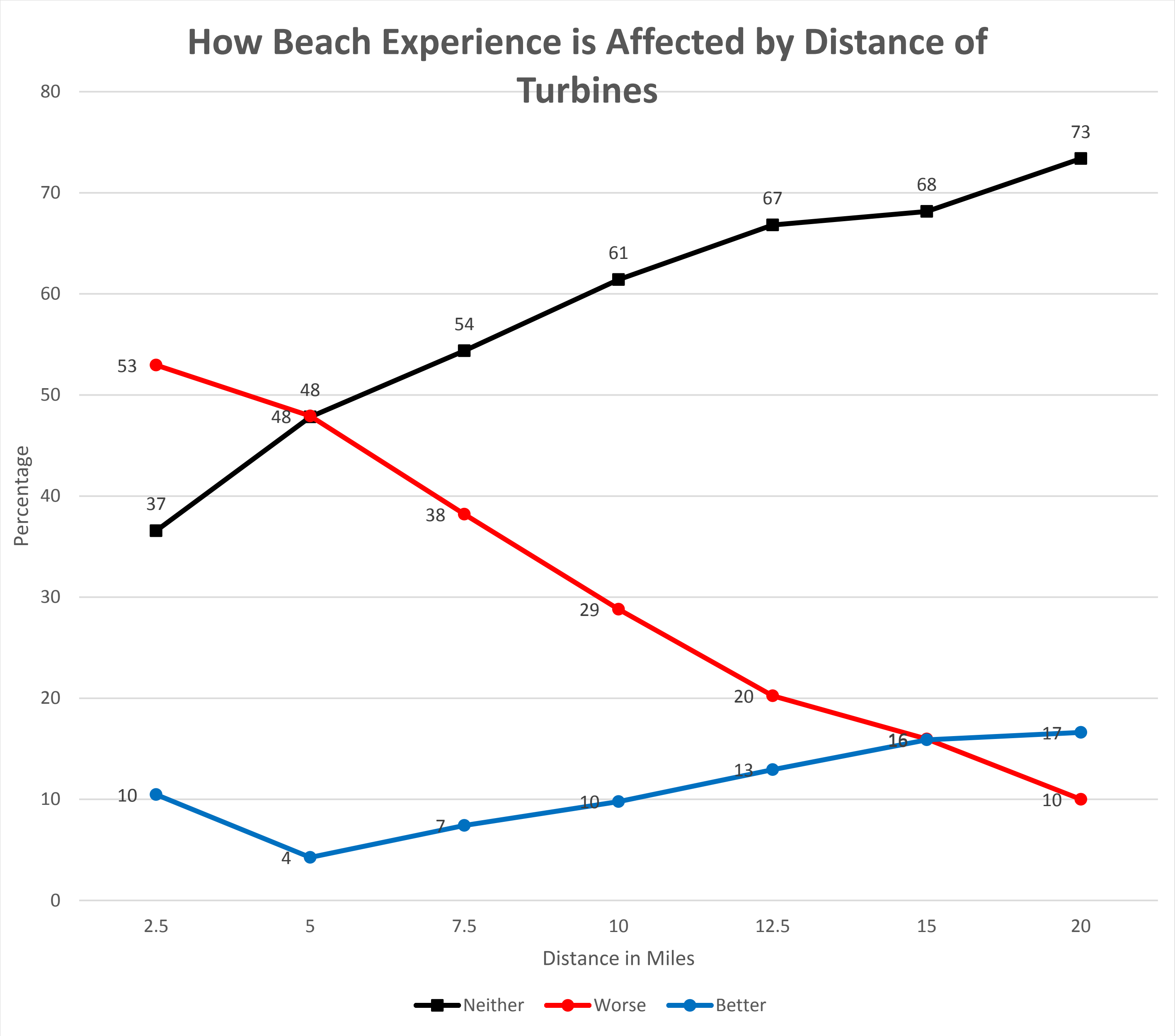
Trip Type

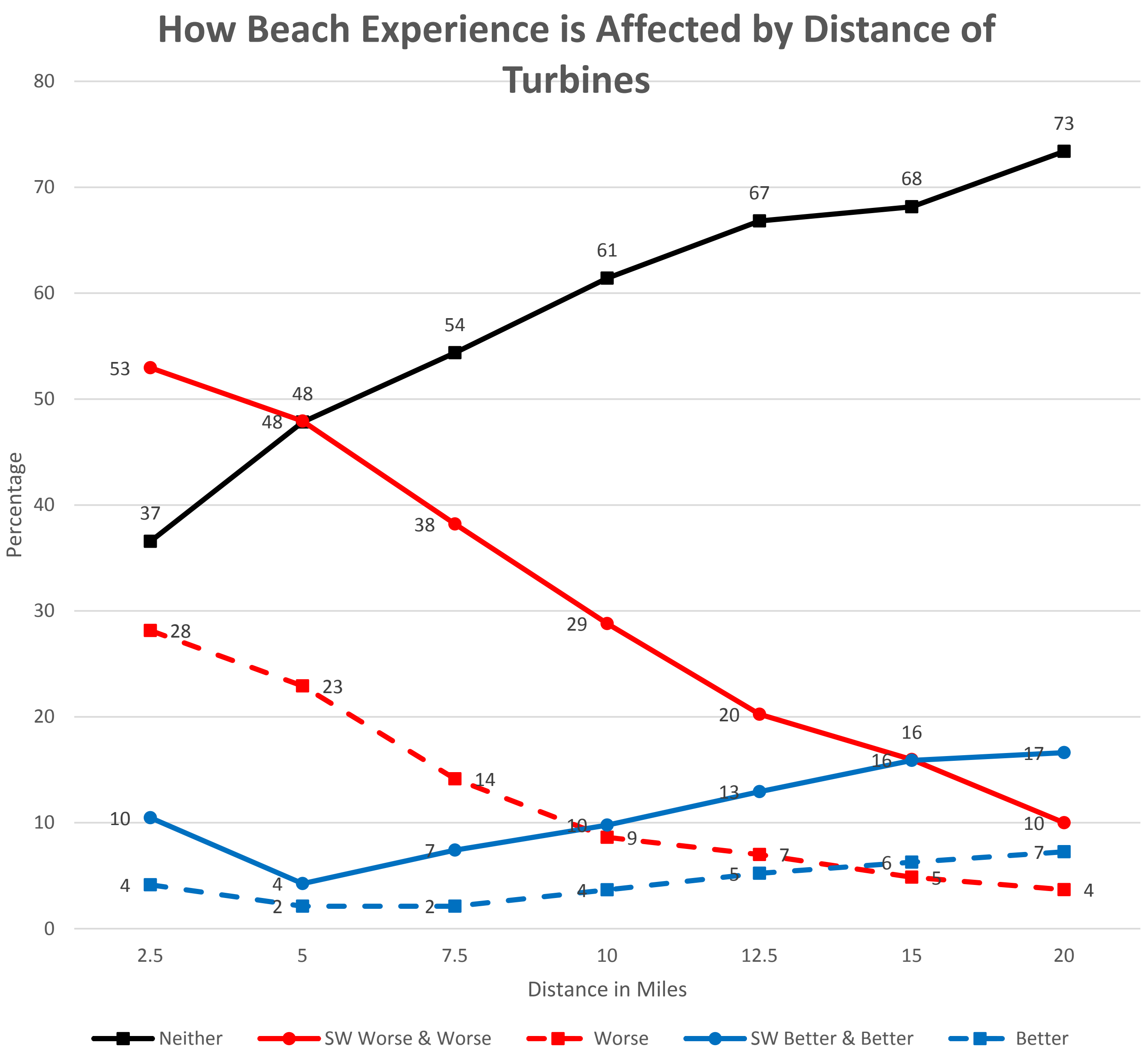
Trip Type	Number of Respondents	Percent of the Sample
Day-Trip	728	42%
Long Overnight-Trip	477	28%
Short Overnight-Trip	442	26%
Other	78	4%
Total	1725	100%

Important Activities

Activities	Number of Respondents	Percent of the Sample
Sand	632	37%
Water	482	28%
Boardwalk	434	25%
Other	183	10%
Total	1723	100%

Effect on Experience/Enjoyment?


How Beach Experience is Affected by Distance of Turbines
Percentage
80
70
60
50
40
30
20
10
0
2.5
5
7.5
10
12.5
15
20
Distance in Miles
37
48
54
61
67
68
73
53
48
38
29
20
16
10
10
4
7
10
13
17
Neither
Worse
Better


How Beach Experience is Affected by Distance of Turbines
Percentage
Distance in Miles
0
10
20
30
40
50
60
70
80
2.5
5
7.5
10
12.5
15
20
37
48
54
61
67
68
73
53
48
38
29
20
16
10
28
23
14
9
7
5
4
10
4
7
10
13
16
17
4
2
2
4
5
6
7
Neither
SW Worse & Worse
Worse
SW Better & Better
Better

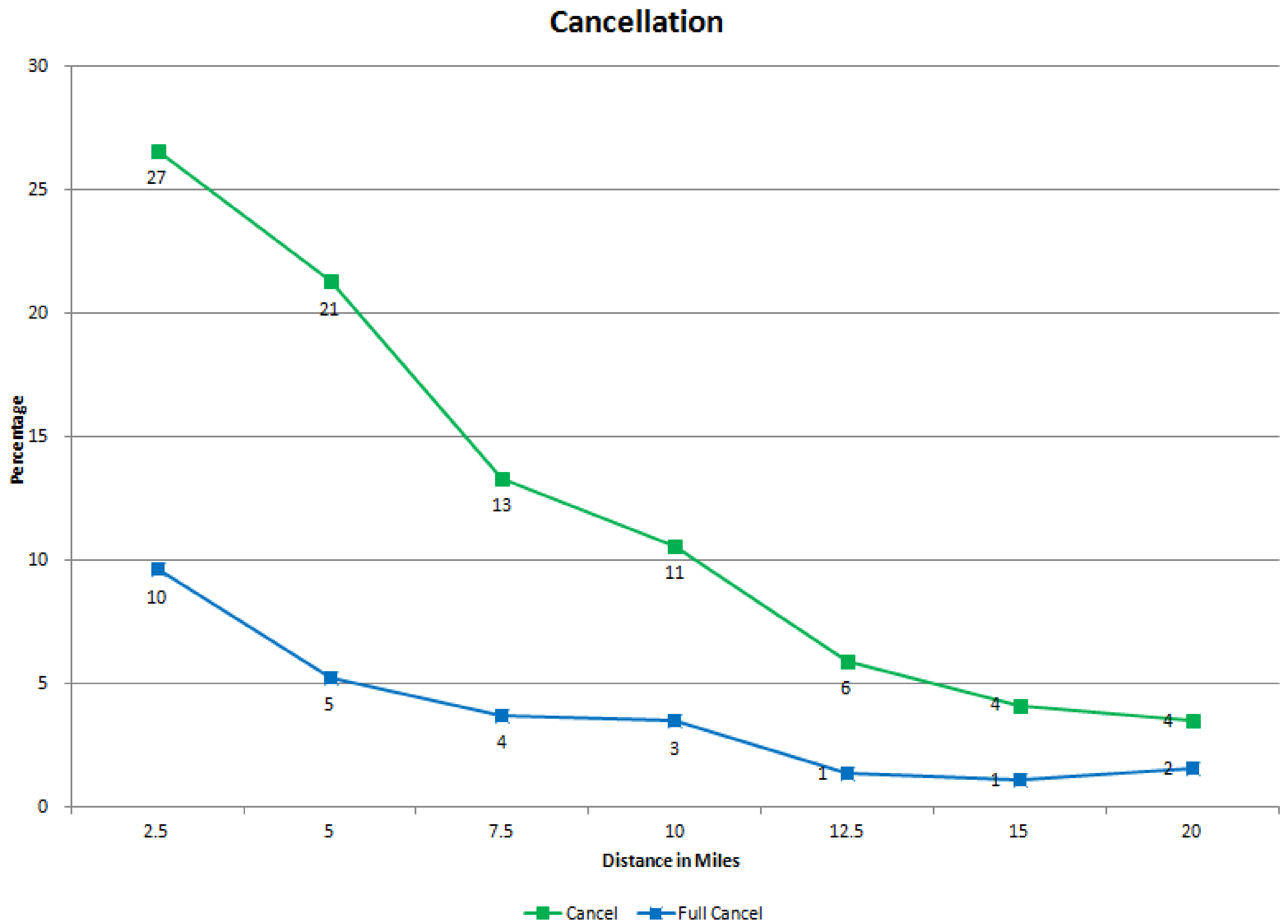
Reasons Worse

Reasons	Number of Respondents	Percent of the Sample
View of Seascape	583	61%
Harm to Marine Life	274	29%
Navigation	25	3%
Waste of Taxes	37	4%
Other	30	3%
Total	949	100%

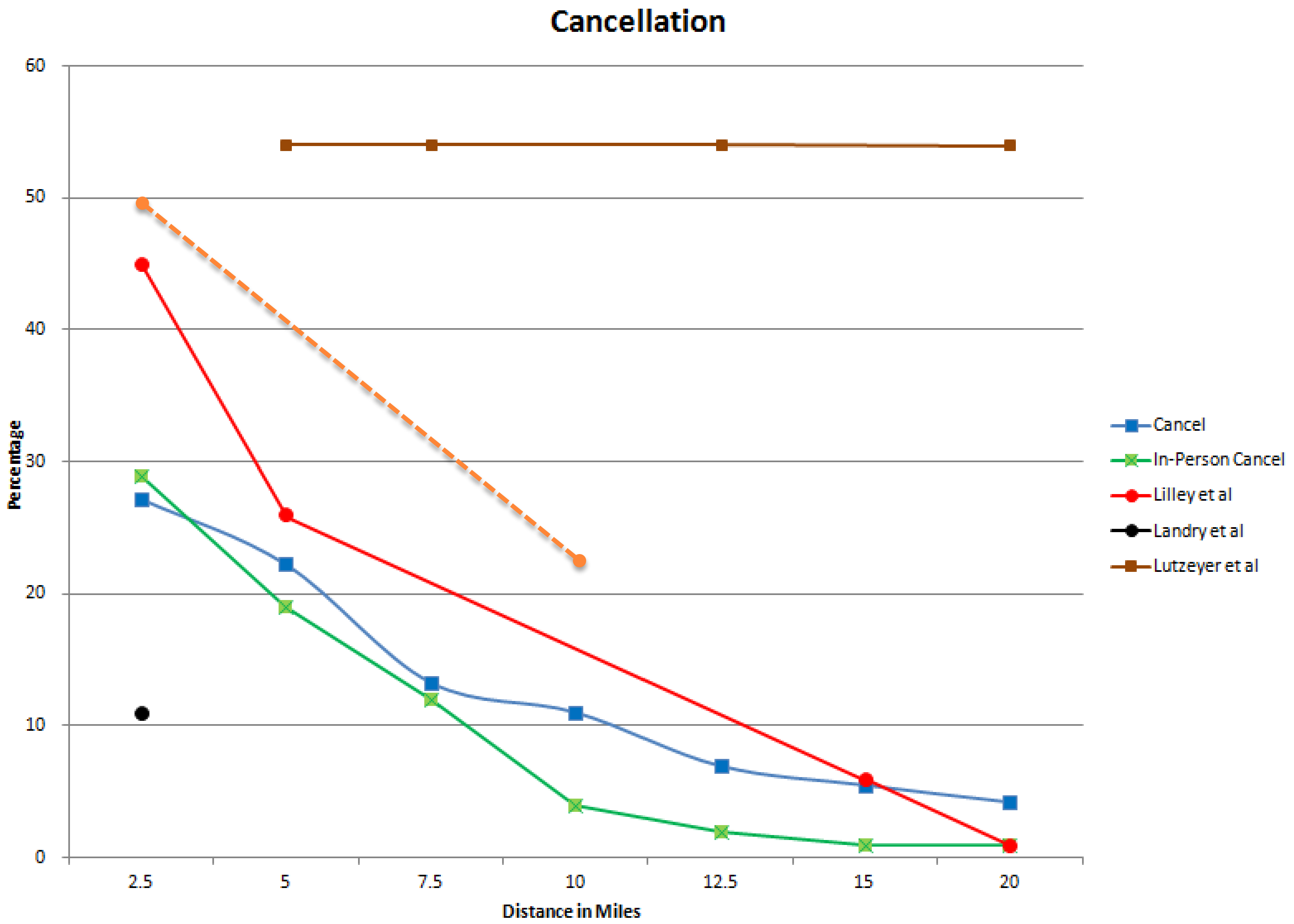
Reasons Better

Reasons	Number of Respondents	Percent of the Sample
Environment	169	52%
Energy	76	24%
Appeal of Seascape	36	11%
Economy	36	11%
Other	5	2%
Total	322	100%

Change Trip Plans?



Cancellation
30
25
20
15
10
5
0
Percentage
27
21
13
11
6
4
4
10
5
4
3
1
1
2
2.5
5
7.5
10
12.5
15
20
Distance in Miles
Cancel
Full Cancel



Cancellation
60
50
40
30
20
10
0
Percentage
2.5
5
7.5
10
12.5
15
20
Distance in Miles
Cancel
In-Person Cancel
Lilley et al
Landry et al
Lutzeyer et al

Cancel Simulations

	Rehoboth Beach		Hyannis Port	
	Day	Overnight	Day	Overnight
2.5 Miles	24%	30%	40%	47%
5 Miles	17%	22%	31%	37%
7.5 Miles	13%	17%	24%	30%
10 Miles	10%	12%	18%	23%
12.5 Miles	7%	9%	14%	18%
15 Miles	6%	8%	12%	15%
20 Miles	4%	5%	7%	10%

Some Findings from the Models

Probability of Cancelling

Income ↑
Education ↑
Age ↓

Overnight Trips ↑
Northern States ↑

Water/Sand Users ↑
Summer ↑

Developed ↓
Park Beaches ↑
Boardwalk ↑

Other turbines (modest effect) ↑
Nearby residence ↓
Favor wind ↓

Distance →←
Frequency →←

Some Findings from the Models

Probability of Cancelling

Income ↑
Education ↑
Age ↓

Overnight Trips ↑
Northern States ↑

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Age ↓

Overnight Trips ↑
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Water/Sand Users ↑
Summer ↑

Developed ↓
Park Beaches ↑
Boardwalk ↑

Other turbines (modest effect) ↑
Nearby residence ↓
Favor wind ↓

Distance →←
Frequency →←

Some Findings from the Models

Probability of Cancelling

Income ↑
Education ↑
Age ↓

Overnight Trips ↑
Northern States ↑

Water/Sand Users ↑
Summer ↑

Developed ↓
Park Beaches ↑
Boardwalk ↑

Other turbines (modest effect) ↑
Nearby residence ↓
Favor wind ↓

Distance →←
Frequency →←

Take a Special Trip to See Wind Farm?

Special Trip

Note: 70% is one trip only

	Number of Respondents	Percent of the Sample
Yes, I would make a special trip	178	7%
No, I would not make a special trip	1782	93%
Total	1928	100%

Model Simulations for Value

Rehoboth Consumer-Surplus-Loss Example

Trip Type	Number of Trips	Per Trip Values
Day	1.90m	$53.92
Short Overnight	2.11m	$165.45
Long Overnight	1.00m	$586.84

Loss by Distance Offshore

2.5 Miles	$293m
5 Miles	$220m
7.5 Miles	$163m
10 Miles	$122m
12.5 Miles	$91m
15 Miles	$78m
20 Miles	$47m

Rehoboth Consumer-Surplus-Loss Example

Trip Type	Number of Trips	Per Trip Values
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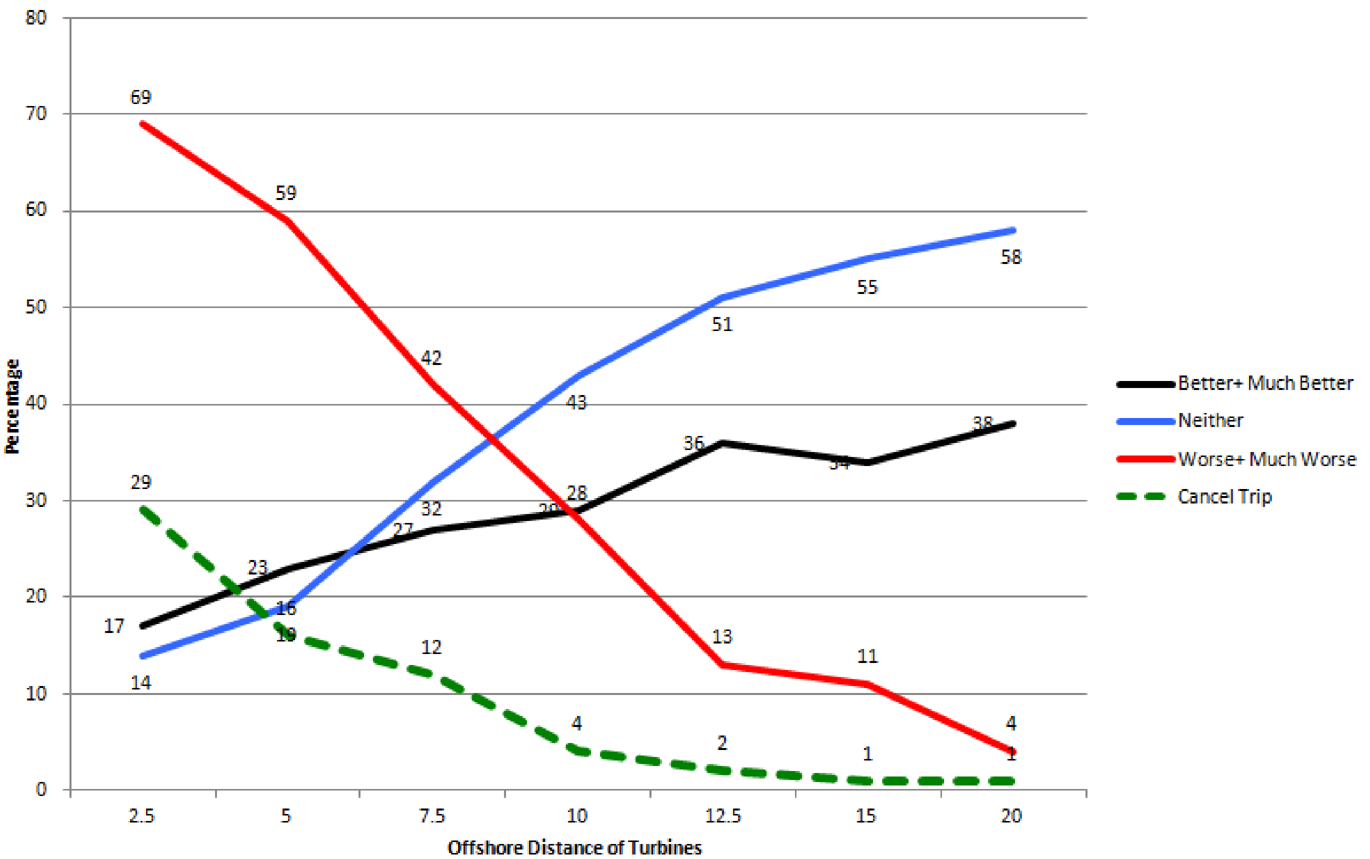
20 Miles	$47m

Price Effects, Sorting, Special Trips & Tours

Thank You!

Beach Experience Affected By Distance



An Analysis of the Effects of the Block Island Wind Farm on Rhode Island Recreation and Tourism Activities

David Bidwell
University of Rhode Island
November 2016

BOEM Contract #M16PC00016

Overview

- Project Introduction
- Background
- Project Team
- Project Components
- Project Timeline
- Questions

Deepwater Wind

Project Introduction

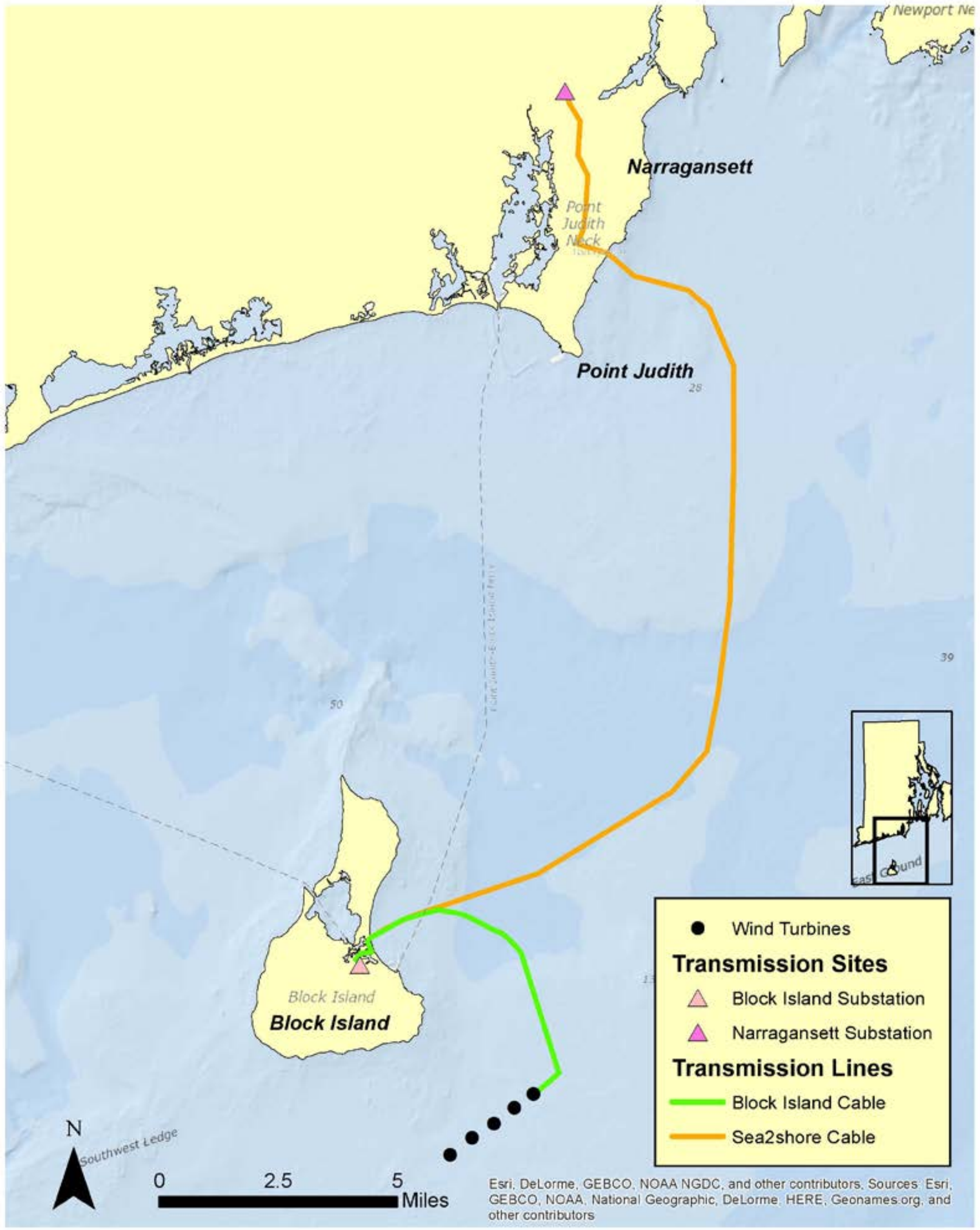
- Response to BSEE/BOEM Broad Agency Announcement, Topic 5: Benefits of Renewable Energy Projects
- Project Goals
  - Empirical data on effects of first U.S. offshore wind farm on local tourism/recreation
  - Develop indicators for measuring effects of offshore wind on tourism/recreation
- Four research components
  - Literature review
  - Content analysis of media
  - Participant observation
  - Focus groups

Background

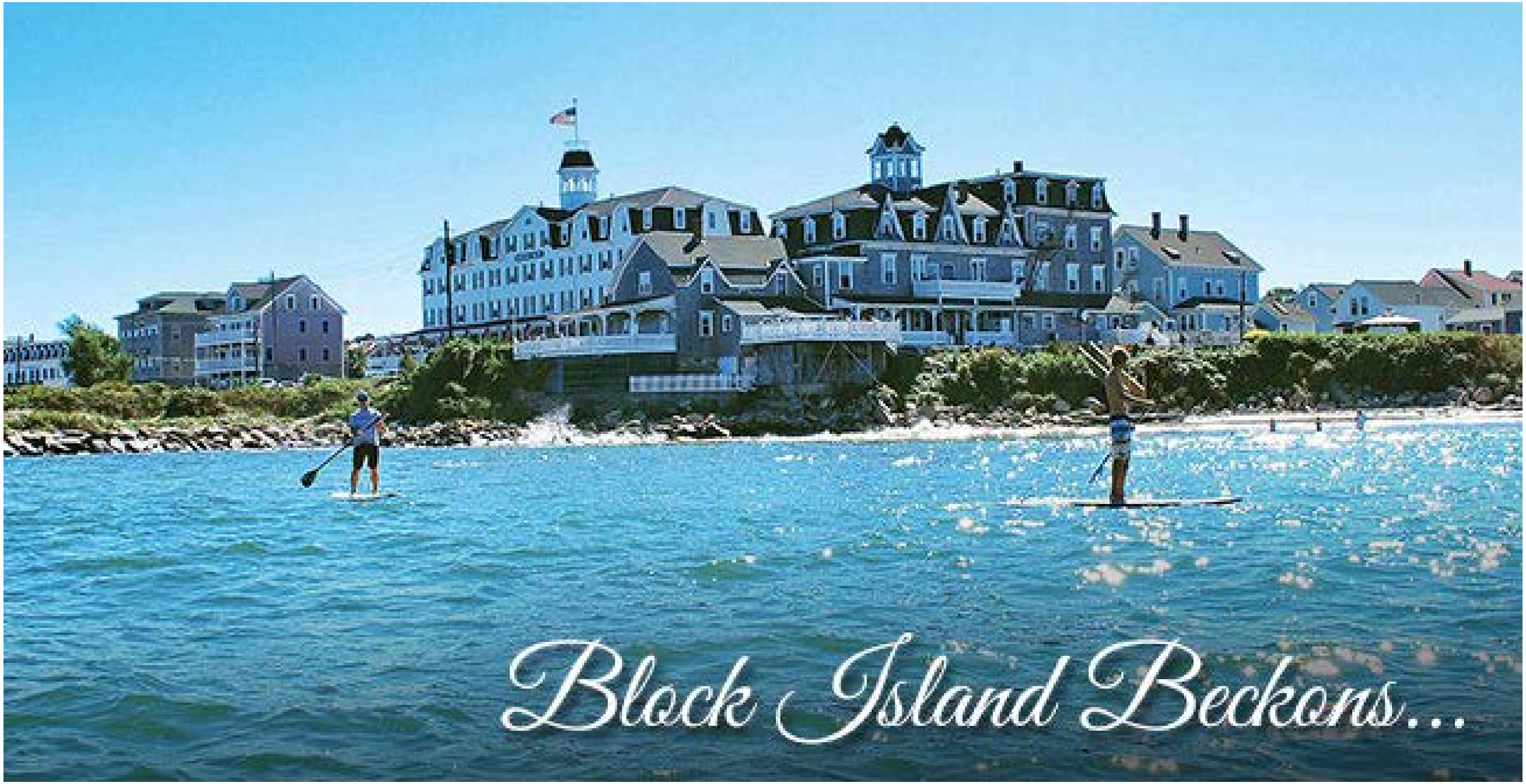
- Block Island Wind Farm
- Rhode Island Tourism
- Tourism/Recreation and Offshore Wind

Deepwater Wind

Block Island Wind Farm



- 30 MW demonstration project of private developer
- Five 6-MW GE Turbines
- Electricity sent to island and integrated into mainland grid via undersea cables
- Operations expected to begin this month



Block Island Tourism Council

Research Objectives

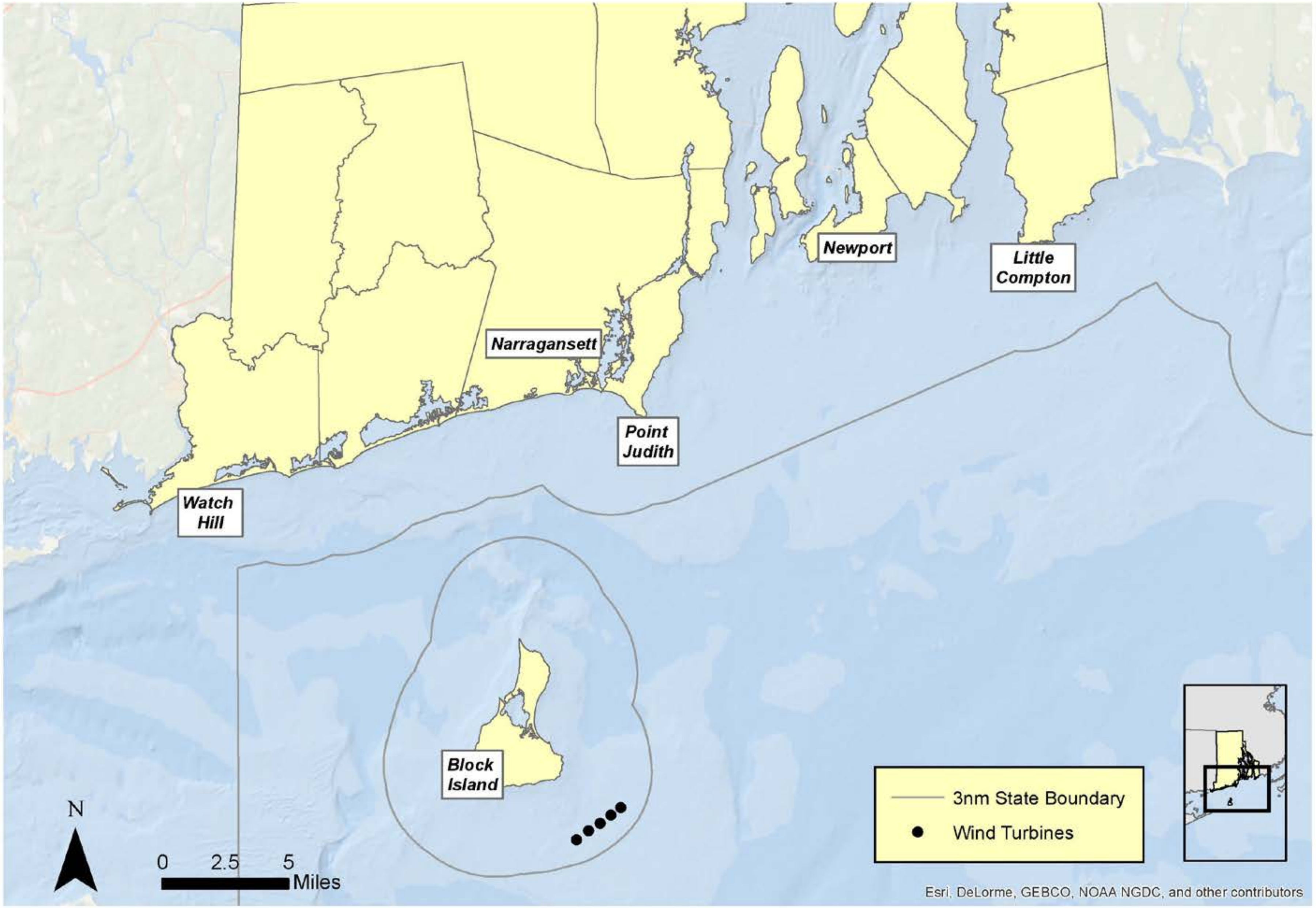
1. Identify potential indicators for effects on tourism/recreation.
2. Identify and synthesize effects of BIWF on tourism/recreation.
3. Develop suite of indicators for effects of offshore wind on tourism/recreation.
4. Recommend a subset of indicators for ongoing monitoring of BIWF.

Project Team

- Jennifer McCann (PI), Coastal Resources Center
- David Bidwell, Marine Affairs
- Amelia Moore, Marine Affairs
- Hollie Smith, Communication and Media
- Tiffany Smythe, Coastal Resources Center
- Advisory Board

Proposed Study Area

Study area includes Block Island as well as Rhode Island south coast communities from Watch Hill to Little Compton



Focal Sectors

- Land-Based Tourism on Block Island
- Land-Based Tourism in Adjacent Rhode island Communities
- Rhode Island-based Recreational Fishing
- Rhode Island-based Charter Boats (fishing/sightseeing)
- Recreational Boating and Sailing

Project Components

- Literature Review
- Content Analysis
- Participant Observation
- Focus Groups
- Synthesis and Recommendations

Timeline

- Literature Review (January 2017)
- Content Analysis (Spring 2017)
- Participant Observation (Summer 2017-Summer 2018)
- Focus Groups (Spring 2018)
- Synthesis and Recommendations (December 2018)

An Introduction to BOEM's Archaeological Research

James D. Moore III, Ph.D., RPA
Marine Archaeologist
Division of Environmental Sciences (DES)
BOEM Office of Environmental Programs (OEP)
November 16, 2016

BOEM's Cultural Heritage Preservation Responsibilities

- Outer Continental Shelf Lands Act (OCSLA) of 1953
  - Section 1346(a)(1)
  - Section 1346(b)

  Studies must include information necessary to identify historic properties.

  Research must also monitor effects to cultural / historic resources and properties in the offshore, nearshore, and onshore environments, which may be impacted by BOEM's proposed activities (ie. energy development and minerals management)

BOEM's Cultural Heritage Preservation Responsibilities (Cont.)

- The National Historic Preservation Act (NHPA) of 1966

Section 1: "… The preservation of this irreplaceable heritage is in the public interest so that its vital legacy of cultural, educational, aesthetic, inspirational, economic, and energy benefits will be maintained and enriched for future generations of Americans."

  - Section 106
  - Section 110

- The National Environmental Policy Act (NEPA) of 1969
- Executive Order 11593 (1971)

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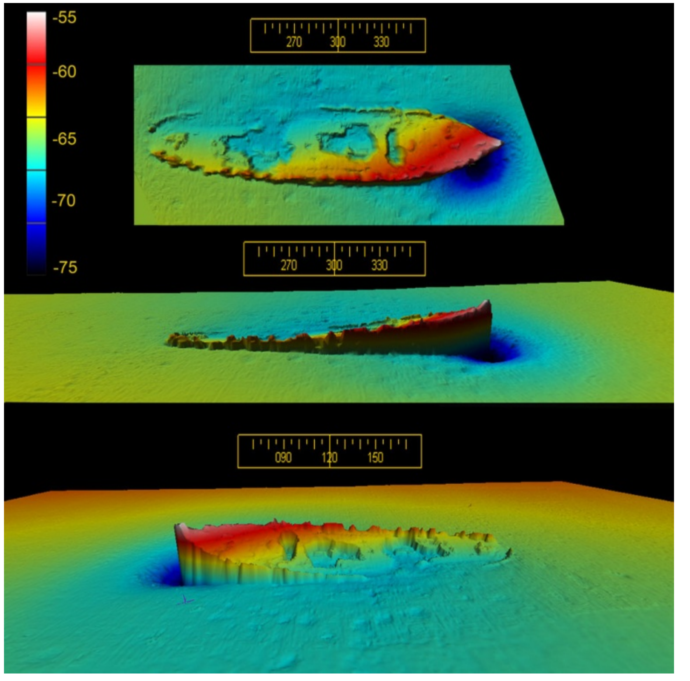
Importance of Archaeology

- The excavation and analysis of artifacts allows researchers to determine past cultural behavior in the absence of historical information
- Time-dependent mechanisms transfer artifacts into a spatial context that must be interpreted by researchers
- Artifacts and sites are non-renewable resources that are physical representations of our past
- Allows researchers to better understand how technological progressions or changes in commerce shaped national or world history

Examples of Survey Techniques

- Magnetometer
- Side-scan Sonar
- Multi-beam Sonar
- Sub-bottom Profiler
- Remotely Operated Vehicle (ROV)
- Autonomously Operated Vehicle (AUV)
- Divers



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Primary Aspects of BOEM's Atlantic Archaeological Studies

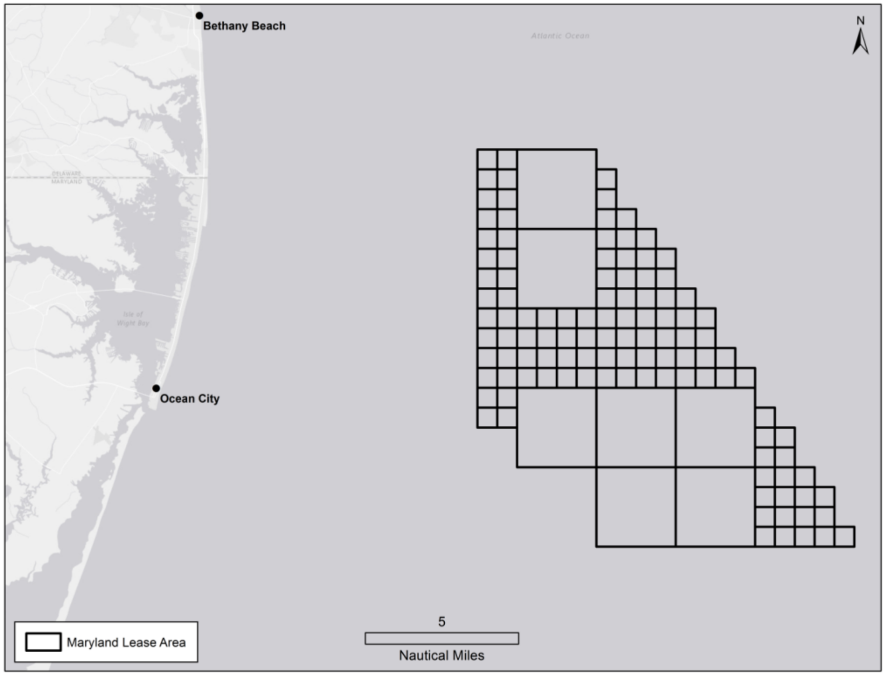
- Collaborative Research Efforts

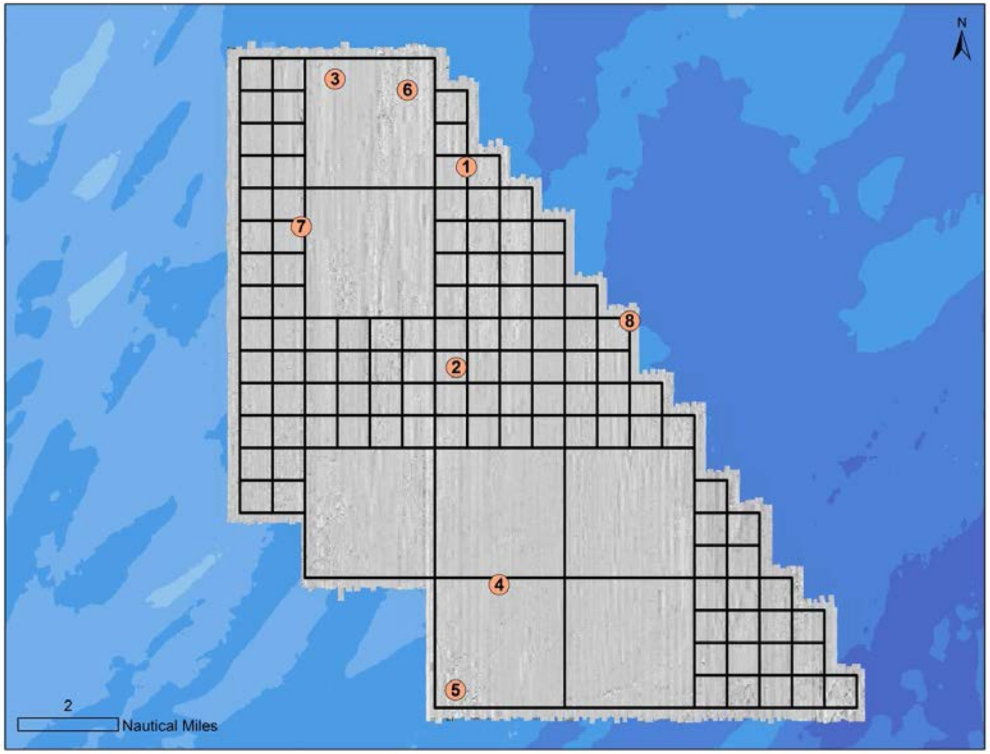
  - Leverage the use the financial resources, personnel expertise, and survey equipment

- Gather and Assess Baseline Data

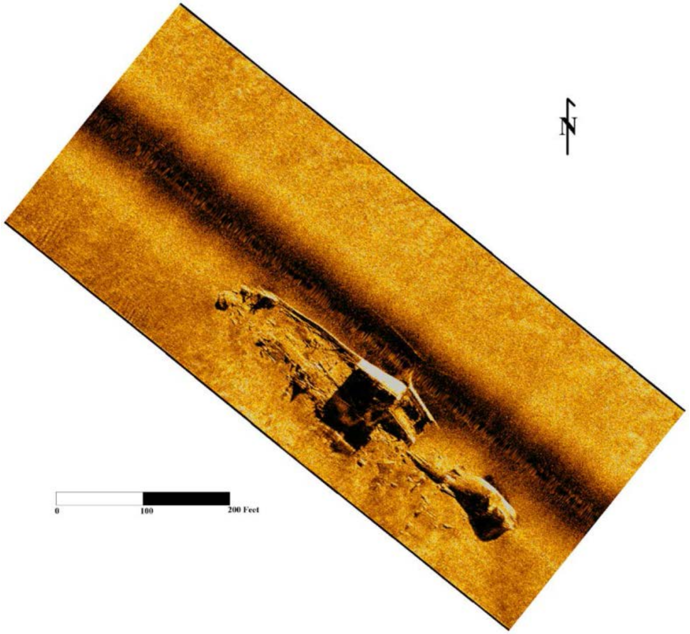
  - Provides informed decision-making as to where BOEM-permitted activities may occur, even within defined regions where prospective industry-related activities may occur, such as Wind Energy Areas (WEAs) and associated Rights-of-Ways (ROWs)

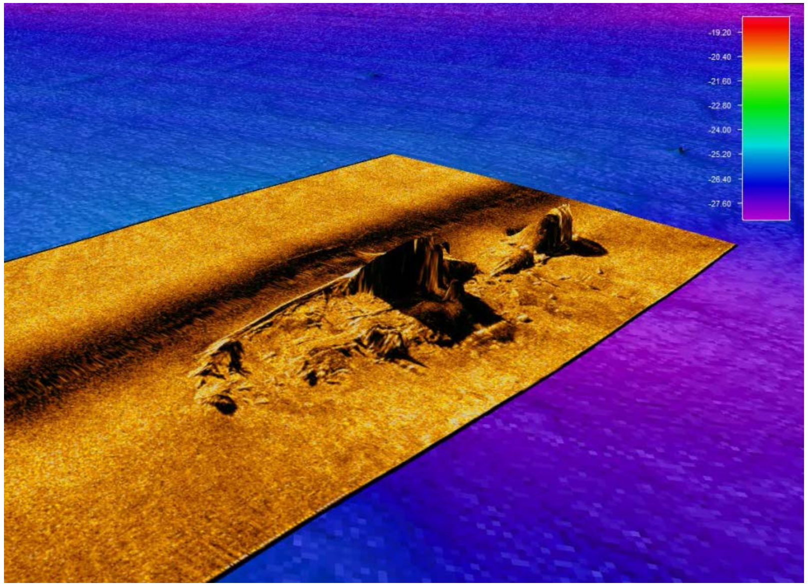
Study Highlight:
Maryland Collaborative Archaeological Survey

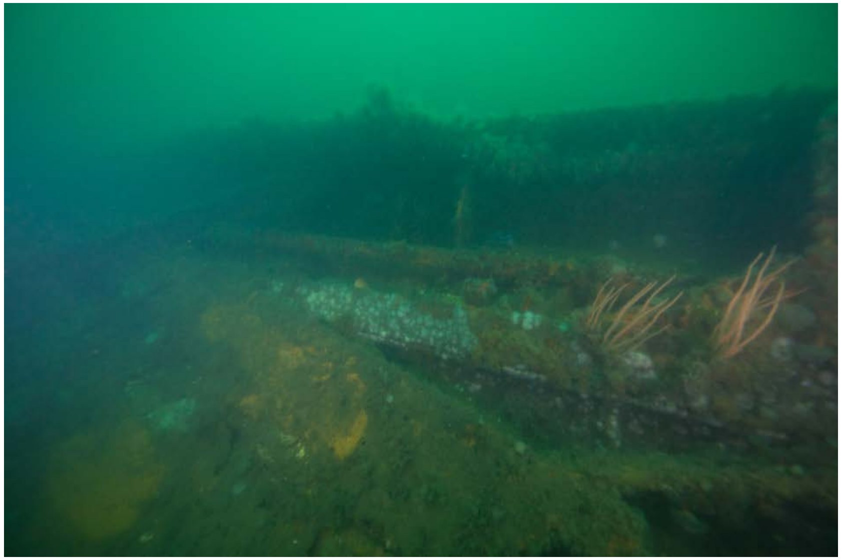




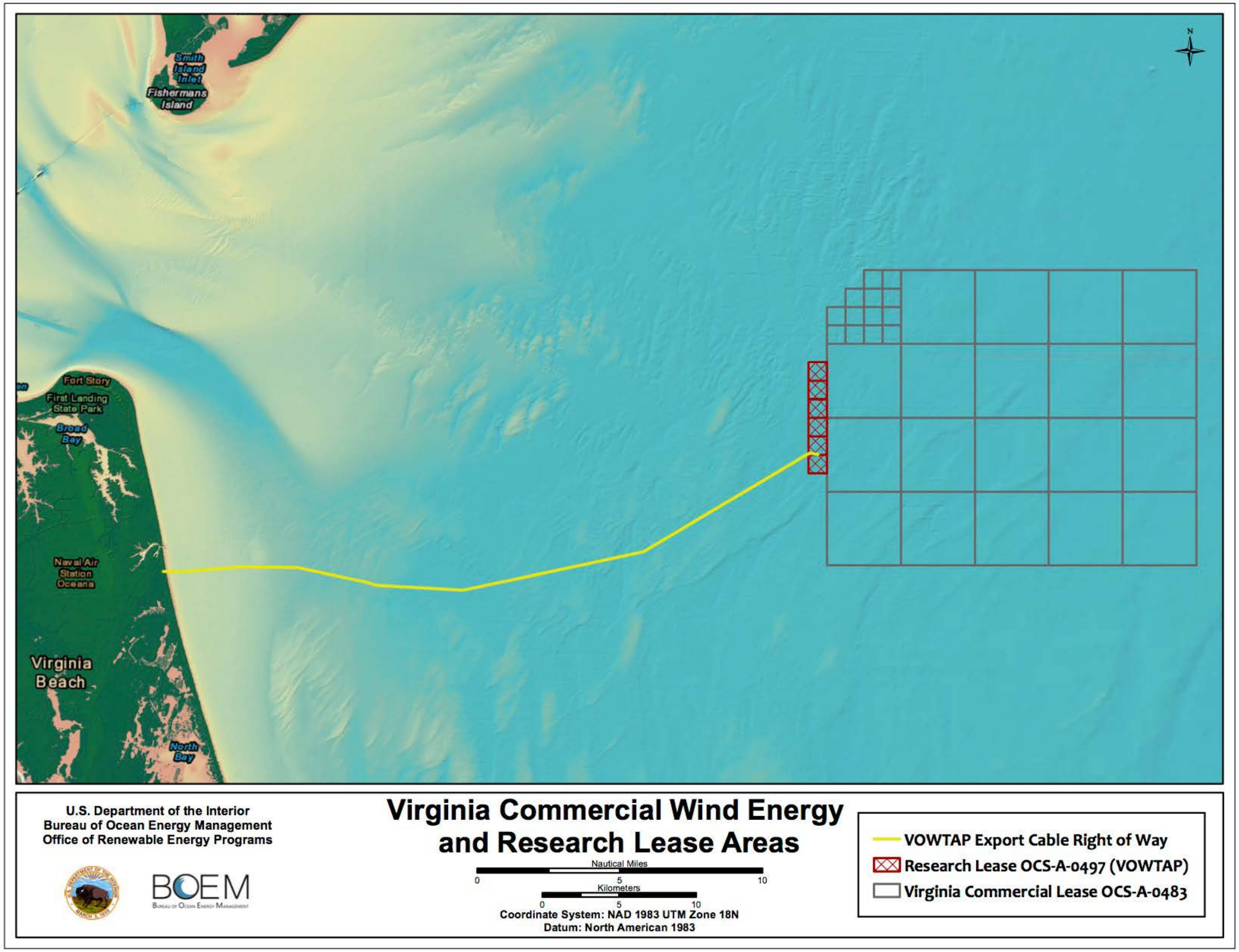
Maryland Collaborative Archaeological Survey
Target 34



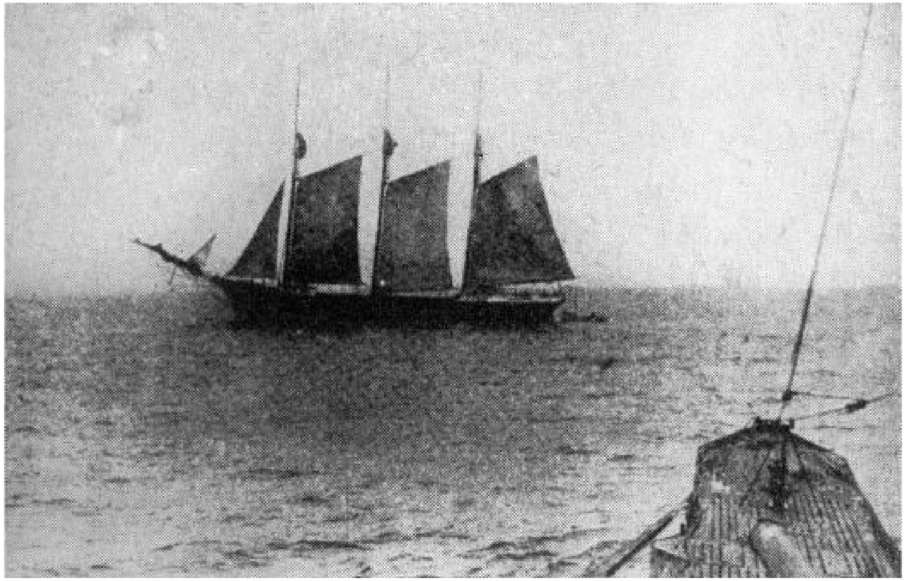




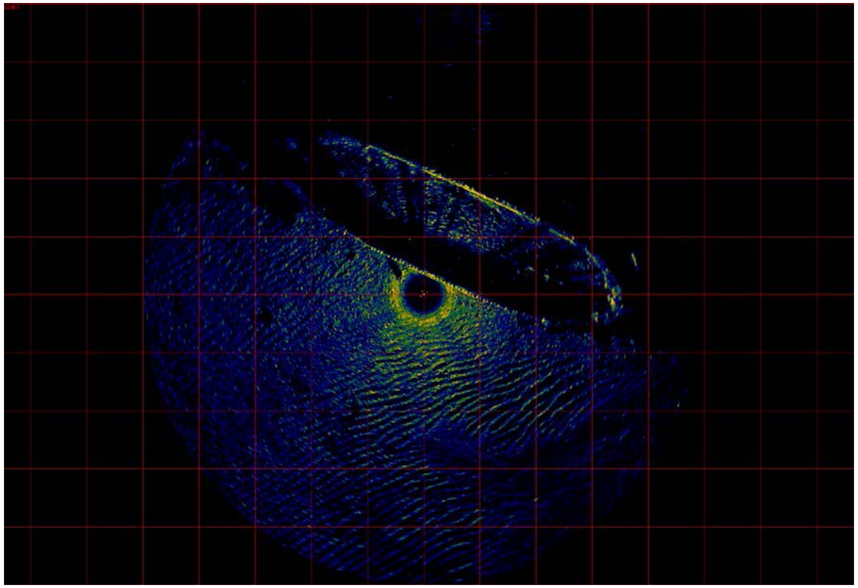
Study Highlight:
Virginia Collaborative Archaeological Survey



Virginia Collaborative Archaeological Survey
Possible Target: *Hattie Dunn*

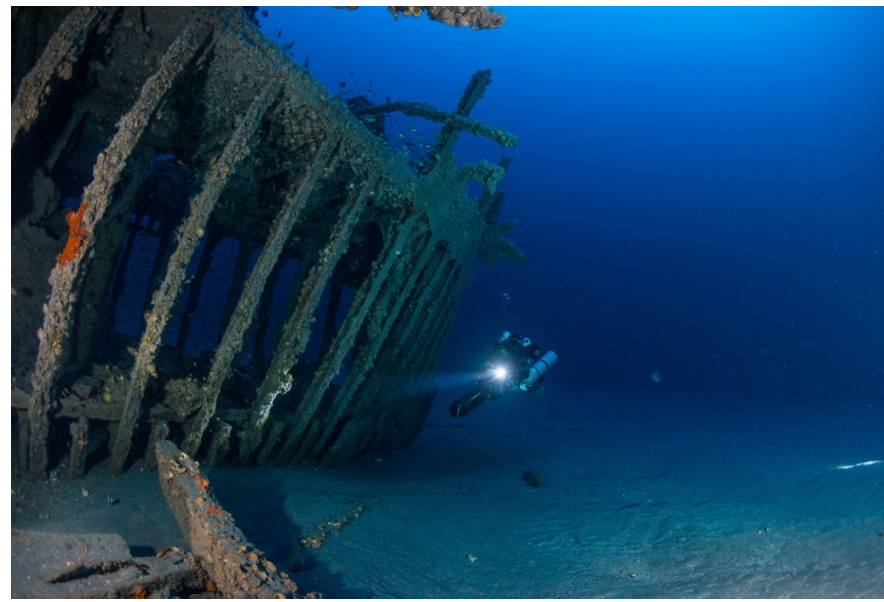


Hattie Dunn viewed from U-*151* (Higgins 2014)



North Carolina: Continuing Collaborative Surveys and the Battle of the Atlantic

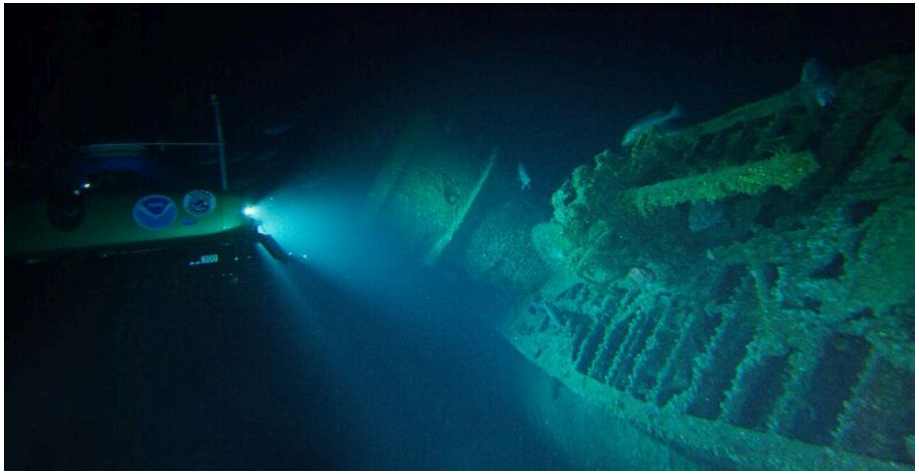
Kitty Hawk WEA Survey



YP-*389* (images courtesy of NOAA)

Battle of the Atlantic Cont.

Freighter *Bluefields*



U-*576*

Images courtesy of Project Baseline

Additional Atlantic Studies

- Inventory and Analysis of Archaeological Site Occurrence on the Atlantic OCS
- Evaluation of Visual Impacts on Cultural Resources and Historic Properties
- Developing Best Practices Protocols for Reconstructing Submerged Paleocultural Landscapes and Identifying Ancient Native American Archaeological Sites in Submerged Environments

DOI Secretarial Order 3330 (2013) and Maritime Cultural Landscapes

- The range of maritime-based activity for an area exemplified by sailing routes, vessel types, and related constructions (ie. ports and harbors)
  - Related to prevailing economic conditions and periods of warfare
  - Sunken vessels reveal the cultural, economic, and technological conditions in which they were constructed
- Submerged paleoenvironmental features and associated material as a result of sea-level or coastal geomorphological changes

Web links for OREP's Historical Preservation Activities and Survey Requirements

General Information:

www.boem.gov/Renewable-Energy/Historic-Preservation-Activities/

Survey Guidelines:

www.boem.gov/Guidelines_for_Providing_Archaeological_and_Historic_Property_Information_Pursuant_to_30CFR585/

Reference Cited

Higgins, P. 2014. *Hidden History of Midcoast Maine*. The History Press: Charleston, SC.

Drivers for Future Studies

- Incorporation of **Ecosystem Services** into Federal Decision Making
- Implementation of **Regional Ocean Action Plans**
- Submission of **Construction & Operation Plans**

Public Perception

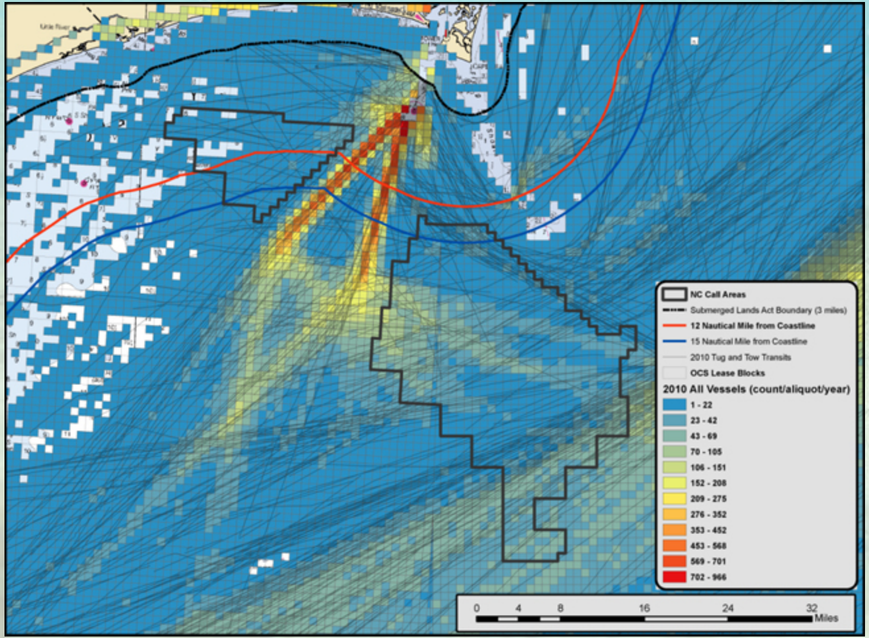
People act on what they perceive

Impacts to Tourism, Housing Value

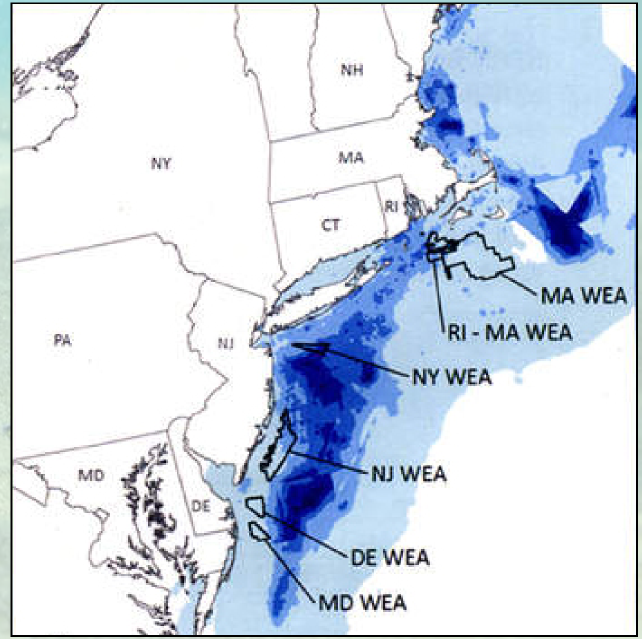
Commercial & Recreational Fishing

Marine Spatial Planning

Tug & Tow Transits with Density Plot of All Vessels *(2010)*



Commercial Fishing Revenue *(2007-2012)*



Request for Study Ideas

Announced on **www.boem.gov**

Ideas sent directly to
Mary Boatman *(Studies Chief)*
Mary.Boatman@boem.gov

Be sure to indicate how the study will inform BOEM decision making

Atlantic Marine Assessment Program for Protected Species (AMAPPS)

NOAA FISHERIES

BOEM
Bureau of Ocean Energy Management

and other organizations

Presented by: Dr. Debra Palka
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, MA

Contributions from:
Abundance: Lance Garrison, Sam Chavez, Doug Sigourney
Pinnipeds: Gordon Waring, Beth Josephson
Birds: Tim Jones, Beth Josephson
Turtles: Heather Haas, Chris Sasso
Passive acoustics: Danielle Cholewiak, Melissa Soldevilla
Ecosystem: Mike Jech, Betsy Broughton

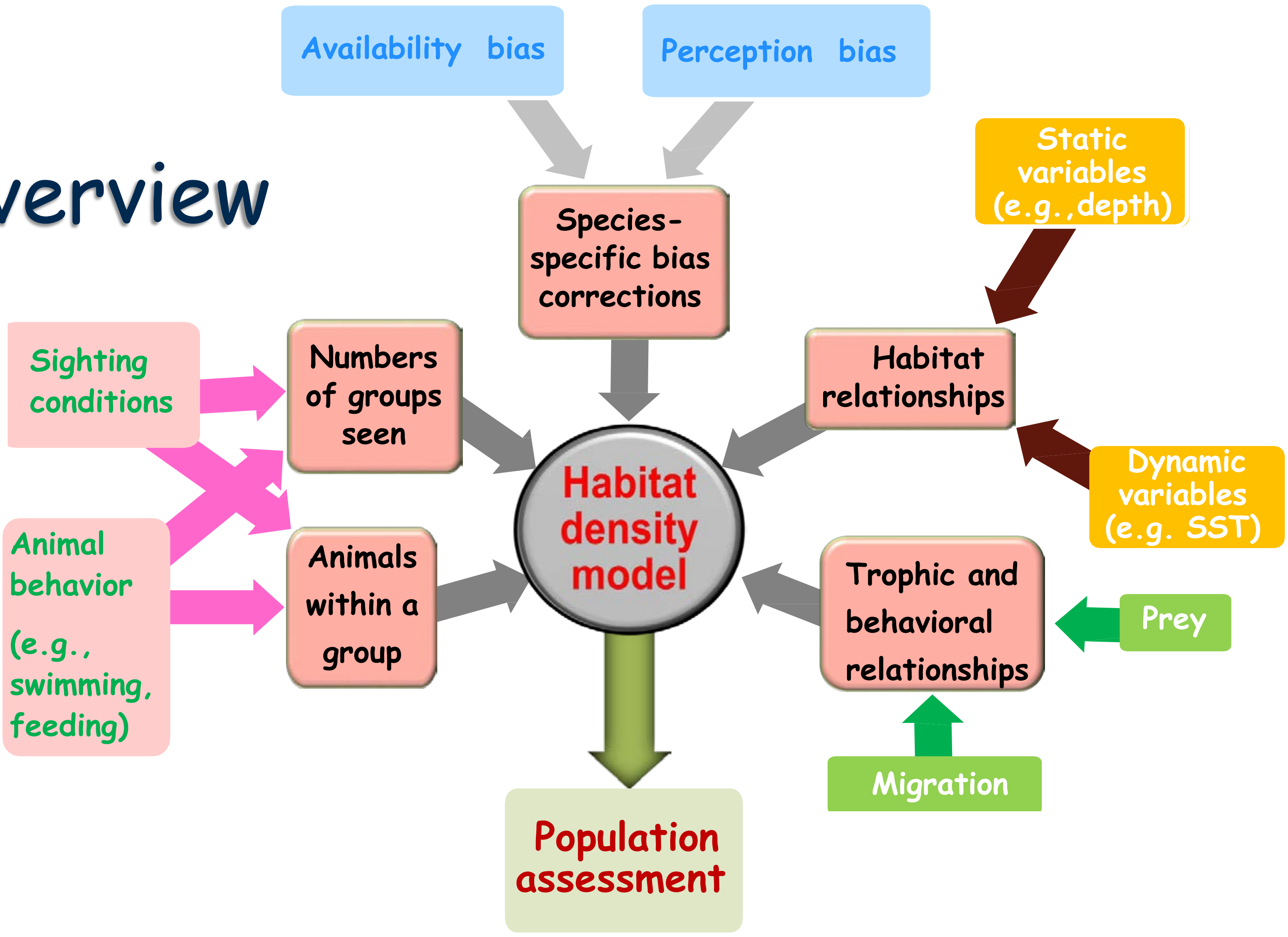
Background of AMAPPS





- Collaborative efforts with NMFS (NEFSC + SEFSC), US Fish and Wildlife Service, BOEM, US Navy and other organizations
- AMAPPS I: 2010 – 2014; AMAPPS II: 2015 – 2019
- Objectives:
  - Collect abundance and distribution data
  - Collect tag telemetry data
  - Estimate broad scale abundance estimates
  - Develop fine scale seasonal, spatially-explicit density estimates within the ecosystem context to be used for management purposes

Overview



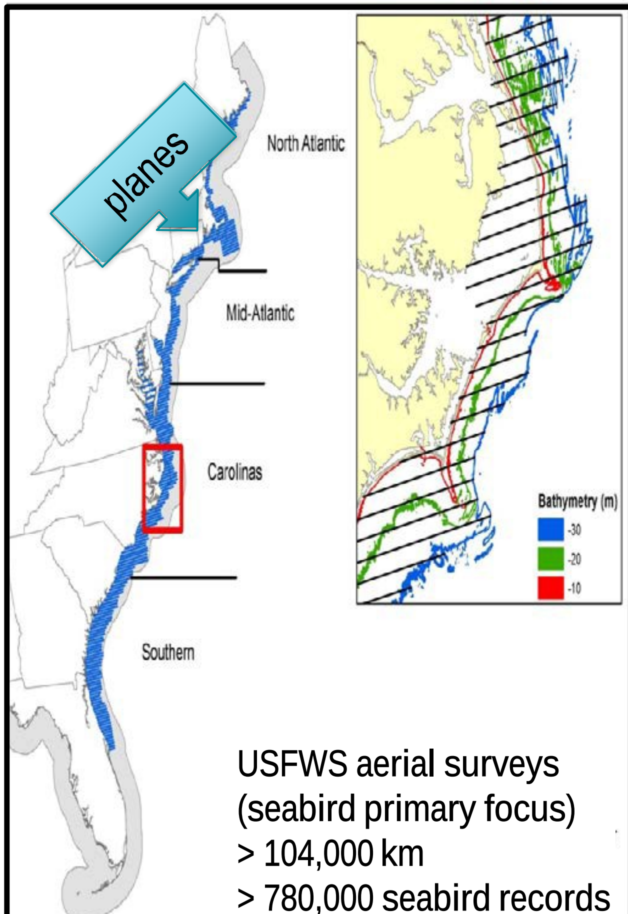
Availability bias
Perception bias
Species-specific bias corrections
Static variables (e.g., depth)
Sighting conditions
Numbers of groups seen
Habitat relationships
Dynamic variables (e.g. SST)
Habitat density model
Animal behavior (e.g., swimming, feeding)
Animals within a group
Trophic and behavioral relationships
Prey
Migration
Population assessment

Outline

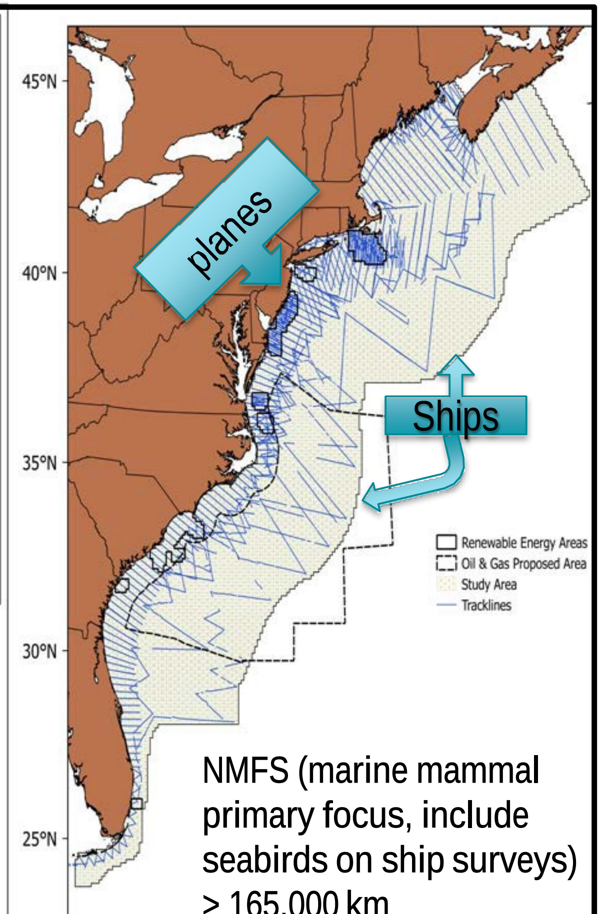
1. Data collection
2. Preliminary results and ongoing activities

Abundance and Distribution

1) Aerial and shipboard surveys:

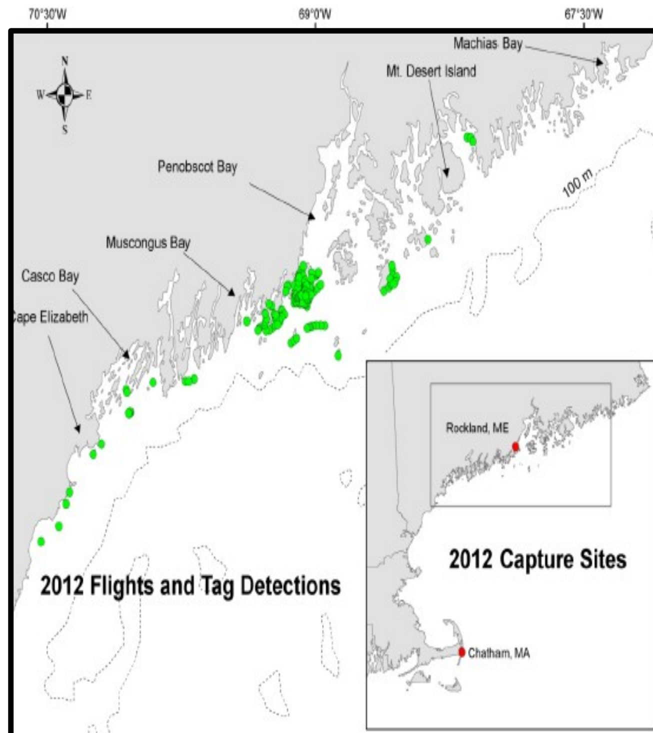


USFWS aerial surveys (seabird primary focus)
> 104,000 km
> 780,000 seabird records



NMFS (marine mammal primary focus, include seabirds on ship surveys)
> 165,000 km

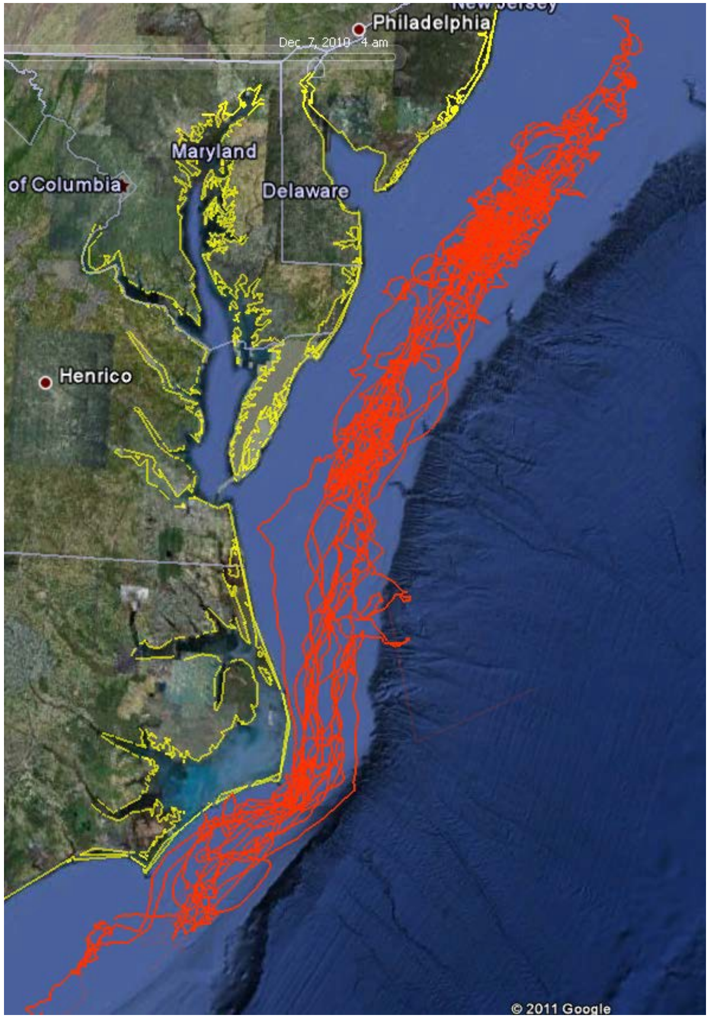
Line transect abundance surveys



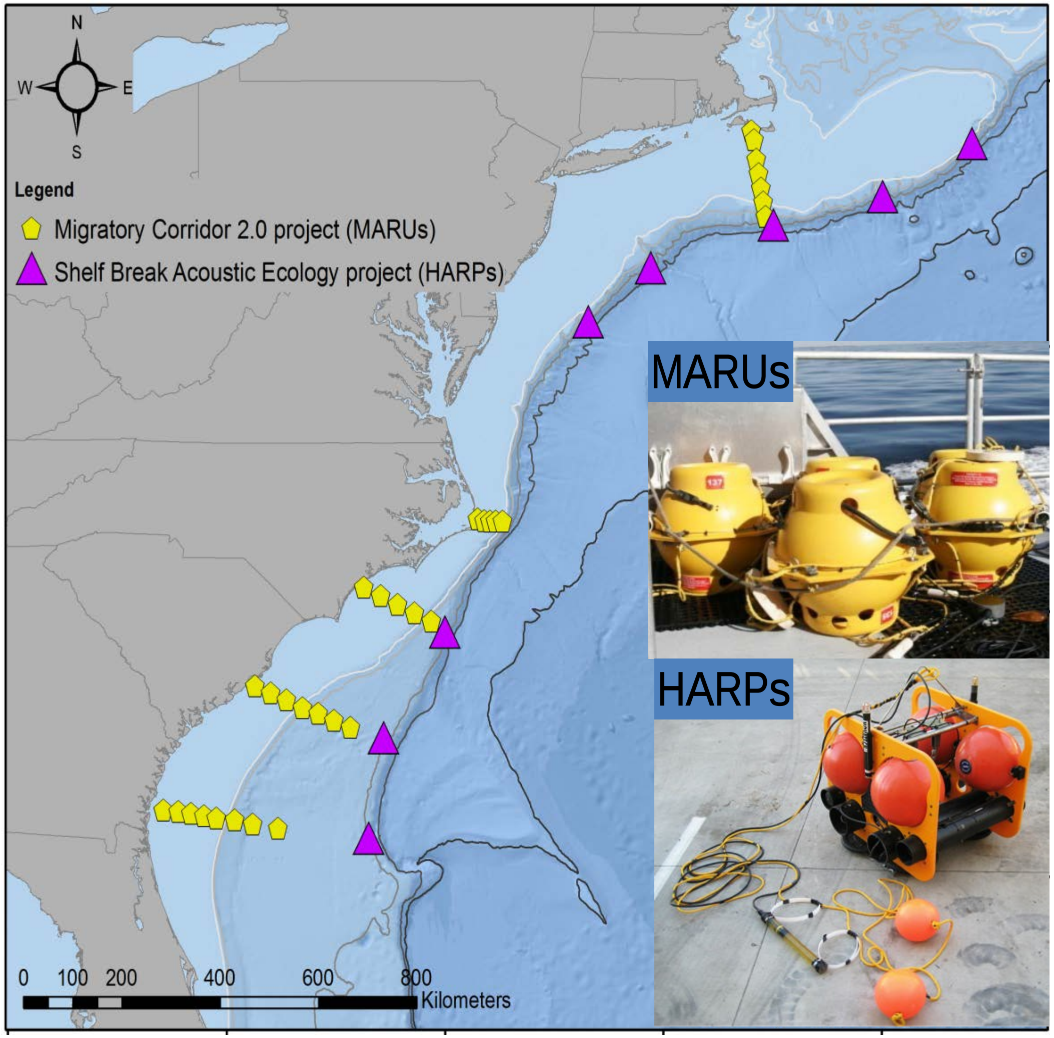
Aerial photography surveys over seal haul out sites

Abundance and Distribution

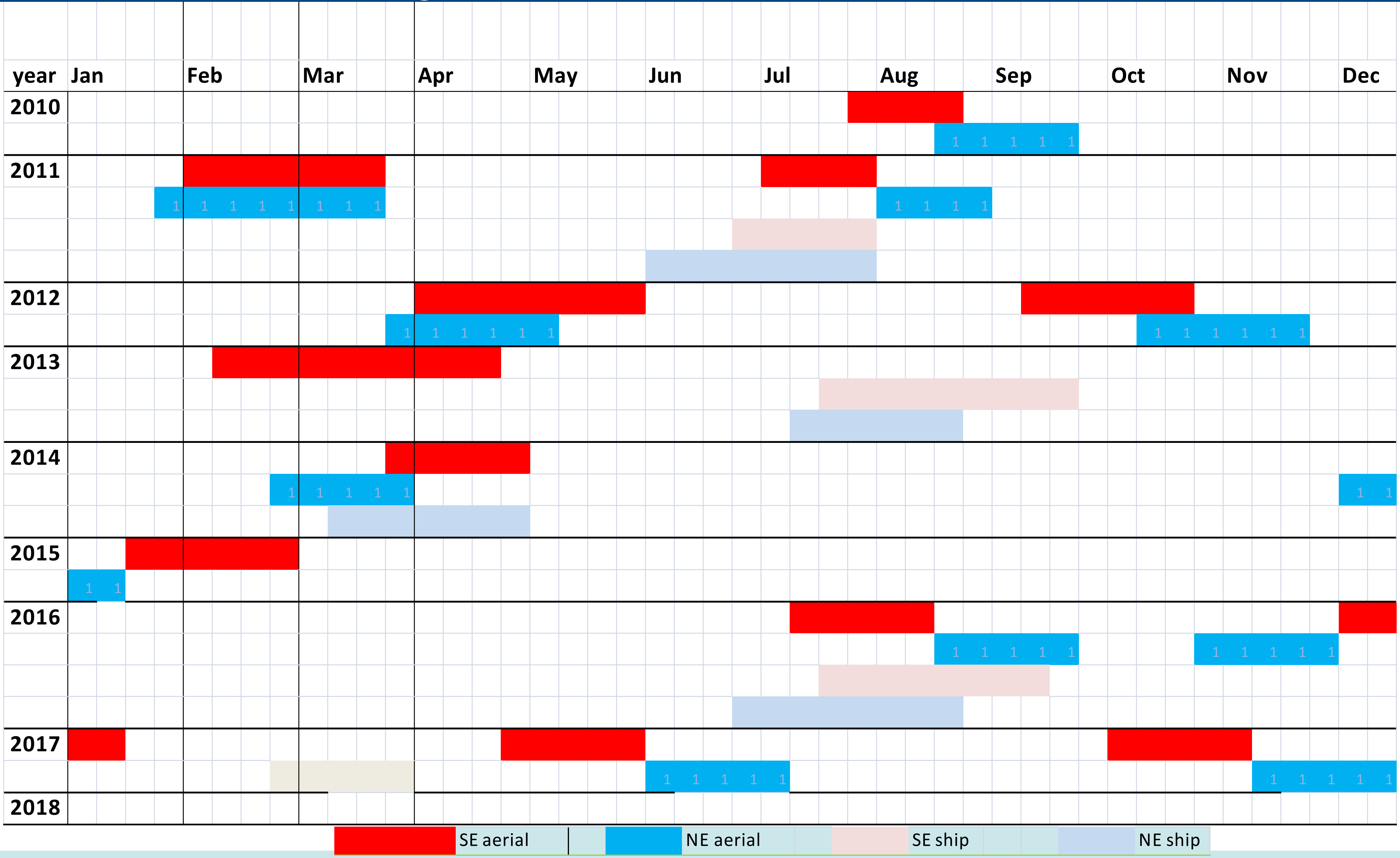
2) Satellite tags



3) Bottom mounted passive acoustic recorders

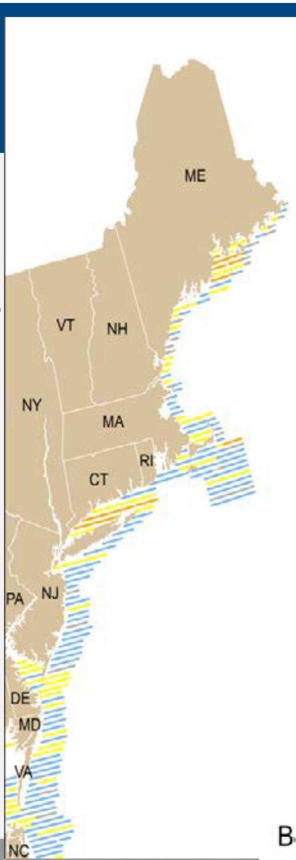


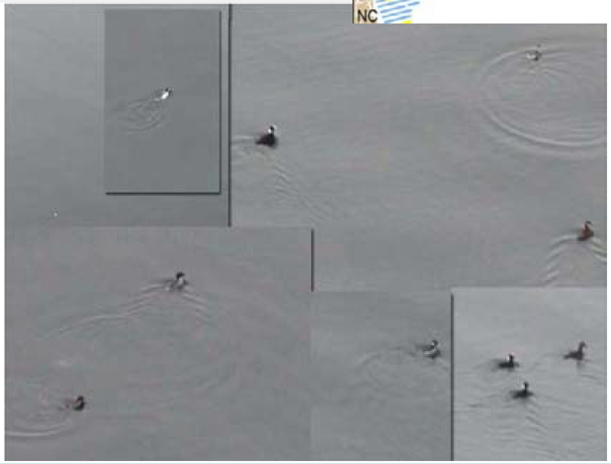
NMFS Survey Schedule



FWS aerial surveys

- Routine surveys
  - 200 ft altitude; 110 knots; 1 team of 3 people
  - 200 m strip width on each side of the aircraft
  - Target species: all birds
  - Record all turtles and marine mammals
- Detection studies (with WA FWS)
  - Goals: quantify perception and availability bias to understand counting errors and mis-identification
  - Double observer teams
  - 2 DSLR cameras mounted to aircraft:
  - forward facing and point of view



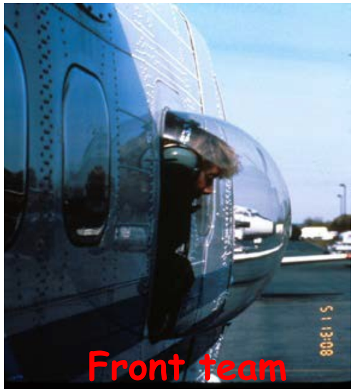


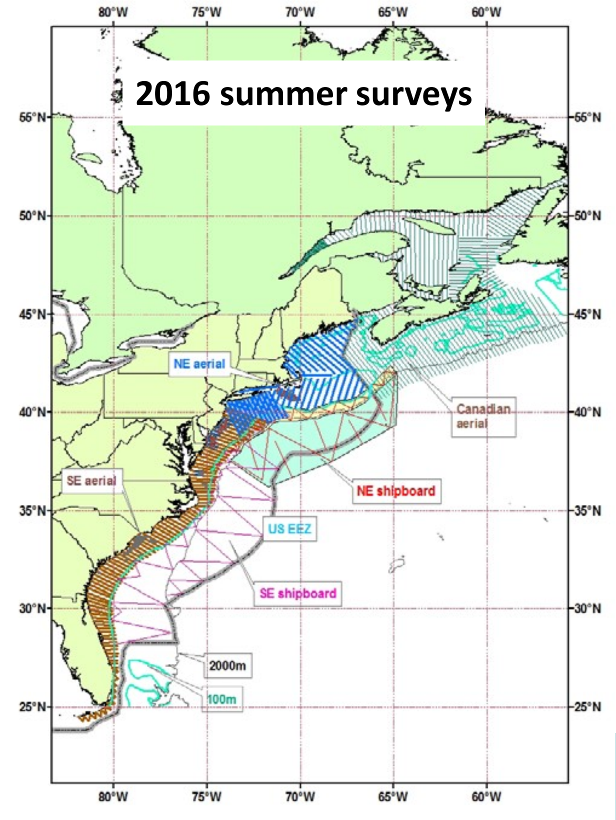
NMFS shipboard and aerial surveys

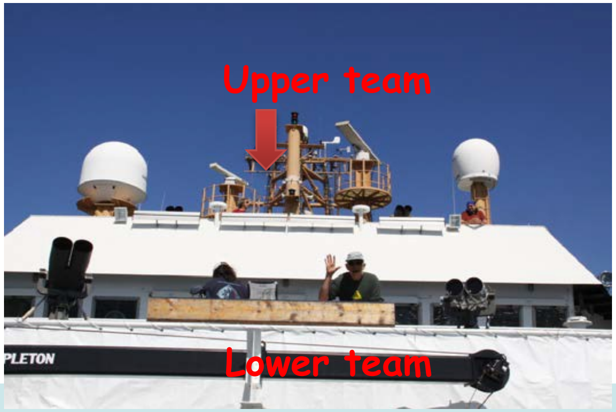
Perception bias accounted for in NMFS ship and plane surveys by using 2 or 3 “independent” line transect platforms and mark-recapture distance analytical techniques to estimate g(0)

Aerial surveys: target marine mammals and sea turtles from 600 ft altitude

Shipboard surveys: target sea birds, marine mammals and sea turtles







Shipboard Seabird Teams

- On NMFS SE and NE shipboard surveys
- Visual strip transect surveys with 1 observer
- ~ 30,000 birds detected from ~ 100 species
- Data sent to NOAA NCCOS to model distribution and abundance

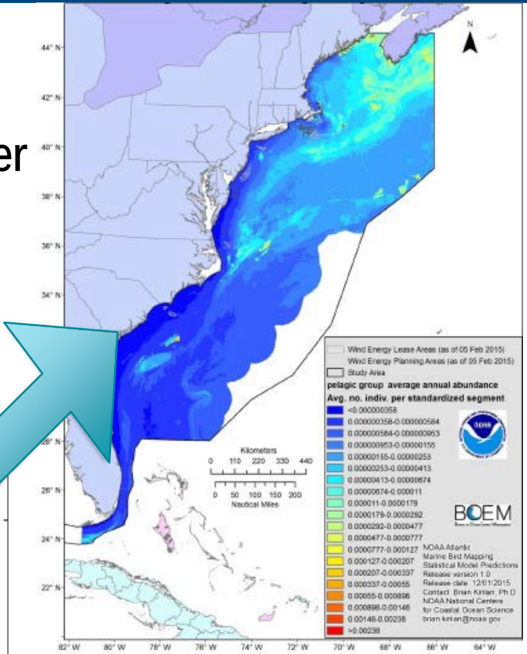


Photo credit: Allison Henry

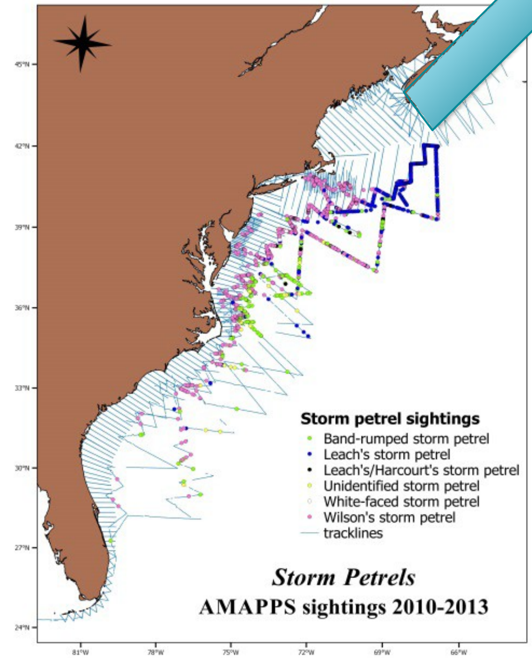
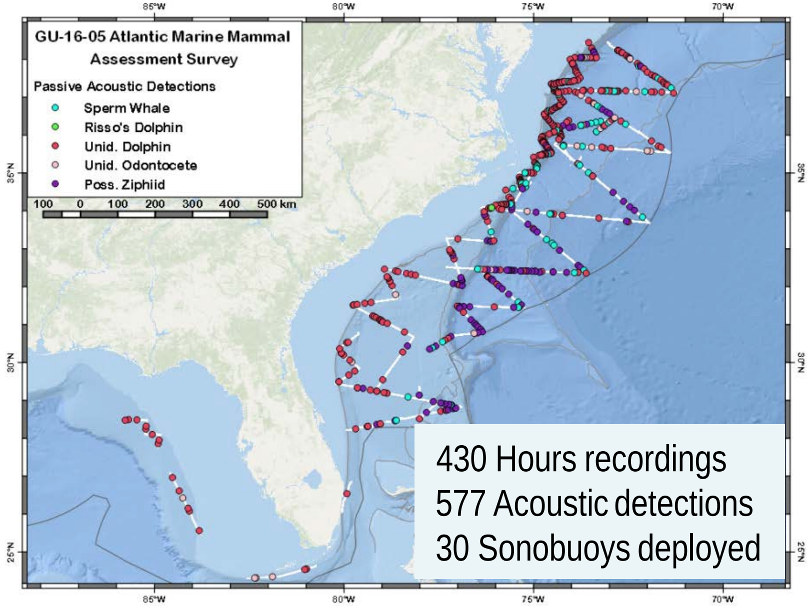



Photo credit: Richard Holt

Shipboard Passive Acoustic Teams

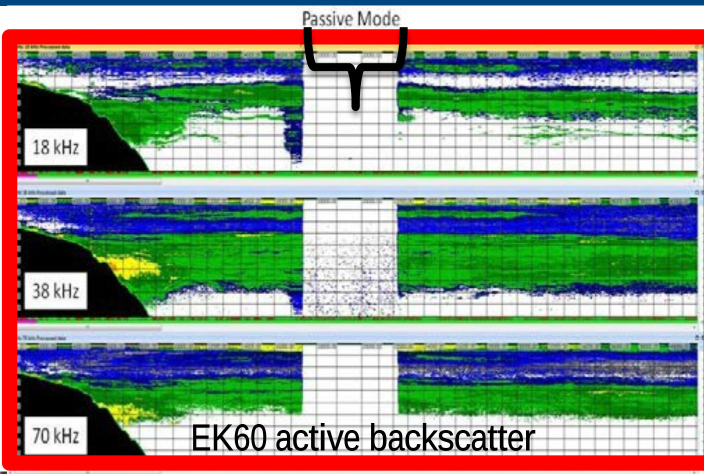
- On NMFS SE and NE shipboard surveys
- Hydrophones deployed in waters > 100 m depth, during daytime and nighttime
- Sonobouys deployed to record large whales
- Goals:
  - Acoustic abundance estimation for deep-divers (sperm whales, beaked whales)
  - Supplement visual data for acoustically identifiable species
  - Contribute to development of species-specific classifiers for other odontocetes
  - Integrate visual and acoustic sperm whale data for improved abundance

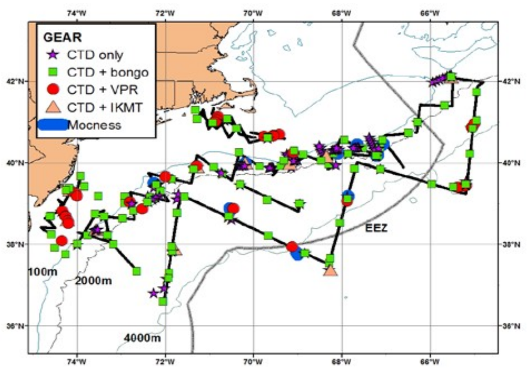


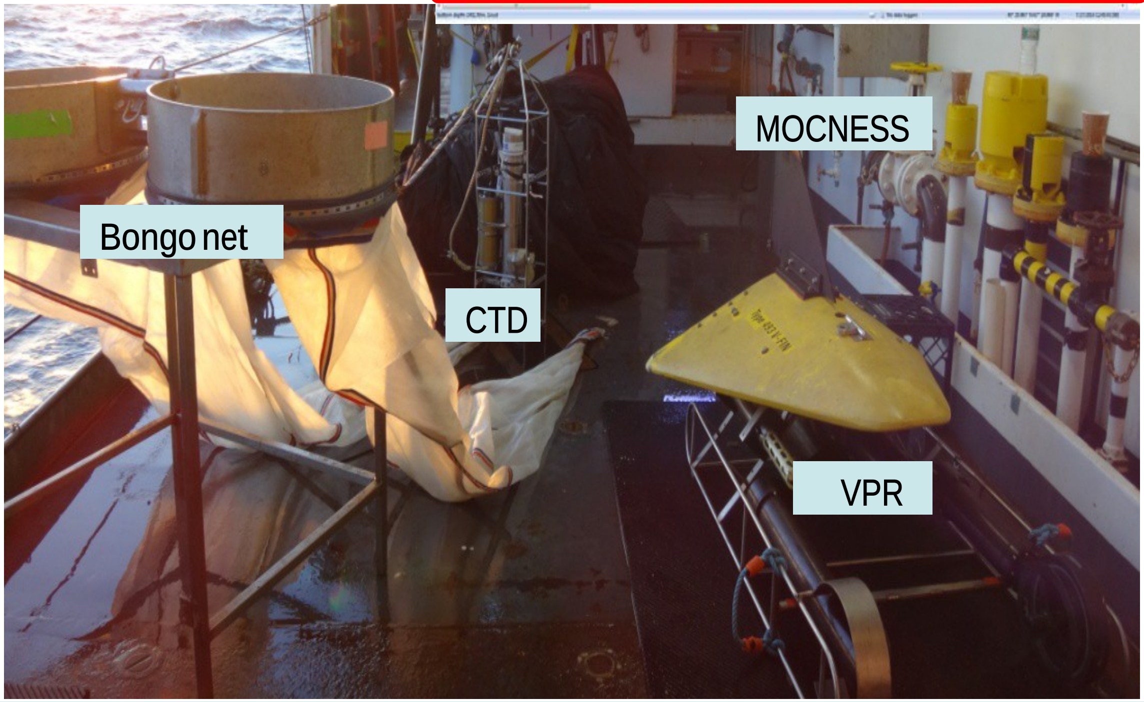
Shipboard Oceanography Teams

Data collected simultaneously

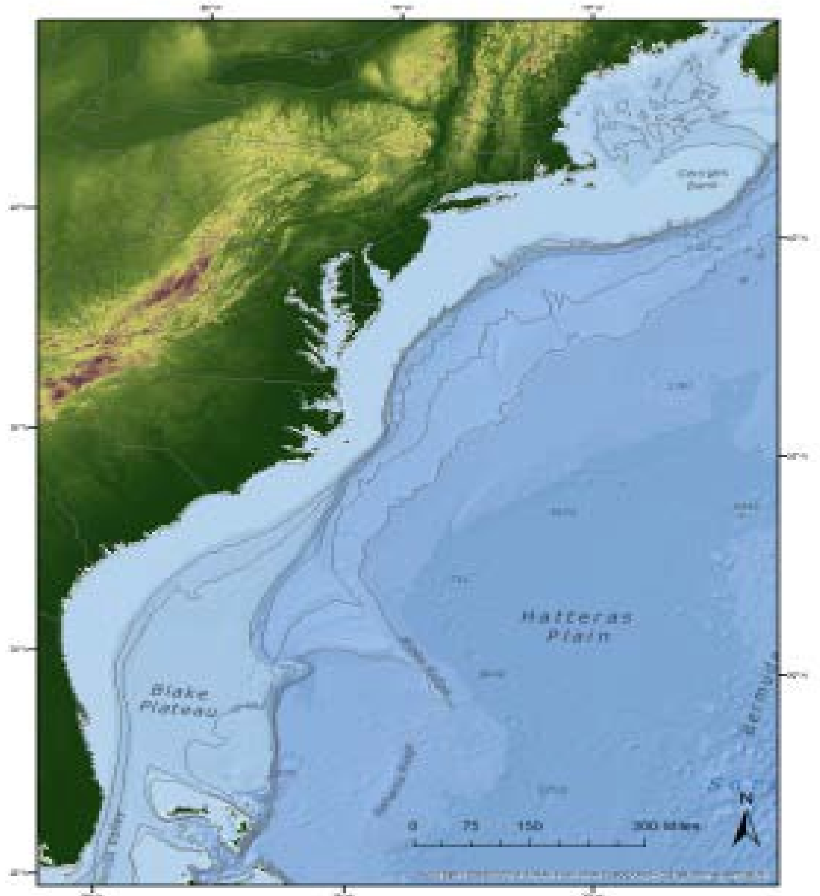
- EK60 backscatter data for plankton & fish
- Plankton and macronekton samples from bongo nets, video plankton recorder (VPR), MOCNESS, Isaac-Kidd trawl, mid-water trawls
- Physical oceanographic characteristics from continuous flow-through surface measurements and station water column samples using CTD etc.



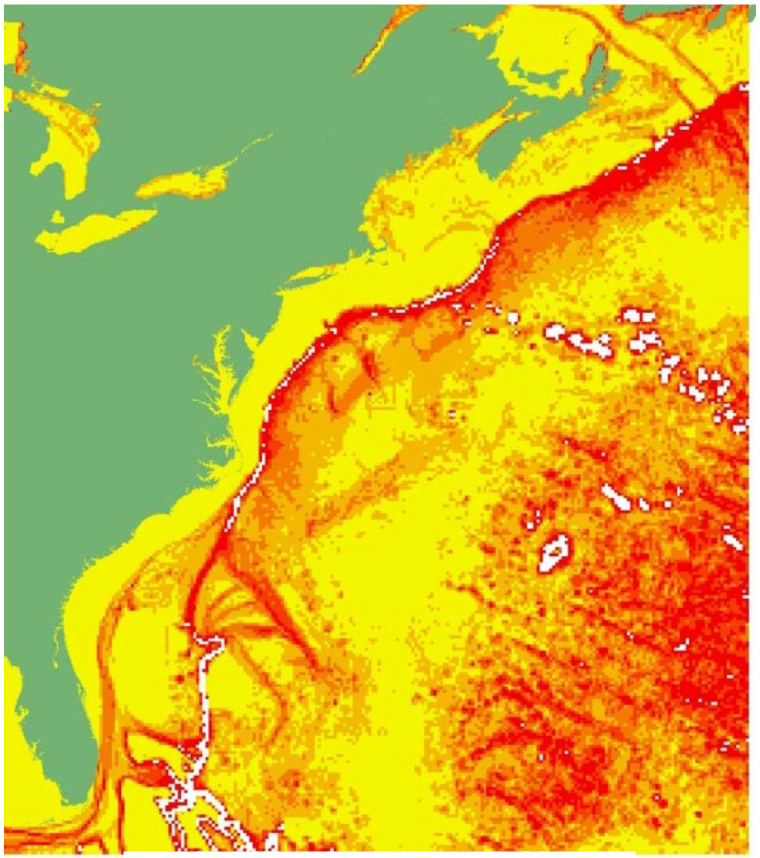




Static Habitat Variables

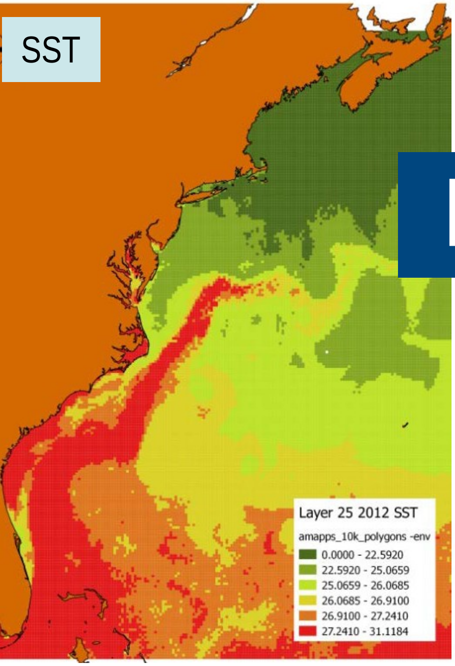


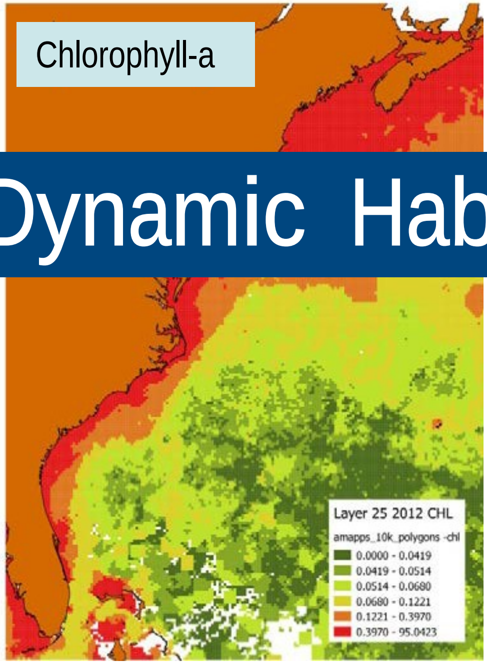
Depth (m)

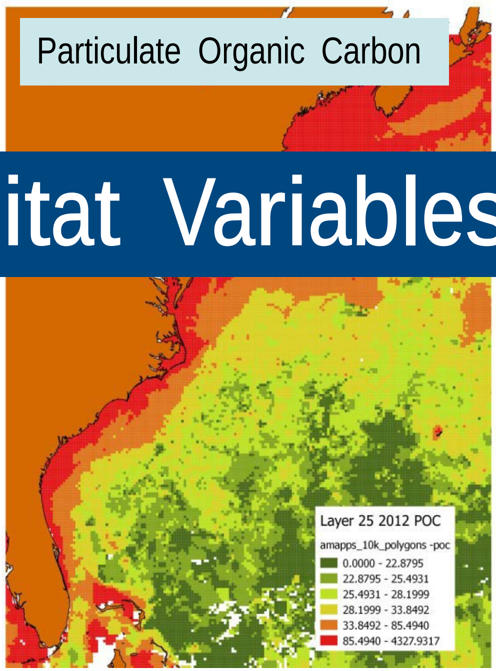


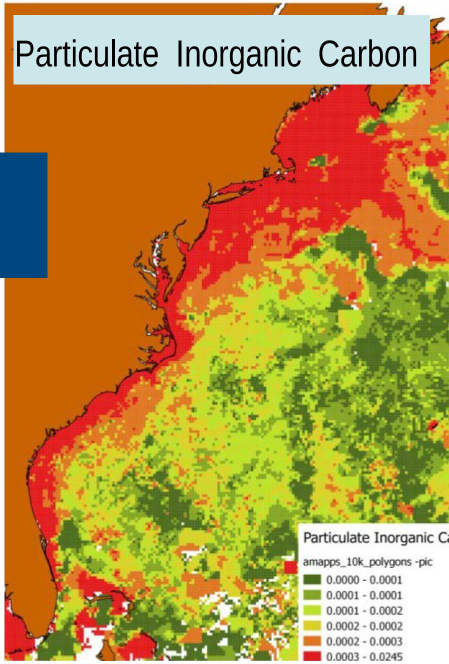
Bottom Slope (degree)

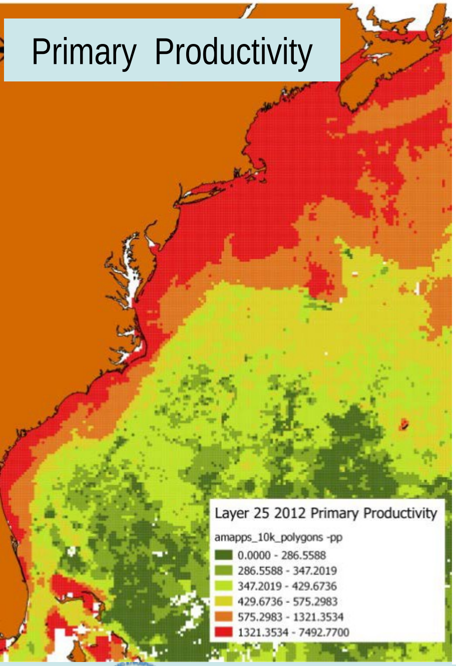
Dynamic Habitat Variables

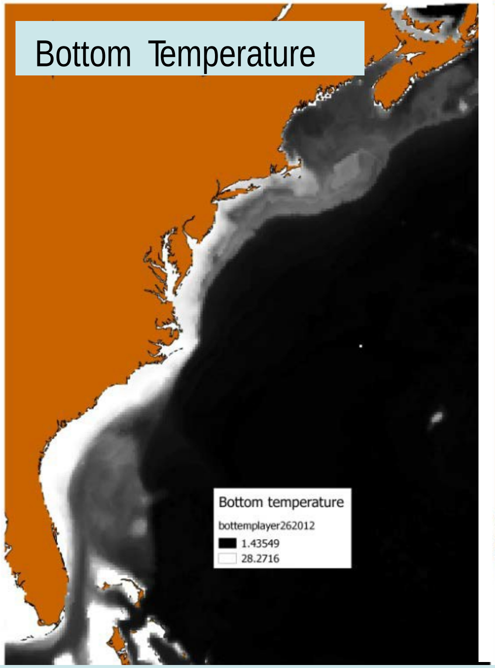


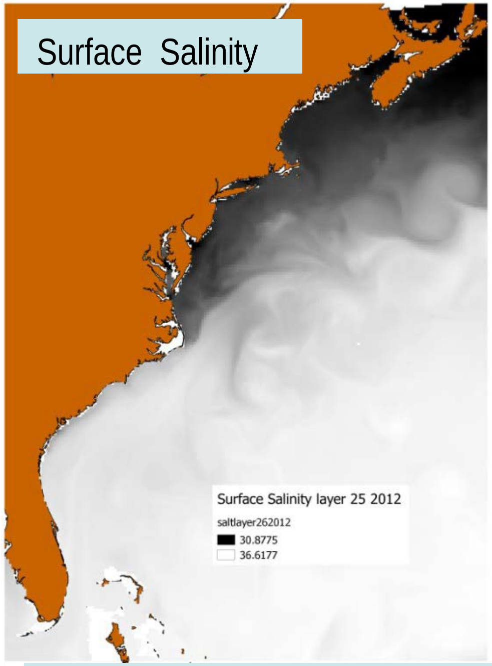


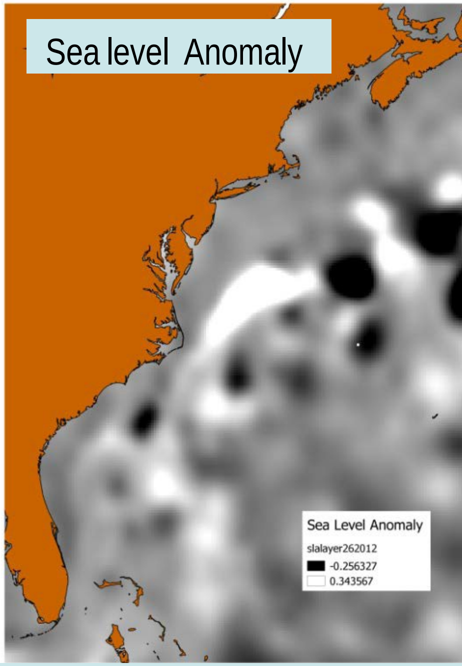








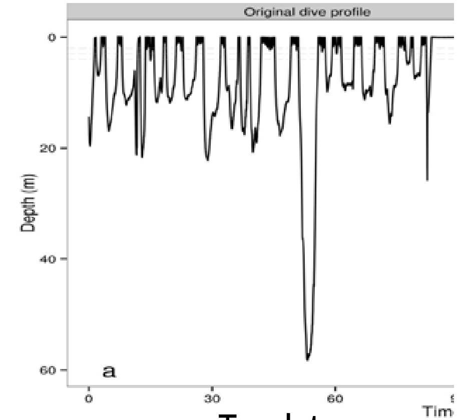




Animal Tagging

To estimate availability, describe habitat usage and vocalization patterns, using data collected from satellite and D-Tags.

Availability bias correction factor increases abundance estimate by 2 – 6 times, depending on platform and species.



Tag data


Satellite tags for gray and harbor seals

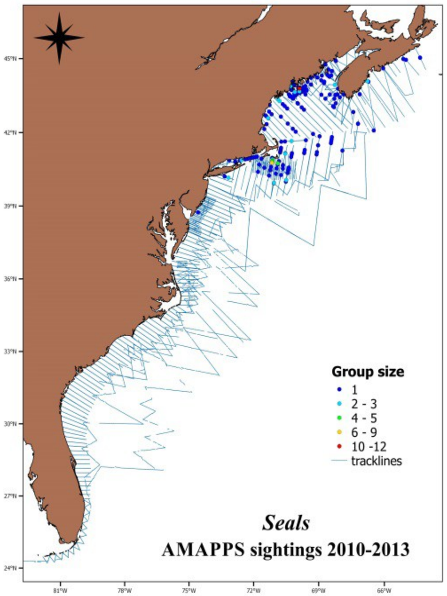

Satellite tags for loggerhead and leatherback turtles

D-Tags for sperm whales, beaked whales and sei whales

Outline

1. Data collection
2. Preliminary results and ongoing activities

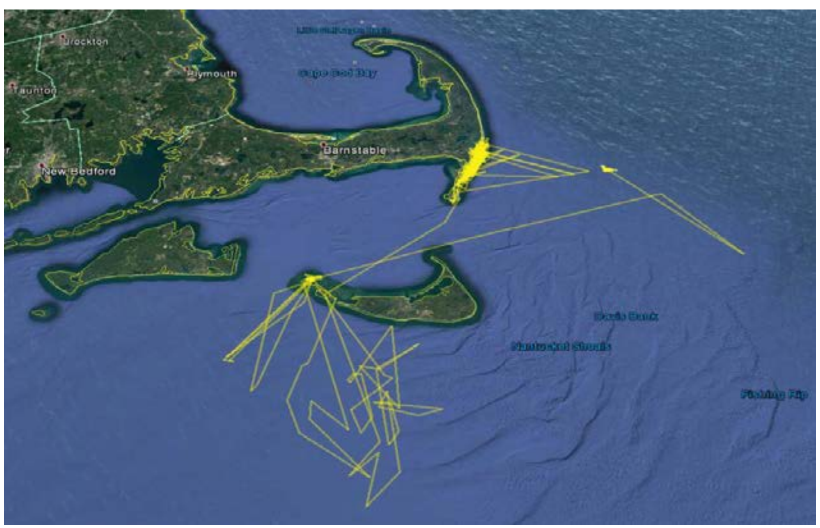
Pinniped Research Results



1) Maine harbor seal abundance surveys
   - Aerial photogrammy surveys conducted 2011 and 2012.
   - Capture and tagging conducted in 2011 and 2012 in Chatham, MA and western Penobscot Bay, ME.
   - G.T. Waring, R.A. DiGiovanni Jr., E. Josephson, S. Wood, and J.R. Gilbert. 2012 population estimate for the harbor seal (*Phoca vitulina concolor*) in New England waters. 2015. NOAA Technical Memo F/NE-235.

2) Satellite tag of adult gray seal, captured in Chatham in June 2013, tracked for 206 days.

3) At-sea and aerial observations of harbor and gray seals.



Cetacean Habitat Density Models

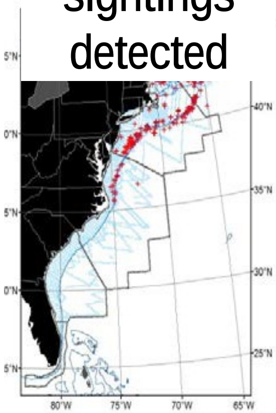
Covariates (Beaufort)

Ship + Plane Data

Dive and surfacing times

Detection relationship

Number of sightings detected



Point independence

Static variables (depth, slope, roughness)

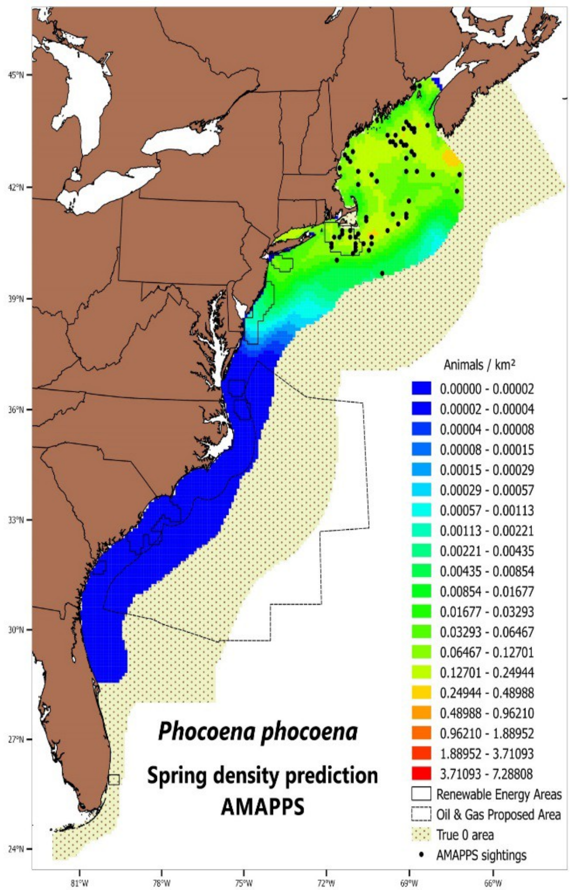
Dynamic variables (SST, chl)

Habitat relationship

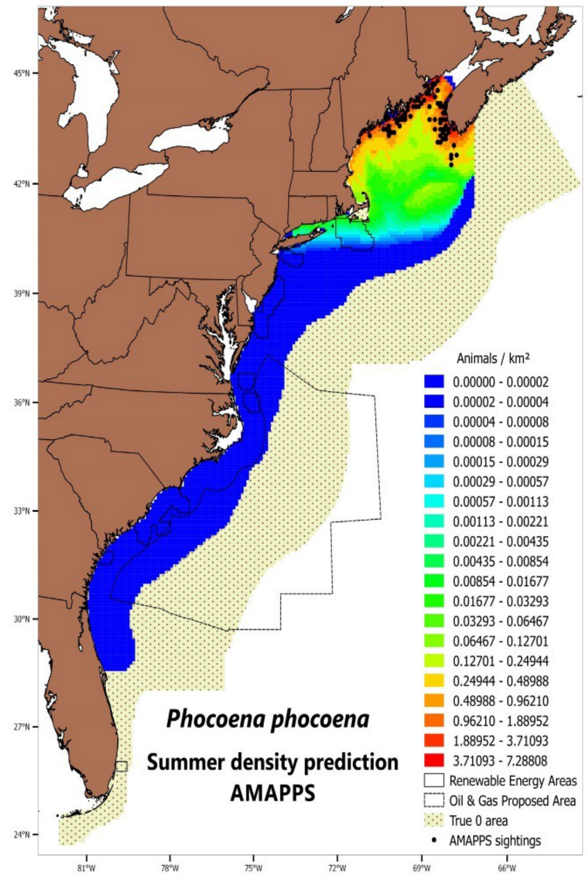
Frameworks: GAMs and Hierarchical Bayesian; Distributions: Tweedie, Zero inflated Poisson, plus others

Cetacean Habitat Density Models Results

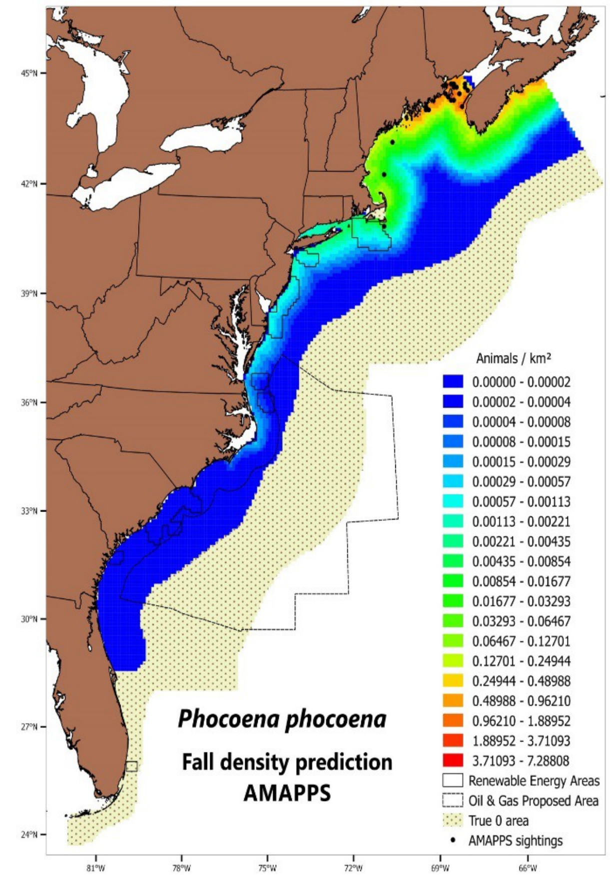
Seasonal maps of density for 17 marine mammal species



Spring

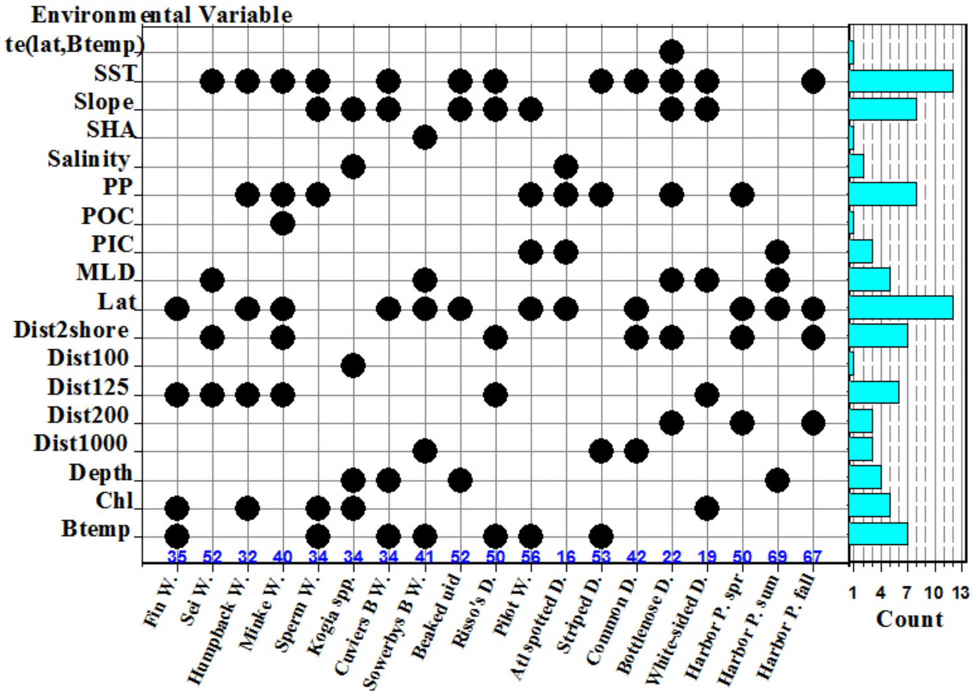


Summer

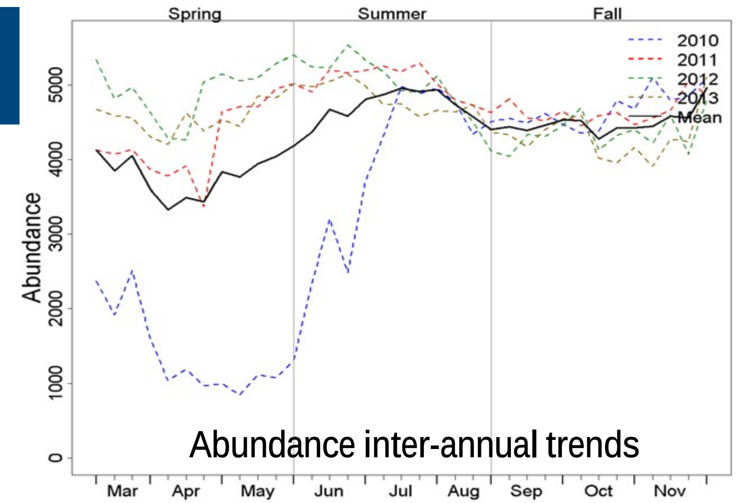


Fall

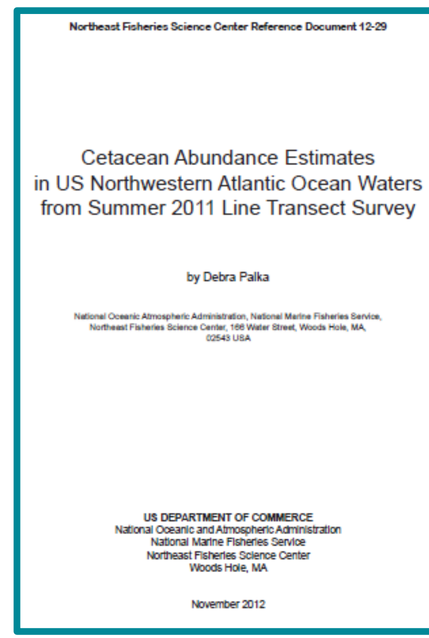
Models Results



Significant environmental variables associated with spatial-temporal density model



Abundance inter-annual trends


Northeast Fisheries Science Center Reference Document 12-29

Cetacean Abundance Estimates
in US Northwestern Atlantic Ocean Waters
from Summer 2011 Line Transect Survey

by Debra Palka

National Oceanic Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA, 02543 USA

US DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, MA

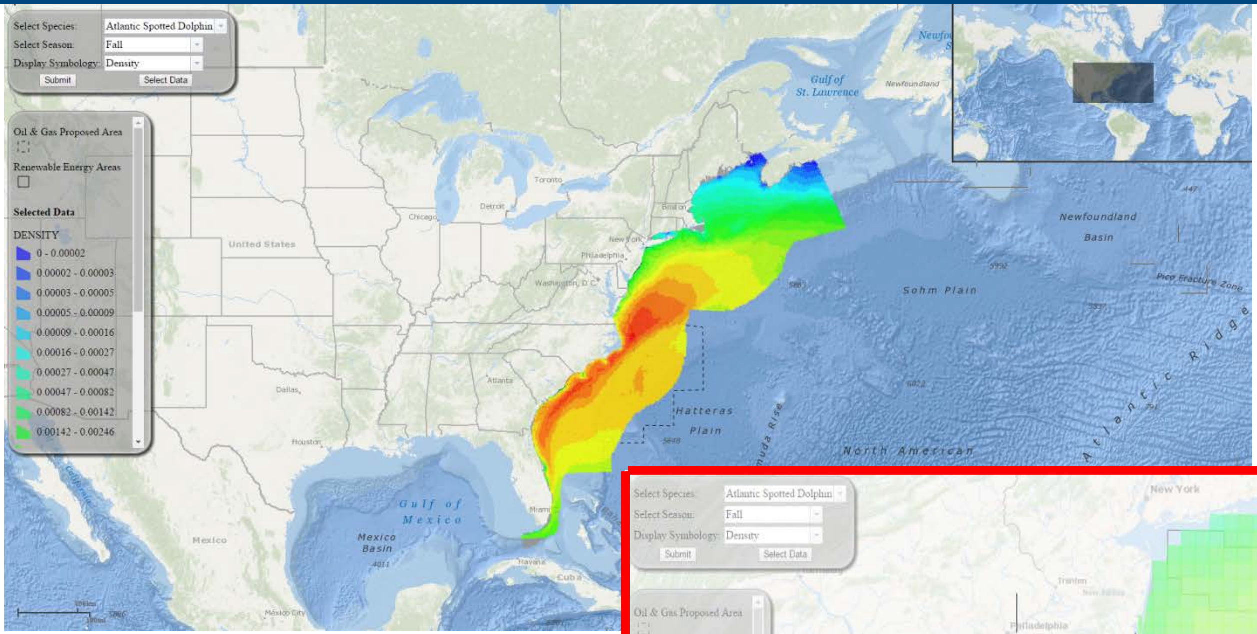
November 2012

Season	Abundance	CV	95% Confidence Interval
Spring (March-May)	3,817	0.148	2,883 - 4,752
Summer (June-August)	4,718	0.127	3,722 - 5,714
Fall (September-November)	4,514	0.123	3,545 - 5,479

Average seasonal abundance estimates

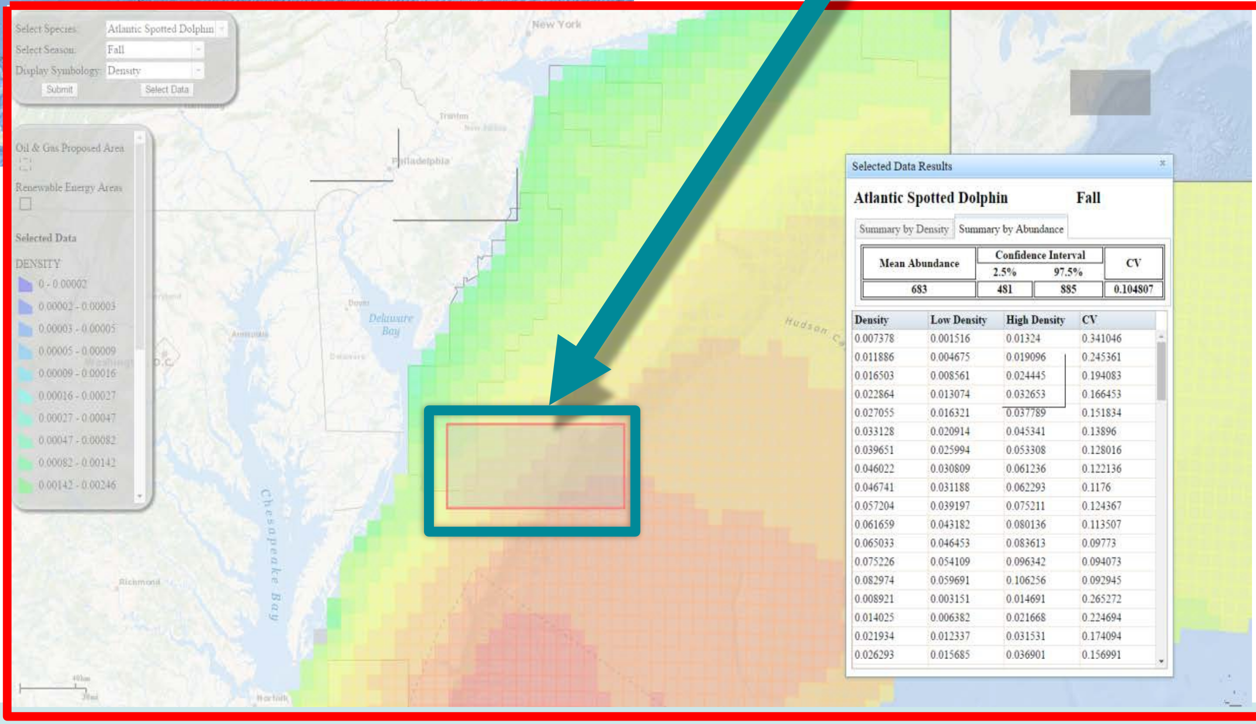
Abundance estimates
in Stock Assessment Reports

Data Availability: Public Website Development



User selected area of interest

Ability to select an area of interest and get density and abundance information for each grid cell



Mean Abundance	Confidence Interval		CV
	2.5%	97.5%	
683	481	885	0.104807

Density	Low Density	High Density	CV
0.007378	0.001516	0.01324	0.341046
0.011886	0.004675	0.019096	0.245361
0.016503	0.008561	0.024445	0.194083
0.022864	0.013074	0.032653	0.166453
0.027055	0.016321	0.037789	0.151834
0.033128	0.020914	0.045341	0.13896
0.039651	0.025994	0.053308	0.128016
0.046022	0.030809	0.061236	0.122136
0.046741	0.031188	0.062293	0.1176
0.057204	0.039197	0.075211	0.124367
0.061659	0.043182	0.080136	0.113507
0.065033	0.046453	0.083613	0.09773
0.075226	0.054109	0.096342	0.094073
0.082974	0.059691	0.106256	0.092945
0.008921	0.003151	0.014691	0.265272
0.014025	0.006382	0.021668	0.224694
0.021934	0.012337	0.031531	0.174094
0.026293	0.015685	0.036901	0.156991

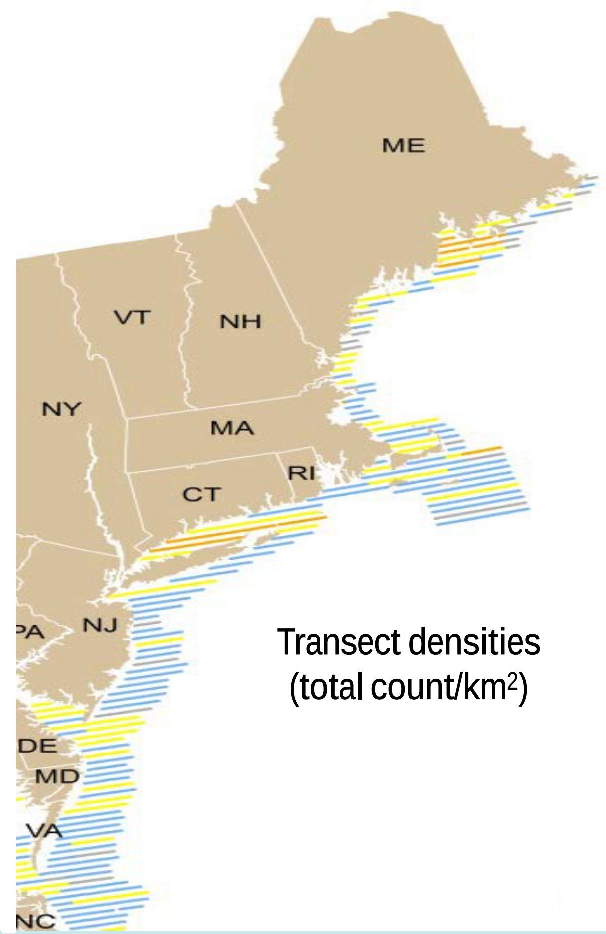
Ongoing activities

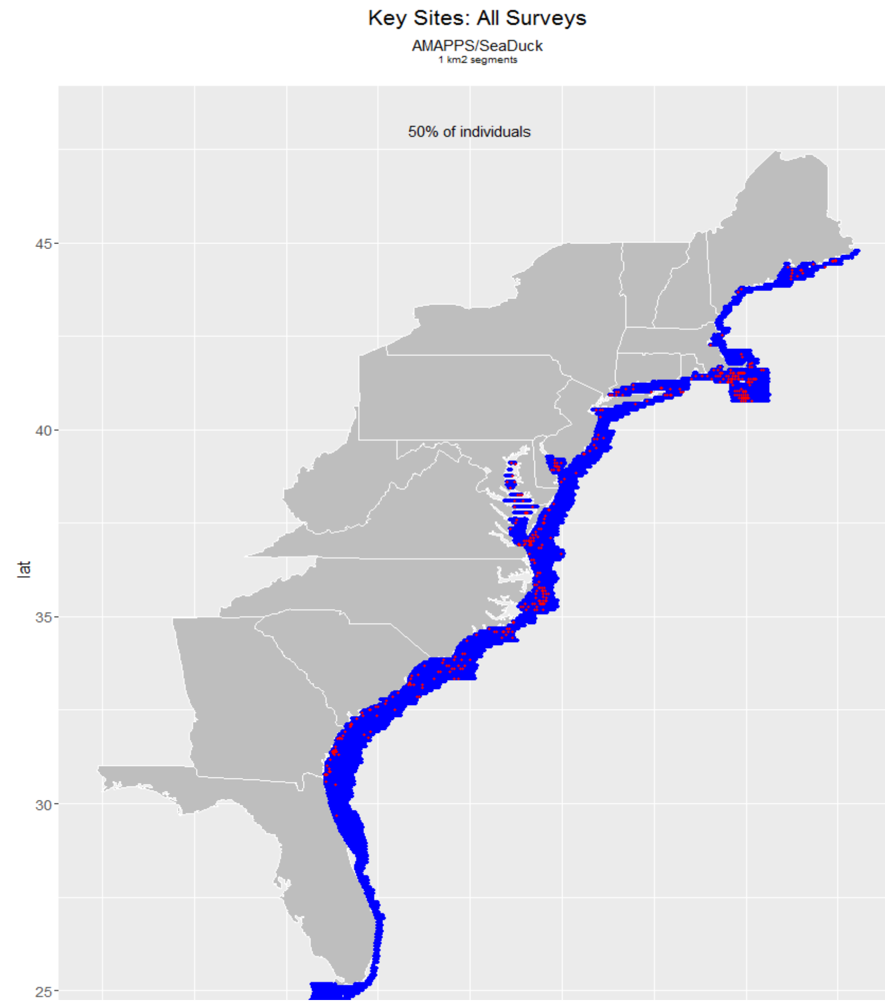
1) Papers in review:
   a) BOEM report of AMAPPS I final results
   b) Availability bias correction factors
   c) Cetacean habitat suitability indicators
2) Employing methods with loggerhead turtle data
3) Expanding hierarchical Bayesian framework to include spatial autocorrelation and other distributions
4) Updating habitat models with newly collected data, resulting in current abundance estimates to be reported in Stock Assessment Reports
5) Investigating longer term annual abundance trends
6) Investigating new analytical methods to separate field sightings not identified to species (like long-finned versus short-finned pilot whales) to derive species specific density models

Seabird Results and Ongoing Activities

Seabird Results

1) Transect densities and Key sites of seabird species





Seabird Results

2) Developed appropriate statistical models for seabird sightings data (Zipkin et al. 2014)

Ongoing activities

3) Continue collecting seasonal aerial survey data
4) Continue detection studies to determine perception and availability bias corrections
5) Continue exploring appropriate statistical models
6) Combine all data to estimate spatial-temporal densities/abundances of species

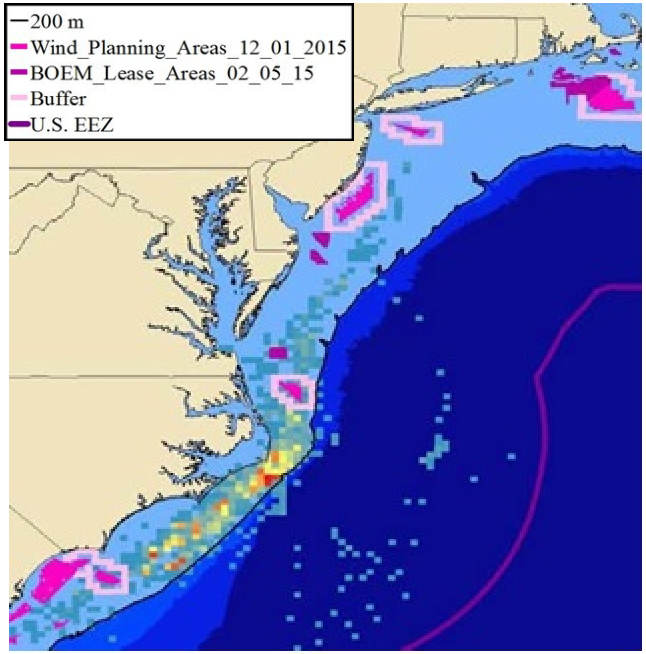
Sea Turtle Results and Ongoing Activities

Photo Credit CFF

Sea Turtle Results

LOGGERHEAD TURTLES

In collaboration with US, Canadian and UK scientists:



Satellite tag data from 2004-2016

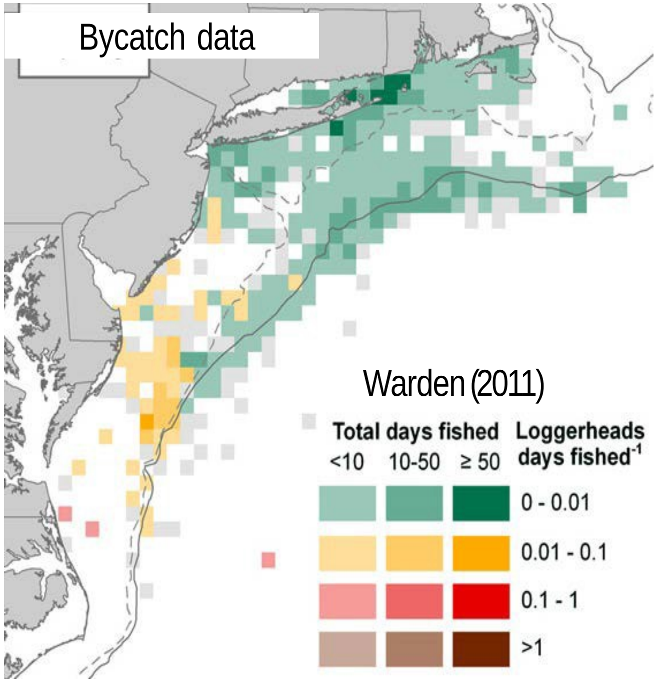
<u>Tags:</u> 120 from AMAPPS
150 other sources

1) New insights into oceanic state duration (Avens et al. 2013)
2) Preliminary loggerhead abundance estimate (NEFSC & SEFSC 2011)
3) Model availability using tag data (Scott-Hayward et al. 2014)

Sea Turtle Ongoing Activities

4) Estimating the distribution of tagged loggerheads from satellite telemetry data
5) Expanding analyses to incorporate other data sources (bycatch and visual surveys)
6) Continuing to tag loggerhead and leatherback turtles, particularly in novel areas to determine spatially-temporal specific habitat usage and availability

Bycatch data



Building upon SEFSC success in tagging.

Incorporating opportunistic sampling.

Visual sightings data

Passive Acoustic Results and Ongoing Activities

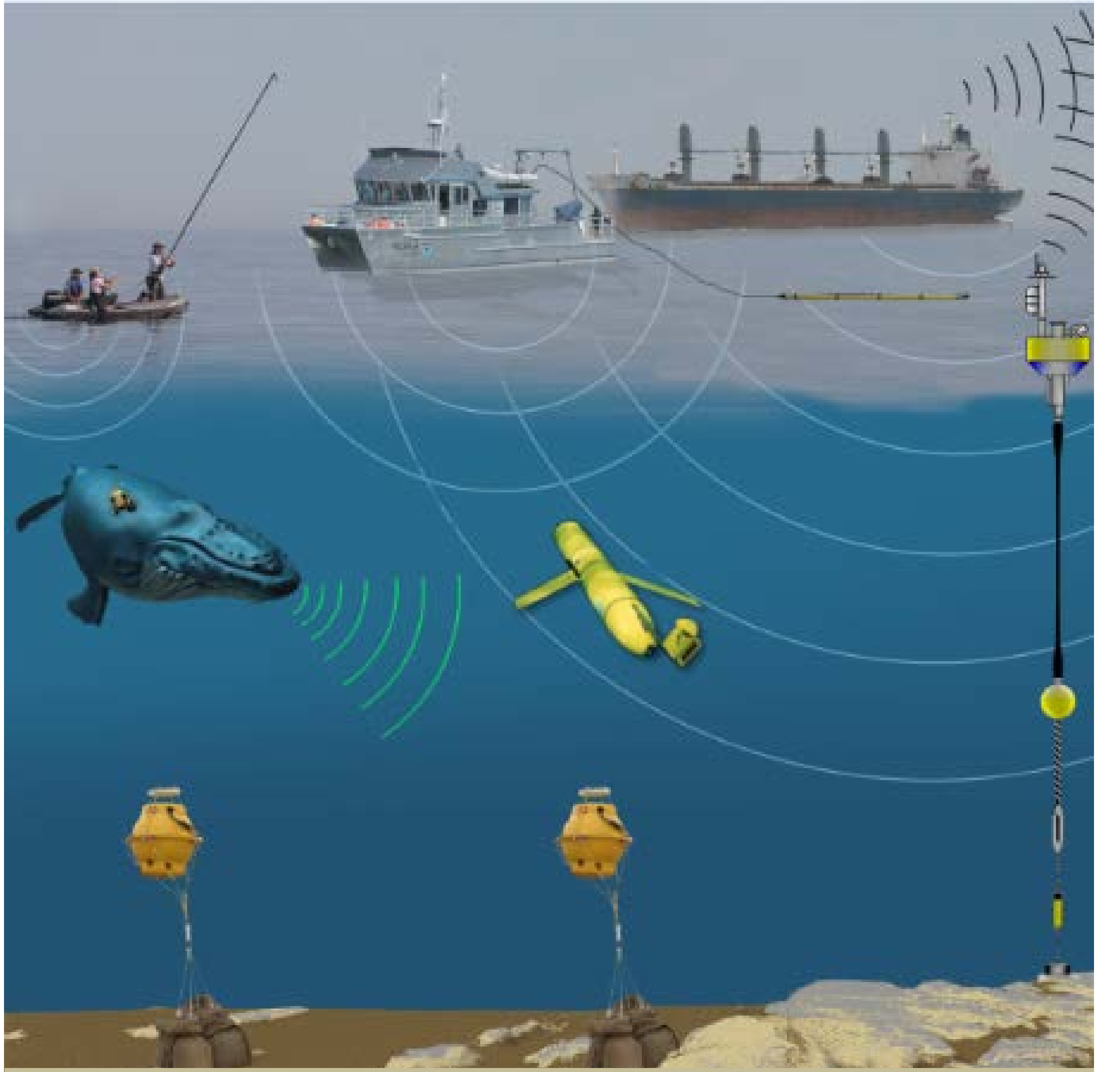
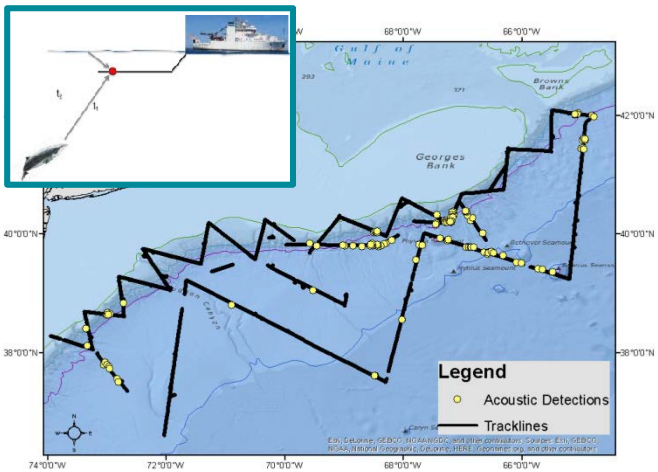


Image credit: Michael Thompson, SBNMS

Passive Acoustic Results

1. First description of acoustic characteristics of Sowerby's beaked whale (Cholewiak et al. 2013)

2. First description of acoustics of True's beaked whale (paper in prep)

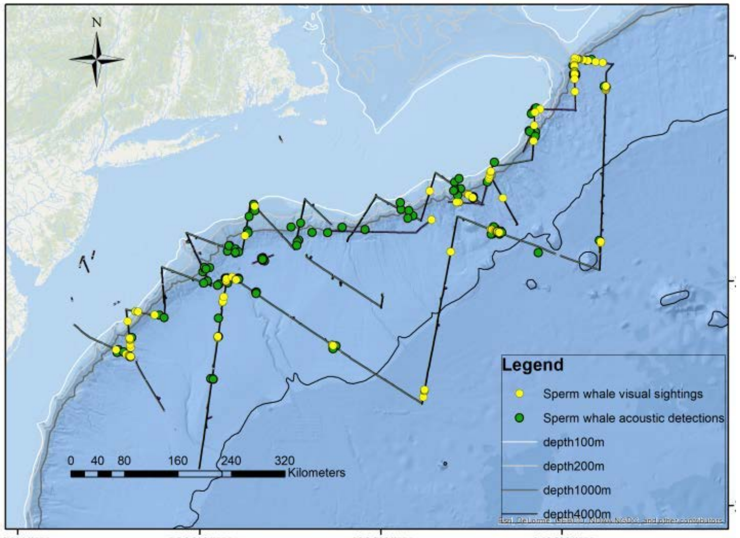


3. Effects of shipboard echosounders on detection rates of beaked whales (paper in prep)

4. 3-D Localization of beaked whales (paper in prep)

5. Geographic variation in Risso's dolphin echolocation (paper in prep)

Ongoing Activities



6. Contributing data to Atlantic delphinid classifier development (ROCCA)

7. Abundance estimates for sperm whales based on passive acoustic data

8. Integrating visual & acoustic data for sperm whale distribution and abundance

- Model framework developed & simulation trials conducted
- Evaluating two potential methodologies for data integration
- Analyses started using AMAPPS 2013 data

Ecosystem Research Results and Ongoing Activities

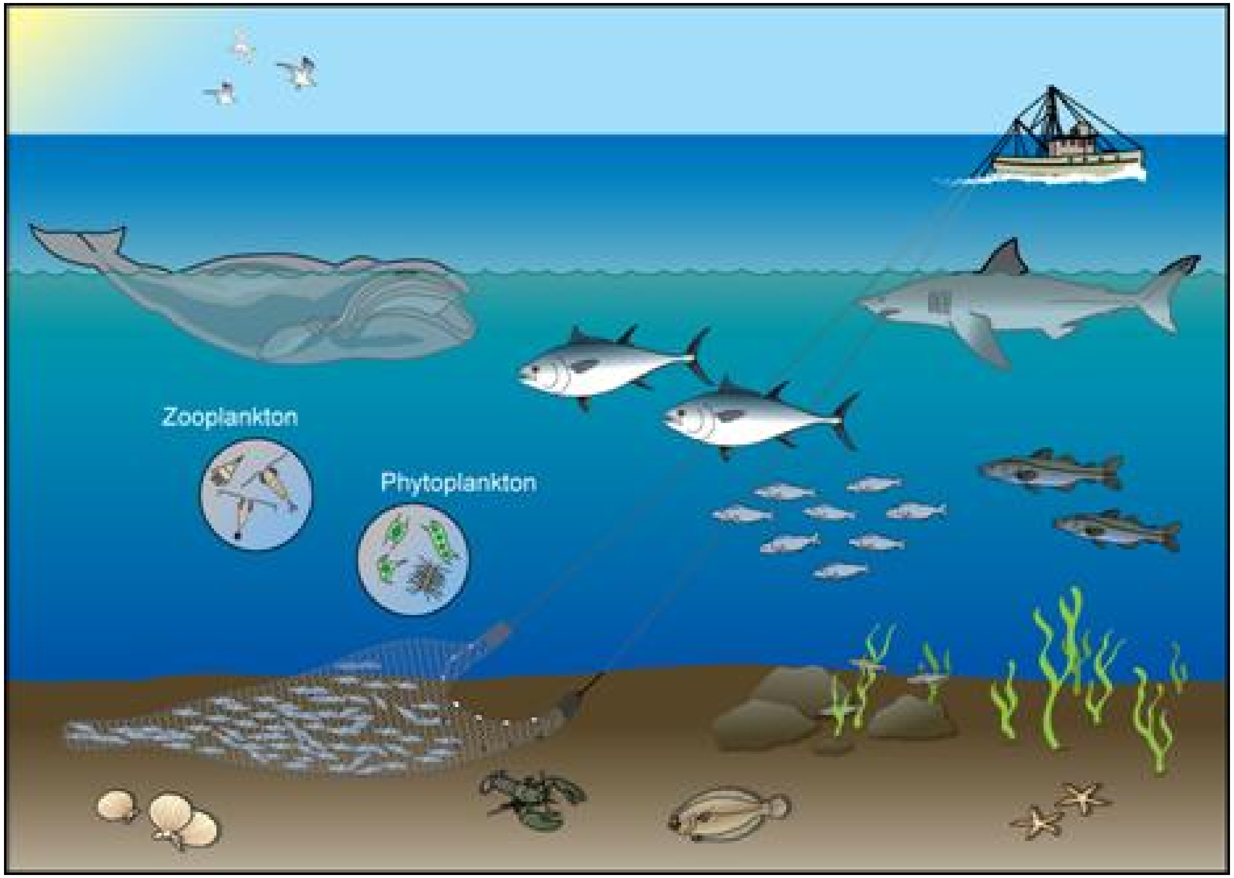
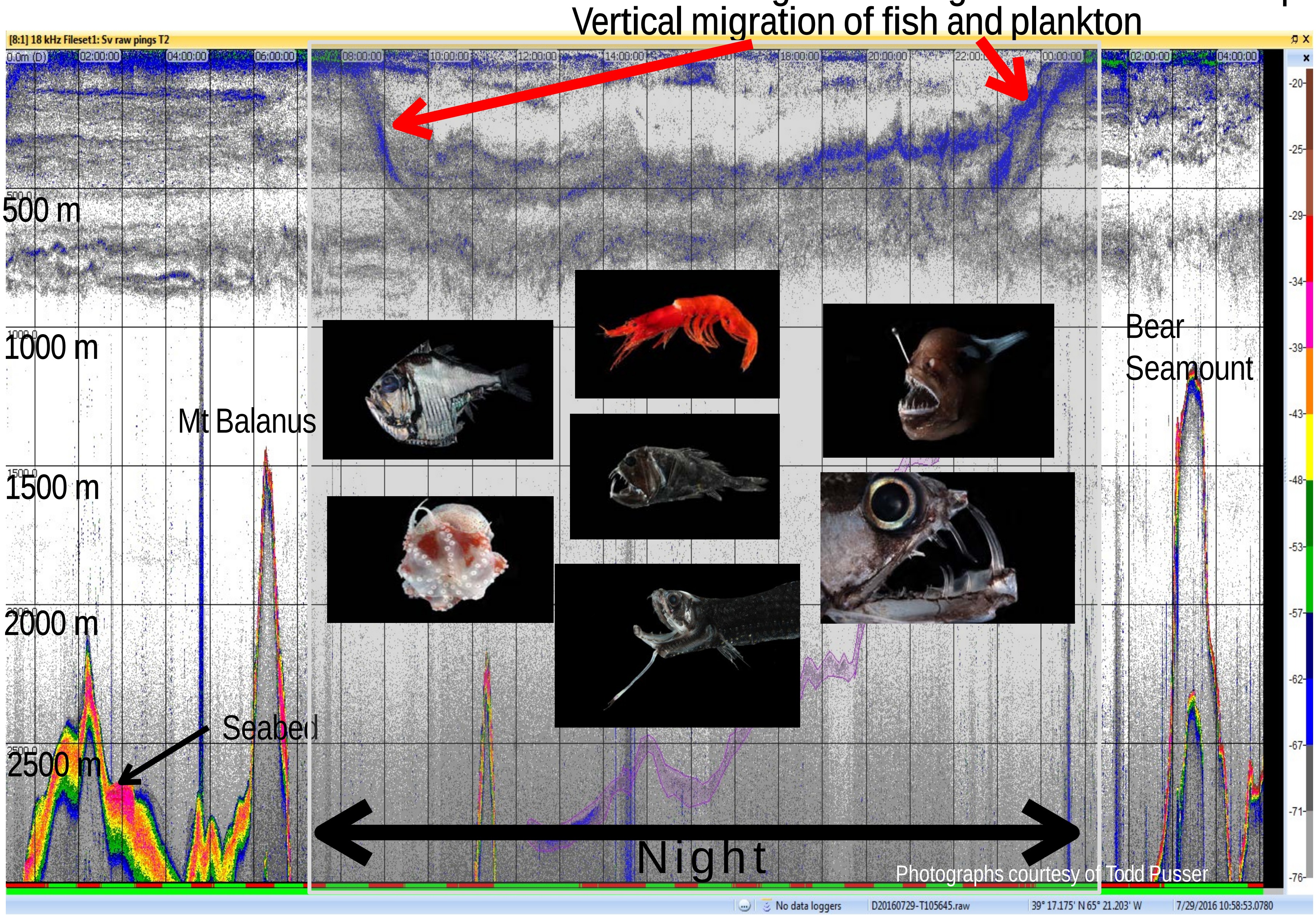
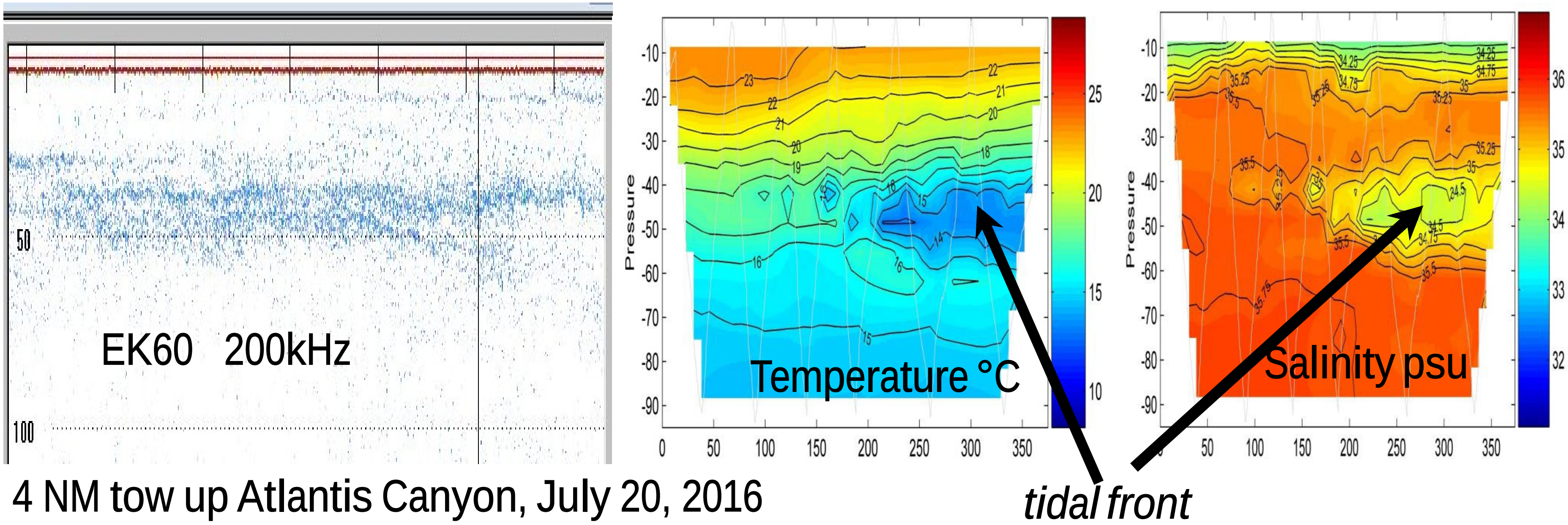


Illustration by Michael Fogarty [NEFSC, NMFS] and Jack Cook [Woods Hole Oceanographic Institution]

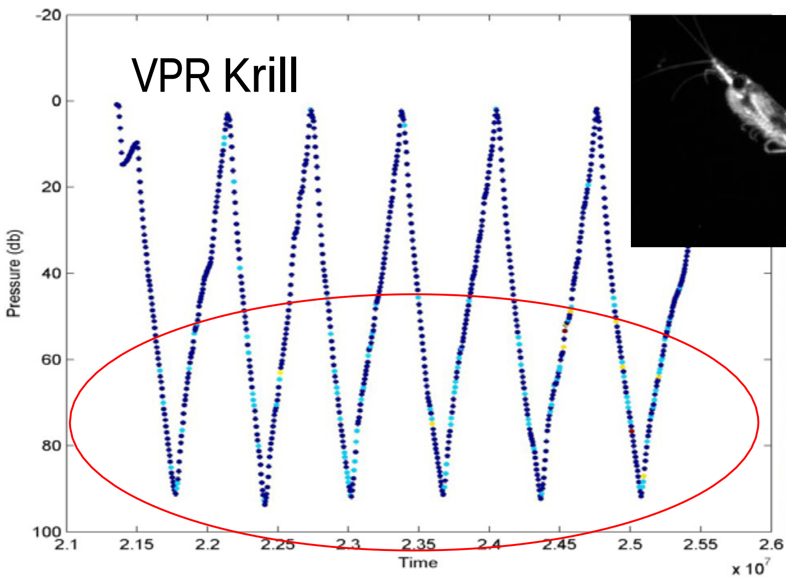
1. Process Simrad Scientific Echosounder EK60 echograms and ground truth with samples

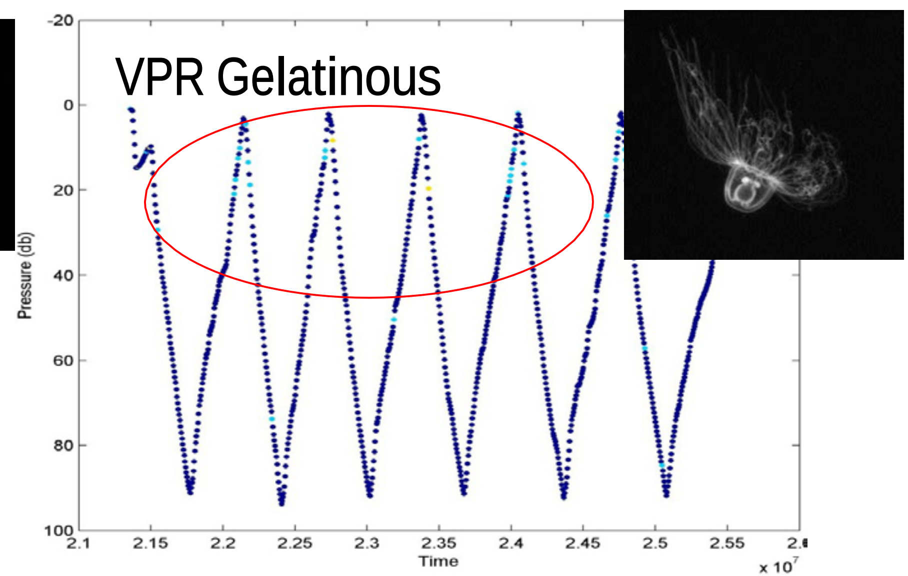


2. Process Video Plankton Recorder (VPR) data and relate to other data



4 NM tow up Atlantis Canyon, July 20, 2016





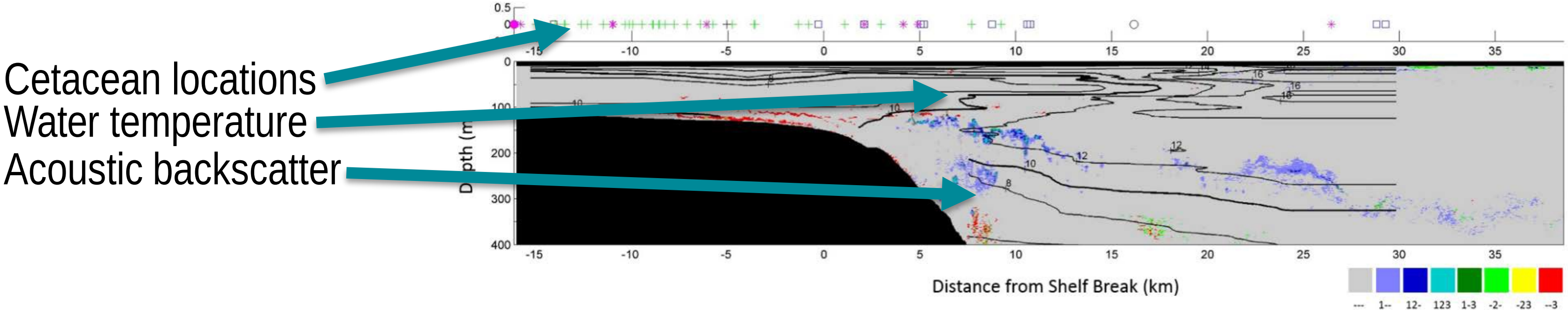
Other Results and Future Activities

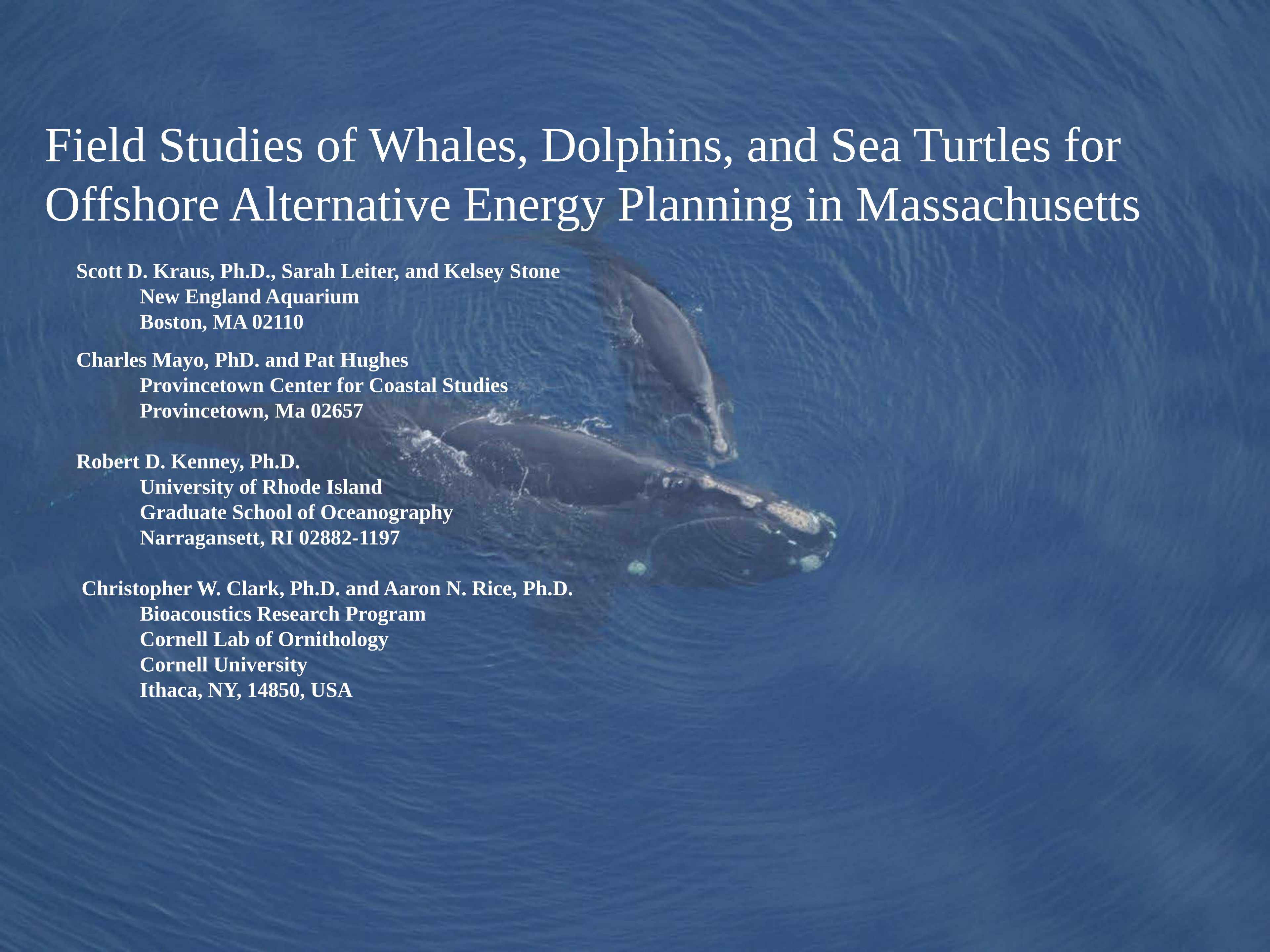
New, unexpected results

3. Net samples identified new spawning area for bluefin tuna (Richardson et al. 2016)
4. VPR identified new information on distribution of salps and inter-annual variability in the dominant salp species (in prep)

Synthesizing data

5. Demonstrated fine scale habitat partitioning of cetaceans related to physical and biological habitat (LaBreque 2016)
6. Continuing to synthesis physical and biological data
7. Continuing to relate habitat to marine mammal distribution





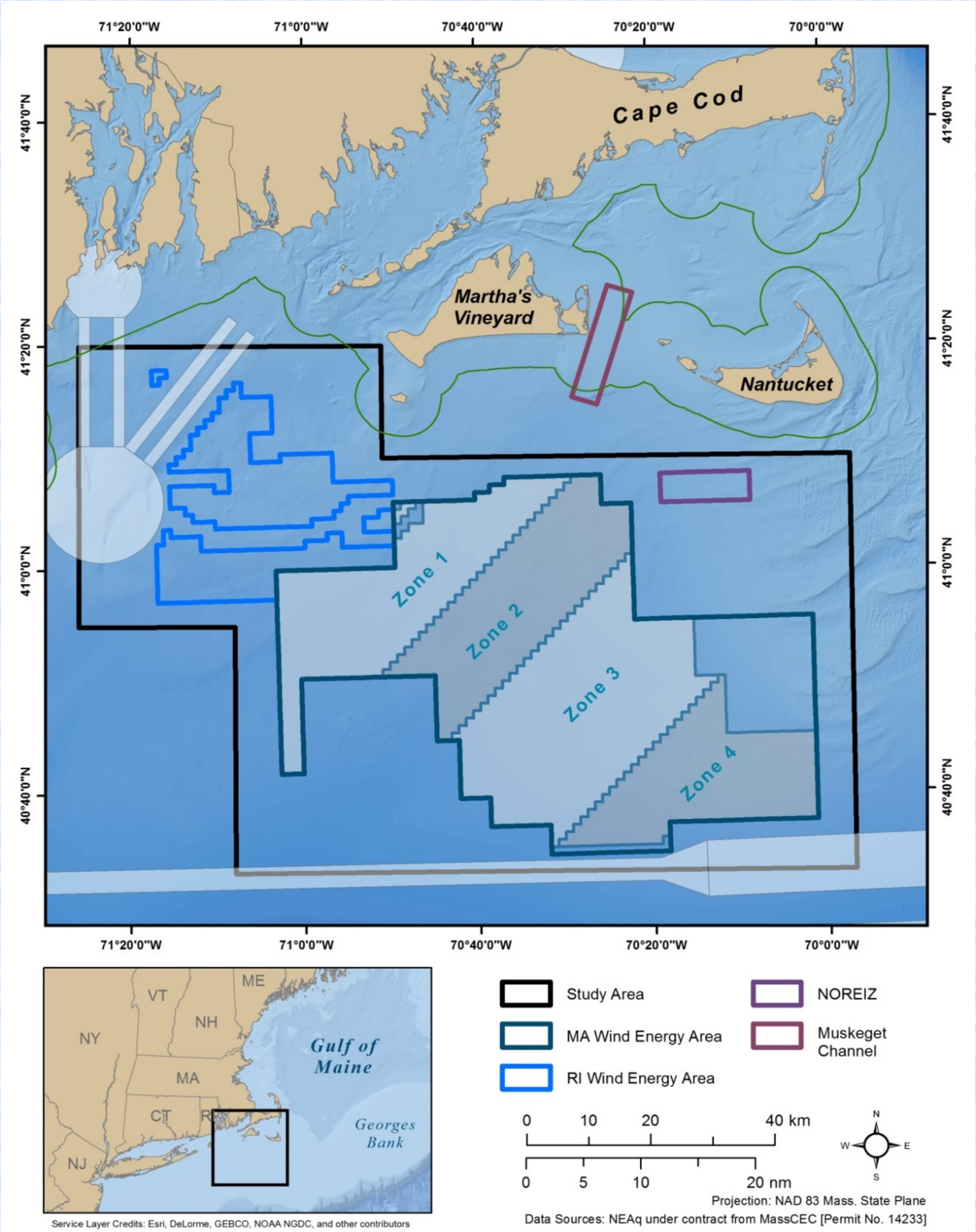
Field Studies of Whales, Dolphins, and Sea Turtles for Offshore Alternative Energy Planning in Massachusetts

Scott D. Kraus, Ph.D., Sarah Leiter, and Kelsey Stone
New England Aquarium
Boston, MA 02110

Charles Mayo, PhD. and Pat Hughes
Provincetown Center for Coastal Studies
Provincetown, Ma 02657

Robert D. Kenney, Ph.D.
University of Rhode Island
Graduate School of Oceanography
Narragansett, RI 02882-1197

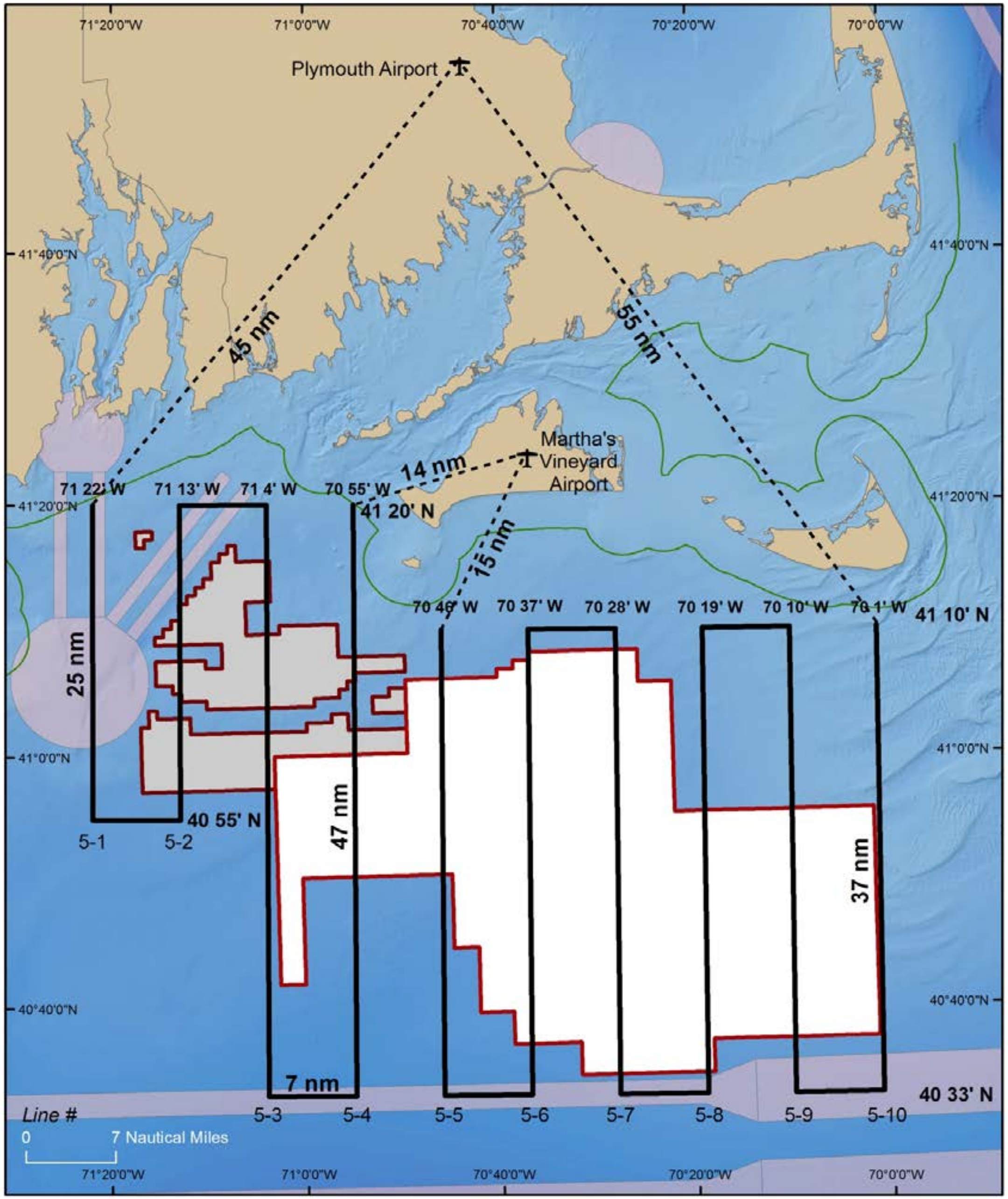
Christopher W. Clark, Ph.D. and Aaron N. Rice, Ph.D.
Bioacoustics Research Program
Cornell Lab of Ornithology
Cornell University
Ithaca, NY, 14850, USA

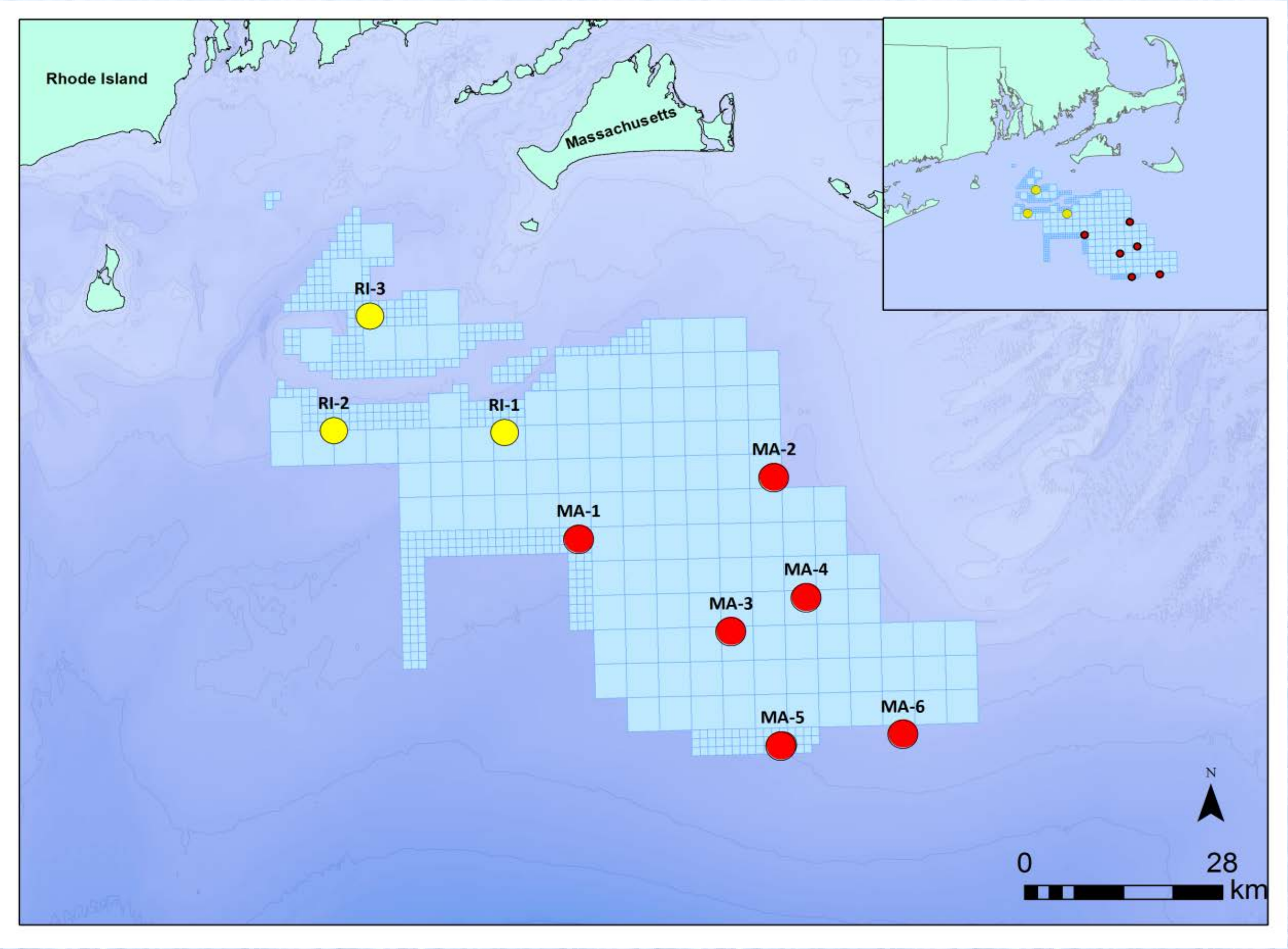


71°20'0"W
71°0'0"W
70°40'0"W
70°20'0"W
70°0'0"W
41°40'0"N
41°20'0"N
41°0'0"N
40°40'0"N
Cape Cod
Martha's Vineyard
Nantucket
Zone 1
Zone 2
Zone 3
Zone 4
ME
VT
NH
NY
MA
CT
RI
NJ
Gulf of Maine
Georges Bank
Study Area
MA Wind Energy Area
RI Wind Energy Area
NOREIZ
Muskeget Channel
0 10 20 40 km
0 5 10 20 nm
N
W
E
S
Projection: NAD 83 Mass. State Plane
Data Sources: NEAq under contract from MassCEC [Permit No. 14233]
Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

Start line: W to E - Line #5-1: 41 20' N, 71 22' W
E to W - Line #5-10: 41 10' N, 70 1' W

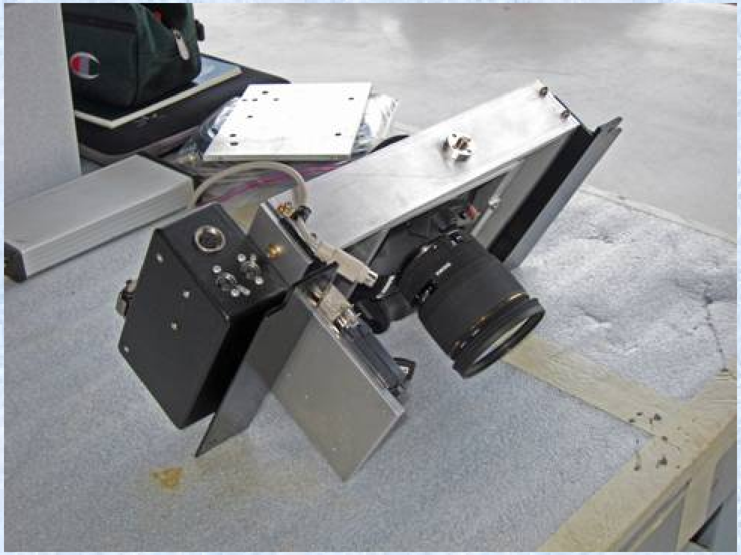
Option #5

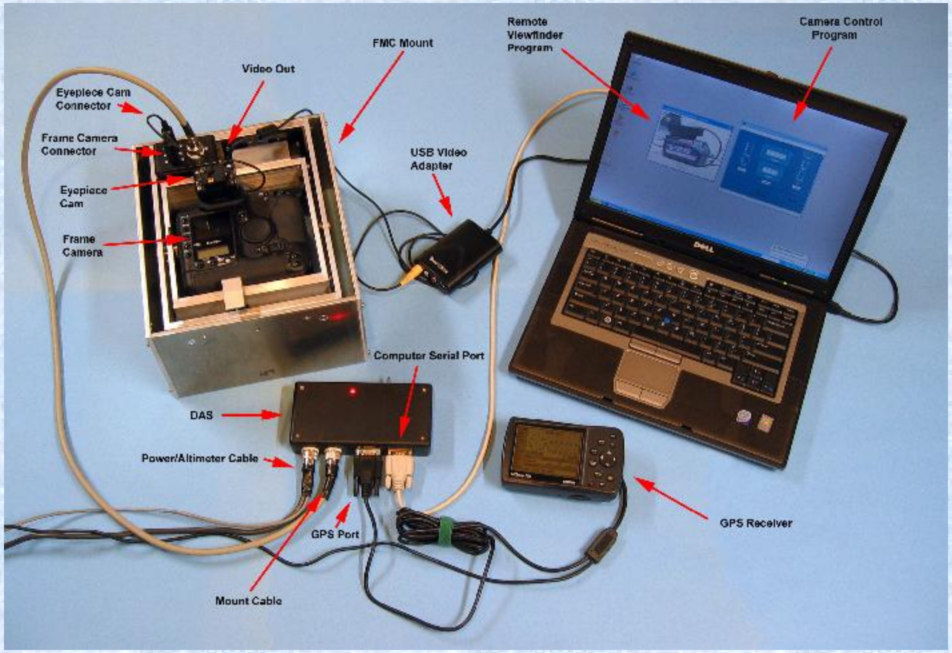




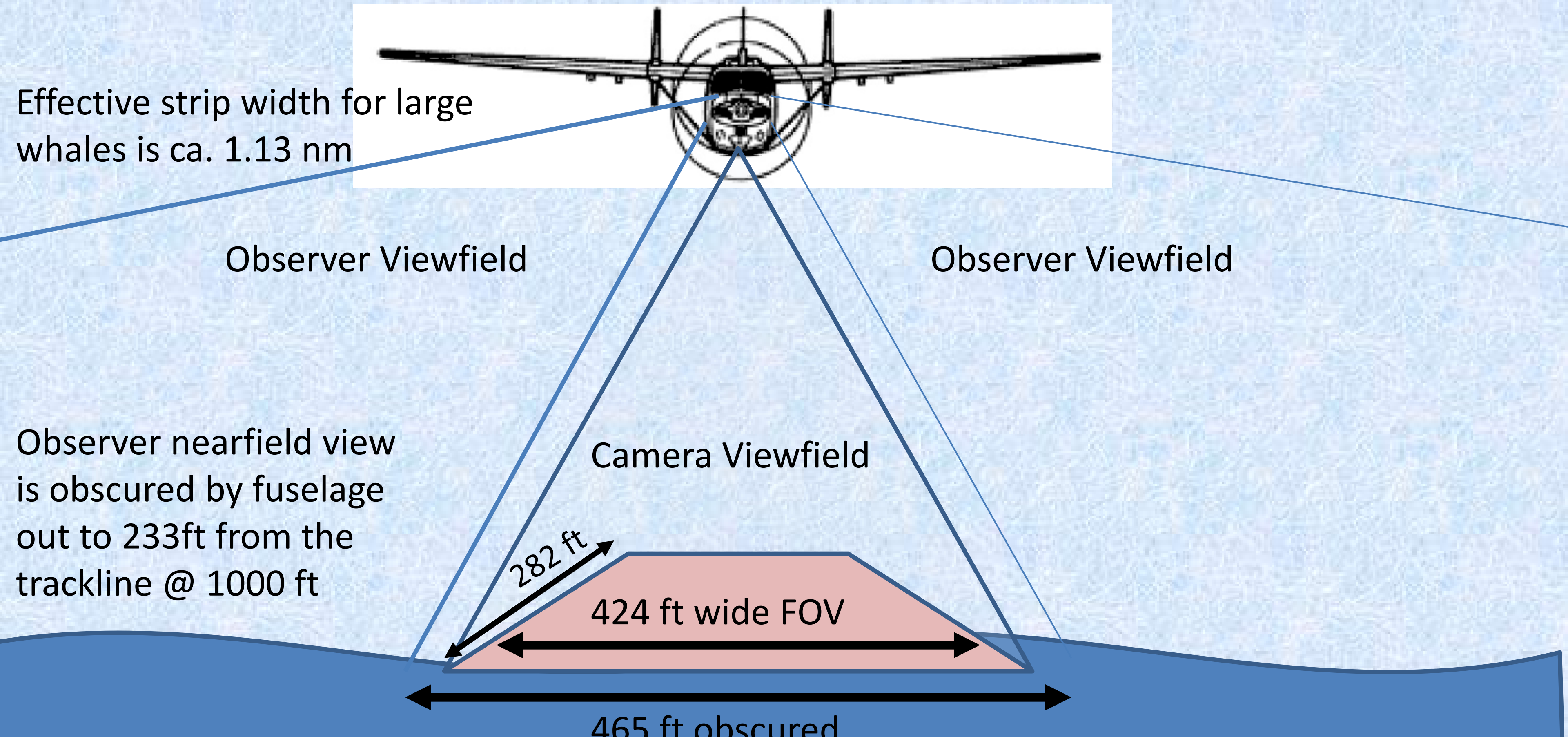
Map of the MA array of MARUs within the Mass Wind area (red circles) and the RIMA array of MARUs within the RIMA WEA (yellow circles). Light blue areas represent lease areas.


PU
#35
CAUTION
Digi-Key

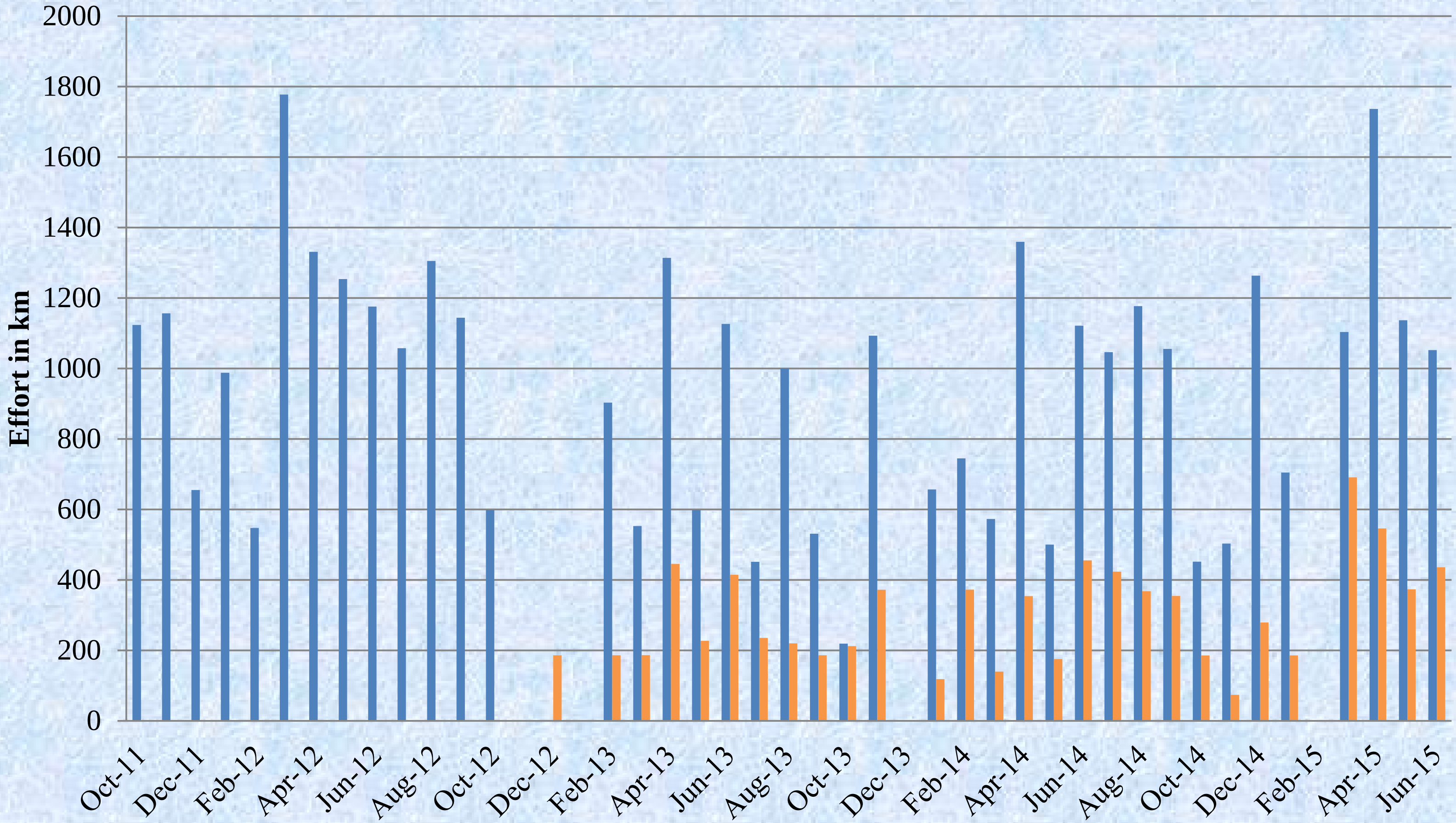



Eyepiece Cam
Connector
Video Out
FMC Mount
Remote
Viewfinder
Program
Camera Control
Program
Frame Camera
Connector
USB Video
Adapter
Eyepiece
Cam
Frame
Camera
Computer Serial Port
DAS
Power/Altimeter Cable
GPS Port
GPS Receiver
Mount Cable

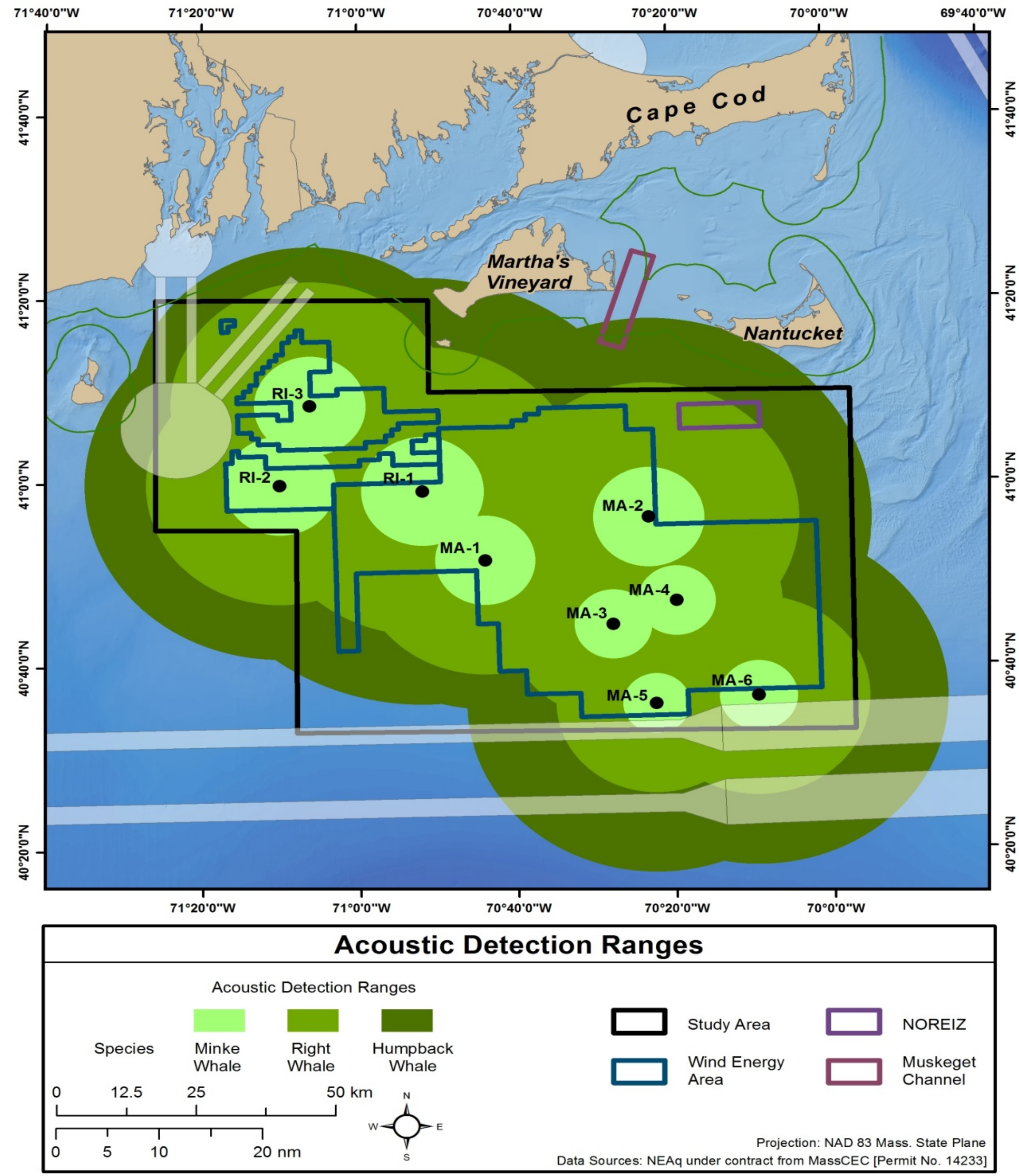
Cessna Skymaster O-2 Observer and Camera Viewfields



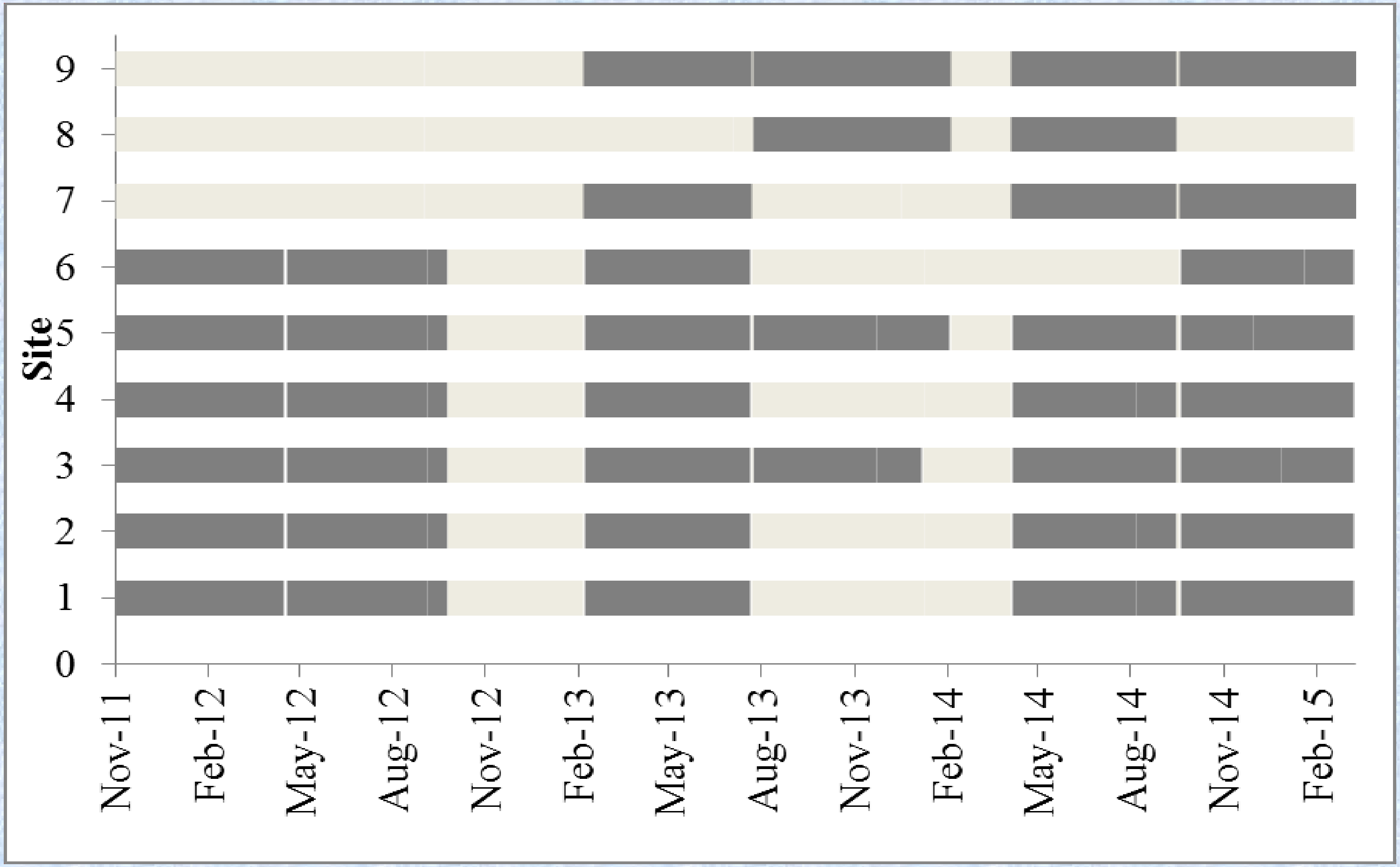
Probability of detection of animals or groups declines with their distance from the transect. In line-transect (or distance) sampling theory, f(0) is the probability density function of right-angle sighting distances (for that species and platform) evaluated at a distance of 0. The reciprocal of f(0) is the "effective strip width," a statistical estimate of the area effectively searched on either side of the transect.



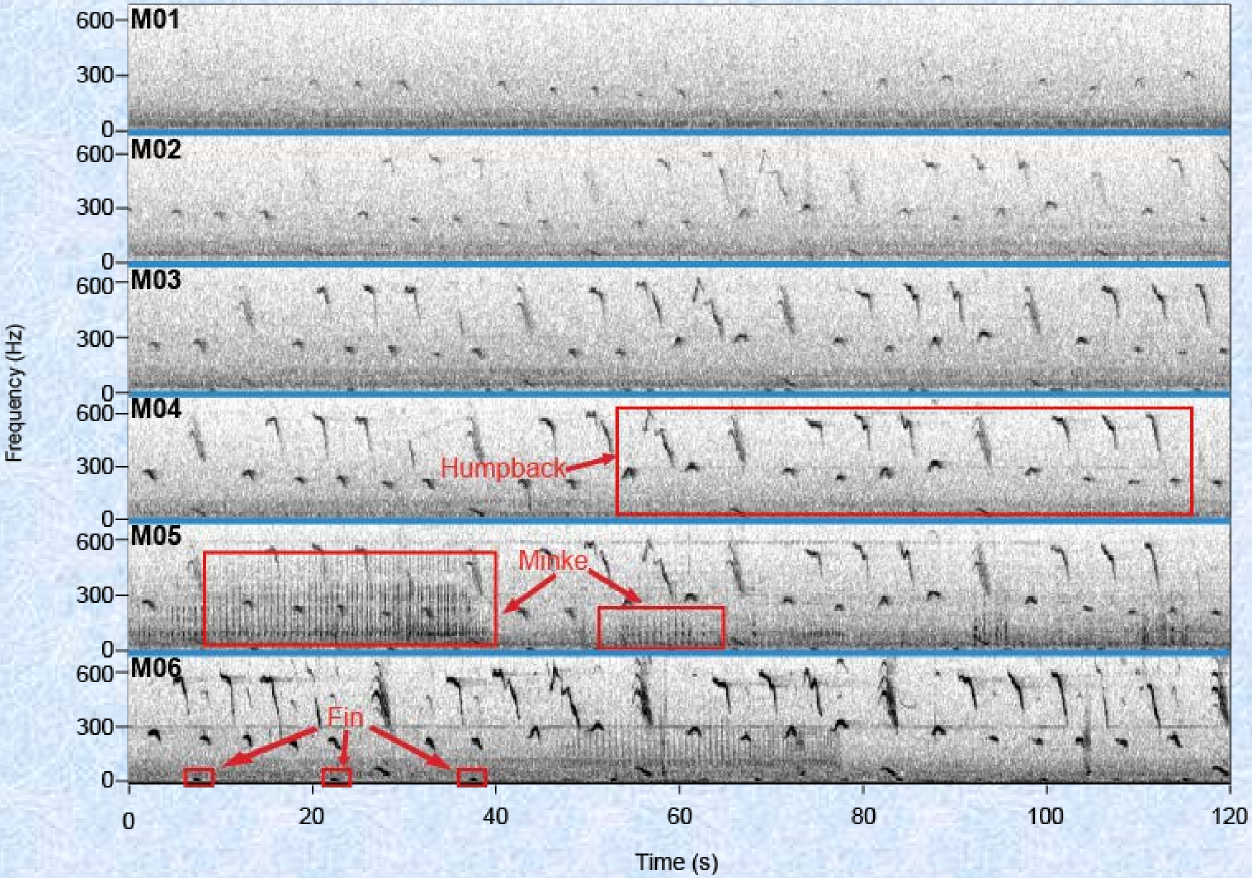
Aerial Survey Effort in km by month and year in the MAWEA (blue) and RIMA (orange)



71°40'0"W
71°20'0"W
71°0'0"W
70°40'0"W
70°20'0"W
70°0'0"W
69°40'0"W
41°40'0"N
41°20'0"N
41°0'0"N
40°40'0"N
40°20'0"N
Cape Cod
Martha's Vineyard
Nantucket
RI-1
RI-2
RI-3
MA-1
MA-2
MA-3
MA-4
MA-5
MA-6
Acoustic Detection Ranges
Acoustic Detection Ranges
Species
Minke Whale
Right Whale
Humpback Whale
Study Area
Wind Energy Area
NOREIZ
Muskeget Channel
0 12.5 25 50 km
0 5 10 20 nm
N
W
E
S
Projection: NAD 83 Mass. State Plane
Data Sources: NEAq under contract from MassCEC [Permit No. 14233]



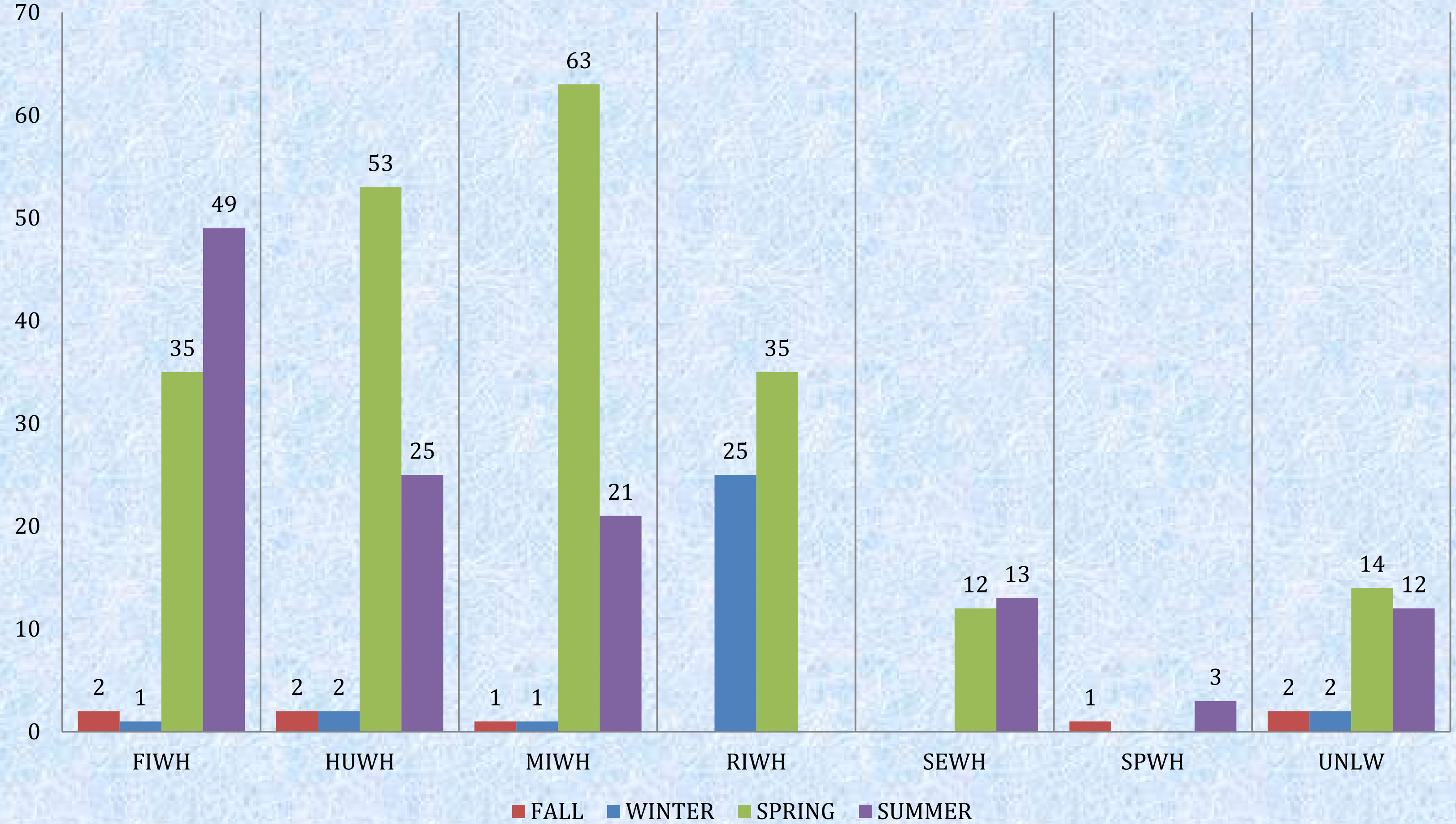
Summary of recording effort throughout the study period by MARU (Site # on left). The light grey lines indicate time periods when a MARU was not recording at a given site. The dark grey lines indicate time periods when a MARU was recording at a given site.



M01
M02
M03
M04
M05
M06
Humpback
Minke
Fin
Frequency (Hz)
600
300
0
Time (s)
0
20
40
60
80
100
120

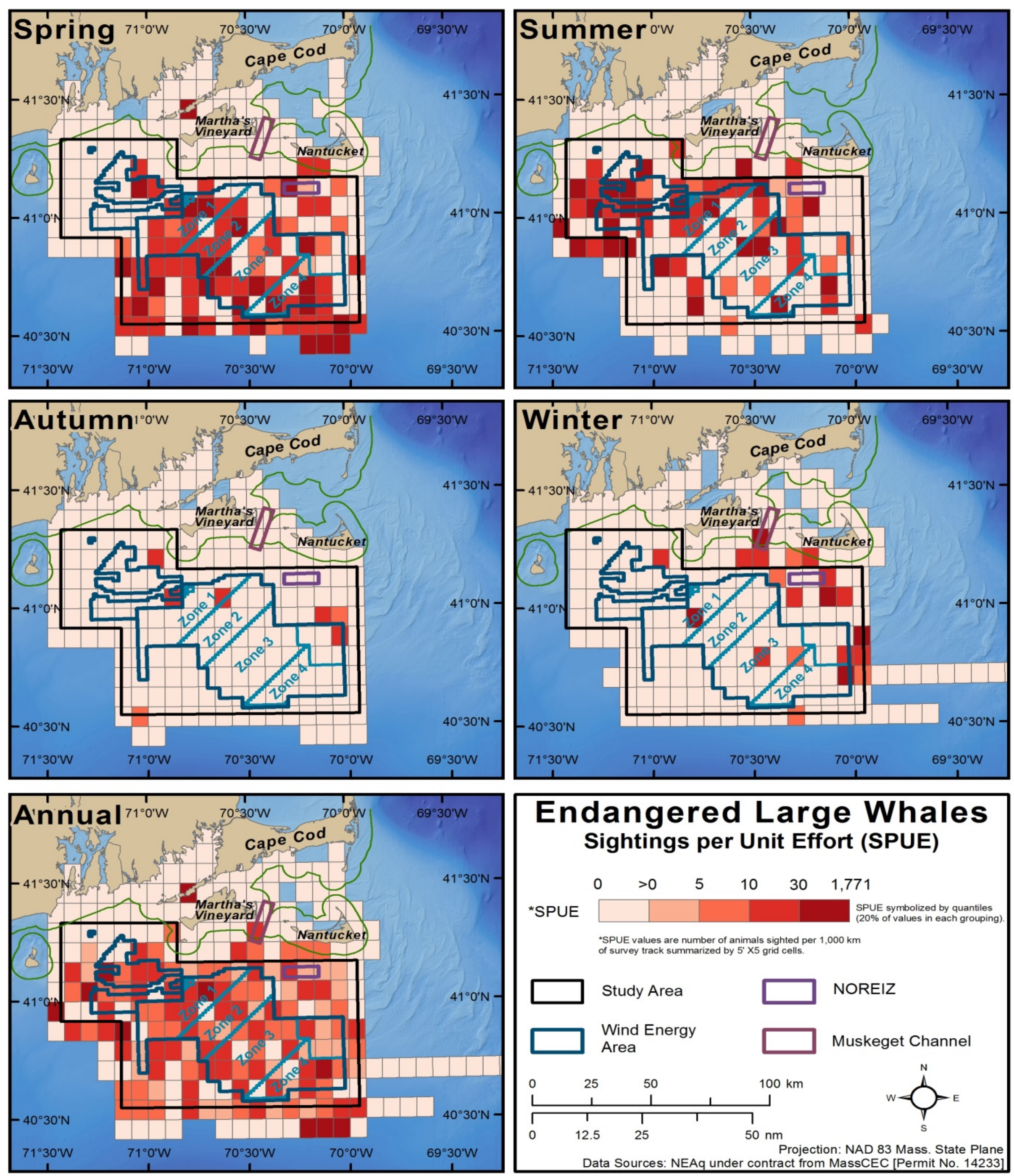
MA CEC Study – Data, analyses, and Limitations

Data Source	Analyses	What they tell us	What they dont tell us
Aerial Survey sightings/transects	Sightings Rates	Provide relative comparable measures of numbers of observed animals per km, per transect, per survey, per month, as needed.	Absolute abundance
	SPUE	Distribution patterns normalized for variable survey effort	Absolute abundance in each block
	Line transect abundance estimates	Point estimates of absolute abundance, with 95%confidence intervals	Abundance within small subsets of the study area
	Species Richness	How many species were observed within a block	
	Hot spot analyses	Shows areas within the context of the entire study are that are used more consistently than the rest of the area - analyses can be done on absolute numbers, or on species richness	
Belly Camera Photographs	Counts	Sea turtle, shark and small animal counts in the area not seen by observers	Whale distribution and abundance
Photographic Identifications	Demographics	Individual identifications are used to determine age, sex, of known whales	Photo-id only feasible for right whales from aircraft
	Movements	Photo-id can link whales to other areas and movements	Residence times
	Minimum Counts	Minimum counts provide lower bounds on line-transect estimates	Not for non-right whales
Acoustic Data (MARUs)	Presence of calling whales	Species specific records of occurrence with the detection range of each MARU	How many whales are present, how many silent whales are in the area.
	Ambient Noise	Background noise in the area	
	Presence by MARU site	Occurrence in some MARU sites and not in others provide crude distribution info	How many whales are calling
Acoustic and Survey data	Comparative analyses	Shows the strengths and weaknesses of both data collection methods	

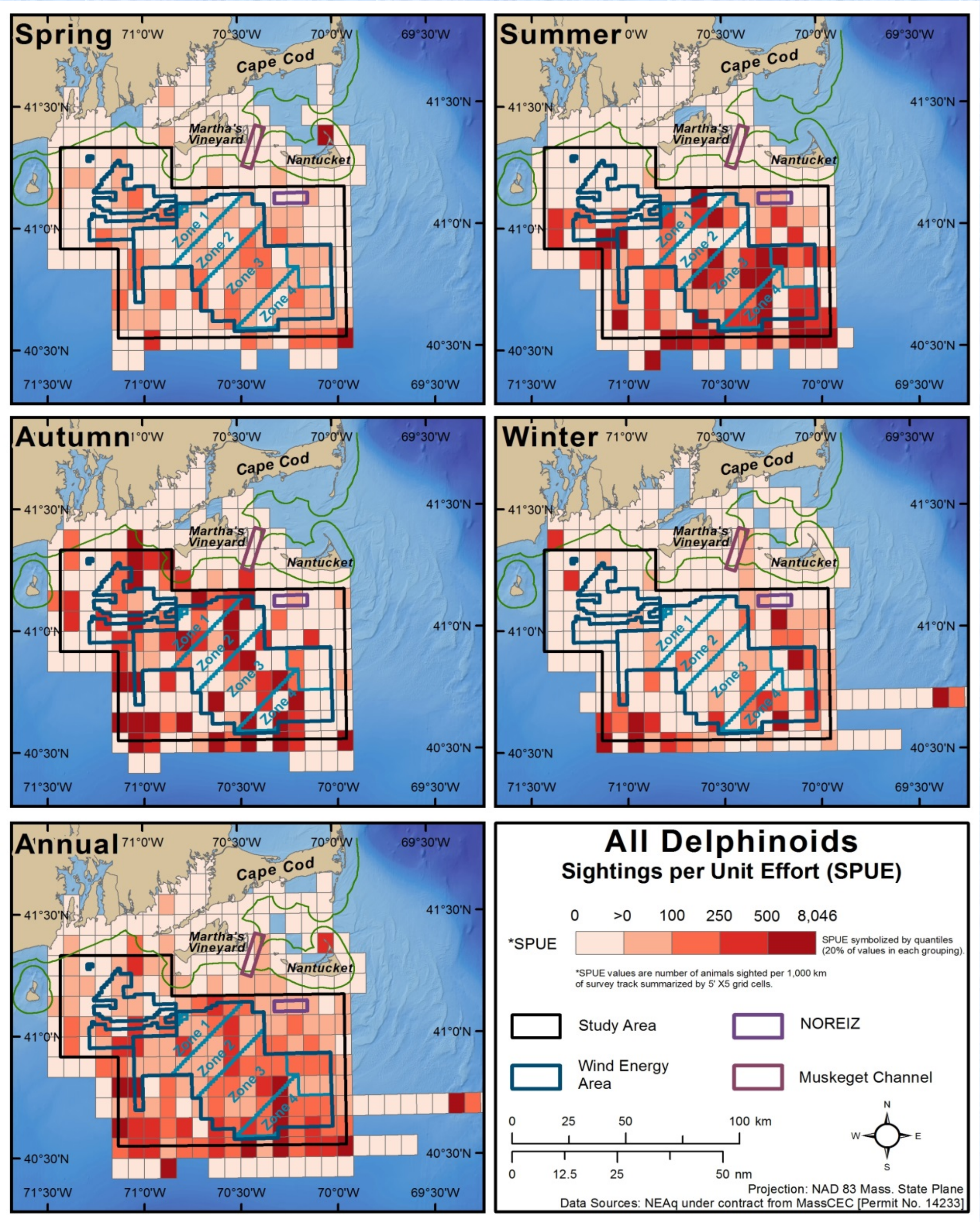


Large whale sightings in the study area by season across all years (FIWH = fin whale, HUWH = humpback whale, MIWH = minke whale, RIWH = North Atlantic right whale, SEWH = sei whale, SPWH = sperm whale, UNLW=any large whales not identified down to species)

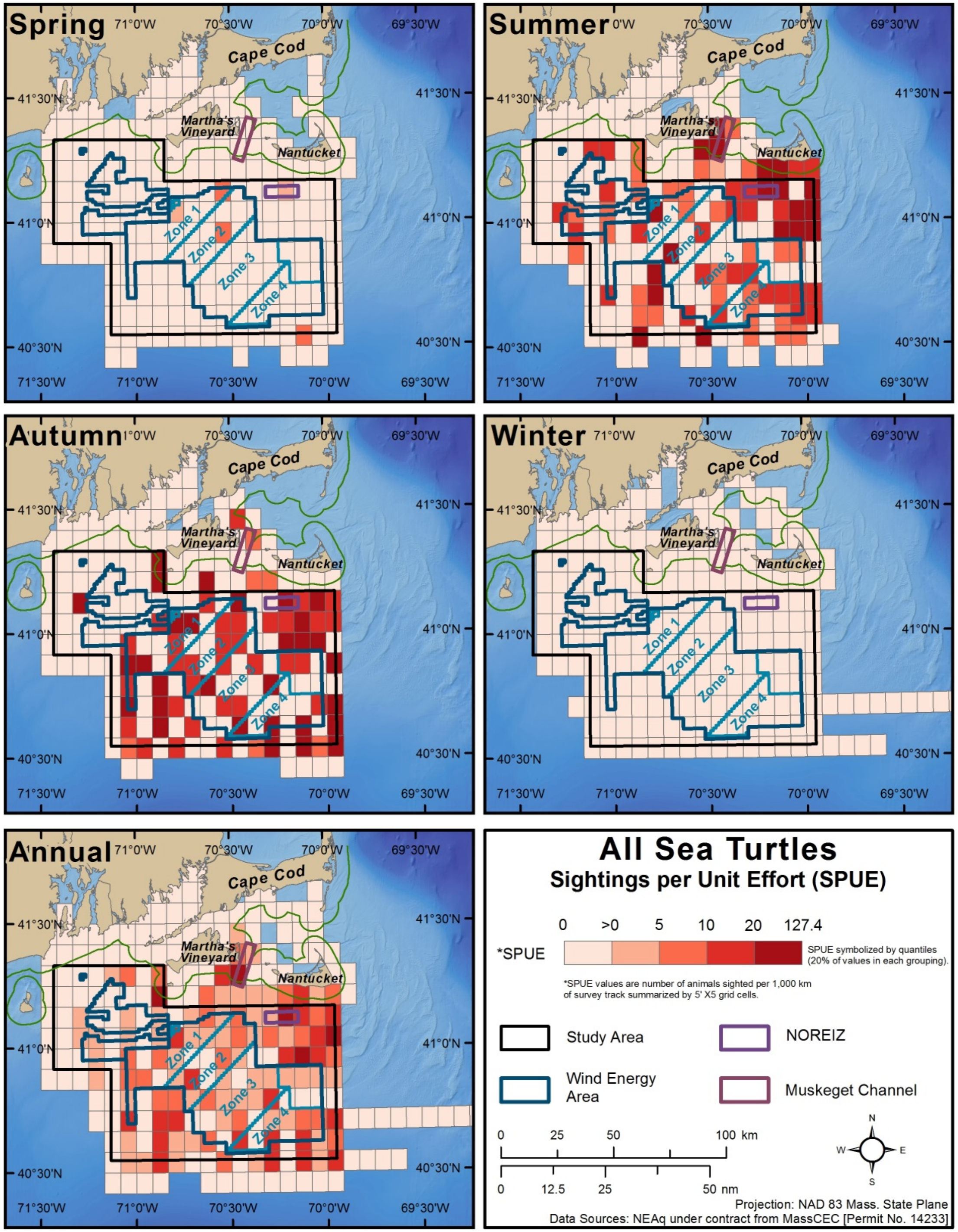
Sightings per Unit Effort of endangered large whales (fin whale, humpback whale, sei whale, sperm whale, and North Atlantic right whale) shown seasonally and annually all years combined (October 2011 – June 2015).

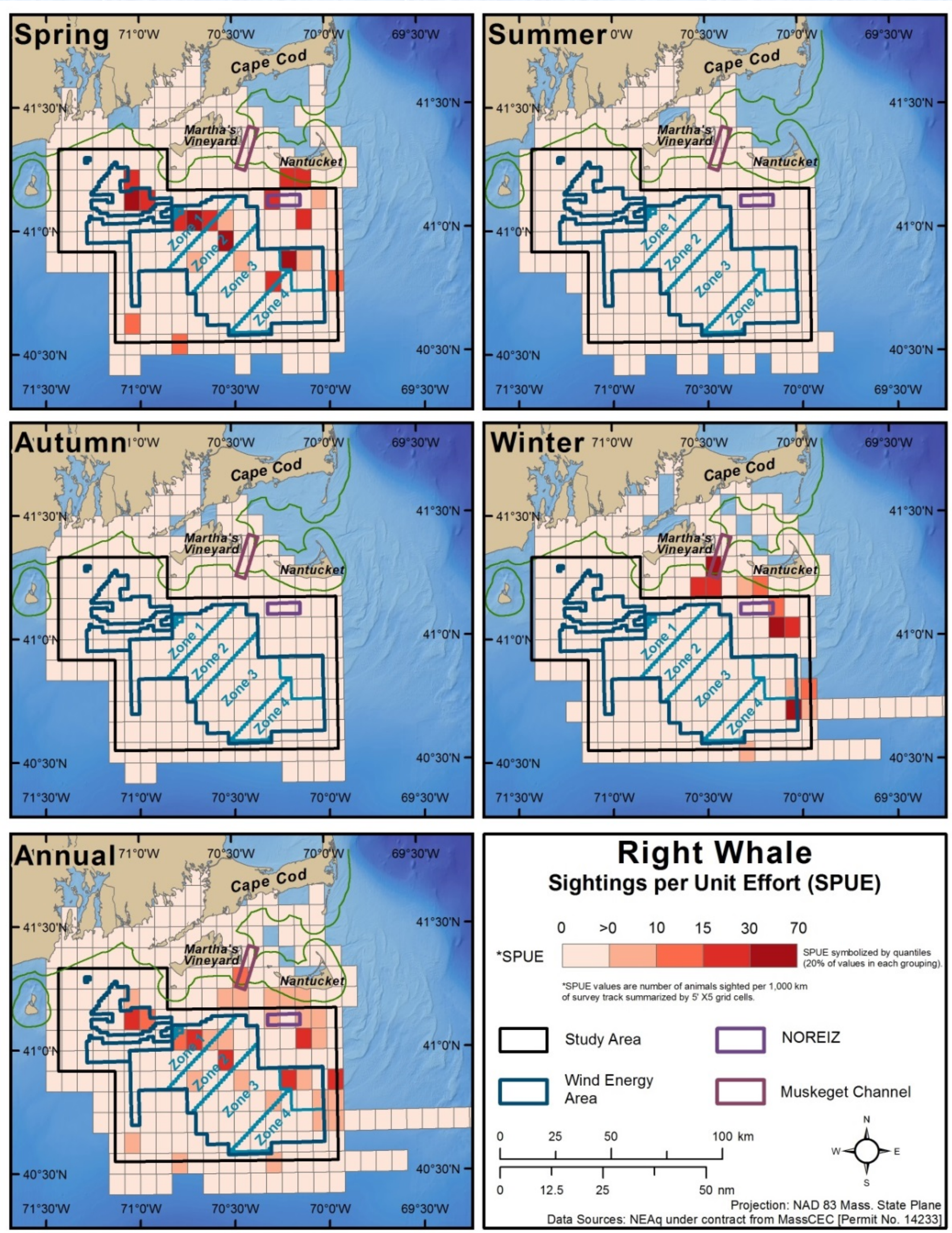


Sightings per Unit Effort of all small cetacean species (includes all dolphin species, harbor porpoise, pilot whales, and sightings of delphinoids not identified down to species) shown seasonally and annually all years combined (October 2011 – June 2015).



Sightings per Unit Effort (SPUE) of all turtle species (LETU, LOTU, RITU) and unidentified turtles (UNTU) sighted in the study area across the entire study period (October 2011 – June 2015), partitioned seasonally and annually





Age class by sex of photo-identified North Atlantic right whales at time of sighting within the Survey Area.

Individuals that were observed on multiple dates were not tallied multiple times within this table. Age classes include: A= adult, J=juvenile, C=calf, U=unknown Age.

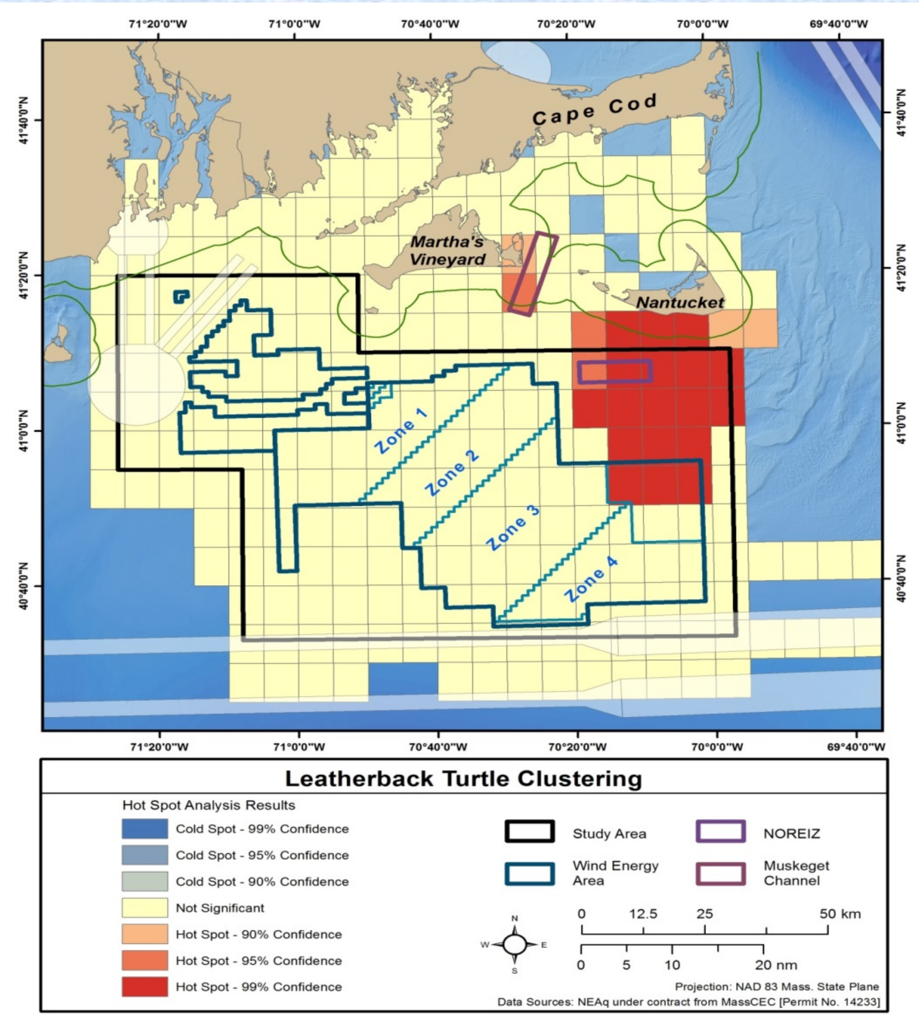
Sex	Age Class A	J	C	U
Female (non cow)	4	10	0	1
Female (cow)	12	0	0	0
Male	28	14	0	1
Unknown	2	1	0	4
Total	**46**	**25**	**0**	**6**

Table 3.

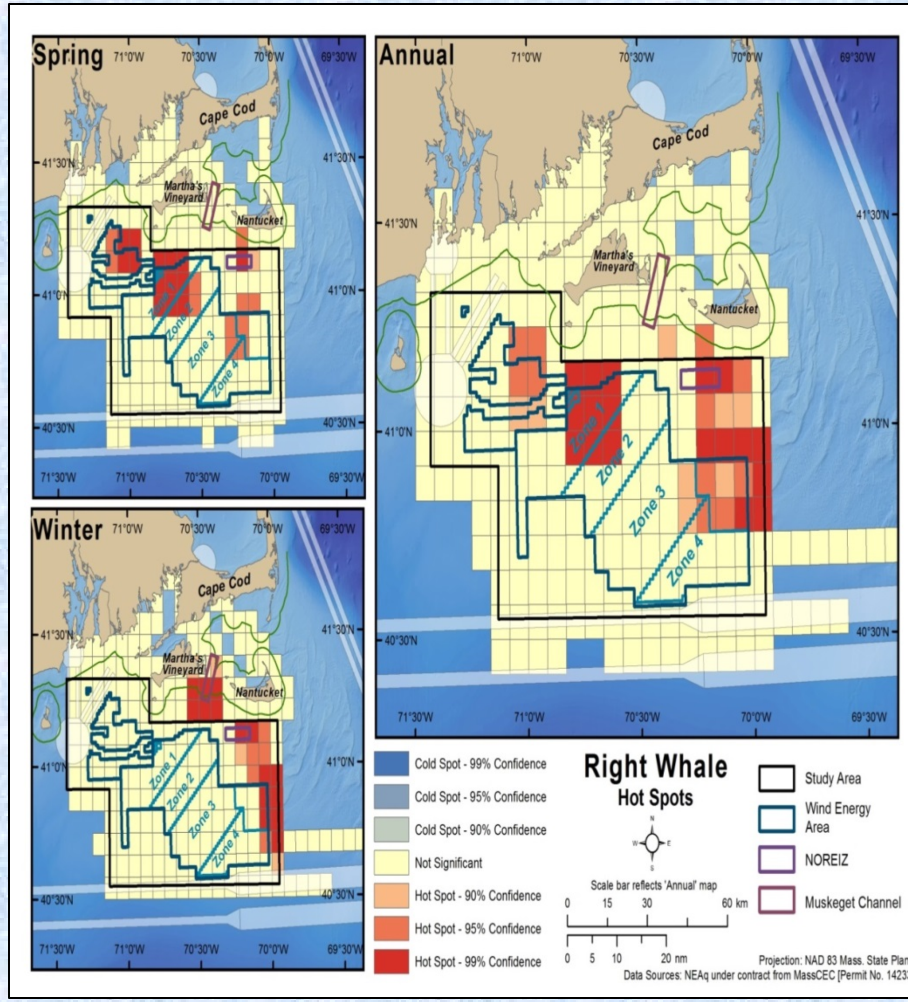
Density and abundance of North Atlantic right whales (*Eubalaena glacialis*) by season-year.

Density and variance are the means of the transect estimates, weighted by transect lengths. T = number of transects flown; G,I = number of groups and individuals sighted; D = density in animals/km^2; V = variance of the density; N = estimated abundance in the study area; CI95=95% confidence interval, with the lower limit changed to zero if it was negative.

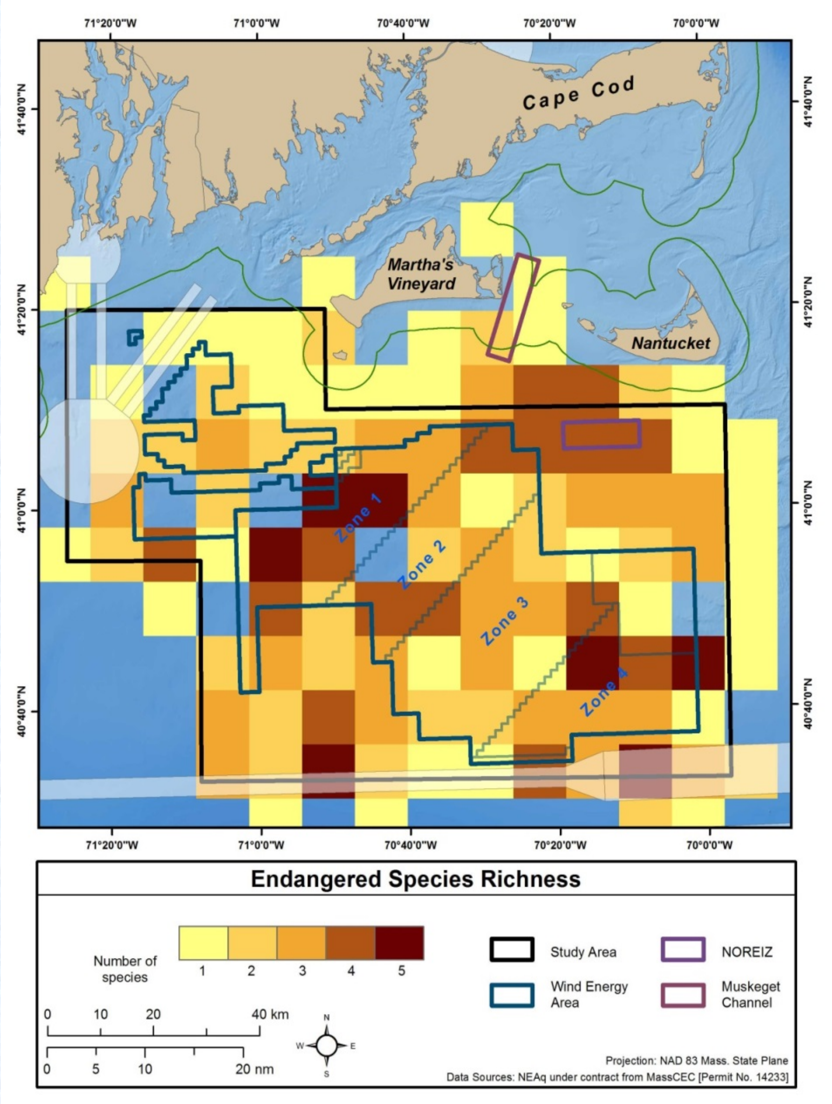
Season-Year	T	G, I	D	V	N	CI95
Fall-2011	32	0, 0	0	–	0	–
Winter-2012	30	0, 0	0	–	0	–
Spring-2012	56	8, 13	0.0035	0.0027	24	0–118
Summer-2012	48	0, 0	0	–	0	–
Fall-2012	24	0, 0	0	–	0	–
Winter-2013	16	3, 5	0.0045	0.004	35	0–296
Spring-2013	39	1, 1	0.0005	0.0003	4	0–43
Summer-2013	46	0, 0	0	–	0	–
Fall-2013	36	0, 0	0	–	0	–
Winter-2014	26	1, 3	0.0008	0.0006	7	0–83
Spring-2014	41	4, 11	0.0019	0.0016	15	0–109
Summer-2014	60	0, 0	0	–	0	–
Fall-2014	39	0, 0	0	–	0	–
Winter-2015	28	4, 15	0.0027	0.002	21	0–155
Spring-2015	65	10, 44	0.0029	0.0021	23	0–111

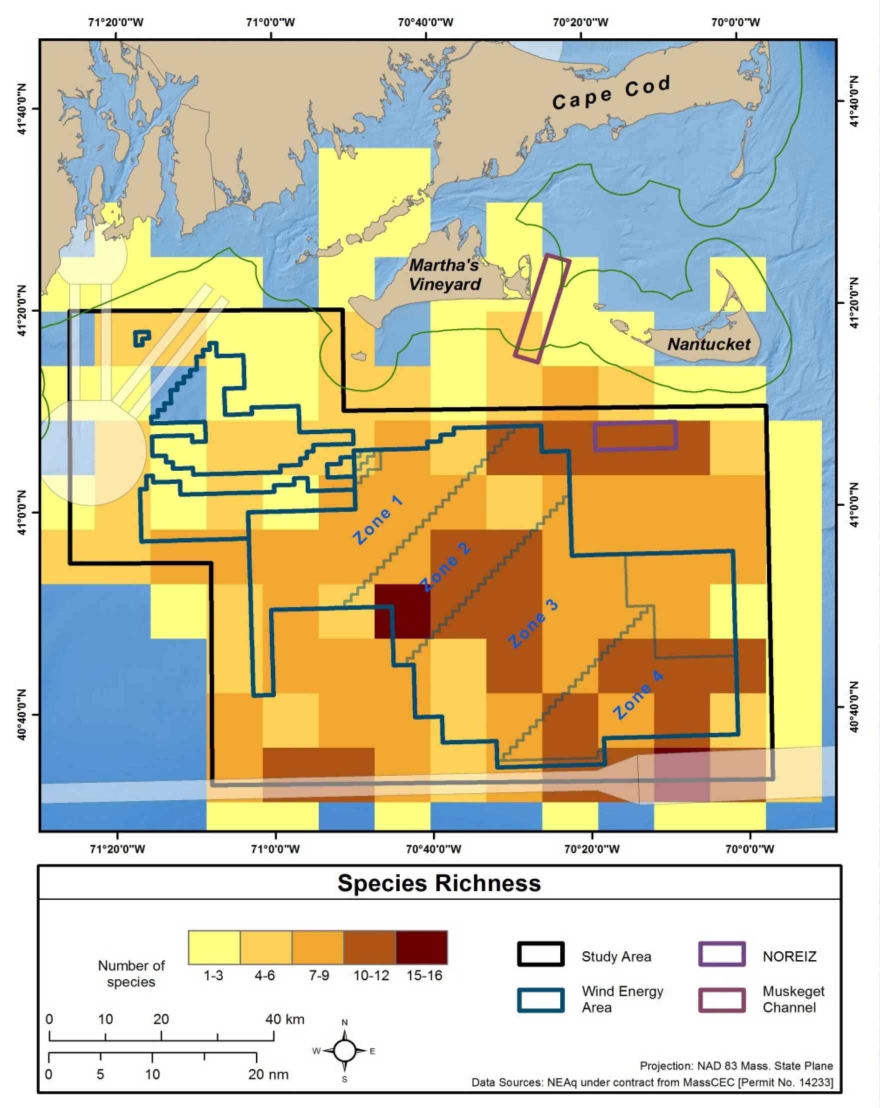


Hot spot analysis of leatherback turtle distribution in the study area (annual distribution , 2012-2015, NEAq survey data only).

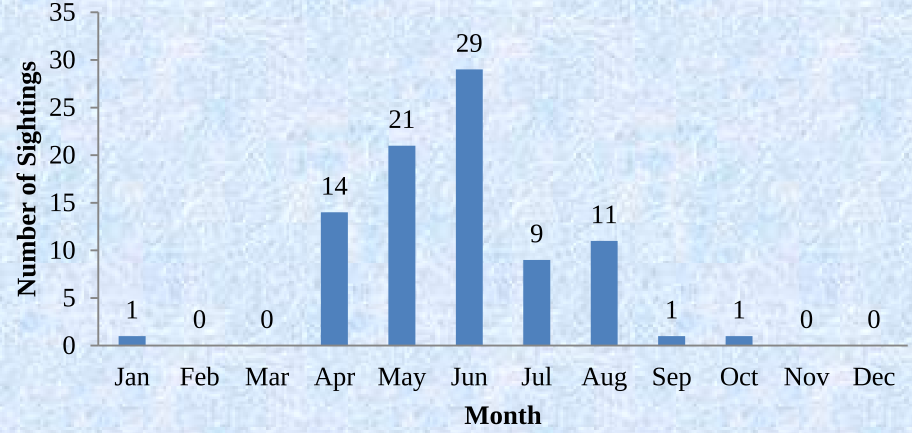


Hot Spot analysis of North Atlantic right whale sightings detected by NEAq showing spring, winter and annual distribution (2012-2015, NEAq Survey data only).

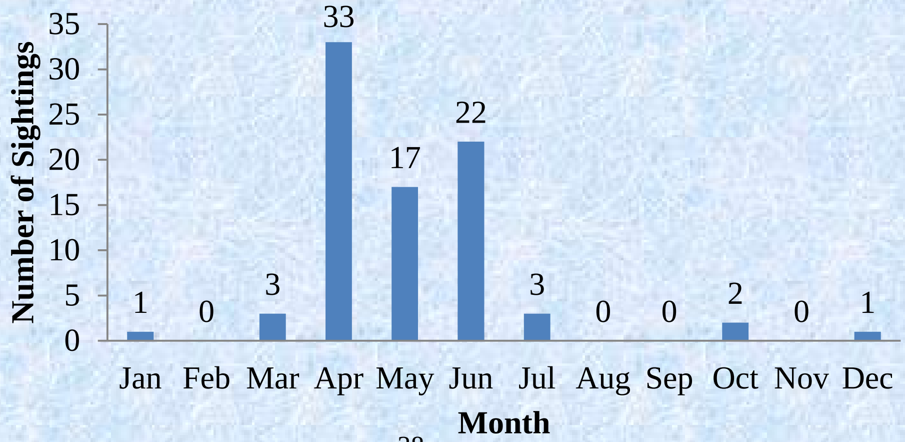




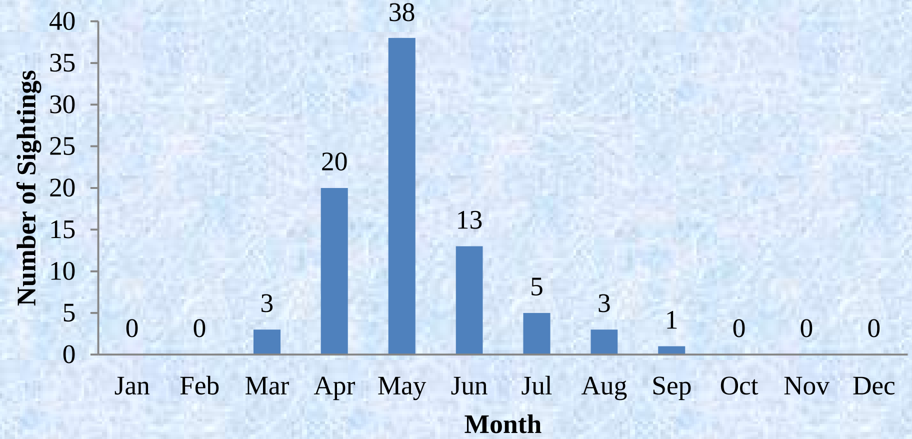
Species Richness maps were developed for all endangered species (left), and for all species observed during the survey flights (right).



Fin whale sighting totals by month, combined across all survey years (October 2011 – June 2015).

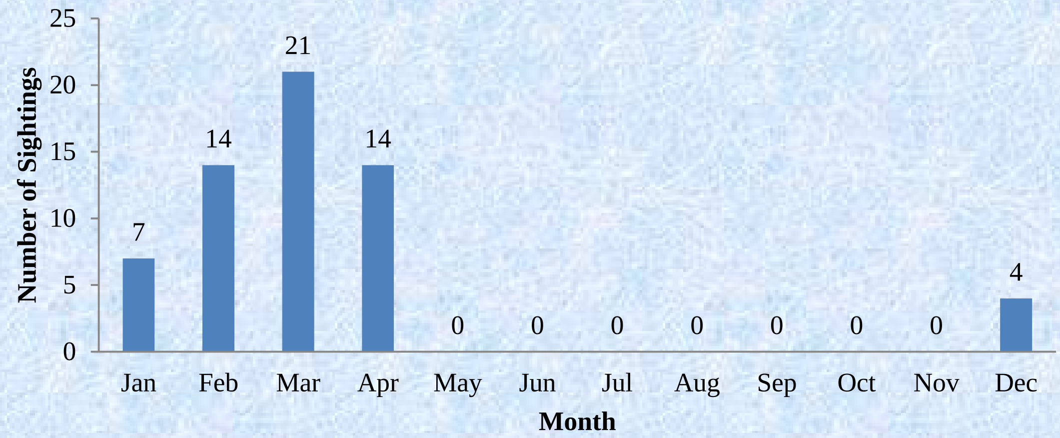


Humpback whale sighting totals by month, combined across all survey years (October 2011 – June 2015).

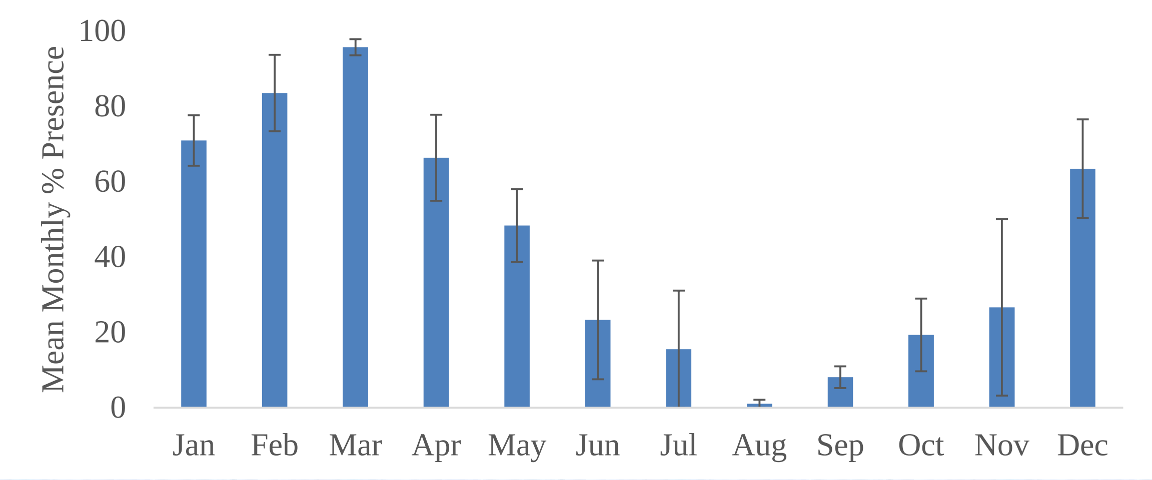


Minke whale sighting totals by month, combined across all survey years (October 2011 – June 2015).

Right whale sighting totals by month, combined across all survey years (October 2011 – June 2015).



Right whale mean monthly acoustic presence ± standard error for all years combined.



Recommendations

1)The seasonality and spatial distribution of marine mammals in the area suggests seasonal and spatial management of survey and construction activities should be considered for implementation during environmental review and permitting.

2 The long-term impacts of offshore wind farm facilities should be carefully assessed using a statistically robust design to understand the consequences of such development on marine mammal and sea turtle distribution, abundance, behavior, and communications.

3) Focused oceanographic studies are needed to interpret the occurrence of endangered whales in the SA. There are two questions:

- Can offshore wind facilities affect whale habitat or behavior, thereby changing distribution and/or behavior?
- Are whale distributions food dependent, and any changes in distribution and/or behavior are due to changes in prey species in the area?

Distinguishing between these two hypotheses will be important in the context of managing future development.

Acknowledgements

Funding was provided by the Massachusetts Clean Energy Center, and the Bureau of Ocean Energy Management. We appreciate the support and good counsel of Tyler Studds, Nils Bolgen, and Brian Hooker through the process. Observers and photo-analysts during these surveys included Laura Ganley, Jessica Taylor, Tracy Montgomery, Sarah Mussoline, Marianna Hagbloom, Leah Crowe, Orla O'Brien, and Jessica Thompson. Thanks to our aircraft vendor Assist Aviation Solutions LLC, including Rick Bartle (Operations Manager), Aidan Wilps (Aircraft Maintenance Manager), project pilots Dan Fields, Don Turner, Keith Lapierre, Raymond Sevard, Richard Euler, and Scott Patten. Additionally, we thank New England Aquarium right whale data analyst Monica Zani for her assistance with processing North Atlantic right whale photographs and data. The NLPSC also thanks Captain Mark Leach of the F/V Sea Holly of Harwichport, MA, for overseeing the MARU deployment and retrieval cruises.

Determining offshore use by marine mammals and ambient noise levels using passive acoustic monitoring

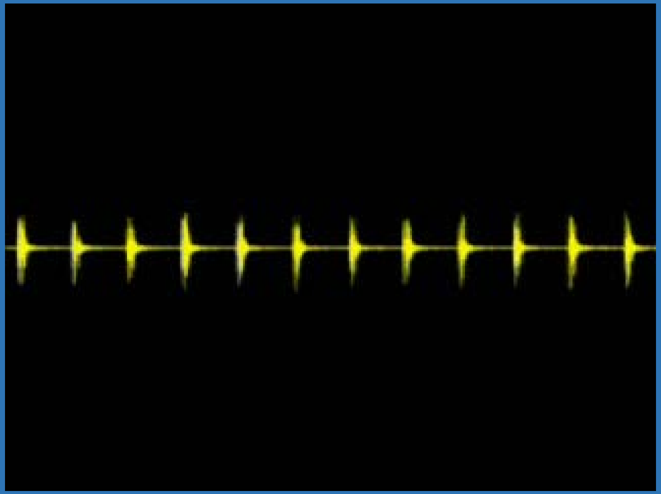
Helen Bailey and Aaron Rice

The Cornell Lab of Ornithology

University of Maryland
Center for Environmental Science
Chesapeake Biological Laboratory

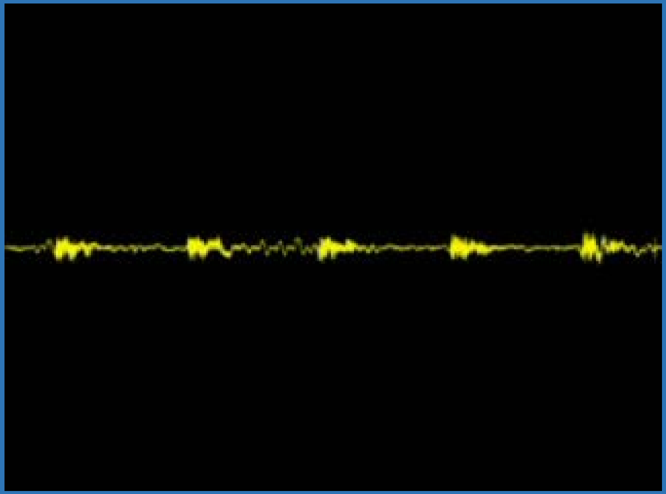
Assessing Environmental Impacts

- For stressors such as sound, the area of potential effect may extend far beyond the immediate vicinity of the proposed development.



Sound 500m from pile-driving

Sound 30km from pile-driving



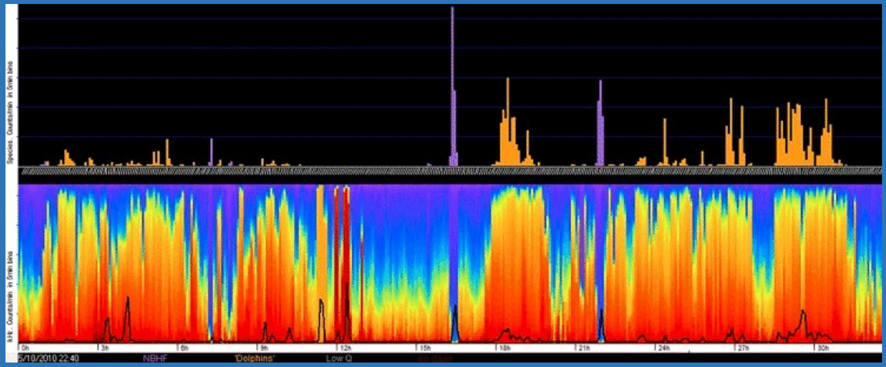
Bailey et al. 2010 Mar. Poll. Bulletin
Bailey et al. 2014 Aquatic Biosystems

Goals

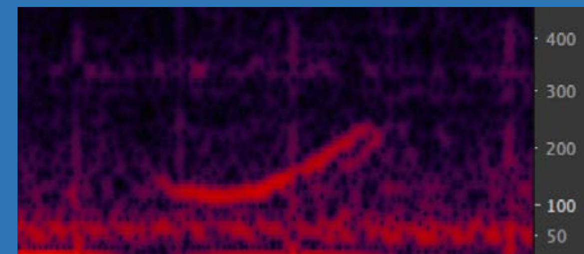
- Collect acoustic data to:
  - characterize patterns of temporal and spatial occurrence of vocalizing marine mammal species (including right whales, fin whales, humpback whales, minke whale and any small cetacean species)
  - characterize the existing ambient noise environment in and around the Maryland Wind Energy Area (MD WEA)

Passive acoustic monitoring

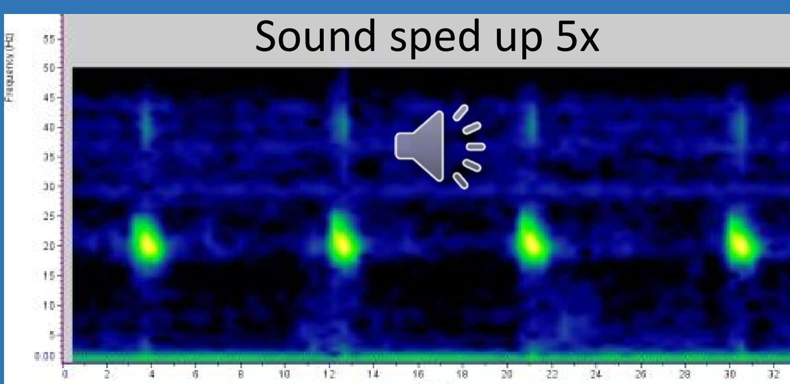
- Excellent for detecting vocally active species at high temporal resolution in all weather conditions
- Provides pervasive record
- Ability to detect other environmental and anthropogenic sounds
- Non-invasive



Marine Mammals

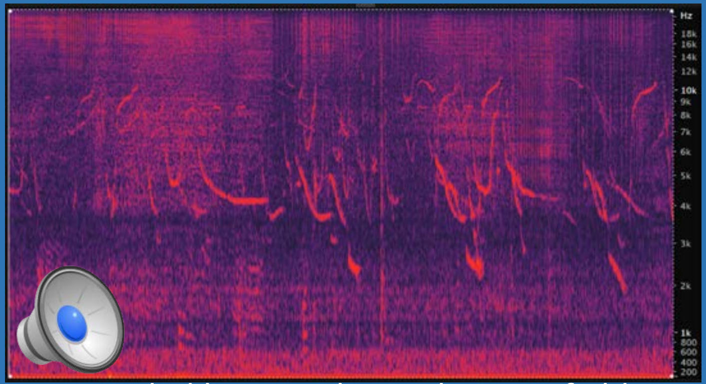


Recorded by A. Rice and his team in the MD WEA.



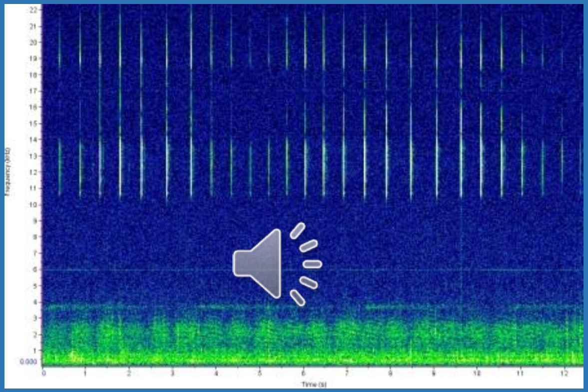
Fin whale sound and spectrogram courtesy of NOAA NEFSC.

Marine Mammals



Recorded by H. Bailey and J. Wingfield in the MD WEA.

Sound 1/20 normal speed

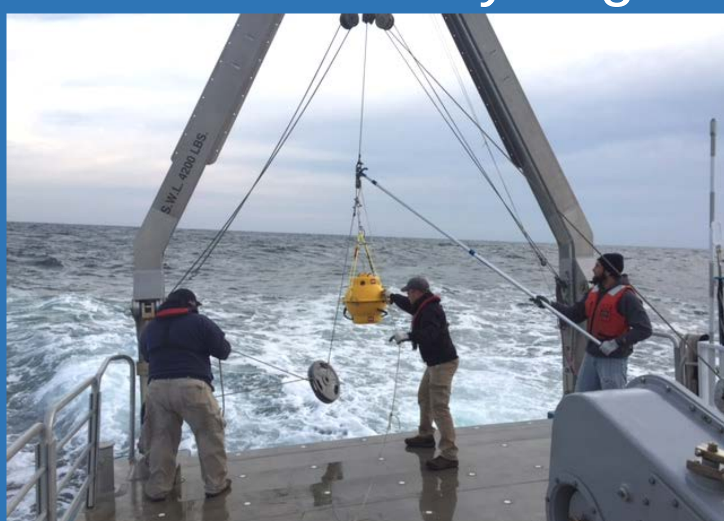


Porpoise sound and spectrograms courtesy of NOAA NEFSC.

Data Collection

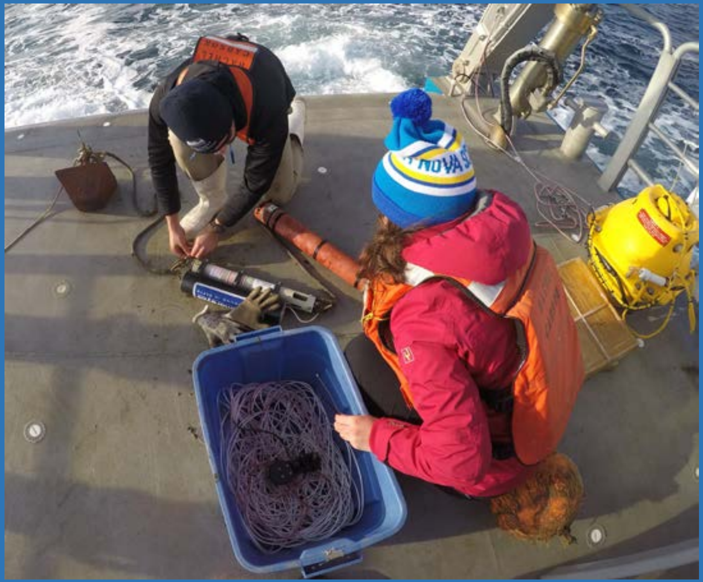
Two types of devices:

1) The Marine Autonomous Recording Unit (MARU) designed by Cornell University collects a continuous archival record of the sound environment (sampling at 2kHz).
   - Calibrated to measure absolute ambient noise levels
   - Detects calls by large whales

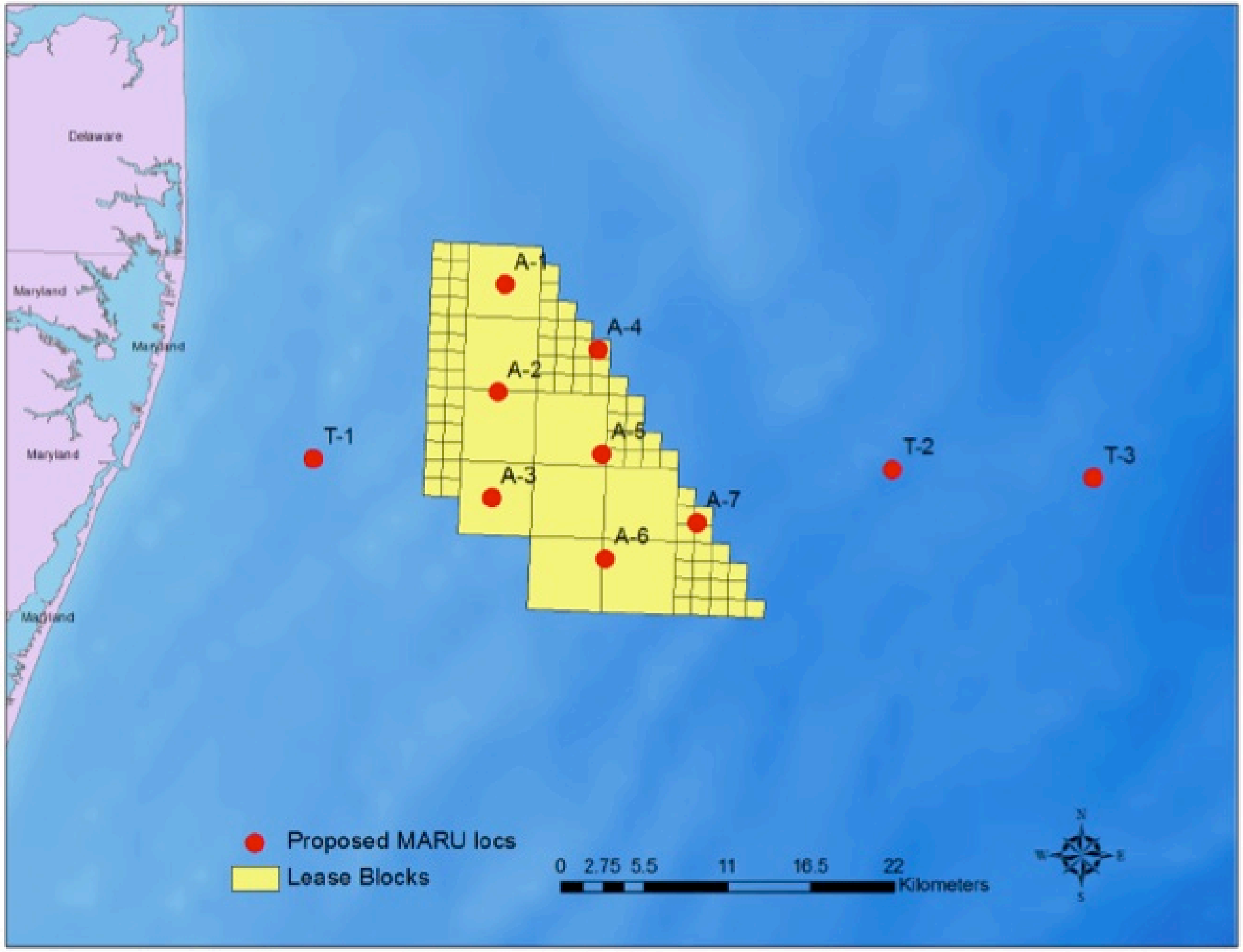


Data collection

2) The C-POD is a tonal click detector that continuously monitors the 20-160kHz frequency range.
   - Detects echolocation clicks by small cetaceans (dolphins and porpoises).

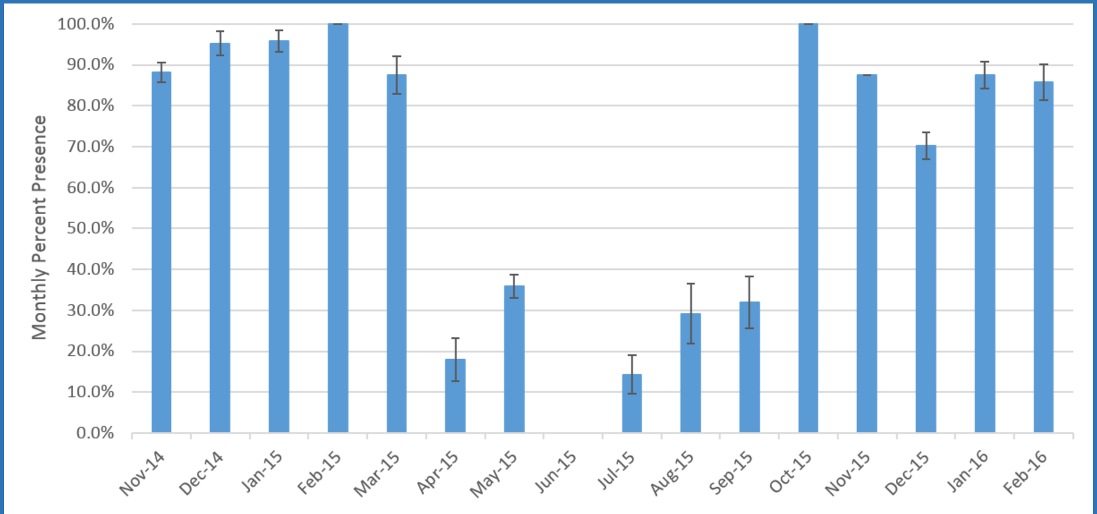


Acoustic Array

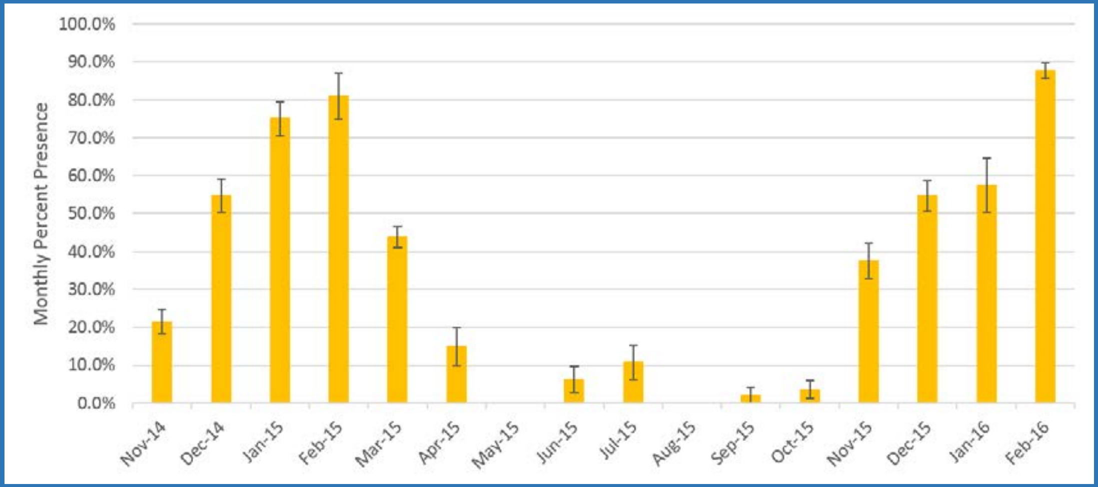


Preliminary Results: Whales

Fin whales



Right whales

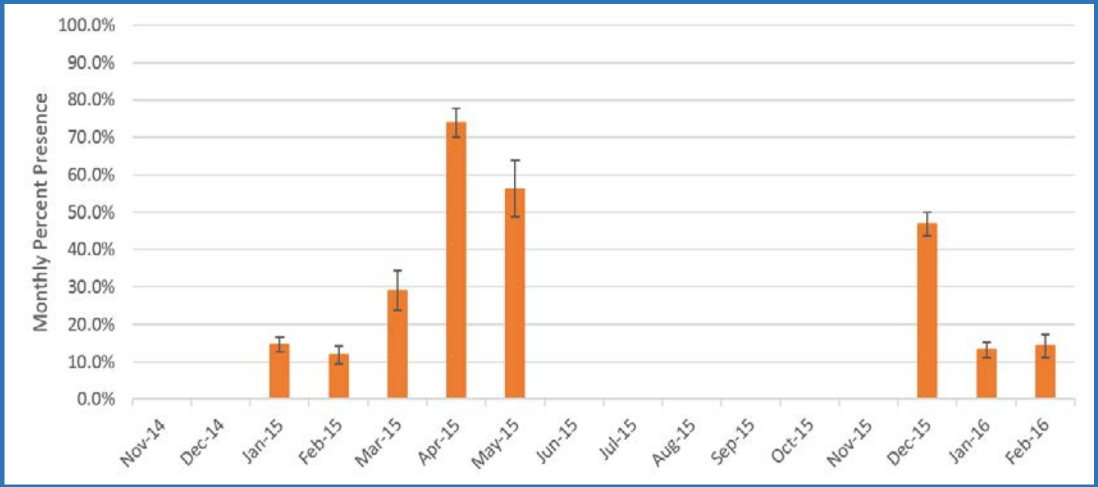


Monthly percent presence in the wind energy area

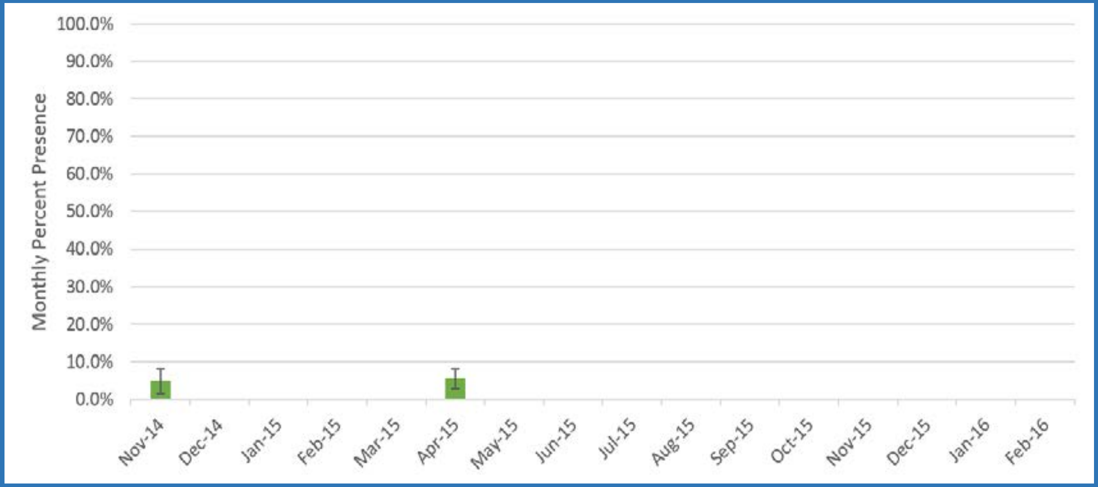
(Hodge, Tielens, Estabrook and Rice, Bioacoustics Research Program Cornell University)

Preliminary Results: Whales

Humpback whales



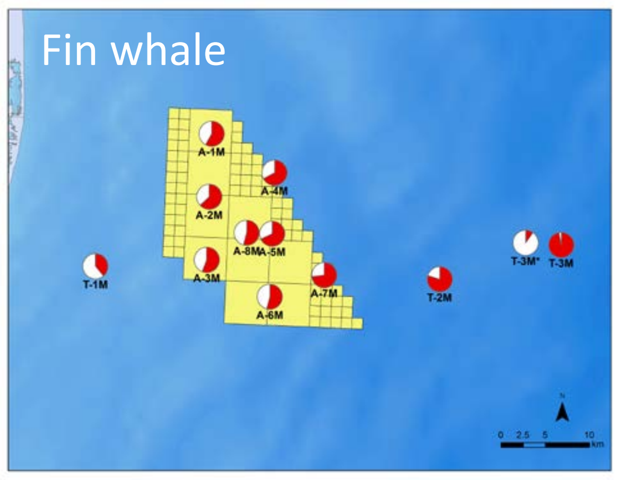
Minke whales

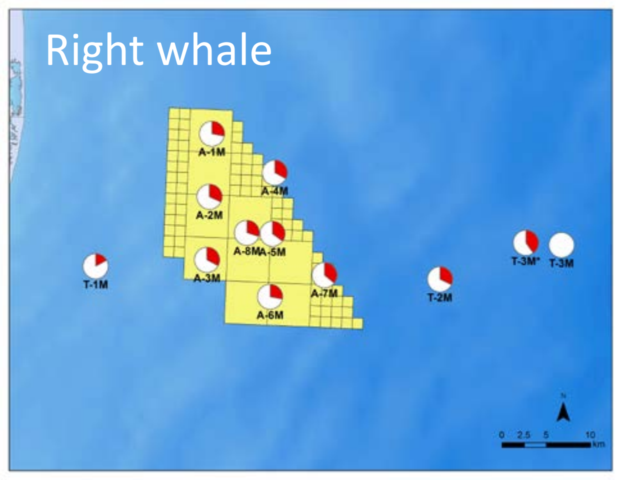


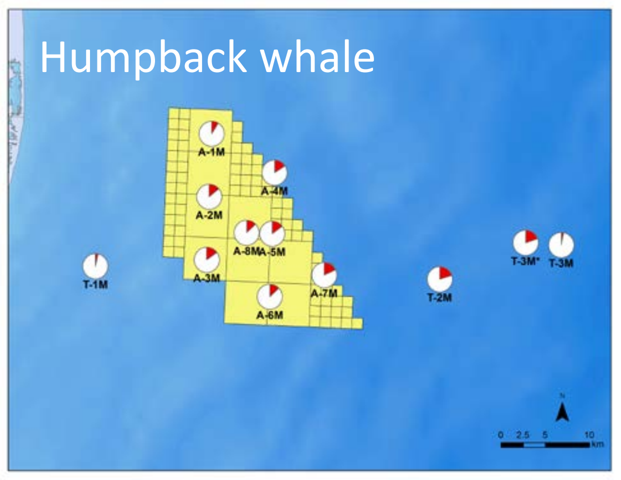
Monthly percent presence in the wind energy area

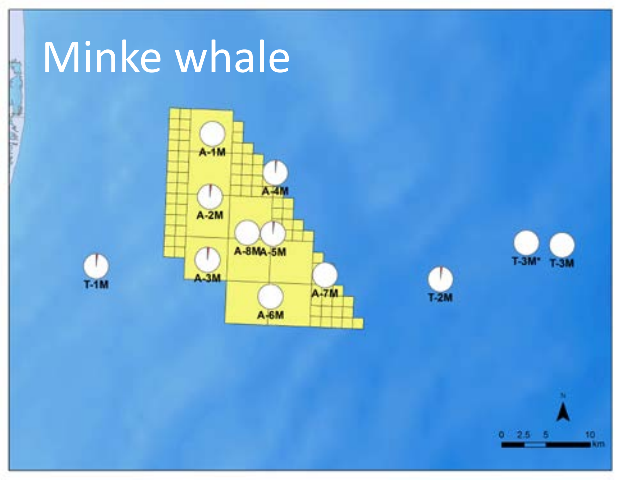
(Hodge, Tielens, Estabrook and Rice, Bioacoustics Research Program Cornell University)

Preliminary Results: Whales





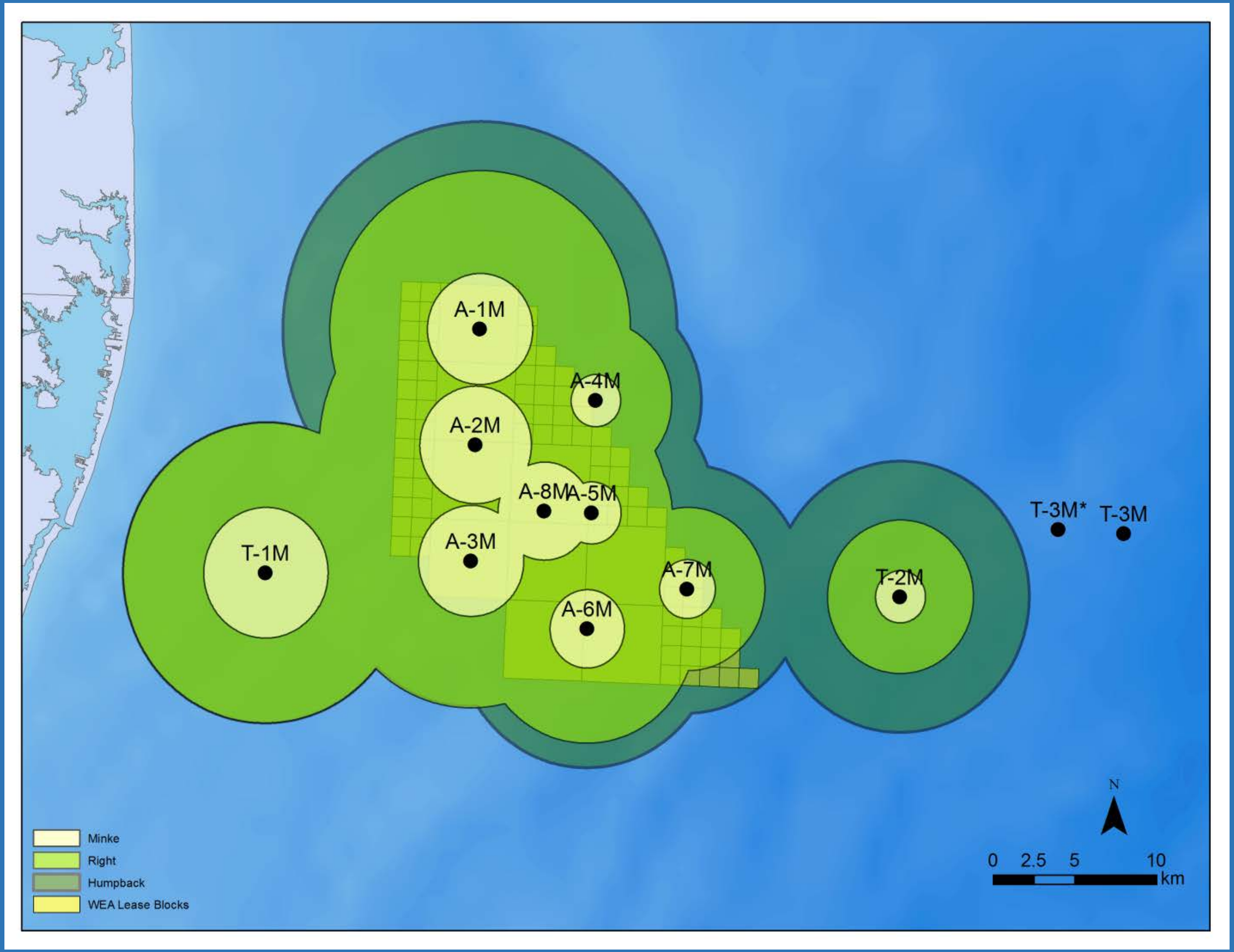




Daily percent presence (red) during November 2014 – February 2016

(Hodge, Tielens, Estabrook and Rice, Bioacoustics Research Program Cornell University)

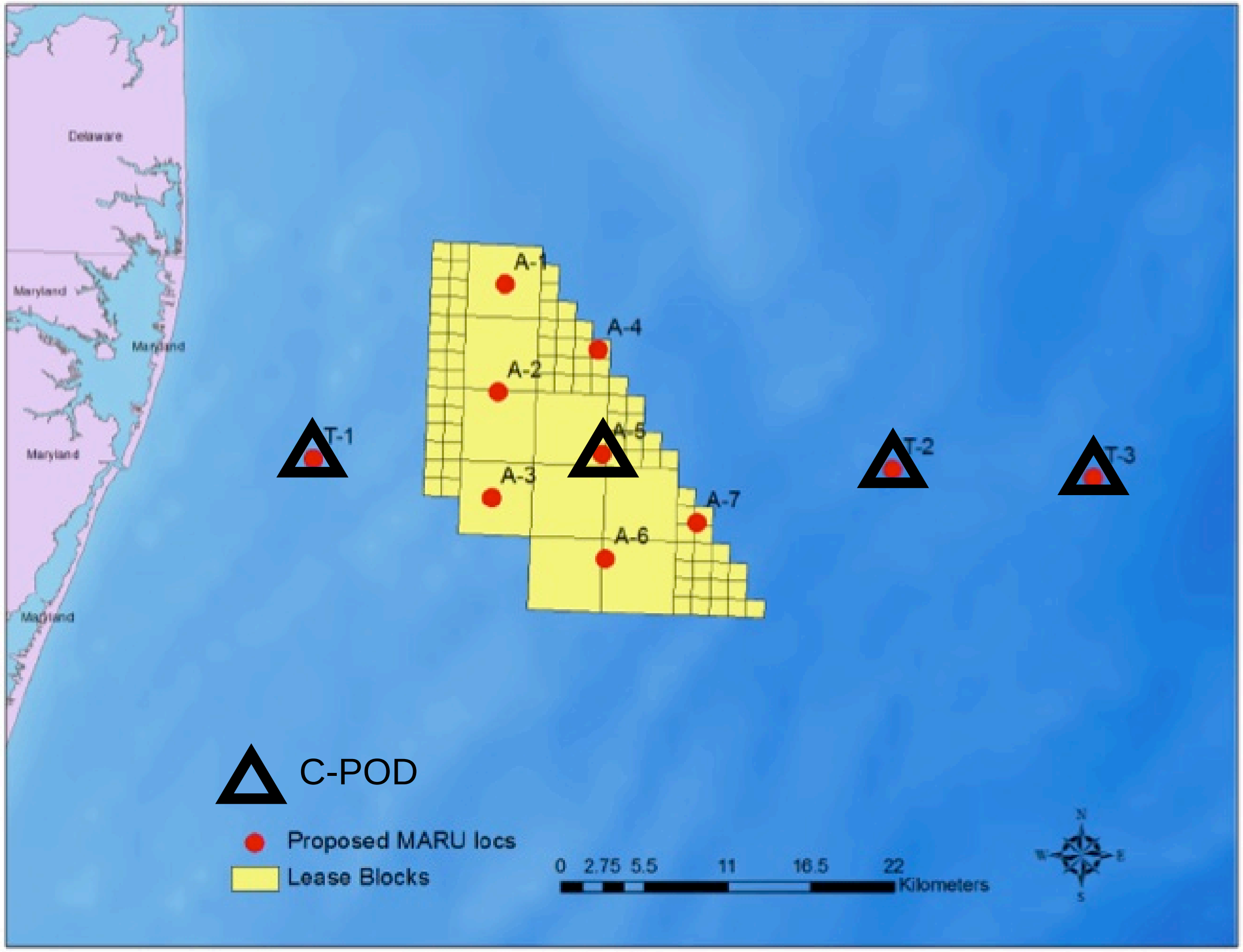
Estimate locations



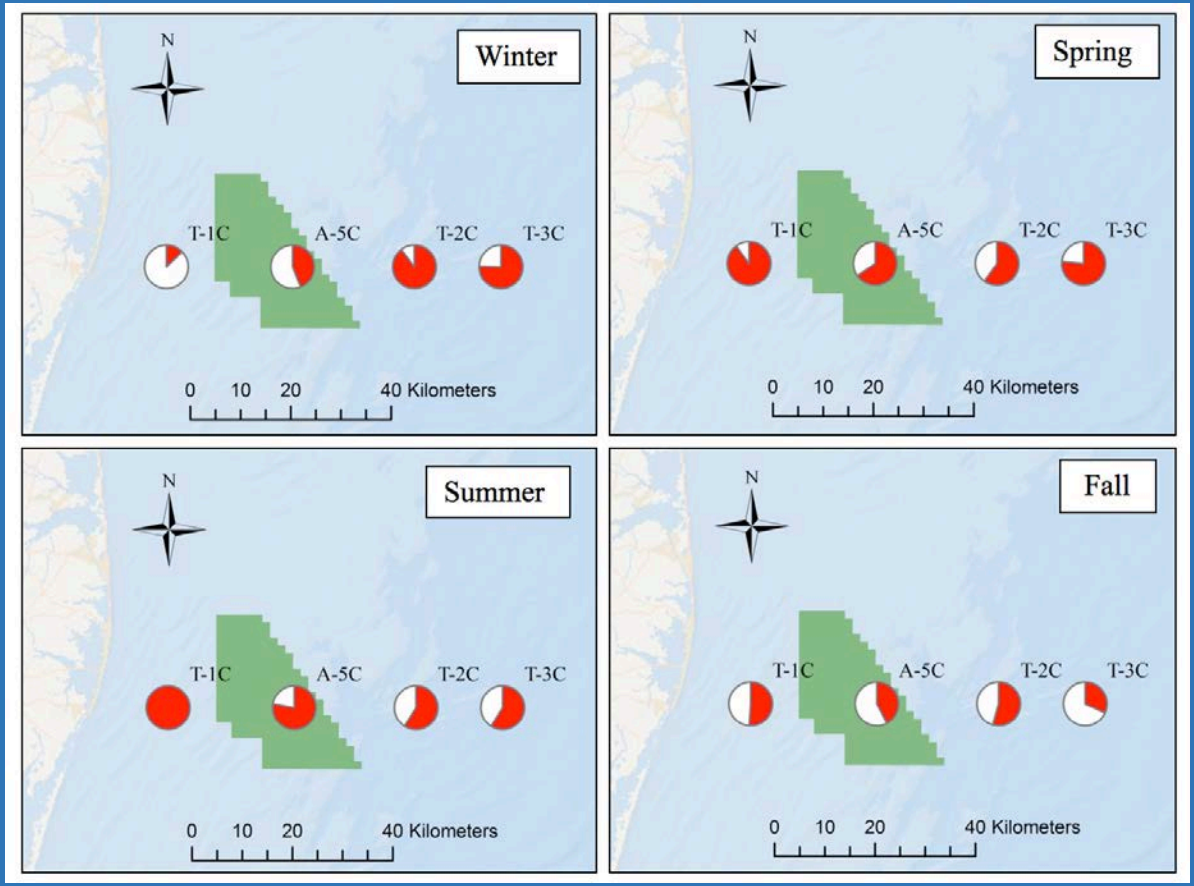
Detection ranges of the MARUs

(Hodge, Tielens, Estabrook and Rice, Bioacoustics Research Program Cornell University)

Acoustic Array



Preliminary Results: Dolphins



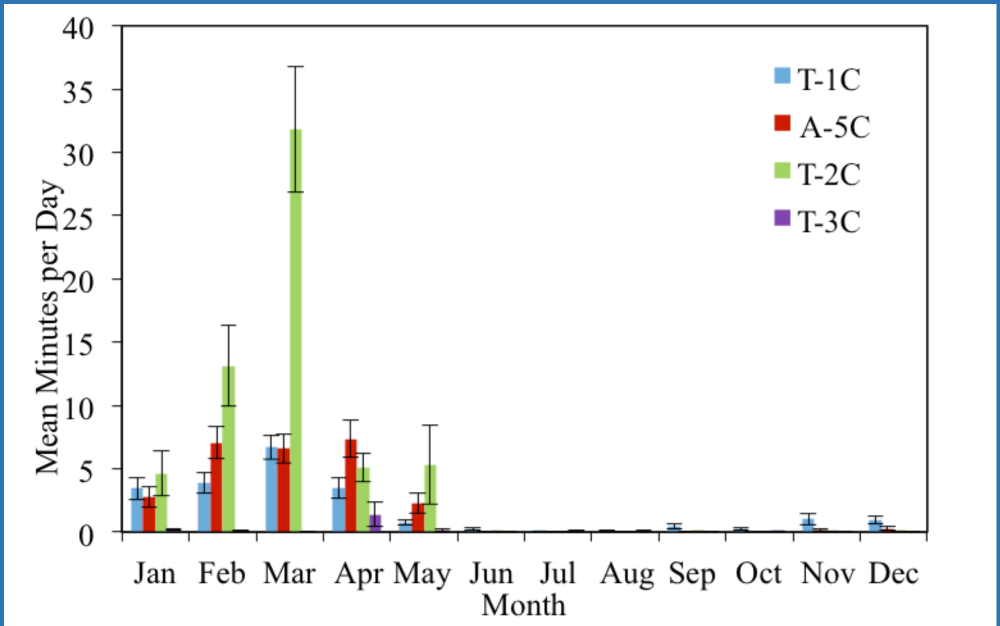
Bottlenose dolphins

Common dolphins

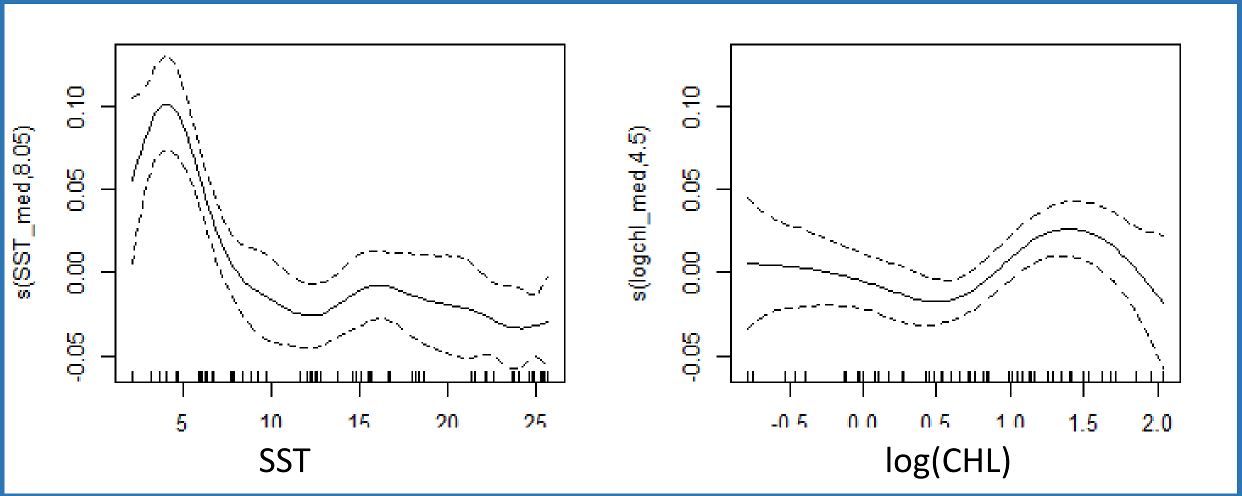
Proportion of days with dolphin detections (red)

By Wingfield and Bailey, CBL UMCES

Preliminary Results: Porpoises

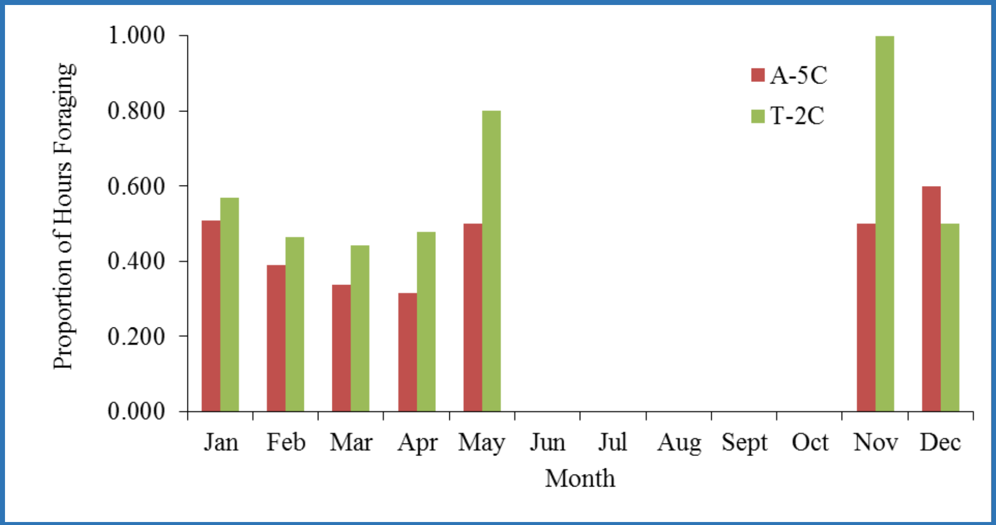


- Harbor porpoises mainly detected during January-May.
- Relationship with environmental variables, sea surface temperature (SST) and chlorophyll a concentration (CHL), in the wind energy area.

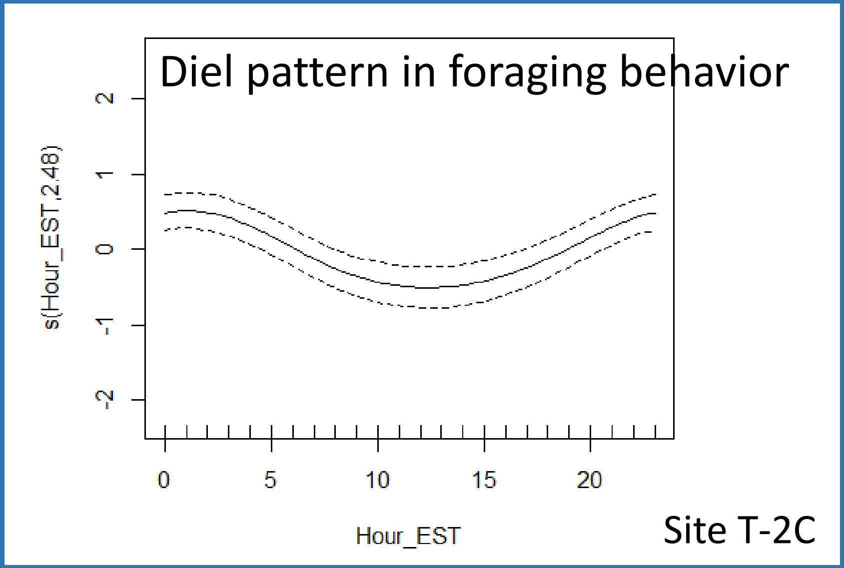


Wingfield et al. In preparation

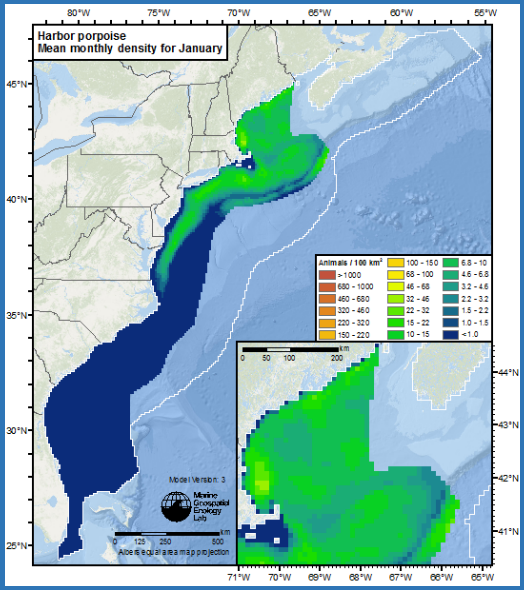
Preliminary Results: Porpoises



Foraging behavior determined by occurrence of feeding buzzes (inter-click interval < 10ms)



Wingfield et al. In preparation

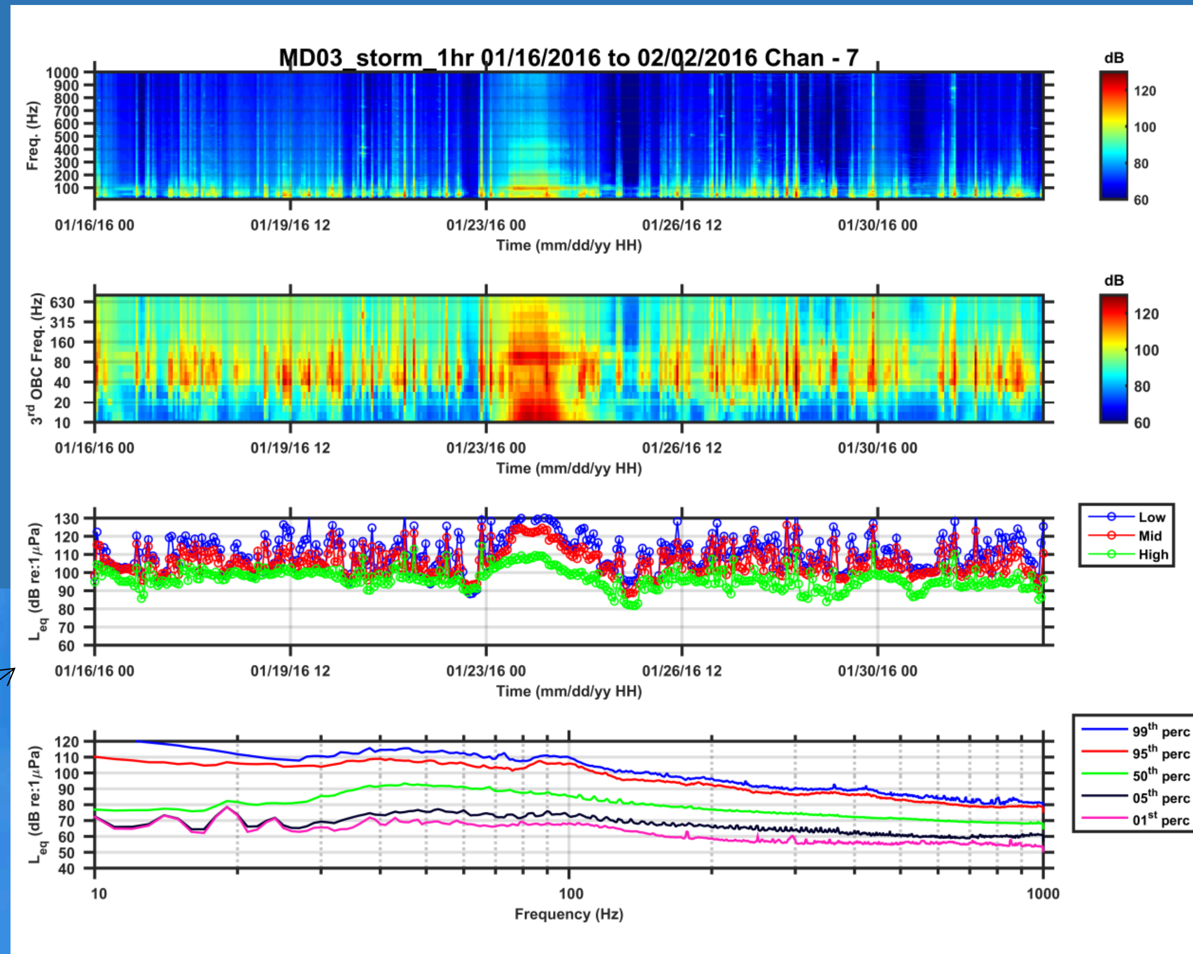


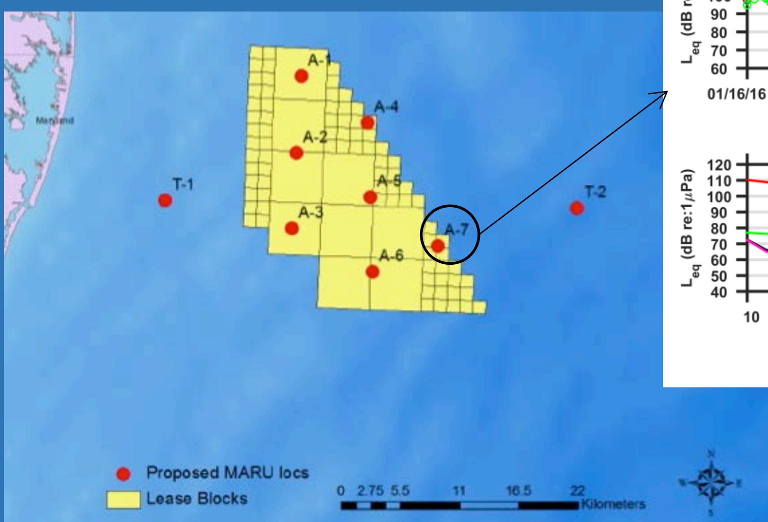
From Roberts et al. 2016

Significant correlation between acoustic detection metrics and habitat-based density estimates

Ambient Noise Analysis

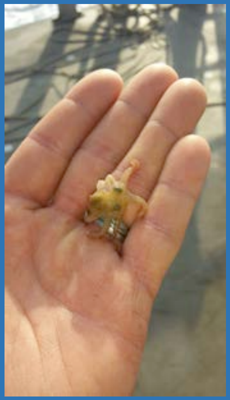
Example of ambient noise levels before, during and after a storm event at site A-7M (16 Jan – 1 Feb, 2016).





(Hodge, Tielens, Charif, Estabrook and Rice, Bioacoustics Research Program Cornell University)

Summary



- Seasonal pattern in whale occurrence, with fin and North Atlantic right whales most frequently detected.
- Dolphins detected year-round whereas porpoises most frequently detected in winter and spring.
- Initial project duration: June 2014-May 2017
- Acoustic monitoring expected to be extended to November 2017.

Acknowledgements

- Thank you to everyone who assisted with the field data collection and analysis.
- The Maryland Department of Natural Resources secured the funding for this project from the Maryland Energy Administration's Offshore Wind Development Fund and the U.S. Department of Interior's Bureau of Ocean Energy Management, Environmental Studies Program.

Colin Dunn

Thank you!

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Aaron Rice (arice@cornell.edu)

Passive Acoustic Surveys for Baleen Whales in the Virginia Offshore Wind Area

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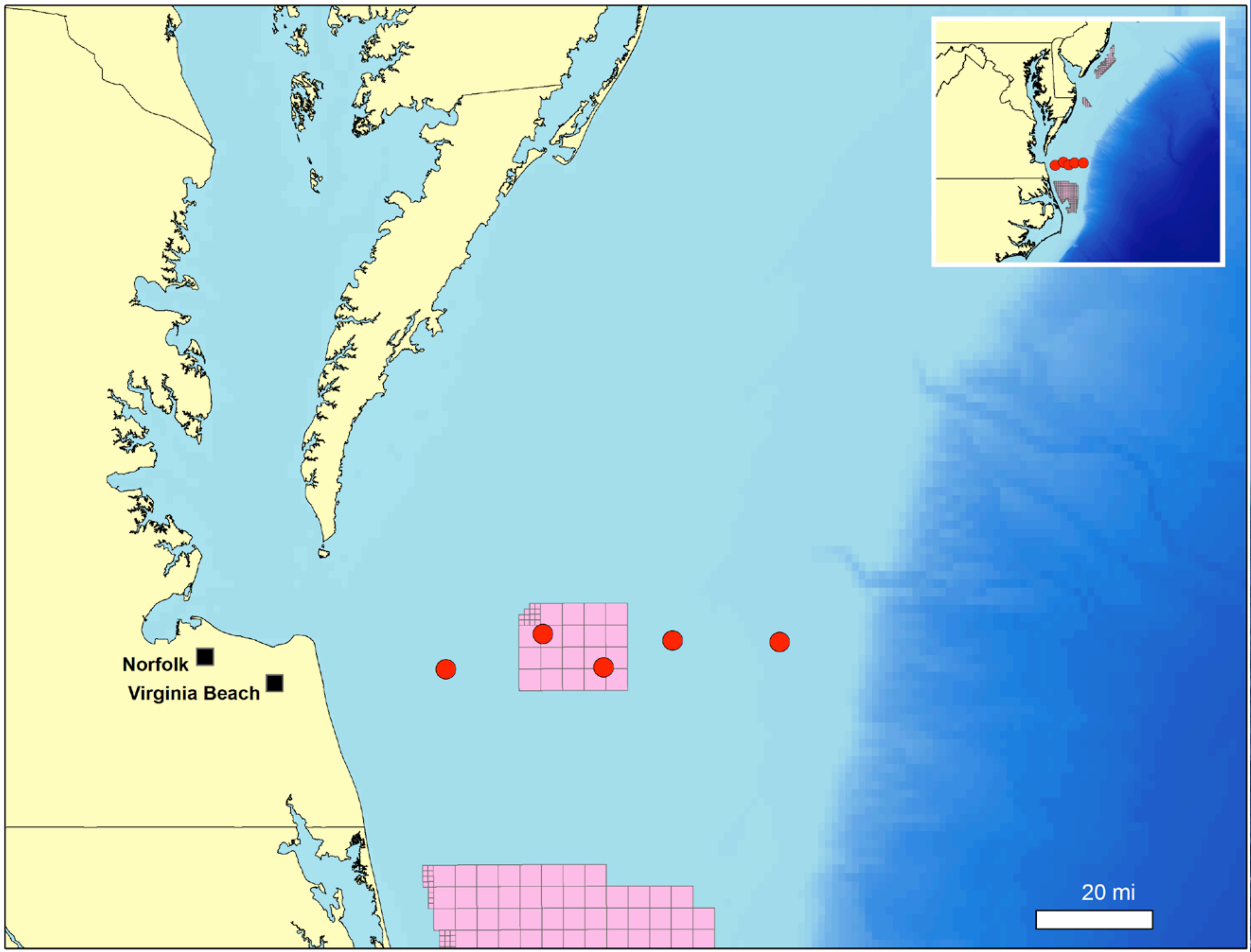
Bioacoustics Research Program
Cornell Laboratory of Ornithology
Cornell University
Ithaca, NY 14850 USA

Importance of Baseline Data

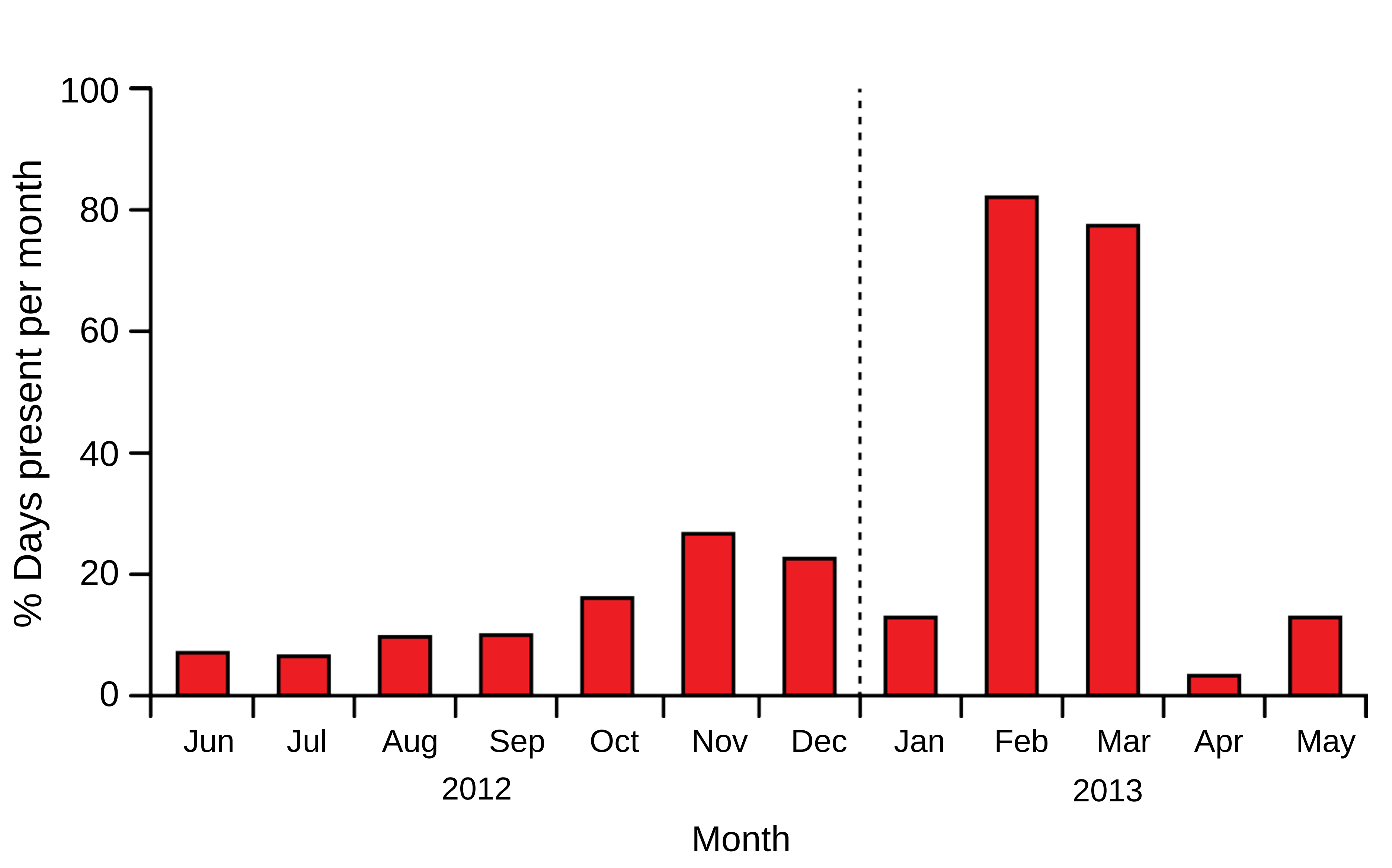
- Document baleen whale occurrence before WEA activities
  - Whale presence in many Mid-Atlantic areas unclear
- Compare baseline data to future occurrence
  - evaluate any changes
- Inform management decisions to mitigate potential impacts to protected marine species

Better data → more effective conservation and management

Previous PAM Survey (2012-2013)

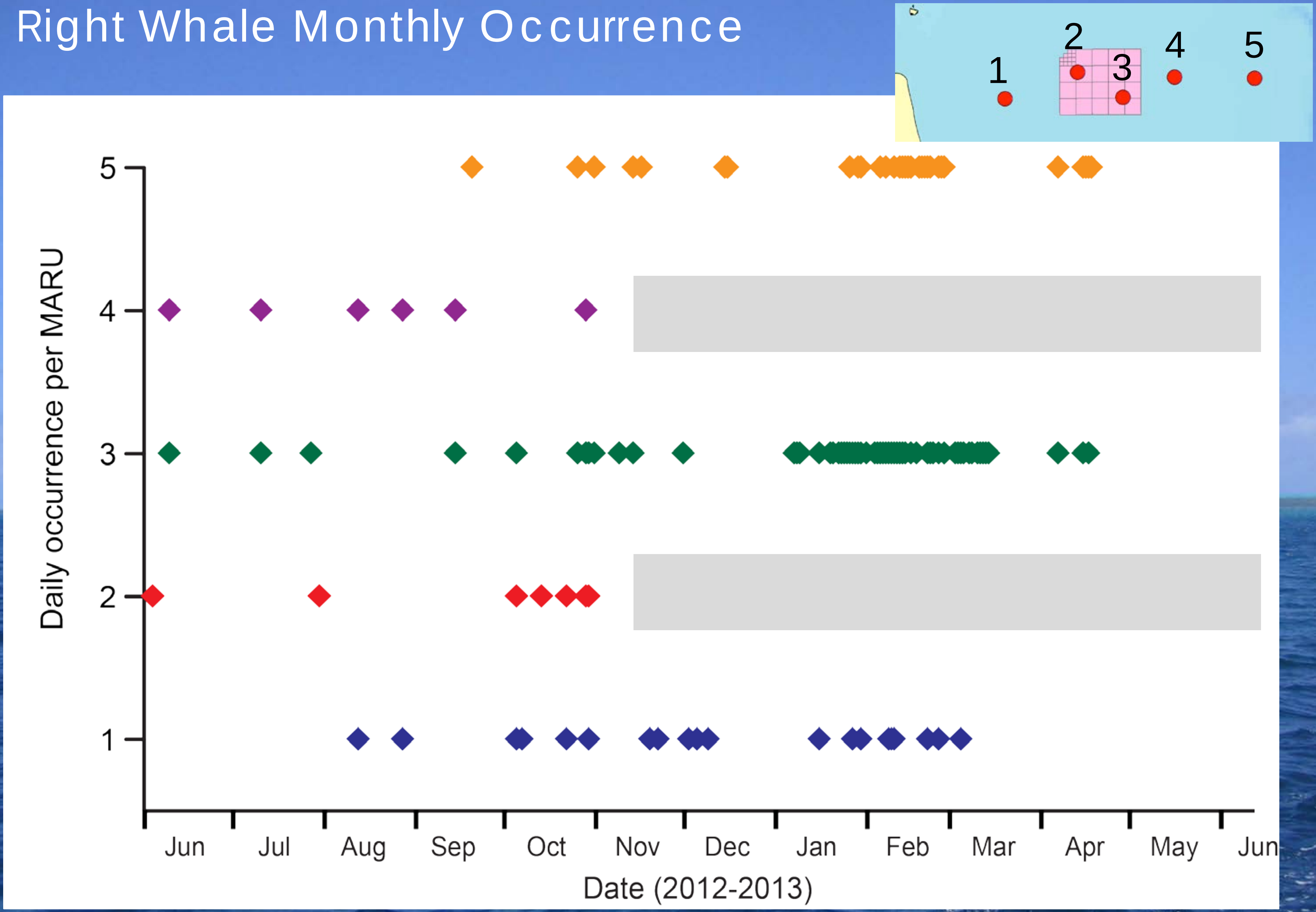


Right Whale Monthly Occurrence



(Salisbury et al. 2016)

Right Whale Monthly Occurrence



(Salisbury et al. 2016)

Project Objectives

1. Quantify temporal occurrence patterns of baleen whales along VA coast and in WEA

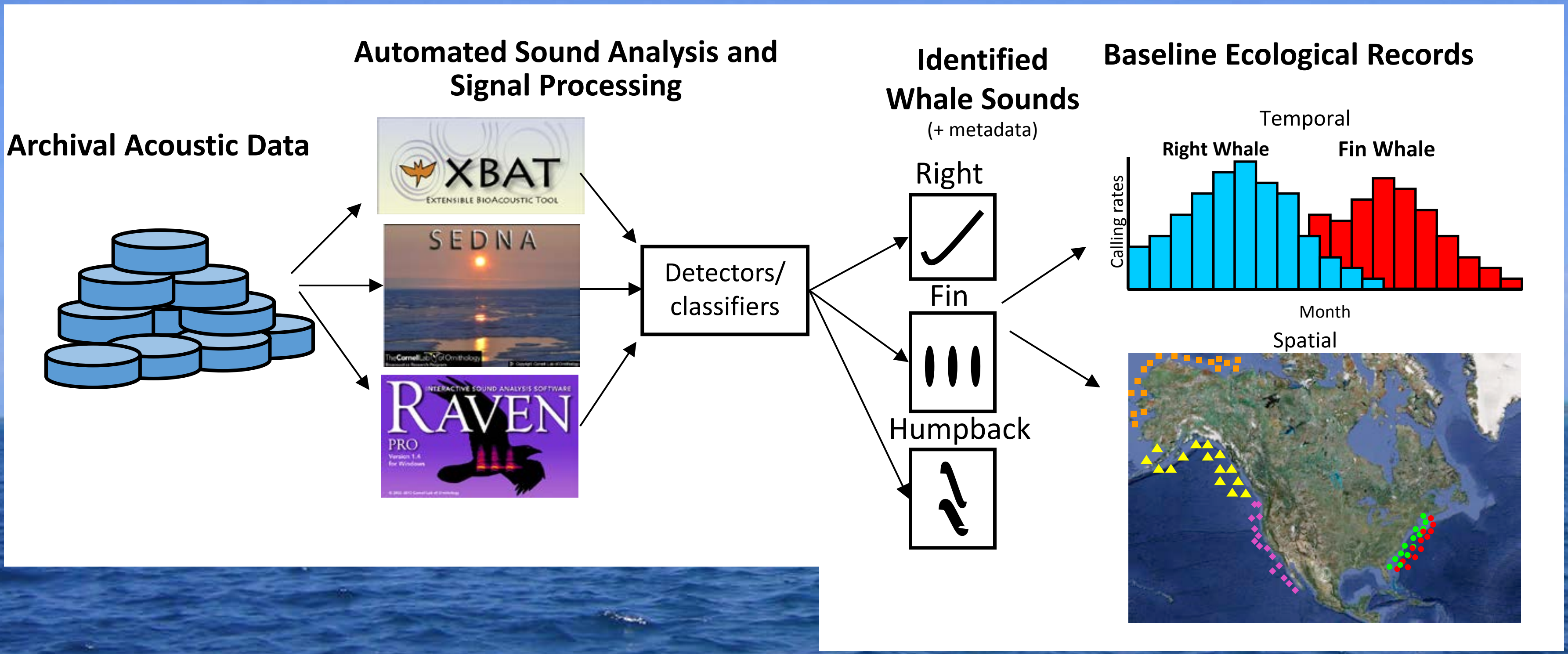
2. Localize calls from whales to infer patterns of spatial habitat usage

3. Quantify baseline ambient noise conditions

Methods

- Combination of recording equipment
  - 6 Cornell Marine Autonomous Recording Units (MARUs)
    - Localization
    - F_s = 2 kHz
  - 4 JASCO AMARs
    - Transect configuration
    - F_s = 8 kHz
    - Seasonal Presence
    - Quantitative noise analysis

Acoustic Monitoring Workflow



Time-stamp and sensor location of sounds of interest becomes the foundation for understanding spatial and temporal occurrence patterns

Acoustic Analysis

- Four focal baleen whale species

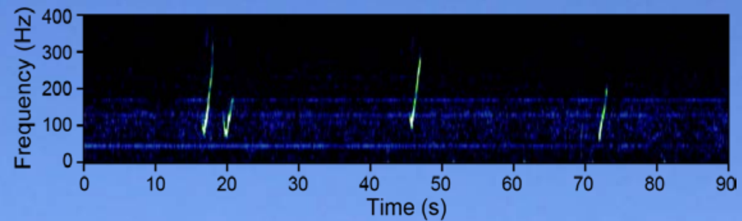
- Determined presence of species-specific calls on each recording unit

- Used combination of human visual analysis and automated detection approaches
  - subsample for initial effort

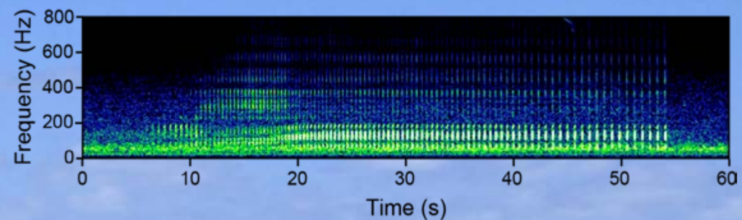
- For localization, examined sounds for the presence of the same sound on >3 units
  - located position and uncertainty using new feature in Raven 2.0

- Ambient noise measured with Matlab

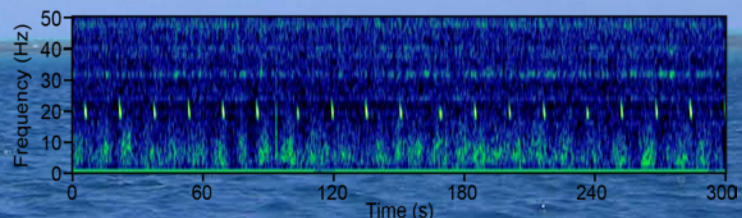
North Atlantic Right Whale



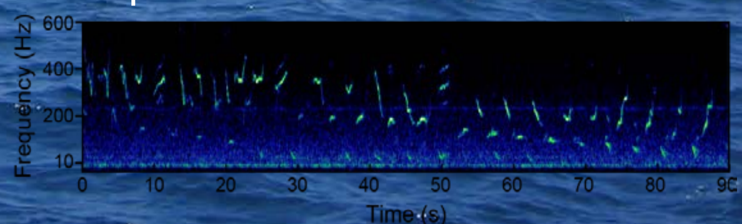
Minke Whale



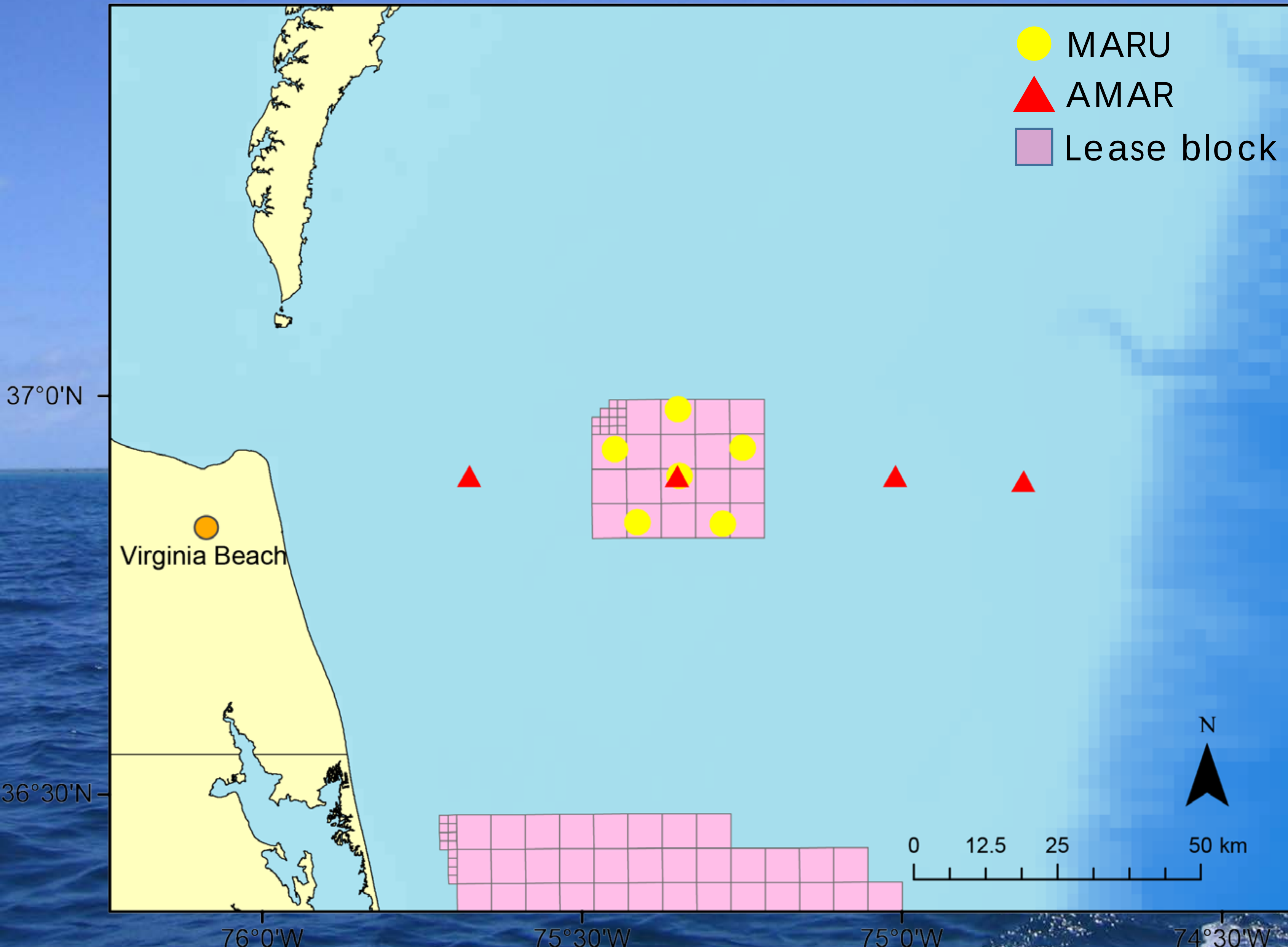
Fin Whale



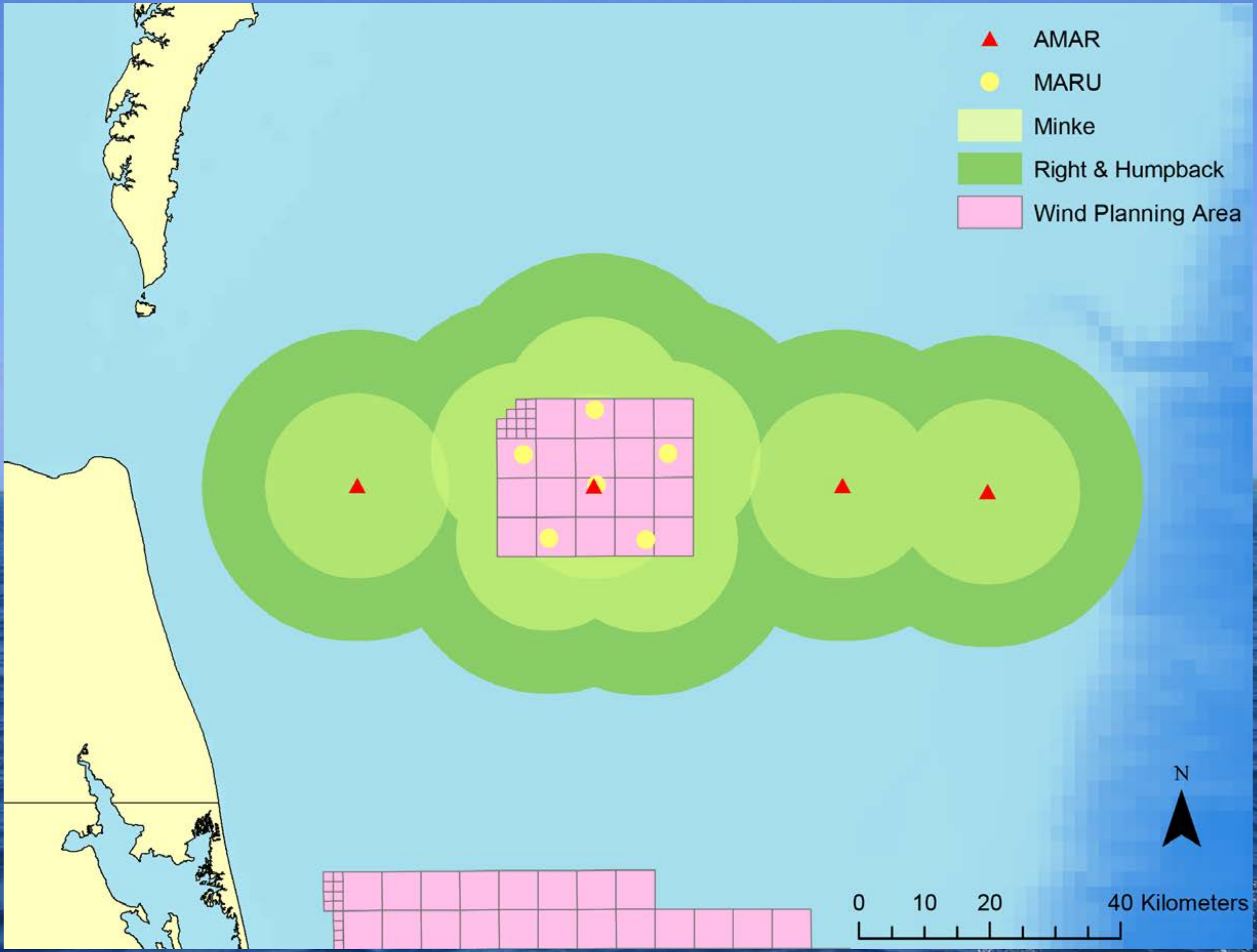
Humpback Whale



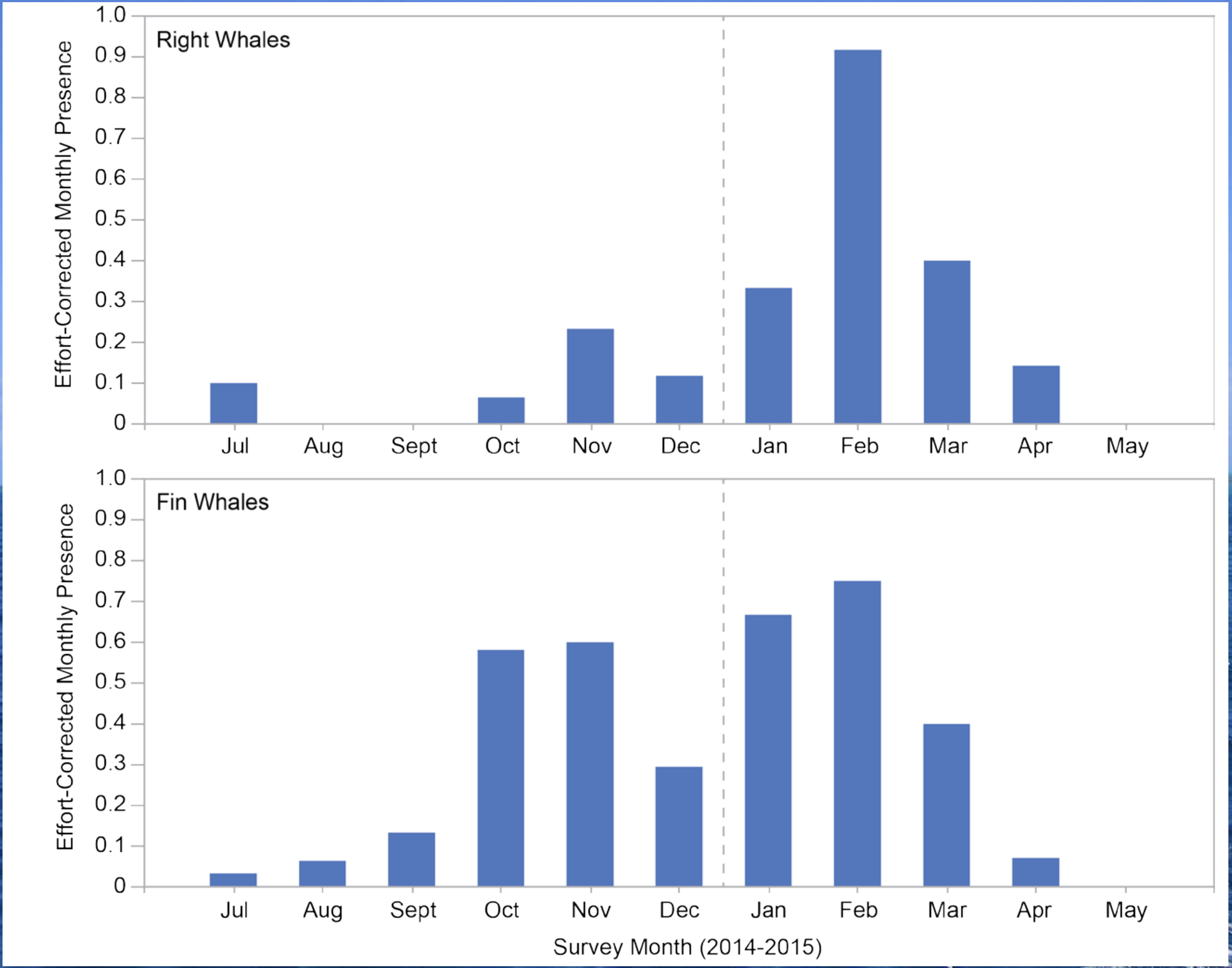
Recorder Configuration



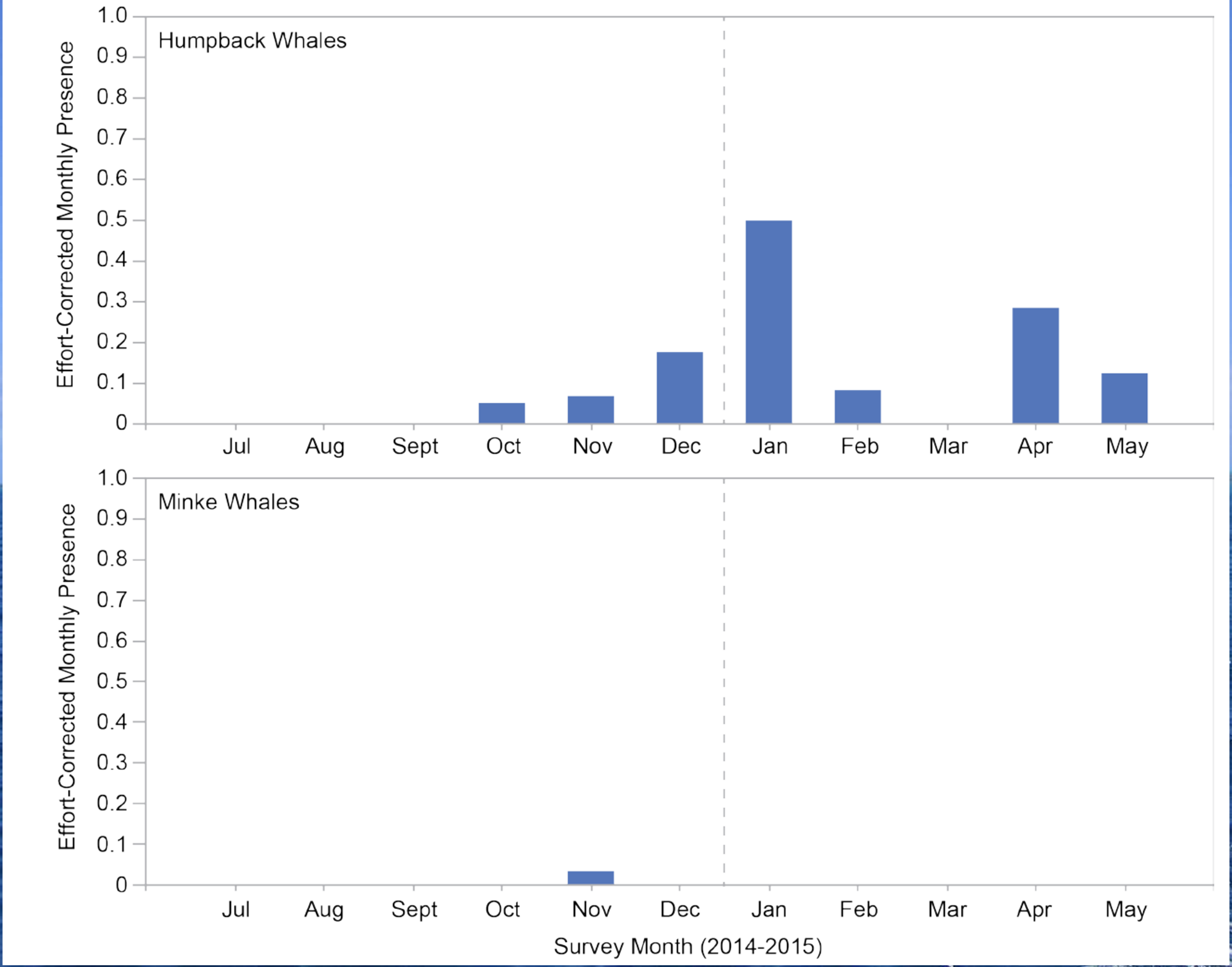
Estimated Detection Range



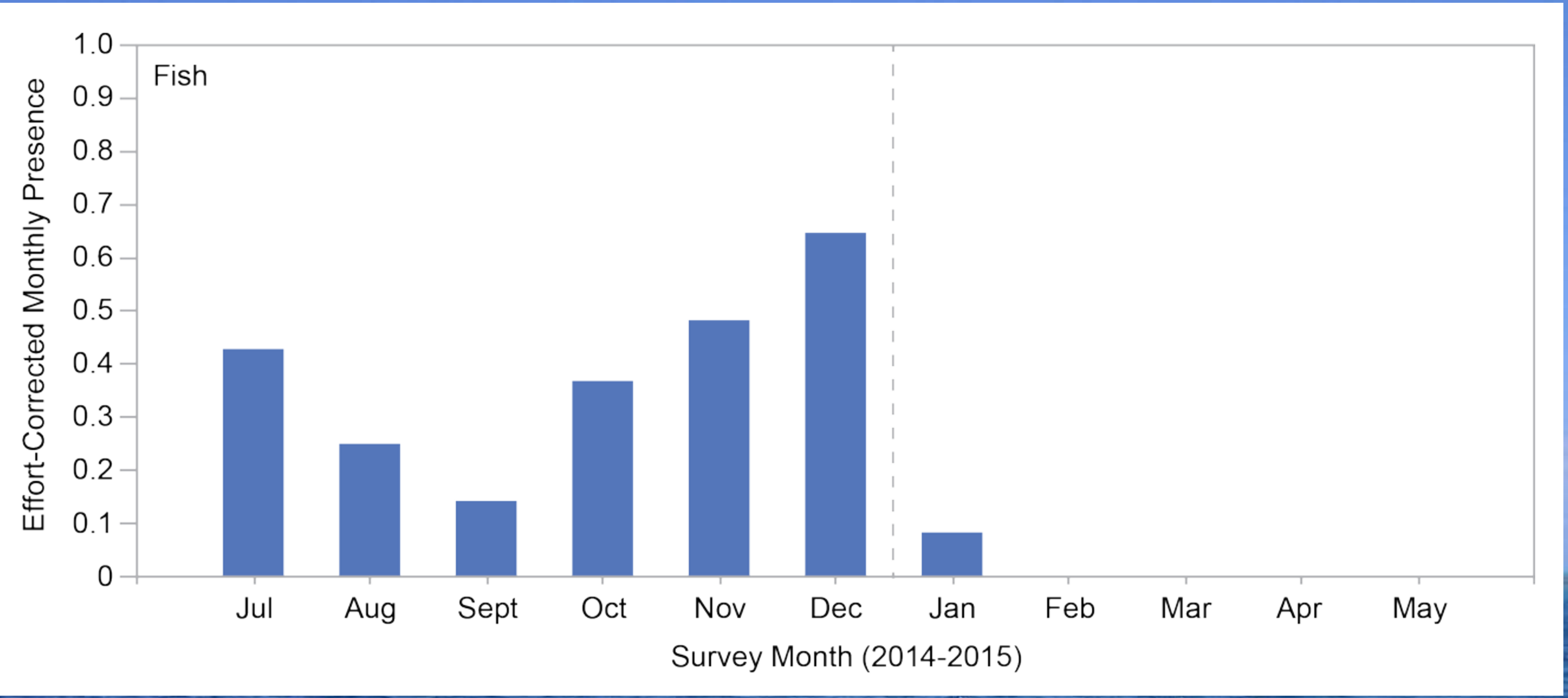
Preliminary Results



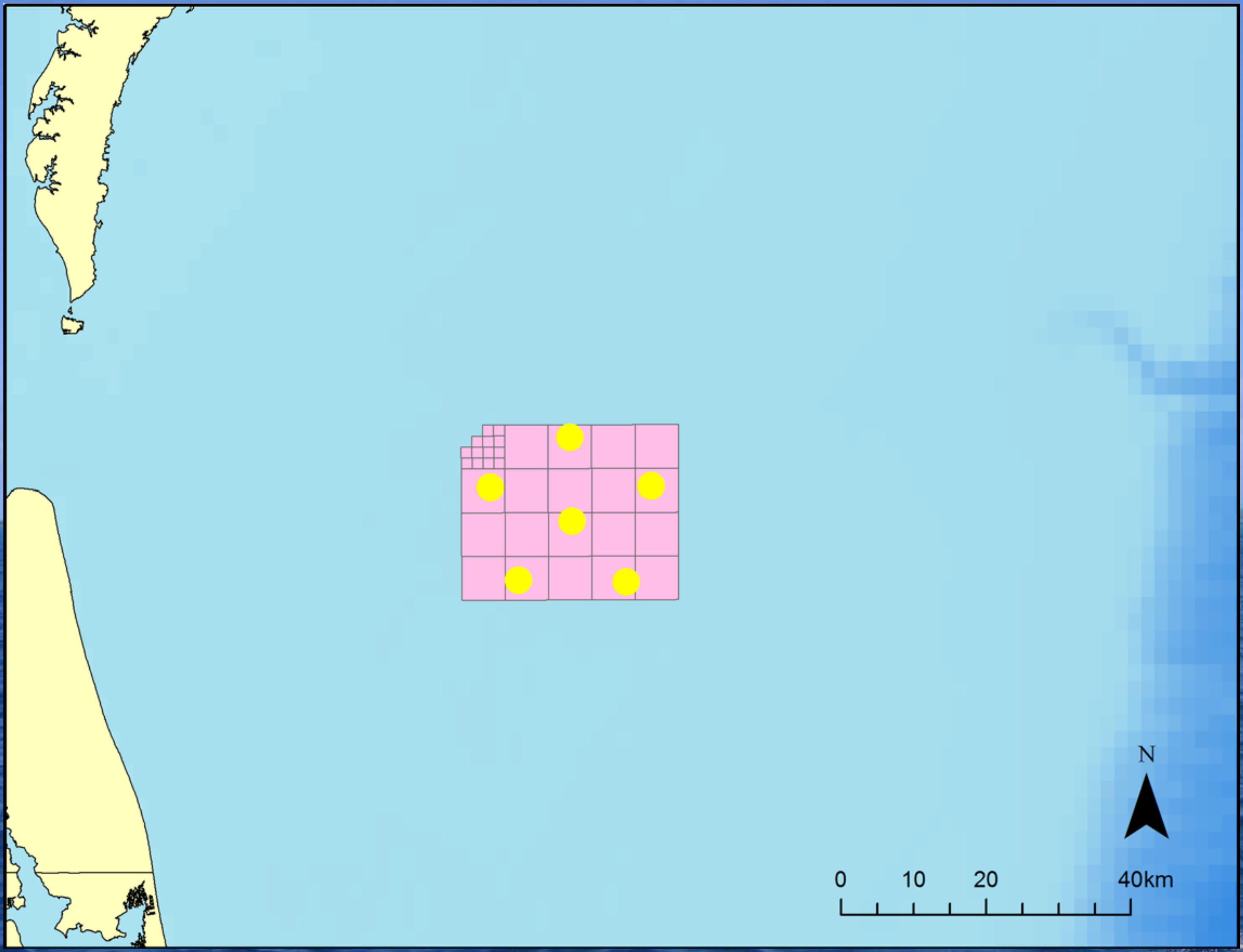
Preliminary Results



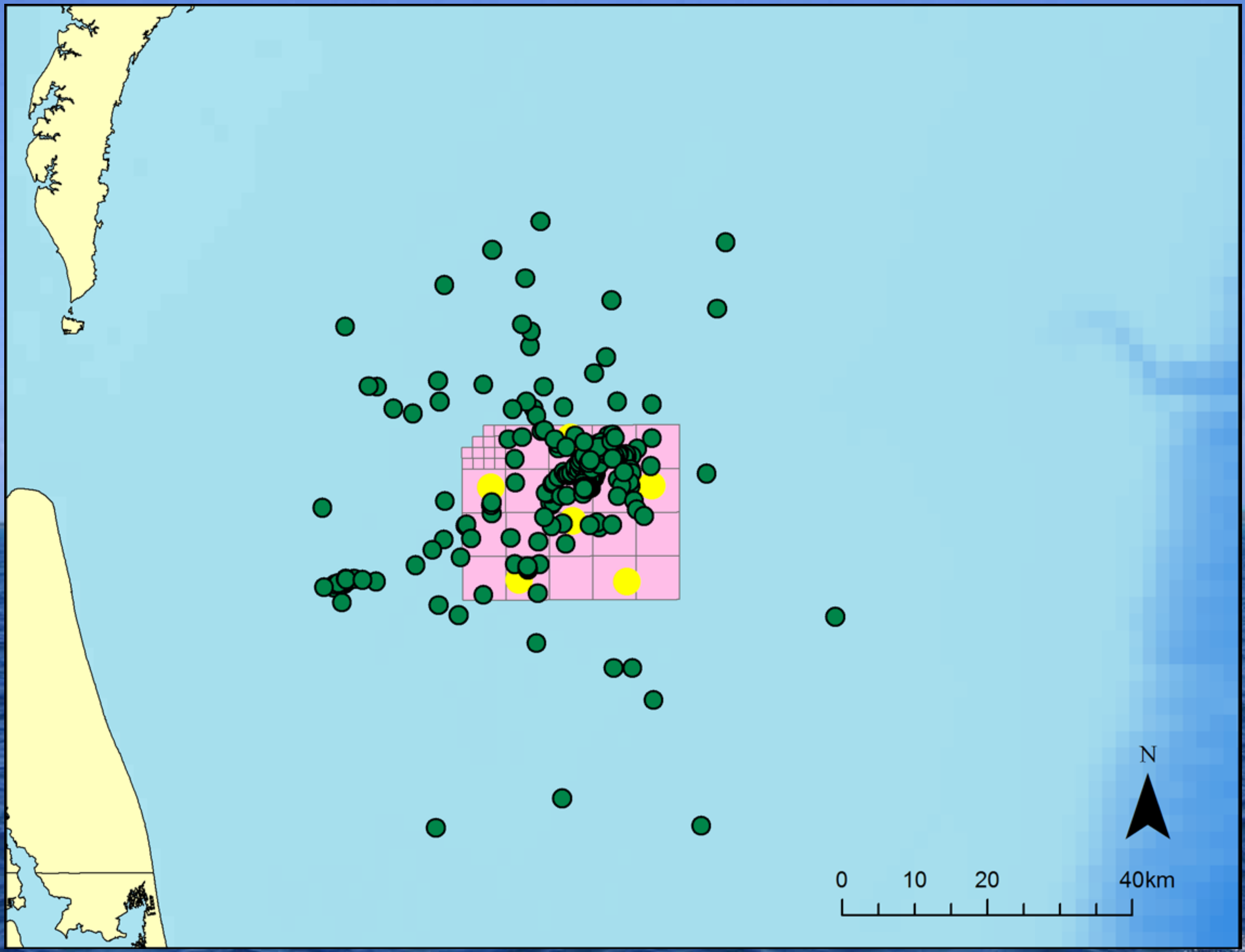
Preliminary Results



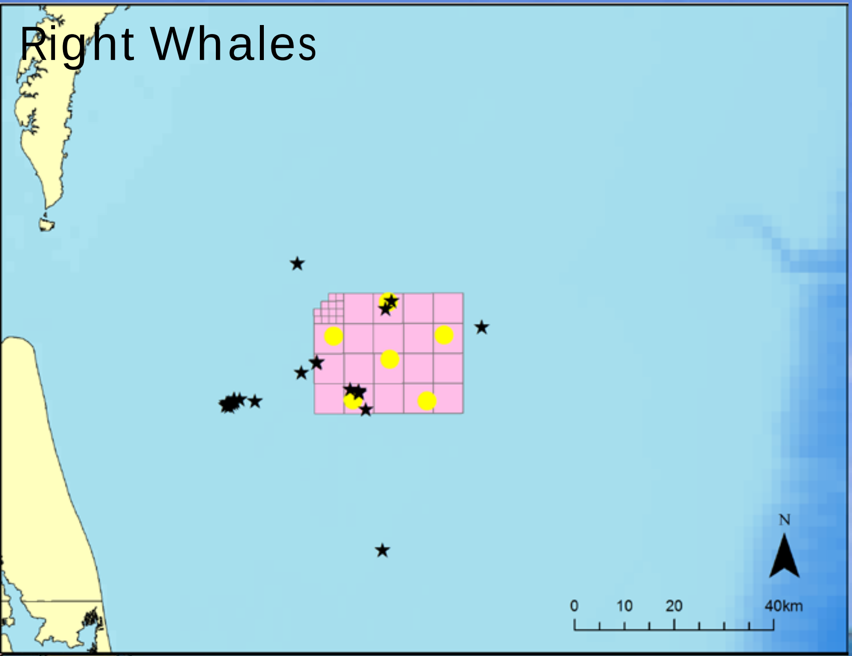
Acoustic Localization

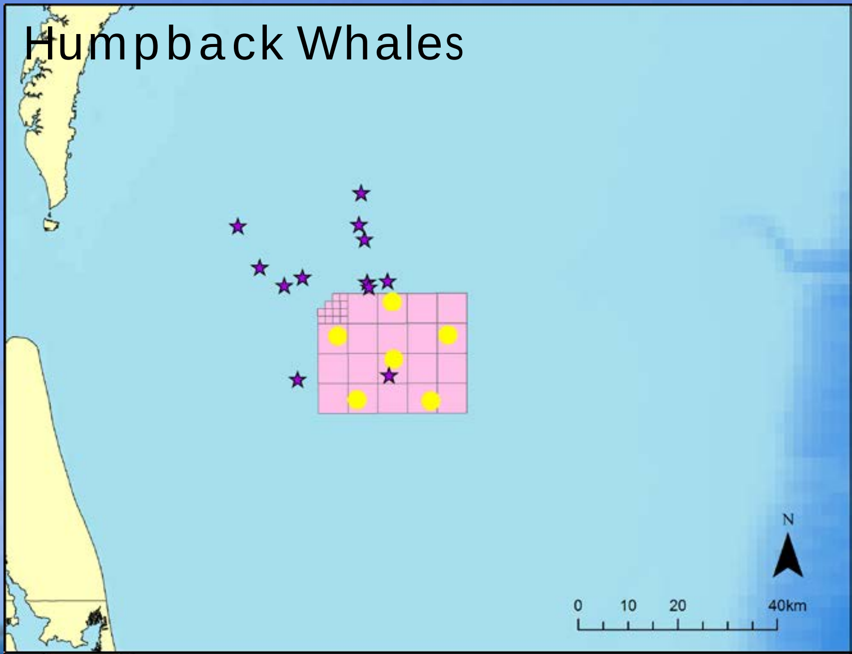


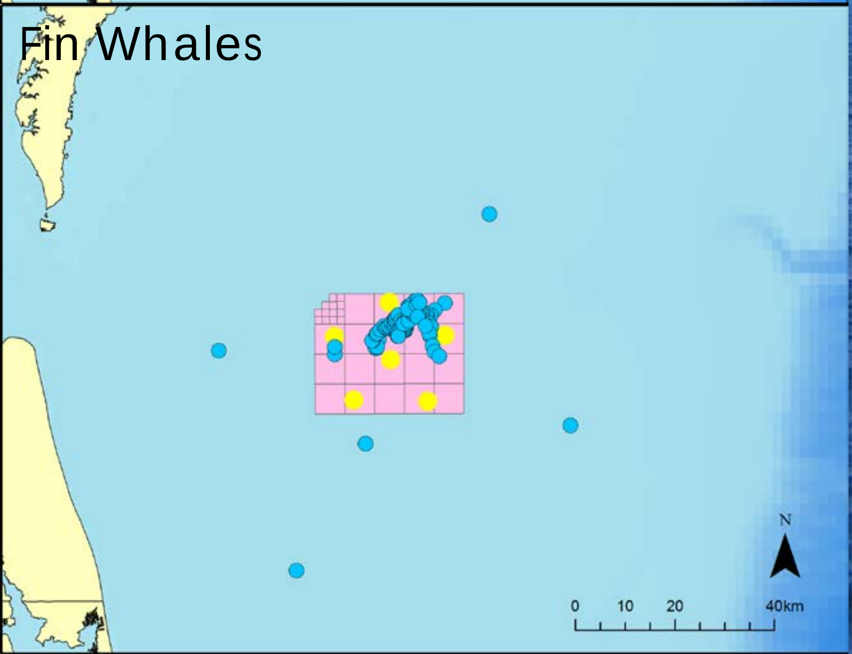
Acoustic Localization – Preliminary Results

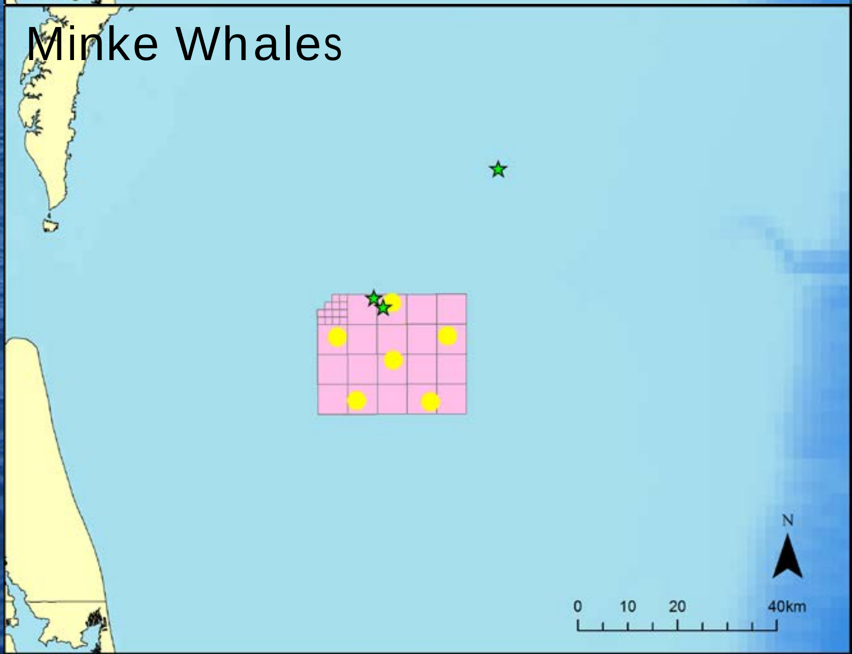


Acoustic Localization – Preliminary Results

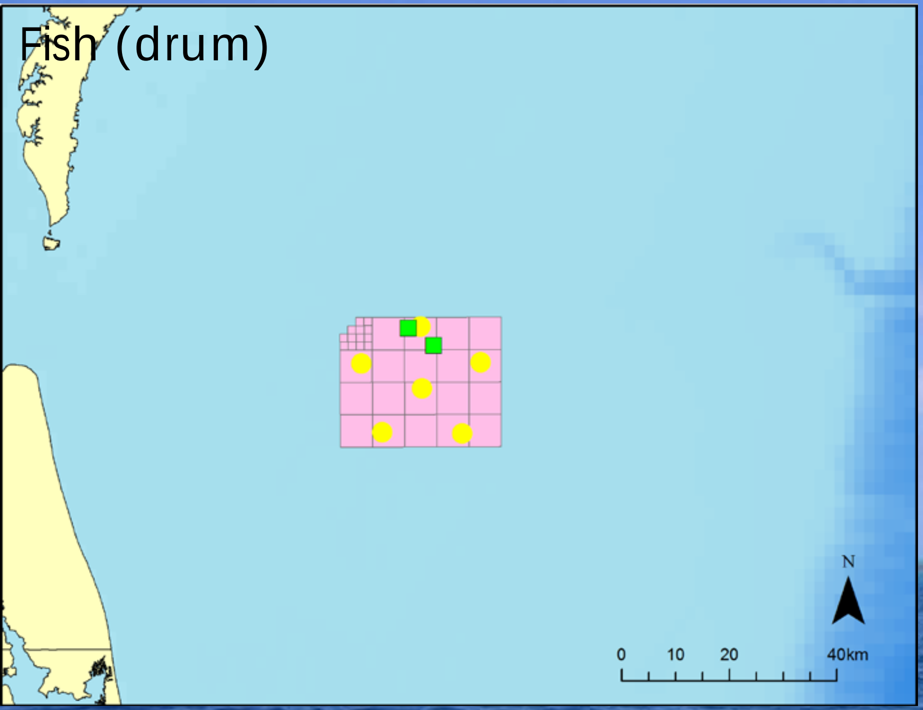


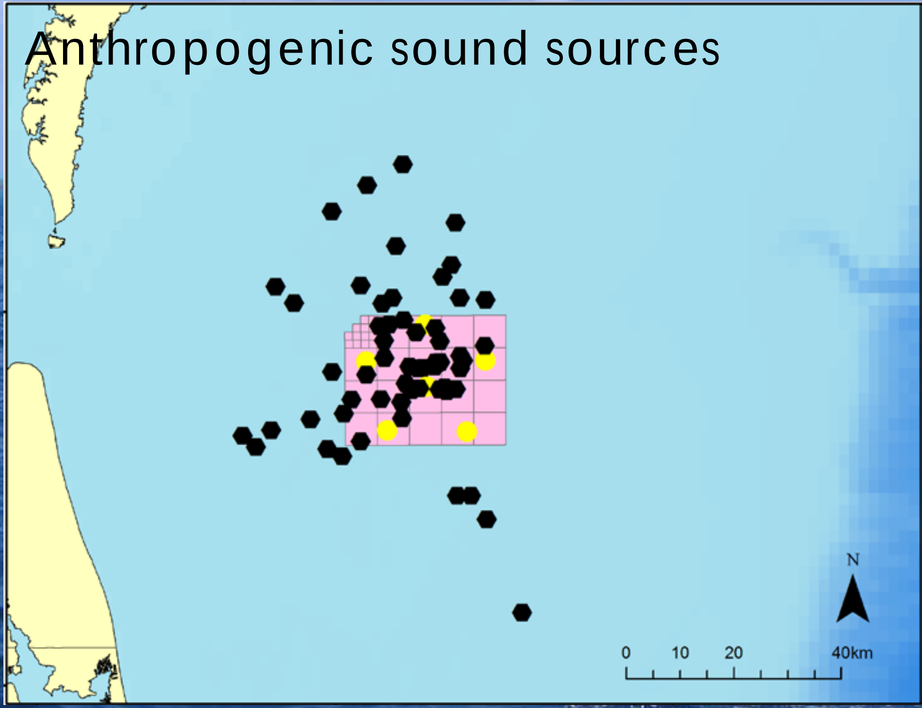






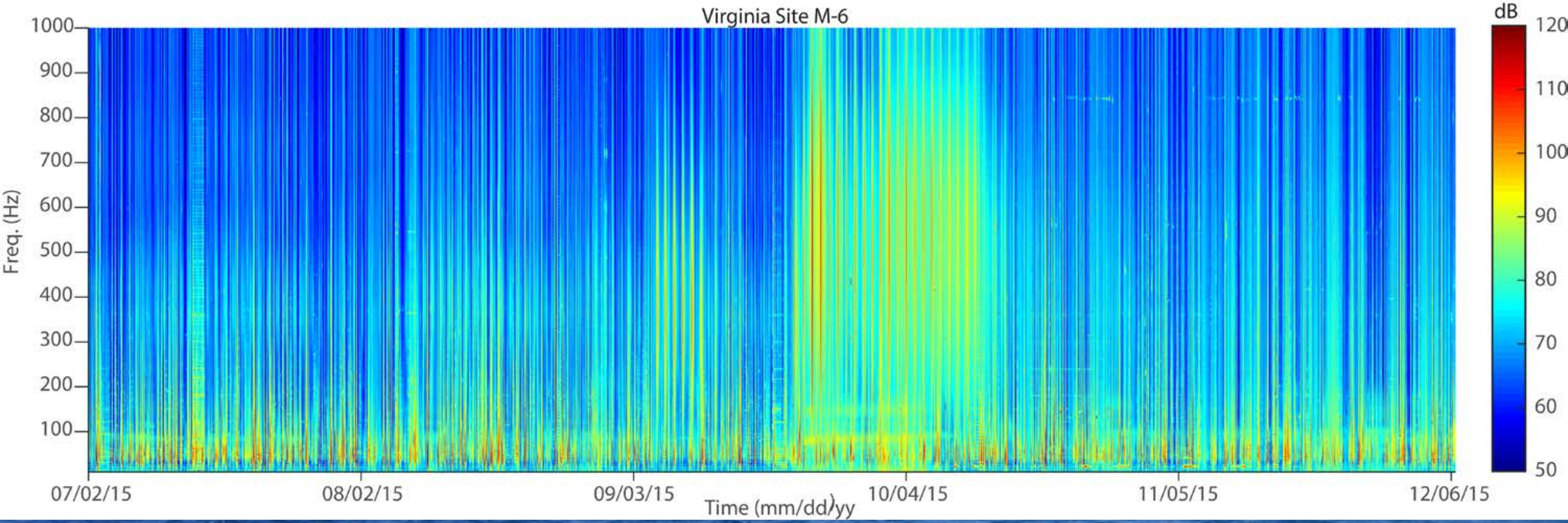
Acoustic Localization – Preliminary Results





Ambient Noise – Preliminary Results

~6 months of sound



Summary

- Fin whales present nearly year round
- Right and humpback whales present primarily Oct-Apr
  - different right whale pattern from 2012-2013 survey data
- Sparse minke presence from array
  - likely higher on outer AMAR unit
- Whales located across wind planning area

Next Steps

- Complete analysis of sensor data for all species for years 1 & 2
- Quantify algorithm detector performance
- Examine seasonal variability in ambient and anthropogenic noise
- Identify spatial trends in distribution
  - Evaluate possible habitat associations
- Evaluate environmental drivers associated with whale occurrence
- Compare trends in Virginia to other mid-Atlantic locations

Acknowledgments

Bioacoustics Research Program Staff

Christopher Clark, Ph.D.
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Peter Wrege, Ph.D.

Collaborators

Virginia Aquarium

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Bureau of Ocean Energy Management

Virginia Department of Mines, Minerals and Energy

Oceana

Questions?
Email:
dps44@co

Large scale monitoring of acoustic soundscapes and species distribution patterns across the western Atlantic ocean.

Sofie Van Parijs[1], Mark Baumgartner[2], Danielle Cholewiak[1], Genevieve Davis[1] and more..

[1] Northeast Fisheries Science Center

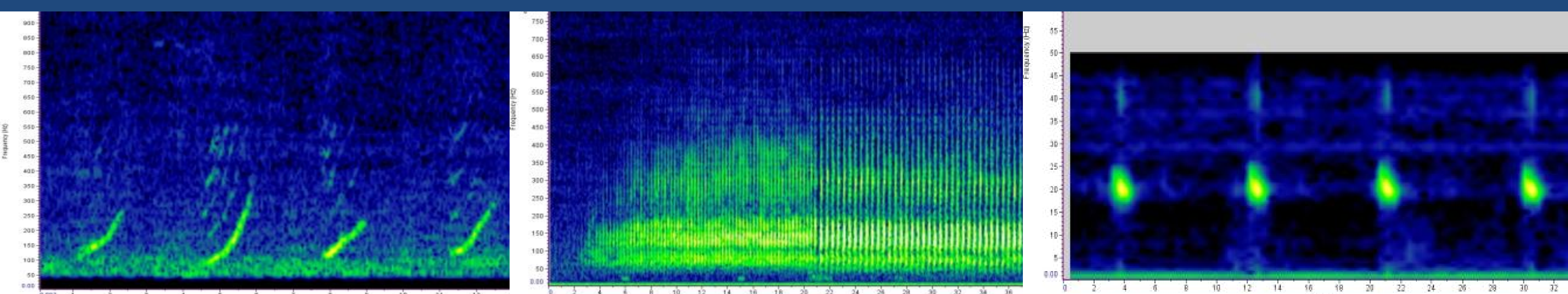
[2] Woods Hole Oceanographic Institution

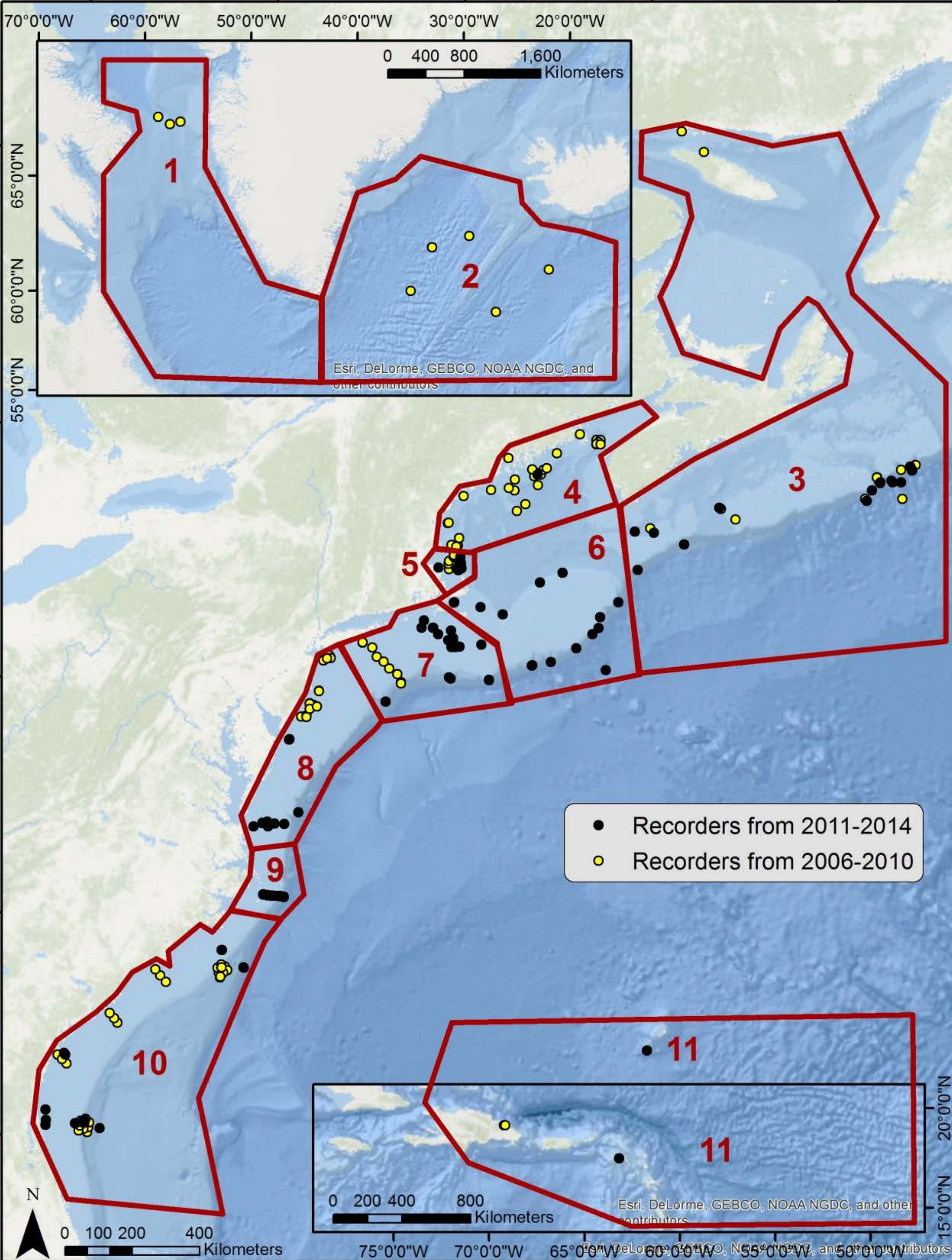
The power of passive acoustics

Long term trends in:

- All acoustically active species
- Movement Patterns
- Timing
- Distance from shore
- Soundscape & ambient noise

Low Frequency Species





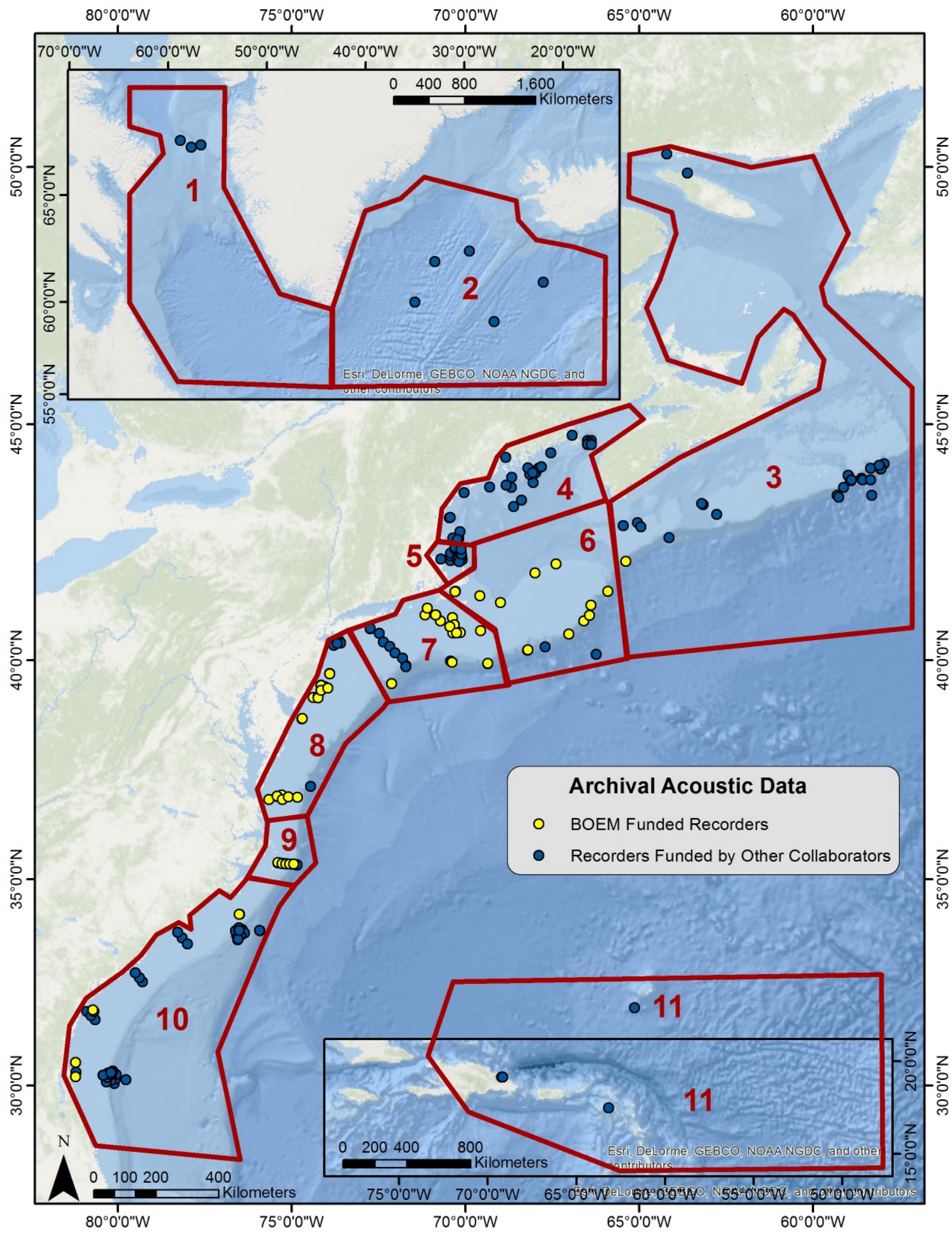
Long Term Changes

Available Recorders: 2006 – 2014

Data Contributors

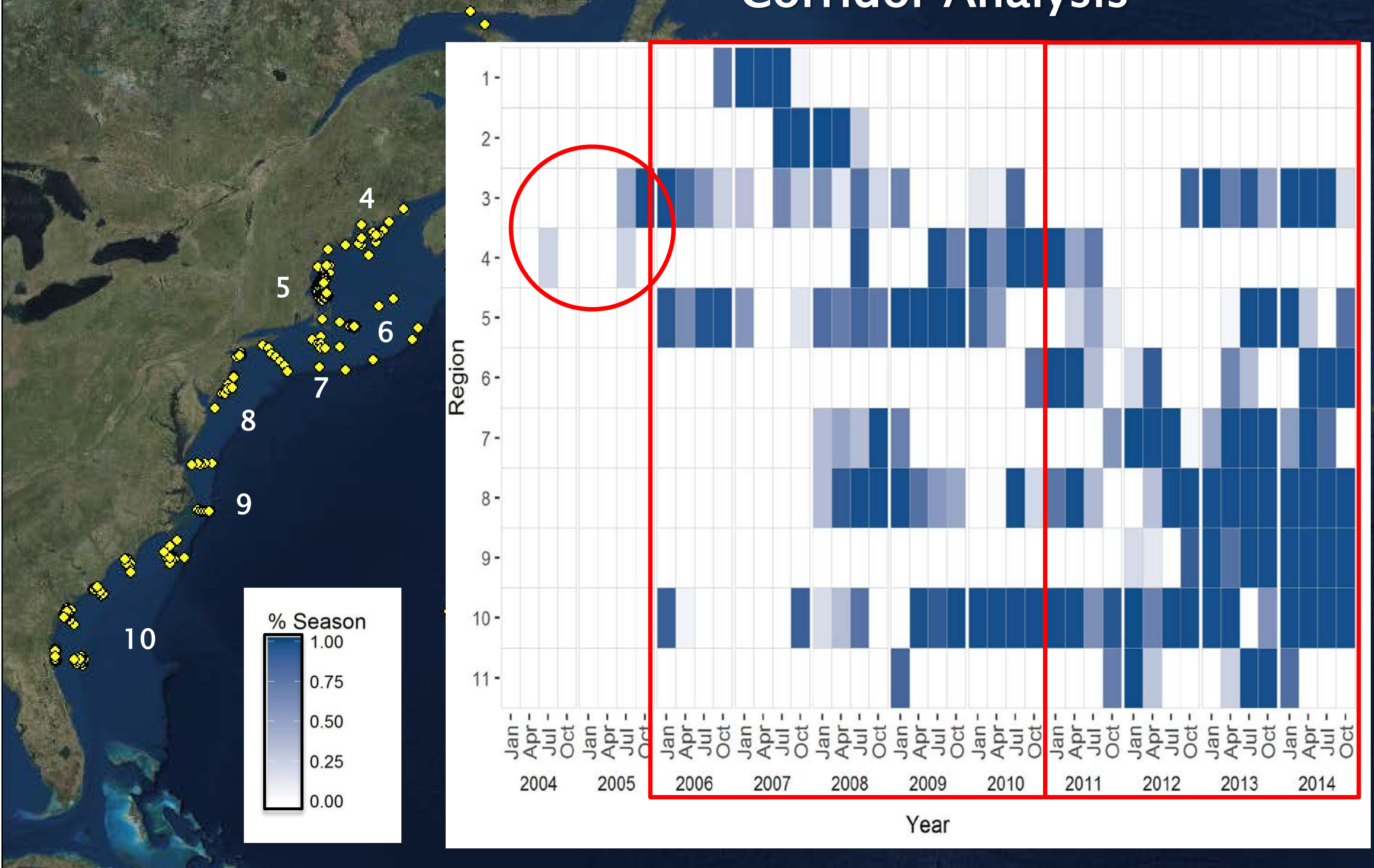
- Sean Todd; College of the Atlantic
- Chris Clark, Russ Charif, Holger Klinck, Aaron Rice; Cornell University
- Hilary Moors-Murphy; Department of Fisheries and Oceans Canada
- Andy Read, Joy Stanistreet, Lynne Hodge; Duke University
- Kathleen Dudzinski; Dolphin Communication Project
- Julien Delarue, Bruce Martin; JASCO Applied Sciences
- Erin Summers; Maine Department of Marine Resources
- Joel Bell, Jaqueline Bort, Anu Kumar; NAVFAC Naval Facilities Engineering Command
- Scott Kraus; New England Aquarium
- Gary Buchanan; New Jersey Department of Environmental Protection
- Catherine Berchok; NOAA National Marine Mammal Laboratory
- Lance Garrison, Melissa Soldevilla; NOAA Southeast Fisheries Science Center
- Mike Thompson, David Wiley, Leila Hatch; NOS Stellwagen Bank National Marine Sanctuary
- Dave Mellinger, Sharon Nieukirk; Oregon State University
- Helen Bailey; University of Maryland
- Kate Stafford; University of Washington
- Denise Risch, Scottish Association for Marine Science
- Ana Sirovic, John Hildebrand; Scripps Institution of Oceanography
- Susan Parks; Syracuse University

Thank You!

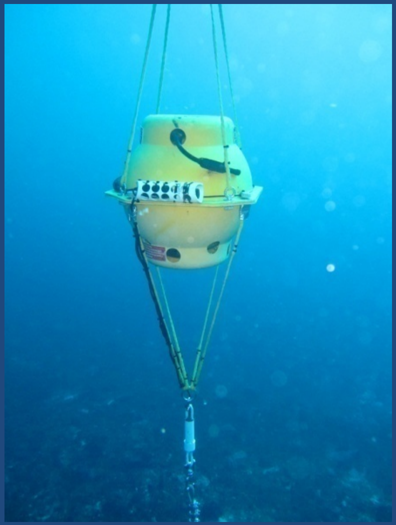


BOEM contribution

Combined Available Data for Migratory Corridor Analysis



Recorder Types



MARU
(Marine Autonomous Recording Unit)
Cornell University

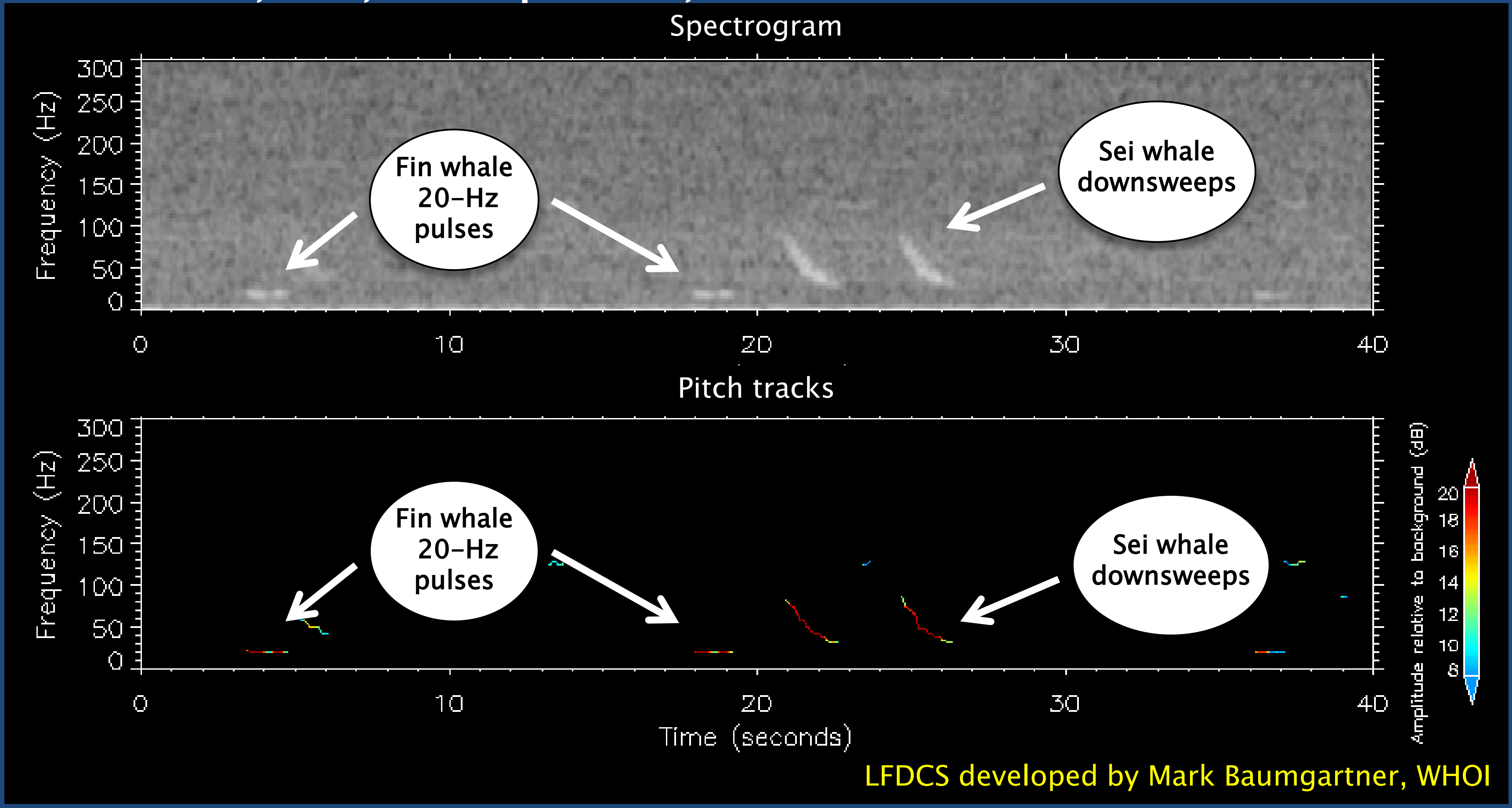
HARP
(High-frequency Acoustic Recording Package)
Scripps Institution of Oceanography

AMAR
(Autonomous Multichannel Acoustic Recorder)
Jasco Applied Sciences

HARU
(Haruphone)
NOAA PMEL &
Oregon State University

LFDCS: Low-frequency detection and classification system

- Creates a spectrogram
- Detects sounds and pitch tracks
- Classifies pitch tracks based on call library
- NARW, fin, humpback, sei and blue

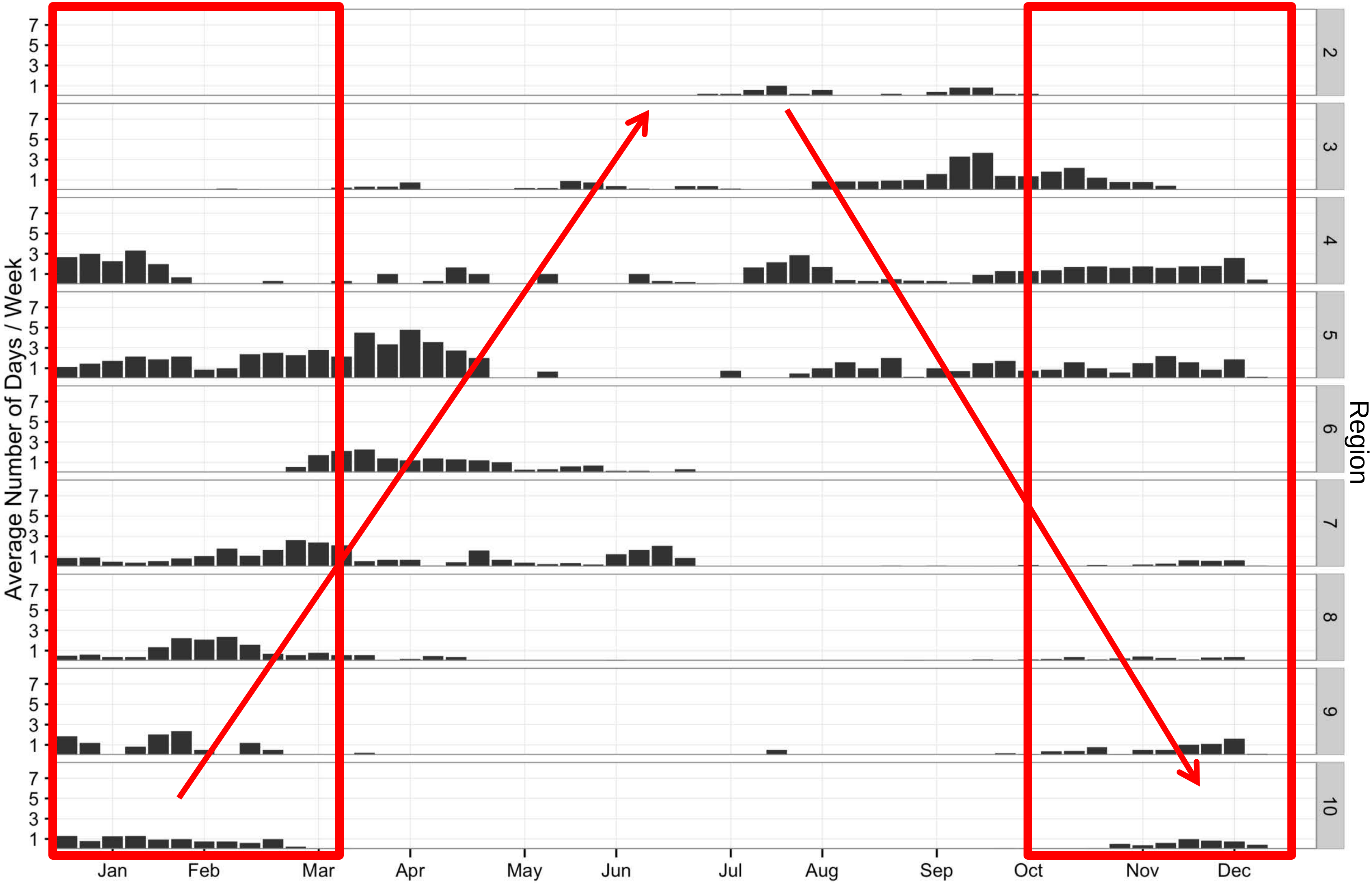


NARW results

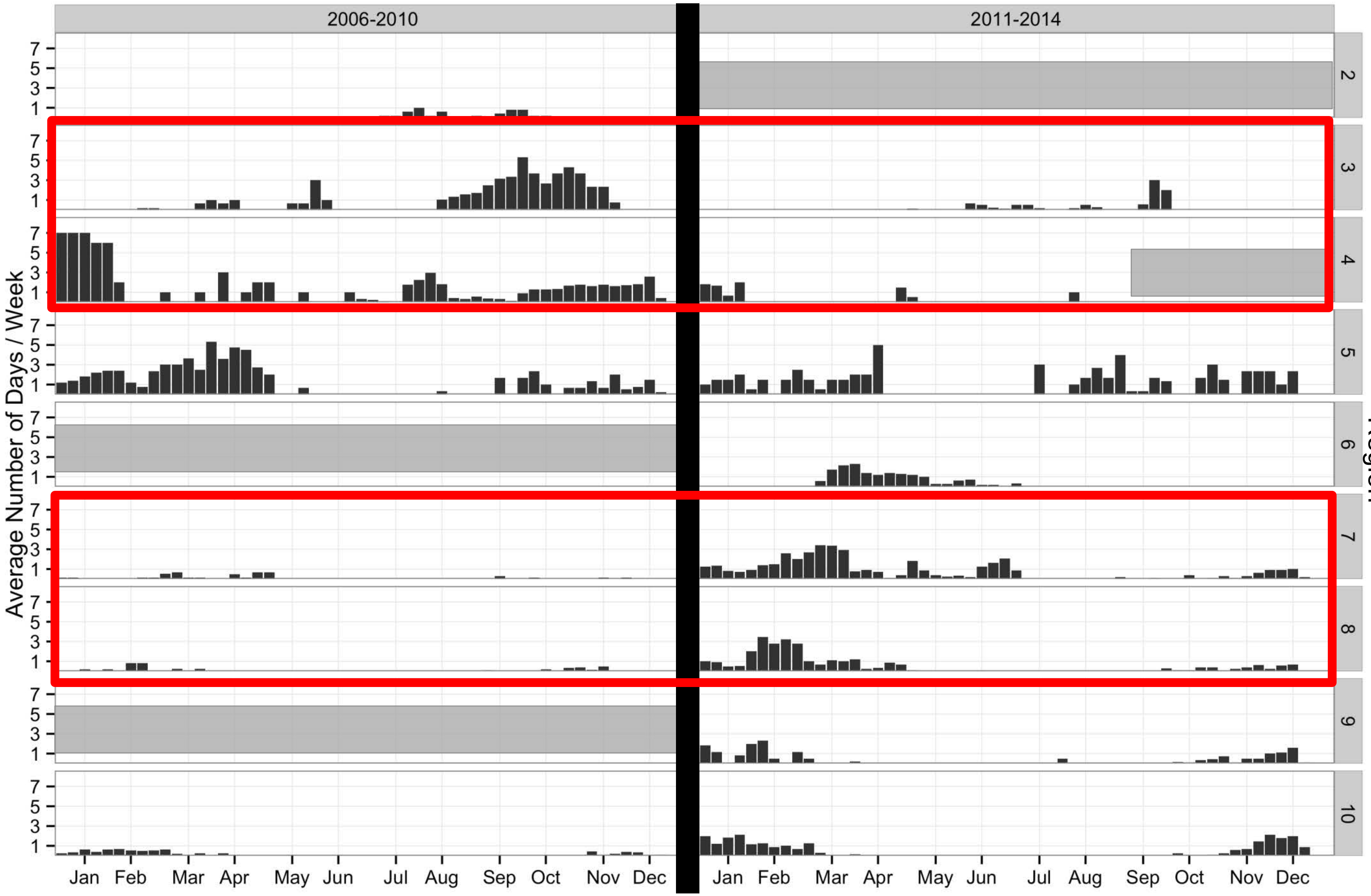
- 324 recorders manually reviewed
- 40,000 days analyzed:
  - Of these, 2,495 days have right whale presence

Photo: NOAA/NMFS/Genevieve Davis
Taken under MMPA permit #17355

Daily Presence Results: 2006–2014



Daily Presence: comparison over time



FISHERIES SERVICE
Northeast Fisheries Science Center
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Right Whale Monthly Presence

2006 – 2014

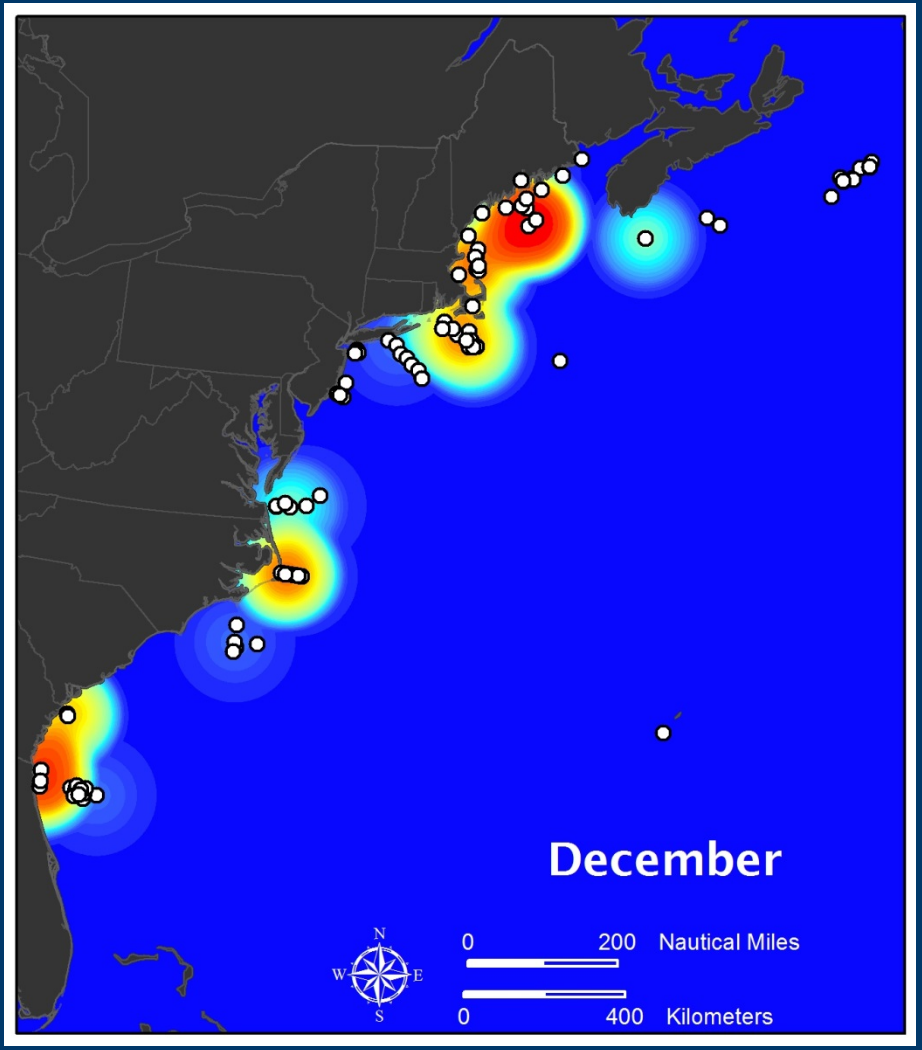
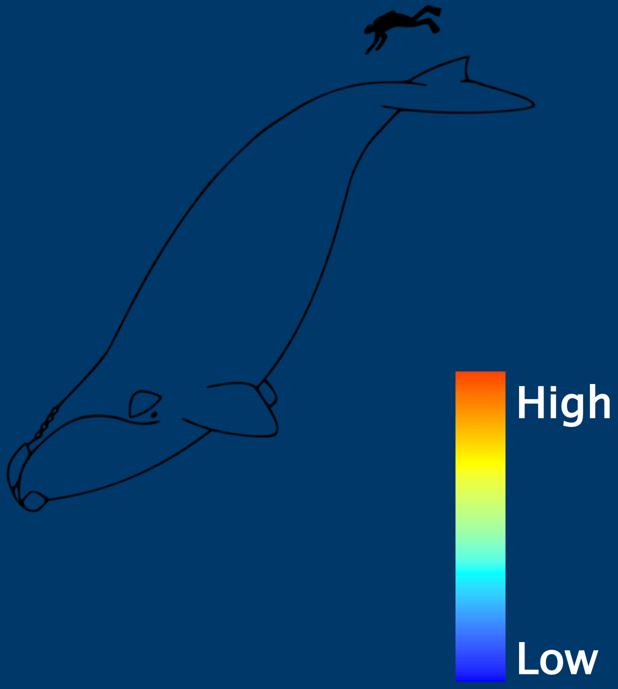
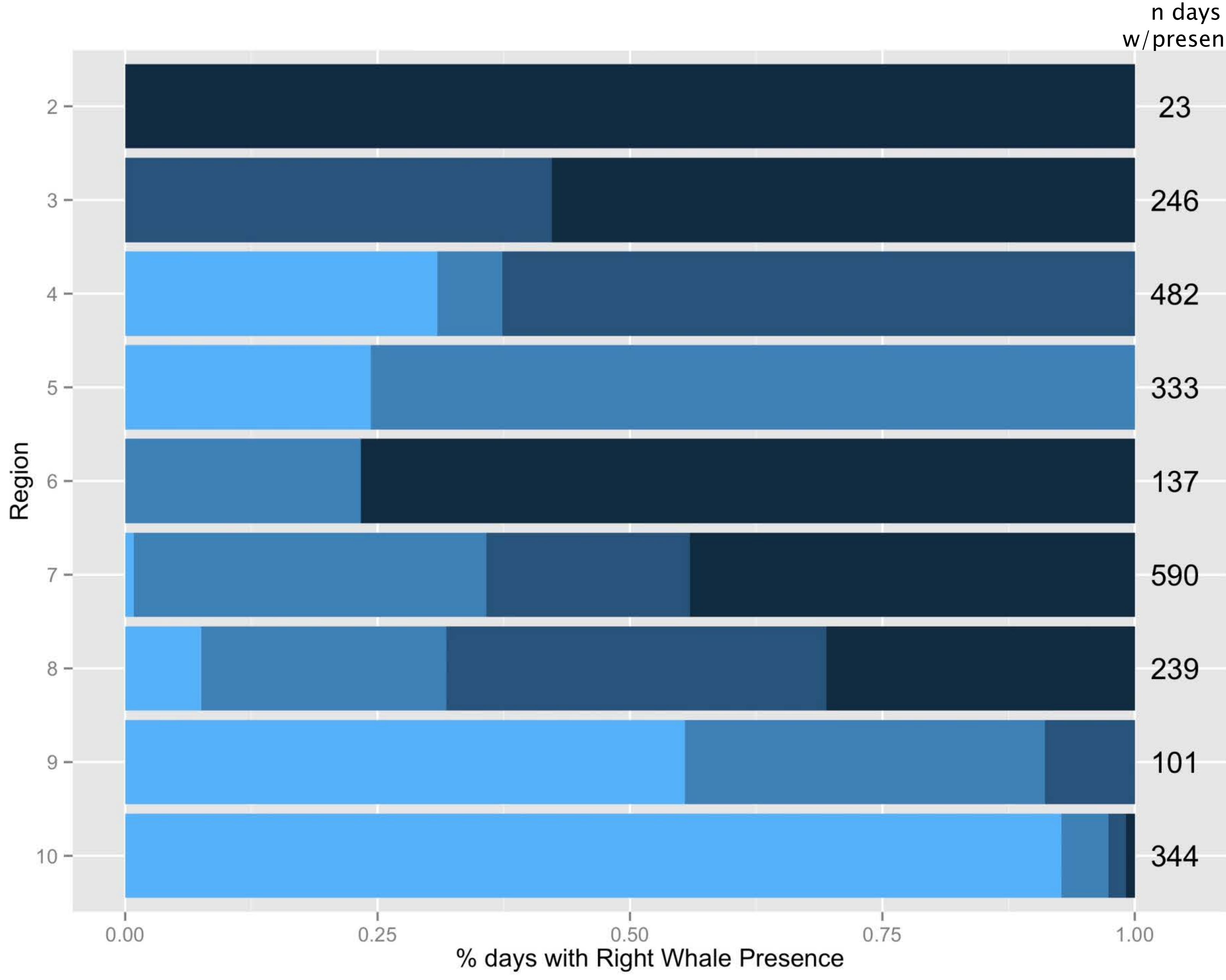


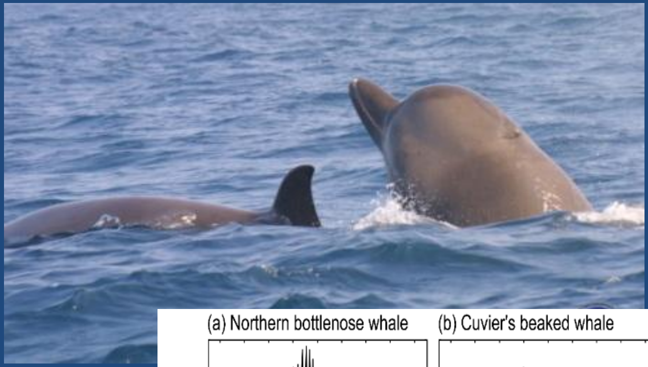
Figure adapted from Mike Thompson, NOAA/SBNMS

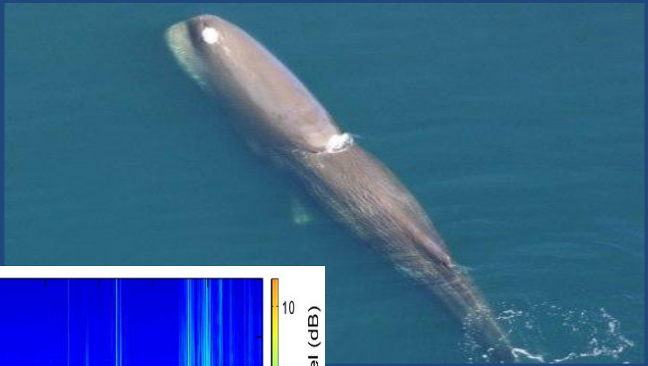


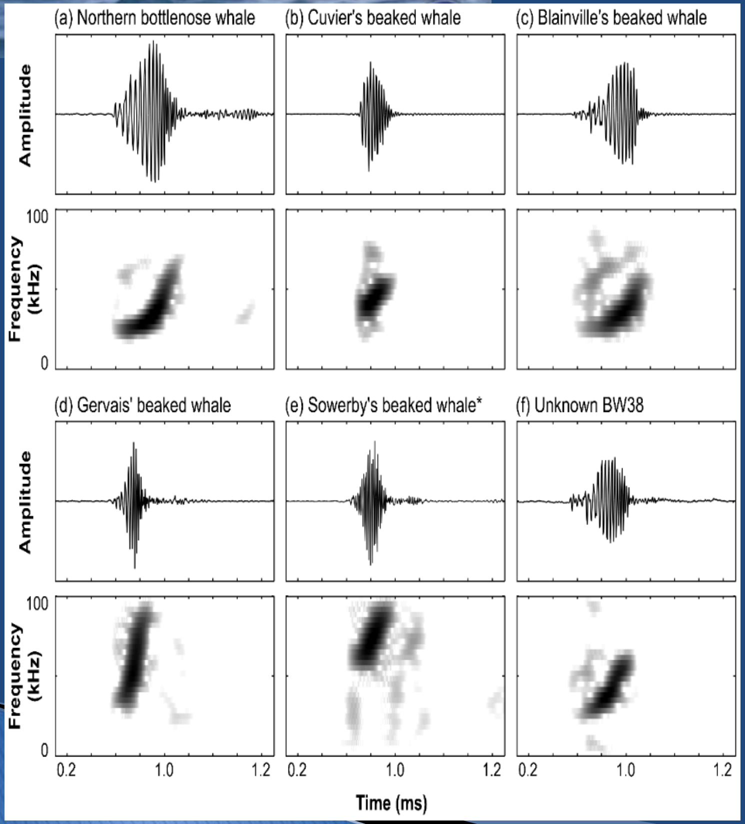
Distance to Shore Breakdown

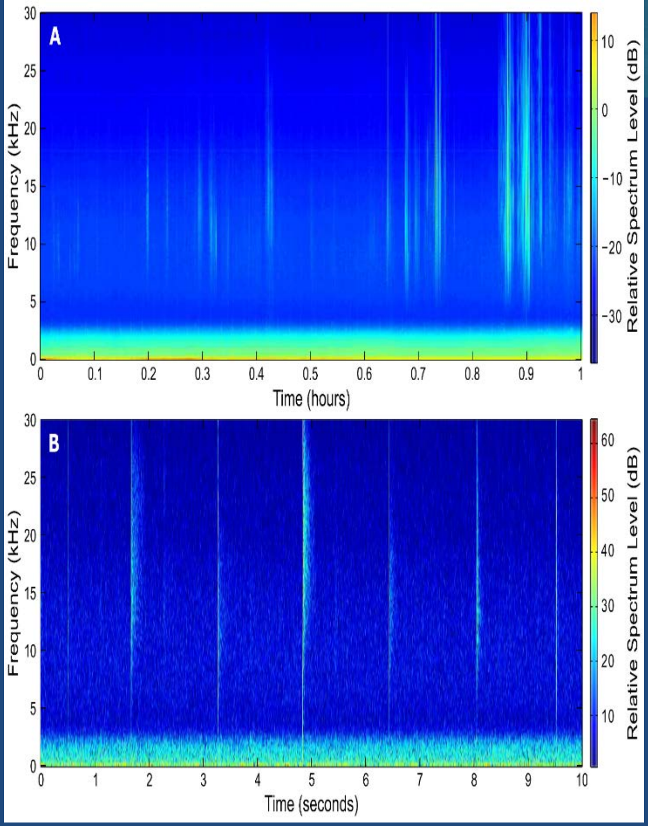


High Frequency species

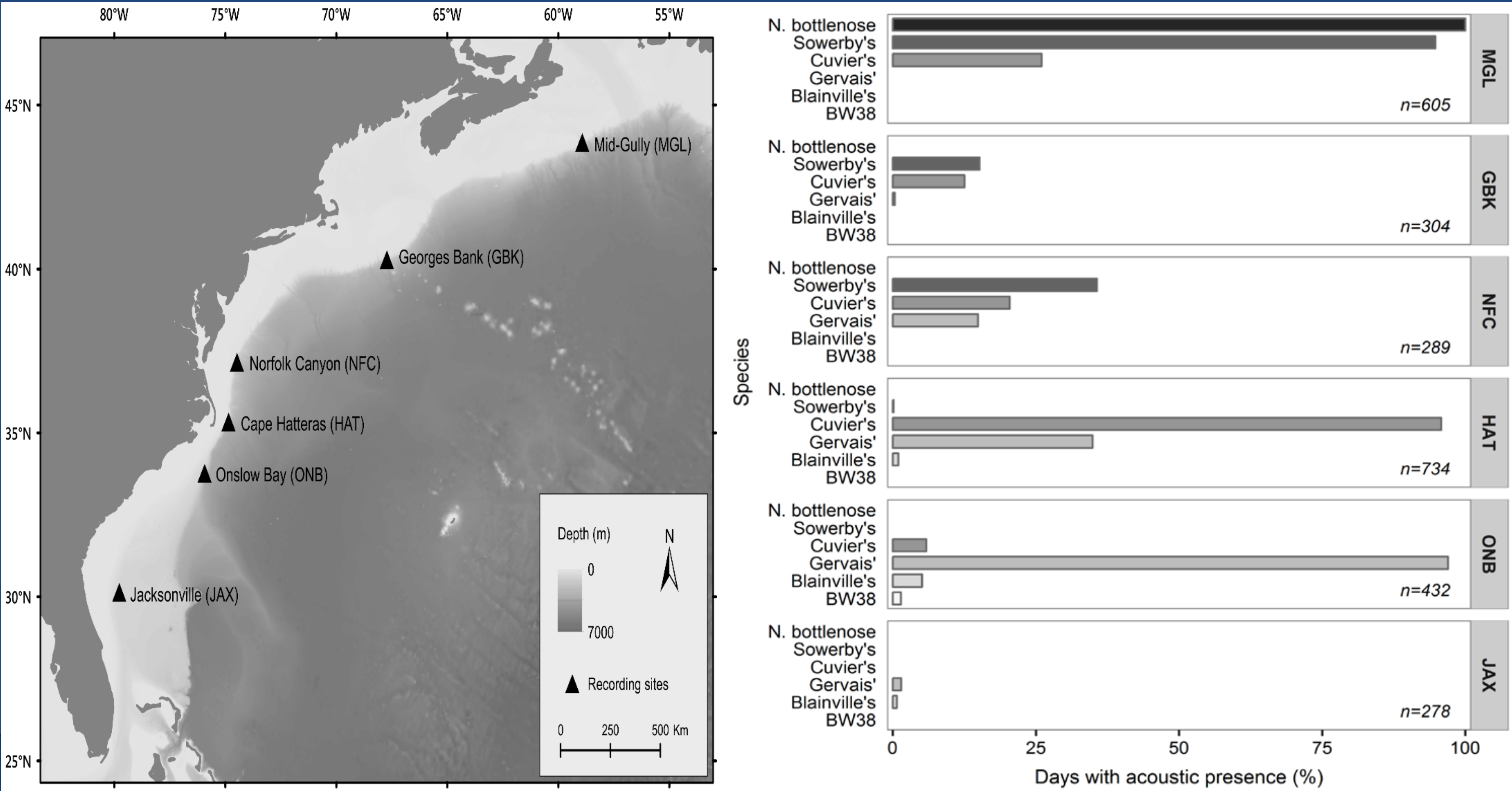






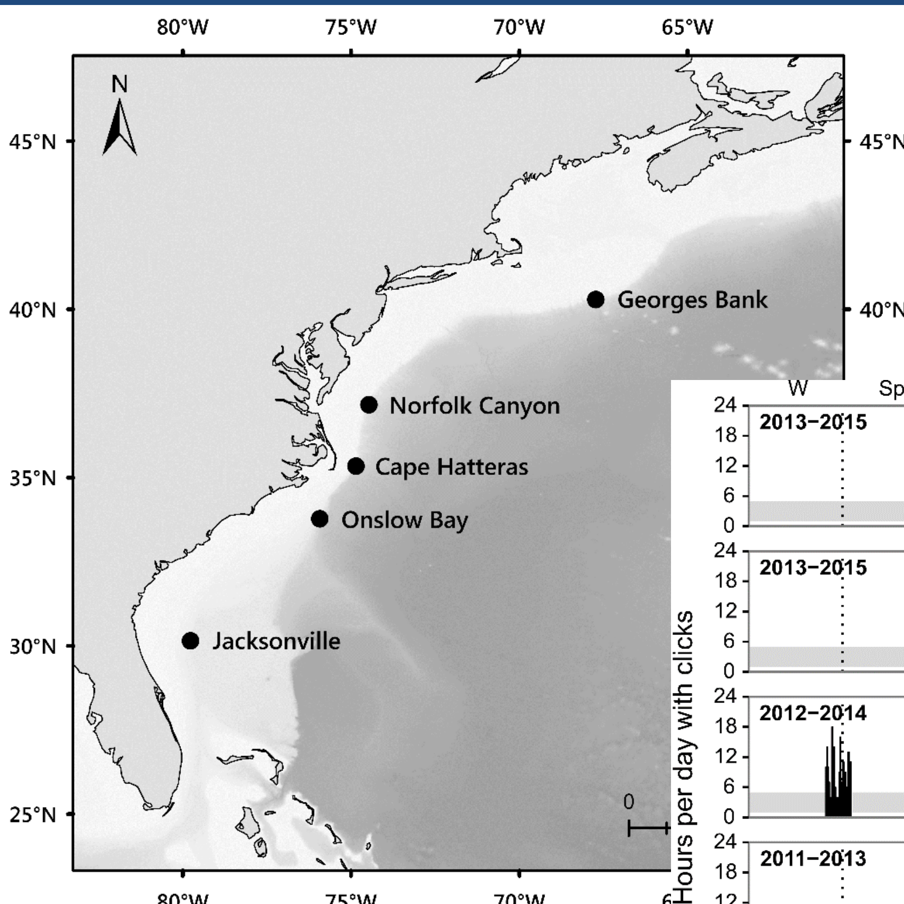


Beaked whales: 2011 – 2015

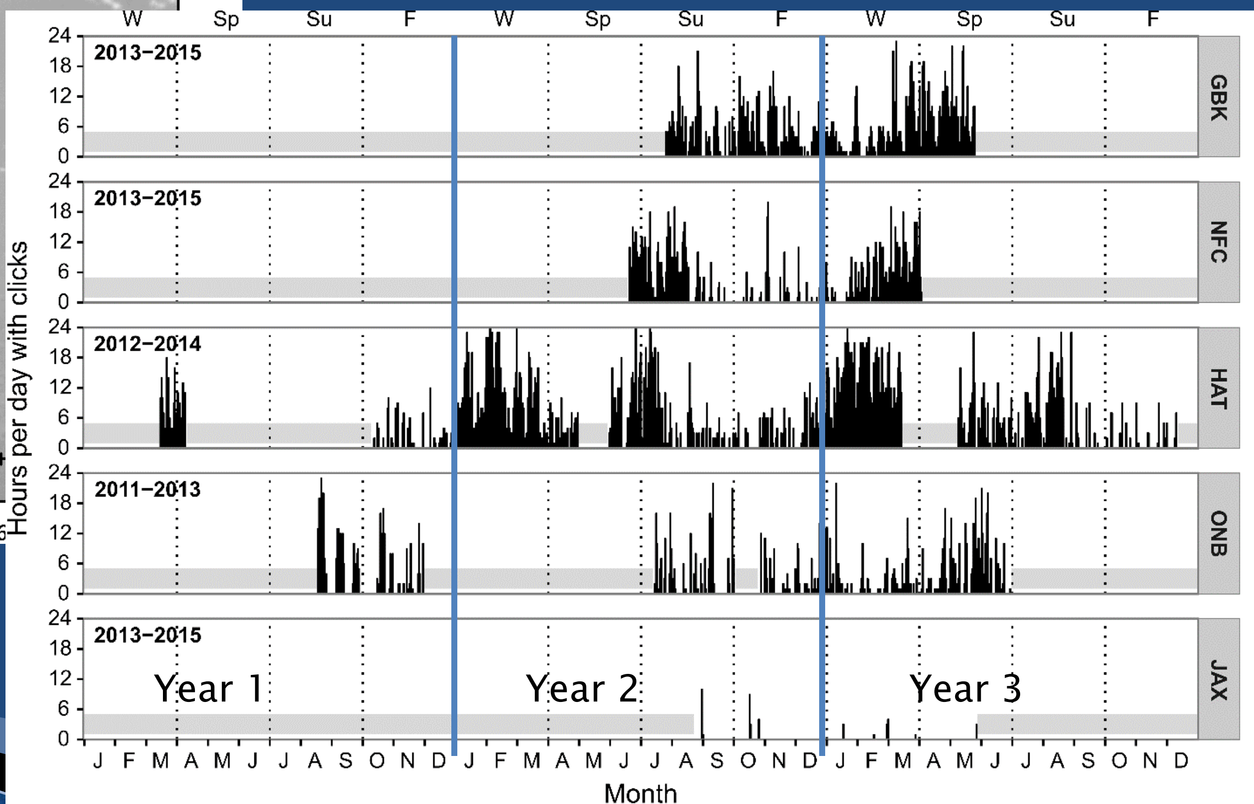


Joy E. Stanistreet[a], Douglas P. Nowacek[a], Simone Baumann-Pickering[b], Joel T. Bell[c], Danielle M. Cholewiak[d], John A. Hildebrand[b], Lynne E. W. Hodge[a], Hilary B. Moors-Murphy[e], Sofie M. Van Parijs[d], Andrew J. Read[a]

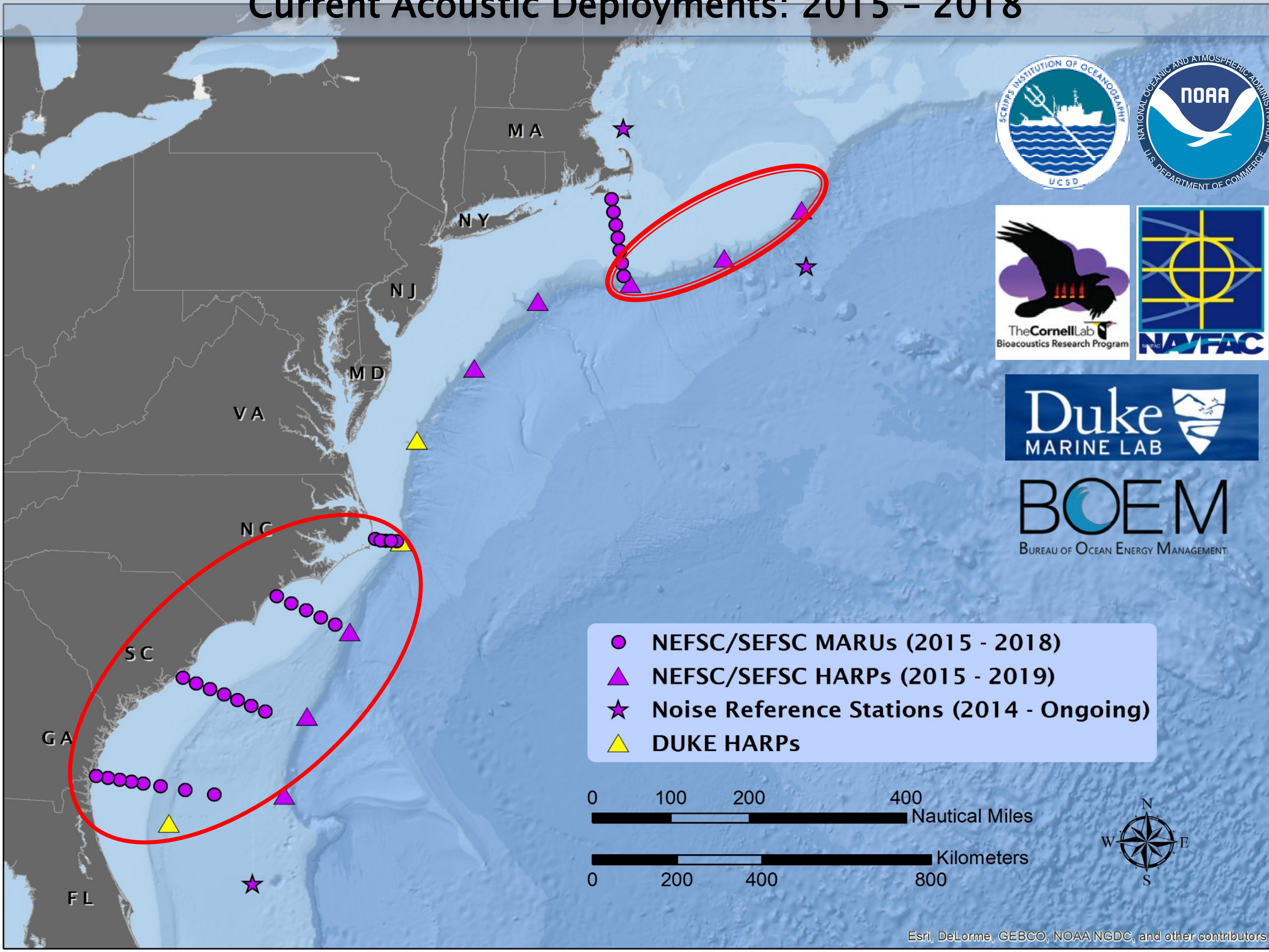
Sperm whales:2011 – 2015



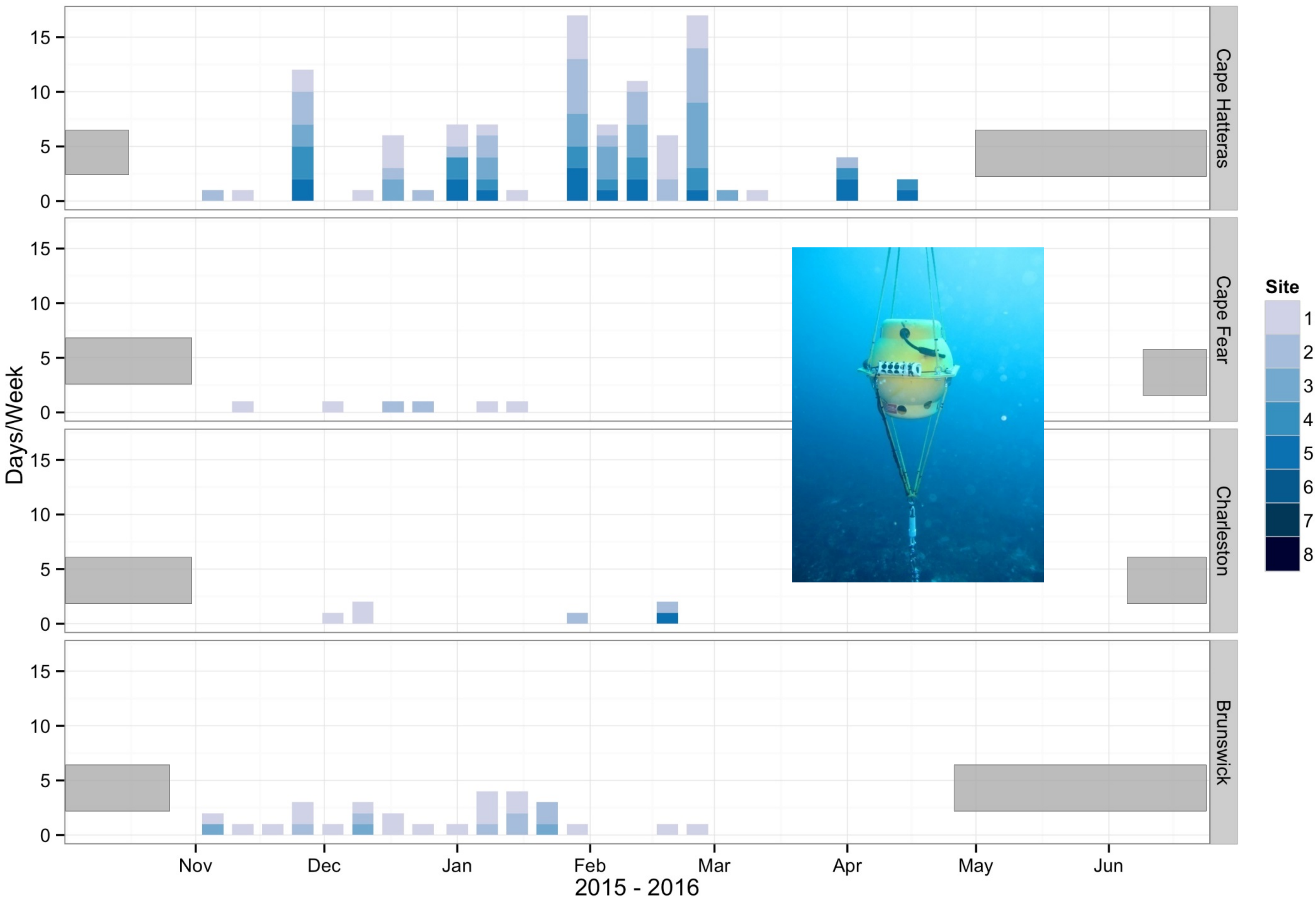
Joy E. Stanistreet[1], Douglas P. Nowacek[1], Joel T. Bell[2], Danielle M. Cholewiak[3], John A. Hildebrand[4], Lynne E. W. Hodge[1], Sofie M. Van Parijs[3], Andrew J. Read[1]



Current Acoustic Deployments: 2015 – 2018



MARU lines with NARW by Deployment & Site



2015 – 2016

Cumulative duration of all BW acoustic encounters:

Heezen Canyon (HC)

~132 hours

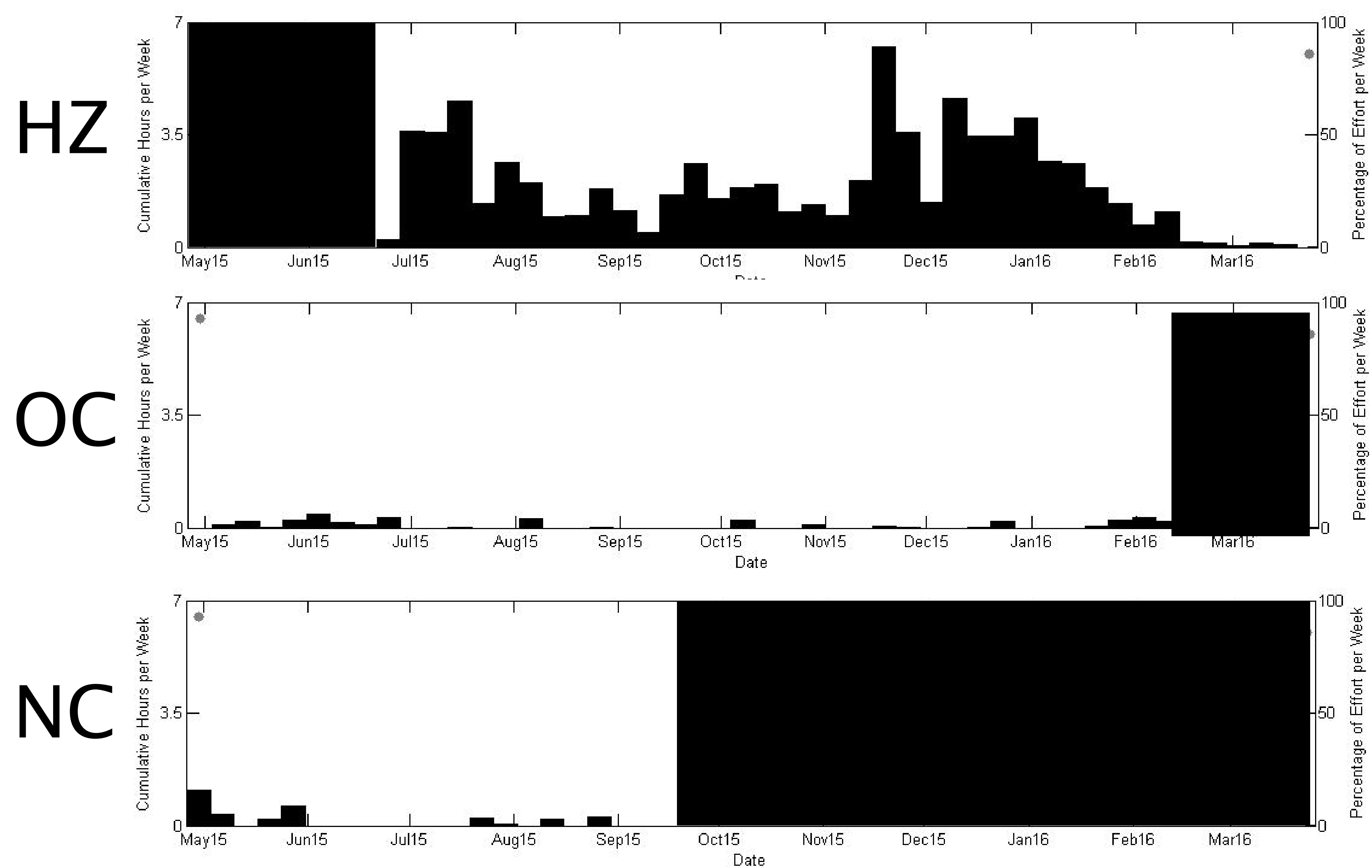
Oceanographer Canyon (OC)

~4 hours

Nantucket Canyon (NC)

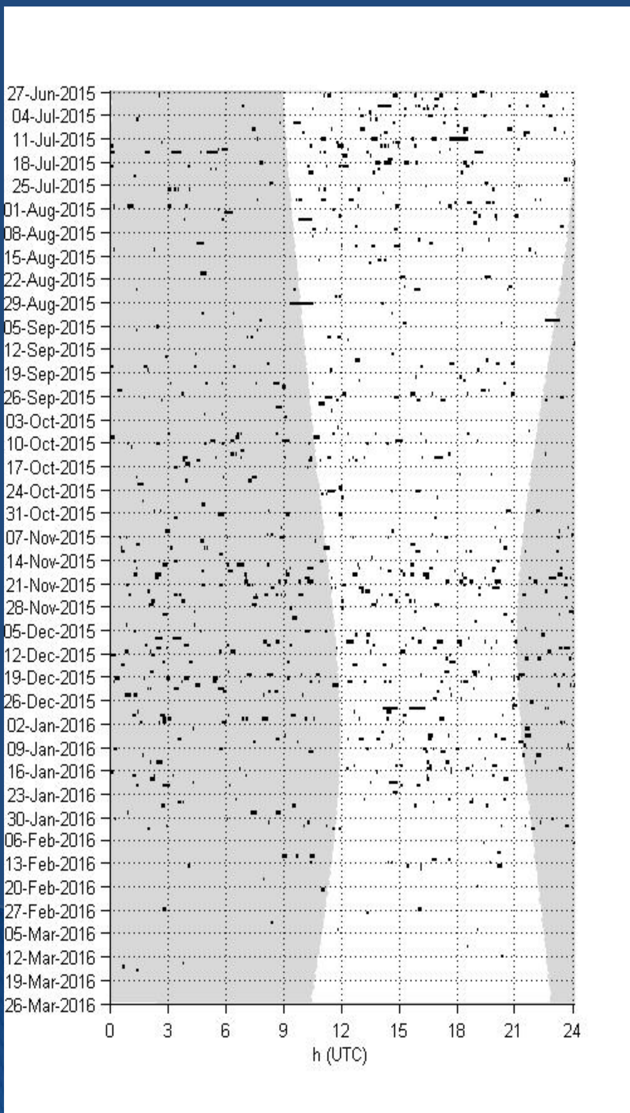
~14 hours

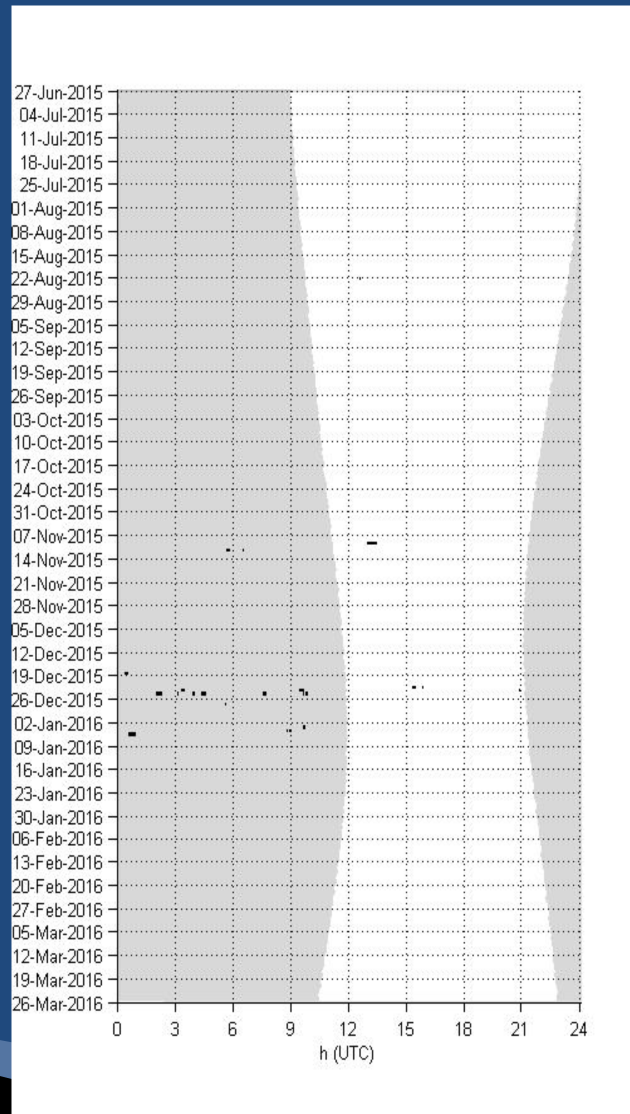
Sowerby's BW: Time series

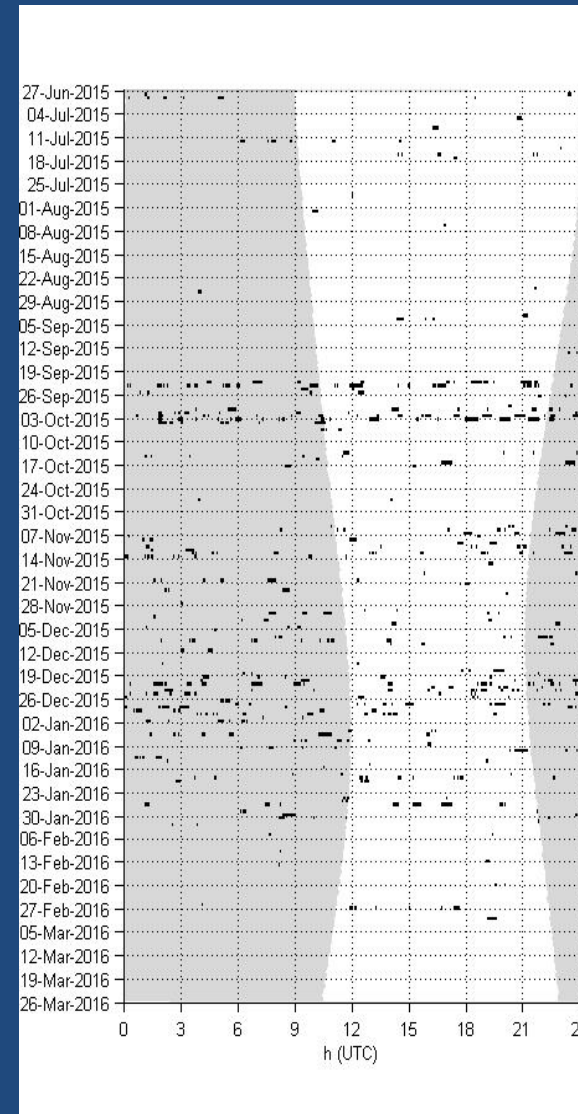


Heezen Canyon: Diel pattern

Sowerby' Gervais' Cuvier's

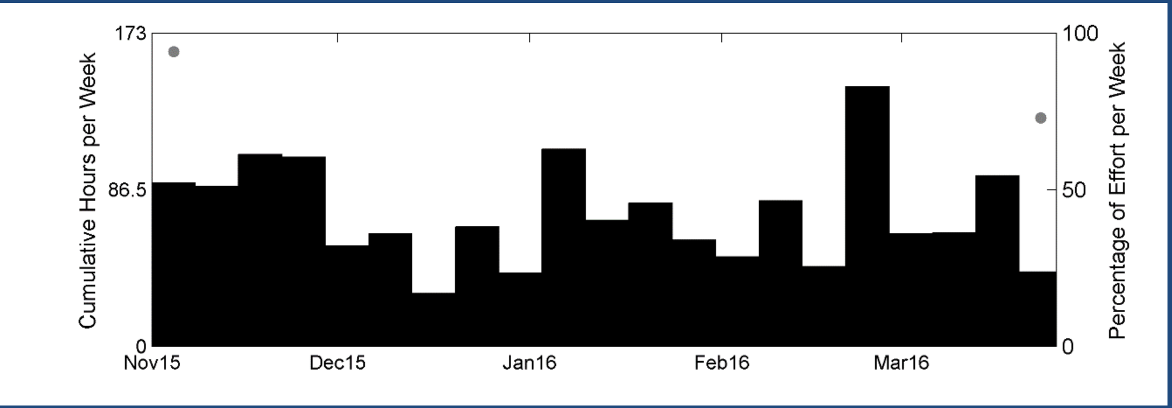


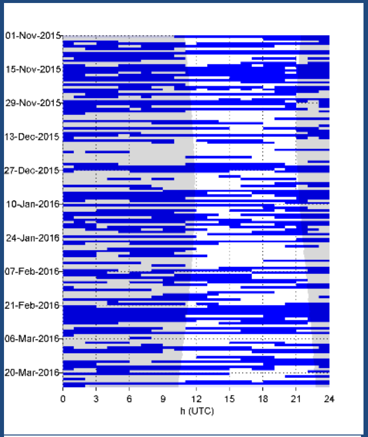




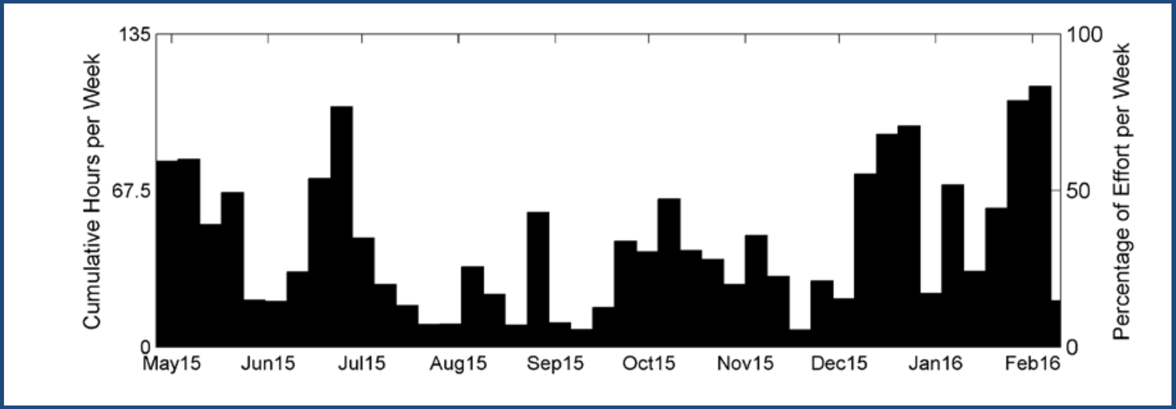
Sperm whale encounters

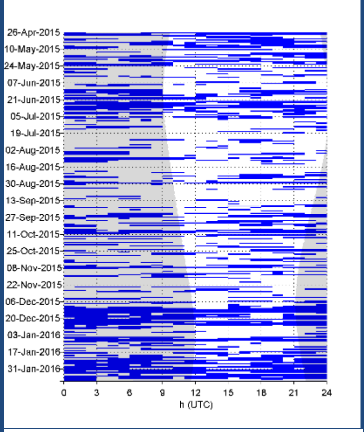
HZ



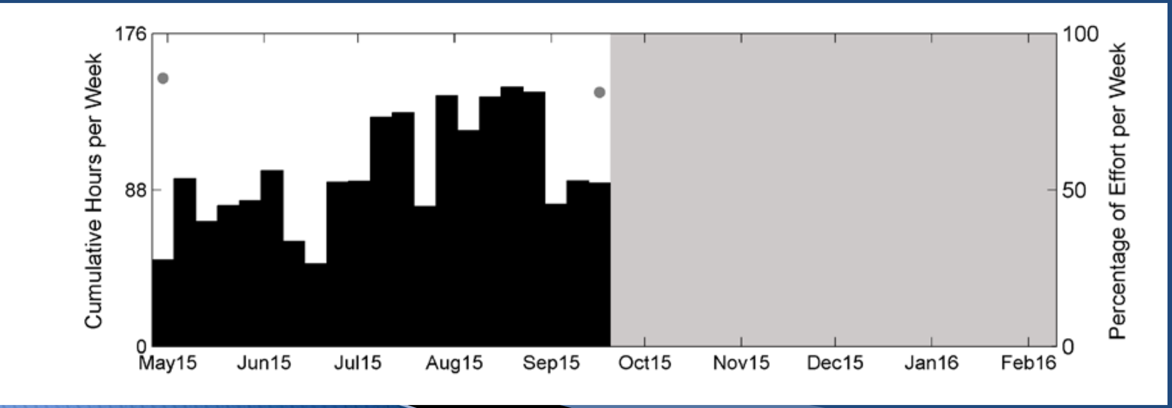


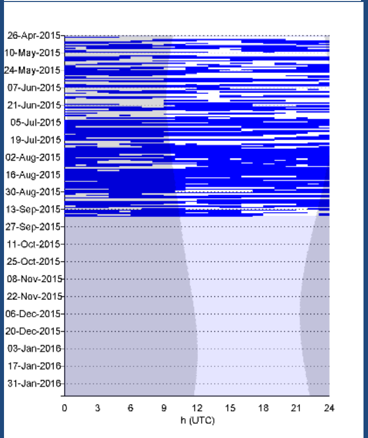
OC





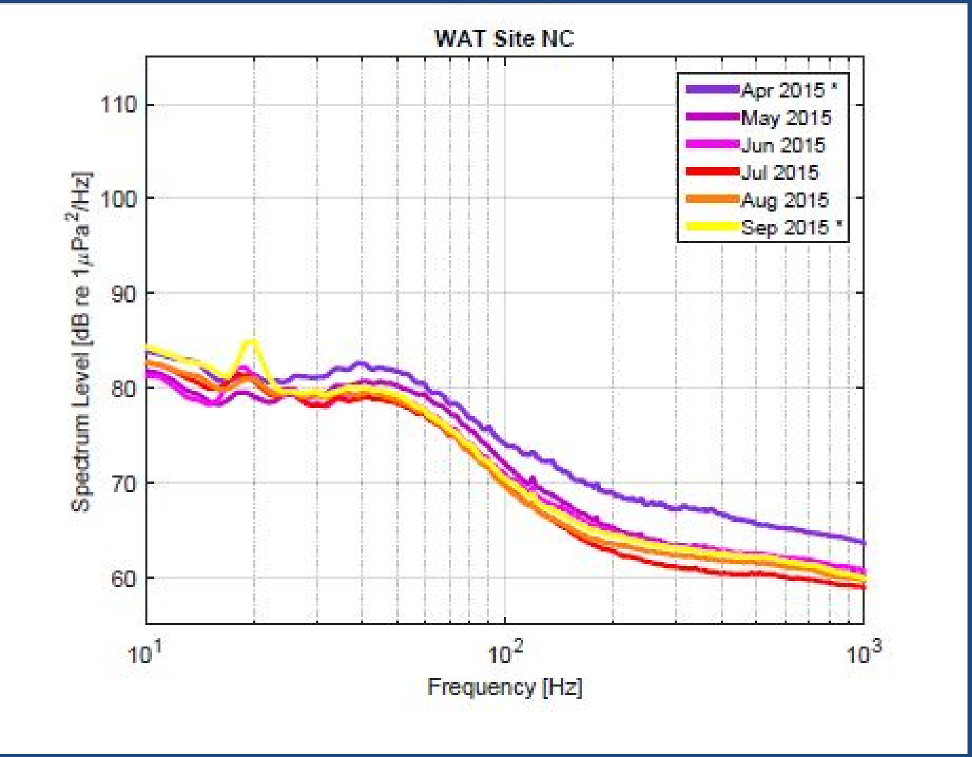
NC

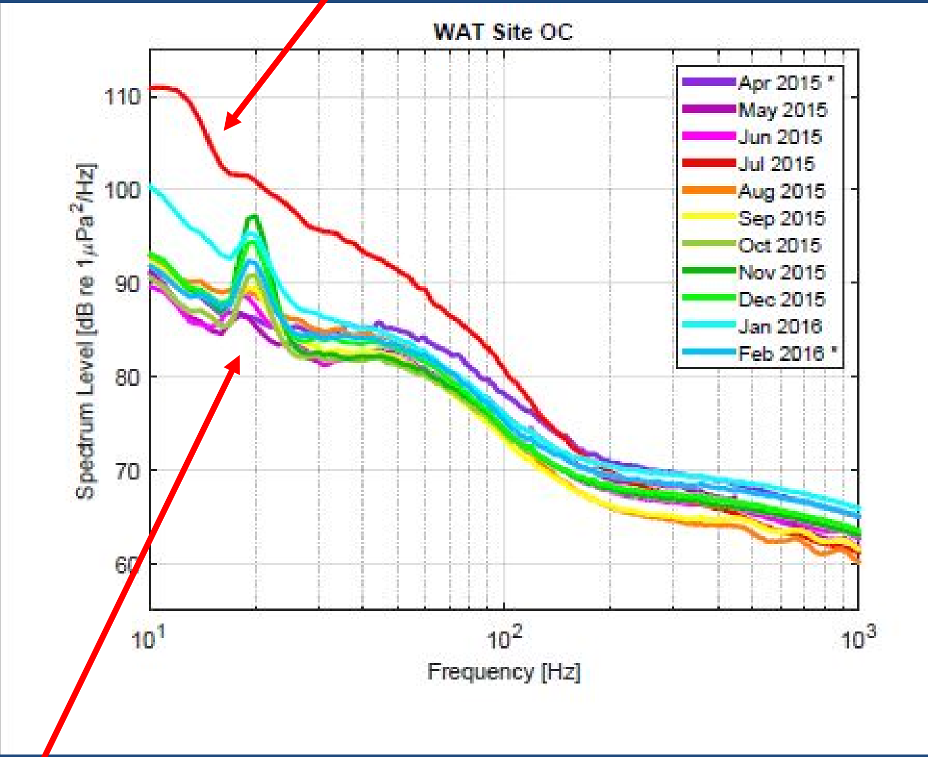




Soundscapes

High currents





NC

OC

Fin whales

What is next?

Field Work

- MARU lines will be turned around in Spring 2017
- Retrieve HARPs in June 2017 and put out new round of 8 HARPs
- Continue to deploy acoustic telemetry

Data Analysis

- Baleen whales
- Beaked whales
- Sperm whales
- Kogia, Dolphins
- Fish and Invertebrates
- Telemetry detections of tagged fish/sharks
- Ambient noise curves

Aims

- Continue to build baseline data on habitat usage
- Detect long term changes is movements/distribution
- Comparisons to environmental parameters
- Before/During /After major anthropogenic activities

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- D. Cholewiak, P. Corkeron, D. Gerlach, J. Gurnee, H. Heenehan, A. Izzi, E. Matzen, J. Stanley, C. Tremblay–NOAA/NEFSC
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- Daniel Woodrich – NOAA/AFSC
- Alyssa Scott – University of Washington
- Joy Stanistreet – Duke University
- Chris Pelkie, Chris Tessaglia-Hymes, Margaret Daly – Bioacoustics Research Program, Cornell University
- Mike Thompson – NOAA/SBNMS
- R/V Auk and crew

Funded by:

- NOAA NMFS OPR

Thank you!

Atlantic Ocean Energy and Mineral Science Forum

BOEM’s RODEO Program

November 16, 2016

THE UNIVERSITY OF RHODE ISLAND

FUGRO

BOEM
Bureau of Ocean Energy Management

Contents

Part 1

- **RODEO Overview – Anwar Khan, HDR**
- Part 2 – Visual Monitoring
- Part 3 – Underwater Acoustic Monitoring
- Part 4 – Sediment Disturbance and Seafloor Recovery Monitoring

The RODEO Program

- Real-time Opportunity for Development of Environmental Observations.
- Direct, real-time measurements of the nature, intensity, duration of potential stressors during the construction and initial operations of proposed offshore wind facilities.
- Includes recording of direct observations during testing of monitoring equipment that may be used during future offshore development to measure or monitor activities and their impact producing factors.

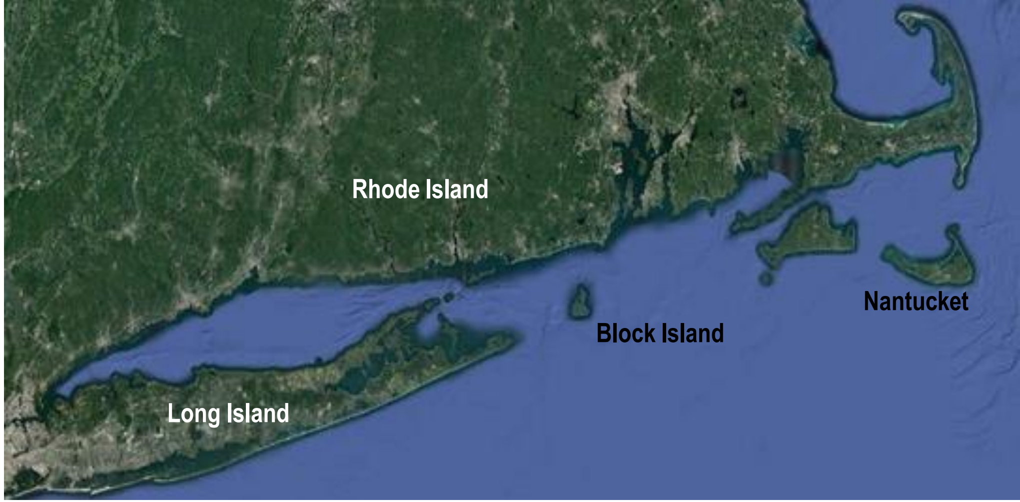
FDR THE UNIVERSITY OF RHODE ISLAND FUGRO BOEM

The RODEO Program …

- Data will support analysis and modeling to evaluate effects or impacts from future offshore activities.
- Program *not* intended to duplicate or substitute for any monitoring required to be conducted by project proponents.
- Monitoring conducted in coordination with industry
  - all efforts are made to ensure that the monitoring does not interfere with or result in delay of industry-sponsored activities.

Block Island Wind Farm

- 30-megawatt facility
- Located approximately 3 miles southeast of Block Island, Rhode Island.
- Five, 6-MW Alstom Haliade 150 wind turbine generators, a submarine cable interconnecting the turbines, and a submarine transmission system (34.5-kilovolt [kV] alternating current bi-directional cable).
- Facility will deliver power to primarily to Block Island and also to the mainland.



BIWF Construction Monitoring

- 3 separate phases
- Multiple rounds of environmental monitoring in and around the BIWF Project area were conducted during each phase.
  - Visual Monitoring
  - Turbine Foundation Scour Monitoring
  - Seafloor Disturbance and Recovery Monitoring
  - Airborne Noise Monitoring
  - Underwater Sound Monitoring
- Monitoring data will be used to support assessment of short-, mid-, and long-term environmental impacts.

BIWF Initial Operations Monitoring

- Visual monitoring
- Airborne noise monitoring
- Underwater sound monitoring
- Benthic monitoring
- Marine mammal monitoring
- Evaluation of acoustic data

Questions on Part 1?

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Part 2

- Part 1 – RODEO Overview
- **Visual Monitoring – James Elliot, HDR**
- Part 3 – Underwater Acoustic Monitoring
- Part 4 – Sediment Disturbance and Seafloor Recovery Monitoring

- Foundation Installation
- Cable Lay
- Wind Turbine Construction
- Initial Turbine Operations

Data Collection - Observations

iPad 6:27 PM 38%

BOEM_Michael_Database_19AUG2015_v6

Project: BOEM Pile Driving | Start Time: 8/24/2015 7:04:45 AM | Observer#1: Tyler Blanpied | Start New Survey

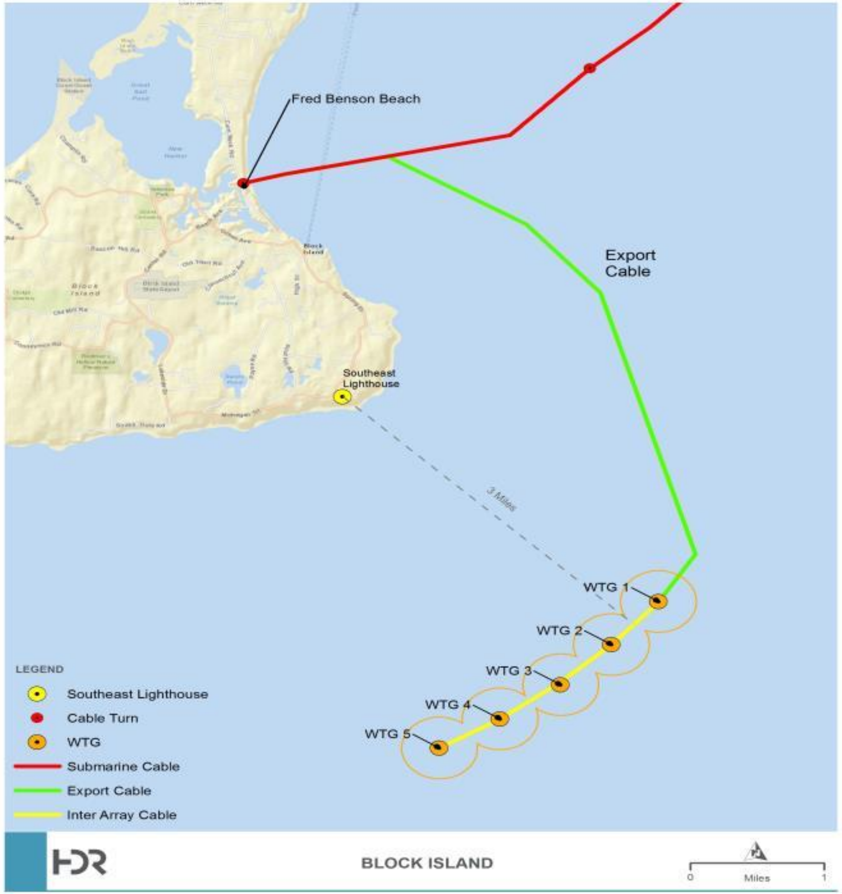
Additional Project Details | End: 8/24/2015 8:22 PM | Additional Observers

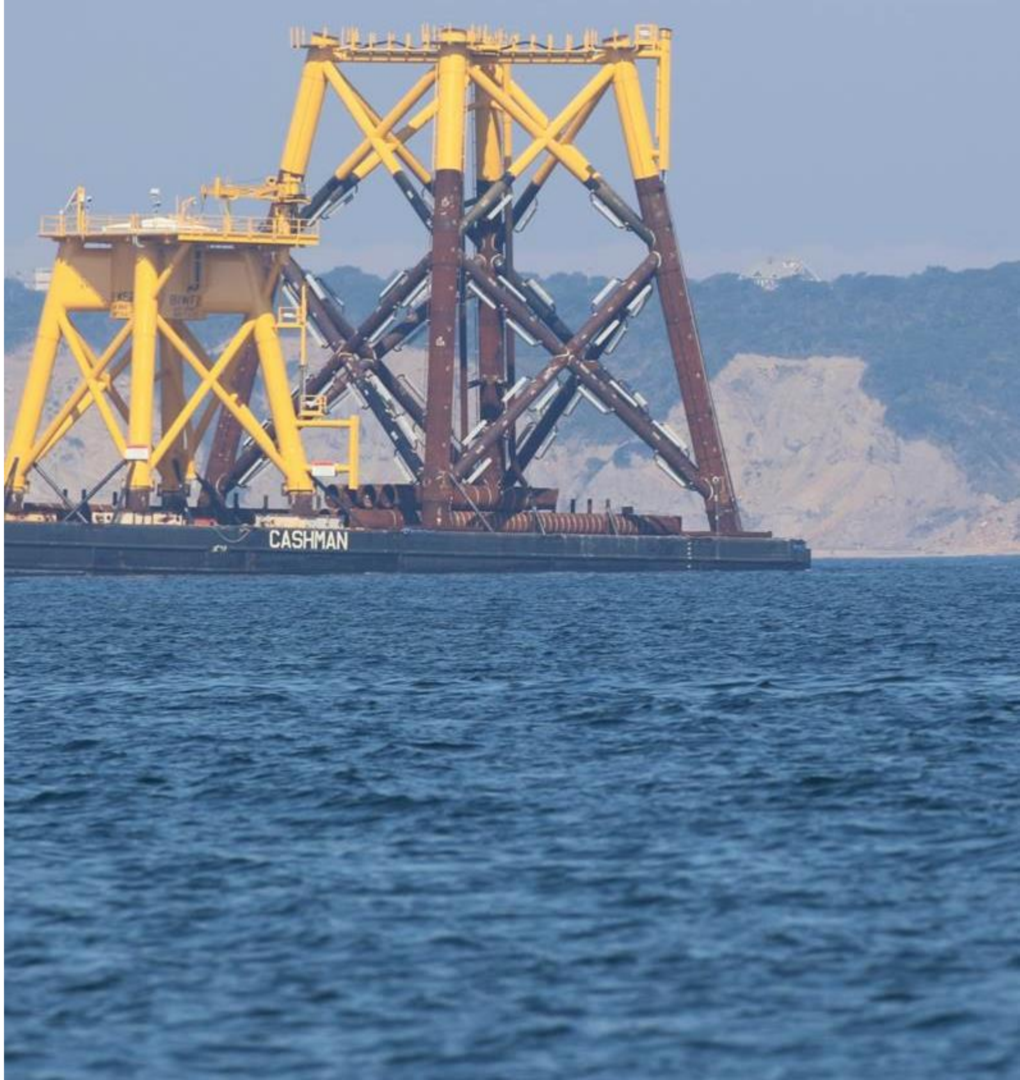
Observations | Environmentals

Time	GPS	Get GPS	Observation Type	Observation Status	Photo Frames	Notes
3:39:26 PM	+41.497514, -71.641928,			Event Stopping		hammer has been
3:00:10 PM	+41.490895, -71.649221,			Other	thru 303	Heather-Lynn
1:54:56 PM	+41.474470, -71.657505,			Other		the Francis fleet
1:44:53 PM	+41.429329, -71.667378,			Other	thru 100-289	putting the hammer
1:24:38 PM	+41.401118, -71.675128,			Event Starting	thru 100-282.	picking up the
12:21:55 PM	+41.412473, -71.675501,			Other		barge 526 moving
11:38:40 AM	+41.410529, -71.675774,			Other	100-253 thru	tender ship
11:27:12 AM	+41.406562, -71.676331,			Other	blanks100- 242	shots of the site.
9:12:31 AM	+41.404538, -71.676615,			Other	100-196thru	tug with equipment
8:09:20 AM	+41.360831, -71.686346,			Other		the white fishing
8:01:58 AM	+41.349319, -71.689301,			Other		second tender
7:51:40 AM	+41.349319, -71.689301,			Other		first tender leaving

Collect Survey Data | Record 4 of 19

Foundation Installation






0715 -SE Lighthouse. F8, 70mm, WTG2


0715 -SE Lighthouse. F8, 200mm, WTG2





Submarine Cable Installation

- **Submarine cable** (bidirectional, 34.5 kV transmission cable) from the mainland to Block Island.
- **Export Cable**: connects northernmost WTGs to Block Island.
- **Inter-array Cable**: connects the WTGs.
- Installation lasted 24 days in June 2016 and covered distance of approximately 20 miles.

Submarine Cable Visual Observations

- Monitored submarine cable laying from mainland to Block Island (20 miles).
- 1-8 June 2016 = cable mats
- 9 June 2016 = cable pull at Scarborough Beach
- 23 June 2016 = cable pulled ashore at Block Island

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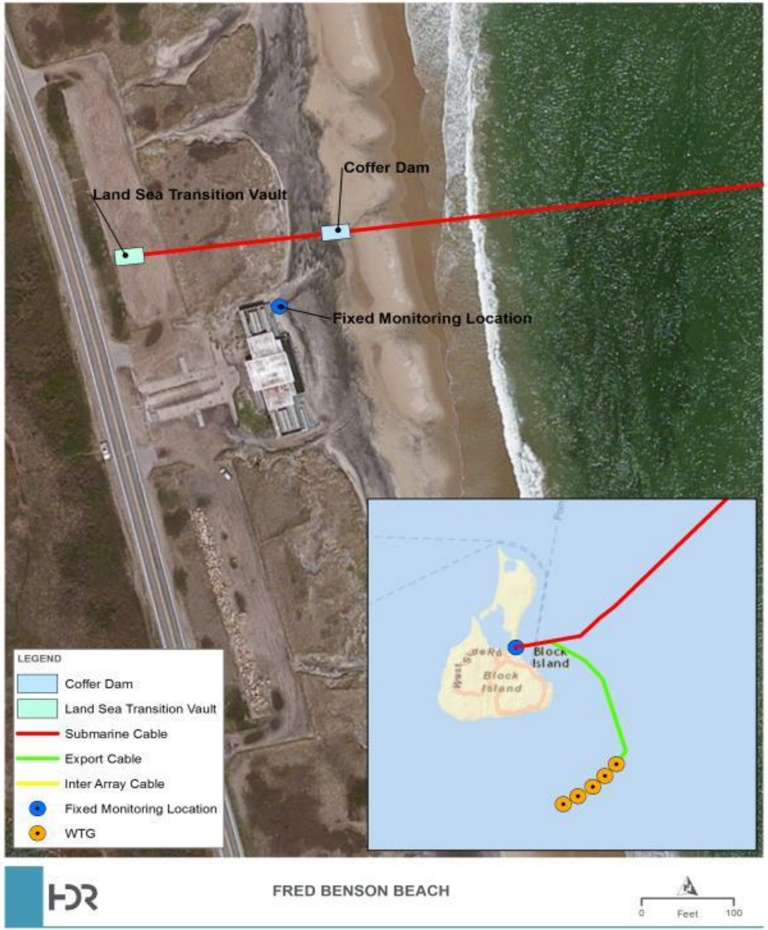

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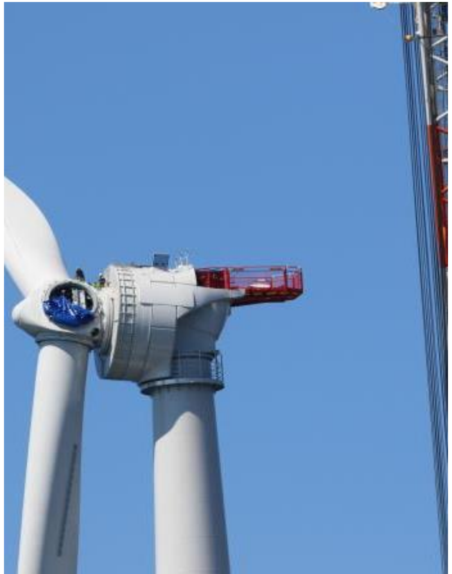
Wind Turbine Construction

- 2 August 2016 First tower installed on WTG1.
- 18 August 2016 Final wind turbine assembly completed.
- HDR monitored construction WTG 2 through completion of WTG 4.


Fred.Olsen Windcarrier

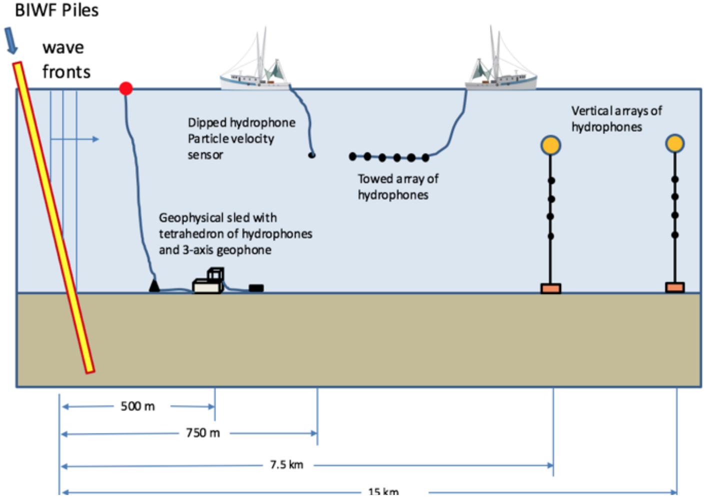
Questions on Part 2?

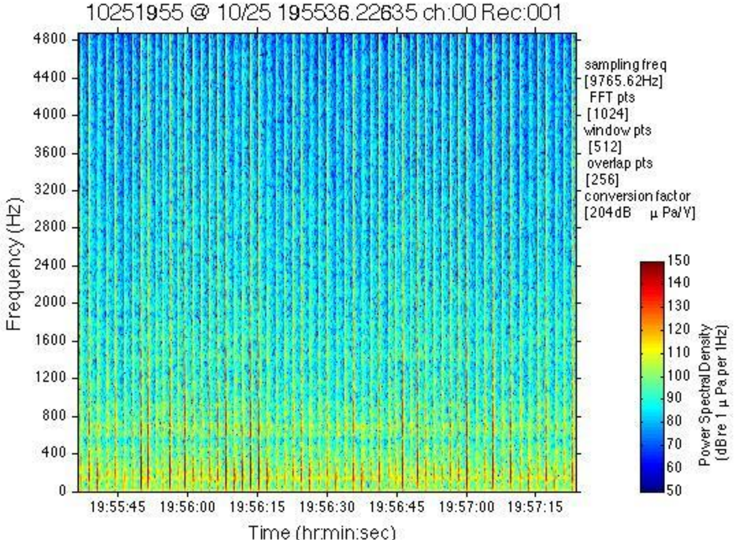
Part 3

- Part 1 – RODEO Overview
- Part 2 – Visual Monitoring
- **Underwater Acoustic Monitoring – Dr. James Miller, URI**
- Part 4 – Sediment Disturbance and Seafloor Recovery Monitoring

Acoustic Monitoring

- Pile driving operations carried out in 2015 generated intense sound, impulsive in nature at close range, which radiated into the surrounding air, water and sediment.
- Our team collected acoustic and seismic data ranging from 500 m to 15 km.
- We used moored vertical arrays of hydrophones, a towed array, tetrahedral array near the seafloor, 3-axis geophone on the seafloor and air noise measurement systems.
- Summary of the results follows.





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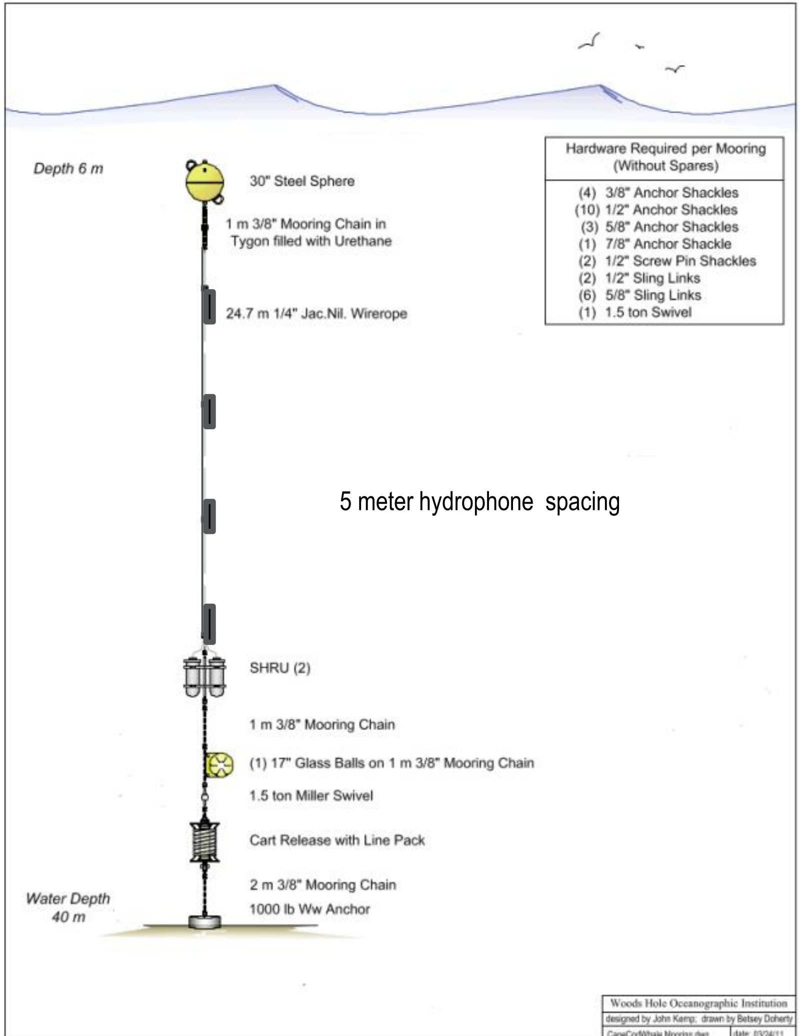
Vertical Array Moorings

- Two vertical arrays were deployed at ranges of 7.5 and 15 km.
- The primary purpose was to measure the acoustic SPL of the pile driving signals.
- On each array of four hydrophones, two phones had high gain and two phones had low gain.
- The spacing between the phones was 5 m and the deepest hydrophone was 5 m above the seafloor.



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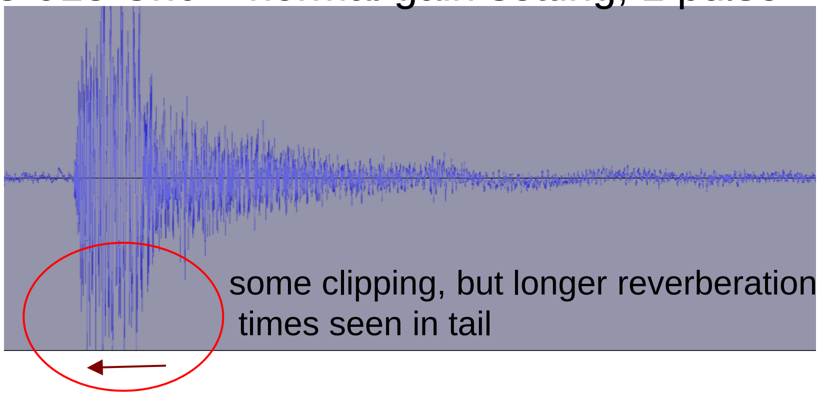
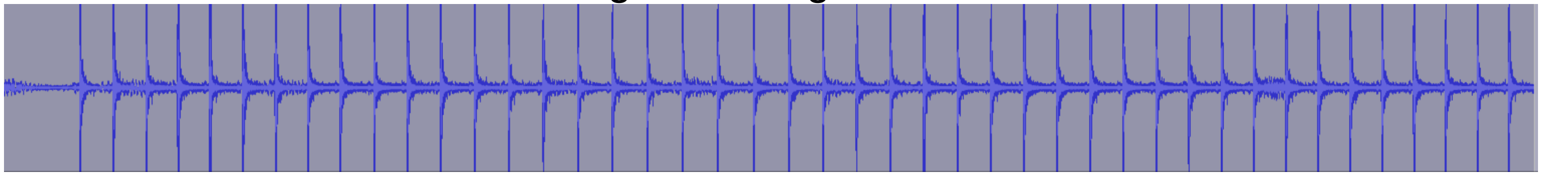
Vertical Array Moorings

- An example of the pile driving signal at 7.5 km.
- The normal gain phone shows some clipping but the reverberation.
- The low gain has no clipping

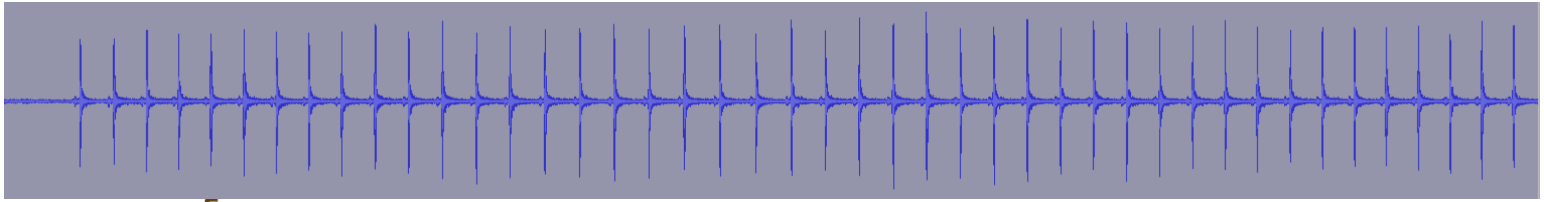
SHRU 913 Ch0 – normal gain setting, 1 pulse



Ch0 – normal gain setting, raw



Ch1 – low gain setting, normalized



Tetrahedral Array

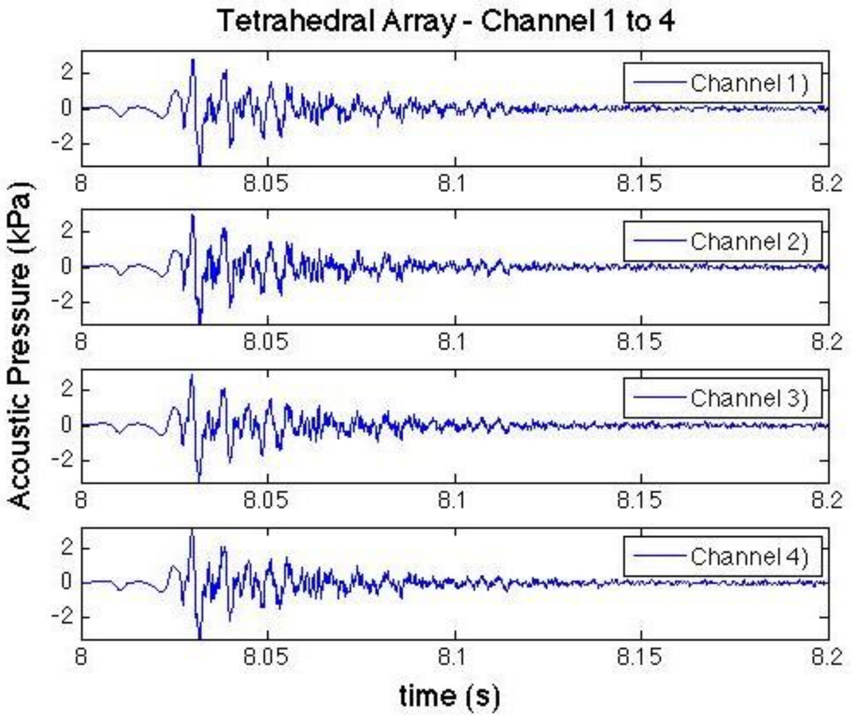
- A tetrahedral array of hydrophones was placed 500 m from the WTG#3 and #4 pile driving.
- The primary purpose was to estimate the acoustic particle velocity of the pile driving signals near the seafloor to assess impacts on fish.
- The hydrophones were arranged in a tetrahedron 0.5 m on a side.
- The tetrahedron was placed within a few centimeters from the seafloor.

Tetrahedral Array

- Data from tetrahedral array 500 meters from pile driving is being used to calculate particle velocity for fish studies.

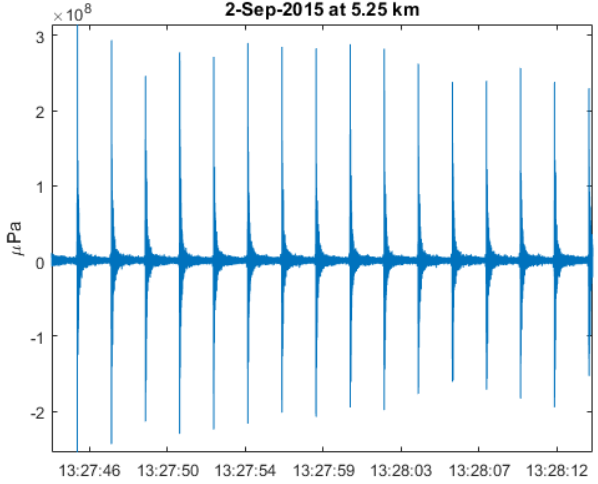
- SPL peak-to-peak is about 194 dB re 1 mPa.

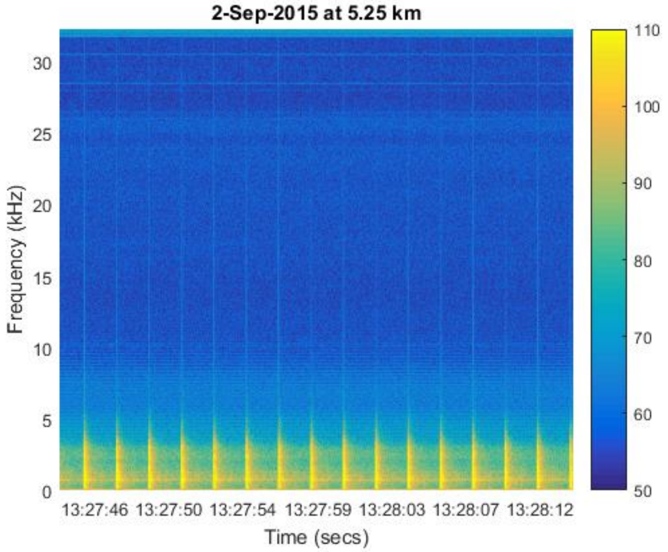
- Assuming spherical spreading, source level is about 248 dB re 1 mPa at 1 m.



Towed Hydrophone Array

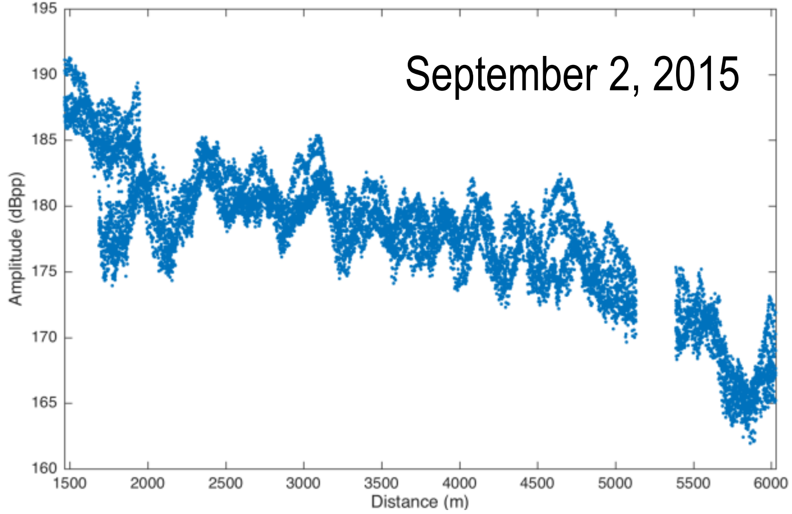
- Towed array with eight elements used to collect data on September 2 and 17.
- Digitized at 64 kHz/channel.
- WHOI depth sensors used to measure array depth.
- Data monitored in real time using Raven 1.5 and stored as 30-second files.
- Data post-processed on shore.

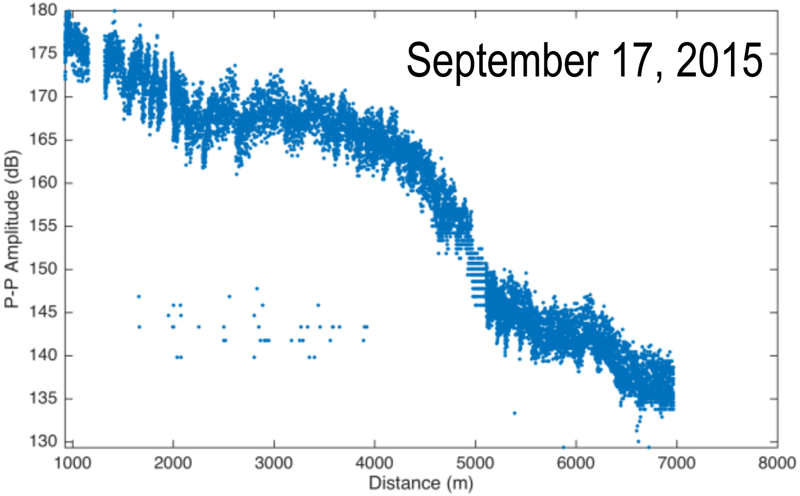




Towed Hydrophone Array

- Towed array with eight elements used to collect data on September 2 and 17.
- September 2 data 10-15 dB higher than on September 17.
- This is possibly due to the rake of the pile.

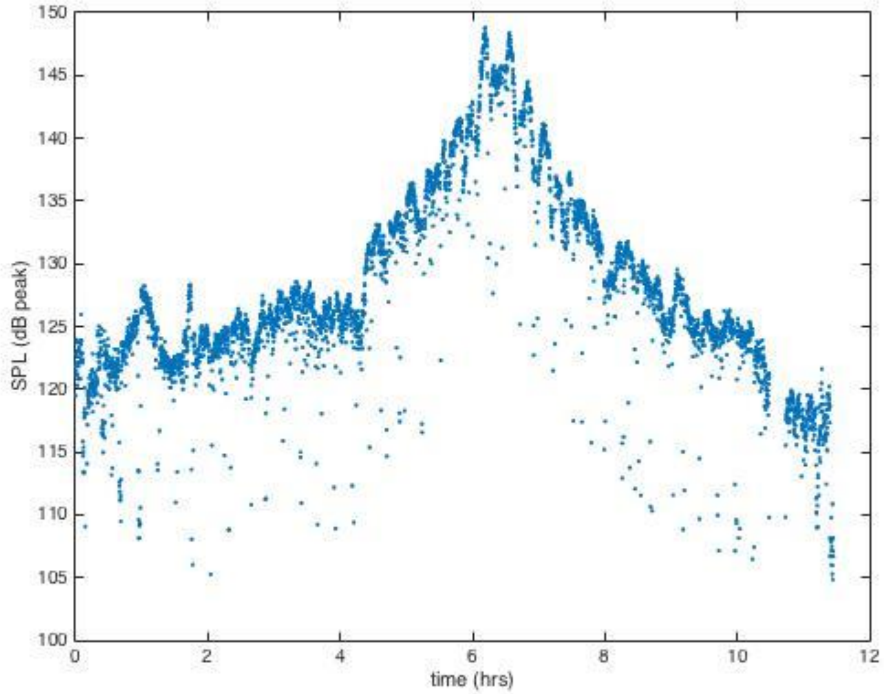




November 4, 2015

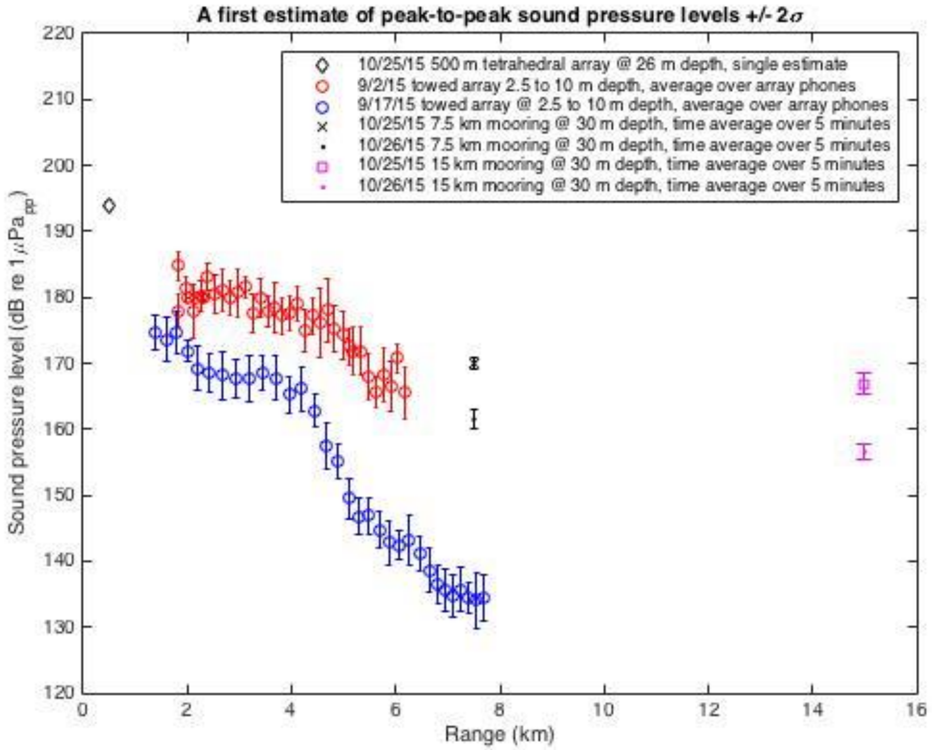
Fin whale calls on VLA

- On November 4, 2015 after the pile driving was completed, fin whale calls were detected for about 12 hours.
- Sound pressure levels of the whale calls reached about 150 dB re 1 muPa peak.
- Preliminary analyses show that the range to the fin whale was estimated at 10-100km.



Summary of pile driving measurements

- September 2 data 10-15 dB higher than on September 17 in the towed array data.
- Similar effect seen in the vertical array data.
- This is possibly due to the rake of the pile.



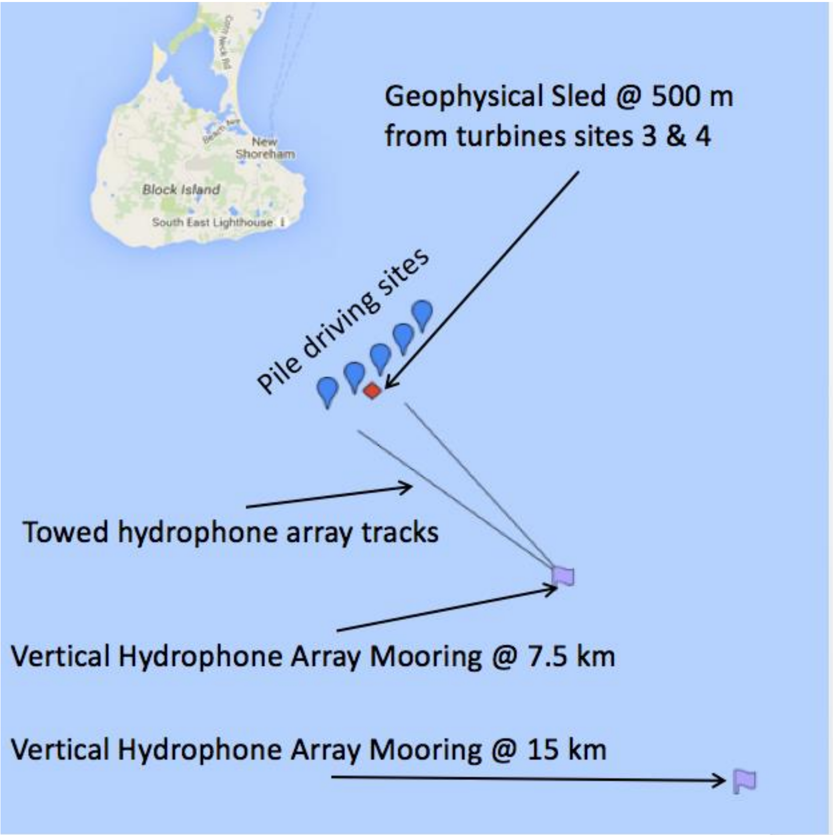
Some conclusions

What did we do right?

- Using fixed and mobile sensors.
- Setting multiple hydrophones to different gains.
- Deploying the sensors at different locations and various ranges.
- All sensors worked and collected data when deployed.

Where could we have done better?

- Better coordination in scheduling the towed array days/times.
- More measurements closer to the pile.
- More measurements > 15 km.
- More particle velocity measurements in mid-water.



Questions on Part 3?

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Part 4

- Part 1 – RODEO Overview
- Part 2 – Visual Monitoring
- Part 3 – Underwater Acoustic Monitoring
- **Sediment Disturbance and Seafloor Recovery Monitoring – Kevin Smith Fugro, Inc.**

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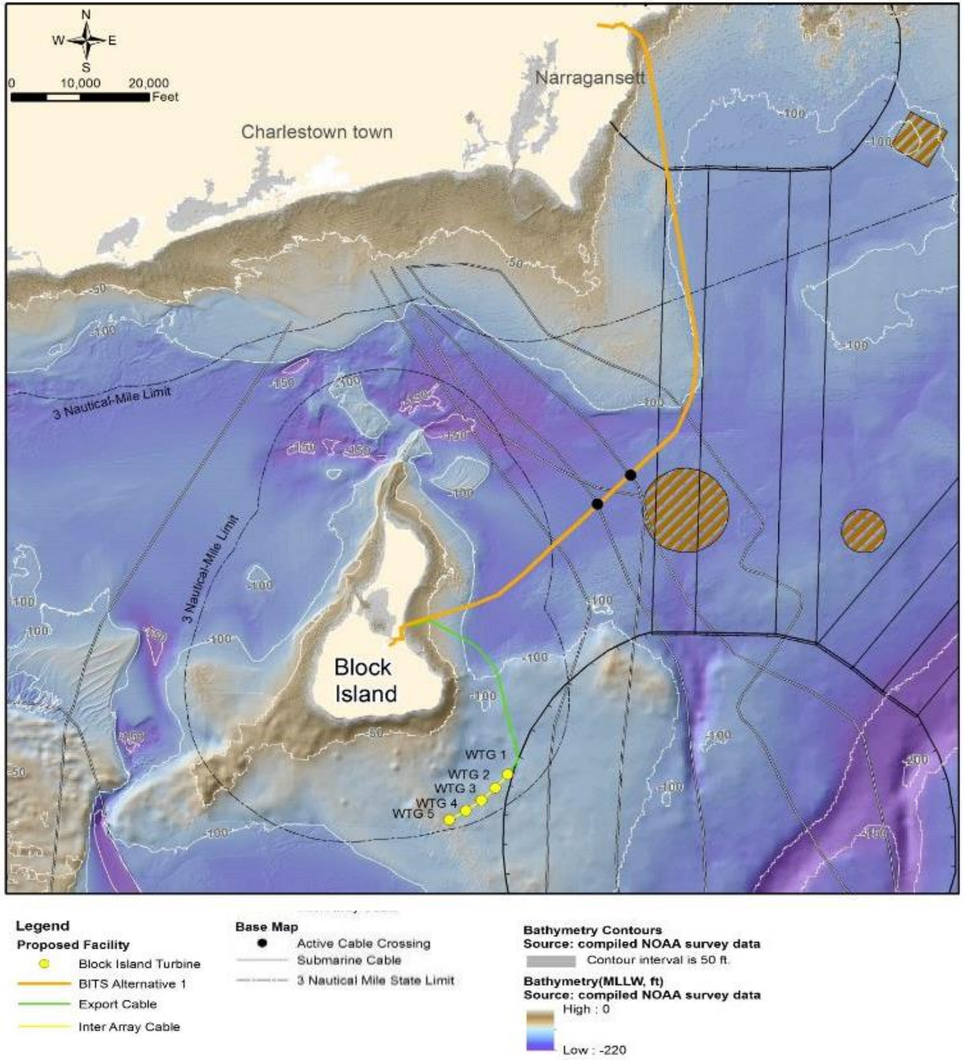
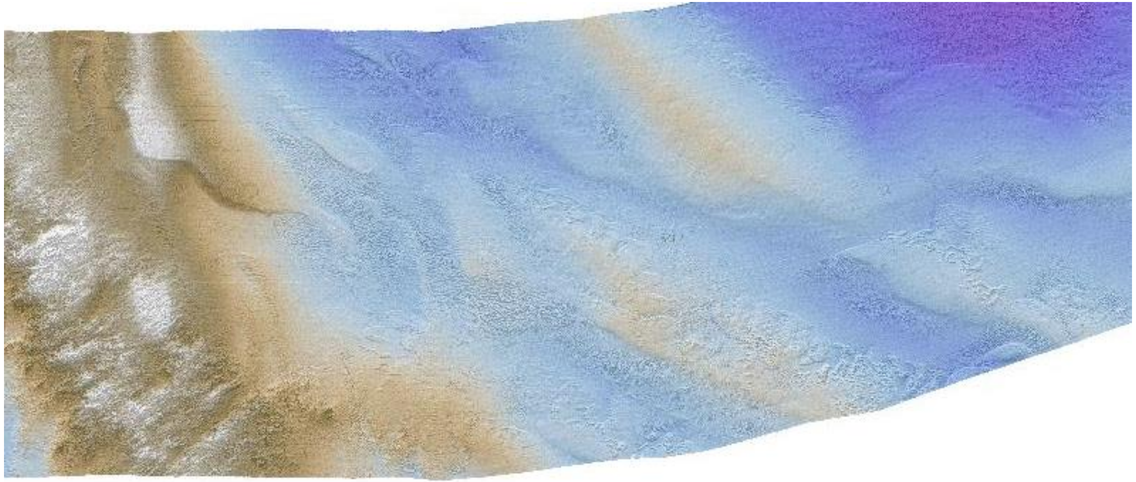
Sediment Monitoring

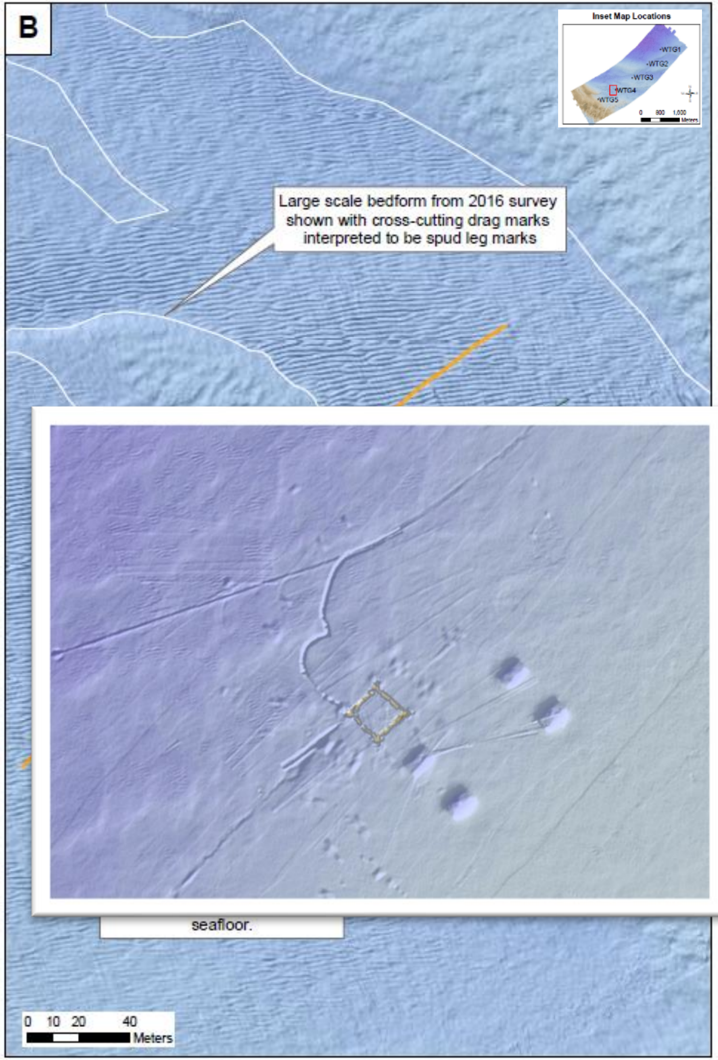
- Construction activities can disturb and impact the seafloor
- Monitoring seafloor recovery rates
- 3 Monitoring Programs
  - Seafloor Disturbance from Construction and Recovery
  - Scour Monitoring Sensor Testing
  - Seafloor Disturbance During Cable Installation



Seafloor Disturbance and Recovery Rate

- Wind turbine and cable installation activities disturb seafloor
- Conducting multibeam surveys for up to 1 year after construction
- Cataloging spud can penetrations, anchor drag, etc.
- Conducted post-2015 and post-2016 construction season surveys





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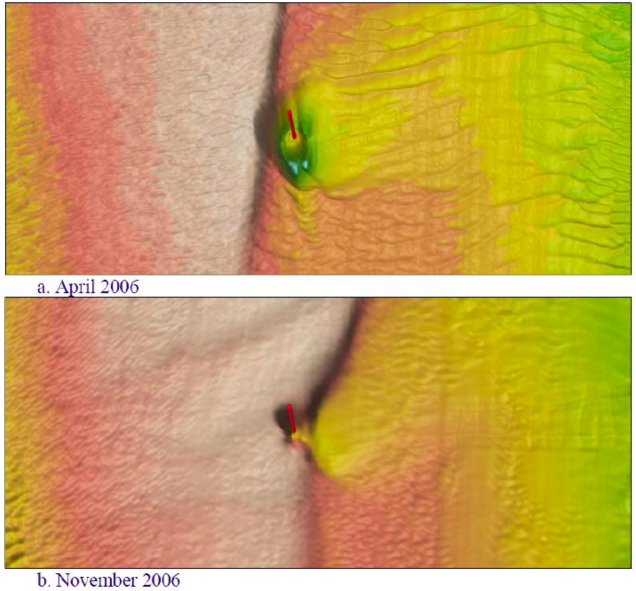
Scour Monitoring Testing

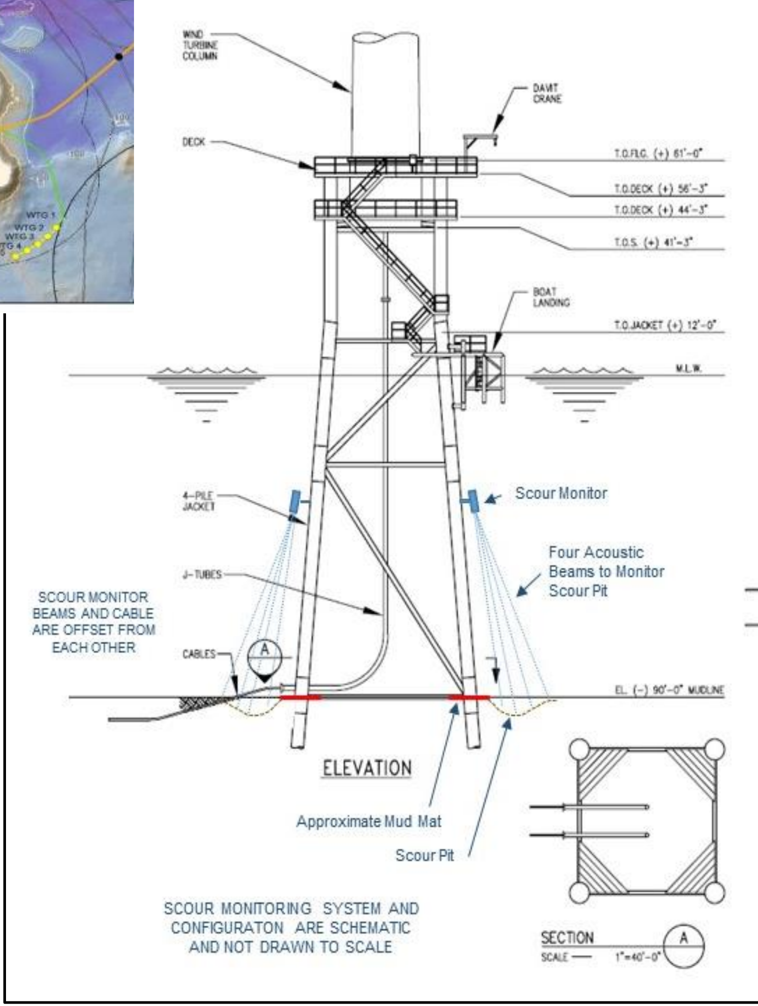
- Industry approach has been to perform multibeam surveys to assess scour at turbines
- Scour depth and extent is proportional to bottom current speeds
- Conducting multibeam survey after event or once a year doesn't capture scour development and infilling
  - May miss greatest extent of scour development
- Scour is a concern for cables
- Scour pit development may affect vibration response of turbine



European Wind Farm (modified from CEFAS 2008)

Scour Monitoring Testing

- Installed 2 scour sensors on Jacket No. 3
  - Continuously monitor scour.
  - Self-enclosed system – simpler than telemetry
    - Retrieved ~3 months for battery supplies and download data.
    - Acoustic Wave and Current Profiler (AWAC) - record currents and waves.
  - Scour sensors and AWAC installed summer 2016.
  - First data download last week.



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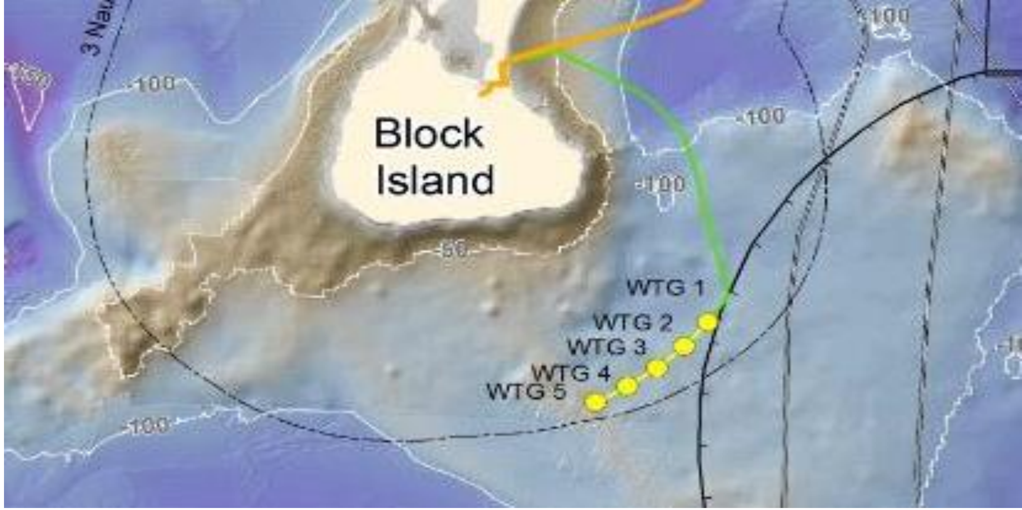
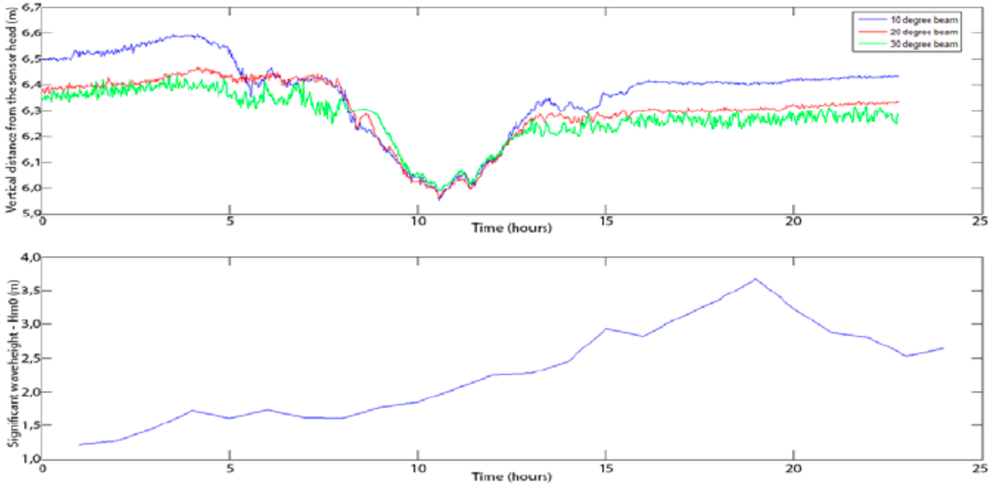
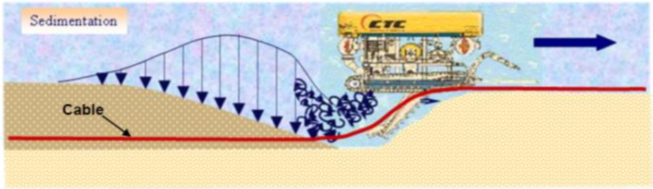


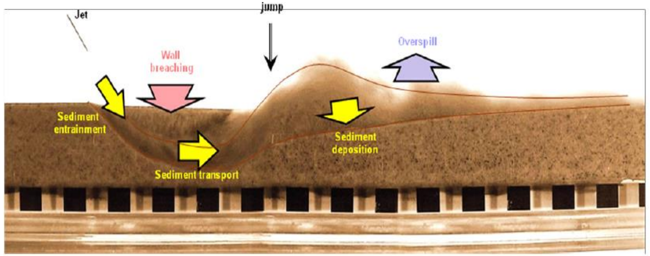


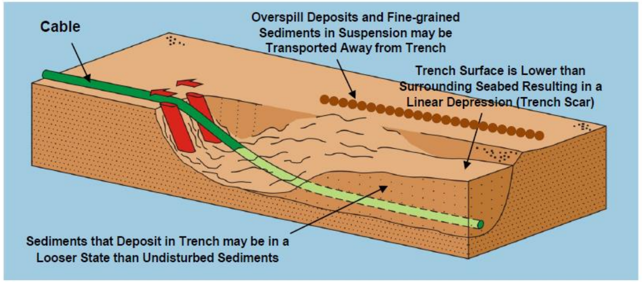
Example Data (not from Block Island)

Seafloor Disturbance During Cable Installation

- Cable installation utilized jet-trenching.
- Does jetting induce sediment plume?
- Was sediment fate/plume modeling reasonable?







Seafloor Disturbance During Cable Installation

- Monitored installation of section from mainland to Block Island.
- Multibeam technology to track sediment plume in water column.
- Vessel mounted ADCP.
- Optical backscatter sensor (OBS) to collect sediment samples in water column.

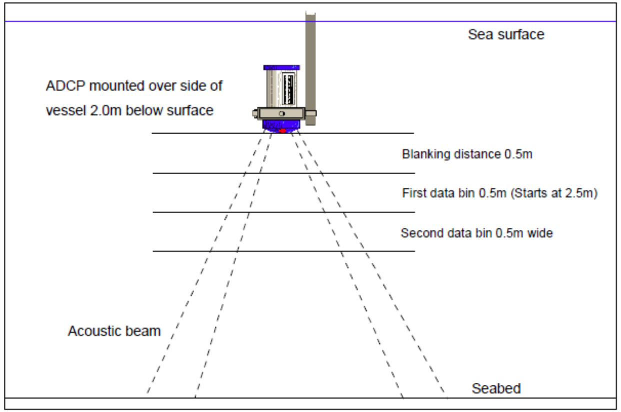


Figure 2.1: ADCP configuration for vessel-mounted works

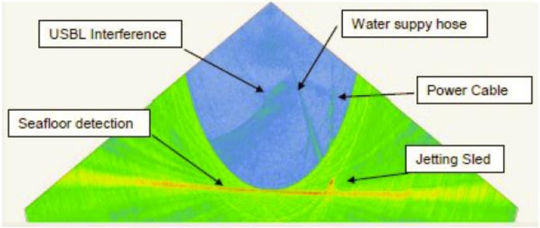


Figure 4.3: MBES data obtained from next to the jet plow. Image taken from Bathymetric Survey Plume Monitoring Report (Fugro Pelagos Inc, 2016)

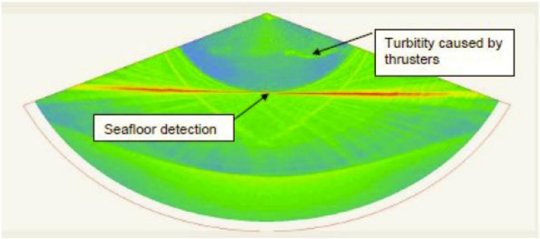
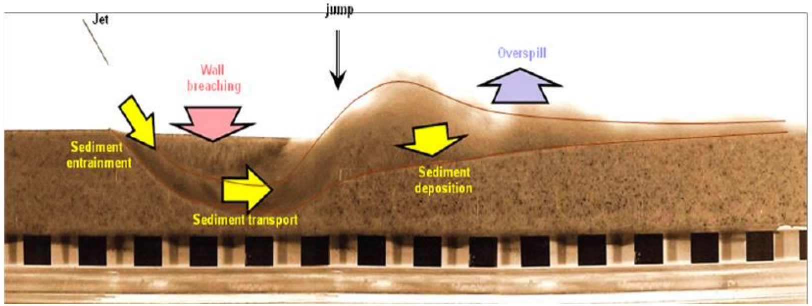
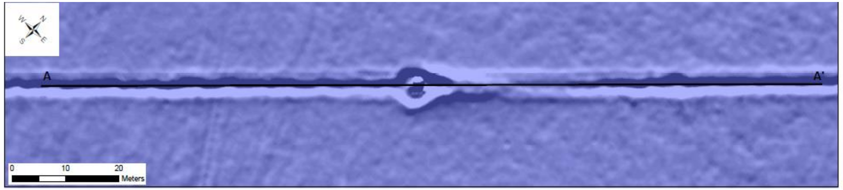


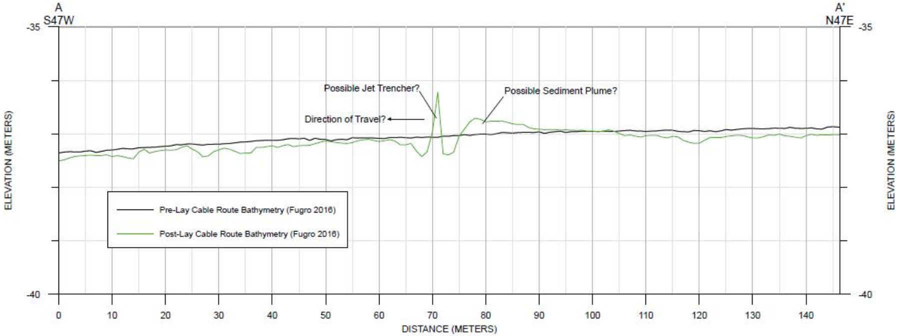
Figure 4.4: MBES data showing turbidity in the water column from the vessel thrusters. Taken from Bathymetric Survey Plume Monitoring Report (Fugro Pelagos Inc, 2016)

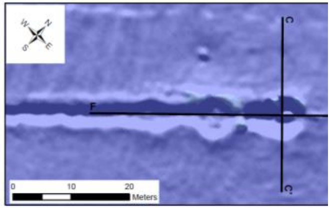
Seafloor Disturbance During Cable Installation

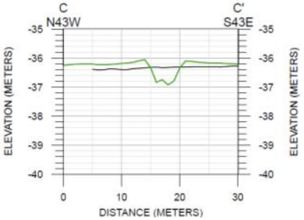
- No significant plume detected in water column.
- Sediment plume extent less than modeled extent.

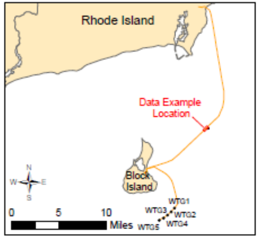












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Questions on Part 4?

The study concepts, oversight, and funding for the RODEO Program were provided by the U.S. Department of the Interior, Bureau of Ocean Energy Management, Environmental Studies Program, Washington, DC under HDR's IDIQ Contract No. M15PC00002.

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Electromagnetic Field Impacts on Elasmobranch and American Lobster Movement and Migration from Direct Current Cables

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Andrew B. Gill
Haibo He
Zoë L Hutchison
Peter Sigray

University of Rhode Island, USA
Cranfield University, UK
Swedish Defence Research Agency, Sweden

BOEM Bureau of Ocean Energy Management | The University of Rhode Island | Cranfield University | FOI | CRMC Coastal Resources Management Council

Project Team: It Takes a Village!!

Principal Investigators & Post-doctural Researcher:

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Andrew B Gill, Zoë L. Hutchison (Cranfield University)
Peter Sigray (FOI - Swedish Defense Agency)

URI Coastal Mapping Laboratory Technical Staff:

Brian Caccioppoli, Danielle Cares, Sierra Davis, Carol Gibson, Chip Heil, Casey Hearn, Roger Kelly, Monique LaFrance Bartley, Taylor Losure, Sean Scannell

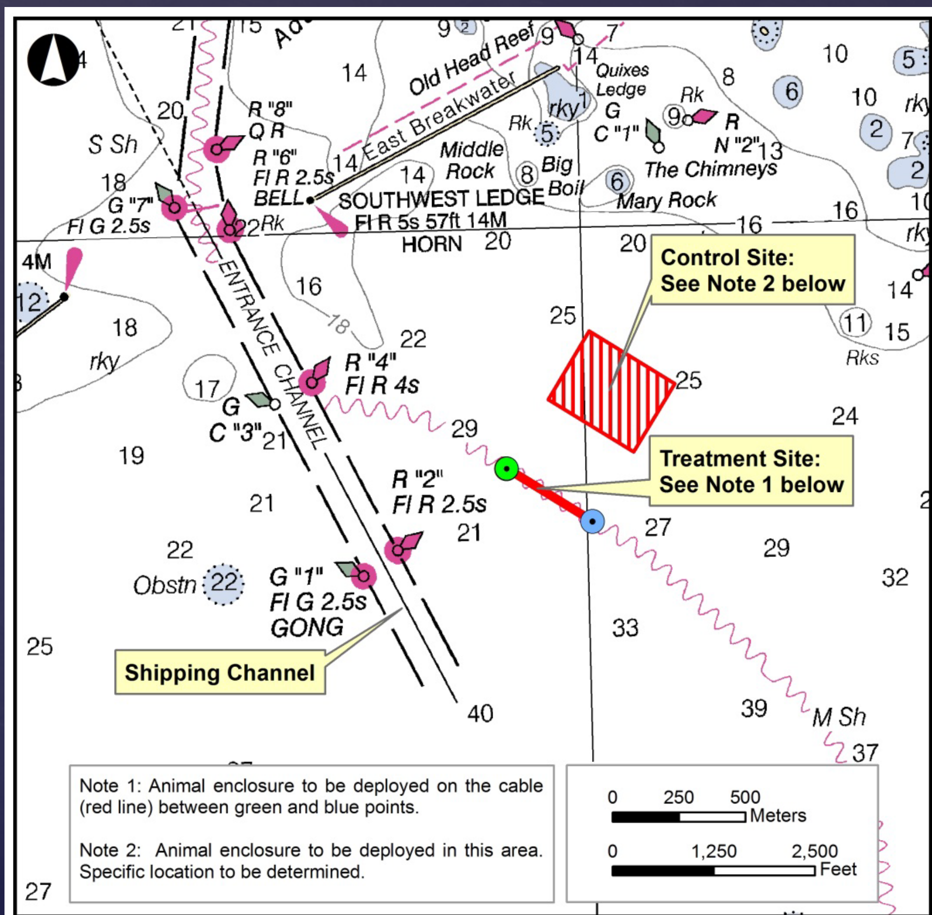
URI Divers:

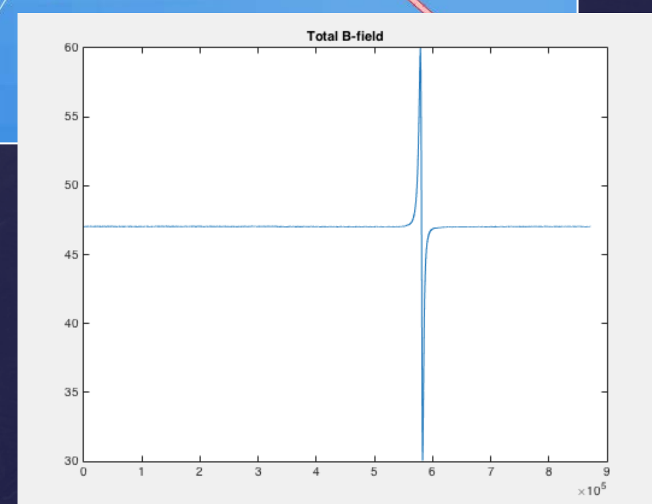
Tabitha Jacobs, Joe Mangiafico, Ryan Patrylak, David Robinson

On-Site Marine Operations

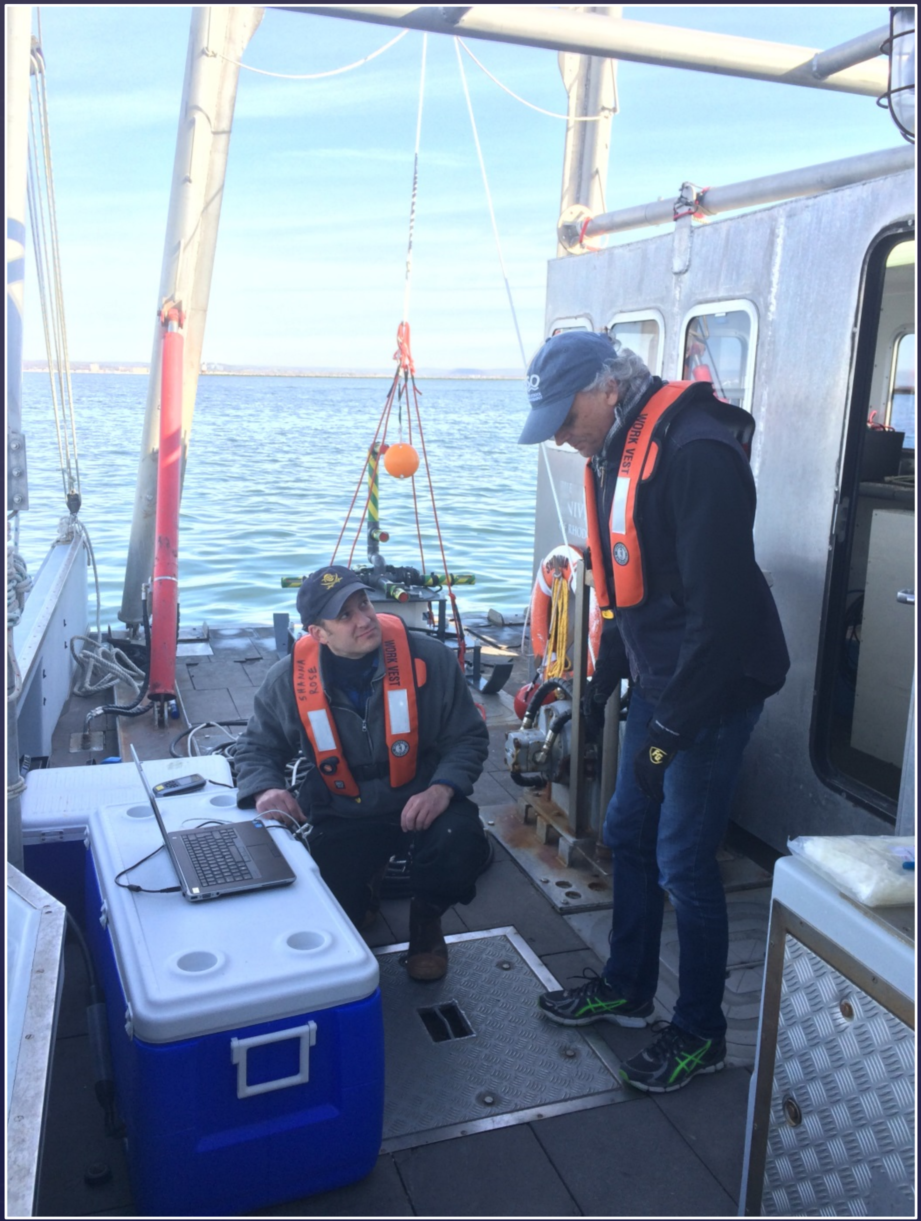
Miller Marine, New Haven CT

Site Selection for Animal Enclosures: SEMLA Survey

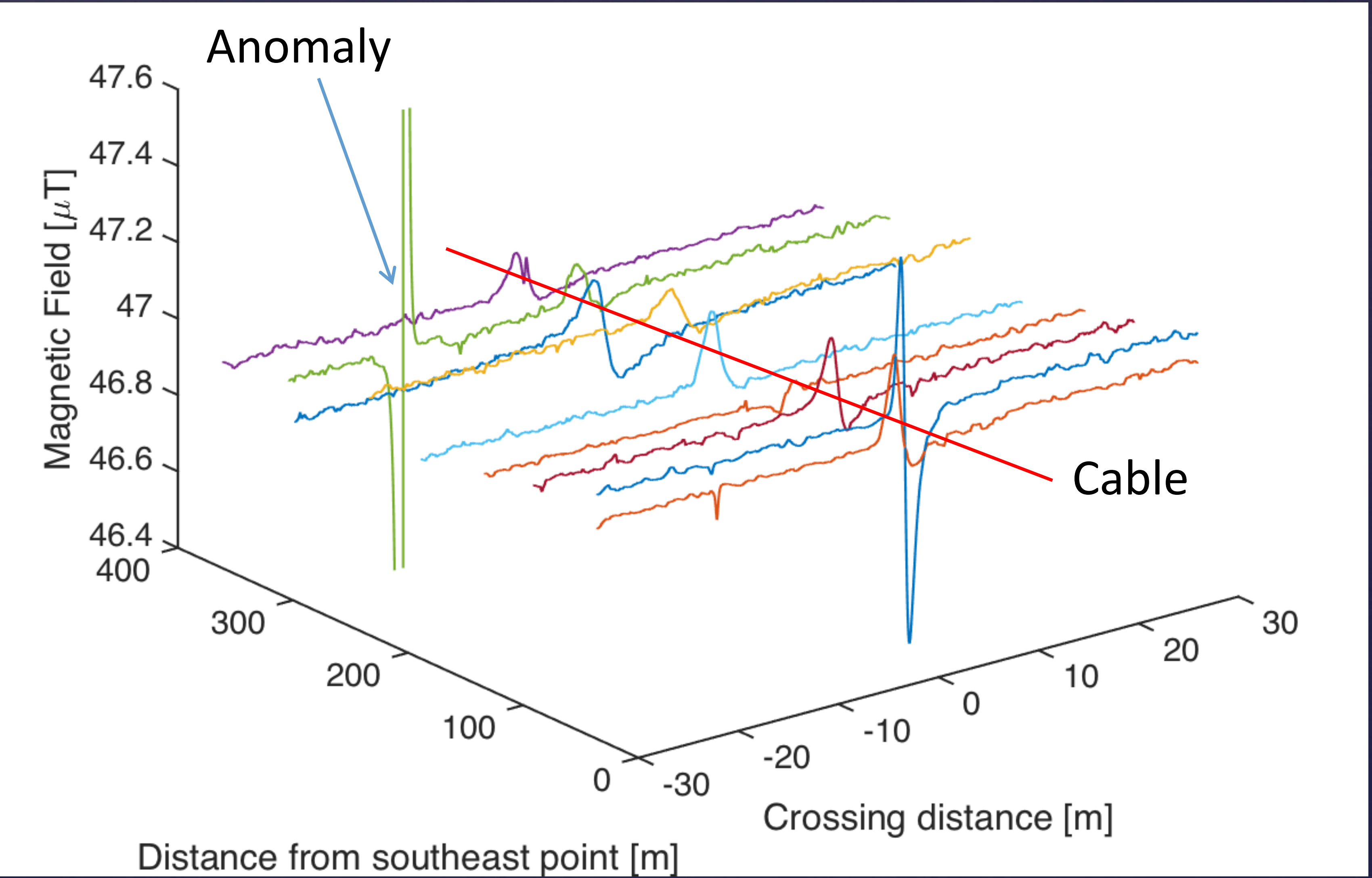




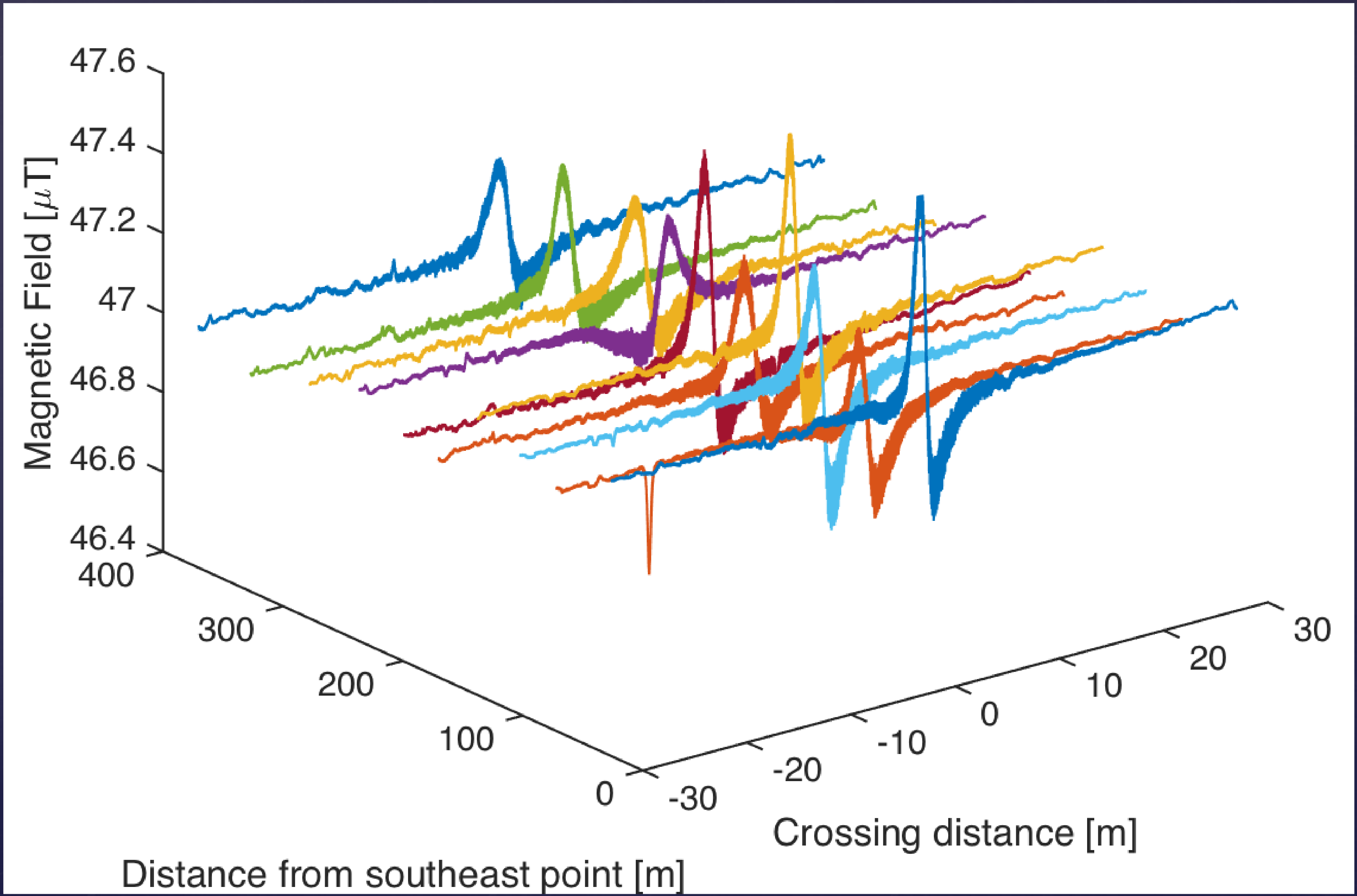
SEMLA Survey



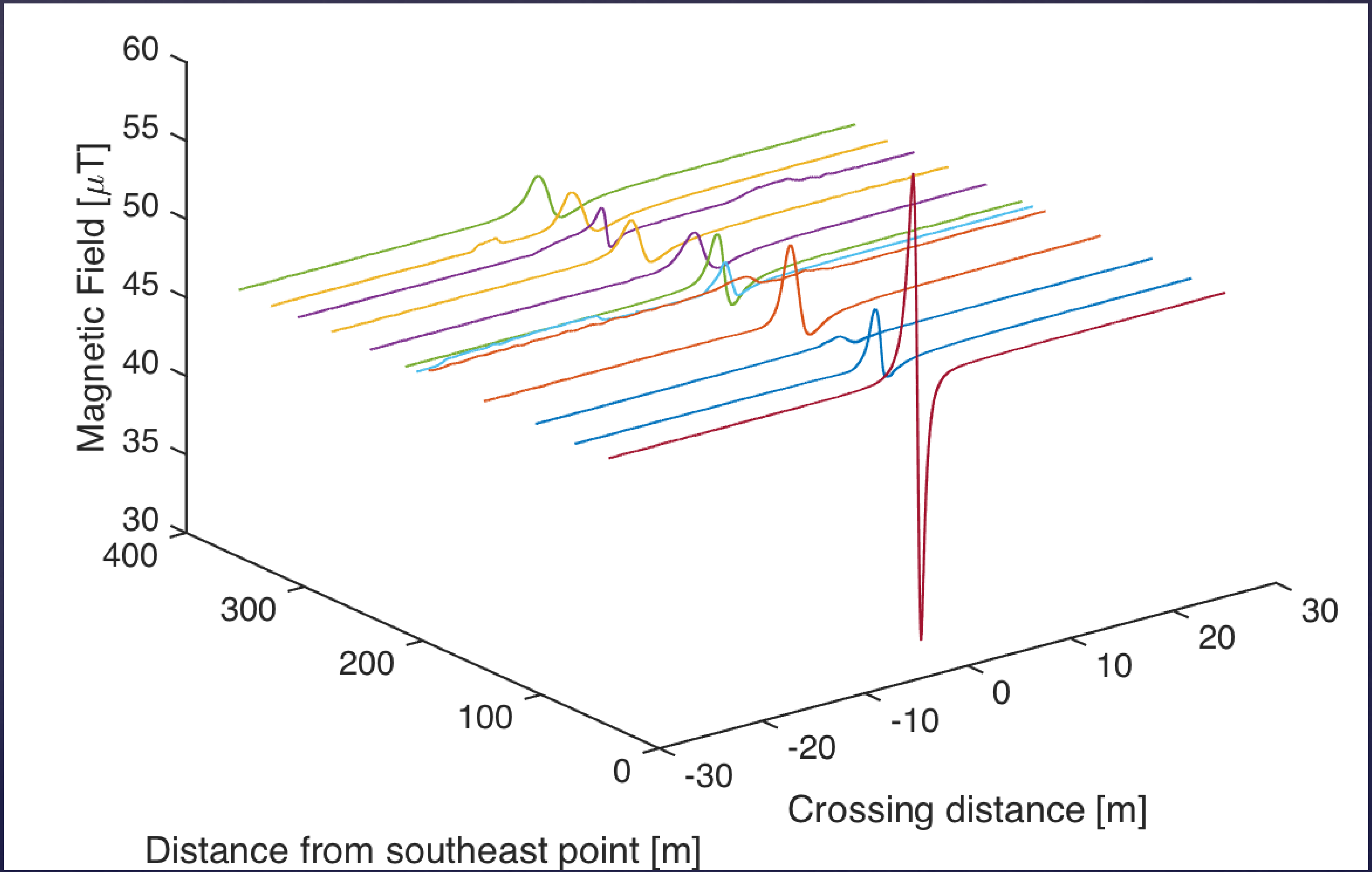
Cable Magnetic Field: Shutdown Mode



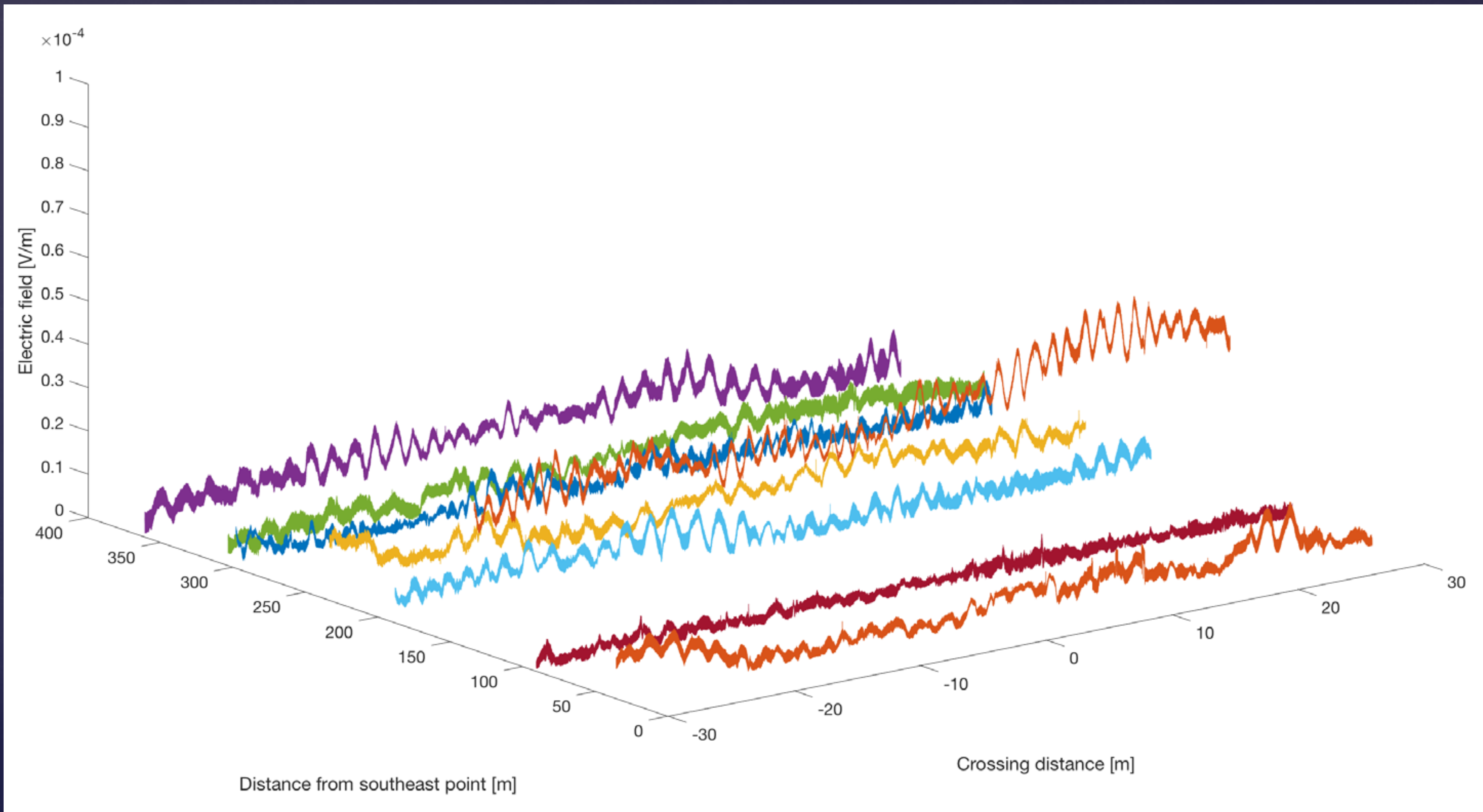
Cable Magnetic Field: Standby Mode



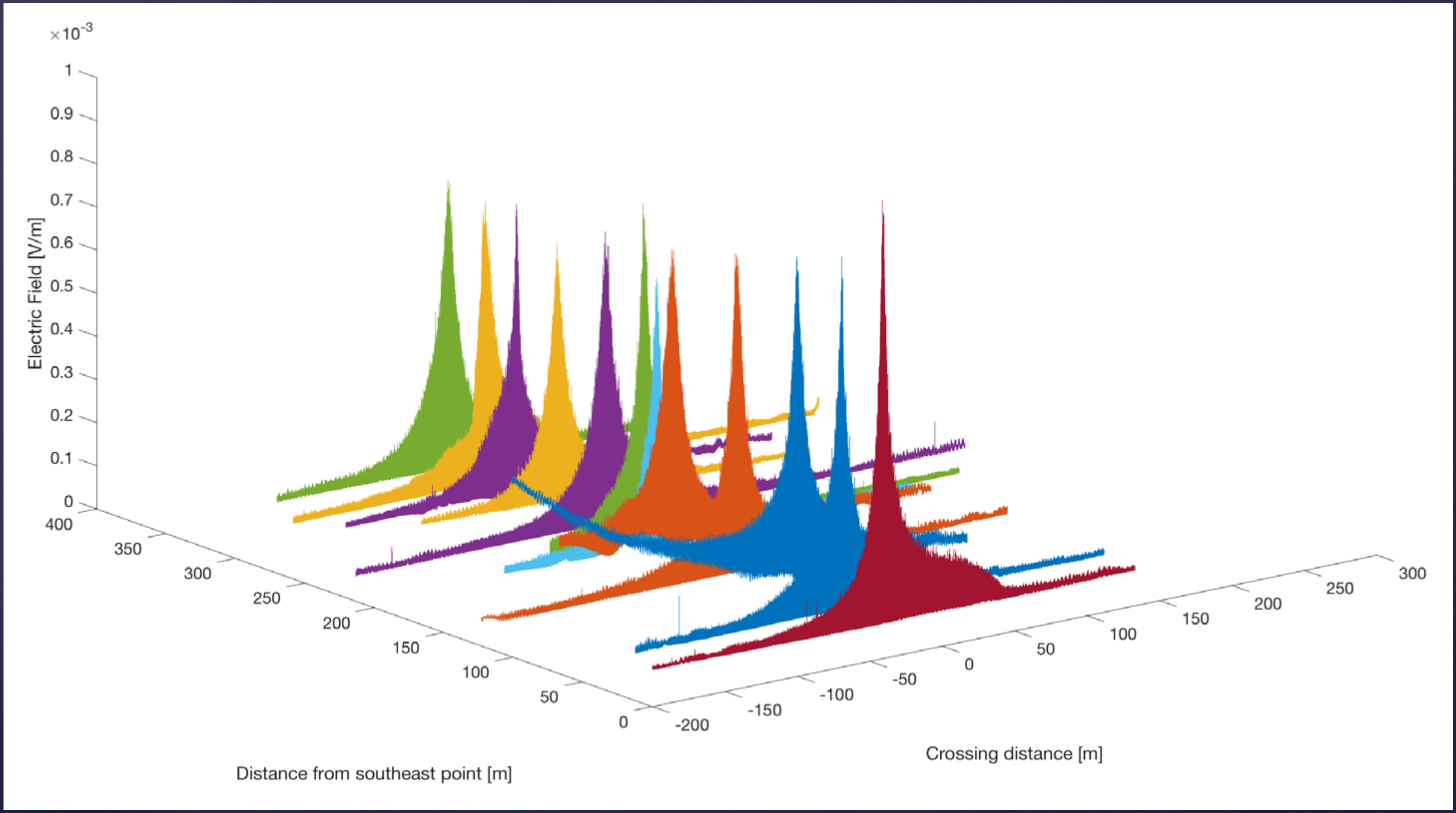
Cable Magnetic Field: Full Power



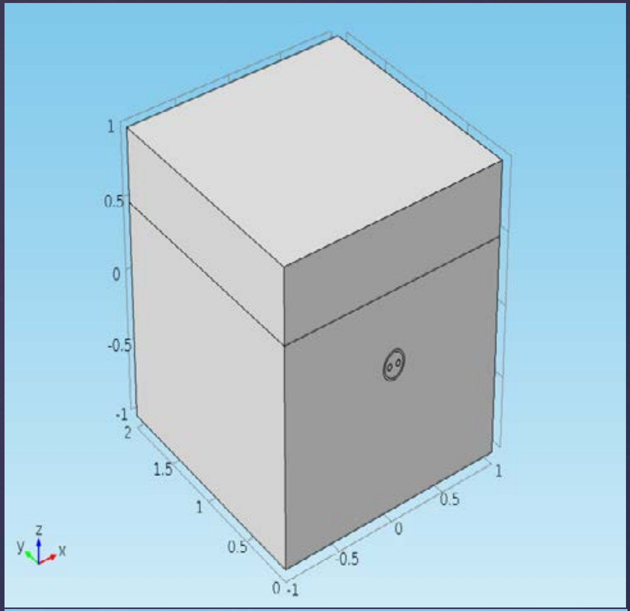
Cable Electrical Field: Shutdown Mode

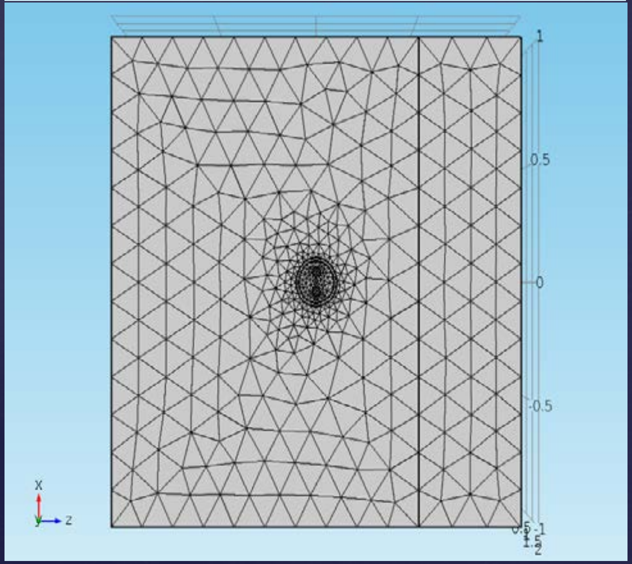


Cable Electrical Field: Full Power



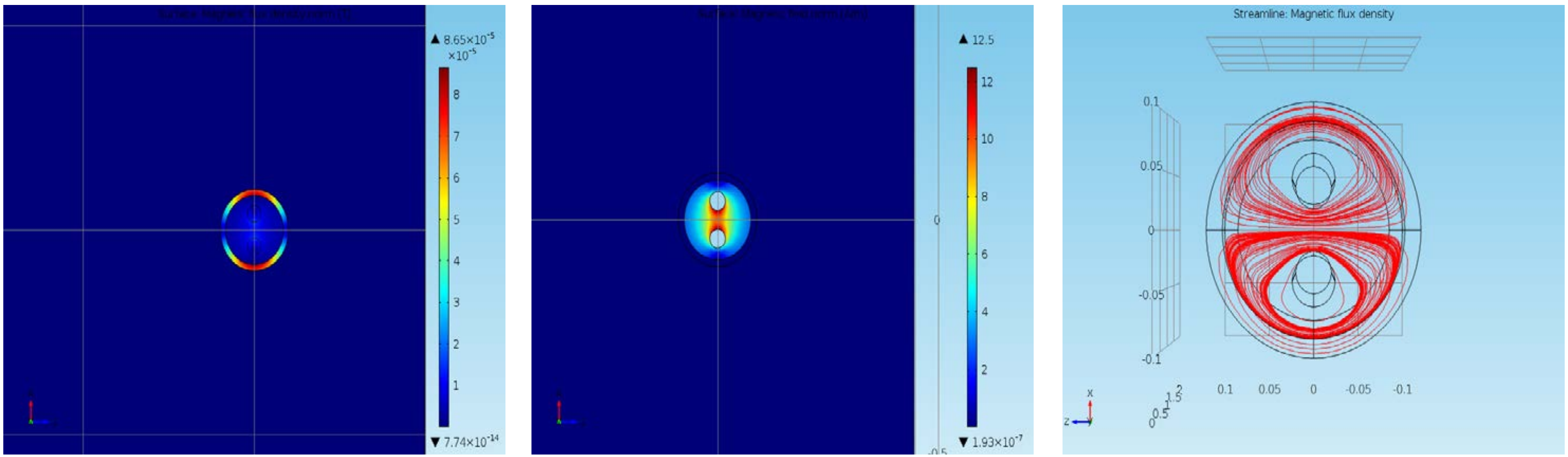
Modeling of Cable-Generated Fields



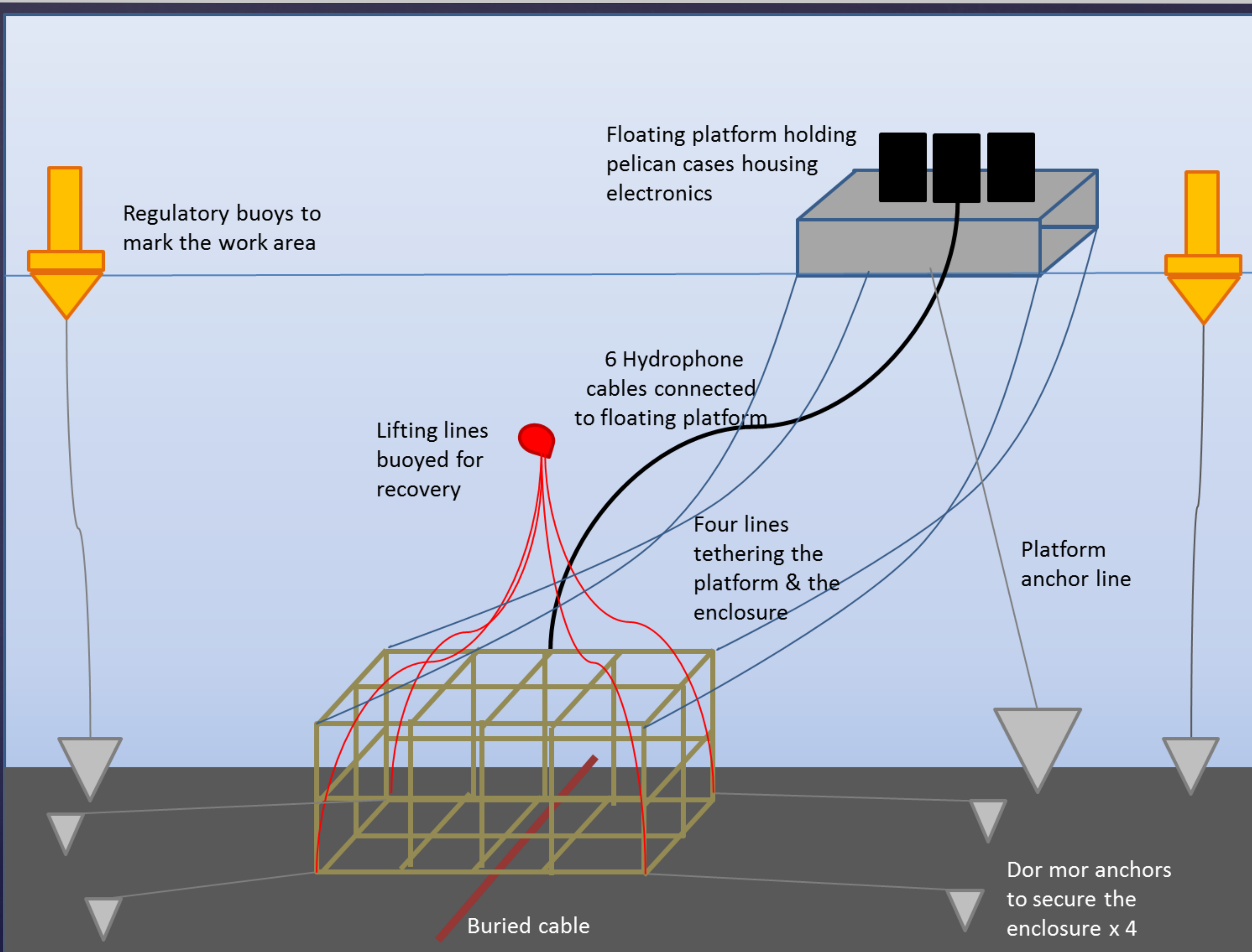


- 3-D simulation is implemented in COMSOL Multiphysics software (version 4.4)
- Geometric model is shown at left
- Upper part of block represents seawater
- Lower part of block represents the seabed
- Cylinder in center of box represents the cable

Modeling of Cable-Generated Fields

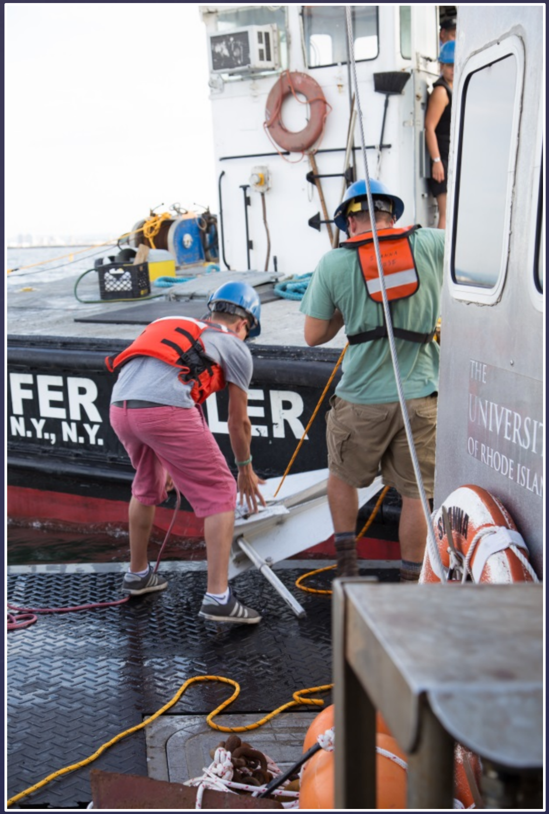


Enclosure and Electronics Deployment Plan (USCG Approved)



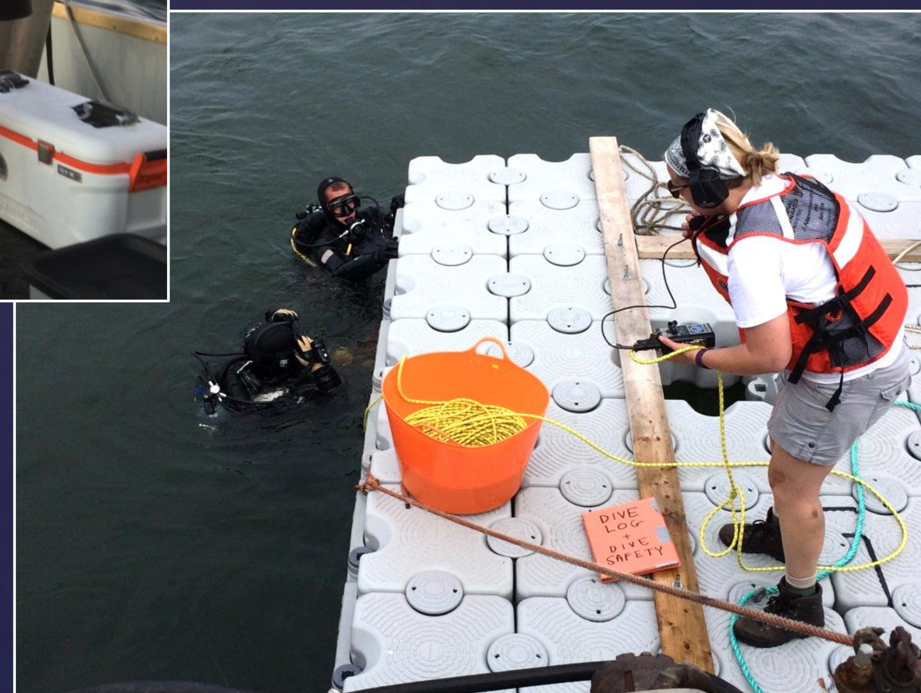
Enclosure Development: Getting Dressed for the Field

Enclosure and Platform Deployment

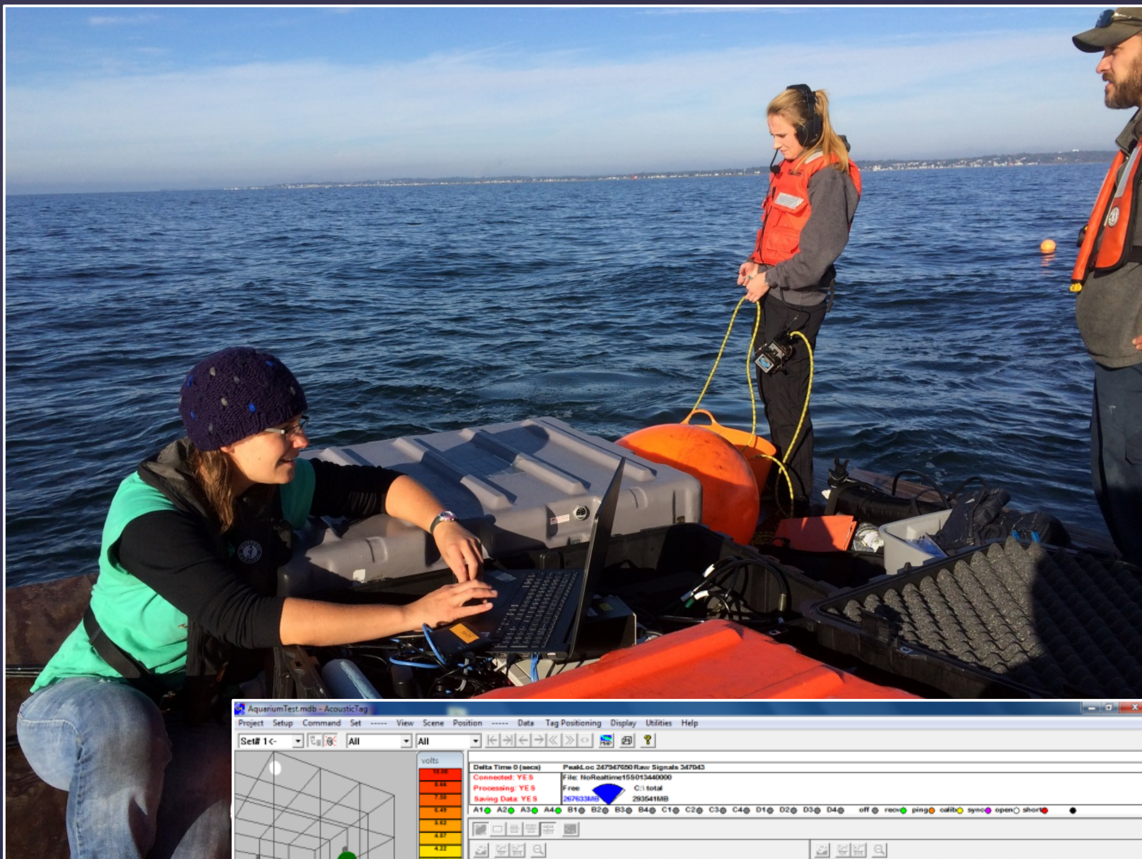


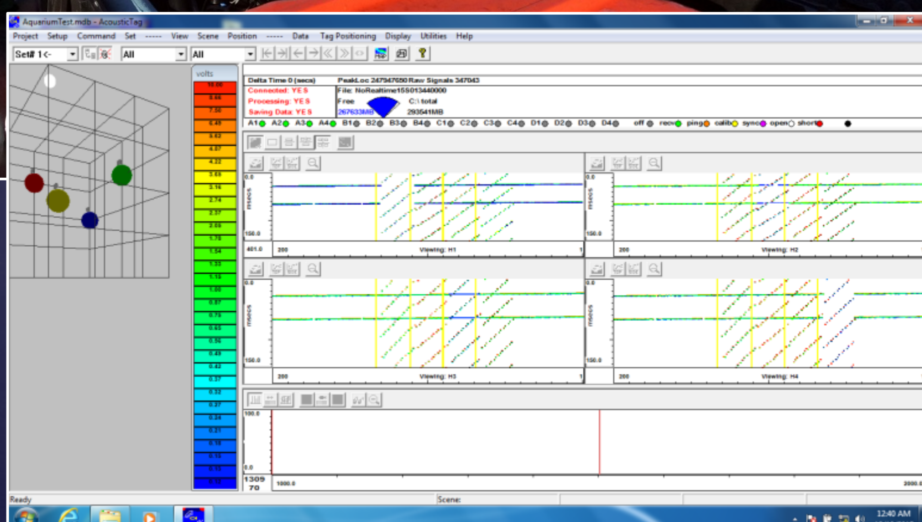
R/V Shanna Rose & Crew Completing Deployment

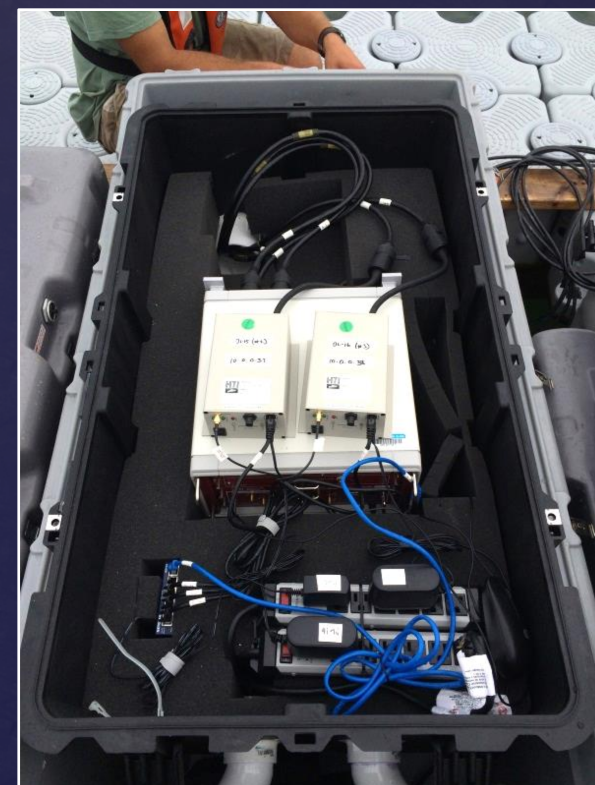
Divers



Life On the Platforms

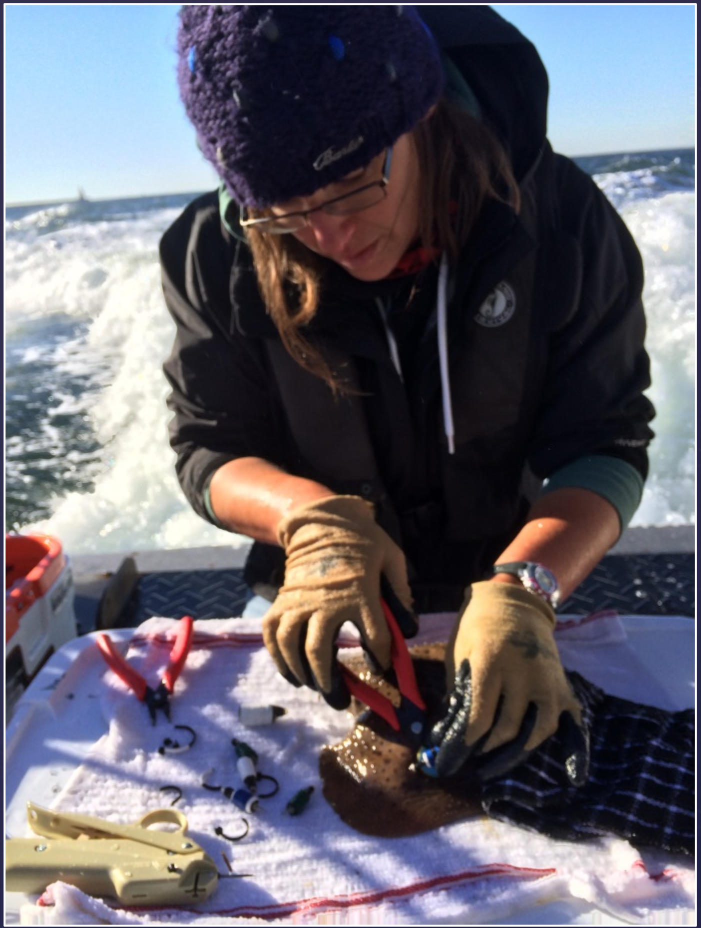




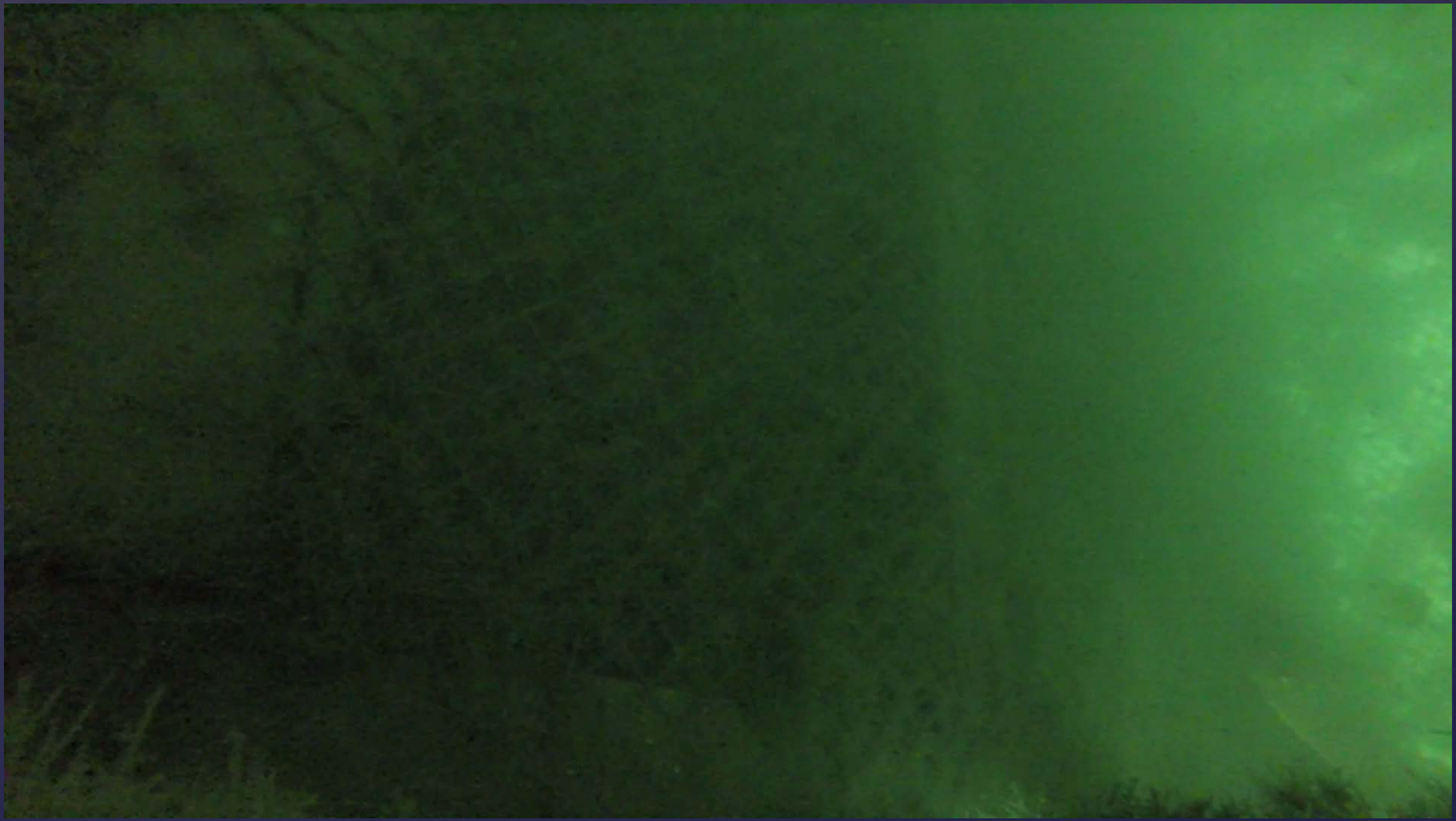


Specimen Capture – GSO Trawl

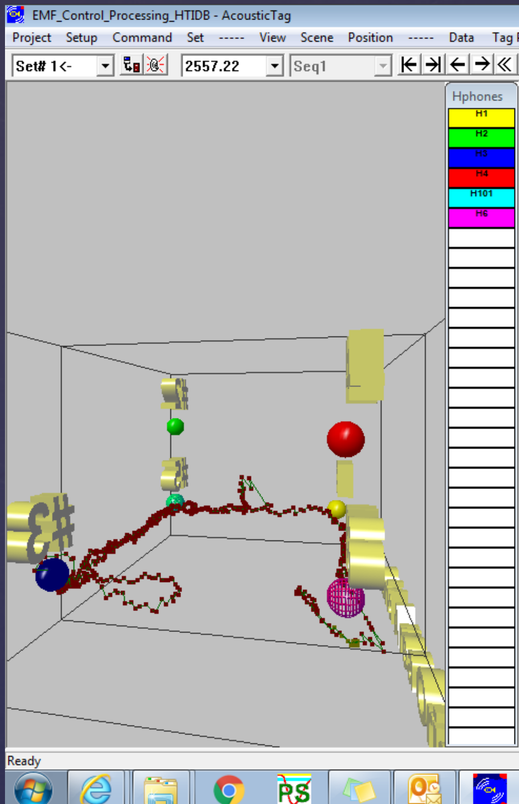
Specimen Tagging

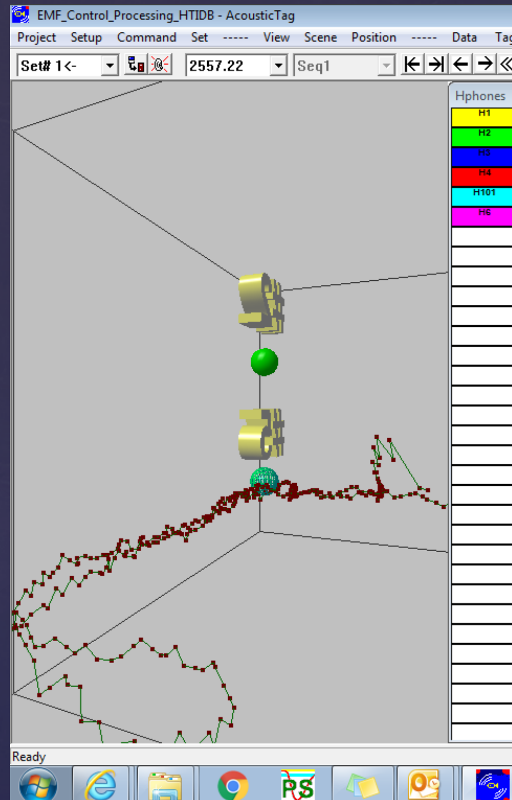


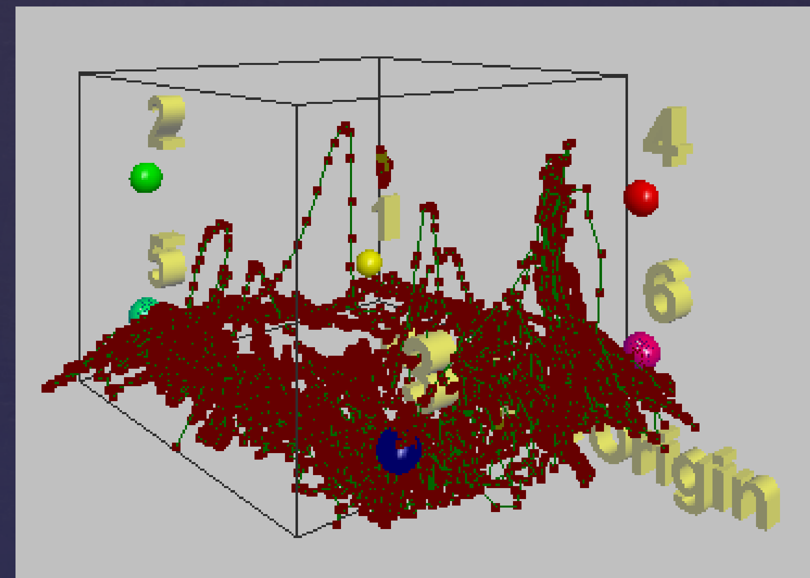
GoPro Video Footage Inside the Enclosure



Examples of Preliminary Data



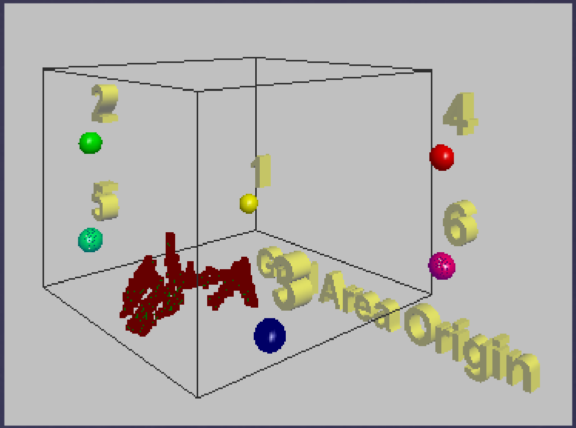




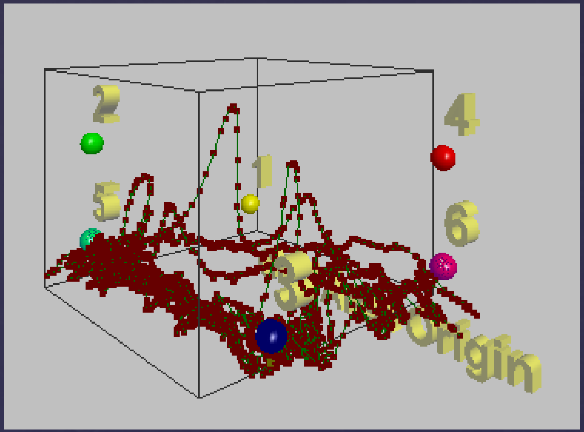
5 lobsters moving over 1 hour

	X Position	Y Position	Z Position
Average	11.689678	12.428766	11.926173
StDev	0.0255143	0.0141711	0.0463334
n	636	636	636

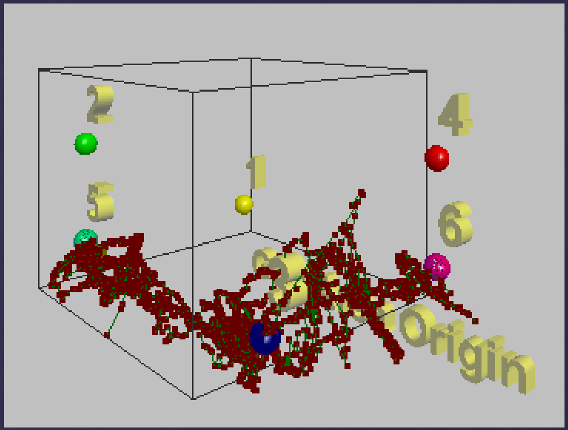
Examples of Preliminary Data



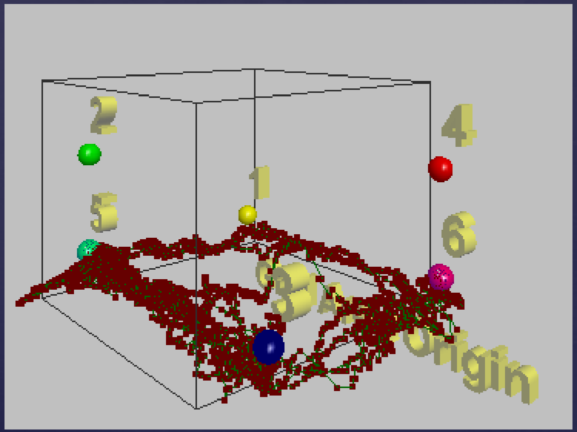
Lobster 2791.19



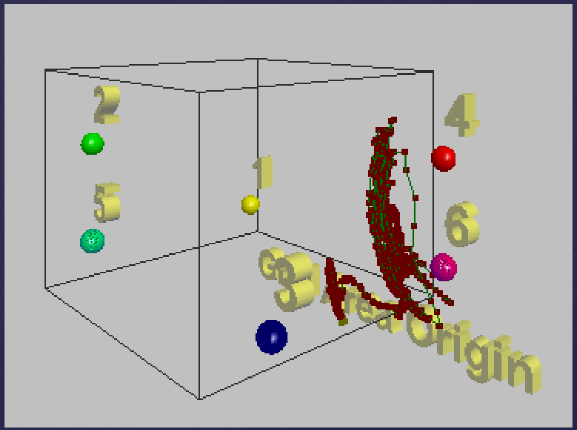
Lobster 2053.01



Lobster 2819.08



Lobster 2557.22



Lobster 2551.12

Homarus americanus;

- 12 true replicates
- 18- 24 hours per lobster
- 56 lobsters
- 2 sites

Leucoraja erinacea;

- 8 true replicates
- 18-24 hours per skate
- 40 skates
- 2 sites

What Can the Data Tell Us?

- Acoustic tagging method is feasible for multiple individuals within an experimental mesocosm (treatment and control)
- Confirmed high precision and accuracy of 3D positioning

Can now assess (in 2D and/or 3D):

- Individual and group distribution with respect to the cable v no cable
- Orientation in the presence of EMF and when not present
- Frequency and duration of any association (attraction)
- Frequency and duration of any repulsion
- Speed of movement with/without EMF, close to and away from the cable
- Changes in turn angle with/without EMF, close to and away from the cable
- Influences of the tide, day, night, and environmental variables
- Limitations on interpretation of spatial data from the acoustic tags

Next Steps

- Analysis of animal behavior from HTI data and GoPro footage
- Survey of Neptune cable
- Continue study with American Eels

MARINE AND COASTAL BIRDS

David Bigger, Environmental Protection Specialist,
Environment Branch

Office of Renewable Energy Programs

Atlantic Ocean Energy and Mineral Science Forum | *Sterling, VA*

November 17, 2016

RESEARCH STRATEGY

- Identify species that may be vulnerable
- Find out where they are and where they are not
- Describe how they move through the area
- Understand how they respond to development

MARINE AND COASTAL BIRD PANEL

Brian Kinlan, NOAA

Tim White, BOEM

Andrew Gilbert, Biodiversity Research Institute

Julia Robinson Willmott, Normandeau

FURTHER AVENUES OF STUDY INCLUDING AVIAN RESPONSES TO TURBINES

David Bigger

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703-787-1802

For more information visit
www.boem.gov/Renewable-Energy

Mapping and Modeling Distribution and Abundance of Seabirds

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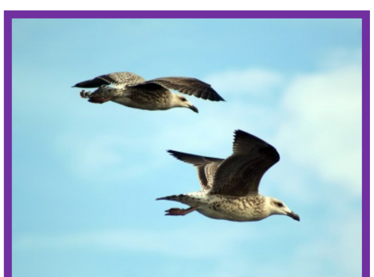
And countless data collectors and providers

ATLANTIC OCEAN ENERGY AND MINERAL SCIENCE FORUM
November 17, 2016

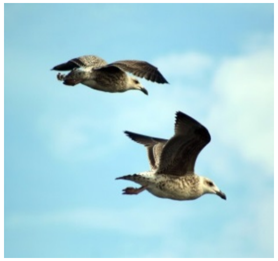



BOEM Bureau of Ocean Energy Management

USGS science for a changing world

Ocean energy spatial planning

- Interest in offshore wind energy in the Atlantic
  – Planned or **leased** areas offshore of **MA**, **RI**, NY, **NJ**, **MD**, **DE**, **VA**, NC (so far!)



- Need information on marine bird distribution for siting, planning, environmental assessment

- Also need information on data gaps and guidelines for sampling and monitoring

Goal: Use Models to…

1. Develop best possible synthesis of all available science-quality at-sea seabird survey data

2. Develop statistically-driven guidelines for marine bird sampling efforts

Both efforts have been partnership involving scientists at NOAA, BOEM, USFWS, USGS

BOEM
Bureau of Ocean Energy Management

science for a changing world

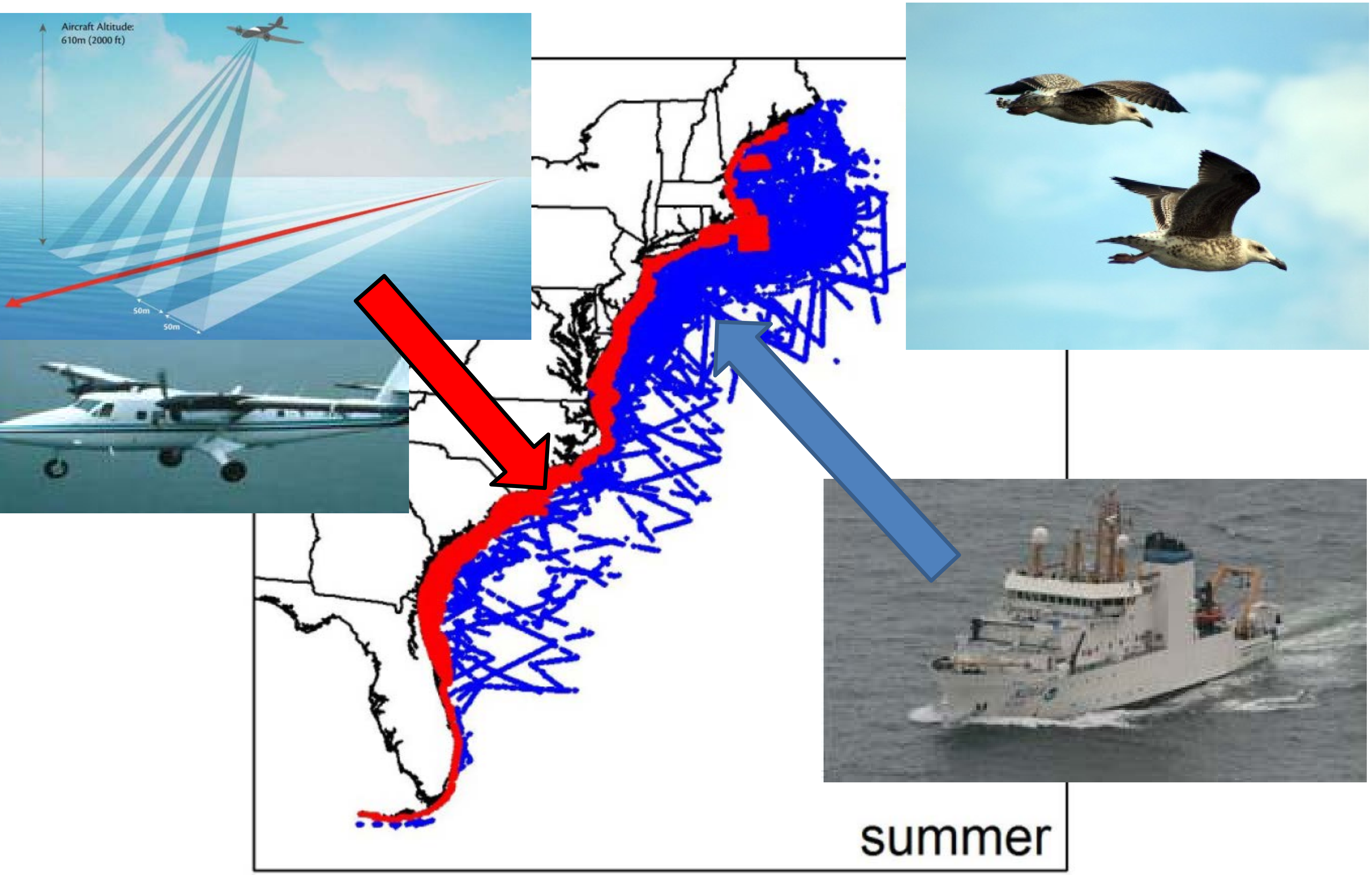
Goal: Use Models to…

1. Develop best possible synthesis of all available science-quality at-sea seabird survey data

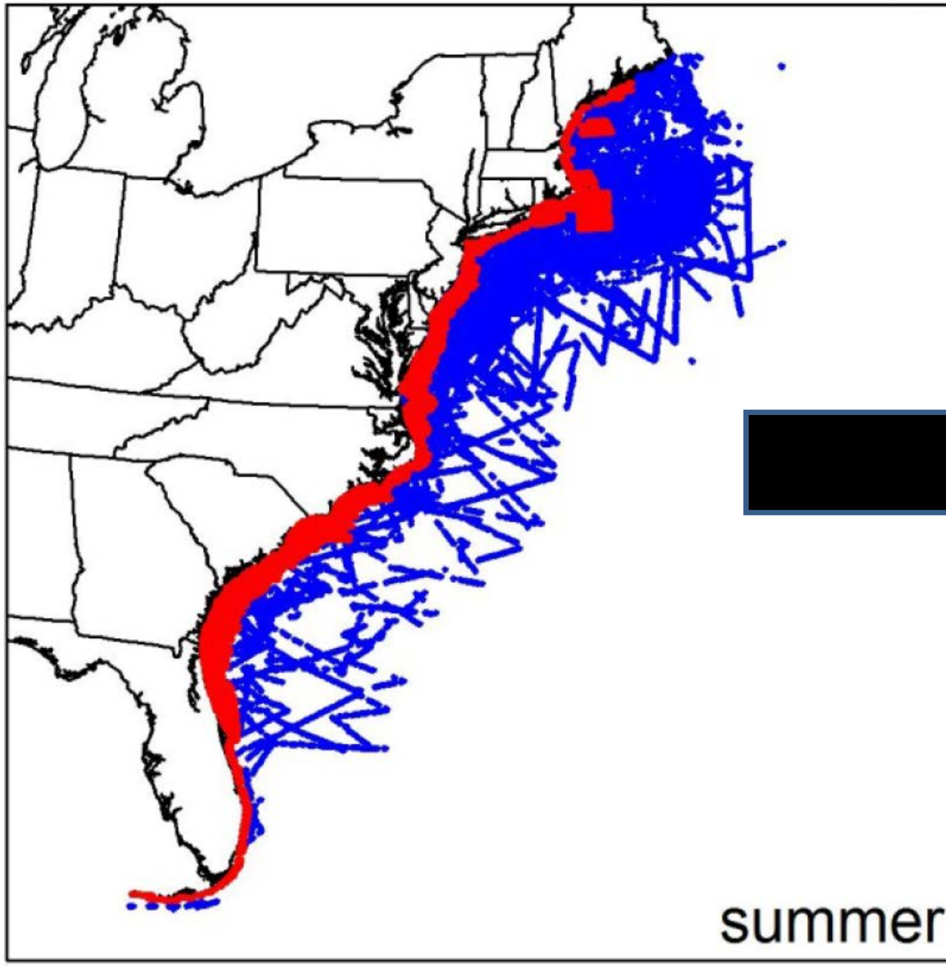
2. Develop statistically-driven guidelines for new marine bird sampling efforts

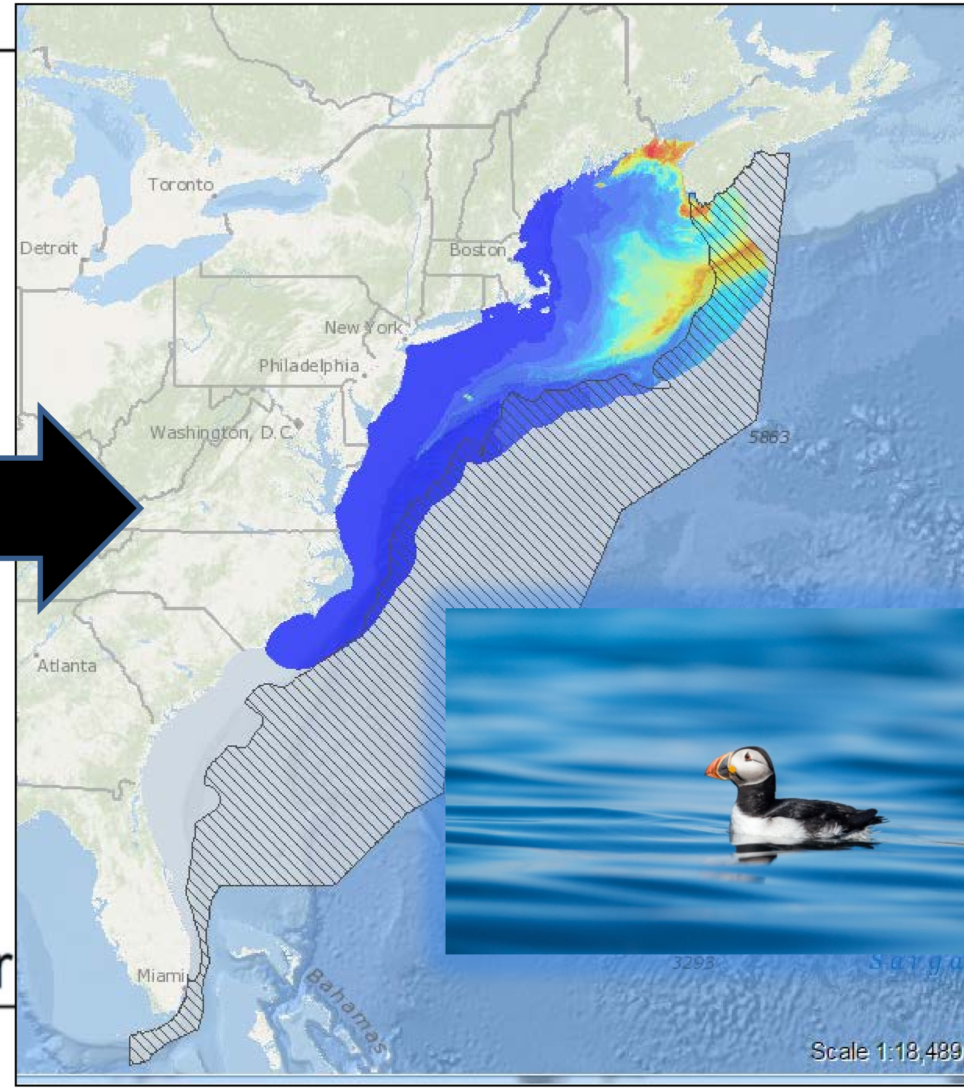
"Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf: Maine – Florida"
https://coastalscience.noaa.gov/projects/detail?key=279

Sampling Seabirds At-Sea

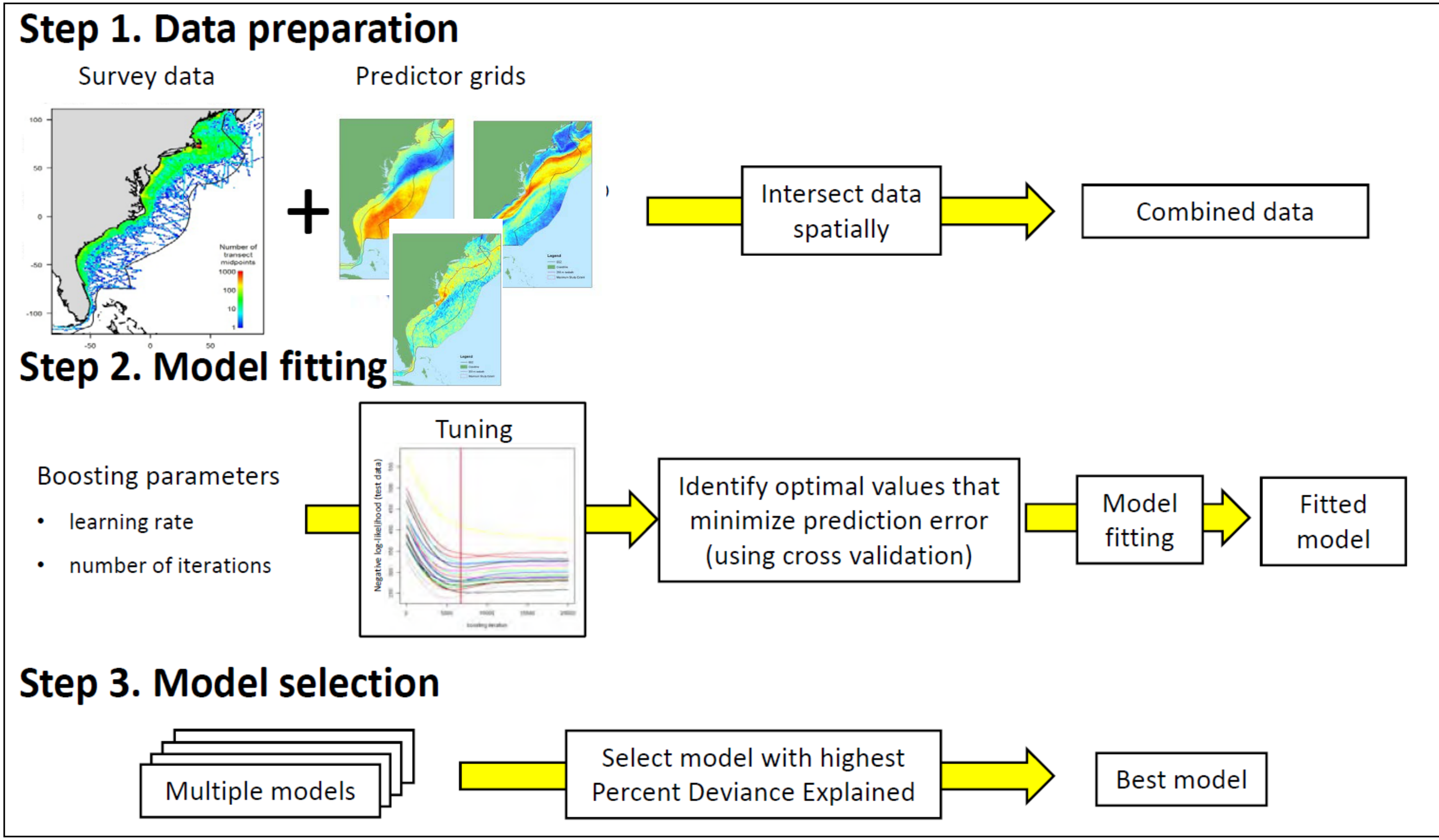


Models as Tools for Data Synthesis





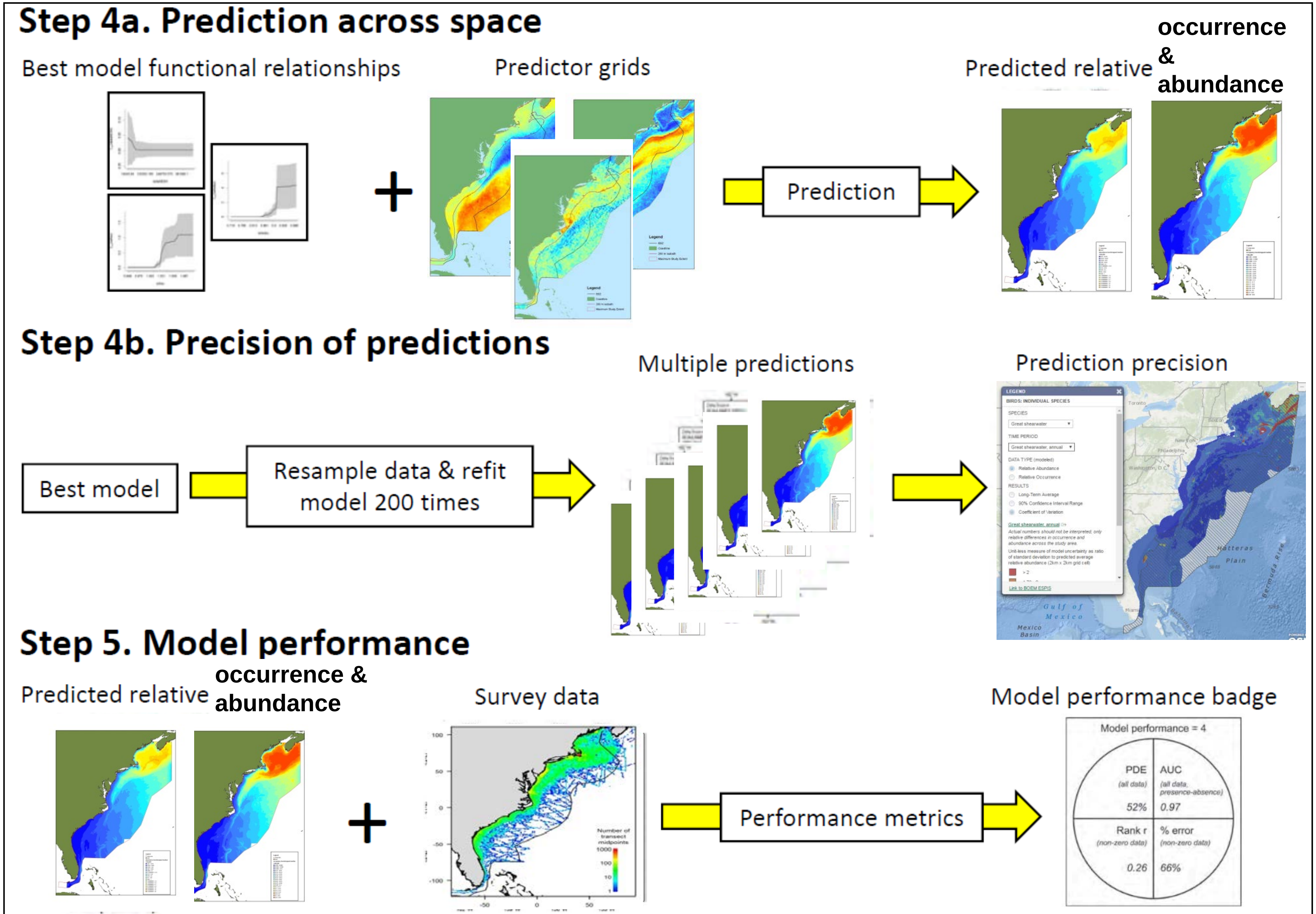
Model Development



Gory details…

- Uses generalized additive models of location, scale and shape (GAMLSS), modified for zero-inflated count distributions (zero-inflated poisson and zero-inflated negative binomial error distributions)
- Fits models using a machine learning technique known as componentwise ensemble boosting with stochastic gradient descent
- Detailed methods in: *Winship et al. 2016, Menza et al. 2016;* Additional background in: *Borisov et al. 2009, Elith et al. 2008*

Model Application

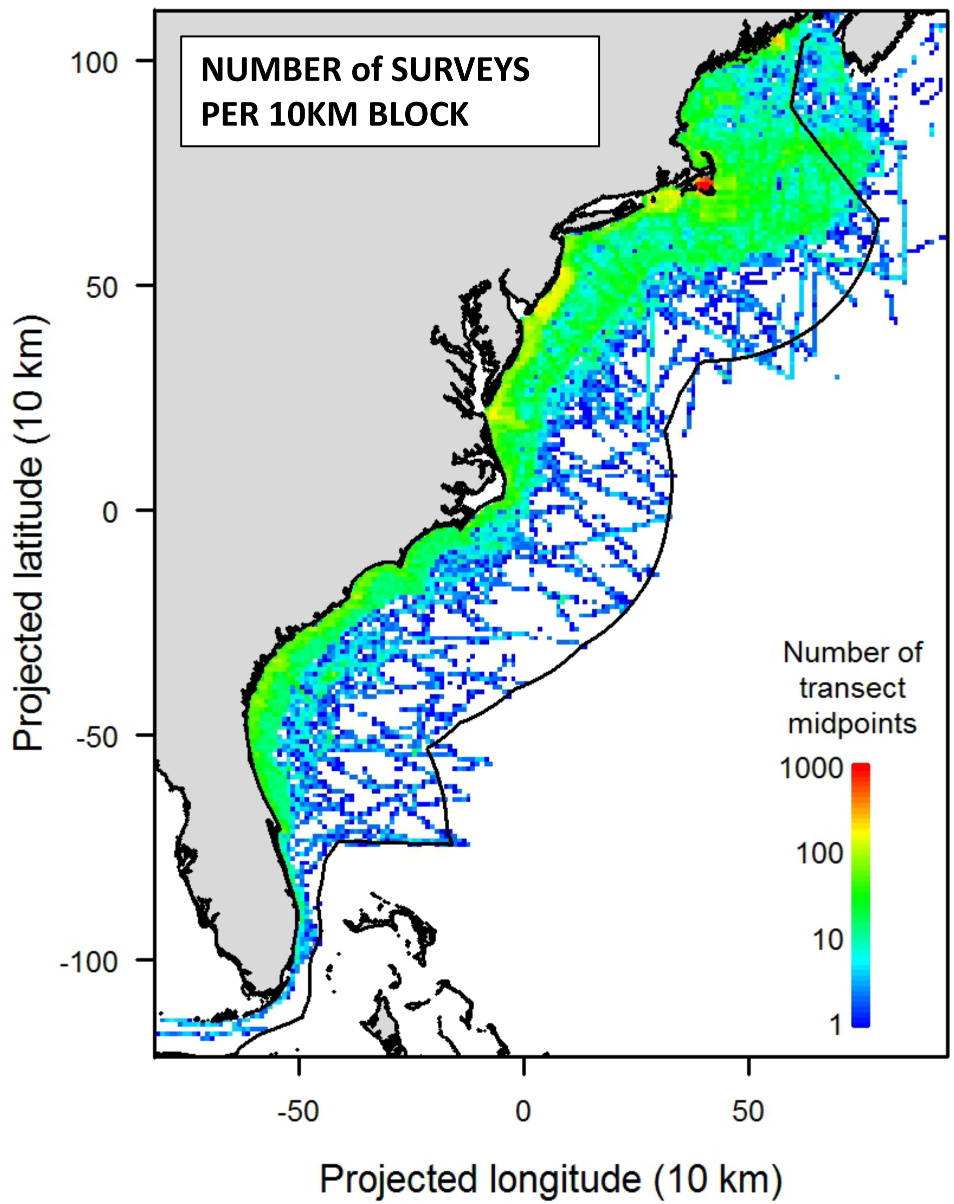


Survey Data

Northwest Atlantic Seabird Catalogue

BOEM, USGS, USFWS (O'Connell et al. 2009, Johnston et al. 2011, O'Connell et al. 2015)

- Developed over 10+ years from 2005-present
- **76** at-sea scientific survey datasets: **62** ship-based, **14** aerial*
- Segmented and standardized to **10 knot/15-minute/300m** strip transect equivalents (~4.6km)
- **111,713** survey transects: **>517km** linear distance, **>155 km^2** area, **>1163 days** equivalent survey effort, spanning from **1978-2014** (**37** years)
- Focus on **46** priority species, produced **134** seasonal abundance models (**spring**, **summer**, **fall**, **winter**)

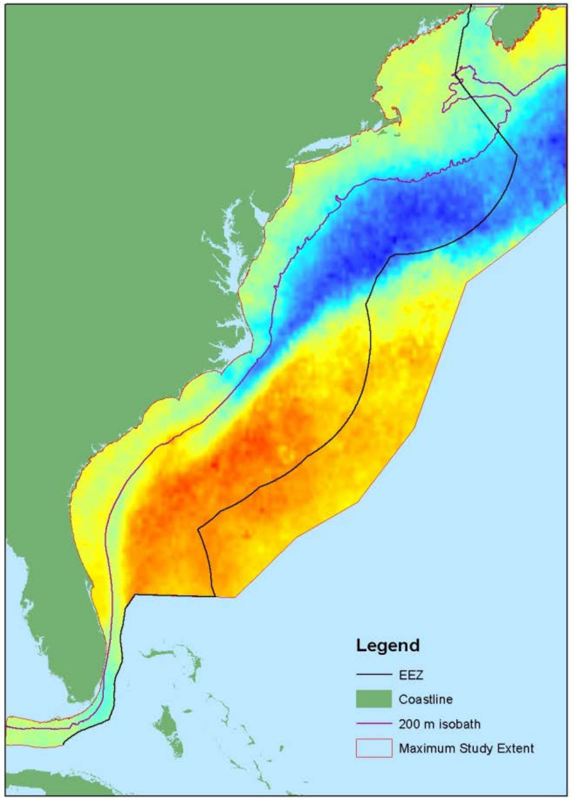


**for Phase I; more datasets will be included in next version of model due in late 2017*

Environmental Predictor Grids
EXAMPLES

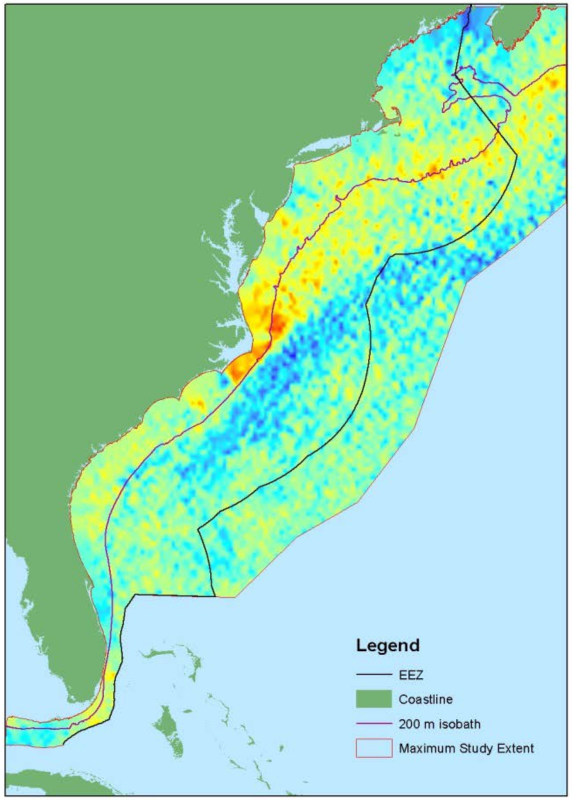
WIND

QuikScat N-S Wind Stress (Spring)



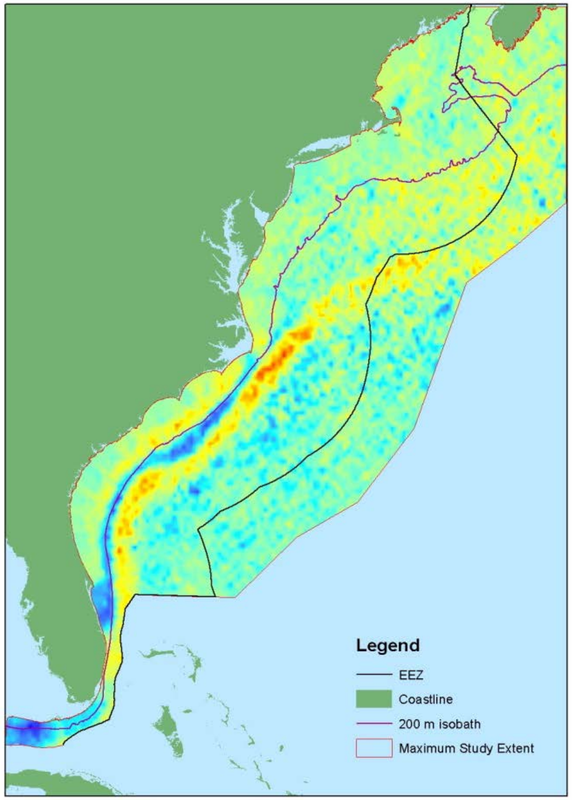
WIND DIVERGENCE

QuikScat Surface Wind Divergence (Spring)



UPWELLING

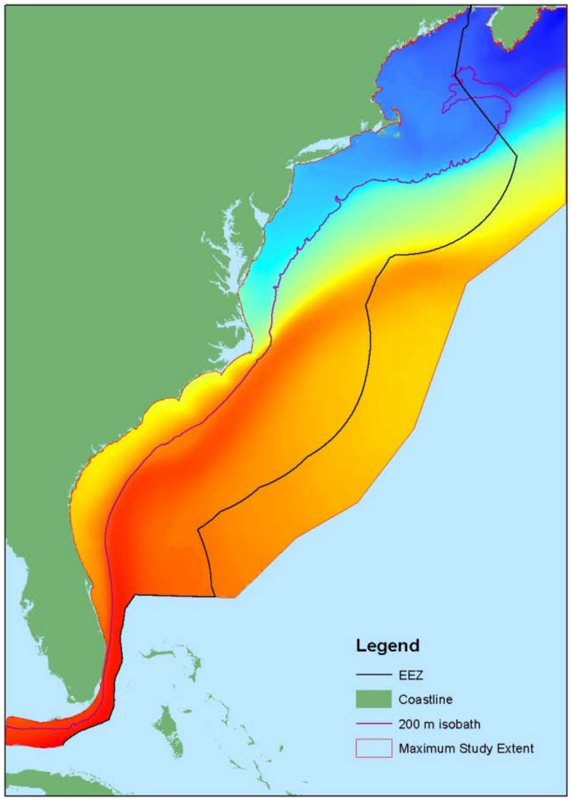
QuikScat Wind-Driven Upwelling Index (Spring)



Environmental Predictor Grids
EXAMPLES

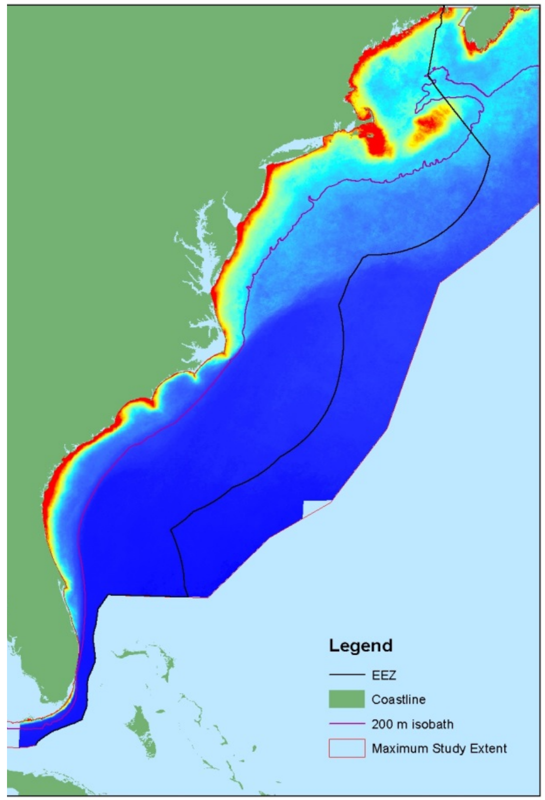
TEMPERATURE

SST
(Spring)



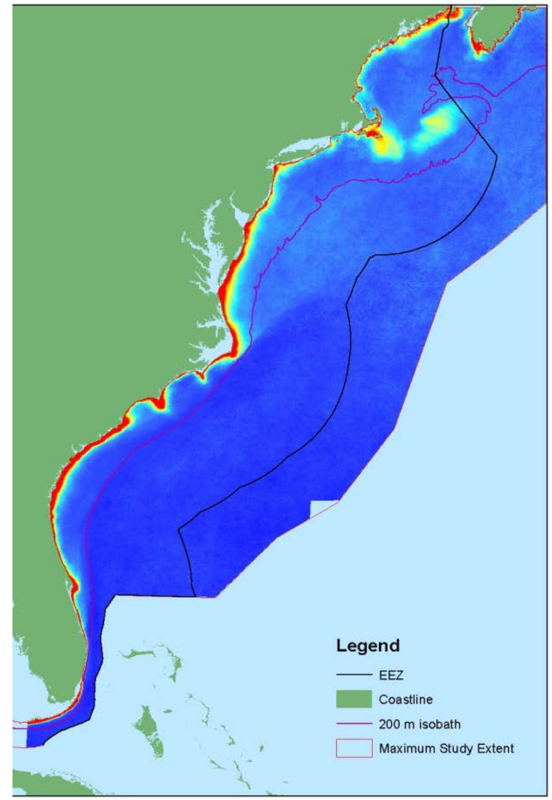
1º PRODUCTIVITY

Surface Chlorophyll-a
(Spring)



TURBIDITY

Surface Turbidity Index (Rrs-670nm)
(Spring)

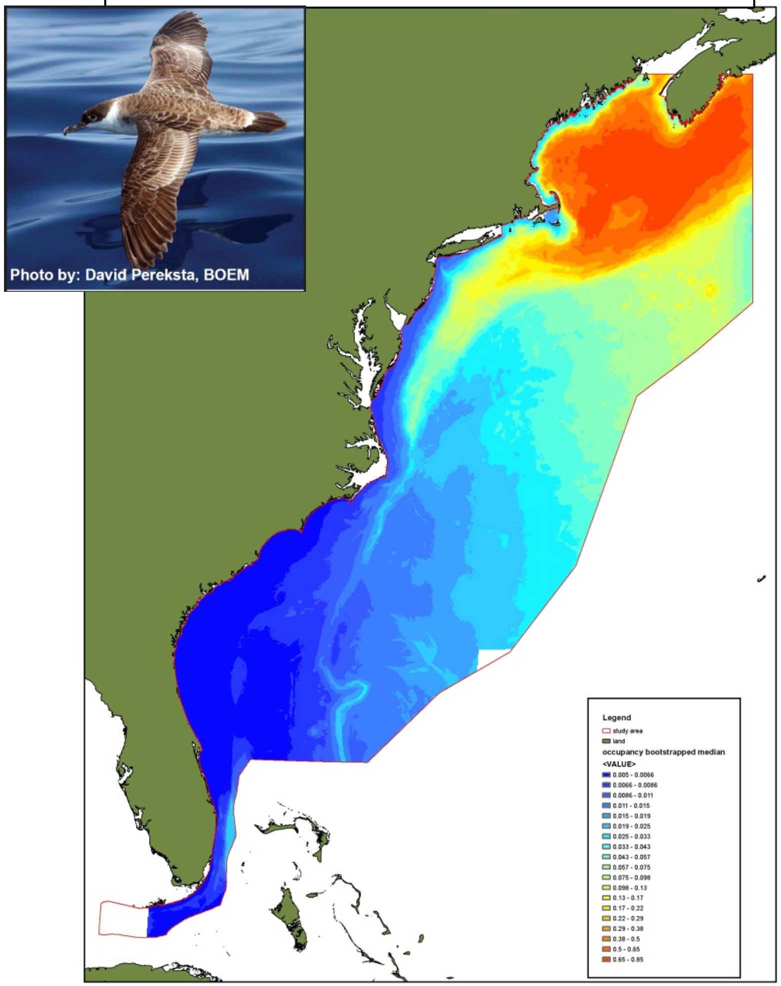


Environmental Predictor Grids

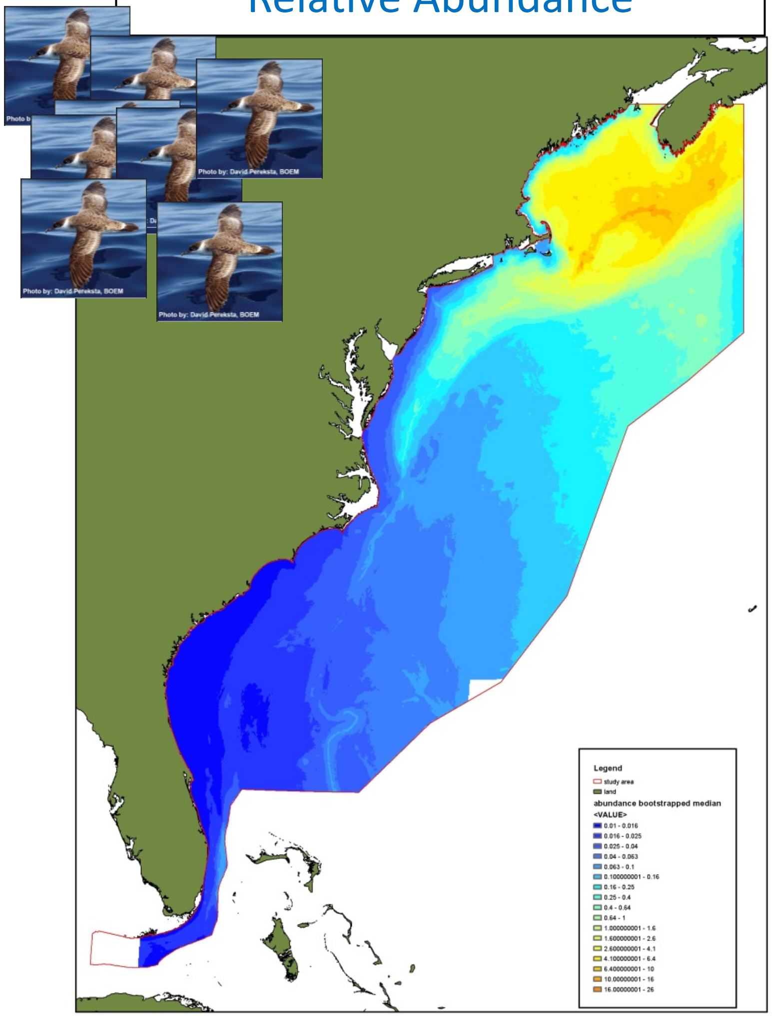
Variable	Type	Dynamic
chlorophyll-a	spatial	yes (seasonal)
turbidity	spatial	yes (seasonal)
upwelling index	spatial	yes (seasonal)
sea surface temperature	spatial	yes (seasonal)
sea surface temperature SD	spatial	yes (seasonal)
sea surface temperature front probability	spatial	yes (seasonal)
sea surface height	spatial	yes (seasonal)
sea surface height SD	spatial	yes (seasonal)
probability of cyclonic eddy ring	spatial	yes (seasonal)
probability of anticyclonic eddy ring	spatial	yes (seasonal)
water current (u direction)	spatial	yes (seasonal)
water current (v direction)	spatial	yes (seasonal)
water current divergence	spatial	yes (seasonal)
water current vorticity	spatial	yes (seasonal)
wind stress (u direction)	spatial	yes (seasonal)
wind stress (v direction)	spatial	yes (seasonal)
wind divergence	spatial	yes (seasonal)
depth	spatial	no
slope (1.5 and 10 km resolution)	spatial	no
slope of slope (10 km resolution)	spatial	no
planform curvature (10 km resolution)	spatial	no
profile curvature (10 km resolution)	spatial	no
distance to shelf break (200 m isobath)	spatial	no
distance to land	spatial	no
longitude (projected)	spatial	no
latitude (projected)	spatial	no
year	temporal	yes (yearly)
day of year	temporal	yes (daily)
Monthly North Atlantic Oscillation (NAO) index (current and 1-year lag)	temporal	yes (monthly)
Monthly Multivariate El Nino-Southern Oscillation index (MEI) (current and 1-year lag)	temporal	yes (monthly)
Monthly Trans-Nino Index (TNI) (current and 1-year lag)	temporal	yes (monthly)
Monthly Atlantic Multidecadal Oscillation (AMO) index (current and 1-year lag)	temporal	yes (monthly)

Output: Maps of long-term occurrence and abundance patterns

Great shearwater (fall)
Relative Occurrence

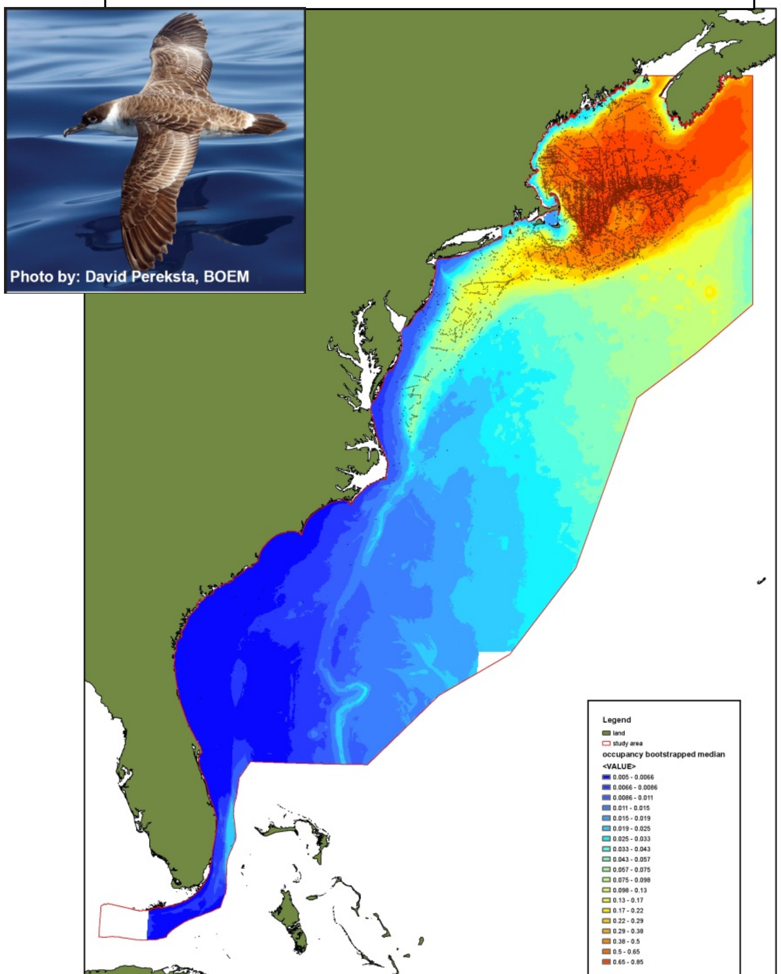


Great shearwater (fall)
Relative Abundance

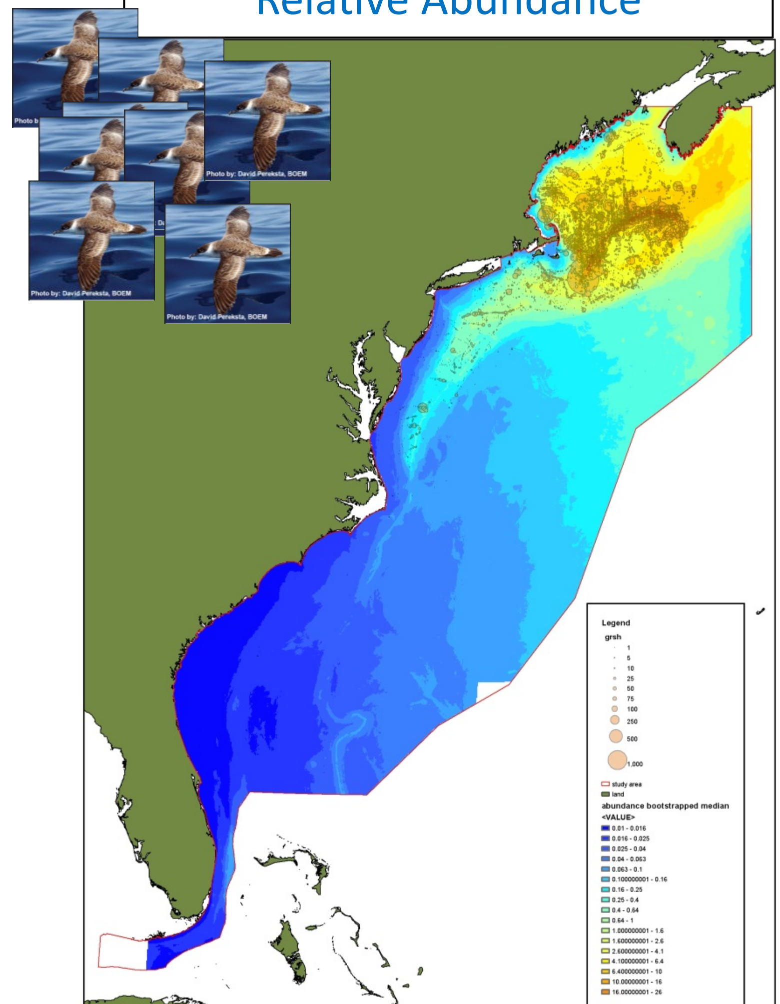


Models agree with sightings data, but generalize scattered data to a gap-free map

Great shearwater (fall)
Relative Occurrence

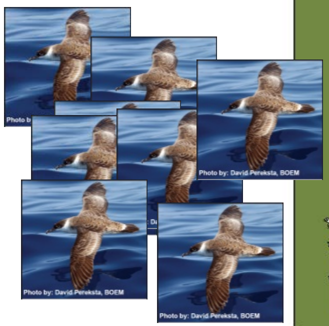


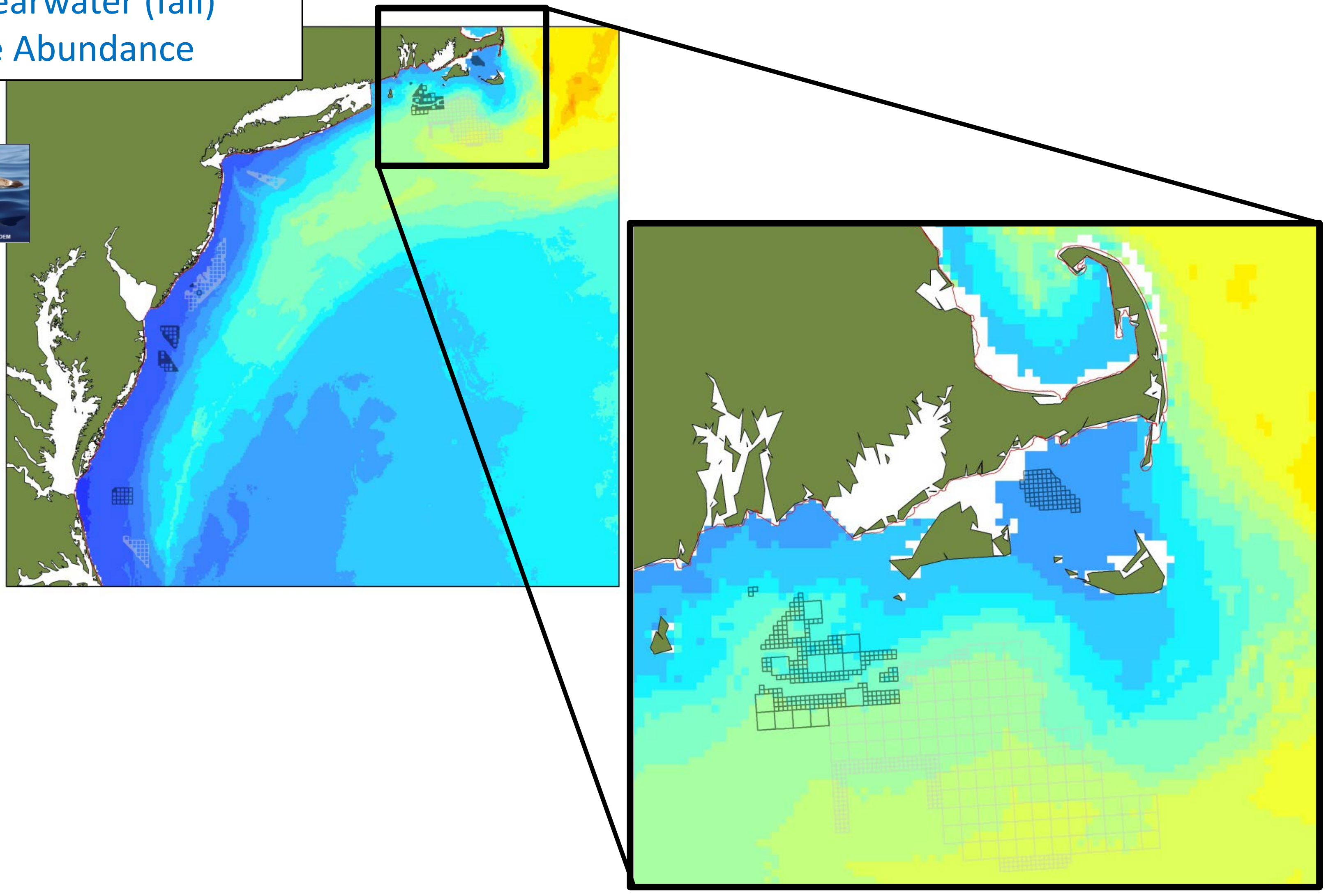
Great shearwater (fall)
Relative Abundance



Resolution matched to planning needs

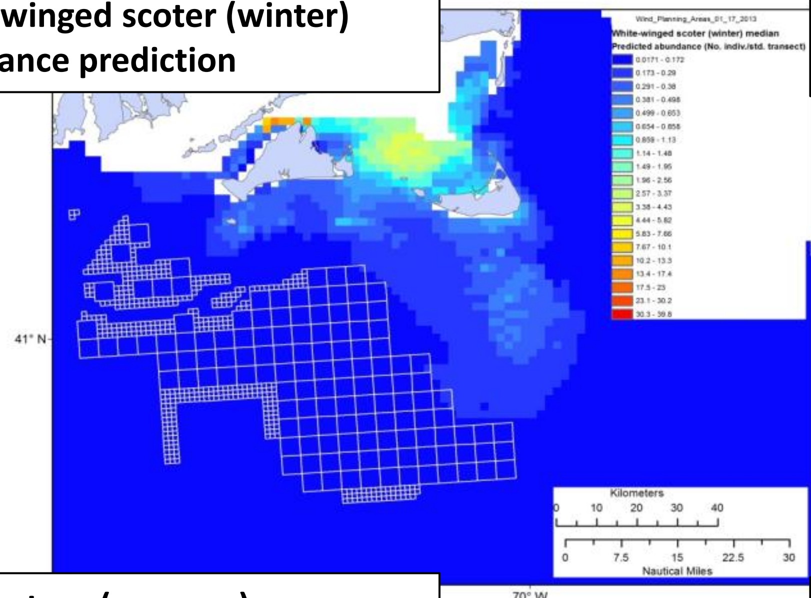
Great shearwater (fall)
Relative Abundance



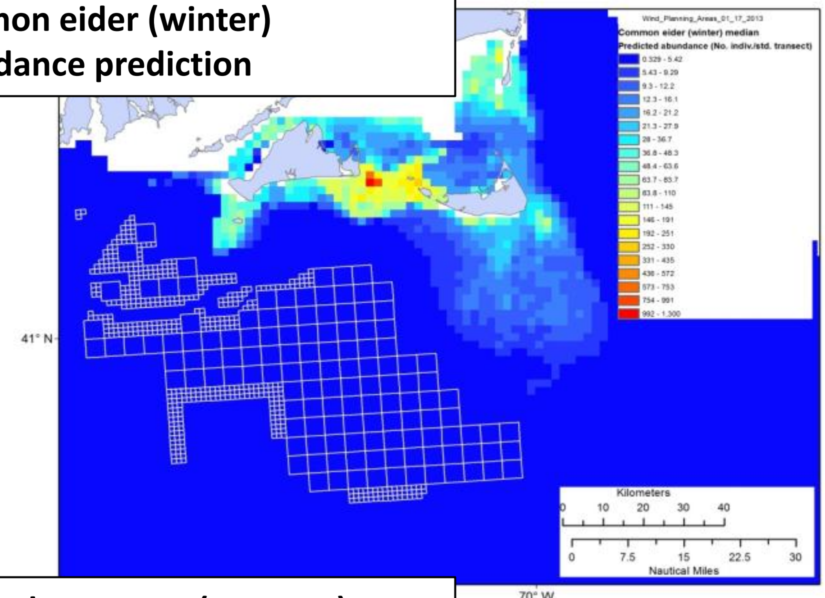


Value of fine-scale information

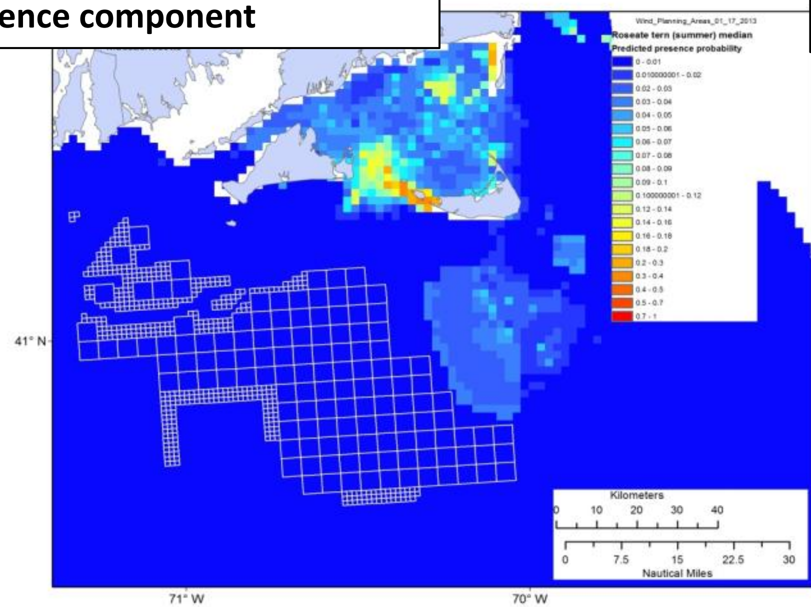
White-winged scoter (winter)
Abundance prediction



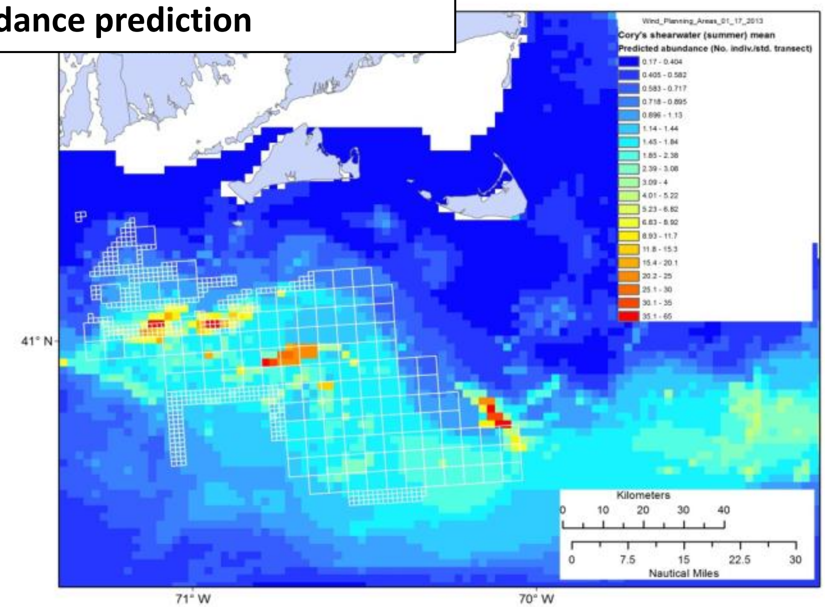
Common eider (winter)
Abundance prediction



Roseate tern (summer)
Occurrence component

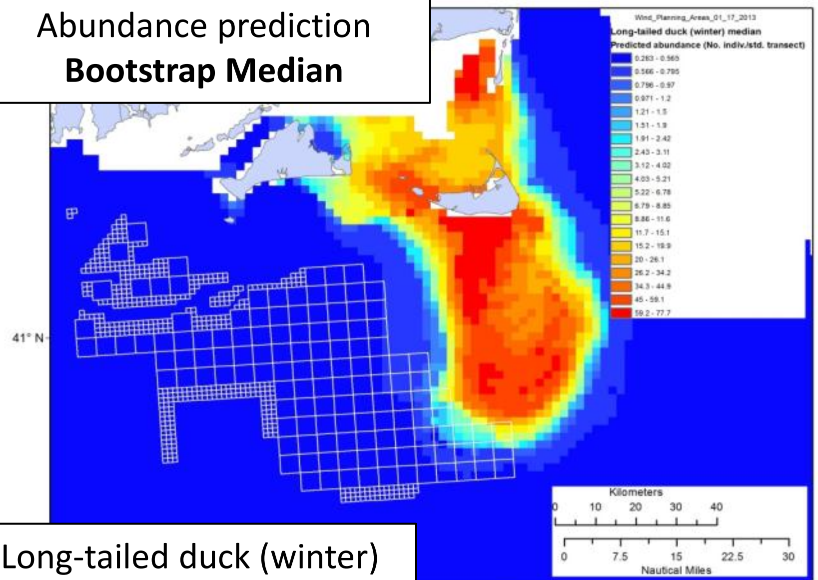


Cory's shearwater (summer)
Abundance prediction

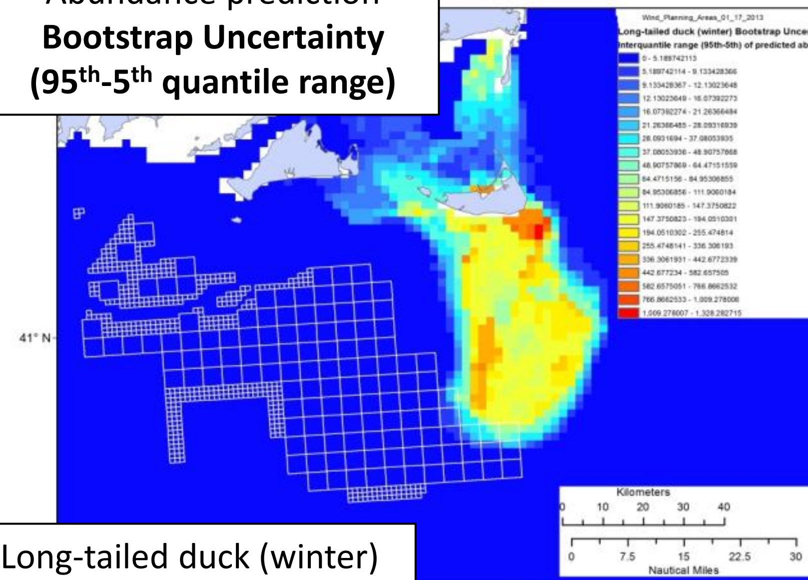


Value of model uncertainty assessment

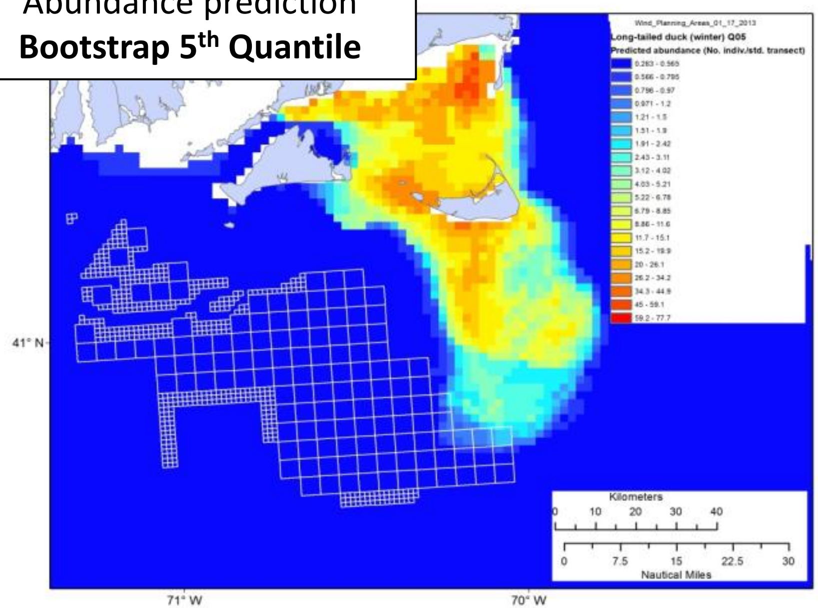
Long-tailed duck (winter)
Abundance prediction
Bootstrap Median



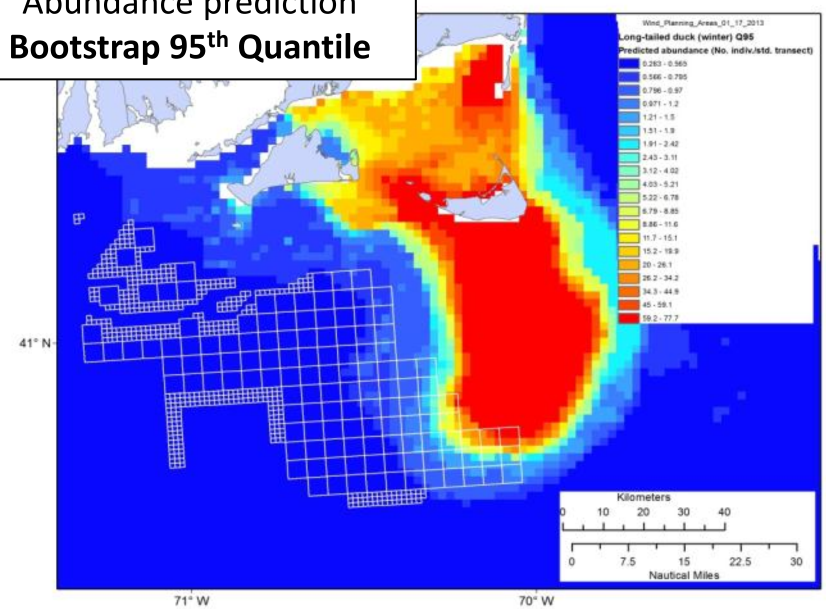
Long-tailed duck (winter)
Abundance prediction
Bootstrap Uncertainty
(95th-5th quantile range)



Long-tailed duck (winter)
Abundance prediction
Bootstrap 5th Quantile

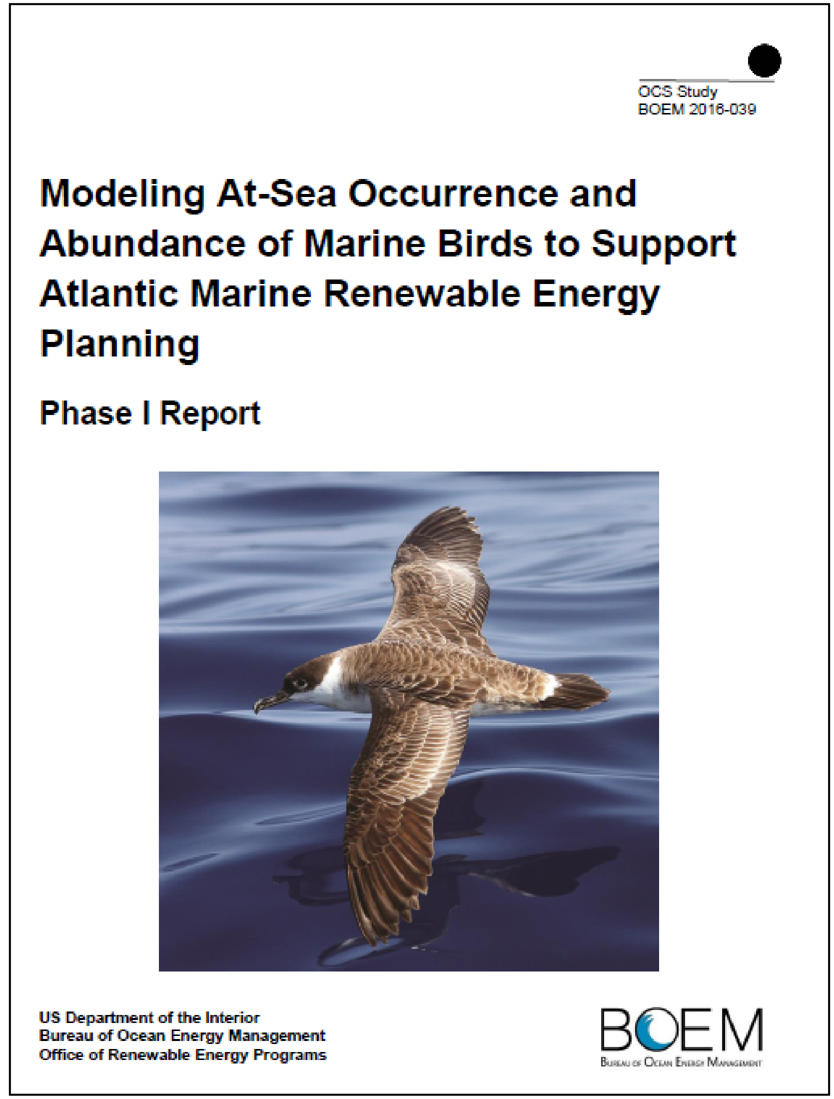


Long-tailed duck (winter)
Abundance prediction
Bootstrap 95th Quantile



How do I access these maps?

1. Report and GIS data packages available on NOAA NCCOS website: https://coastalscience.noaa.gov/projects/detail?key=279



OCS Study
BOEM 2016-039

Modeling At-Sea Occurrence and Abundance of Marine Birds to Support Atlantic Marine Renewable Energy Planning

Phase I Report

US Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

BOEM
Bureau of Ocean Energy Management

How do I access these maps?

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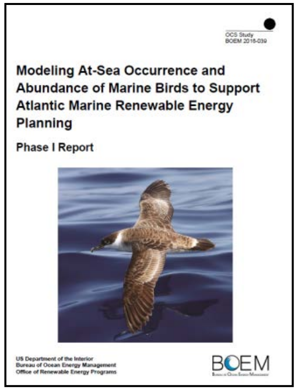
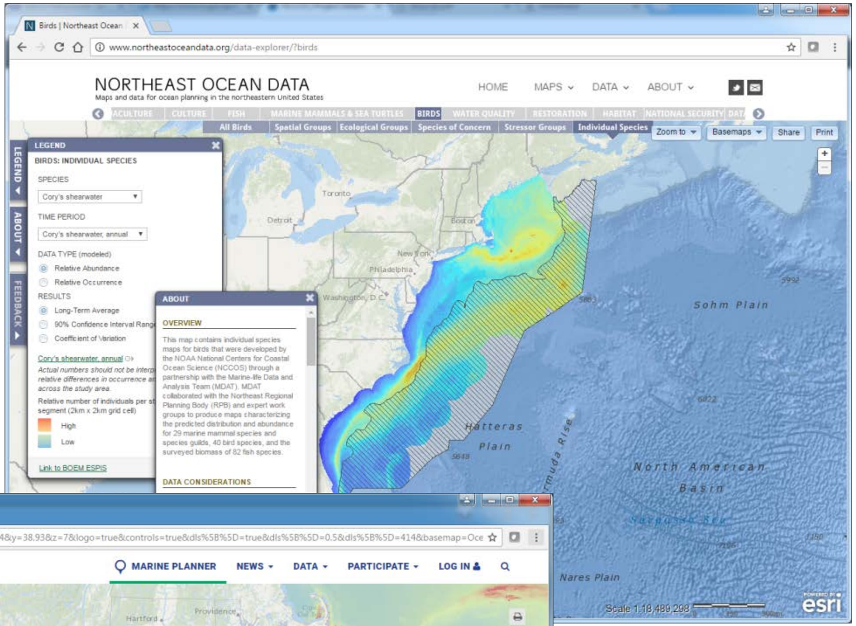
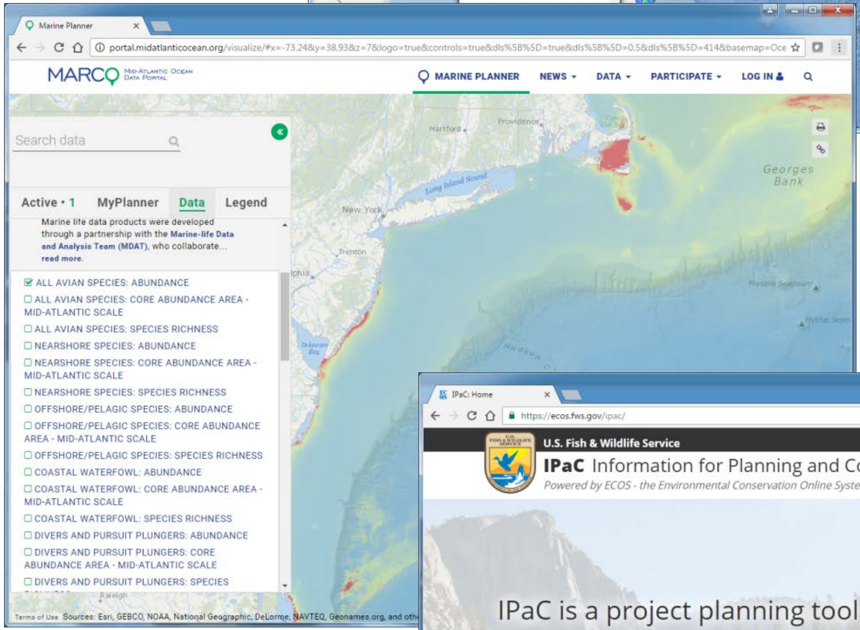


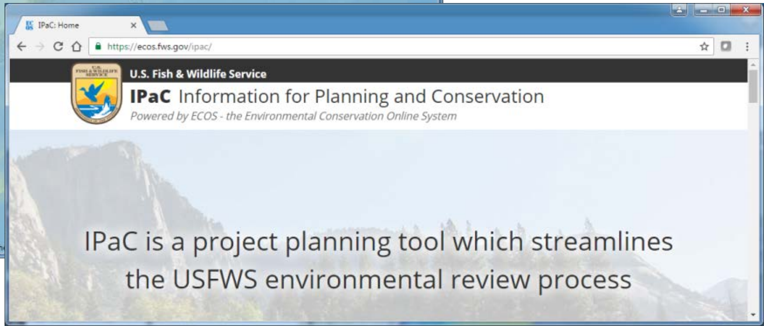
2. Northeast Regional Ocean Council (NROC) Ocean Planning Data Portal http://www.northeastoceandata.org/data-explorer/?birds



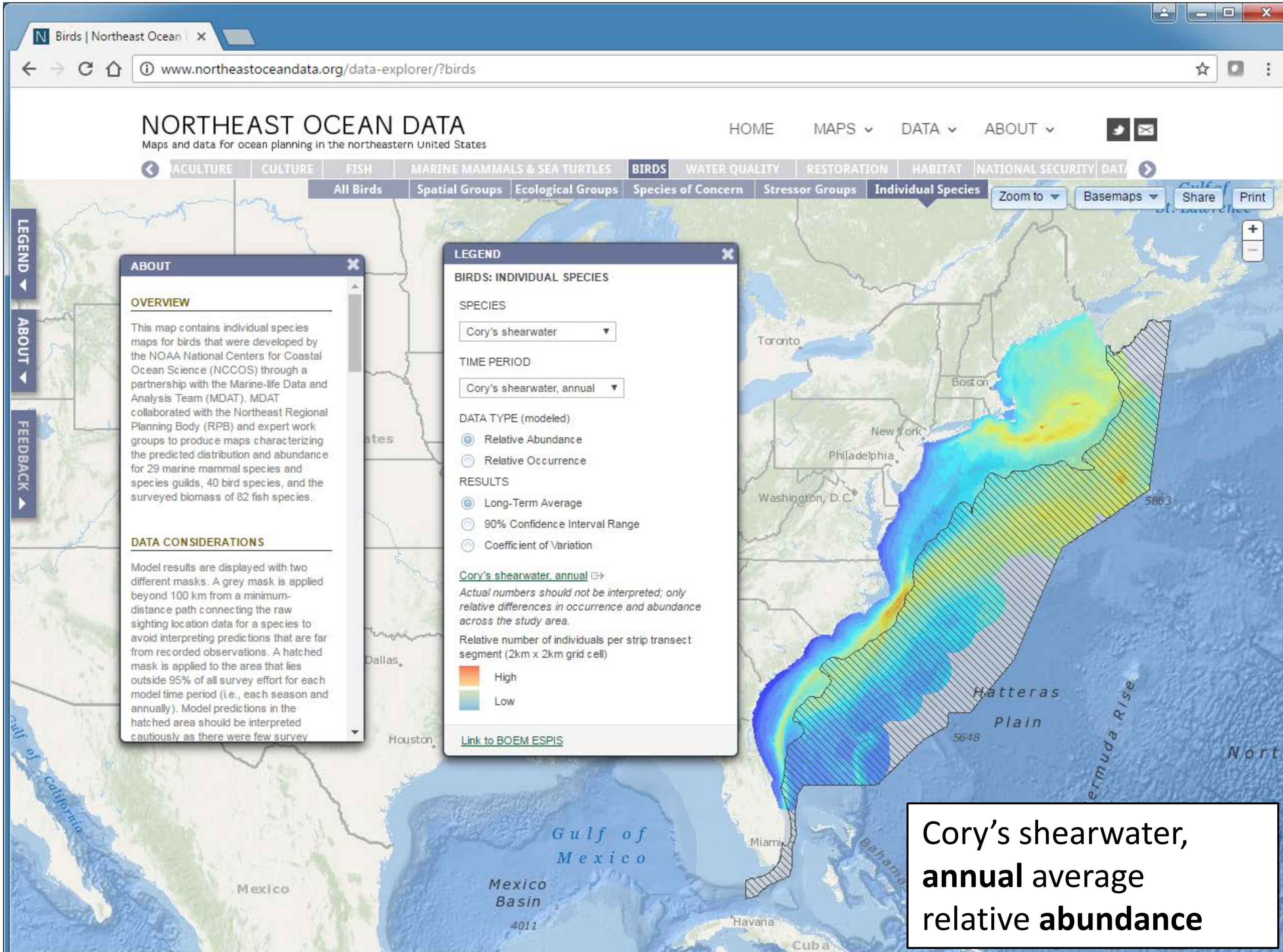
3. Mid-Atlantic Regional Council on the Ocean (MARCO) Ocean Planning Data Portal http://portal.midatlanticocean.org/



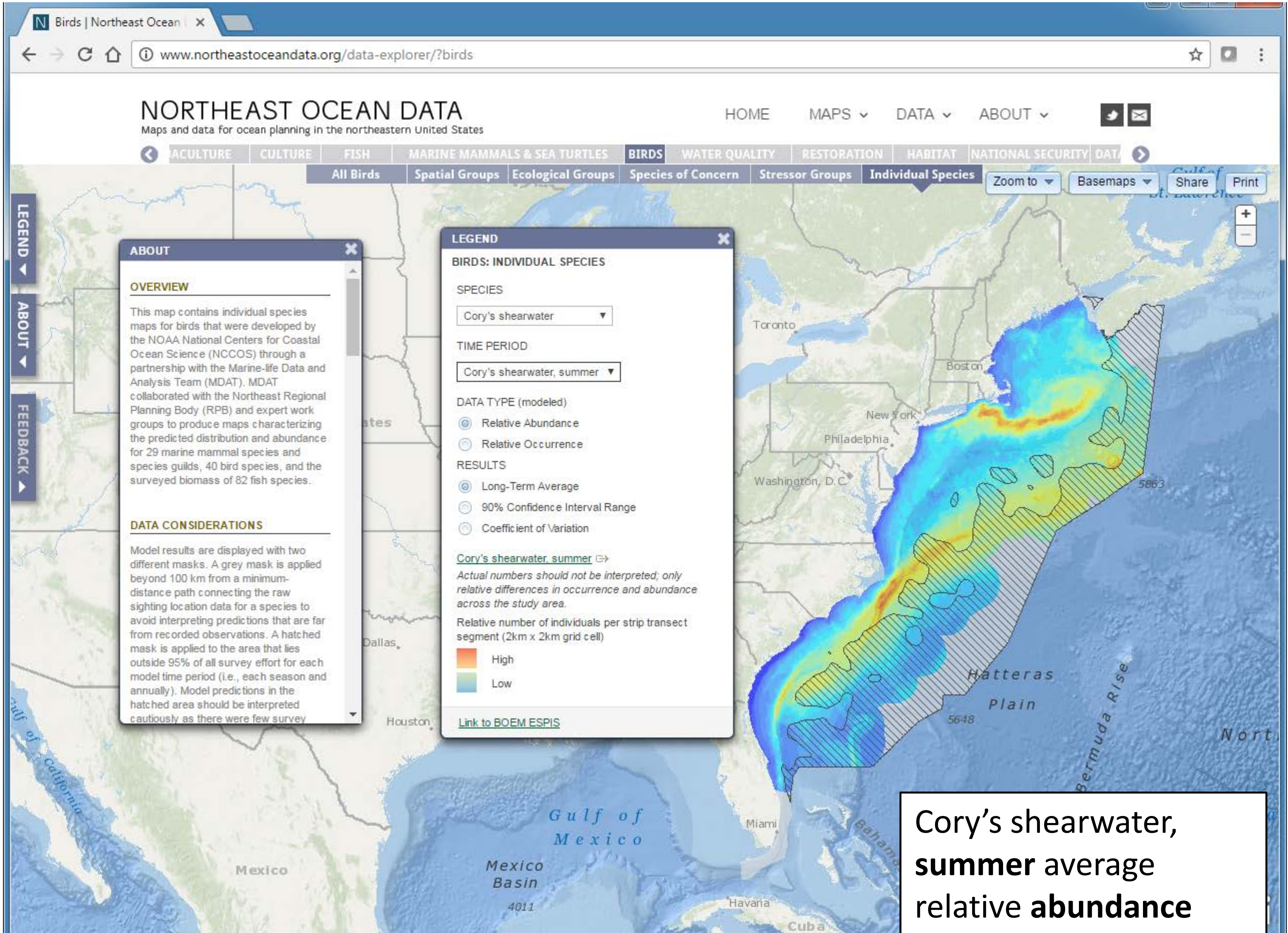
4. USFWS IPaC Tool https://ecos.fws.gov/ipac/



NortheastOceanData.Org Demo

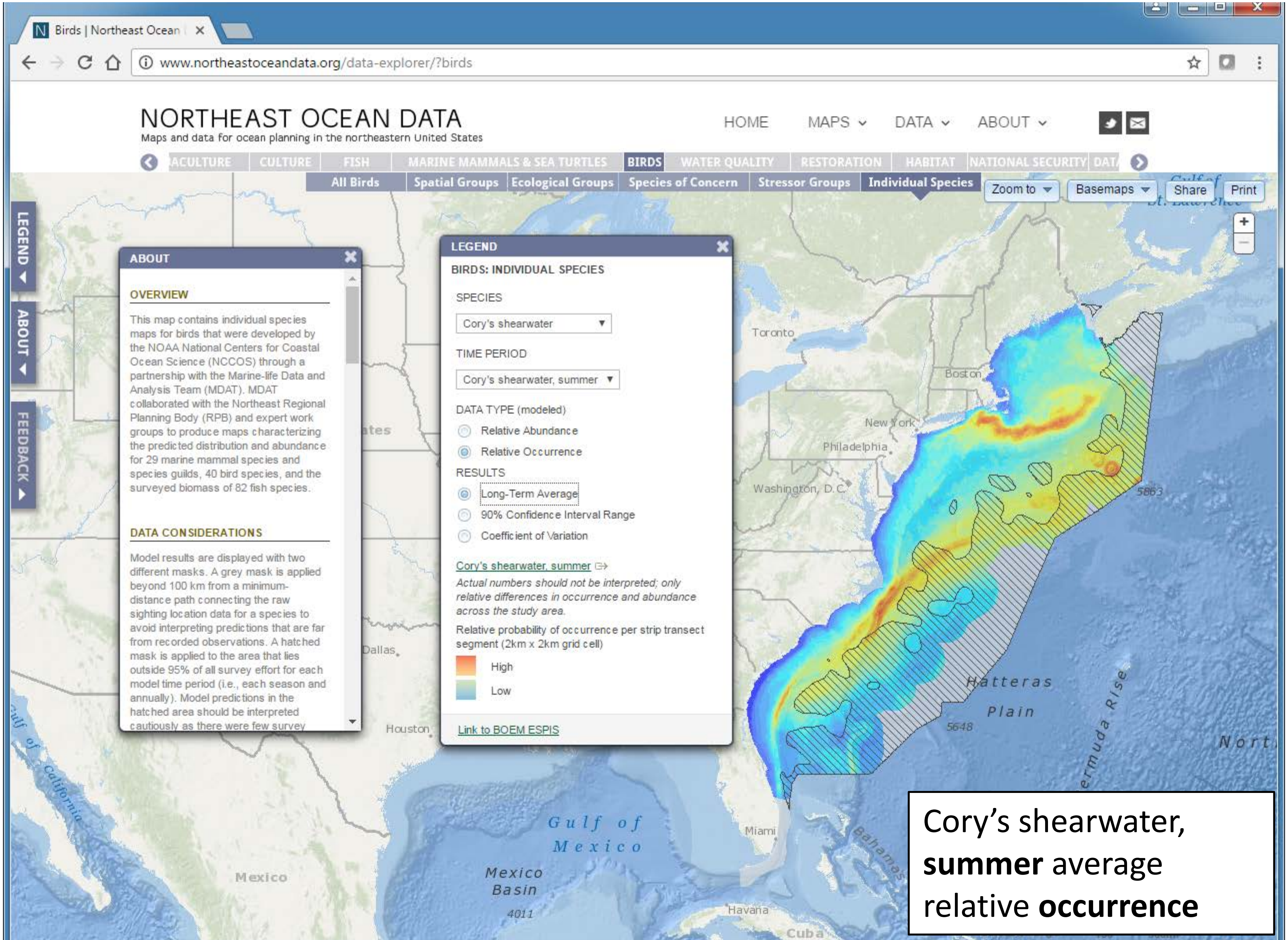


Seasonal patterns



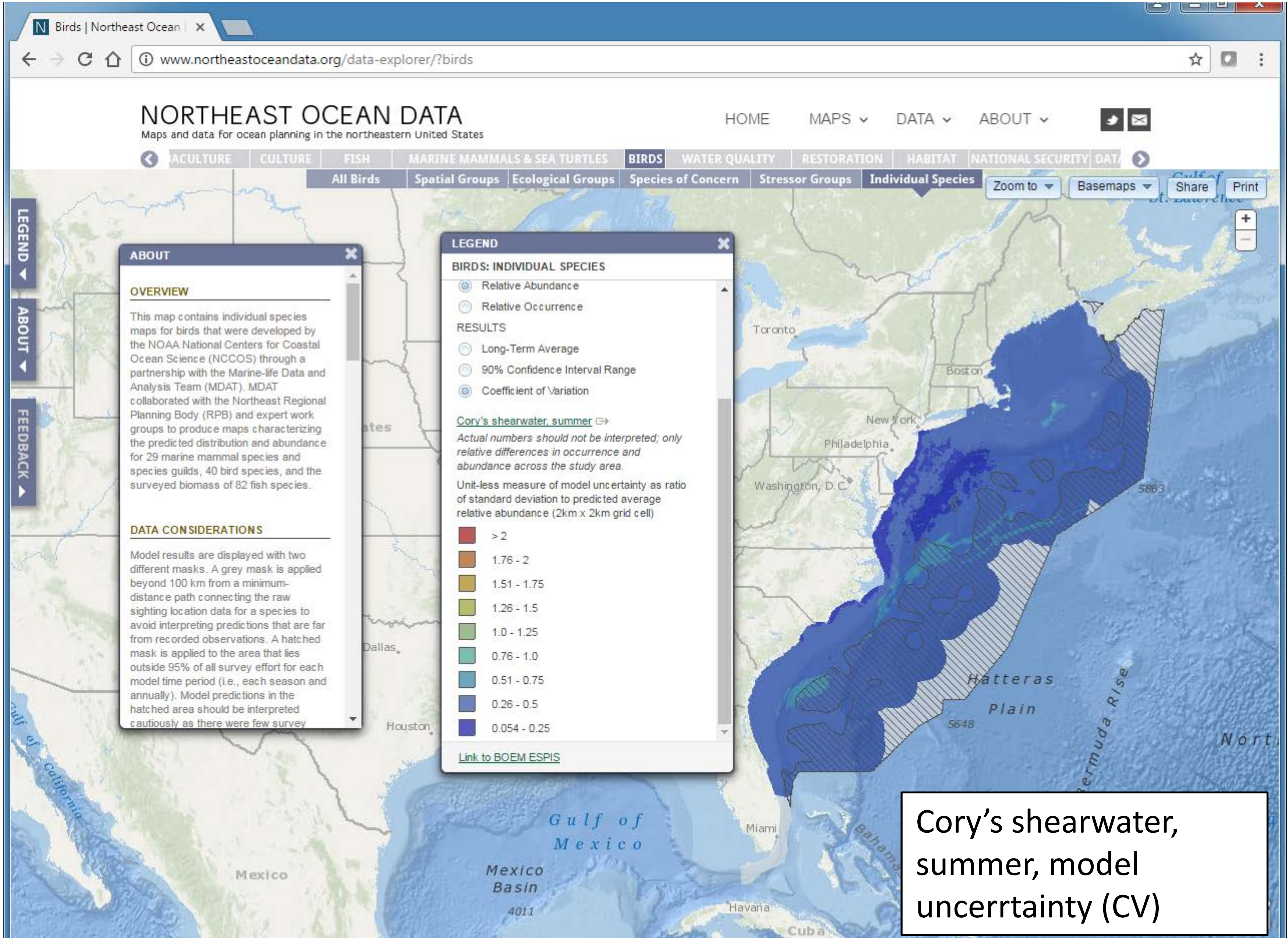
Cory's shearwater, **summer** average relative **abundance**

Occurrence



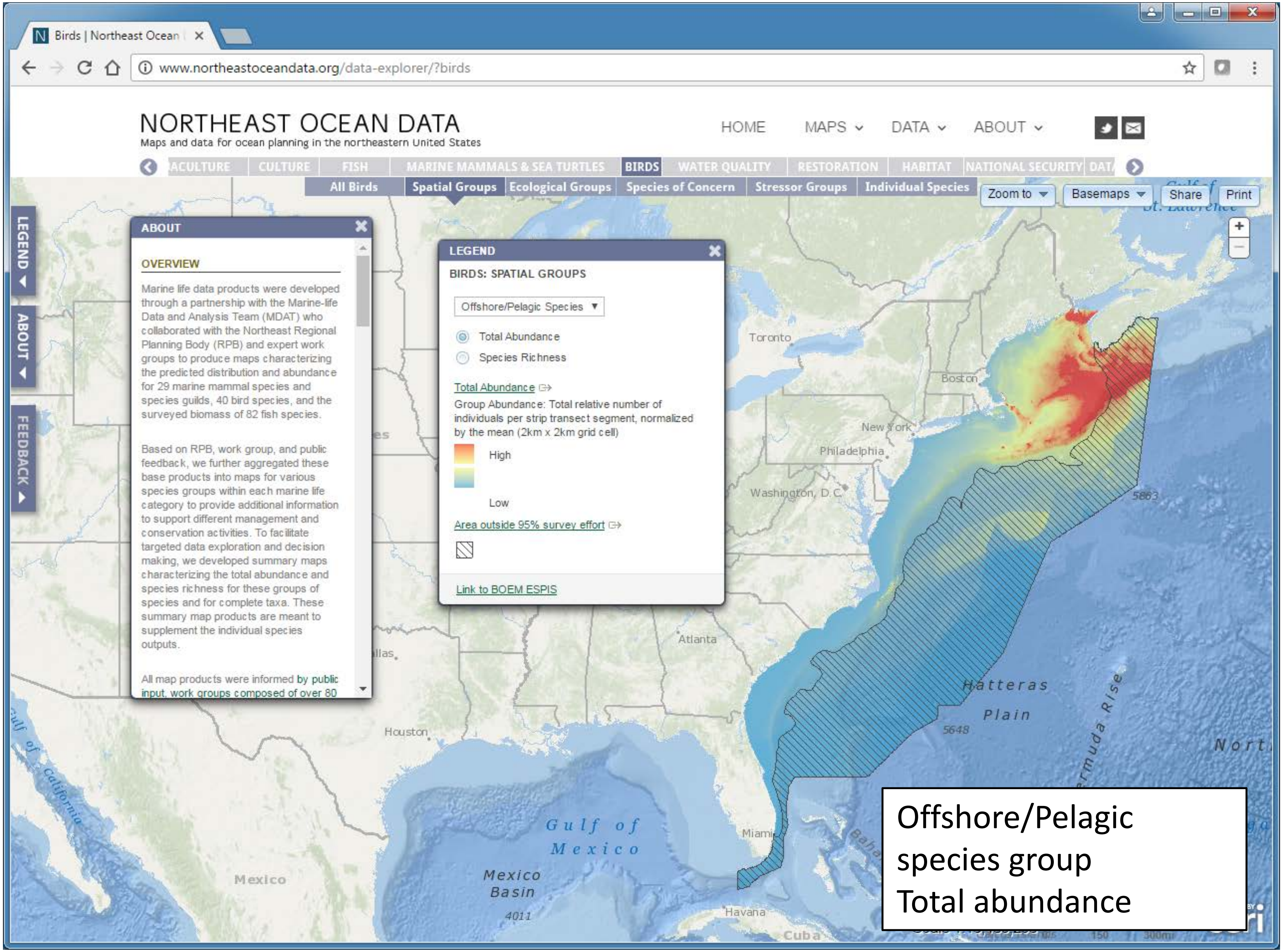
Cory's shearwater, **summer** average relative **occurrence**

Model Uncertainty



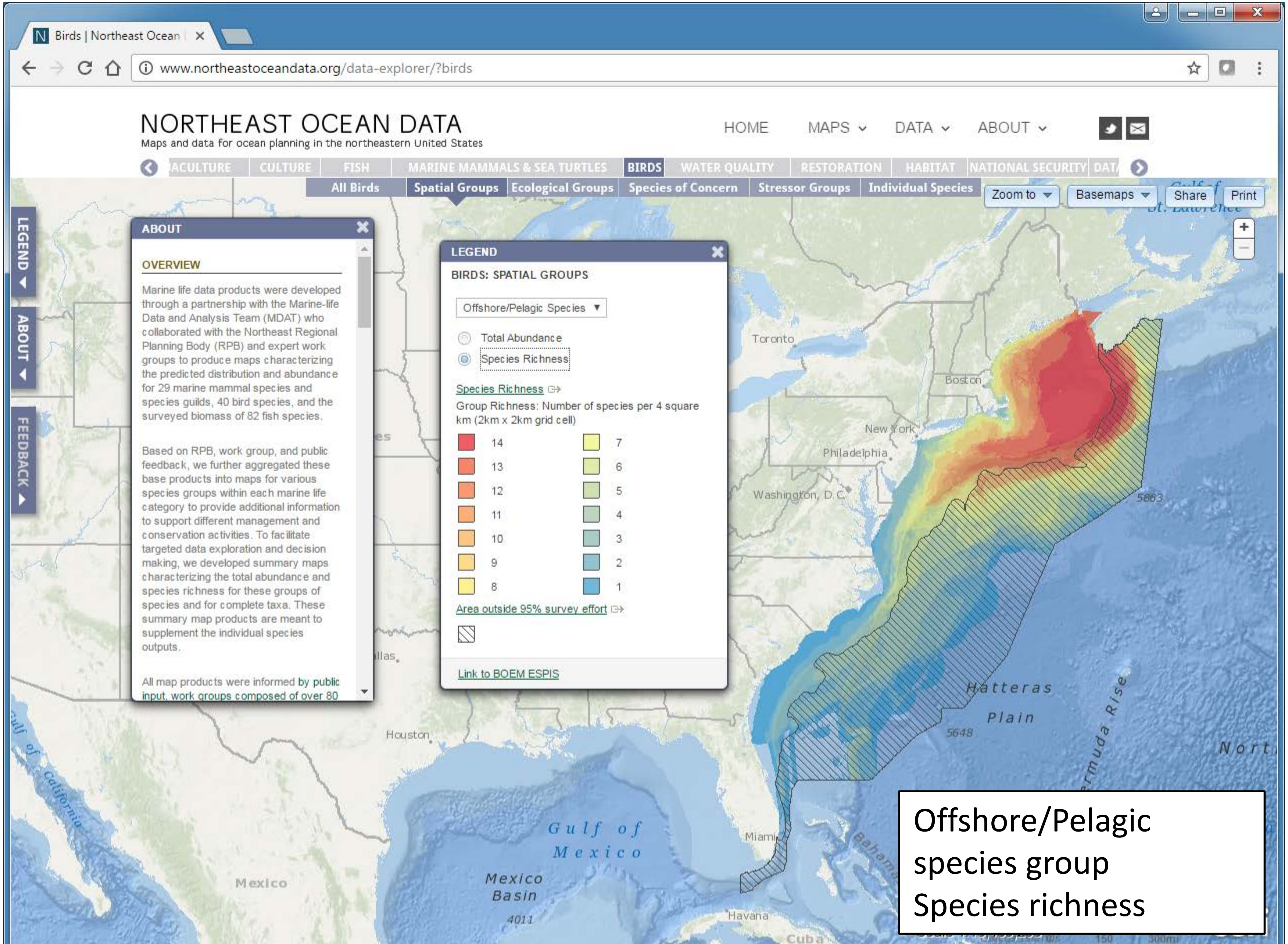
Cory's shearwater, summer, model uncerrtainty (CV)

Species Group Patterns



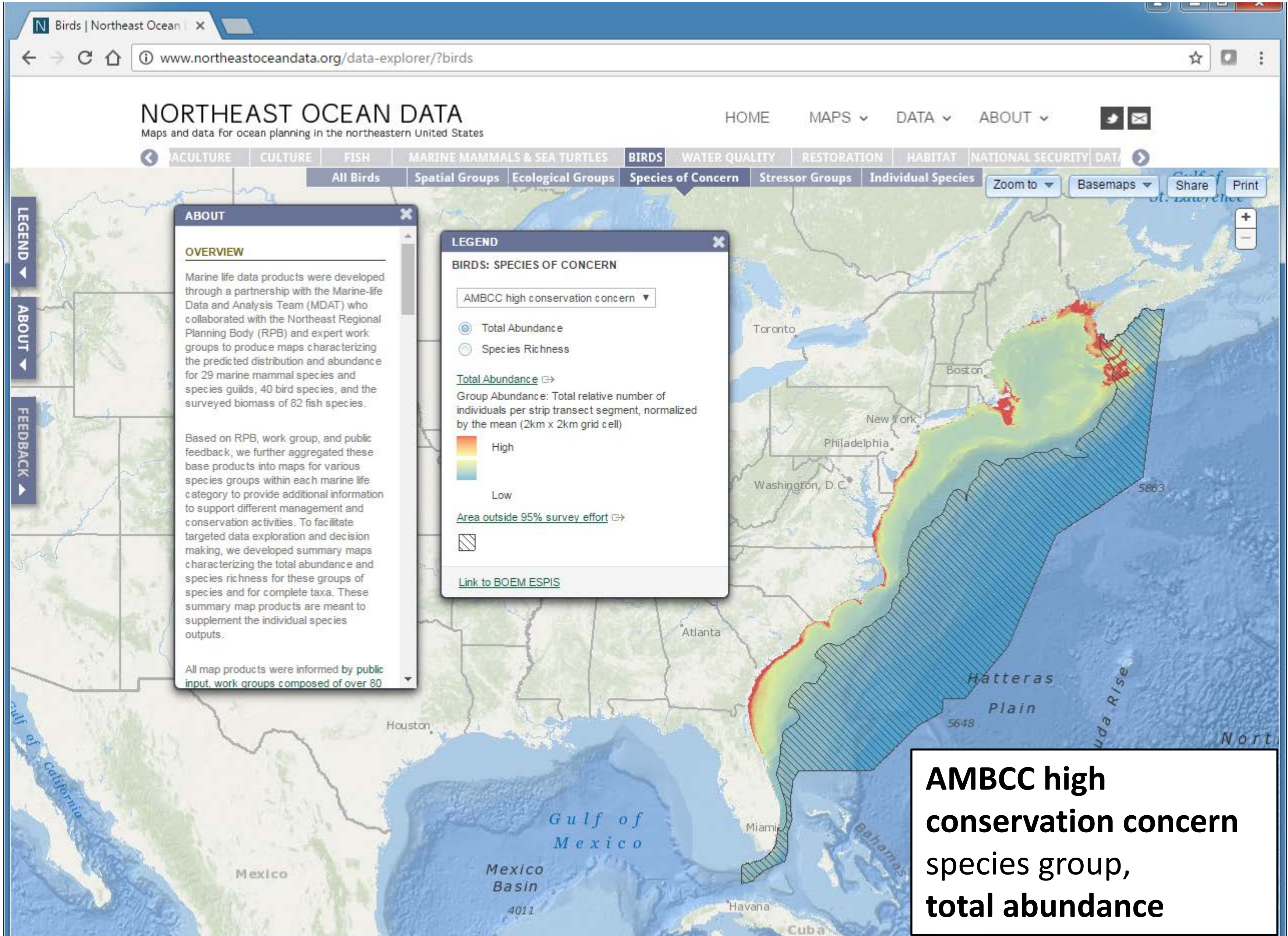
Offshore/Pelagic species group
Total abundance

Species Richness



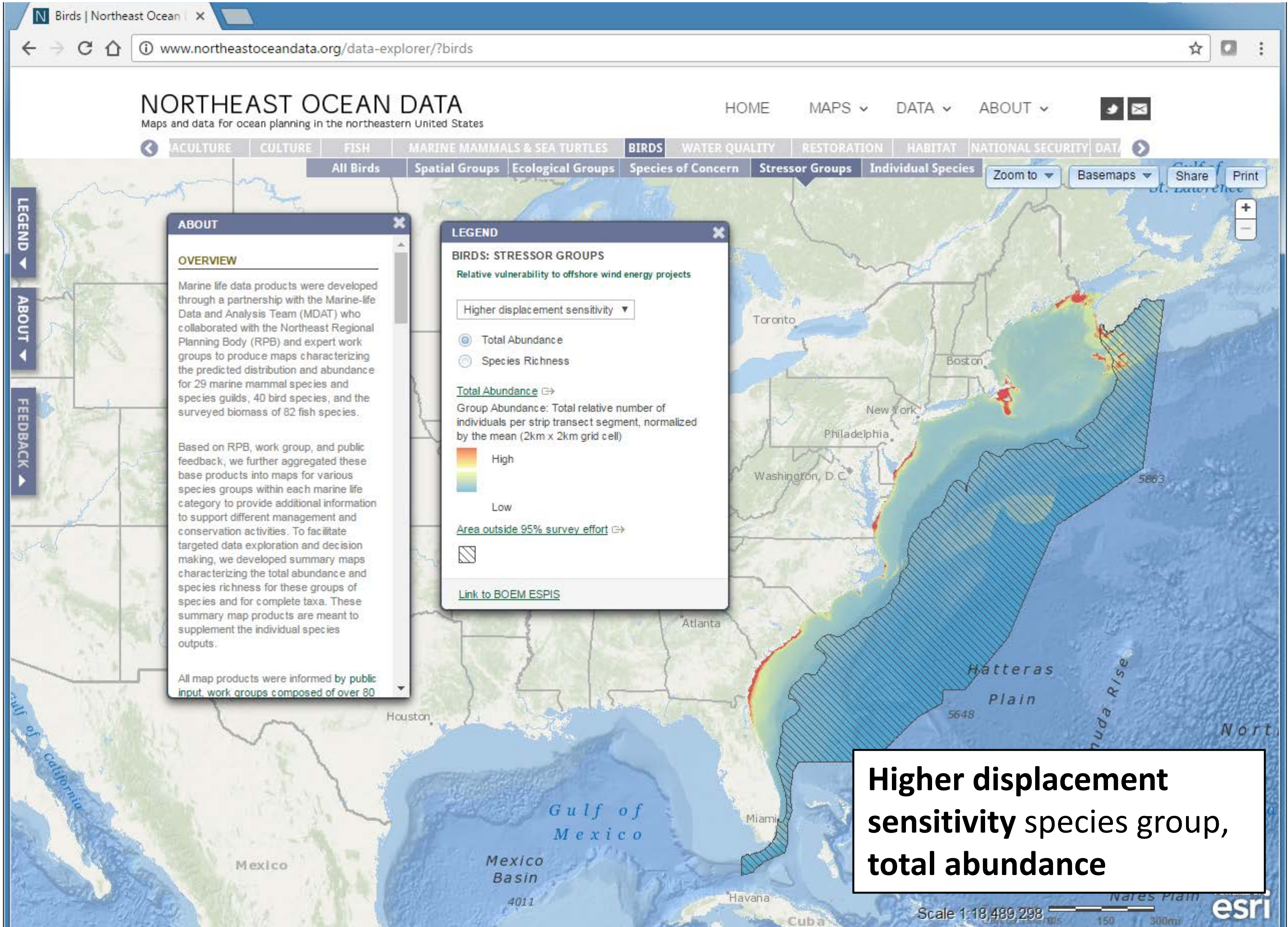
Offshore/Pelagic species group
Species richness

Management-relevant Groupings



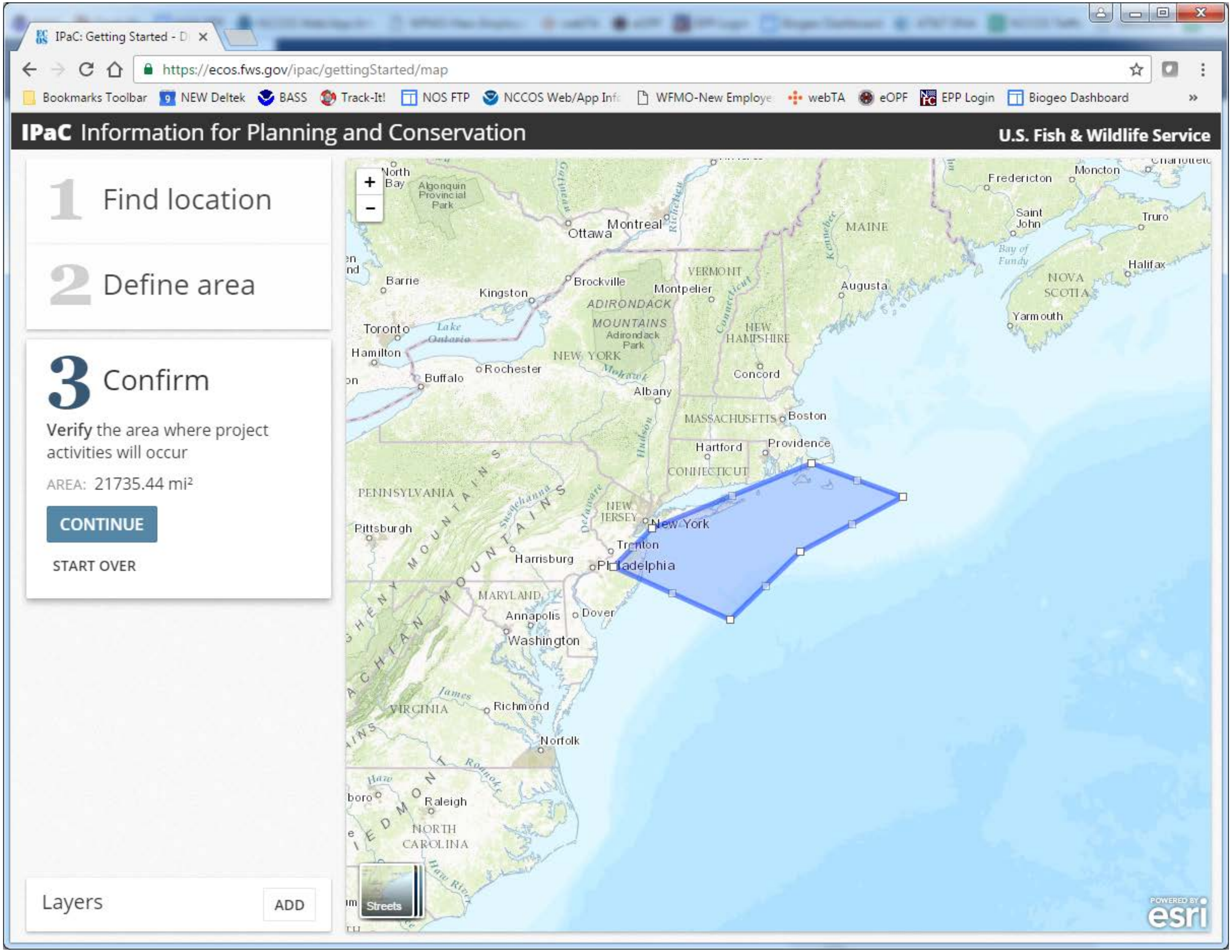
AMBCC high conservation concern species group, **total abundance**

Potential Stressor Sensitivity Groupings

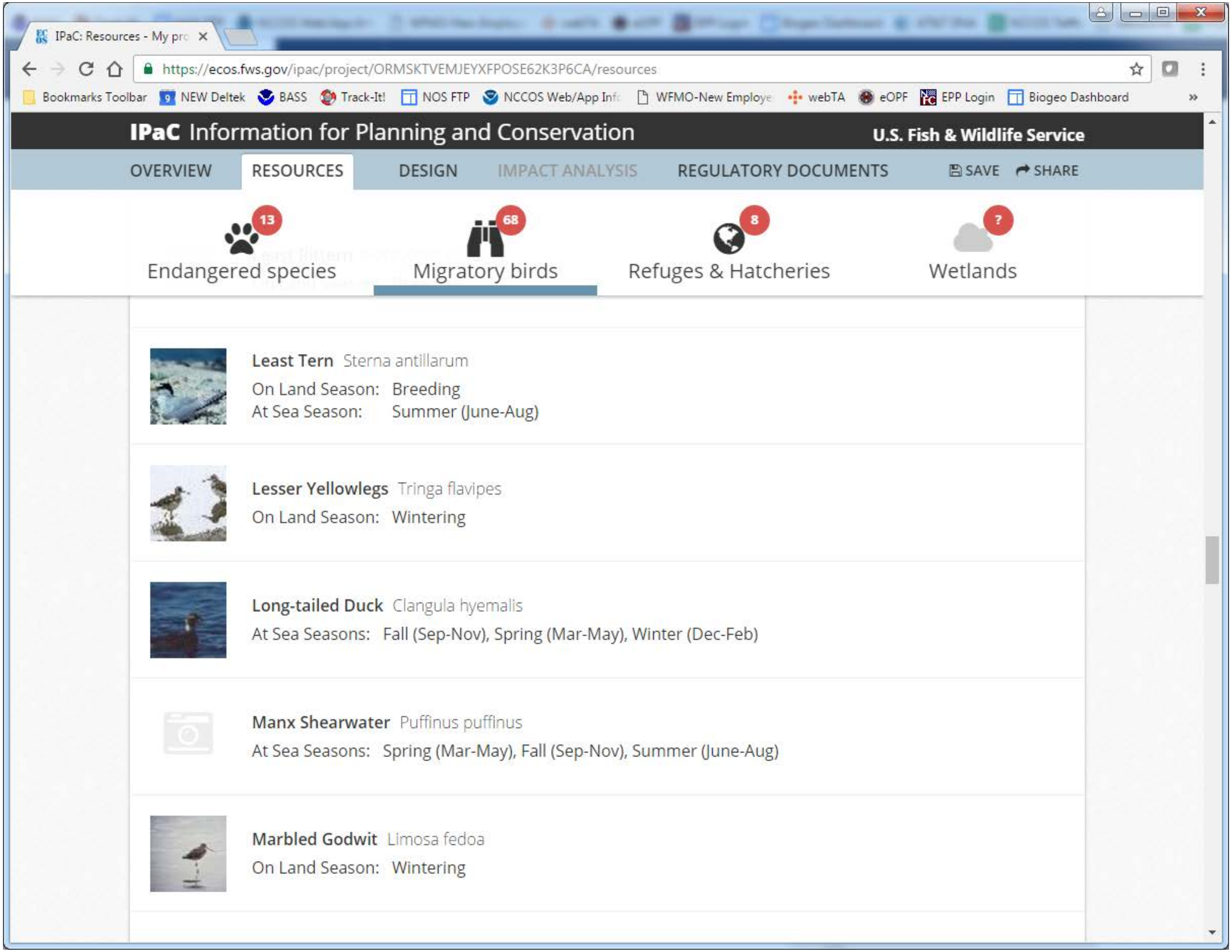


Higher displacement sensitivity species group, **total abundance**

FWS IPaC Tool



FWS IPaC Tool



Models to inform seabird spatial planning

1. Develop best possible synthesis of all available science-quality at-sea seabird survey data

2. Develop statistically-driven guidelines for marine bird sampling efforts

"Statistical Guidelines for Marine Bird Sampling to Support Offshore Renewable Energy Planning"
https://coastalscience.noaa.gov/projects/detail?key=189

METHOD

OCS Study
BOEM 2012-101

NOAA Technical Memorandum NOS NCCOS 158

Statistical Analyses to Support Guidelines for Marine Avian Sampling

Final Report

U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

BOEM
Bureau of Ocean Energy Management

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Centers for Coastal Ocean Science

Biological Conservation 191 (2015) 216–223

Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/bioc

ELSEVIER

Statistical guidelines for assessing marine avian hotspots and coldspots: A case study on wind energy development in the U.S. Atlantic Ocean

CrossMark

Elise F. Zipkin [a,*], Brian P. Kinlan [b,c], Allison Sussman [a,d], Diana Rypkema [e], Mark Wimer [d], Allan F. O'Connell [d]

[a] Michigan State University, Department of Integrative Biology, East Lansing, MI 48824, United States
[b] NOAA National Ocean Service, National Centers for Coastal Ocean Science (NCCOS), SSMC-4, N/SCI-1, 1305 East–west Hwy, Silver Spring, MD 20910–3281, United States
[c] CSS-Dynamac, Inc. 10301 Democracy Lane, Suite 300, Fairfax, VA 22030, United States
[d] USGS Patuxent Wildlife Research Center, 12100 Beech Forest Rd., Laurel MD 20708 United States
[e] Stanford University, Department of Biology, Stanford, CA

Statistical Methodology 17 (2014) 67–81

Contents lists available at ScienceDirect

Statistical Methodology

journal homepage: www.elsevier.com/locate/stamet

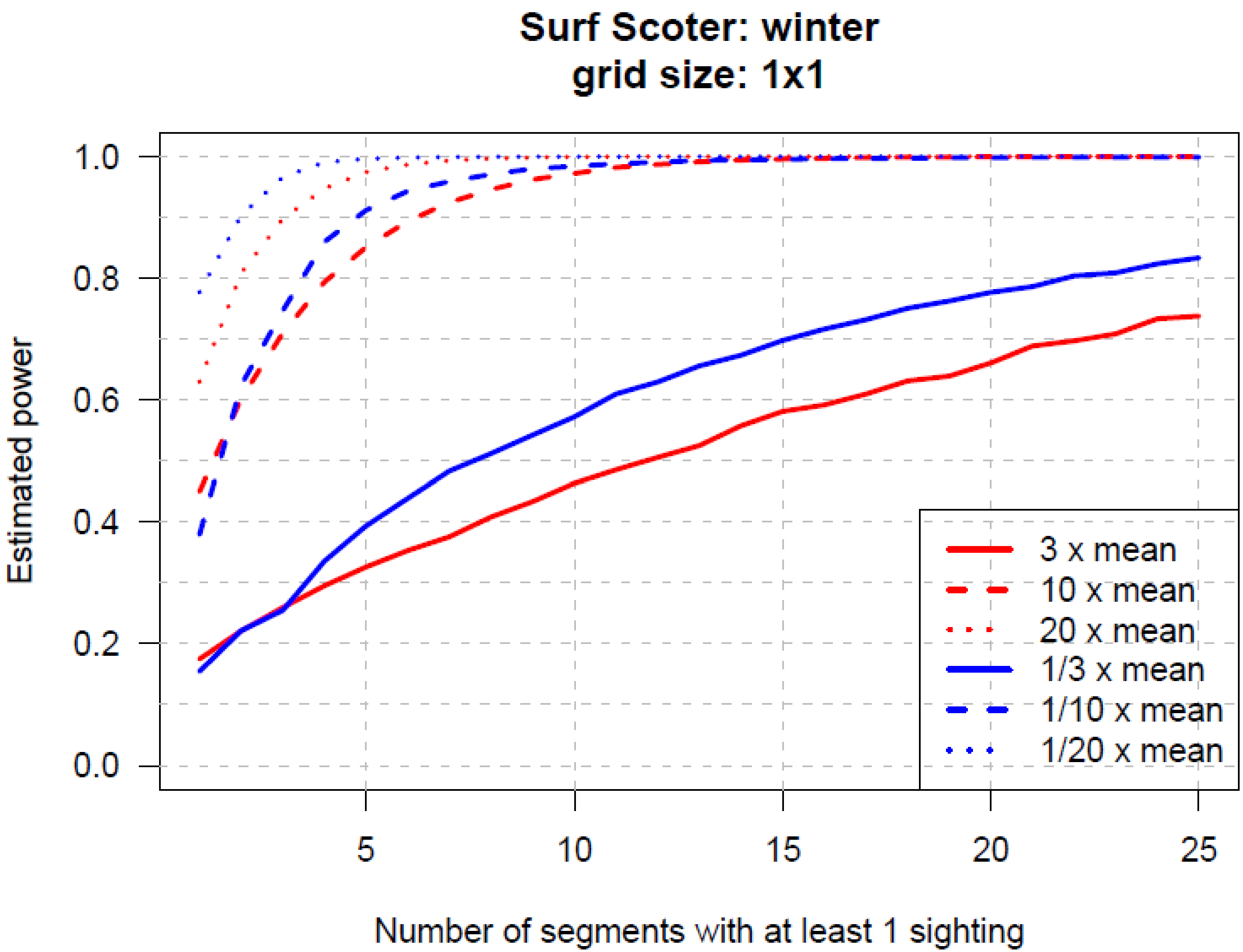
ELSEVIER

Fitting statistical distributions to sea duck count data: Implications for survey design and abundance estimation

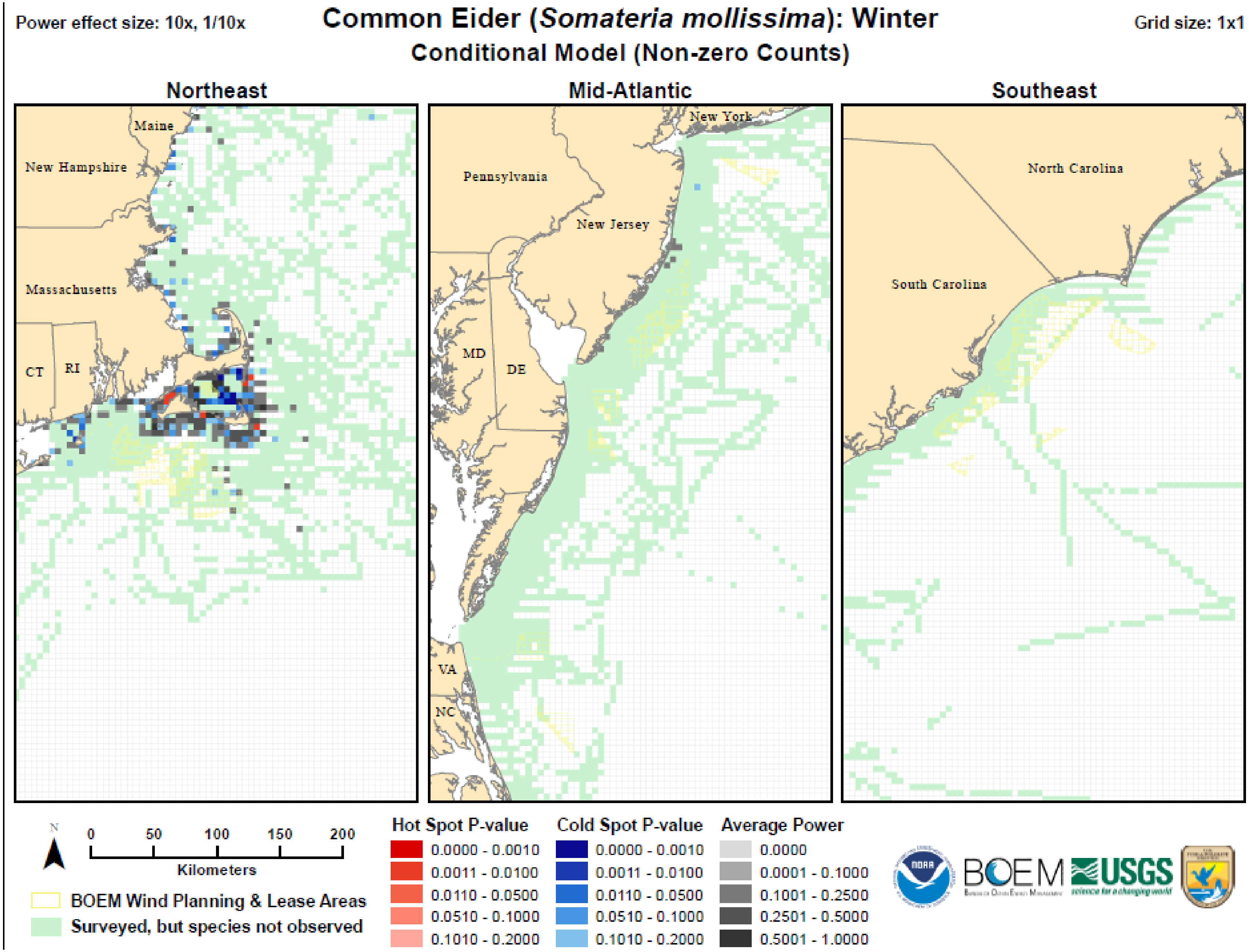
Elise F. Zipkin [a,*], Jeffery B. Leirness [b,c], Brian P. Kinlan [d,e], Allan F. O'Connell [f], Emily D. Silverman [b]

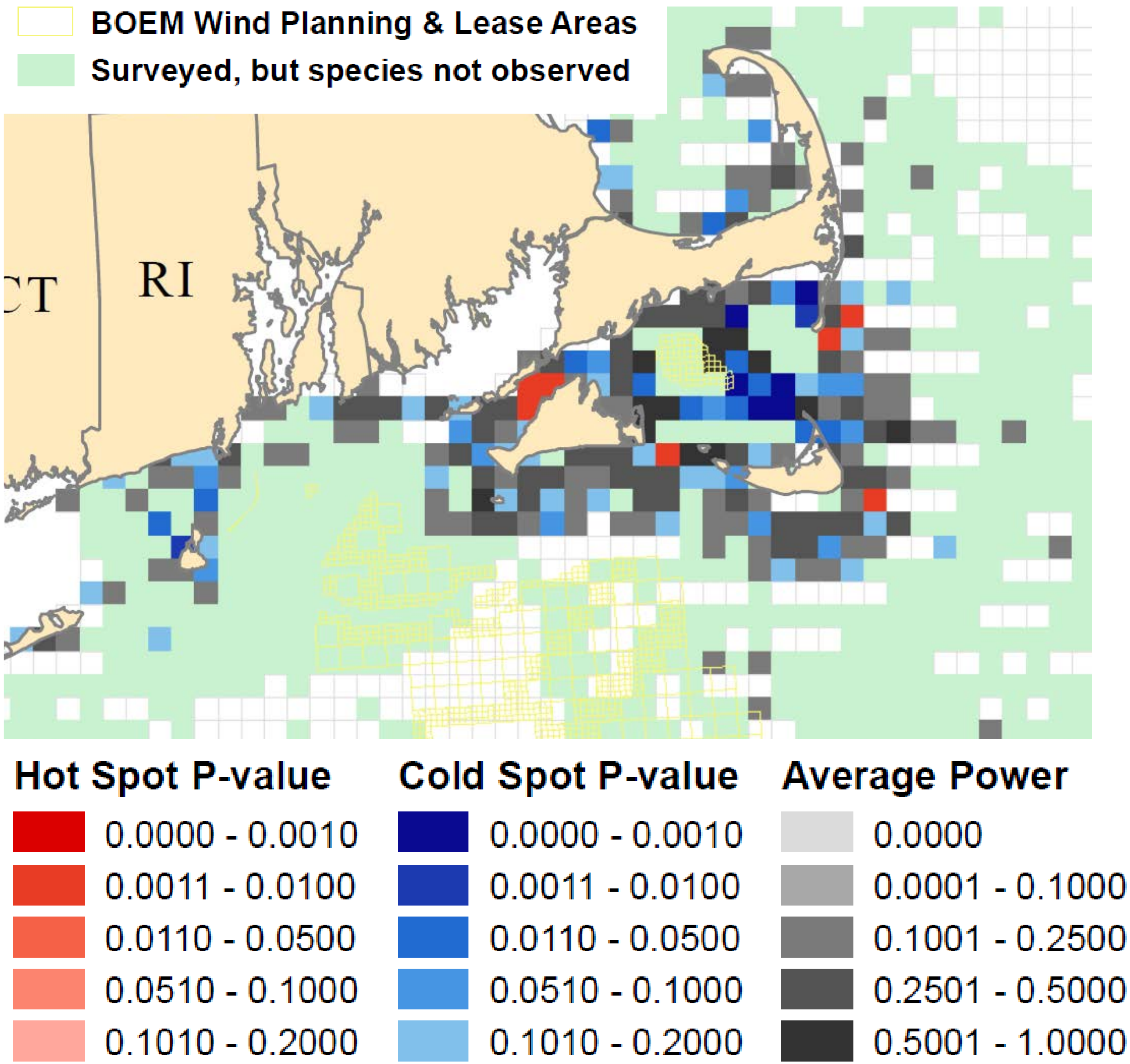
[a] USGS Patuxent Wildlife Research Center, 12100 Beech Forest Rd., Laurel MD, 20708, United States
[b] USFWS Division of Migratory Bird Management, 11510 American Holly Dr., Laurel MD, 20708, United States
[c] Department of Entomology and Wildlife Ecology, University of Delaware, Newark, DE 19716, United States
[d] NOAA National Ocean Service, National Centers for Coastal Ocean Science, Center for Coastal Monitoring and Assessment, Biogeography Branch, SSMC-4, N/SCI-1, 1305 East-West Hwy., Silver Spring, MD 20910-3281, United States
[e] Consolidated Safety Services, Inc. 10301 Democracy Lane, Suite 300, Fairfax, VA 22030, United States
[f] USGS Patuxent Wildlife Research Center, BARC East, Bldg. 308, 10300 Baltimore Ave., Beltsville, MD 20705, United States

Power curves for prospective power analysis (for planning future surveys)



Retrospective power analysis & significance tests





BOEM Wind Planning & Lease Areas
Surveyed, but species not observed
CT
RI
Hot Spot P-value
0.0000 - 0.0010
0.0011 - 0.0100
0.0110 - 0.0500
0.0510 - 0.1000
0.1010 - 0.2000
Cold Spot P-value
0.0000 - 0.0010
0.0011 - 0.0100
0.0110 - 0.0500
0.0510 - 0.1000
0.1010 - 0.2000
Average Power
0.0000
0.0001 - 0.1000
0.1001 - 0.2500
0.2501 - 0.5000
0.5001 - 1.0000

Acknowledgements

Special thanks to:

Allan O'Connell, Andrew Gilbert, Mark Wimer, Allison Sussman, Tim Jones, Scott Johnston, Kaycee Coleman, Kyle Detloff, Melanie Steinkamp, David Bigger, Jim Woehr, Beth Gardner, Elise Zipkin, Jeff Leirness, Earvin Balderama, Kate Williams & BRI/DOE programs, Dick Veit & Tim White – Ships of Opportunity project, Peter Paton & RI SAMP program, NJ Ocean/Wind Power Baseline Studies program, Pat Jodice, Tim White, Debi Palka & AMMAPS Team, Nick Napoli, Emily Schumchenia, & the NROC team, Chris Bruce, Jay Odell & the MARCO/TNC team, Matt Poti for ocean data processing support, and the many, many people who contributed their data to the Northwest Atlantic Seabird Catalogue.

NATIONAL OCEAN SERVICE
National Centers for Coastal Ocean Science
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Principal Investigator Contact Info:
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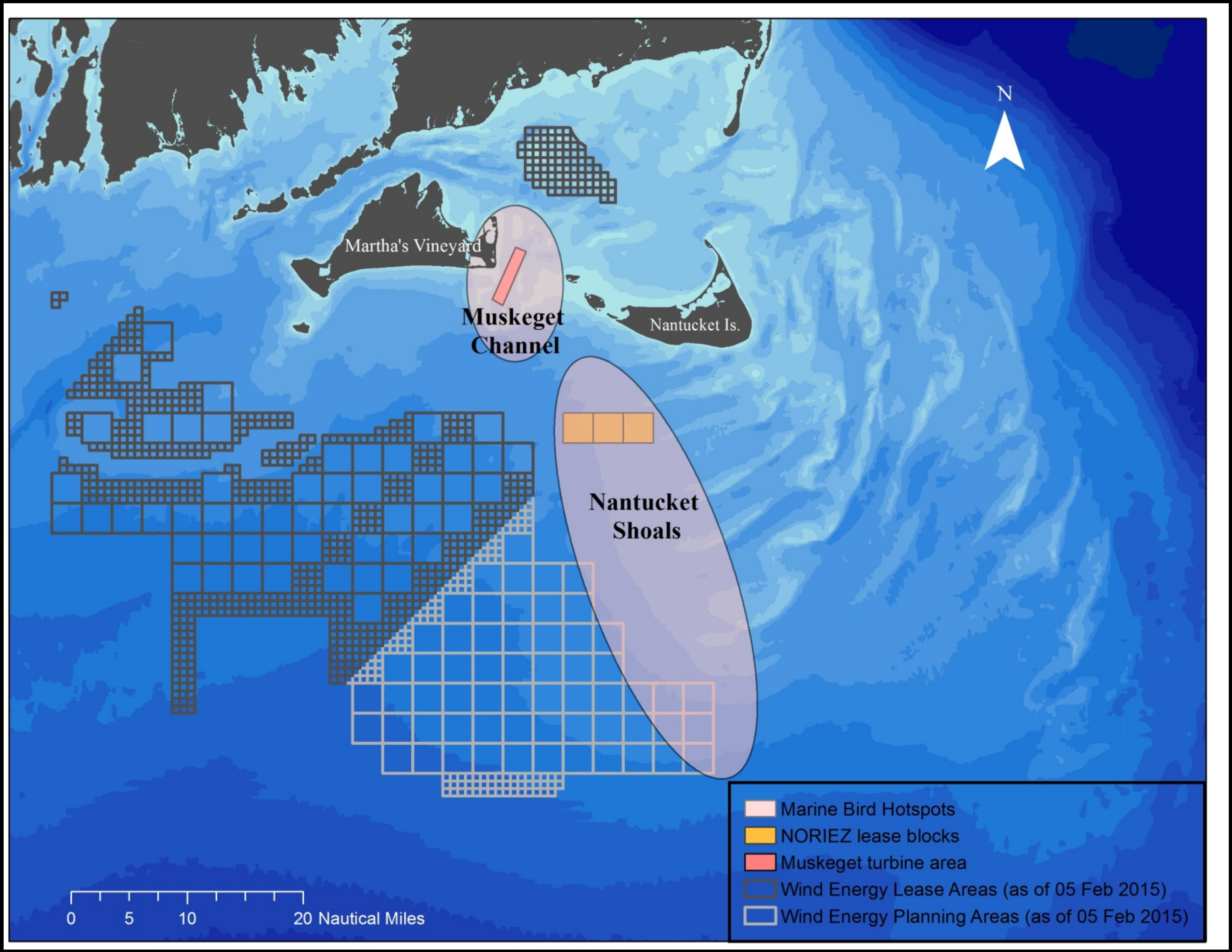
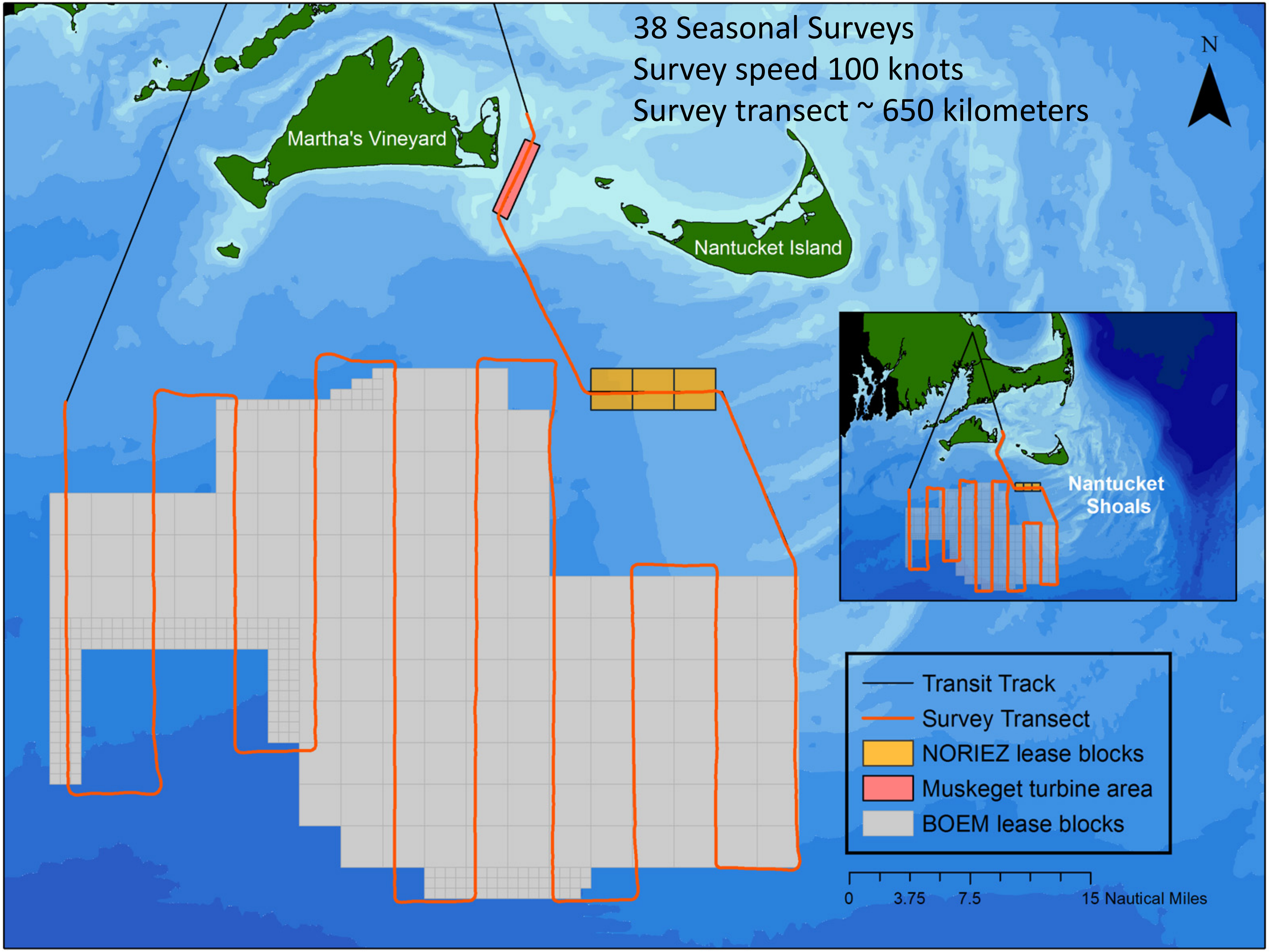
(240) 533-0359

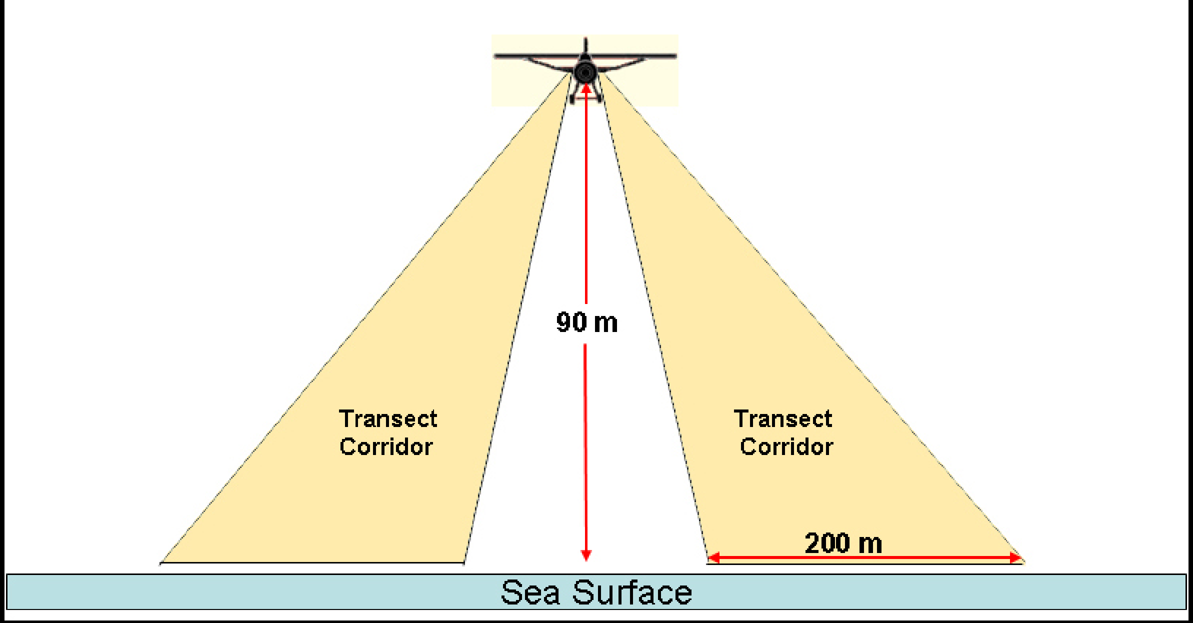


Abundance and Distribution of Seabirds off Southeastern Massachusetts, 2011-2015

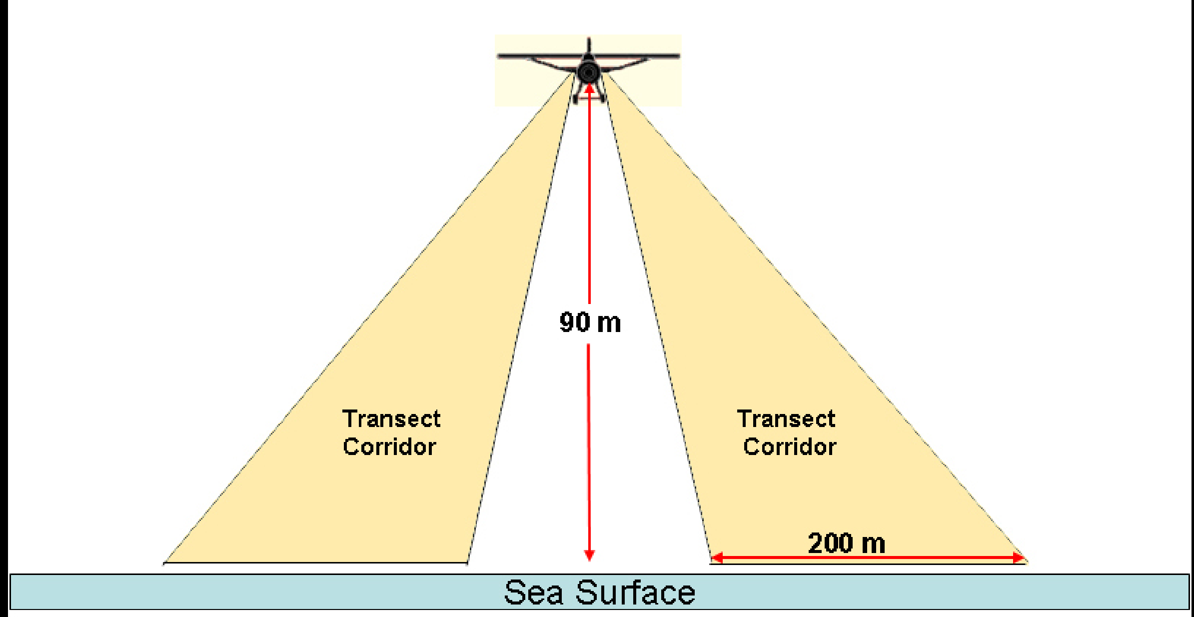
Timothy P. White, Richard R. Veit, Simon A. Perkins, and Shannon Curley


38 Seasonal Surveys
Survey speed 100 knots
Survey transect ~ 650 kilometers
N
Martha's Vineyard
Nantucket Island
Nantucket Shoals
Transit Track
Survey Transect
NORIEZ lease blocks
Muskeget turbine area
BOEM lease blocks
0
3.75
7.5
15 Nautical Miles

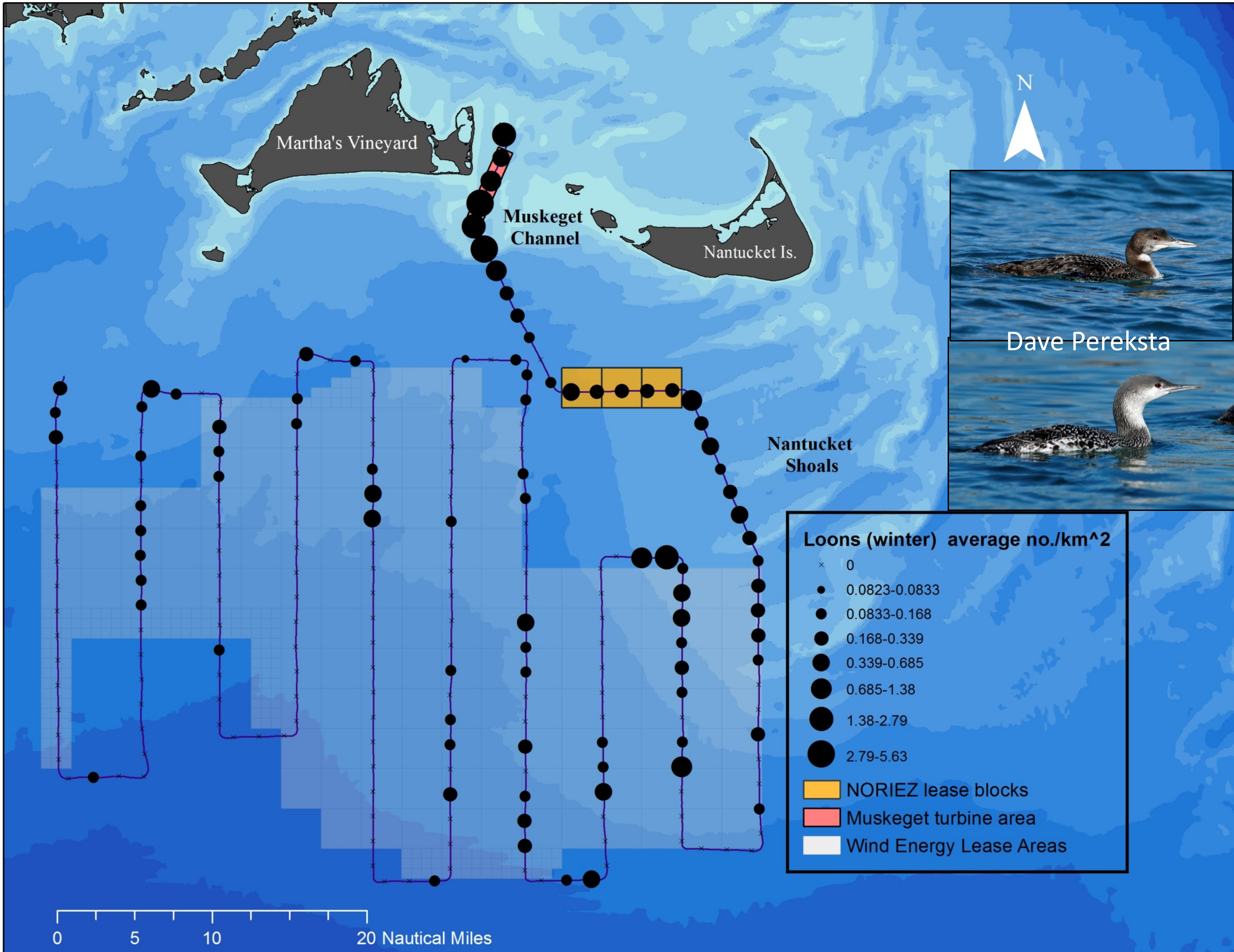

Western tip of Cutty Hunk Island
Canapitsit Channel
Nashawena Island


90 m
Transect Corridor
Transect Corridor
200 m
Sea Surface

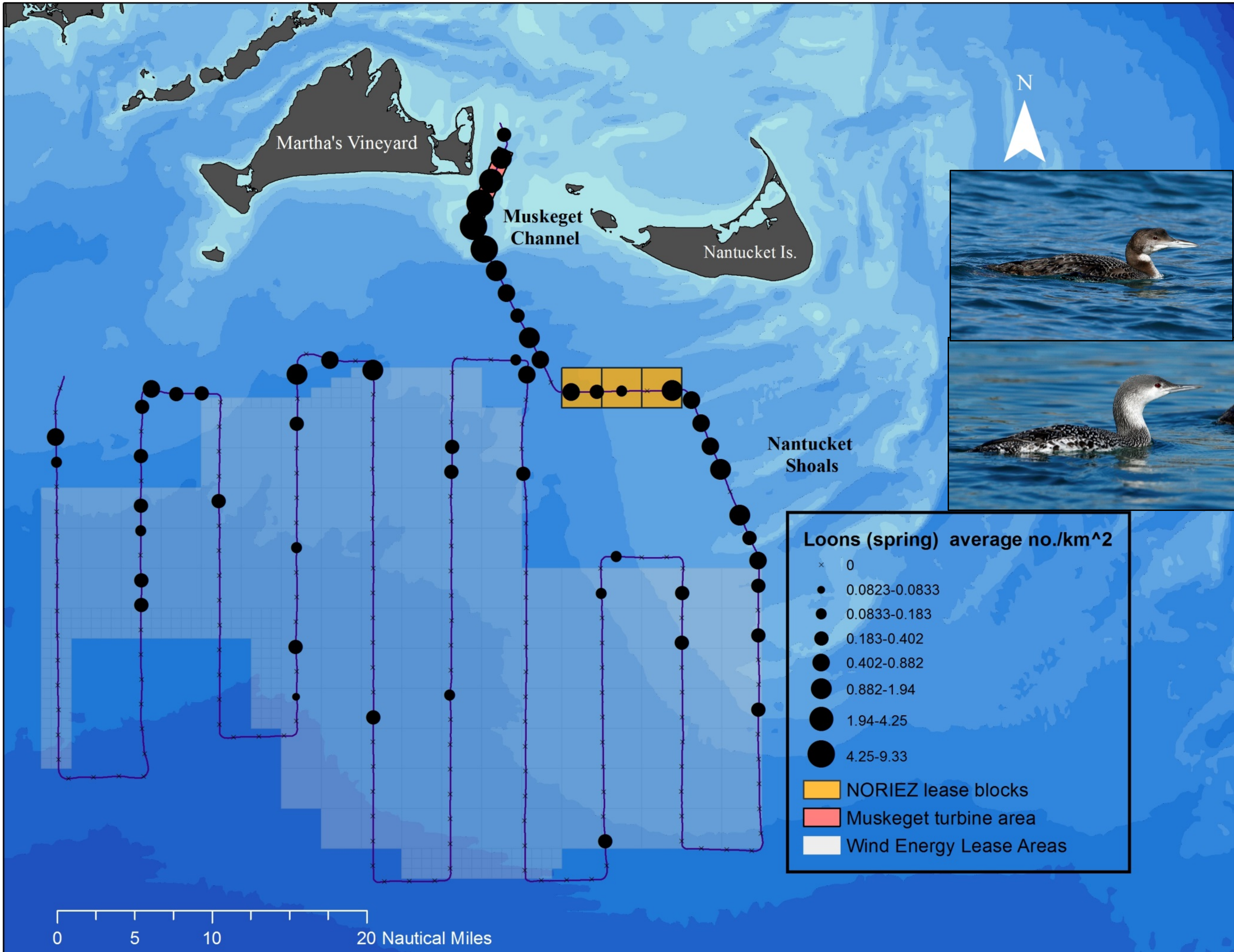

USAF
21398


90 m
Transect Corridor
Transect Corridor
200 m
Sea Surface

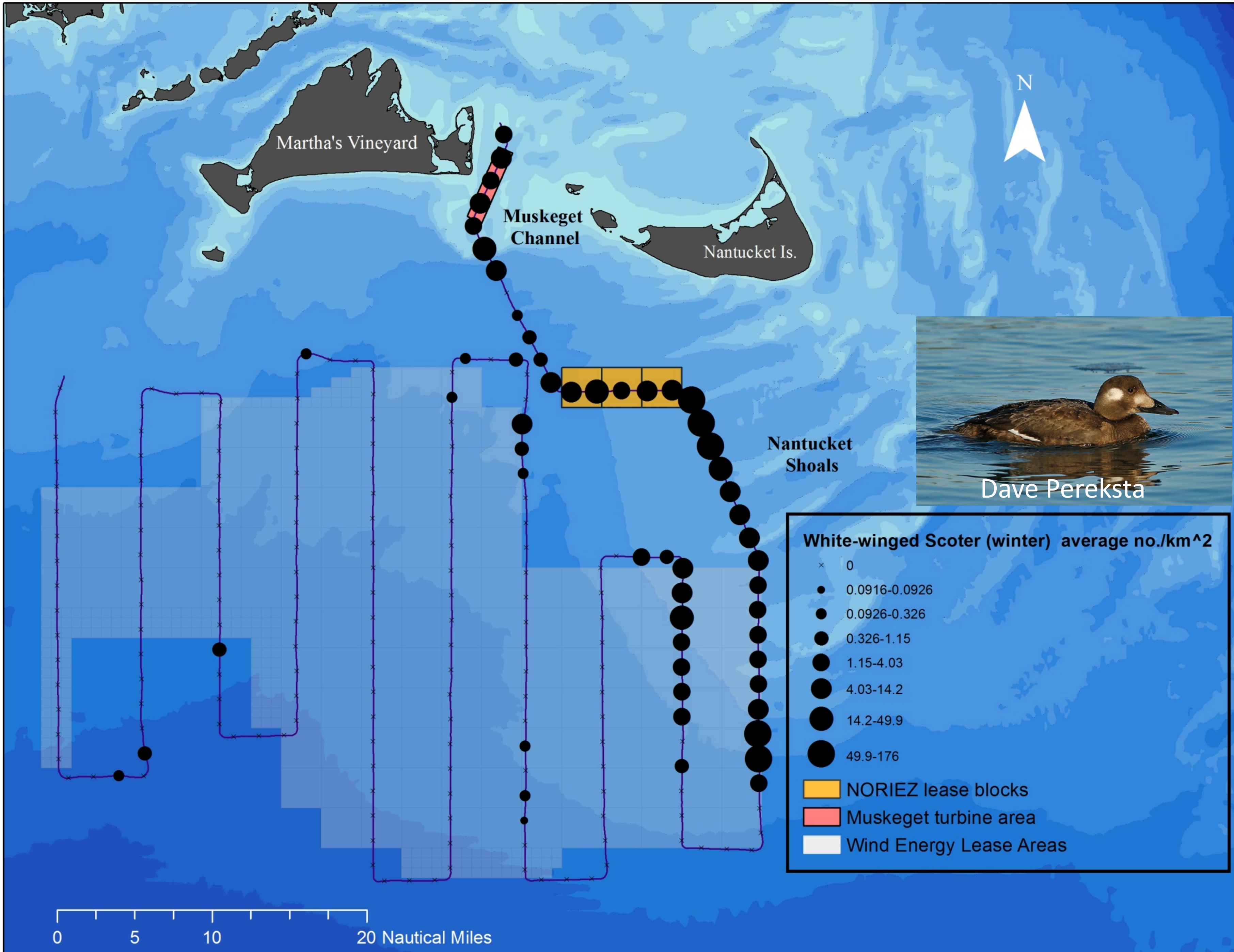

U.S. AIR FORCE O-2A
A.F SERIAL NO. 67-21398
SERVICE THIS AIRCRAFT WITH
GRADE 115/145 FUEL



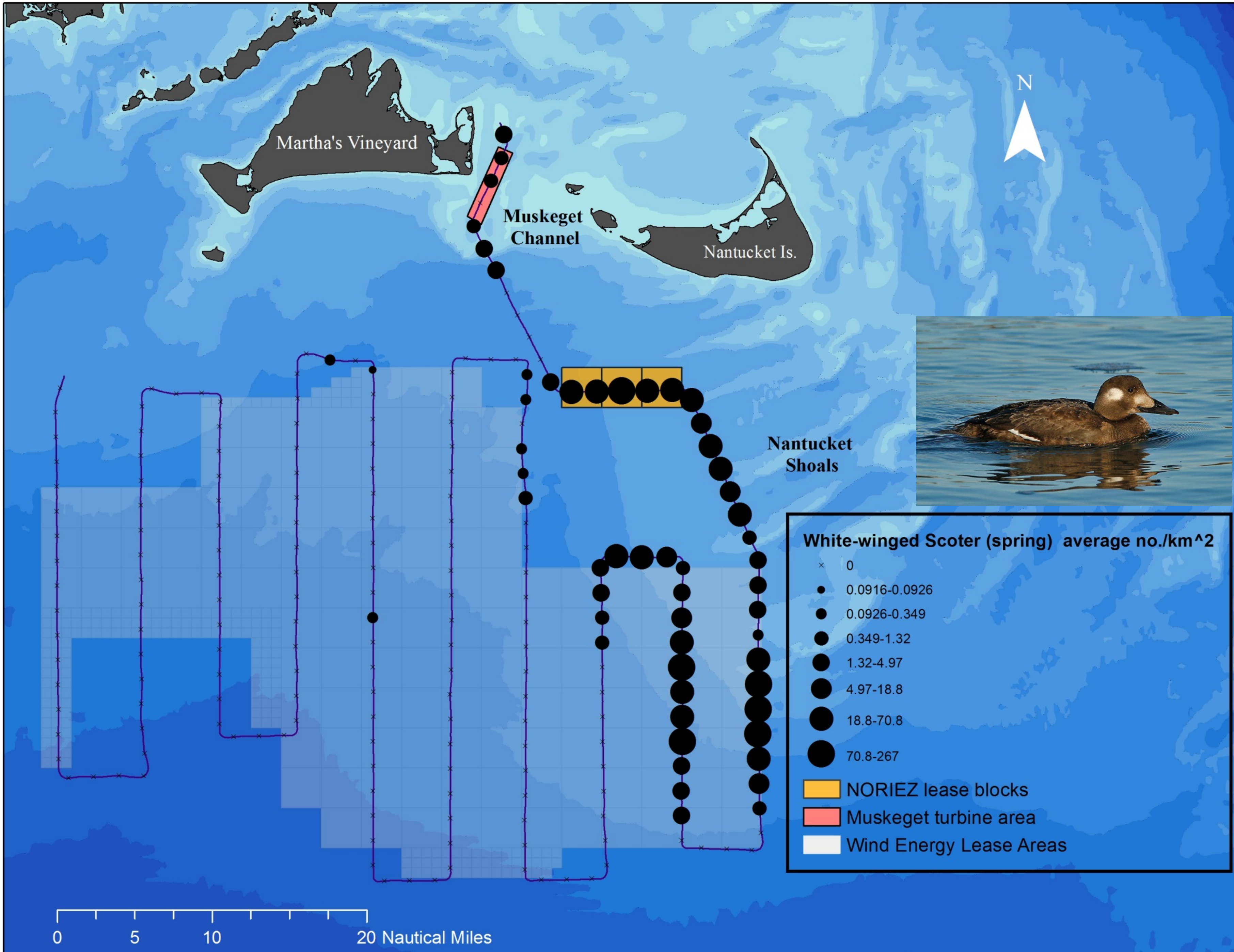
N
Martha's Vineyard
Muskeget
Channel
Nantucket Is.
Nantucket
Shoals
Dave Pereksta
Loons (winter) average no./km^2
0
0.0823-0.0833
0.0833-0.168
0.168-0.339
0.339-0.685
0.685-1.38
1.38-2.79
2.79-5.63
NORIEZ lease blocks
Muskeget turbine area
Wind Energy Lease Areas
0
5
10
20 Nautical Miles



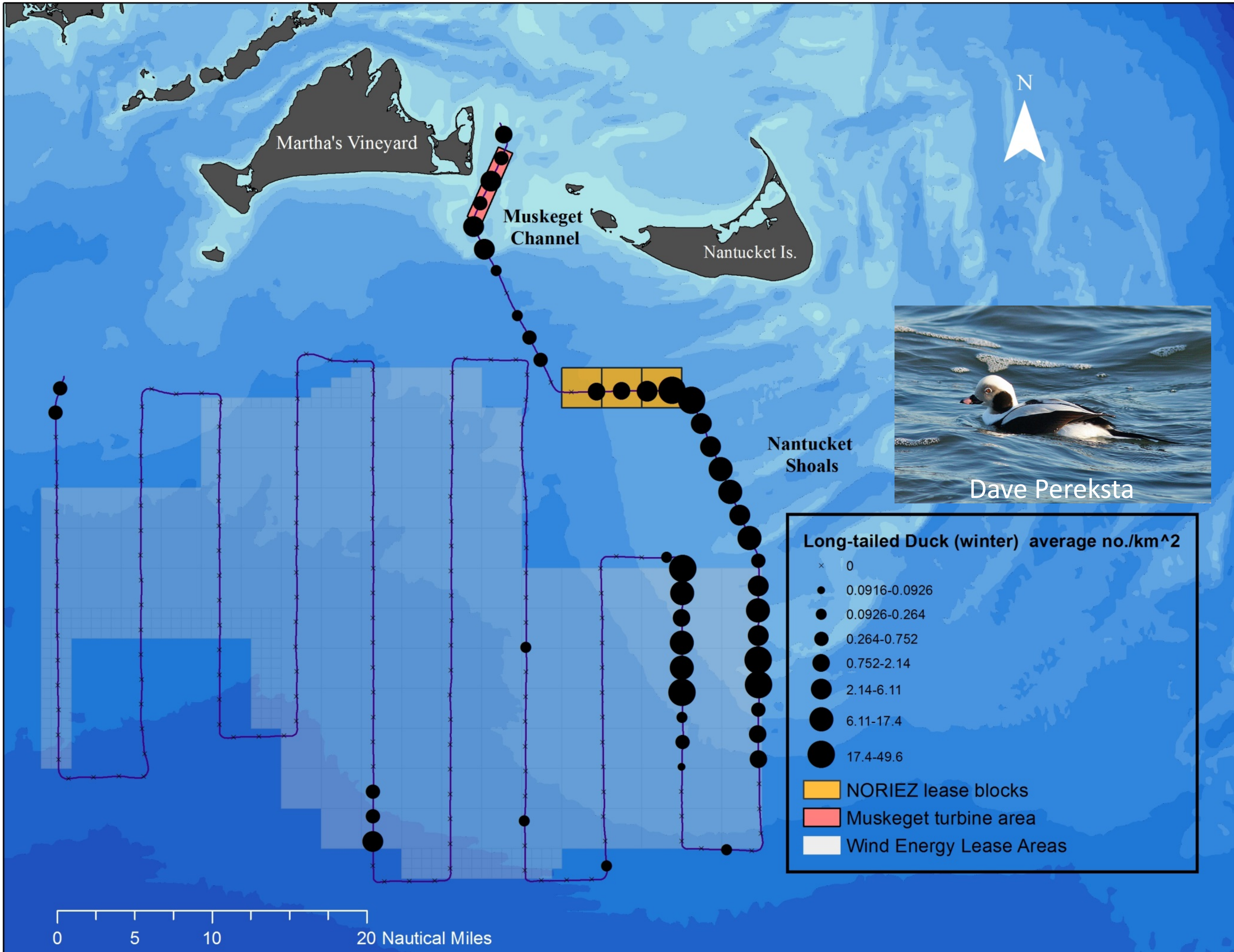
Martha's Vineyard
Muskeget Channel
Nantucket Is.
Nantucket Shoals
N
Loons (spring) average no./km^2
0
0.0823-0.0833
0.0833-0.183
0.183-0.402
0.402-0.882
0.882-1.94
1.94-4.25
4.25-9.33
NORIEZ lease blocks
Muskeget turbine area
Wind Energy Lease Areas
0
5
10
20 Nautical Miles



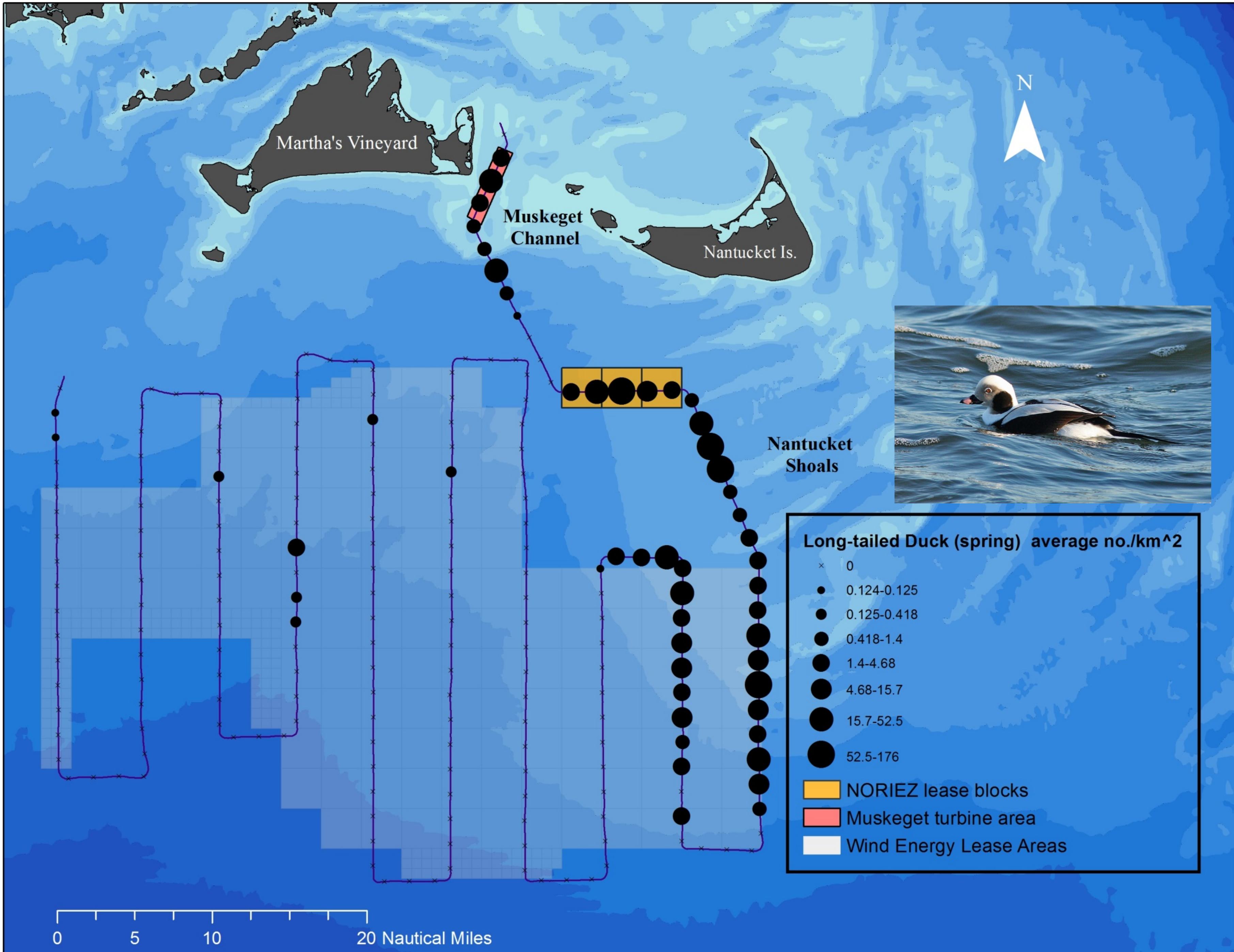
N
Martha's Vineyard
Muskeget Channel
Nantucket Is.
Nantucket Shoals
Dave Pereksta
White-winged Scoter (winter) average no./km^2
0
0.0916-0.0926
0.0926-0.326
0.326-1.15
1.15-4.03
4.03-14.2
14.2-49.9
49.9-176
NORIEZ lease blocks
Muskeget turbine area
Wind Energy Lease Areas
0
5
10
20 Nautical Miles



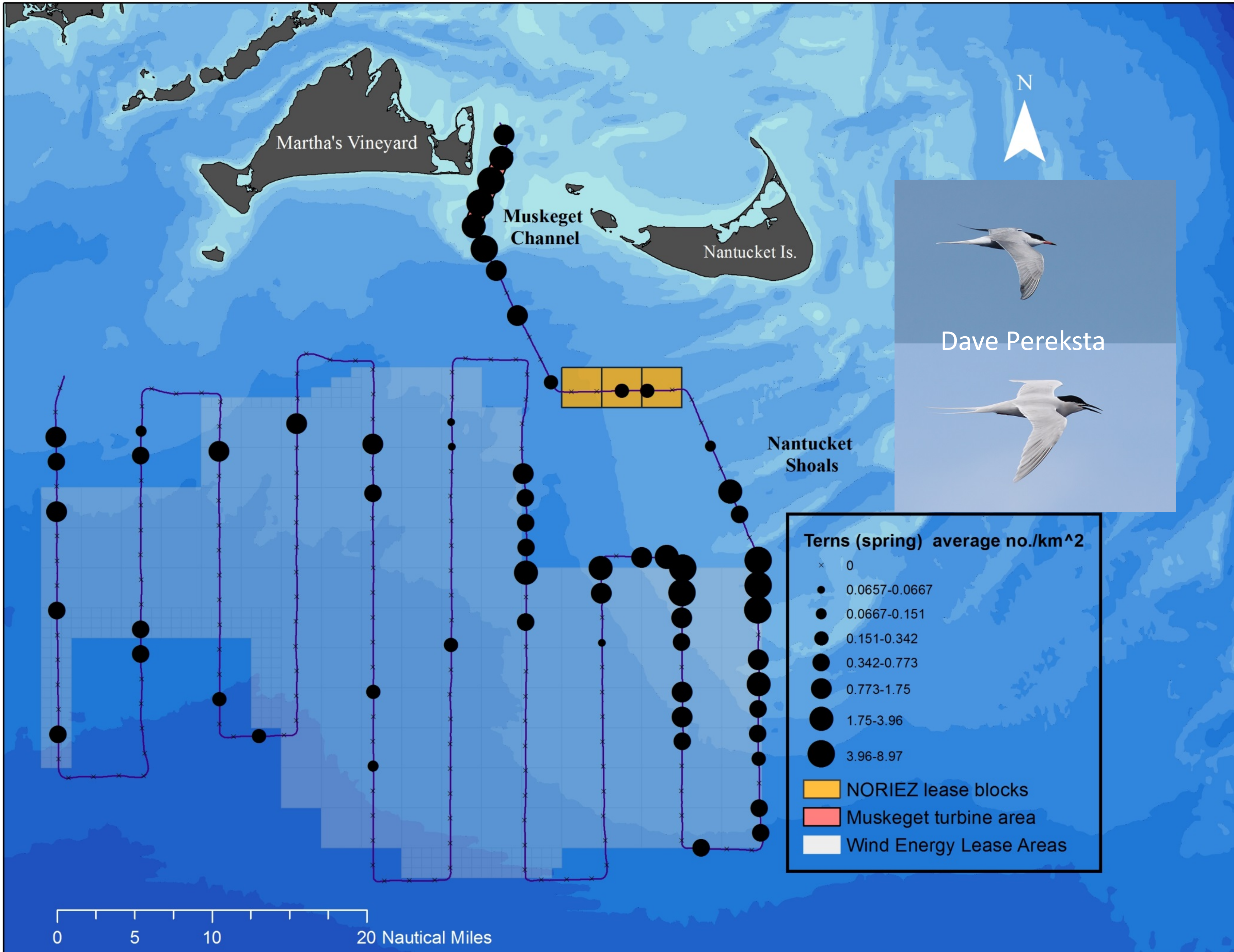
N
Martha's Vineyard
Muskeget Channel
Nantucket Is.
Nantucket Shoals
White-winged Scoter (spring) average no./km^2
0
0.0916-0.0926
0.0926-0.349
0.349-1.32
1.32-4.97
4.97-18.8
18.8-70.8
70.8-267
NORIEZ lease blocks
Muskeget turbine area
Wind Energy Lease Areas
0
5
10
20 Nautical Miles



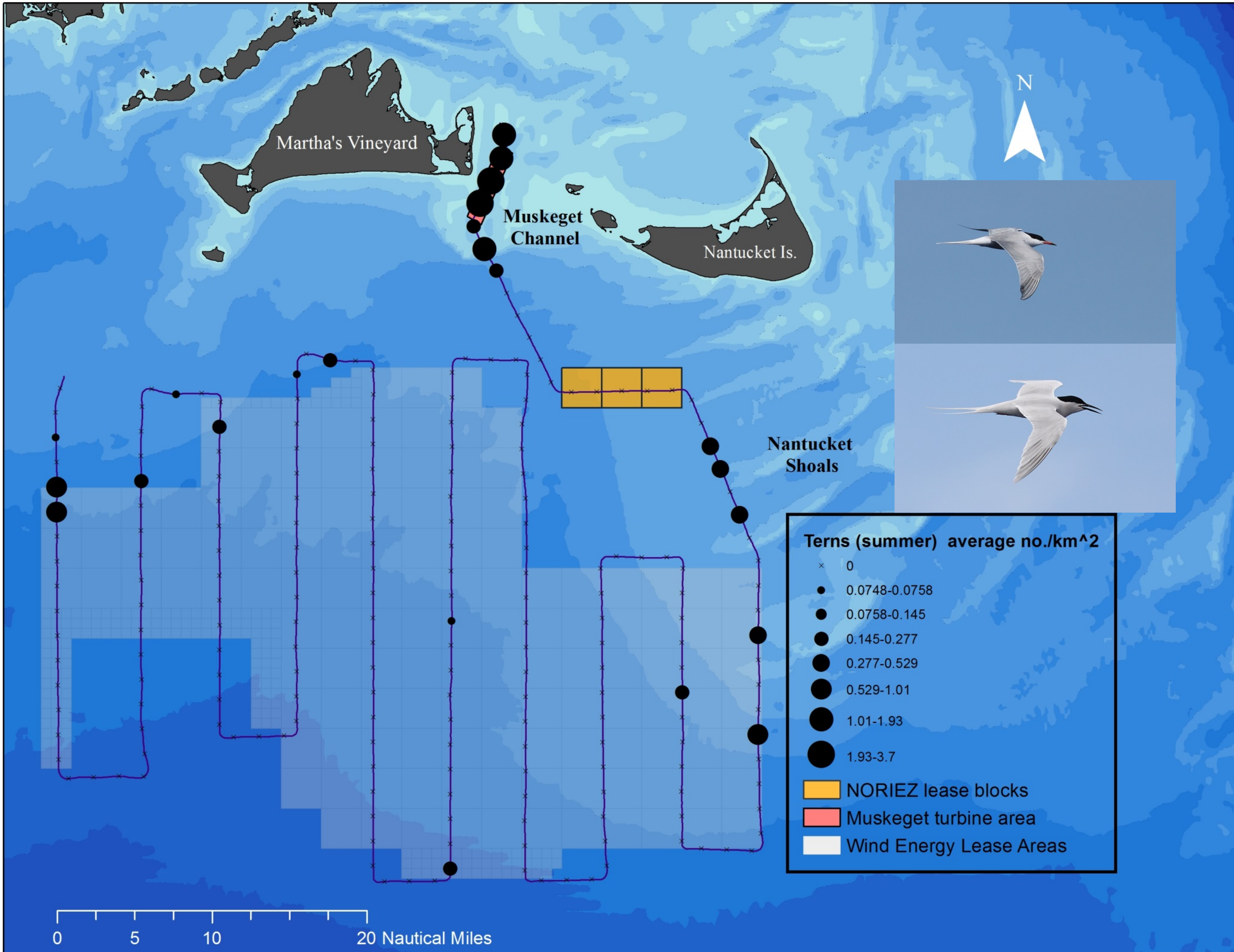
Martha's Vineyard
Muskeget Channel
Nantucket Is.
Nantucket Shoals
N
Dave Pereksta
Long-tailed Duck (winter) average no./km^2
0
0.0916-0.0926
0.0926-0.264
0.264-0.752
0.752-2.14
2.14-6.11
6.11-17.4
17.4-49.6
NORIEZ lease blocks
Muskeget turbine area
Wind Energy Lease Areas
0
5
10
20 Nautical Miles



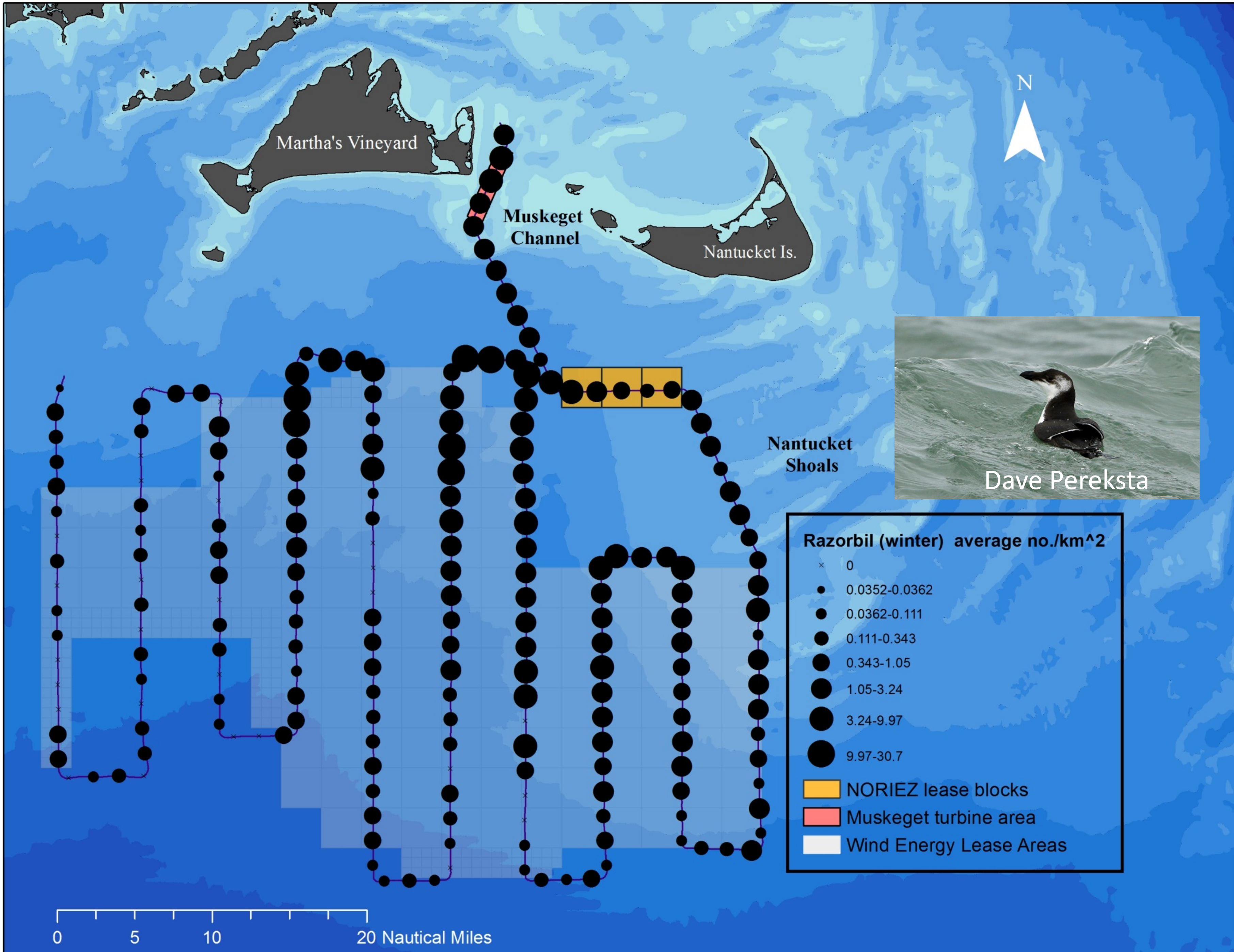
N
Martha's Vineyard
Muskeget Channel
Nantucket Is.
Nantucket Shoals
Long-tailed Duck (spring) average no./km^2
0
0.124-0.125
0.125-0.418
0.418-1.4
1.4-4.68
4.68-15.7
15.7-52.5
52.5-176
NORIEZ lease blocks
Muskeget turbine area
Wind Energy Lease Areas
0
5
10
20 Nautical Miles



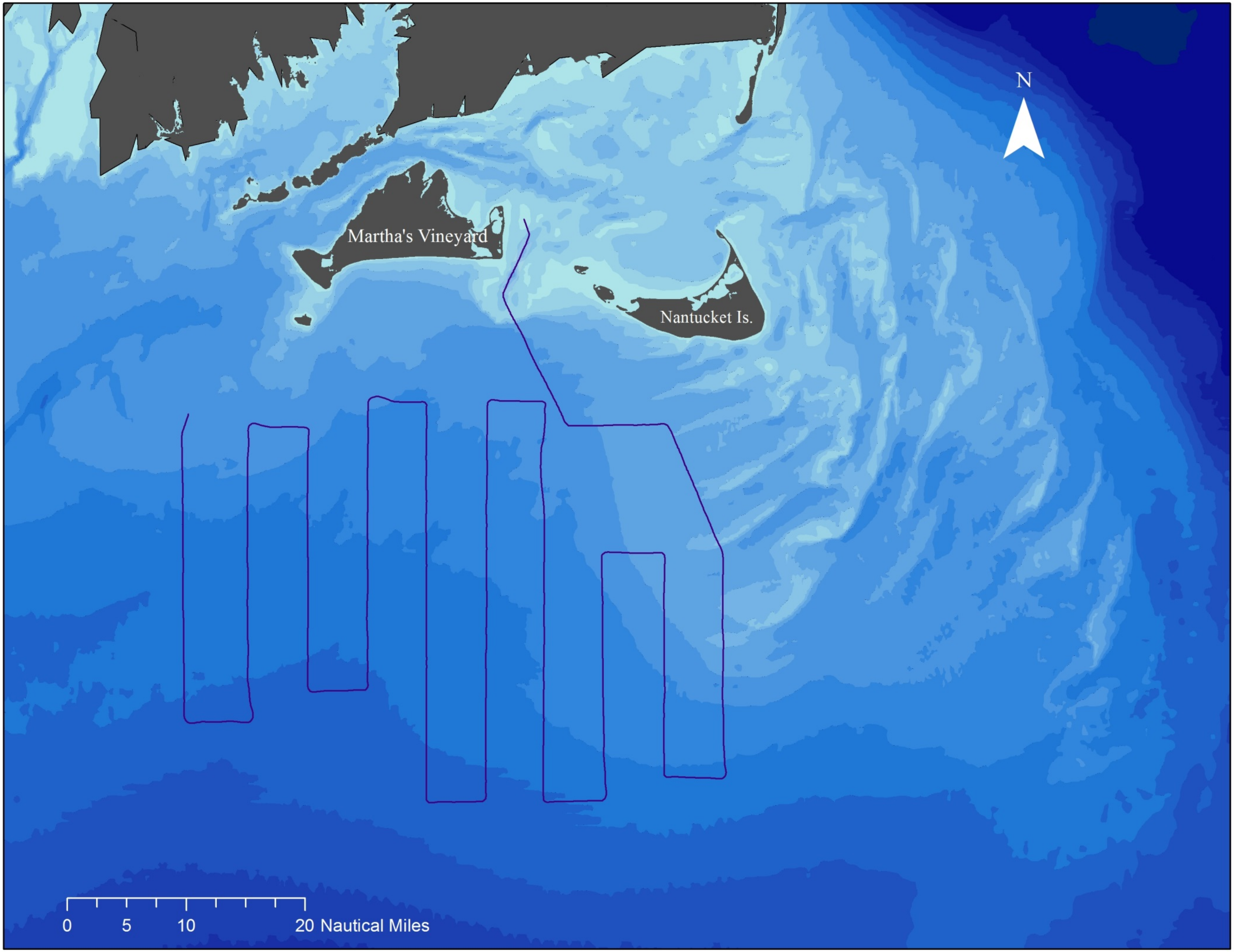
Martha's Vineyard
Muskeget Channel
Nantucket Is.
Nantucket Shoals
N
Dave Pereksta
Terns (spring) average no./km^2
0
0.0657-0.0667
0.0667-0.151
0.151-0.342
0.342-0.773
0.773-1.75
1.75-3.96
3.96-8.97
NORIEZ lease blocks
Muskeget turbine area
Wind Energy Lease Areas
0
5
10
20 Nautical Miles



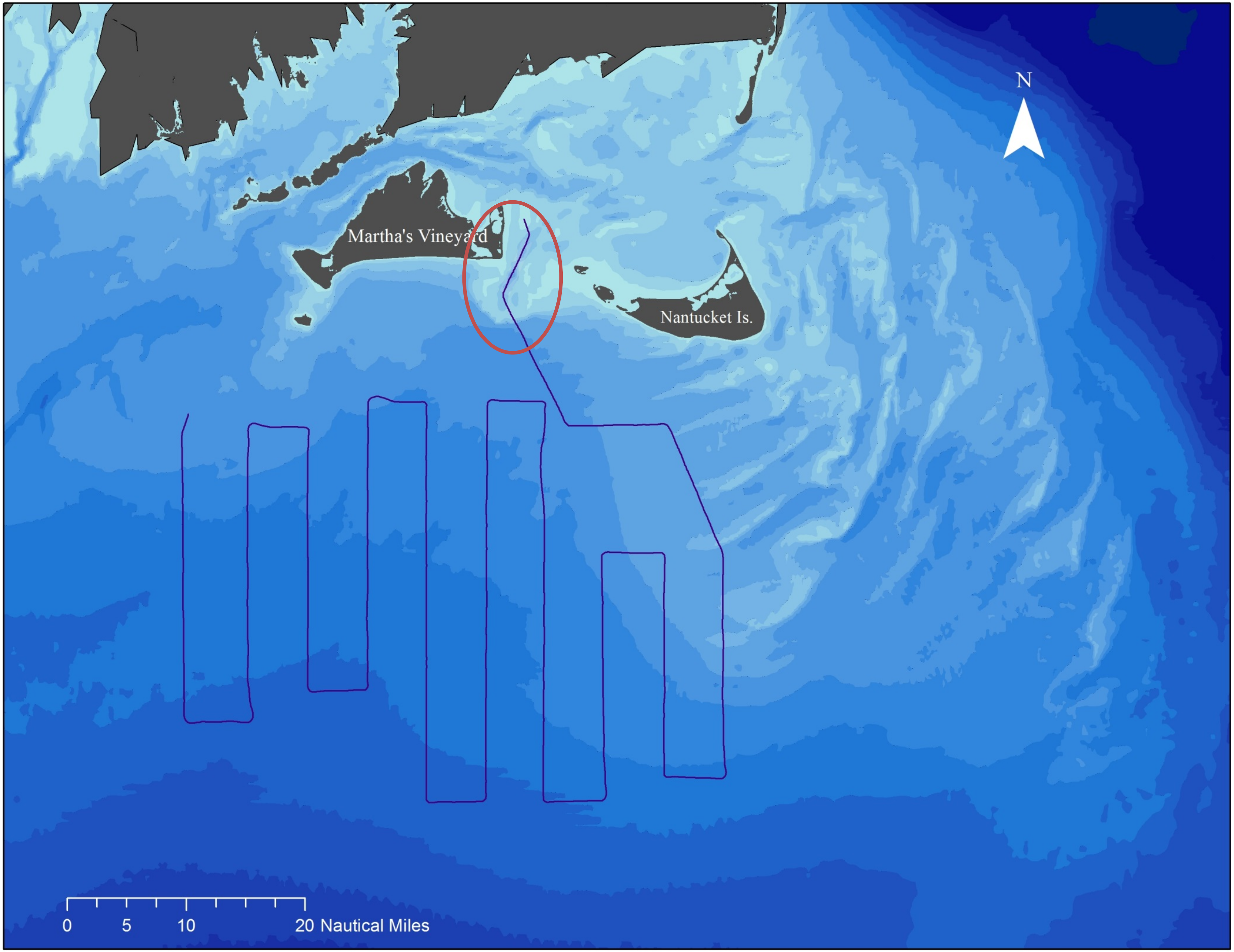
N
Martha's Vineyard
Muskeget Channel
Nantucket Is.
Nantucket Shoals
Terns (summer) average no./km^2
0
0.0748-0.0758
0.0758-0.145
0.145-0.277
0.277-0.529
0.529-1.01
1.01-1.93
1.93-3.7
NORIEZ lease blocks
Muskeget turbine area
Wind Energy Lease Areas
0
5
10
20 Nautical Miles

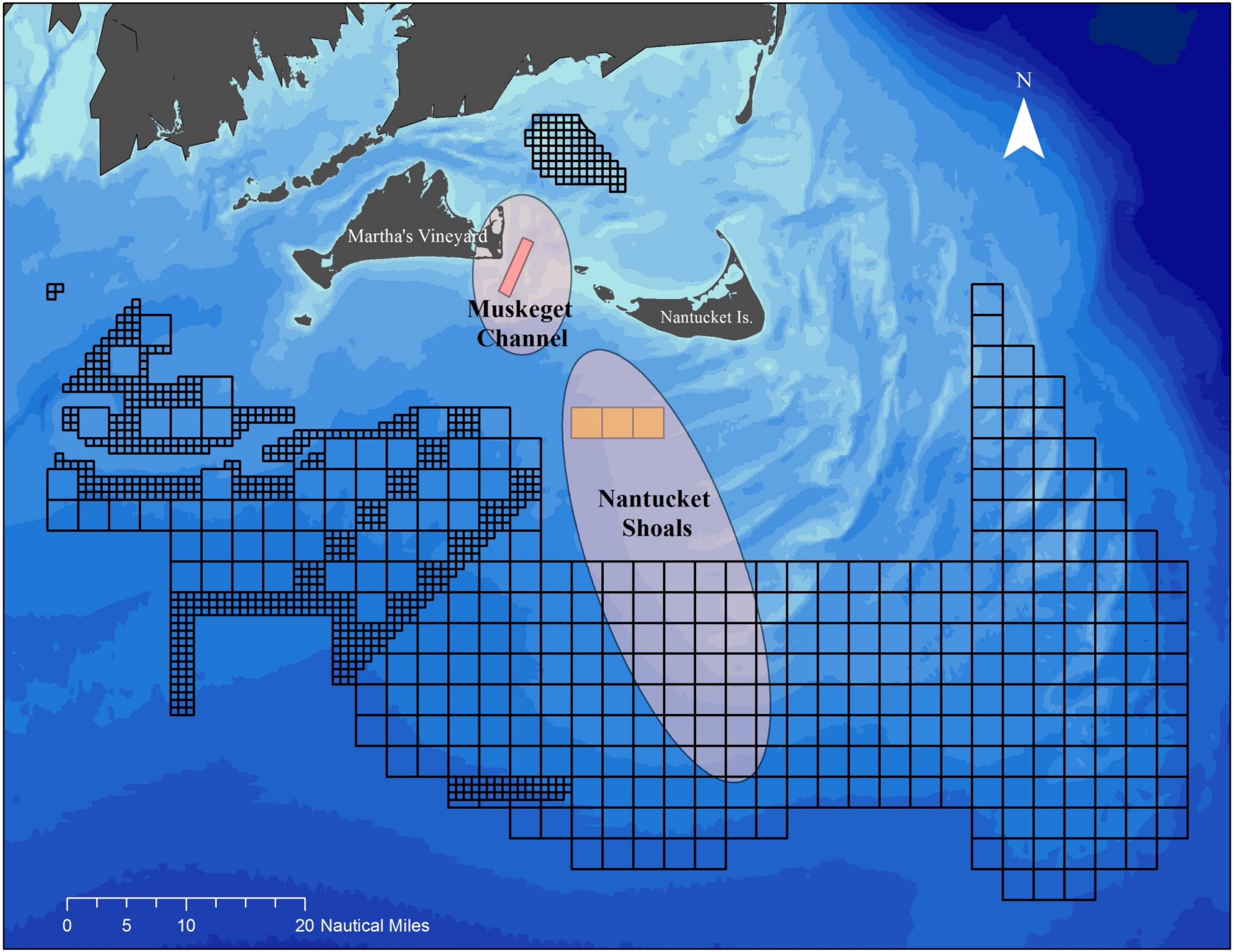


Martha's Vineyard
Muskeget
Channel
Nantucket Is.
N
Nantucket
Shoals
Dave Pereksta
Razorbil (winter) average no./km^2
0
0.0352-0.0362
0.0362-0.111
0.111-0.343
0.343-1.05
1.05-3.24
3.24-9.97
9.97-30.7
NORIEZ lease blocks
Muskeget turbine area
Wind Energy Lease Areas
0
5
10
20 Nautical Miles

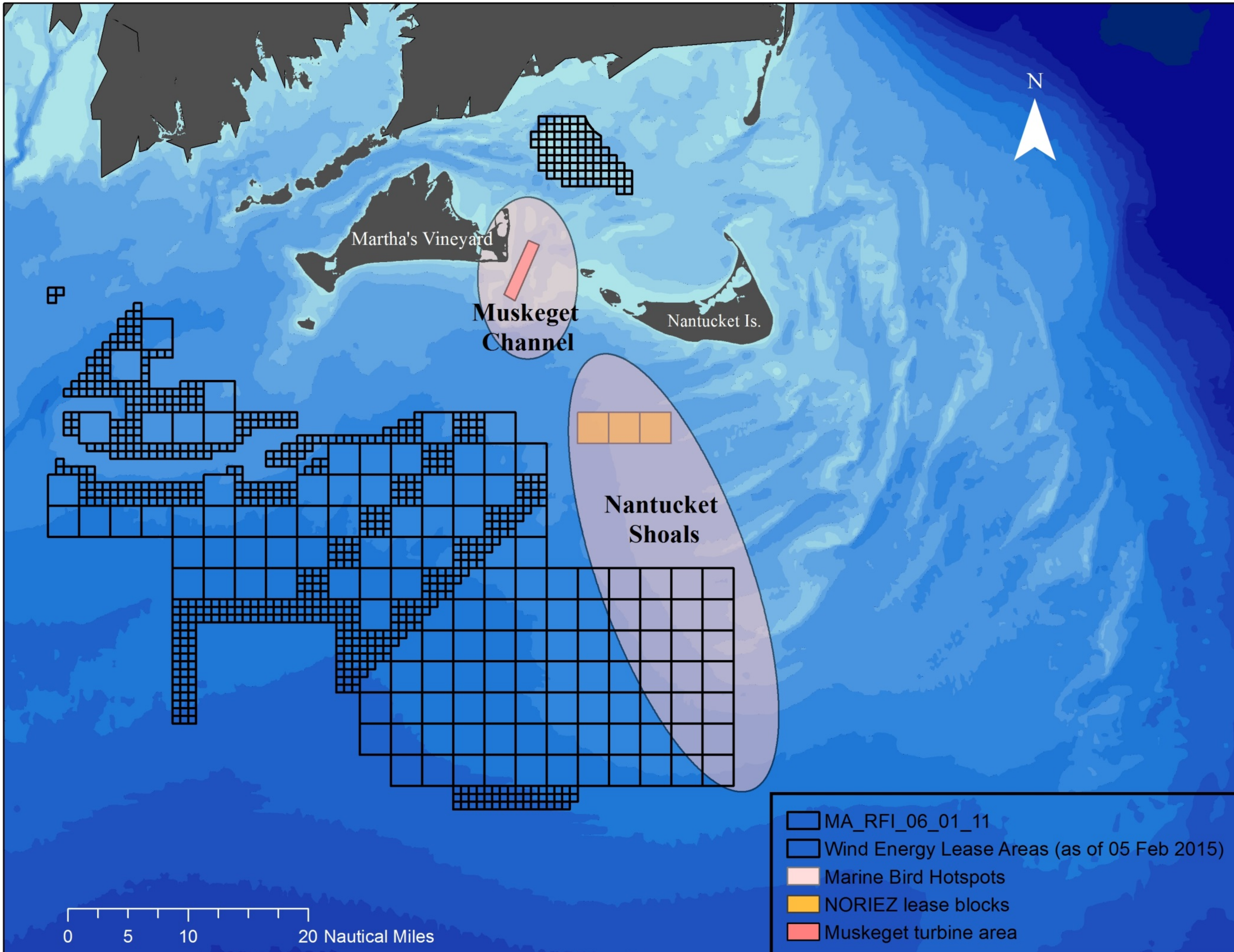


N
Martha's Vineyard
Nantucket Is.
0
5
10
20 Nautical Miles

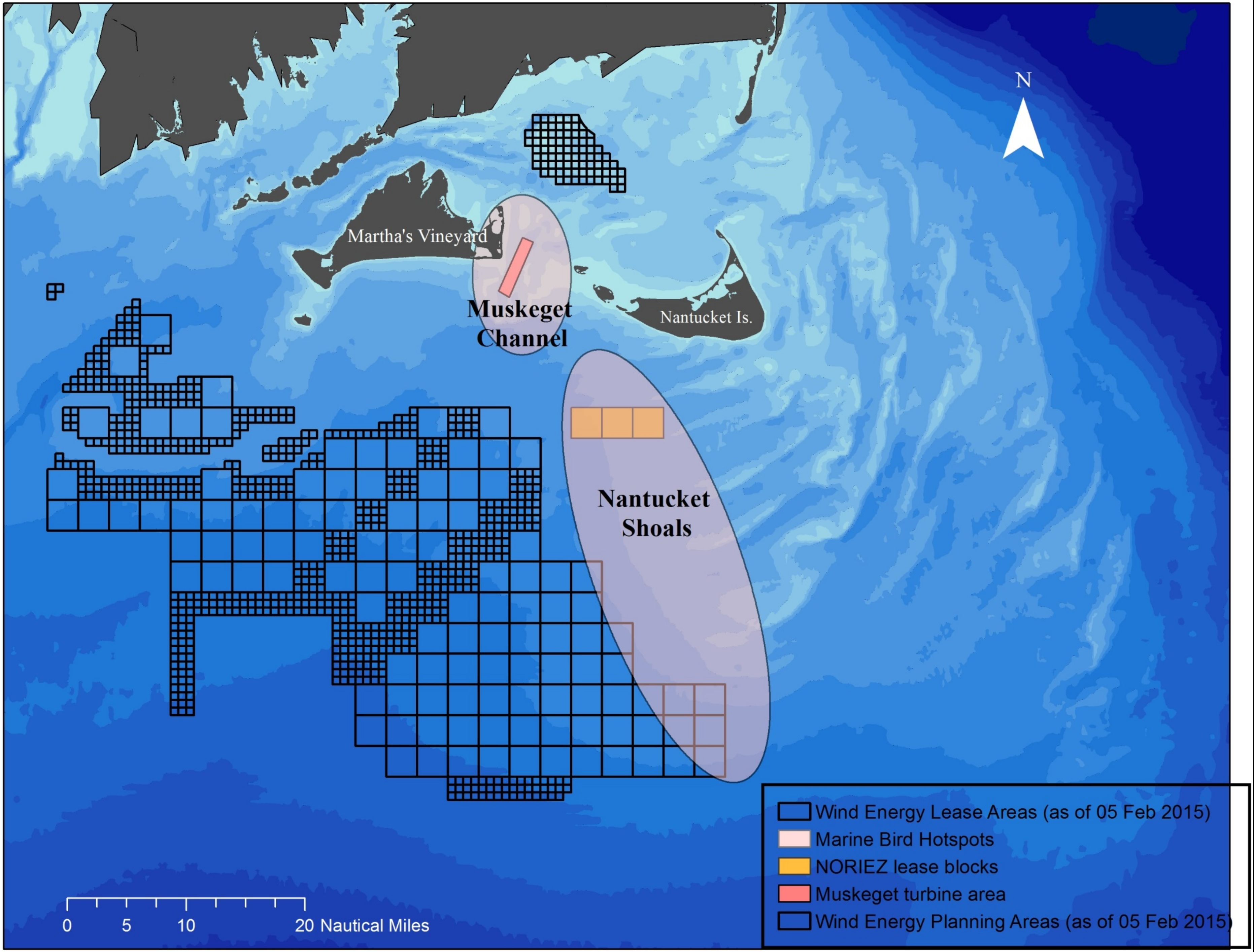

N
Martha's Vineyard
Nantucket Is.
0
5
10
20 Nautical Miles



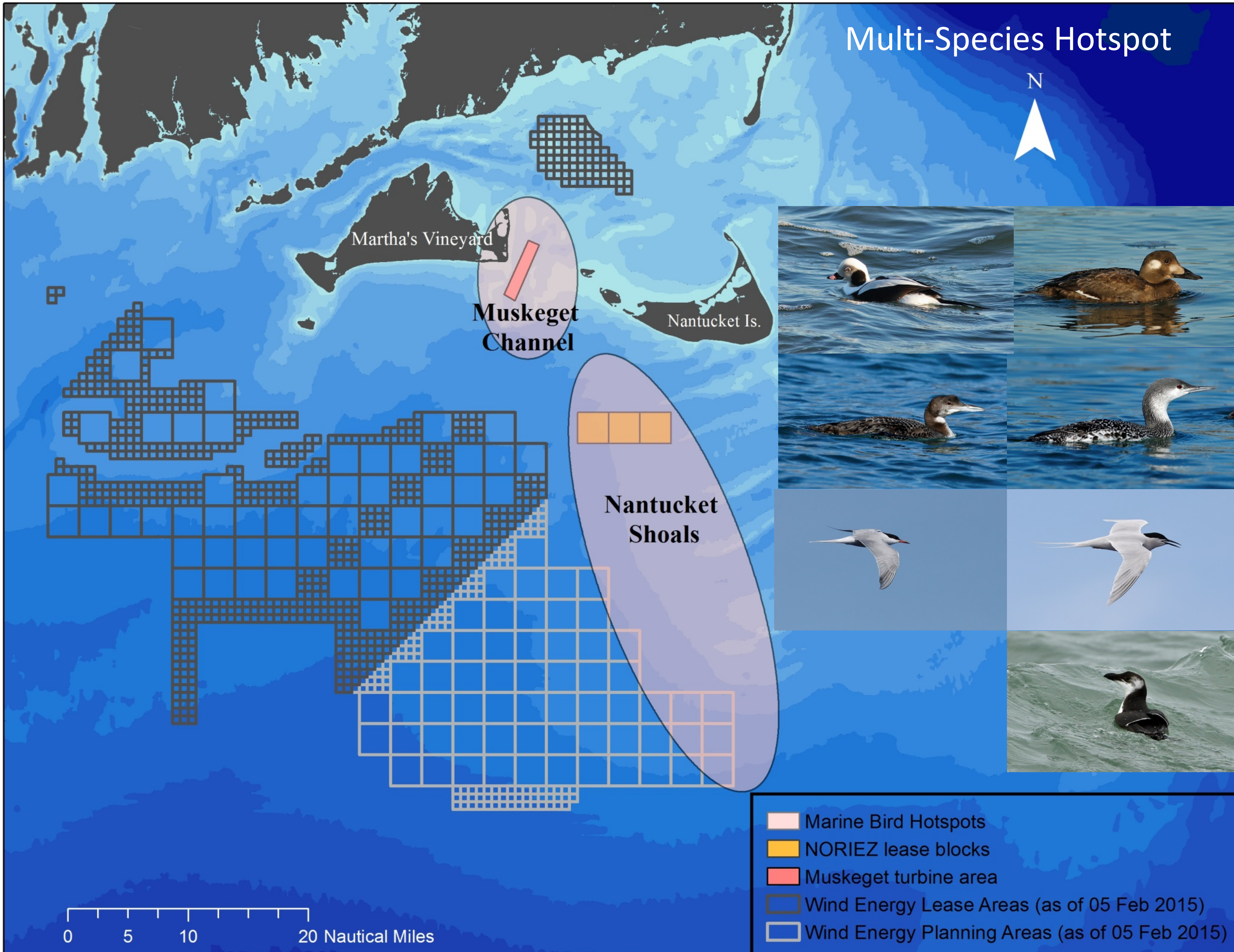
N
Martha's Vineyard
Muskeget Channel
Nantucket Is.
Nantucket Shoals
0
5
10
20 Nautical Miles



N
Martha's Vineyard
Muskeget Channel
Nantucket Is.
Nantucket Shoals
MA_RFI_06_01_11
Wind Energy Lease Areas (as of 05 Feb 2015)
Marine Bird Hotspots
NORIEZ lease blocks
Muskeget turbine area
0
5
10
20 Nautical Miles



N
Martha's Vineyard
Muskeget Channel
Nantucket Is.
Nantucket Shoals
Wind Energy Lease Areas (as of 05 Feb 2015)
Marine Bird Hotspots
NORIEZ lease blocks
Muskeget turbine area
Wind Energy Planning Areas (as of 05 Feb 2015)
0
5
10
20 Nautical Miles



Multi-Species Hotspot
N
Martha's Vineyard
Muskeget Channel
Nantucket Is.
Nantucket Shoals
Marine Bird Hotspots
NORIEZ lease blocks
Muskeget turbine area
Wind Energy Lease Areas (as of 05 Feb 2015)
Wind Energy Planning Areas (as of 05 Feb 2015)
0
5
10
20 Nautical Miles

OCS Study
BOEM 2016-067

Abundance and Distribution of Seabirds off Southeastern Massachusetts, 2011-2015

Final Report

Richard R. Veit[1], Timothy P. White[1,2], Simon A. Perkins [1,3] and Shannon Curley[1]

[1]Biology Department, College of Staten Island, City University of New York, 2800 Victory Boulevard, Staten Island, NY 10314; and CUNY Graduate Center, 365 Fifth Avenue, New York, NY 10016; [2] NOAA, National Centers for Coastal Ocean Science 1305 East West Highway, SSMC IV Silver Spring, MD 20910 [3] Notice Nature, Inc., 61 Elm Brook Lane, Concord, MA 01742.

U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs
www.boem.gov

BOEM
Bureau of Ocean Energy Management

Spatial Use of the Atlantic OCS by Vulnerable Marine Birds.

Red-throated Loon (*Gavia stellata*) released with satellite transmitter.

Northern Gannet (*Morus bassanus*) released with satellite transmitter.

Surf Scoter (*Melanitta perspicillata*) released with satellite transmitter.

Andrew Gilbert – *Data Management Director*
Biodiversity Research Institute
Portland, Maine, USA
www.briloon.org

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Glenn Olsen, PhD, DVM

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Biodiversity Research Institute, Portland, ME
Andrew Gilbert, MSc
Carrie Gray , PhD candidate
Lucas Savoy
Iain Stenhouse, PhD

Project Funding

BOEM

Bureau of Ocean Energy Management

U.S. DEPARTMENT OF ENERGY

Sea Duck Joint Venture

Plan Conjoint des Canards de Mer

Bailey Wildlife Foundation

Background and Objective

- Current interest in offshore wind in US Atlantic
- Expressed need to understand individual movement to inform siting
- Primarily focused on wintering and migration from in Mid-Atlantic (NC-NY)
- Study species: Northern Gannet (NOGA), Red-throated Loon (RTLO), and Surf Scoter (SUSC)
- Disparate habits and life history strategies, representing a cross-section of marine birds

Primary objective

Determine fine-scale occurrence and local movement patterns of Red-throated Loons, Surf Scoters, and Northern Gannets in Federal waters of the mid-Atlantic U.S. during migration and winter, using platform terminal transmitter satellite tracking tags (PTTs).

Northern Gannet (*Morus bassanus*)

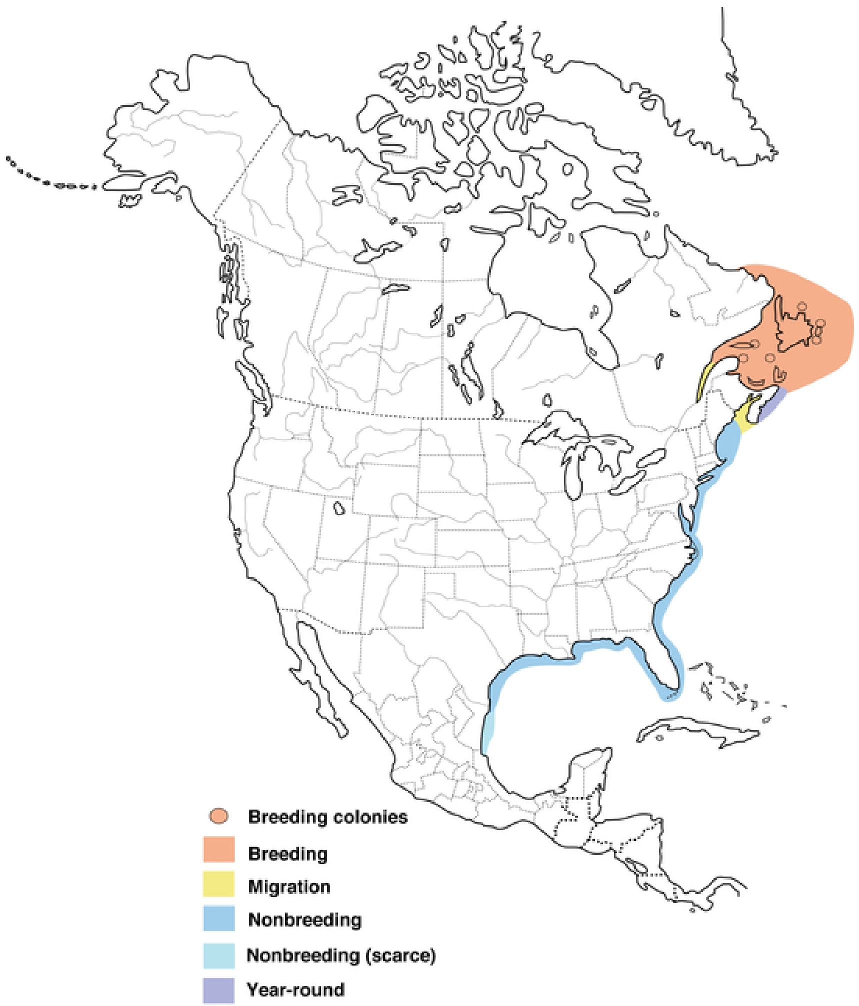


Photo credit: Ryan Hagerty
Source: USFWS National Digital Library

Range map source: Birds of North America, online edition

Red-throated Loon (*Gavia stellata*)

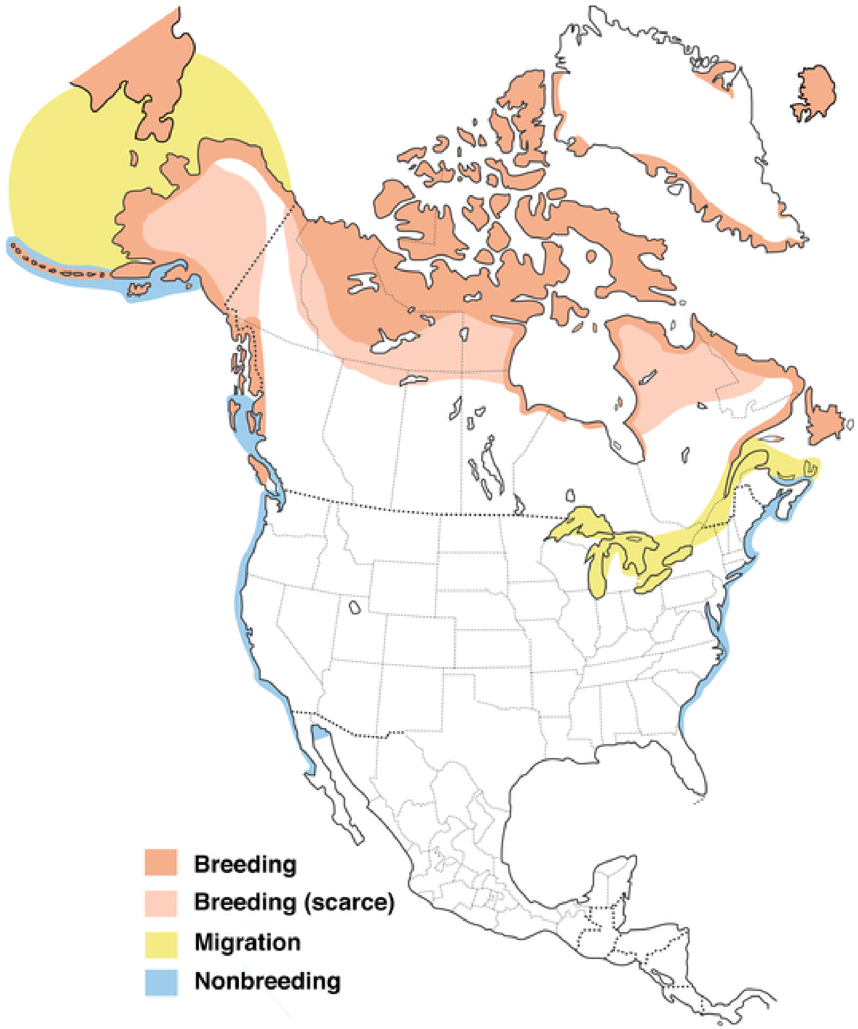


Photo credit: Dave Menke
Source: USFWS National Digital Library

Range map source: Birds of North America, online edition

Surf Scoter (*Melanitta perspicillata*)

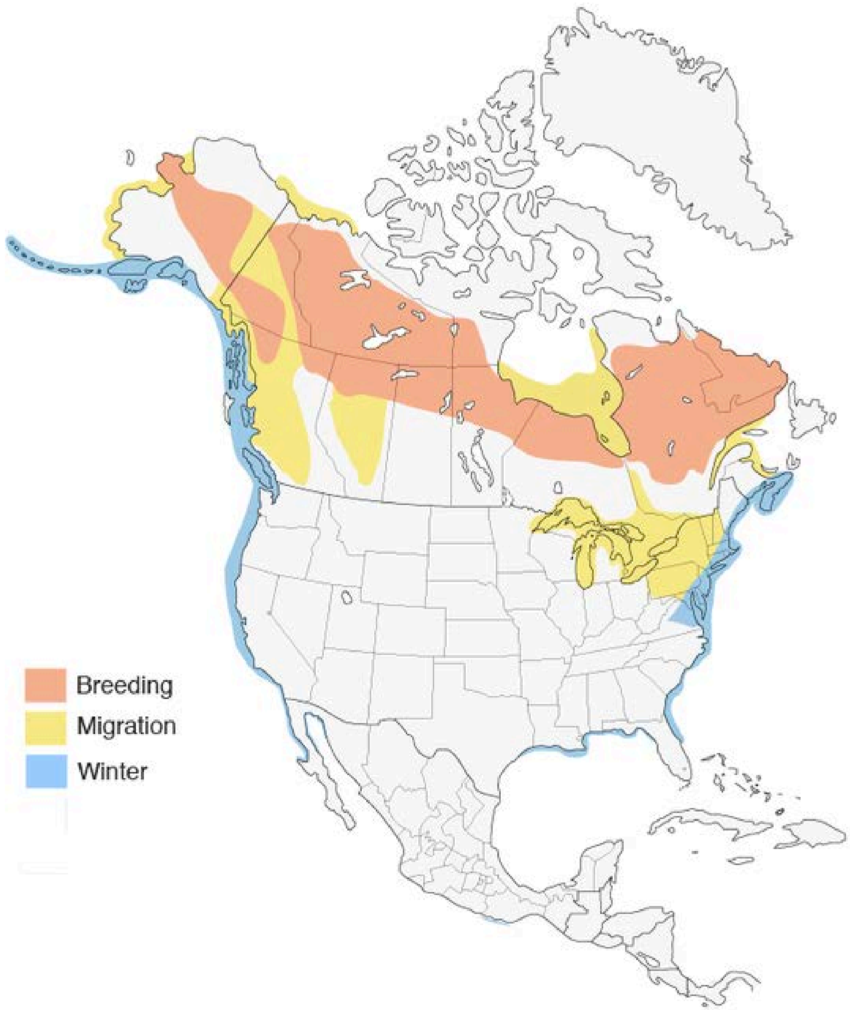


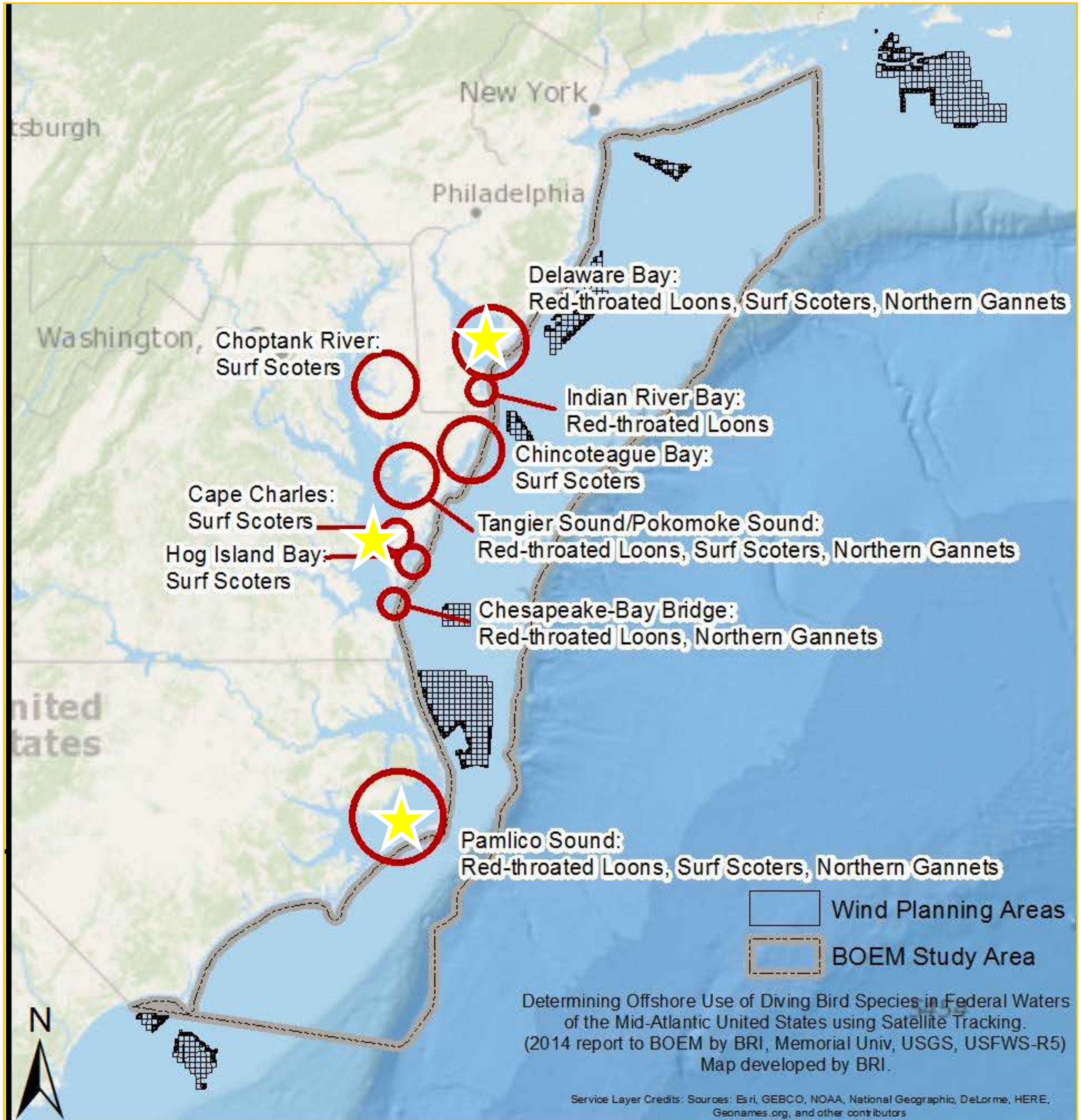
Photo credit: Gary Kramer
Source: USFWS National Digital Library

Range map source: Birds of North America, online edition

Capture methods

- SUSC, NOGA, and RTLO captured at sea in January, February and March using night-lighting techniques and some mist-netting.
- Some molting scoters mist-netted in Quebec in fall (SDJV), and other methods

- Birds banded, measured and appropriately sized animals, tagged
- Transmitters surgically implanted, 6 were tail-taped at-sea and 9 tailed taped in 2012 at the colony
- Bird released close to capture sites



2012-2015

Capture Areas

Delaware Bay

Chesapeake Bay

Pamlico Sound

Gulf of St. Lawrence (scoters)

Cape St. Mary's, NL (gannets)

Satellite Tag Sample Size

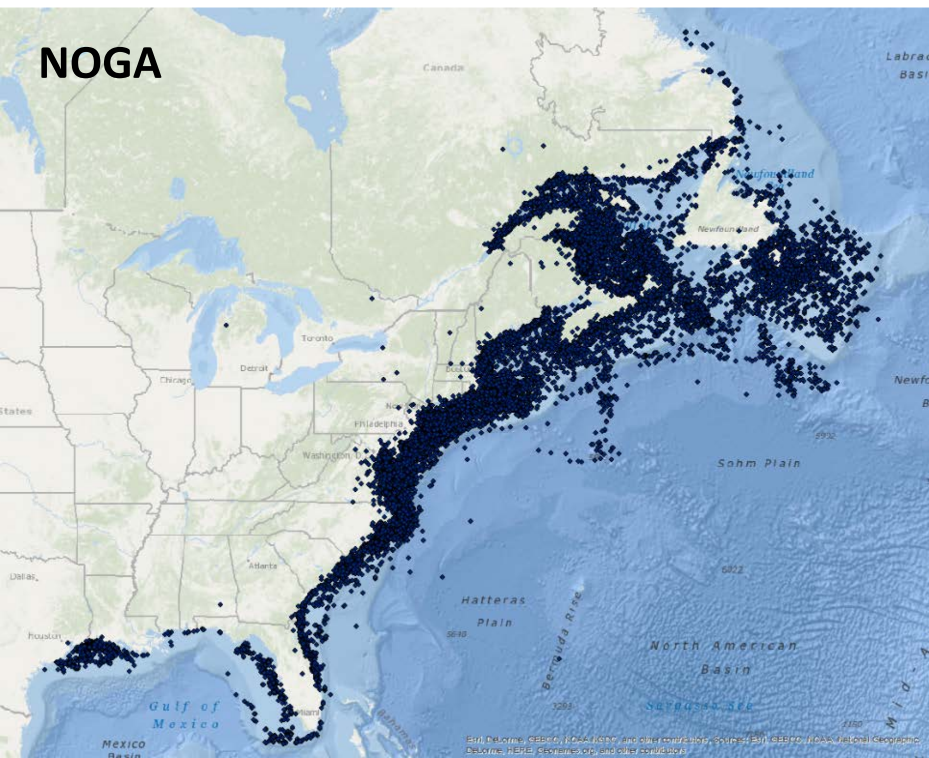
Year	NOGA	RTLO	SUSC
2011 (SDJV)			21
2012 (SJDV)			36
2012 (BOEM)	15	17	15
2013 (SDJV)			53
2013 (BOEM)	20	26	20
2014	20	23	21
2015	20	20	20
Total	75	86	186

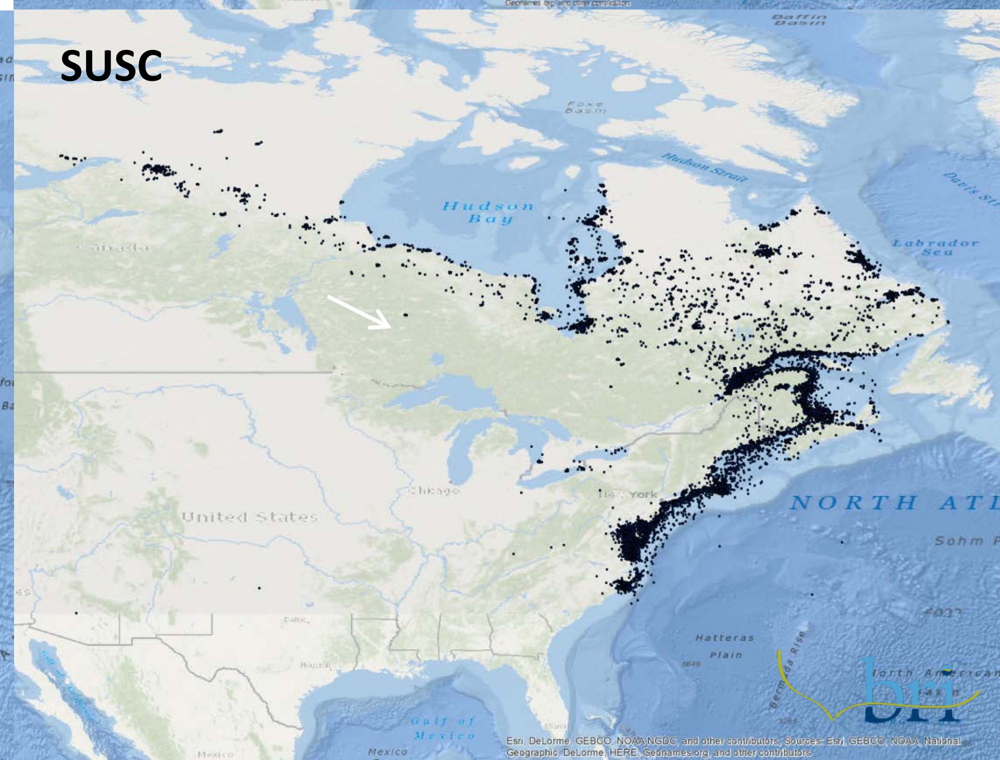
Data Management and Analysis

- Automated download process from Argos
- Process to compile, remove duplicates, and filter poor quality data using the Douglas Argos Filter (DAF)[1]
- Culled first 14 days of data for each animal
- > 30 days data min. required for implanted birds for use in analyses
- Identified unique breeding, staging, molting, wintering, and migrating periods for each animal
- Used dynamic Brownian bridge movement model (dBBMM) to generate utilization distributions for each animal and period in R package, *move*[2]
- Composited individual movement models into sample “population” level mean utilization distribution (UD) of all animals for each species

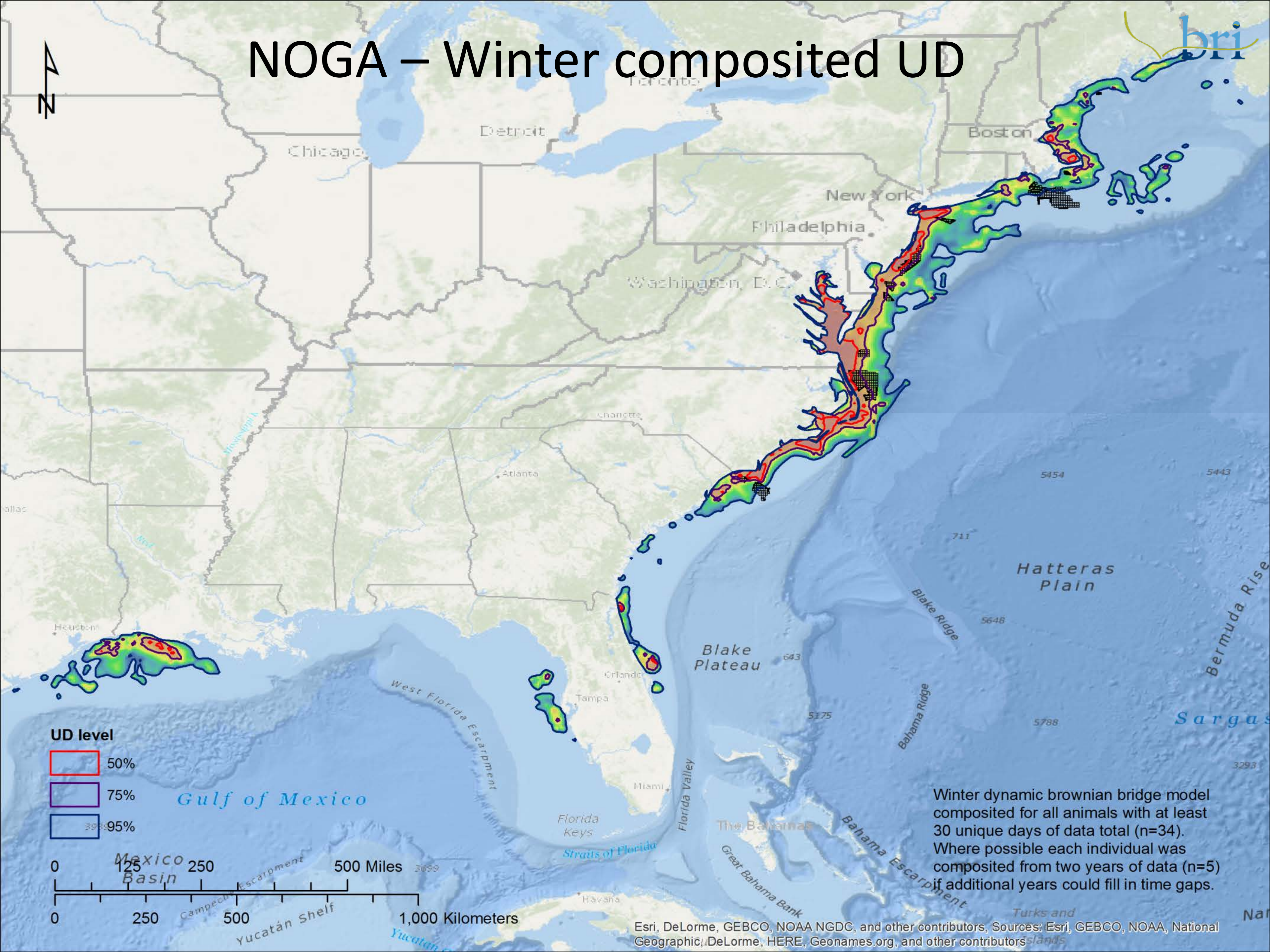
[1] Douglas, D. C., R. Weinzierl, S. C. Davidson, R. Kays, M. Wikelski, and G. Bohrer. 2012. Moderating Argos location errors in animal tracking data. Methods in Ecology and Evolution 3(6):999-1007. doi: 10.1111/j.2041-210X.2012.00245.x
[2] Kranstauber, B. et al., 2012. A dynamic Brownian bridge movement model to estimate utilization distributions for heterogeneous animal movement. *Journal of Animal Ecology*, 81(4):738-746.

Year	NOGA	RTLO	SUSC
2011			21
2012	15	17	51
2013	20	26	73
2014	20	23	21
2015	20	20	20
Total	75	86	186

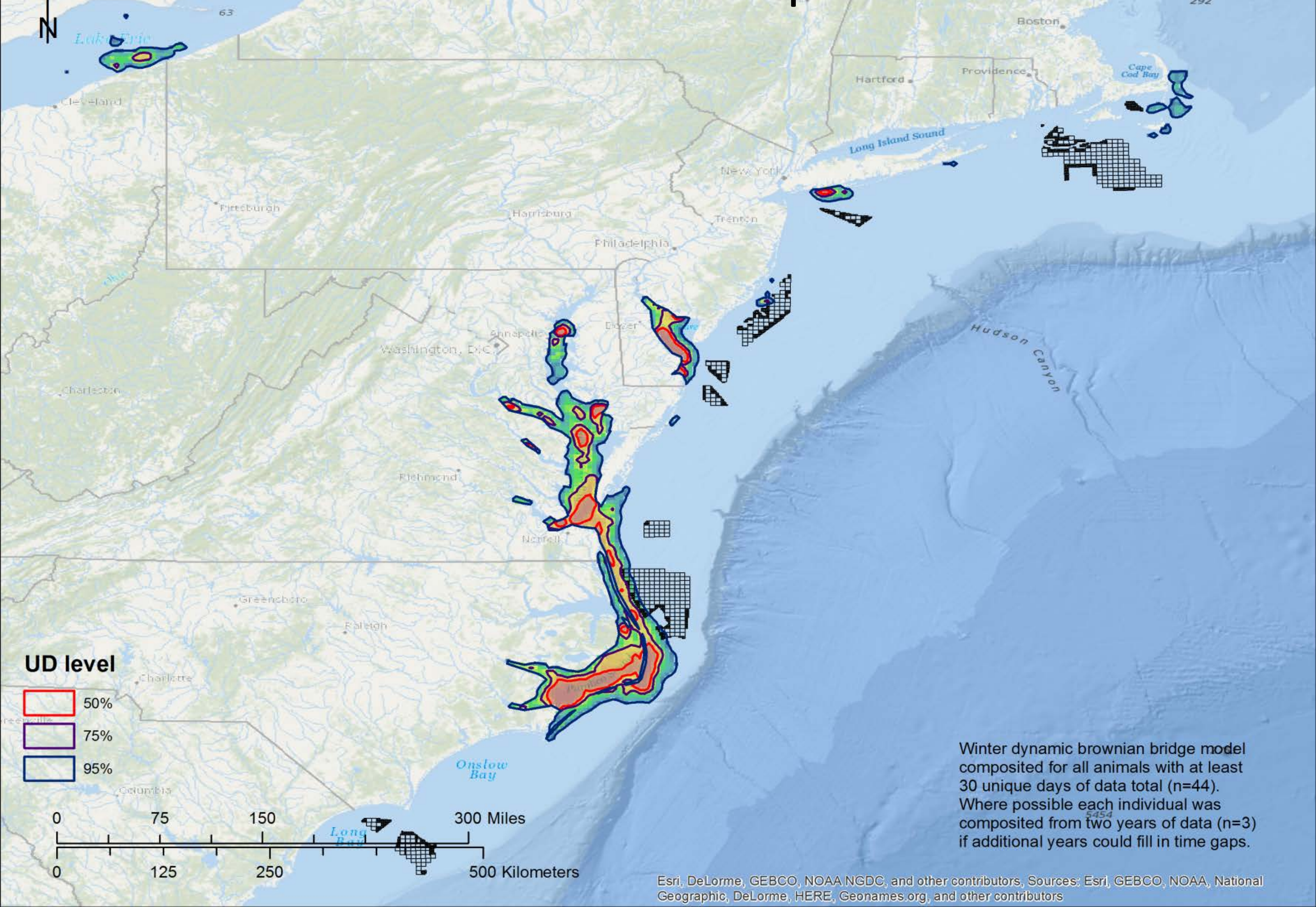




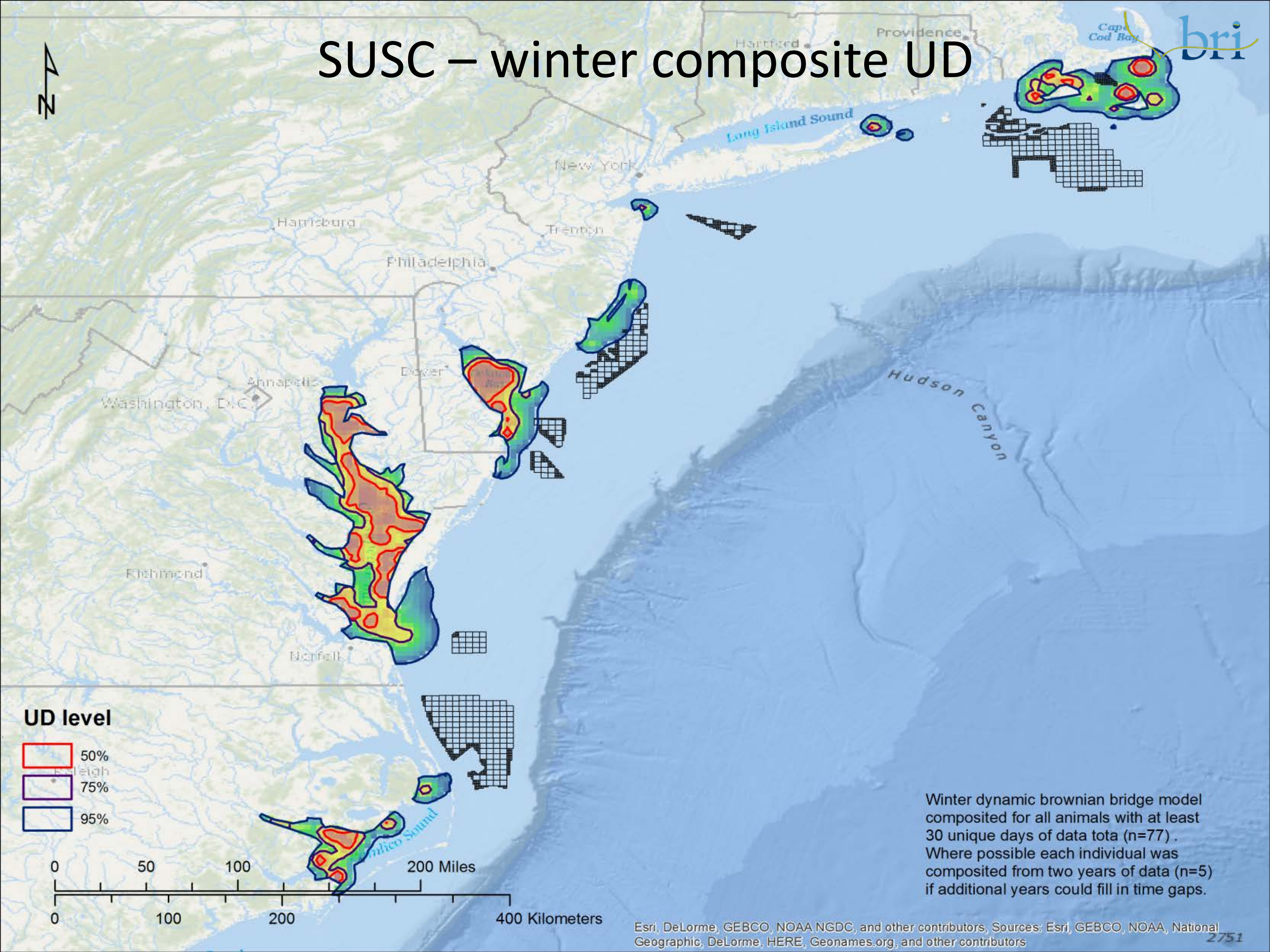
NOGA – Winter composited UD



RTLO – winter composite UD

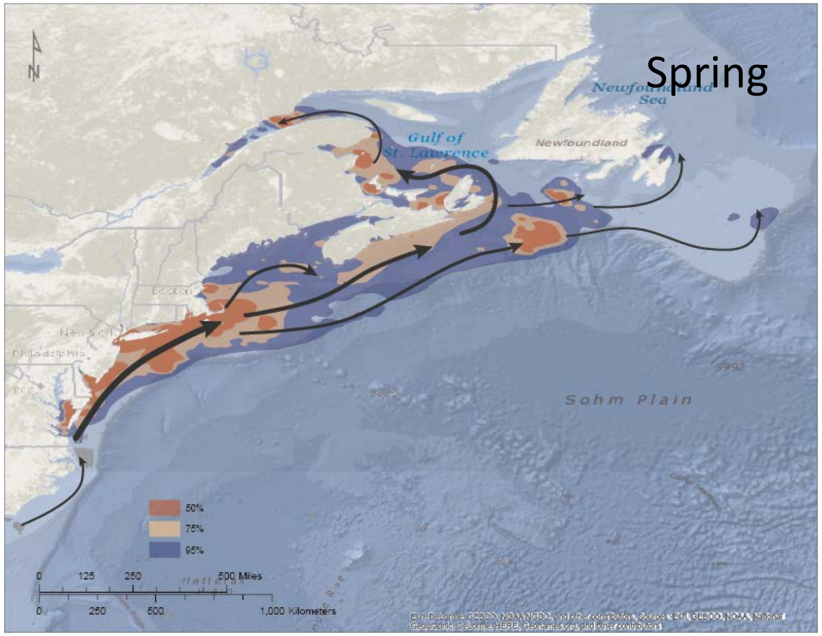


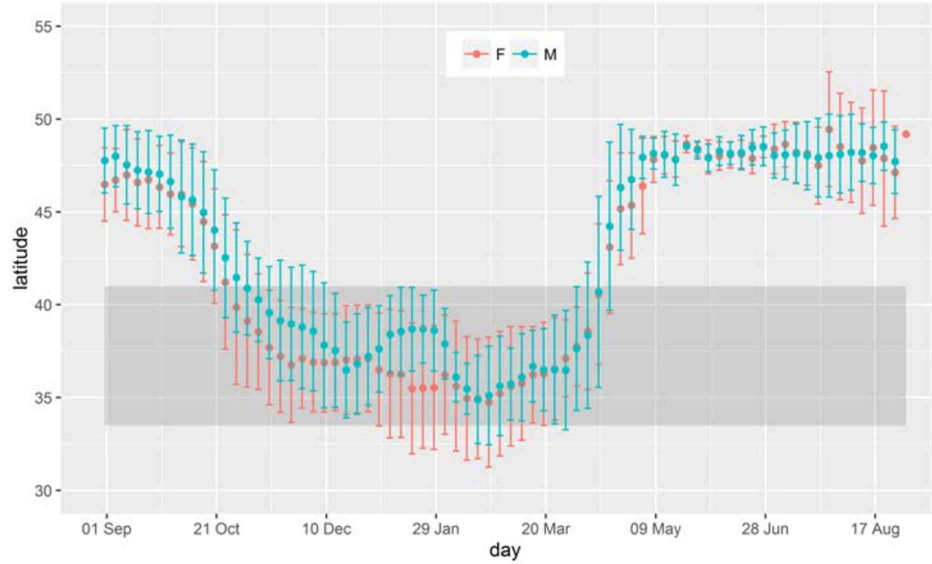
SUSC – winter composite UD

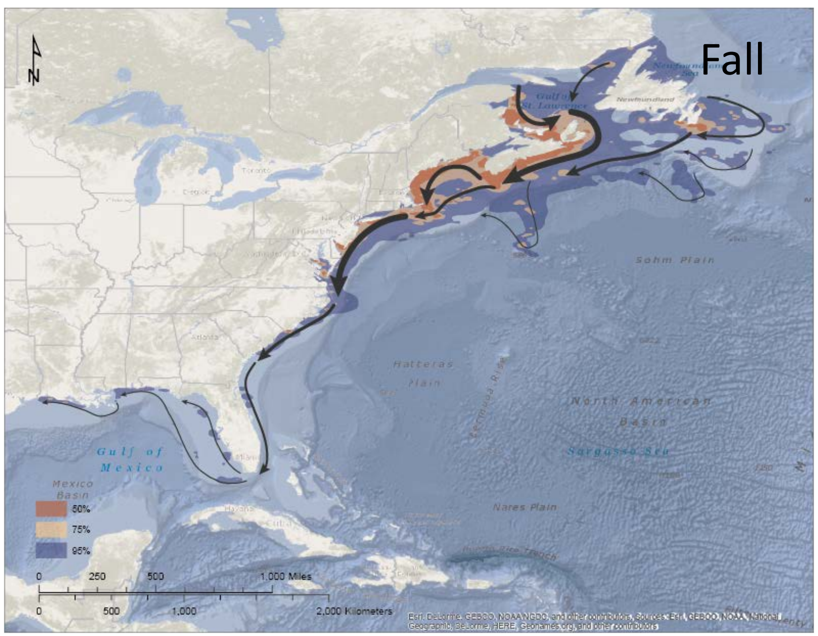


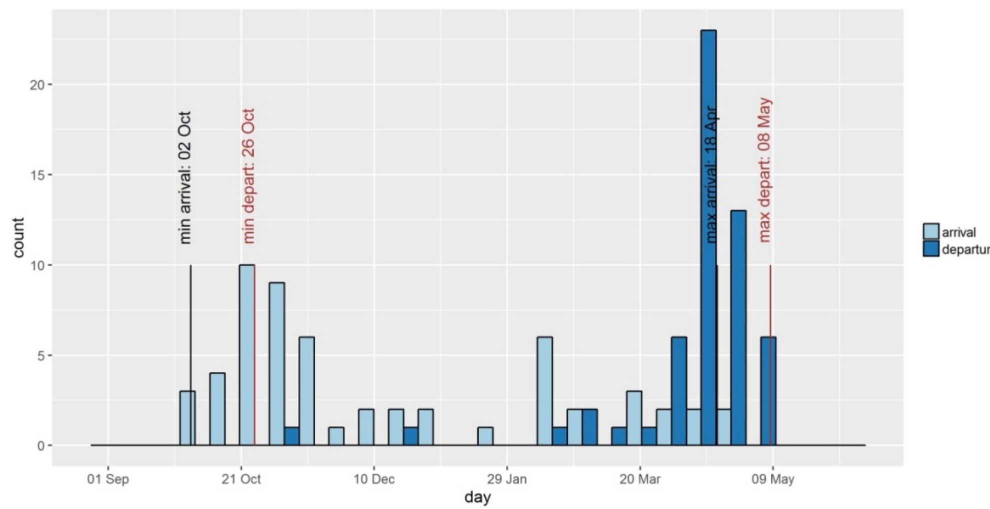
Winter dynamic brownian bridge model composited for all animals with at least 30 unique days of data tota (n=77) . Where possible each individual was composited from two years of data (n=5) if additional years could fill in time gaps.

NOGA migration

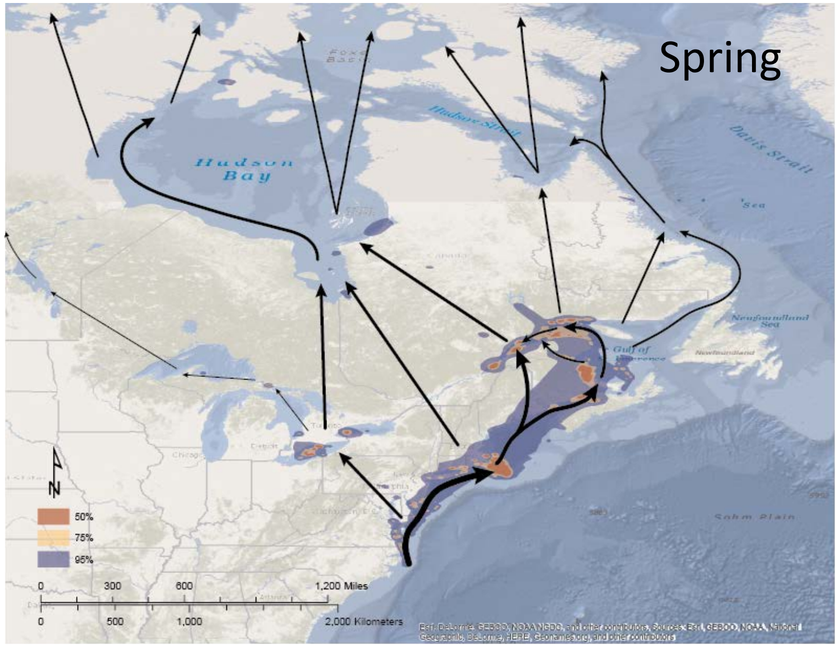


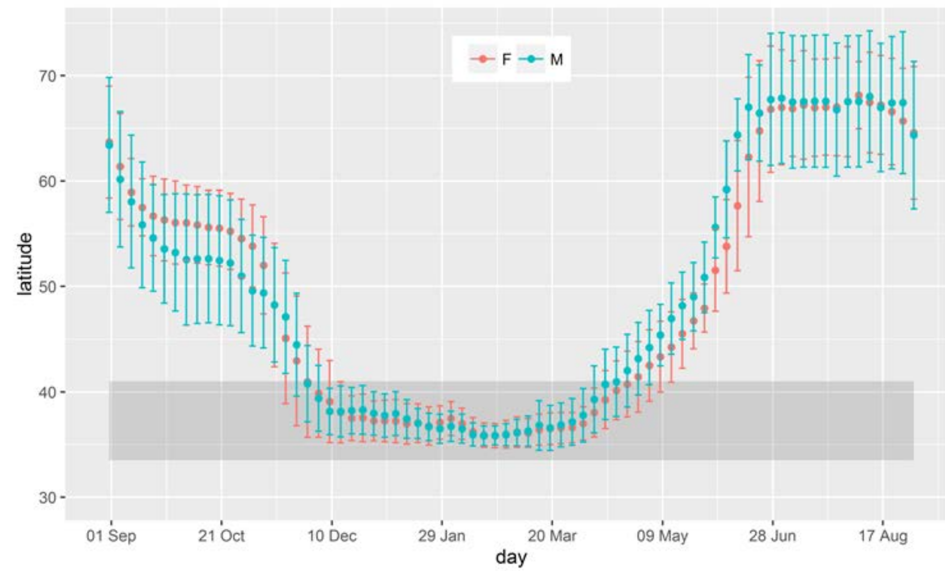


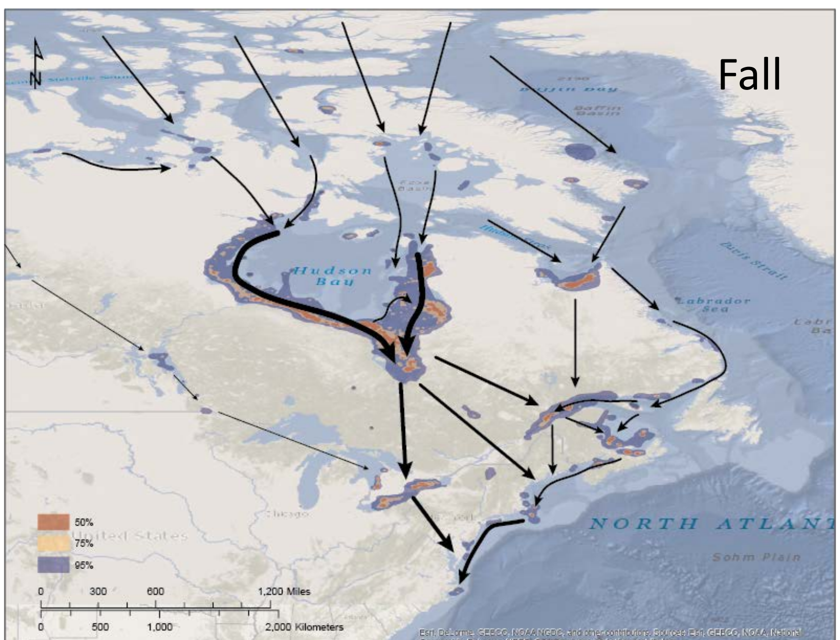


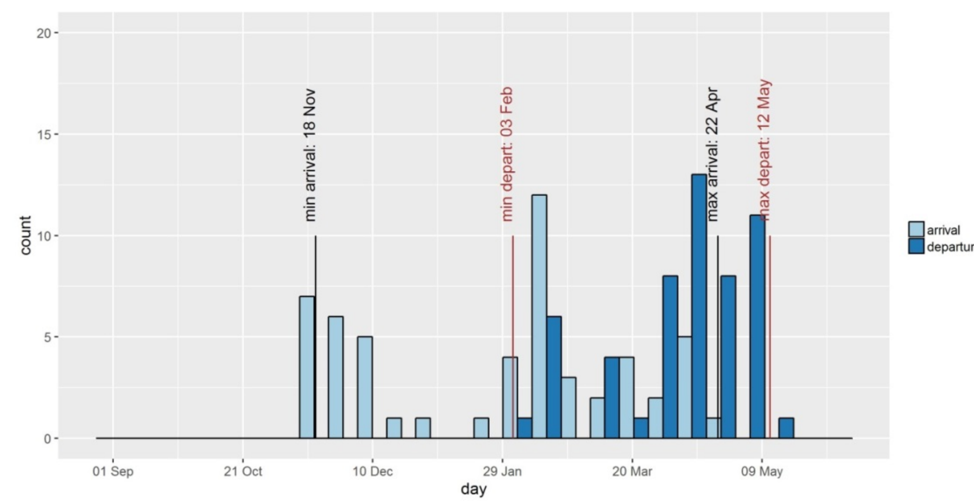


RTLO migration

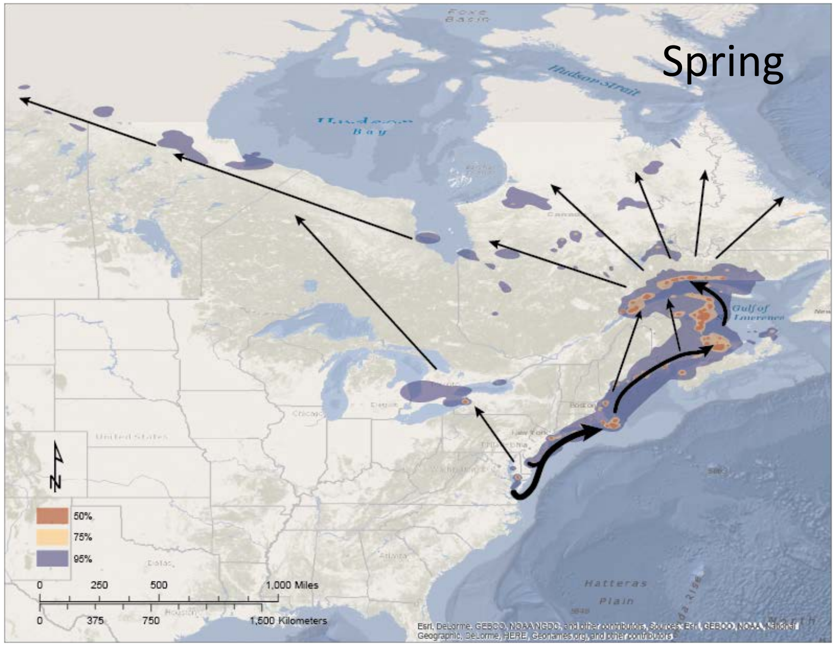


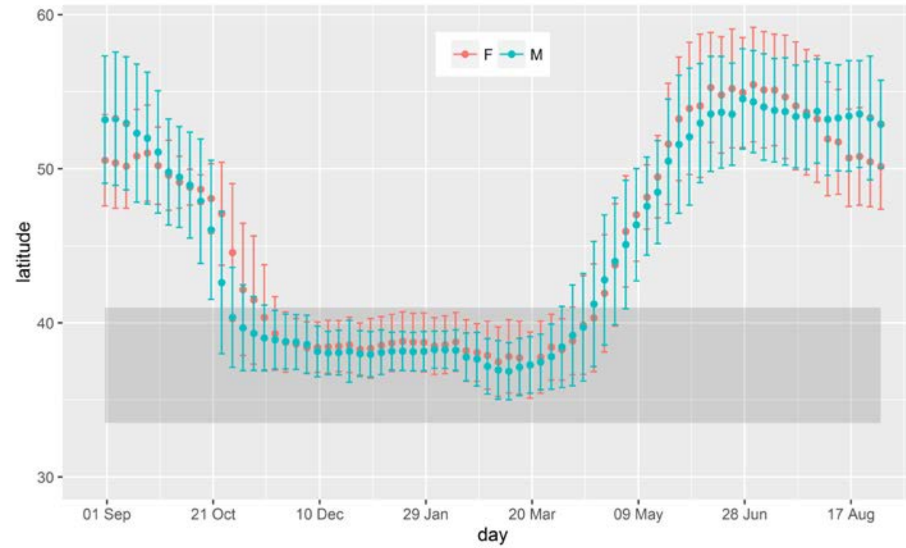


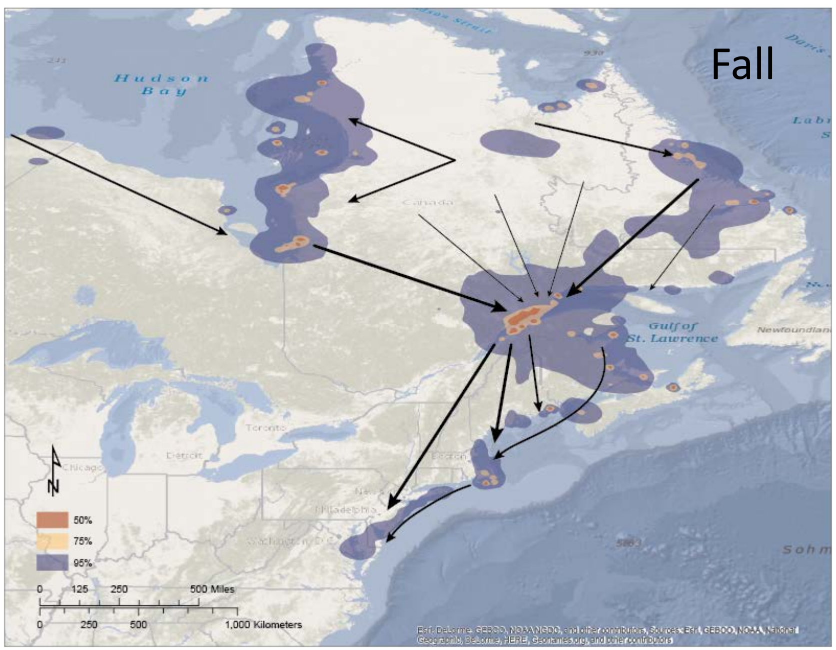


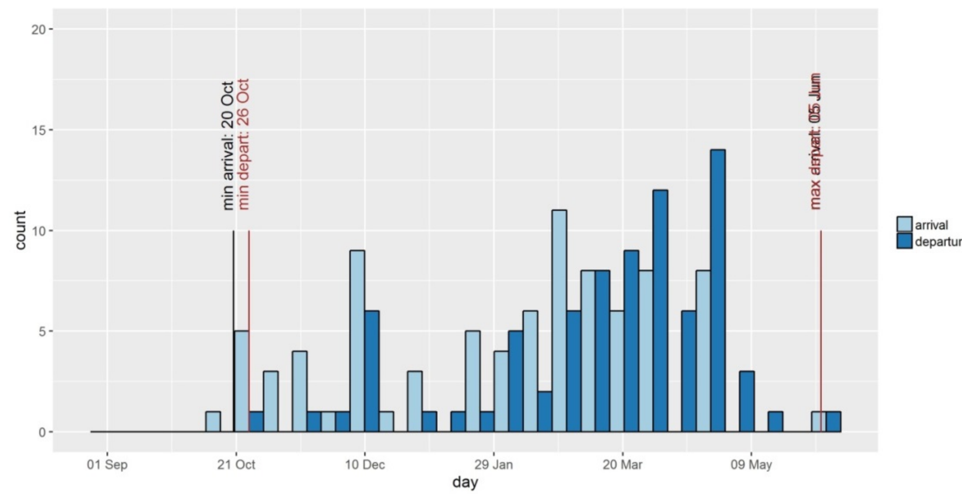


SUSC migration



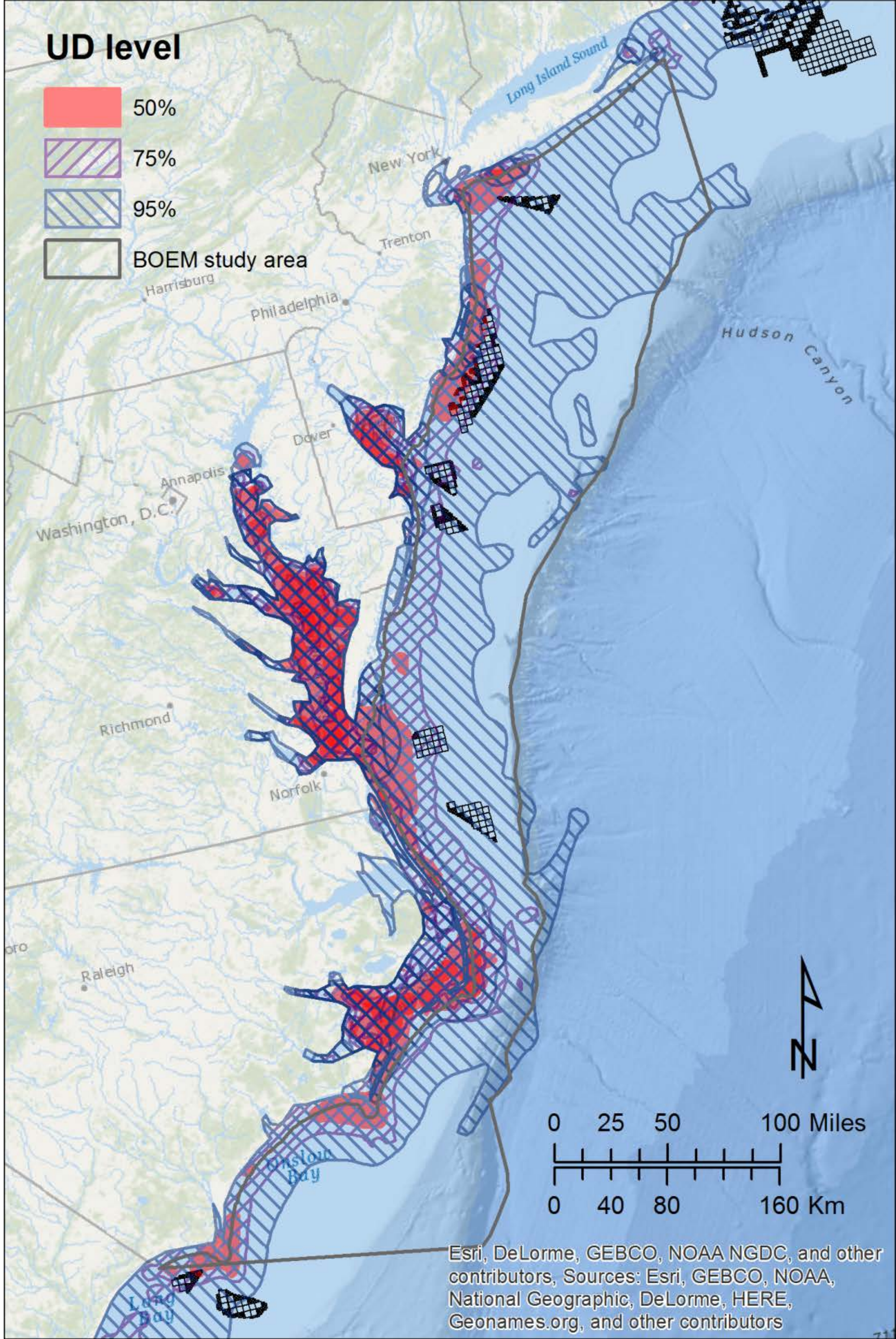






Preliminary Conclusions

- Heavy use of large bays by all species
- Use of offshore varied by species and season
- Capture mostly in winter may bias results
- More work needs to be done to understand movements of juveniles



THANKS!

- Capture Crew Members: Carl Anderson, Allie Byrd, Mike Chickering, Jonathan Fiely, Lucas Savoy, Carrie Gray, Rick Gray, Ian Johnson, Robby Lambert, Chris Persico, Vin Spagnuolo, Alicia Berlin, Kathleen McGrew, Charlotte Kilchenstein, Sarah Fitzgerald, Tony Senn, Alexander Vidal, Sally Yannuzzi, Suzanne Gifford
- Vets: Scott Ford, Glenn Olsen, Michelle Kneeland, Ginger Stout, Darryl Heard

New technologies and approaches for characterizing bird exposure to offshore energy in the OCS

Presentation at BOEM Atlantic Science Workshop
Washington-Dulles Airport Hotel. November 2016

Julia Robinson Willmott

remote.normandeau.com

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ENVIRONMENTAL CONSULTANTS

Outline

- **High Resolution Aerial Digital Imagery**
  - Data Collection – Broad-area surveys using transects

- **Acoustic and Thermographic Offshore Monitoring System (ATOM)**
  - Data Collection – Single location point count

- **Relative Vulnerability of Birds to Offshore Wind Projects**
  - Data Interpretation – Is there potential for population-level impacts to birds from offshore wind?

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High Resolution Digital Imagery

- **Europe 2007:** Aerial digital surveys are used for collecting offshore biological data

- **USA 2011:** Normandeau completed a comparison of three offshore survey methodologies
  - Boat-based visual
  - Low-altitude aerial visual
  - High-altitude aerial digital

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High Resolution Aerial Digital Imagery

Density

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Turtle Density Estimates

- Digital survey estimates 4x higher than visual aerial
- Digital survey estimates 10x higher than boat survey

Reasons

- Low visibility of turtles from boats at sea-level and from aircraft given short observation time
- Disturbance by both boat and aerial visual survey platforms

High Resolution Aerial Digital Imagery

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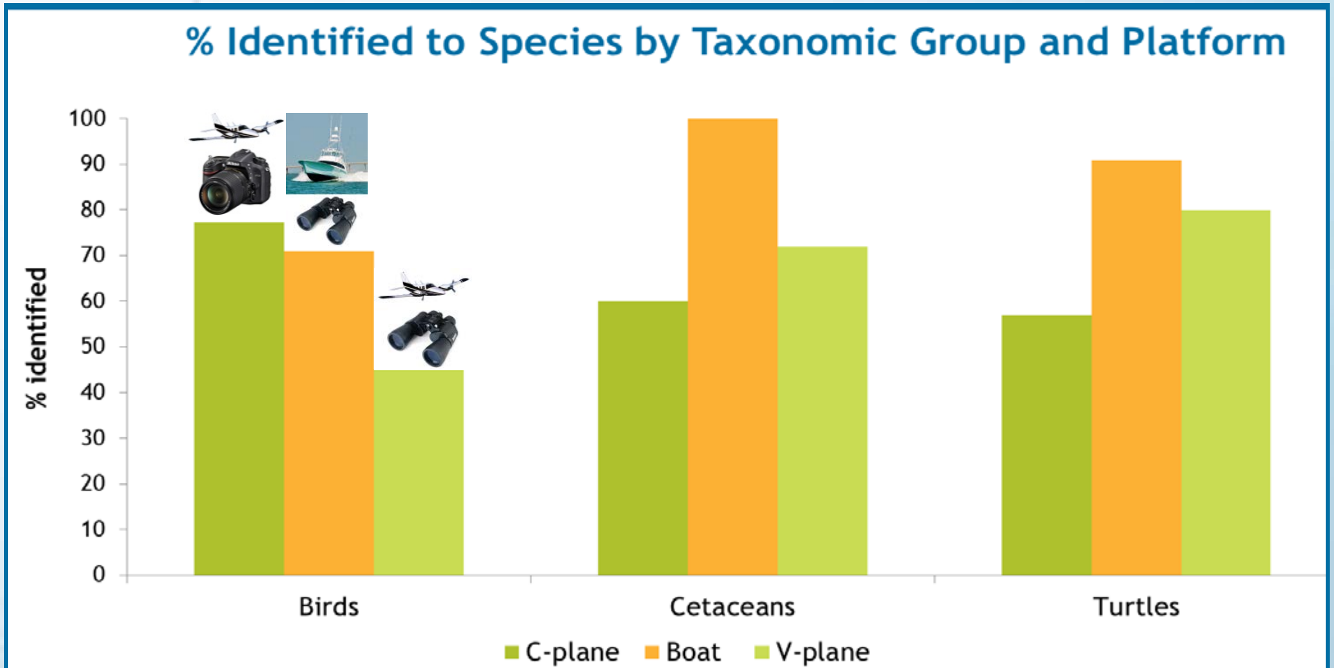
Identification

Birds: digital aerial surveys and boat-based surveys achieved higher success than visual aerial surveys

Turtles and Cetaceans: boat-based surveys had highest success



ATOM

Design and test system to survey bird and bat species potentially affected by offshore developments

- thermal imagery
- acoustic and ultrasound sensors

Deploy system on a structure in the AOCS

- gather acoustic and thermographic data
- report seasonal, annual, and weather-related variation in bird species' presence

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Test

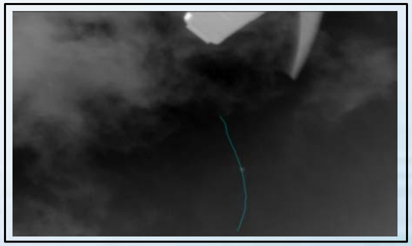
Deployed at **UD Lewes** 18 July-9 August 2011

13.2 TB of thermographic data

6 gigabytes (GB) of ultrasound data

- 641 bat passes detected of 5 species.

Example data: Big brown bat -Altitude 40.87m, Bearing 12.02 NNE, Velocity 23.075 km/hr



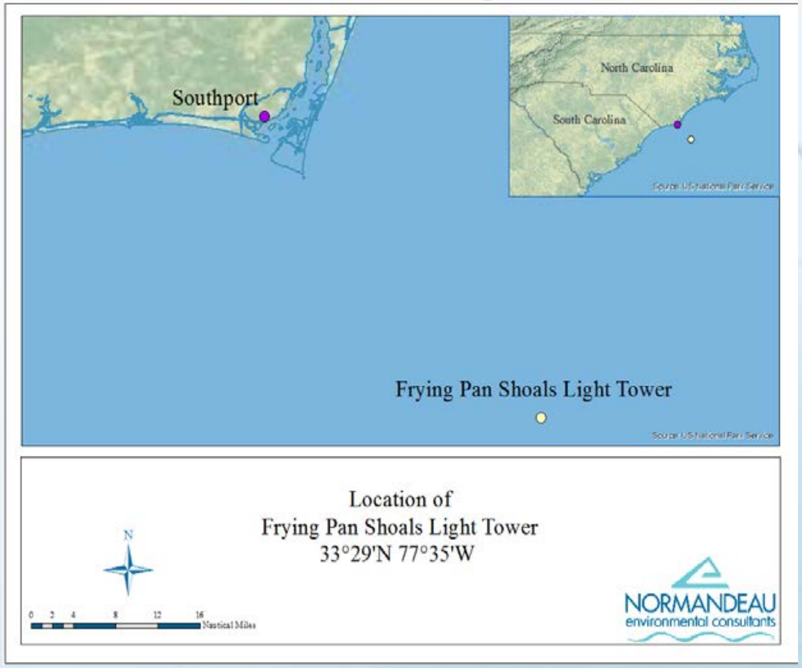
ATOM

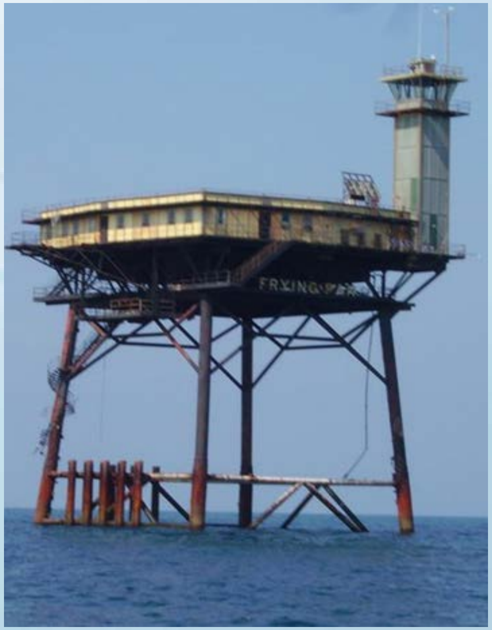
Deploy

Frying Pan Shoals Light Tower

29 mi offshore, southeast of Southport, North Carolina

6 December 2011-03 April 2013





ATOM

Deploy Results

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Month	Target	Timestamp	Altitude (m)	Decimal Bearing	Compass Bearing	Velocity (km/hr)
April	Bird	03:18:50.495	135.1	312	WNW	15.6
April	Bird	11:19:45.198	140.6	160.5	SSE	17.6
April	Bird	16:56:32.099	108.2	34	NNE	23.9
April	Bird	22:07:10.627	117.2	285.1	WNW	15.6

ATOM

Deploy Results

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2,640 songbird calls in files analyzed of 30+ species. Peak October.

Cape May Warbler	476
Palm Warbler	325
Northern Parula	212
Yellow-rumped Warbler	203
Swainson's Thrush	114
Ovenbird	89
Gray-cheeked Thrush	81
American Redstart	69
Black-throated Blue Warbler	55
Blackpoll Warbler	48

Deploy Results

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Clear pattern of migrant occurrence April and October - higher nocturnal activity in April

Peak fall density of migrating birds during periods of north to northwest winds (i.e., with a tail wind)

Most birds flew higher in evenings with estimated flight height increase of 1.8 times from 8 pm to 12 am

Passerine flight altitudes frequently higher than non-passerines

Flight altitude unaffected by wind speed although activity tailed off in higher wind speeds

ATOM

Relative Vulnerability of Birds to Offshore Wind Projects

- Factors of bird species ecology that influence vulnerability of population-level impacts from offshore wind.
- Created method for assessing relative vulnerability among species
- Incorporated elements of sensitivity assessments from UK and Europe

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Metrics

Three Suites Assessing 177 Species:

- Population sensitivity
  - Identifying widespread and common species along with more restricted-range species with smaller populations
- Collision sensitivity
  - Identifying behavioral traits contributing to collision risk and the direct loss of an individual

- Displacement sensitivity
  - Identifying behavioral traits contributing to displacement from foraging grounds during construction and operation of a wind facility

Relative Vulnerability of Birds

Population Sensitivity

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- **Global Population Size (GPS)**
  - Bermuda Petrel- 142 individuals
  - American Goldfinch- 42,000,000
- **Percent of Population in AOCS (AOCS)**
  - <1% Canada Goose
  - >99% Kirtland's Warbler
- **Threat Ranking (TR)**
- **Adult Survival (SR)**
  - Bermuda Petrel- 98% survival rate. Age 7 at first breeding. Lays 1 to 3 eggs.

Relative Vulnerability of Birds

Population Sensitivity

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$$\frac{[(GPS \pm GPS_u) + (AOCS \pm AOCS_u) + TR + (SR \pm SR_u)]}{4}$$

Common Name	Lower	Middle Value	Upper
1. Black-capped Petrel	3.65	4.50	4.60
2. Bermuda Petrel	3.88	4.25	4.38
3. Least Tern	3.25	4.25	4.88
4. Roseate Tern	3.38	4.00	4.5
5. Kirtland's Warbler	3.75	4.00	4.03
8. Bicknell's Thrush	3.25	3.50	3.53
27. Northern Gannet	2.19	2.75	3.19
177. American Goldfinch	1.00	1.00	1.11

Relative Vulnerability of Birds

Collision Sensitivity

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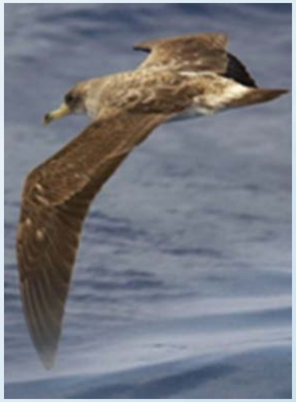
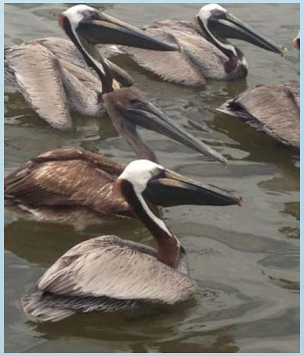
- **Annual Occurrence**
  - Least Bittern- 4 hours
  - Common Eider- Maximum 8,760
- **Nocturnal Flight Activity**
  - Land birds and shorebirds migrating
- **Diurnal Flight Activity**
- **Amount of time spent flying in the RSZ**
  - <5% petrels, shearwaters
- **Macro Avoidance Figures**
  - 30 to 40% (gulls and migrant songbirds)
- **Breeding and Feeding Score**





Relative Vulnerability of Birds (Min 2, Max 4,380,000)

Collision Sensitivity

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$$AO \times \left\{ \left[\frac{(NFR \pm NFR_u) + (DFR \pm DFR_u)}{(RSZ \pm RSZ_u)} \right] \times [(MA \pm MA_u) \times BR] \right\} \times \text{Population Sensitivity}$$

Common Name	Lower	Middle Value	Upper
1:Herring Gull	61,685	438,000	975,645
2:Great Black-backed Gull	75,920	438,000	962,340
3:Parasitic Jaeger	85,050	388,800	552,825
4:Red Phalarope	41,760	345,600	765,450
5:Long-tailed Jaeger	97,256	340,200	472,500
7: Roseate Tern	123,120	276,480	486,000
8: Northern Gannet	114,975	240,900	383,934
11: Black-capped Petrel	63,948	157,680	322,368
13: Common Tern	59,280	155,520	310,500
58: Red-throated Loon	6,200	14,400	48,510
60:Common Murre	4,380	9,198	21,922
65:American Oystercatcher	169	1,350	2,278
93: Wilson's Snipe	162	788	1,553
157: American Goldfinch	28	80	178
177: Brant	2	5	21

Relative Vulnerability of Birds

Displacement Sensitivity

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- **Disturbance from boats and aircraft**
- **Habitat Flexibility**

  Habitat generalist versus habitat specialist

  - Common Eider, Black Scoter- specialist
  - Gulls- generalists
  - Migrant land birds- no preference
- **Macro Avoidance**
  - Represents heightened rather than lowered risk

  (Opposite of collision)

- **Annual Occurrence**
- **Breeding/Feeding**

Relative Vulnerability of Birds (Min 0, Max 1,204,500)

Displacement Sensitivity

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$$AO \times \left\{\left[\frac{(DI \pm DI_u)+(MA \pm MA_u)}{2}\right] \times \left[(HF \pm HF_u) \times BR\right]\right\} \times \text{Population Sensitivity}$$

Common Name	Lower	Middle Value	Upper
1:Black Guillemot	411,544	700,800	1,019,729
2:Common Eider	368,971	560,640	779,793
3:Roseate Tern	178,459	414,720	521,769
4:Atlantic Puffin	279,389	413,910	525,547
5:Razorbill	255,441	394,200	517,362
8:Red-throated Loon	165,726	288,000	388,080
12:Great Black-backed Gull	119,837	262,800	376,382
14: Black-capped Petrel	77,937	236,520	314,813
16: Common Tern	85,925	233,280	333,353
19: Common Murre	106,434	183,960	272,928
34: Red Phalarope	27405	86400	159,468

Thank You to ALL of our Collaborators!

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BOEM Renewable Energy and Fisheries Studies

Brian Hooker
BOEM
November 17, 2016

U.S. DEPARTMENT OF THE INTERIOR
MARCH 3, 1849

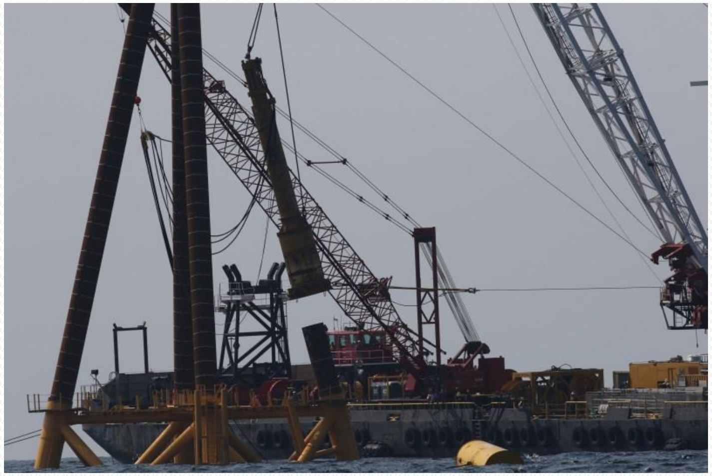
BOEM
BUREAU OF OCEAN ENERGY MANAGEMENT

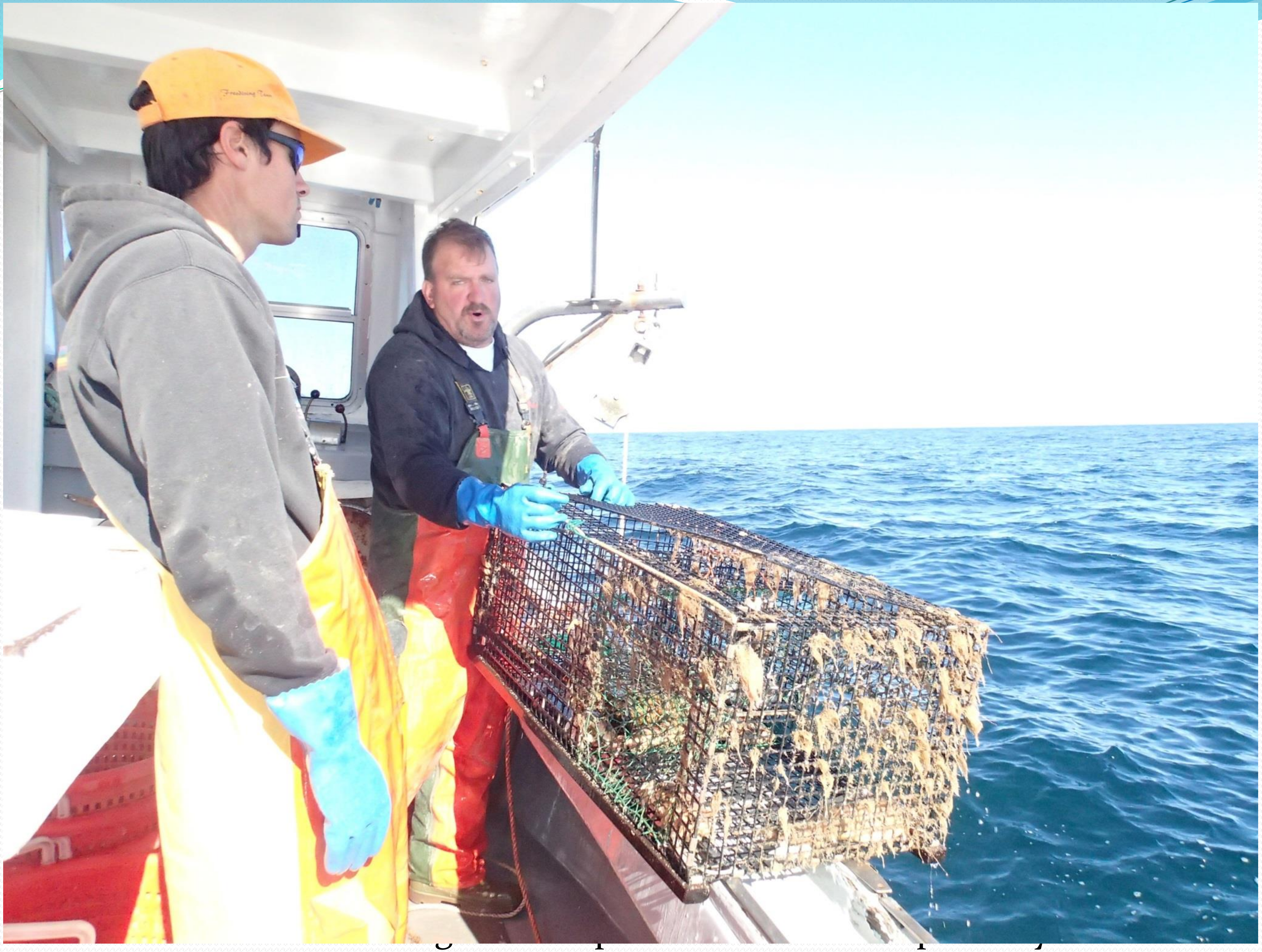
Outline

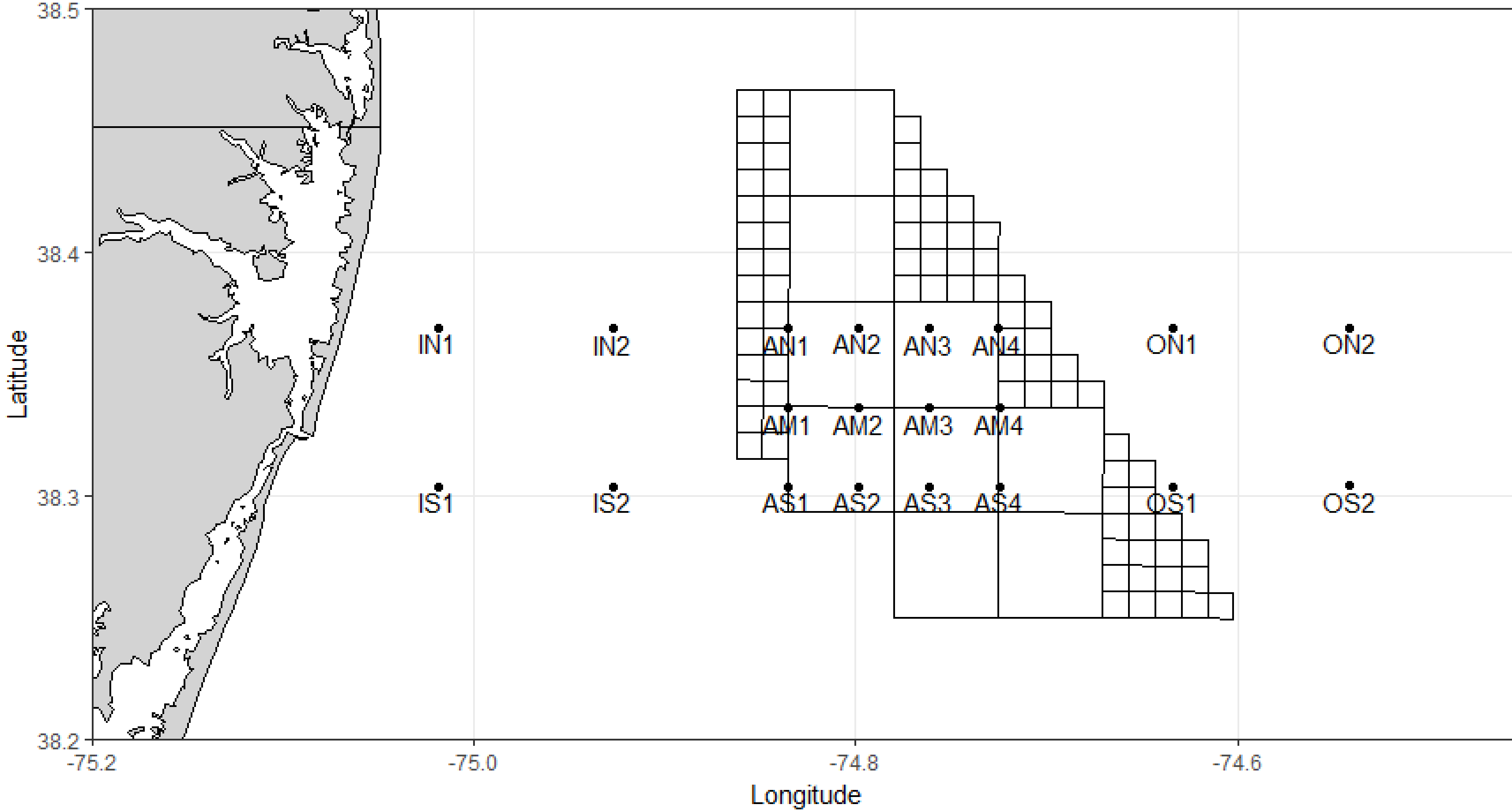
- Potential impact producing factors.
- Brief history of BOEM's fisheries outreach/studies for the renewable energy program.
- Future studies and outreach?

Potential Fisheries Impact Producing Factors

- Vessel Traffic
- Noise (Pile Driving, Surveys)
- Vessel Collisions/Allisions
- Bottom Disturbance
- Emissions (EMF) & Discharges
- Lighting
- Visual Impacts






Latitude
Longitude
38.5
38.4
38.3
38.2
-75.2
-75.0
-74.8
-74.6
IN1
IN2
AN1
AN2
AN3
AN4
ON1
ON2
AM1
AM2
AM3
AM4
IS1
IS2
AS1
AS2
AS3
AS4
OS1
OS2

Future Fisheries Studies?

- Understanding fish auditory thresholds/masking.
- Real-time Opportunity for Development Environmental Observations (RODEO).
  - Acoustic environment monitoring
  - Benthic habitat monitoring
- Other baseline studies?

Fish Auditory Thresholds Part 1

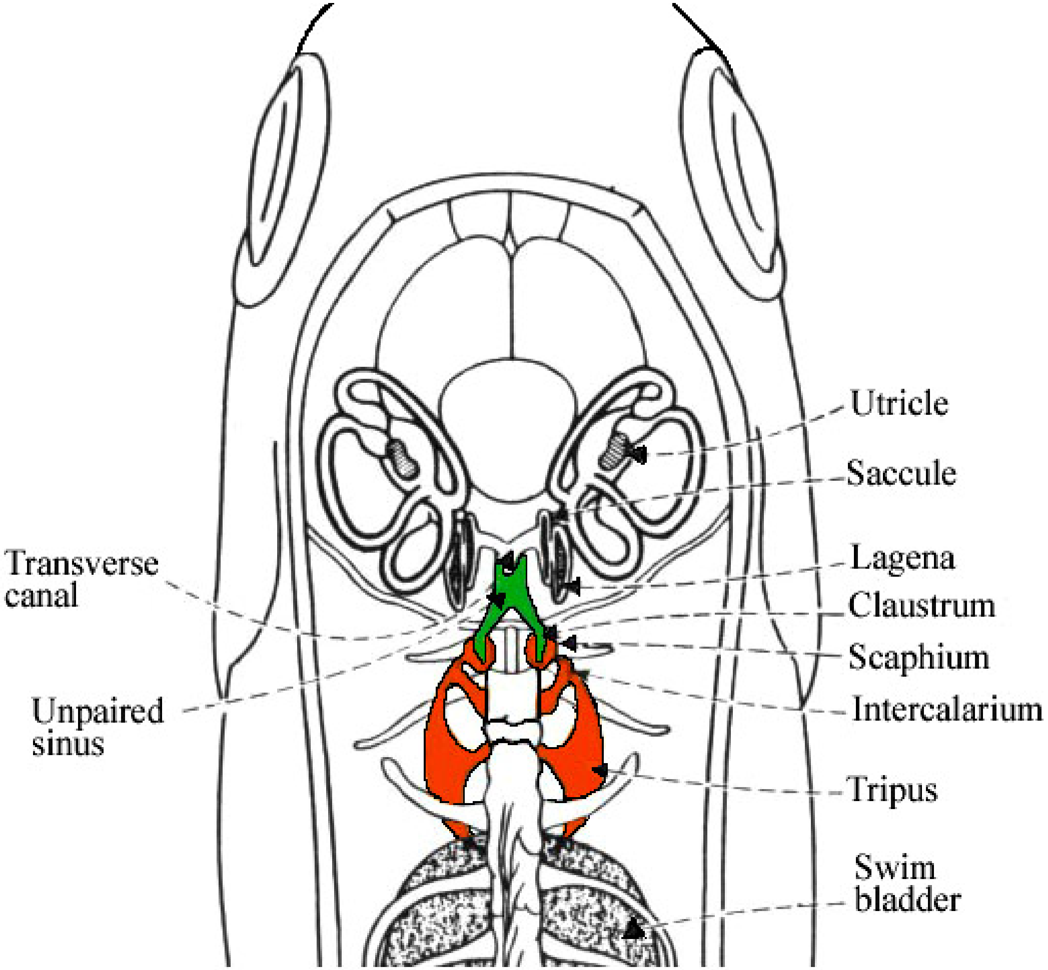
- The objective of this study is to understand black sea bass, and potentially other species such as squid, behavioral and physiological effects when exposed to anthropogenic sounds.
- The methodology would be controlled exposure studies to evaluate behavioral and physiological effects in a laboratory setting experimentation evaluating behavior and habitat use during sound exposure.


Thank You!
http://www.boem.gov/Atlantic-Fishing-Industry-Communication-and-Engagement/

Overview of Hearing in Fishes and Invertebrates

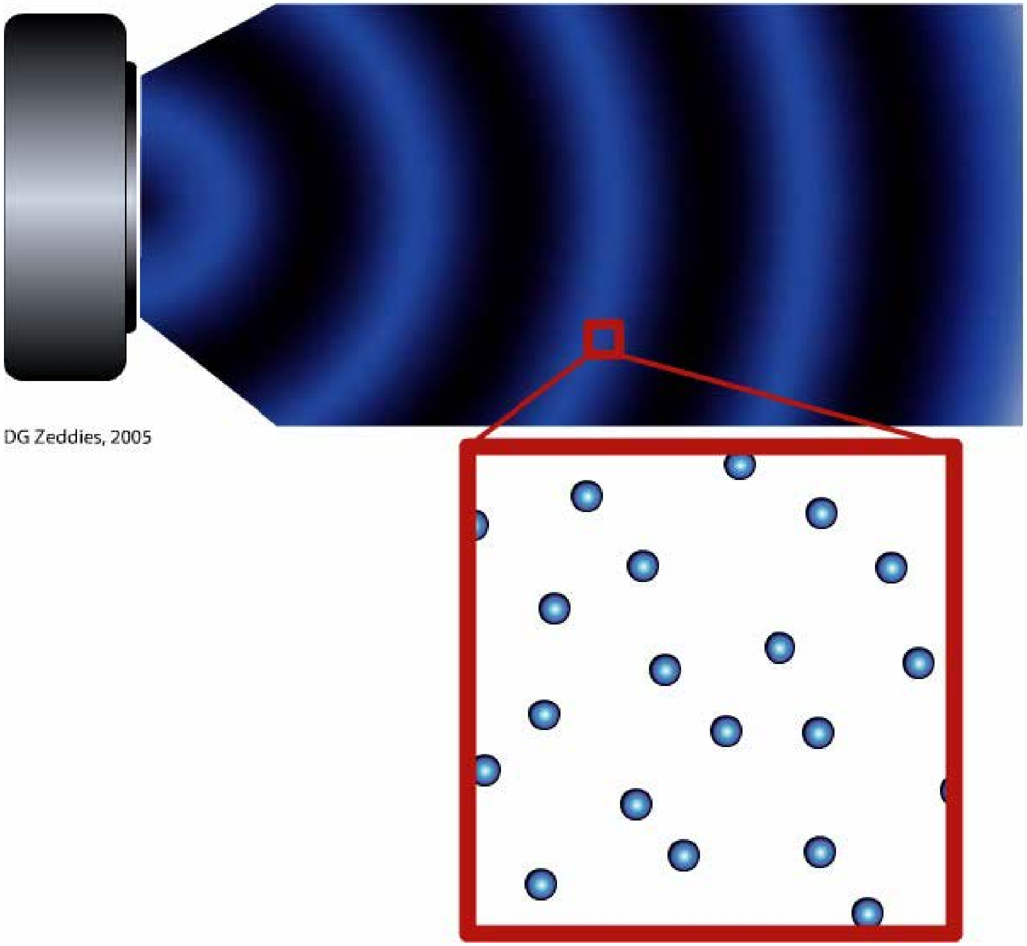
David G. Zeddies, Ph.D.
JASCO Applied Sciences
Silver Spring, MD
david.zeddies@jasco.com

How do fish hear?

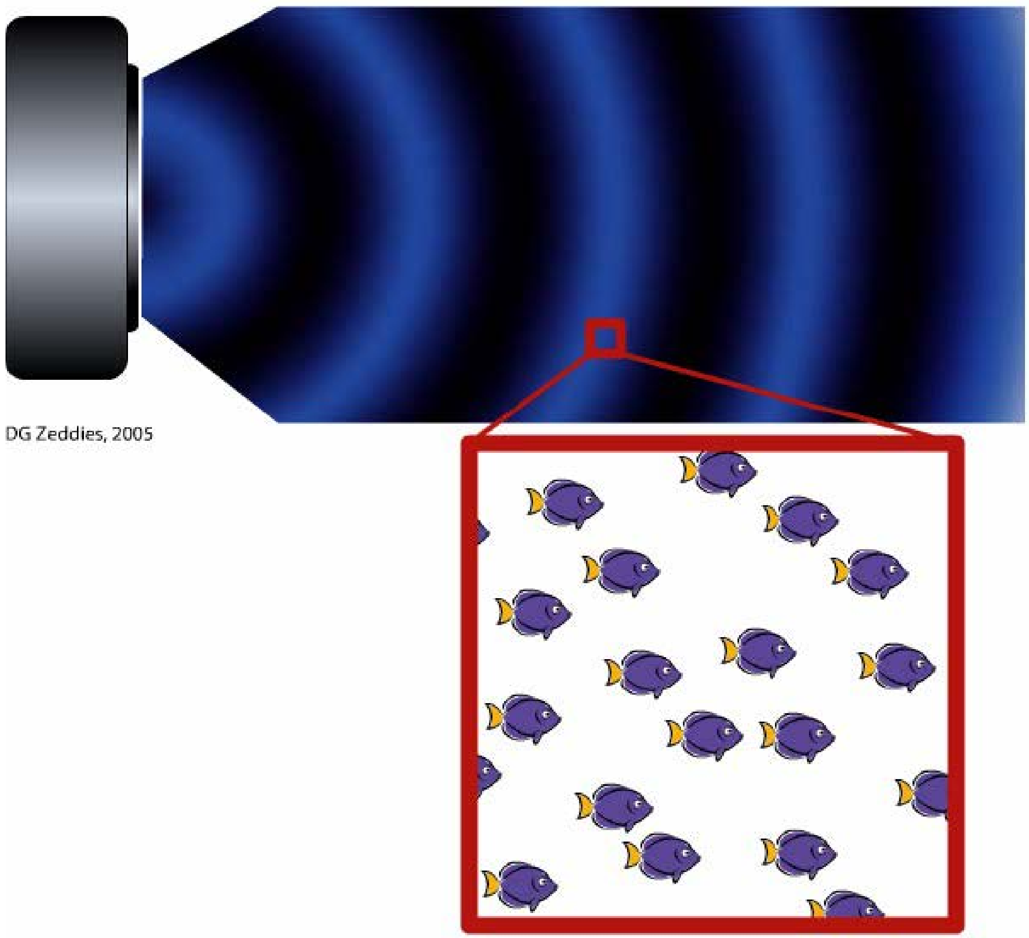


von Frisch K (1938)

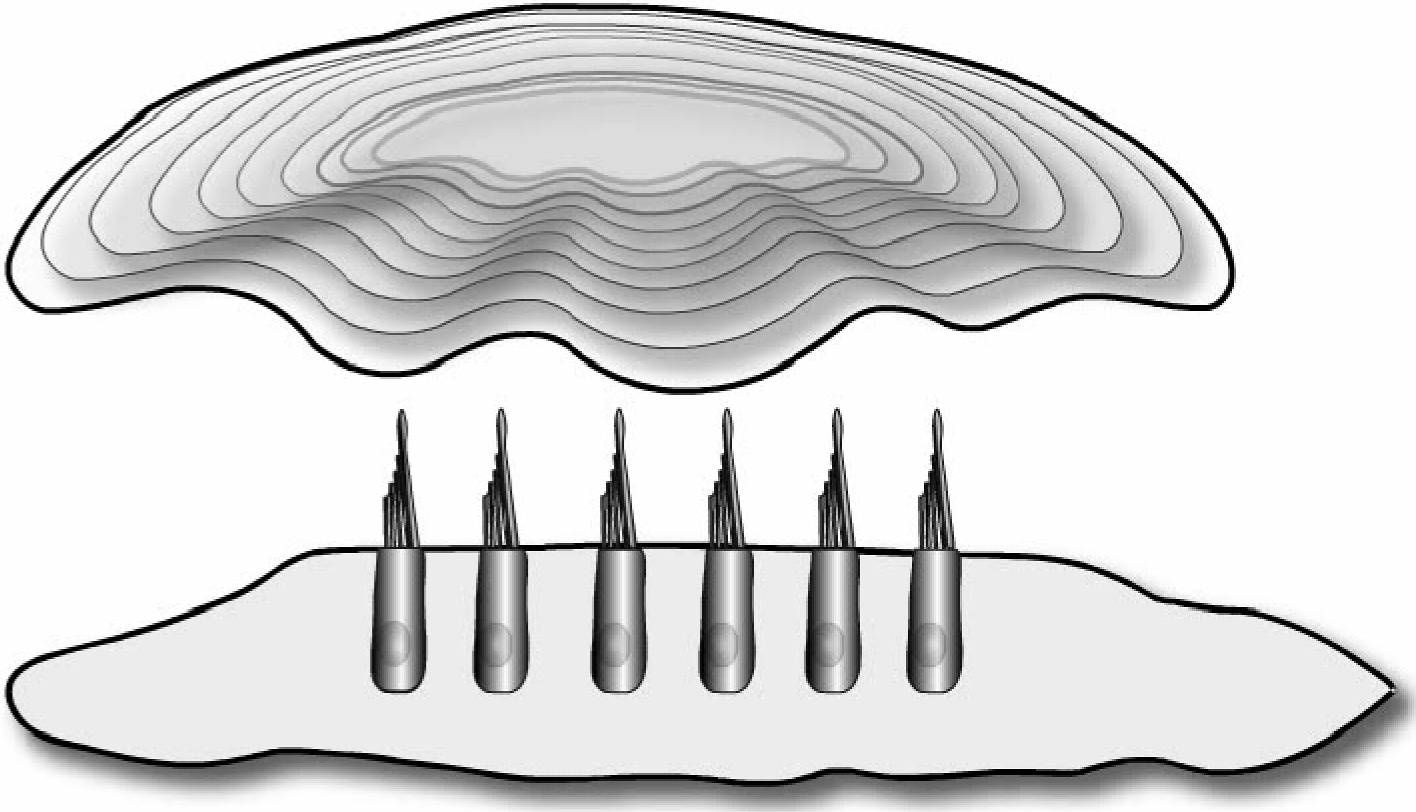
Basic physical acoustics



Basic physical acoustics

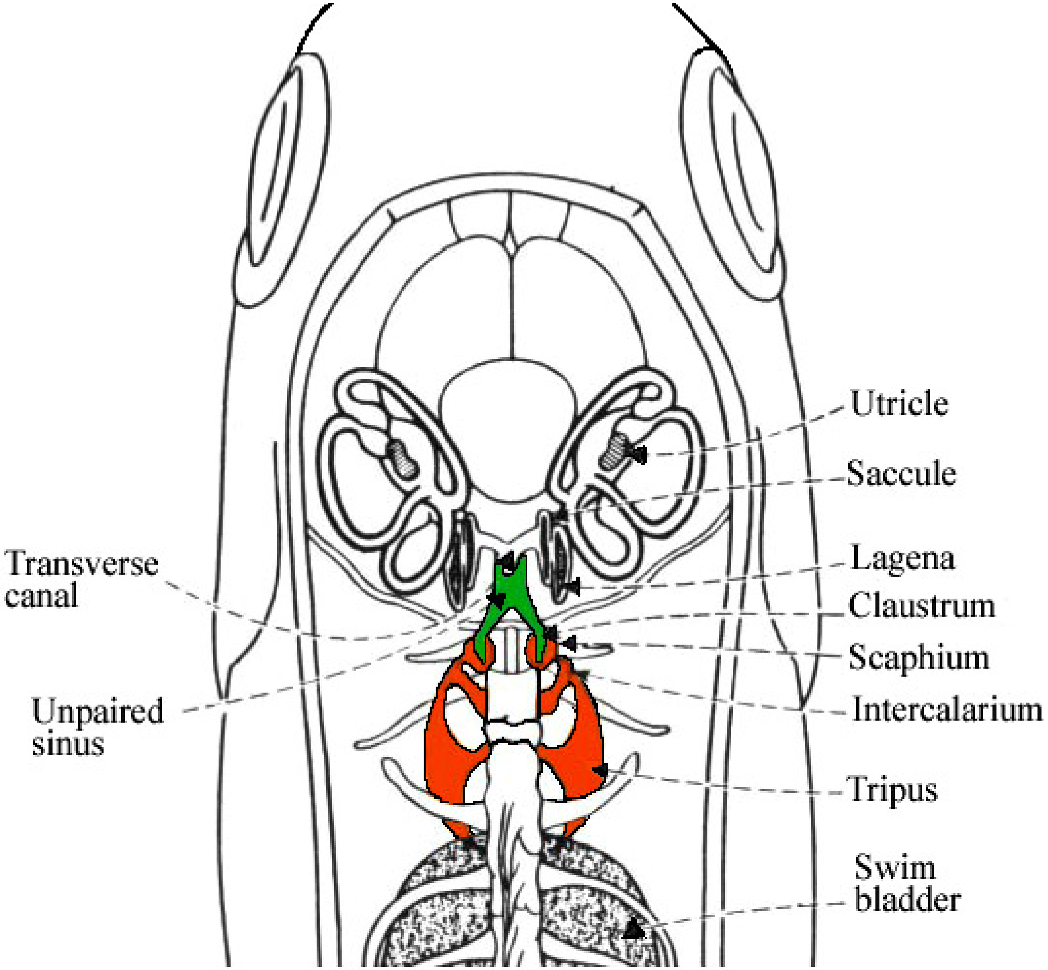


How do the otoliths move?



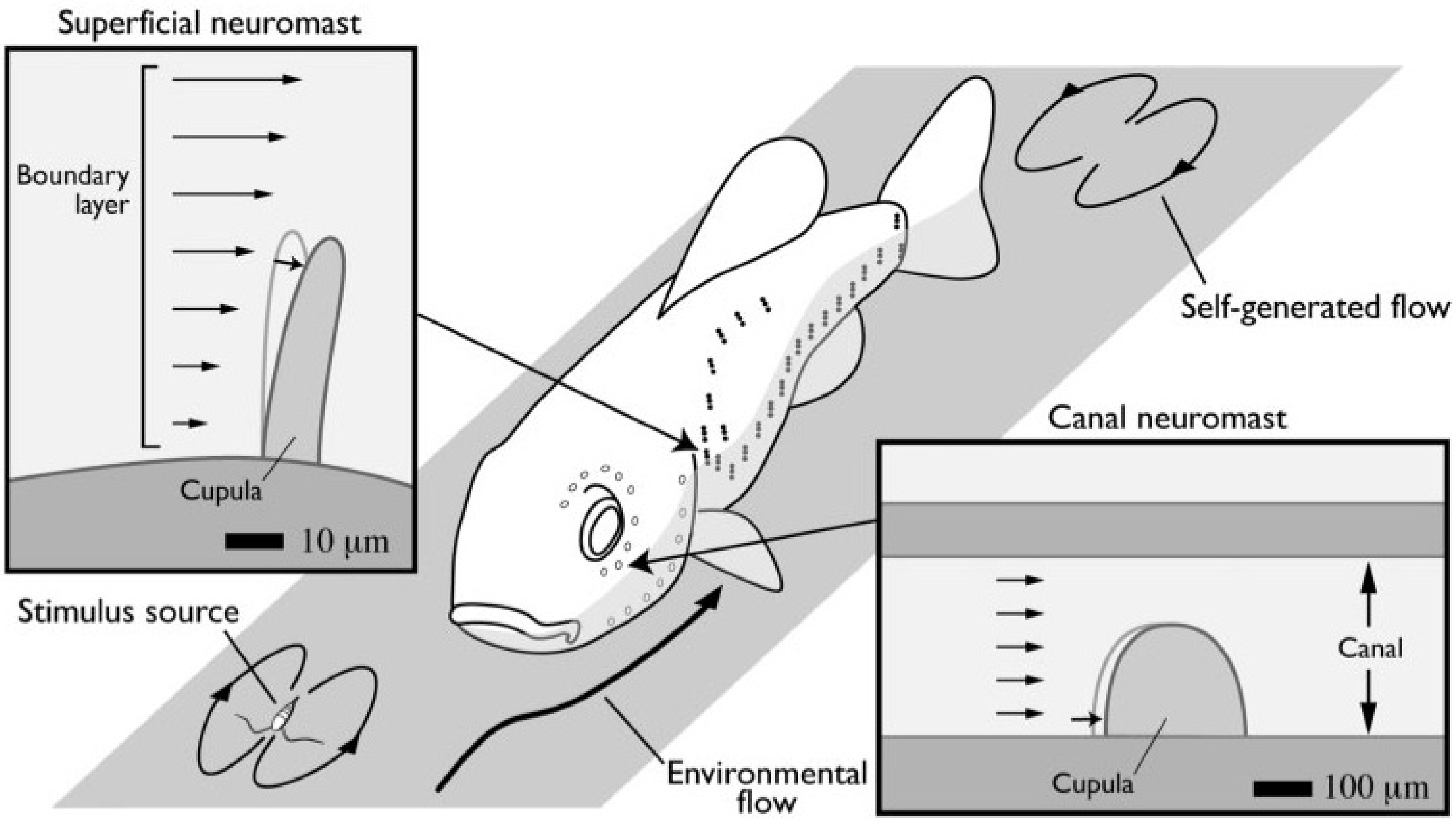
DG Zeddies, 2005

Pressure reception



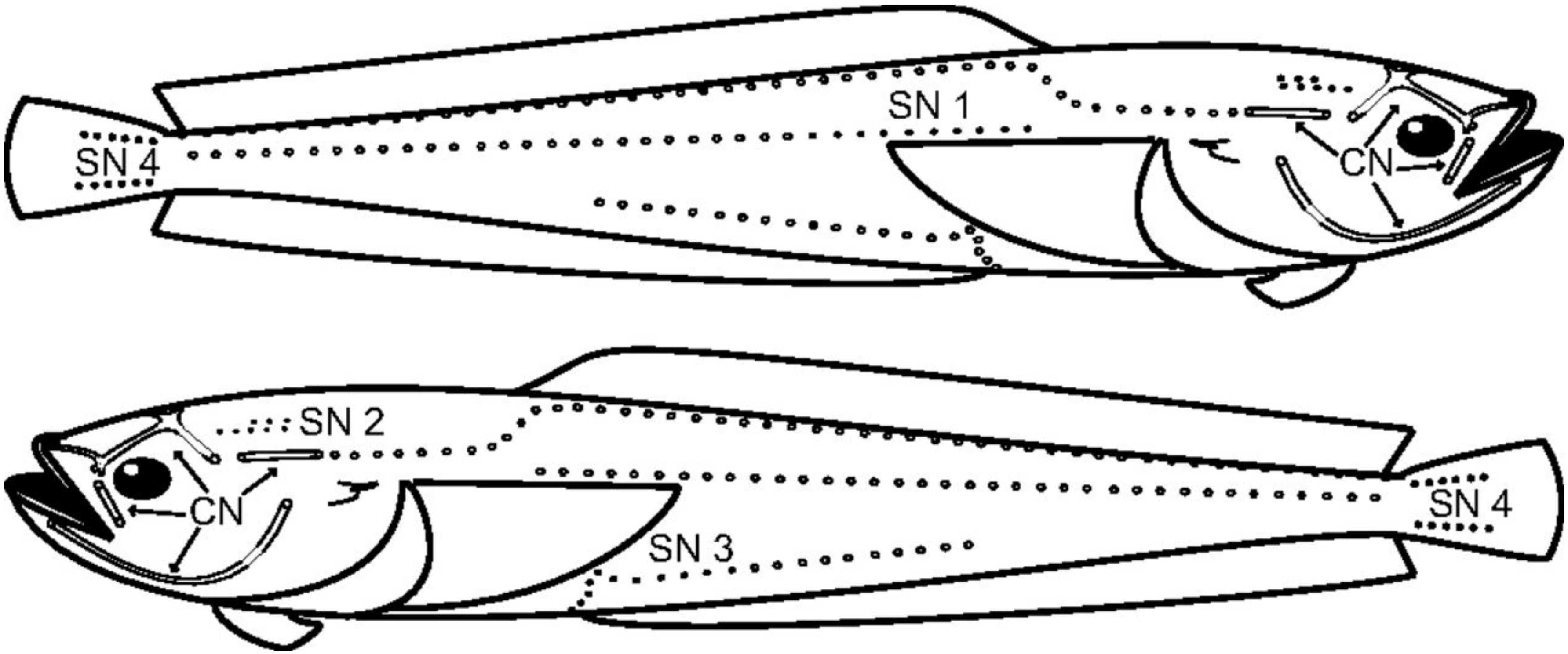
von Frisch K (1938)

Lateral line: Superficial and canal neuromasts



Windsor, S., & McHenry, M. (2009)

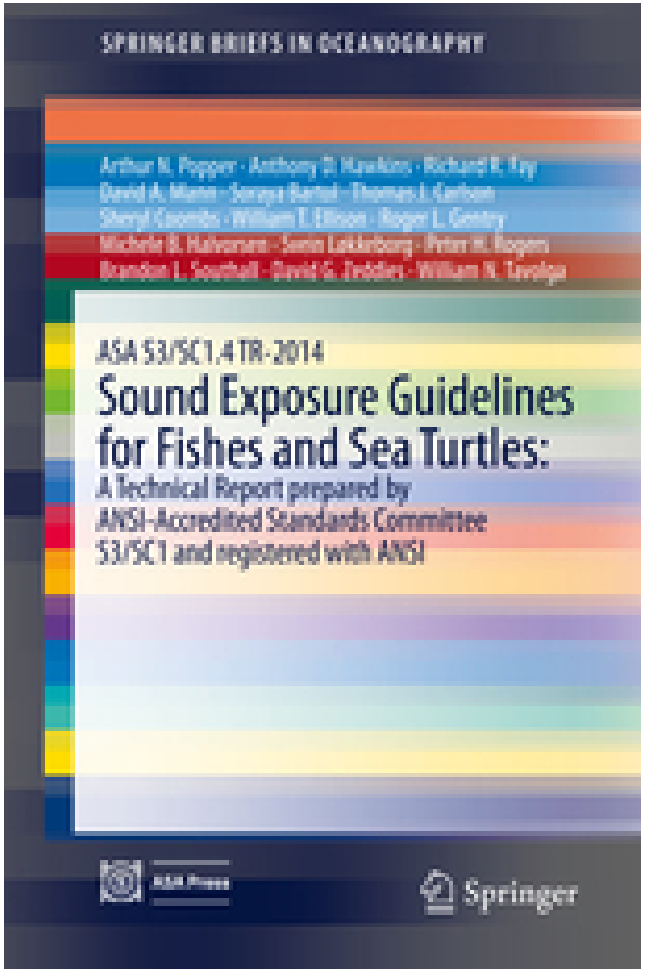
Lateral Line



Guidelines for Acoustic Exposure

- ANSI registered

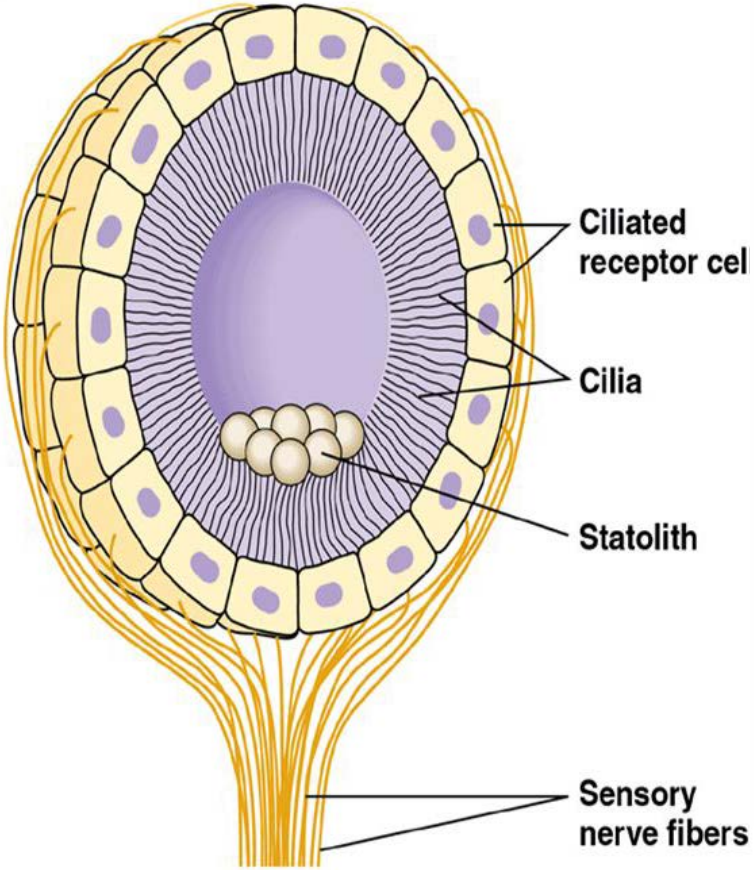
Popper et al. 2014

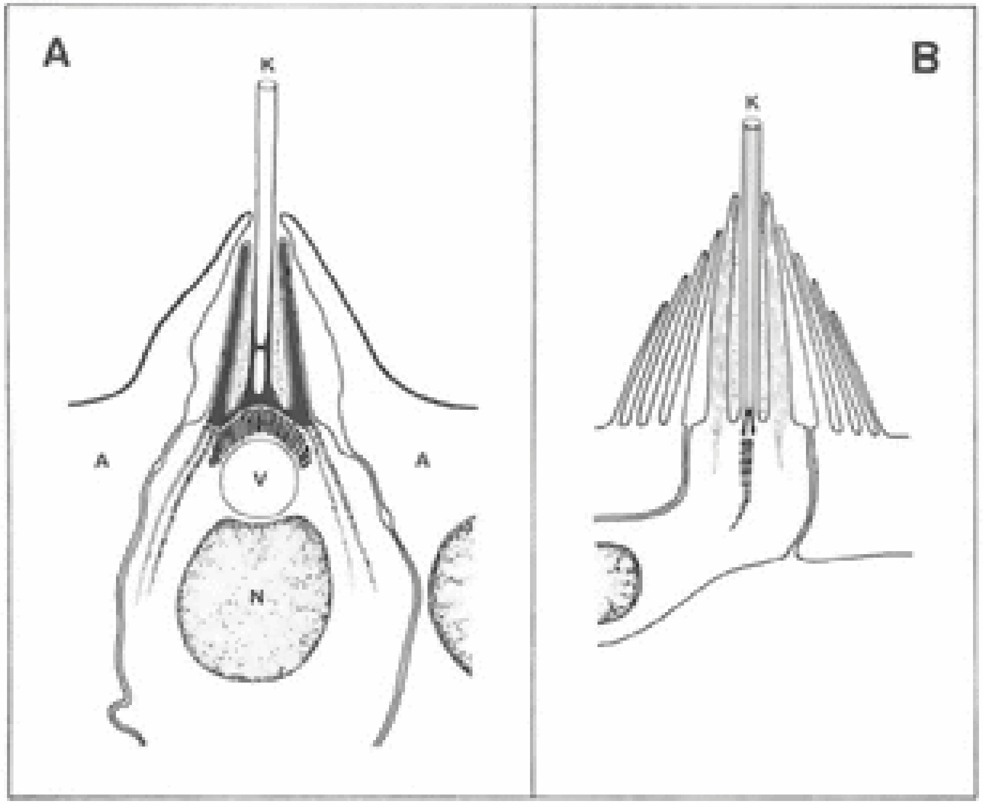


Marine Invertebrate

Invertebrate sensory receptors

The statocyst of an invertebrate





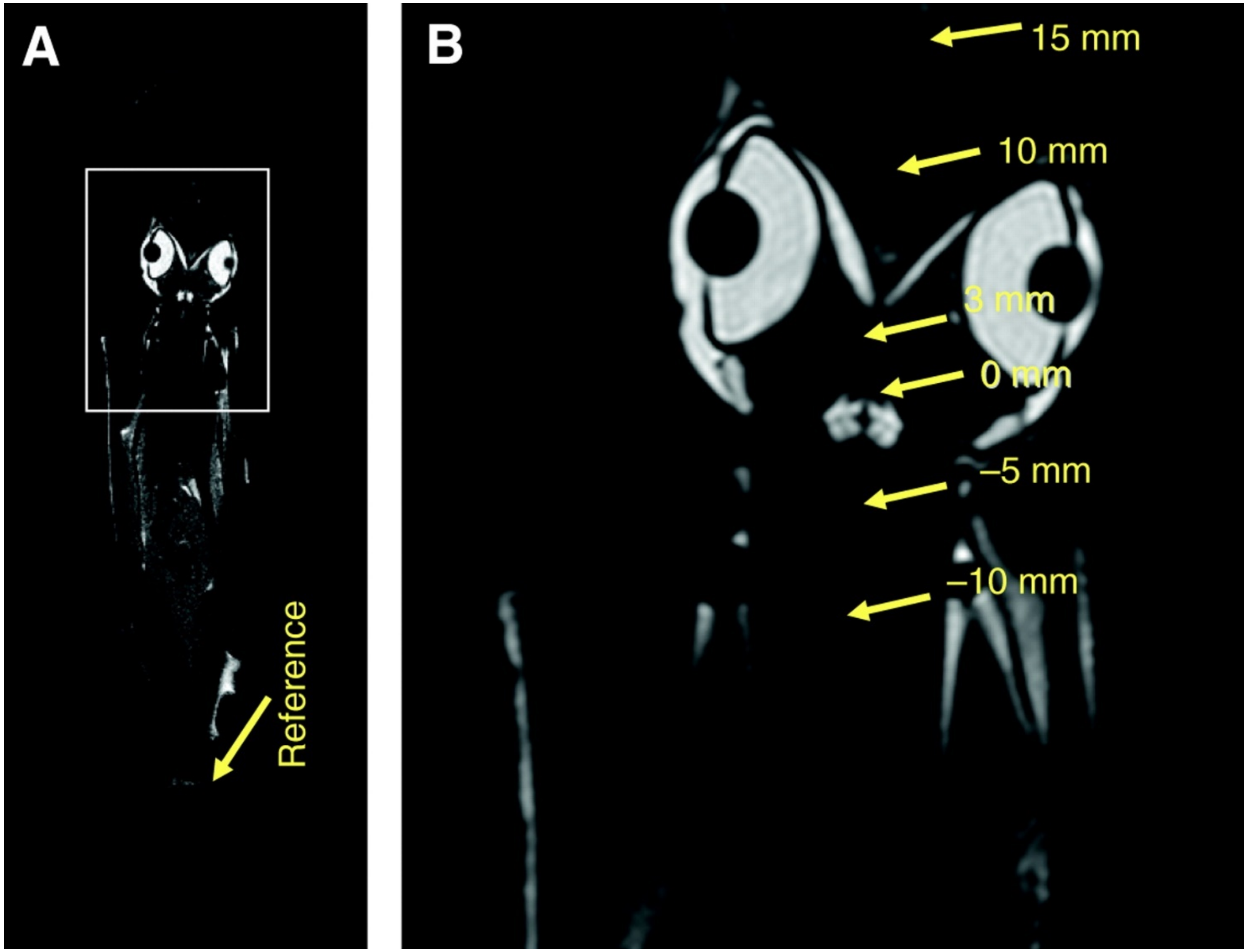
Tardent and Schmid 1972

Invertebrate Hearing Behavior

- Behavioral response to sound (Squid: Fewtrell and McCauley)
- Orientation in sound field
- Sound influences larval settlement
  - Oyster (Lillis et al. 2013)
  - Coral (Vermeij et al. 2010)

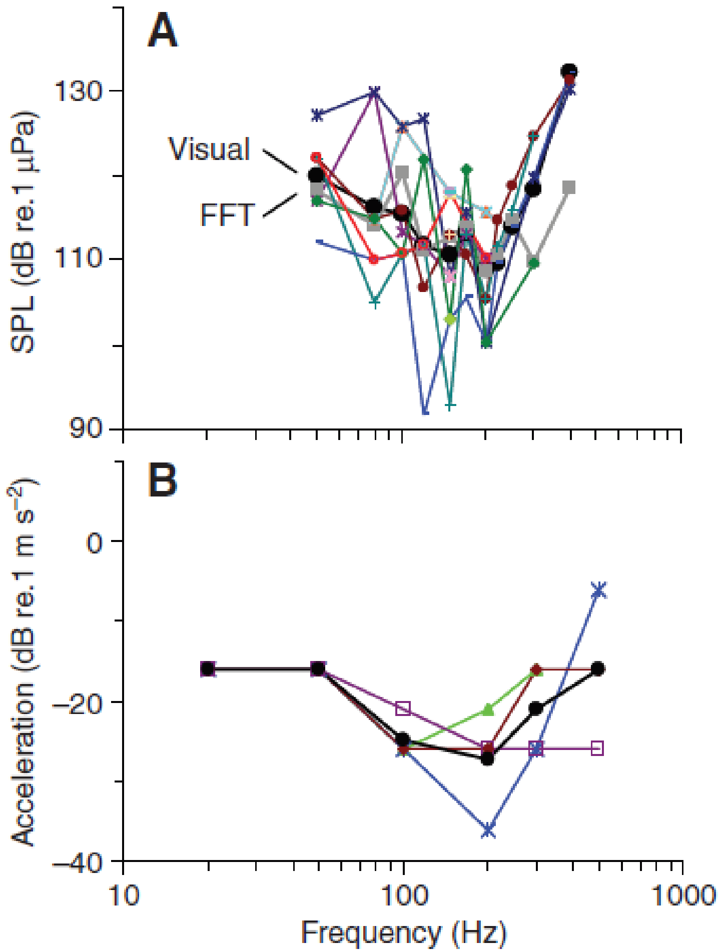
Mooney et al. 2010

Invertebrate sensory receptors



Mooney et al. 2010

Audiograms of squid



Mooney et al. 2010

Impacts of sounds on marine invertebrates

FRDC 2012/008 Impacts of marine seismic surveys on scallop and lobster fisheries

FRDC
FISHERIES RESEARCH & DEVELOPMENT CORPORATION

ASSESSING THE IMPACT OF MARINE SEISMIC SURVEYS ON SOUTHEAST AUSTRALIAN SCALLOP AND LOBSTER FISHERIES

Ryan D. Day, Robert D. McCauley,
Quinn P. Fitzgibbon, Klaas Hartmann
and Jayson M. Semmens

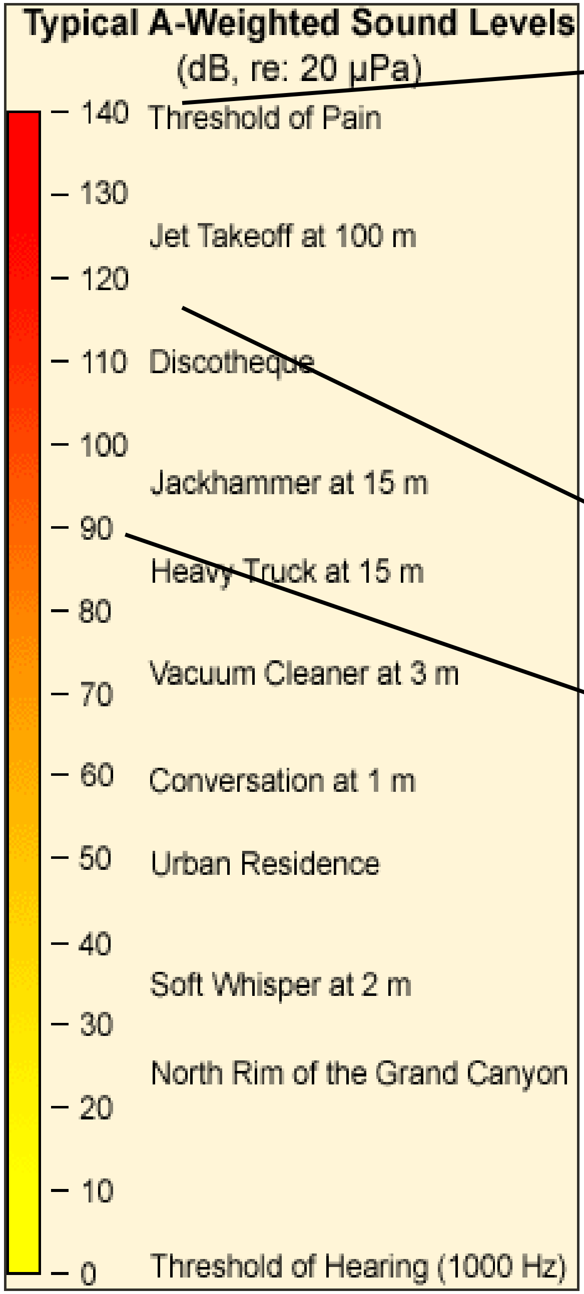
19 October 2016

FRDC Project No 2012/008

Exposure to an airgun

- Lobster –
  - impaired tail extension
  - Impaired righting behavior (statocyst damage)
  - summer only
- Scallops –
  - Repeated exposure increases mortality

Pressure (Pa)	Pressure (dB re 1µPa)	Underwater sounds
1,000,000	240	Maximum linear source level. Cavitation begins at the face of transmitters. Seismic air gun (1m from source)
316,000	230	Cetacean exposure threshold
100,000	220	Typical active sonar transmission level Beluga whale call (1m)
20,000	206	Fish exposure threshold
10,000	200	Large ship broadband (source level, 1m)
1,000	180	
100	160	Large ship broadband (100m)
10	140	Fish behavior Killer whale (1m)
1	120	Cetacean behavior
0.1	100	Ambient noise, sea state 4
0.01	80	
0.001	60	Ambient noise, sea state 0 (flat calm)
0.0001	40	
0.00001	20	
0.000001	0	(acoustic reference)



dB SPL (Air)	Band	dB SPL (water*)
139	Manowar (2008)	201
136	KISS (2009)	198
133	Gallows (2007)	195
129	Manowar (1984)	191
126	The Who (1976)	188
117	Deep Purple (1972)	179

* dB water ≈ dB air + 62 dB

OSHA permissible exposure :
90 dB SPL for 8 hours (SEL = 135 dB)

OSHA equivalent in water:
152 dB SPL for 8 hours (SEL = 197 dB)

Fish exposure criteria:
206 dB SPL; 187 dB SEL
Marine Mammal exposure criteria:
Cetaceans: 230 dB SPL; 198 dB SEL
Pinnipeds: 218 dB SPL; 186 dB SEL

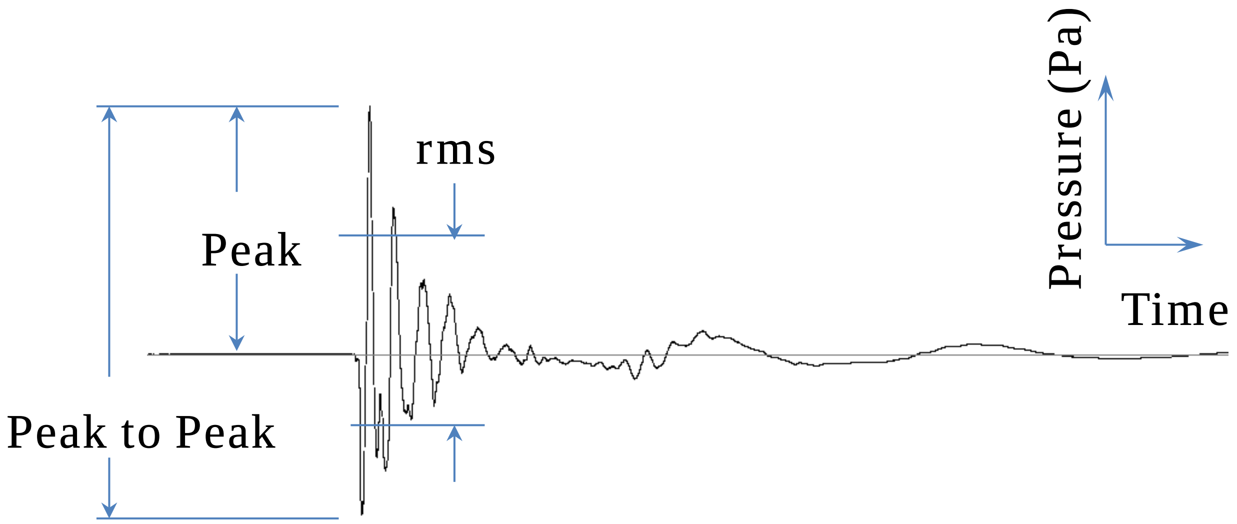
Acoustic Metrics

Sound Exposure Level (*SEL*)

SEL_{ss} cSEL

Sound Pressure Level (*SPL*)

SPL_{peak} $SPL_{p\text{-}p}$ SPL_{rms}

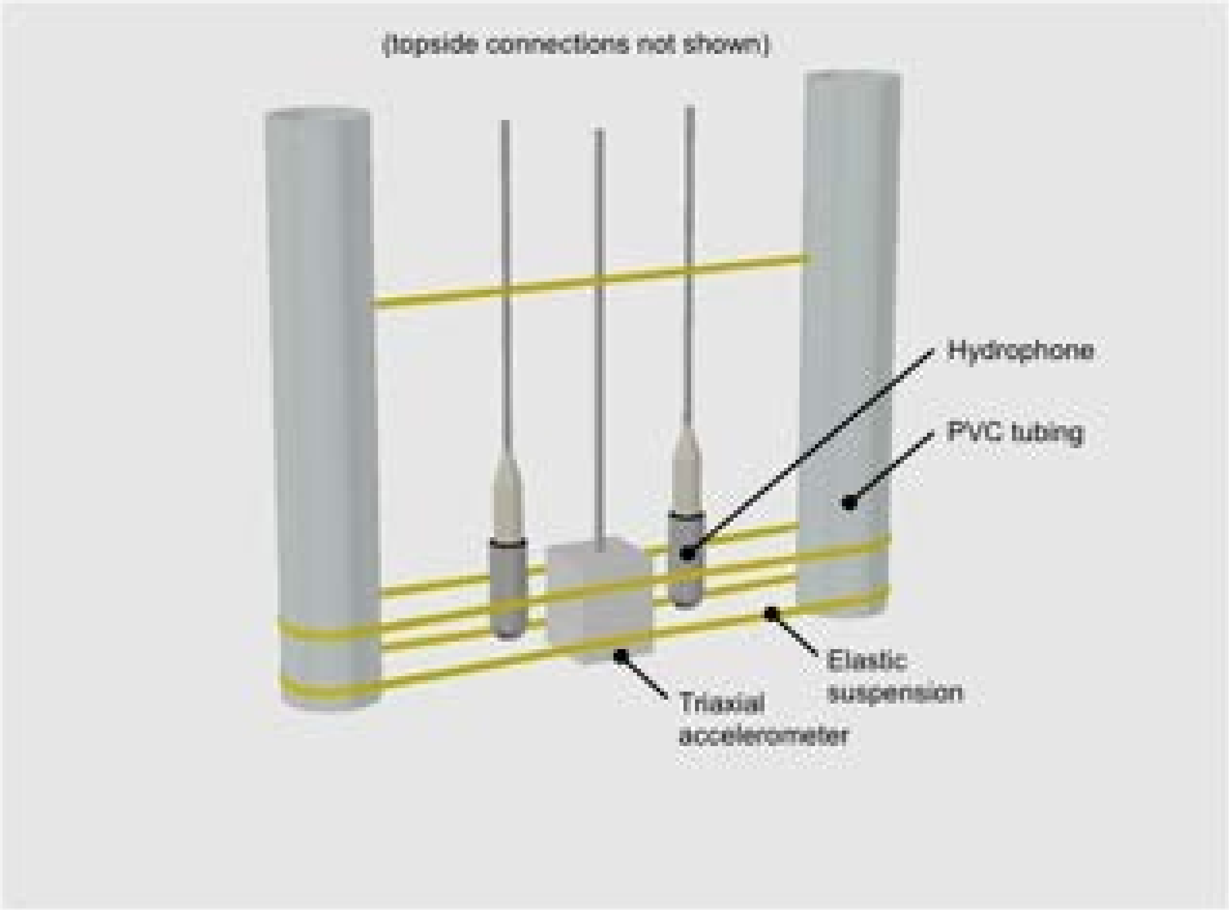


$$dB\ SPL = 20\ \log_{10}\left(\frac{Pa}{1\ uPa}\right)$$

$$dB\ SEL = 10\ \log_{10}\left\{\frac{\sum_{N=1}^{N}\int_0^T Pa(t)^2\ dt}{(1\ uPa)^2}\right\}$$

Measuring Particle Motion

- Pressure gradient
- Inertial methods
    - Accelerometer
    - Geophone



Potential Effects of Offshore Wind Development on Fish and Invertebrates

Aaron N. Rice, Ph.D.
Bioacoustics Research Program
Cornell Laboratory of Ornithology
Cornell University
Ithaca, NY 14850

CORNELL UNIVERSITY FOUNDED A.D. 1865

The Cornell Lab of Ornithology

What We Need to Know About Biological Risk

- What’s there?
- How many are there?
- How are they distributed in time & space?
- Why are they there?
- What is the mechanism that leads to risk?

Importance of Understanding Bioacoustics

Hearing

- Hear using ears similar to other vertebrates
- Most sensitive to sounds between 100-1000 Hz
- Very few examples of deaf fish

Communication

- Many communicate with sound for spawning and territoriality
- Produce species-specific calls
- Possibly as many as 10,000-19,000 vocalizing species
- Many fisheries stocks produce sounds in spawning aggregations (e.g., drum, snappers, jacks, groupers)
- Major contributors to their acoustic environments

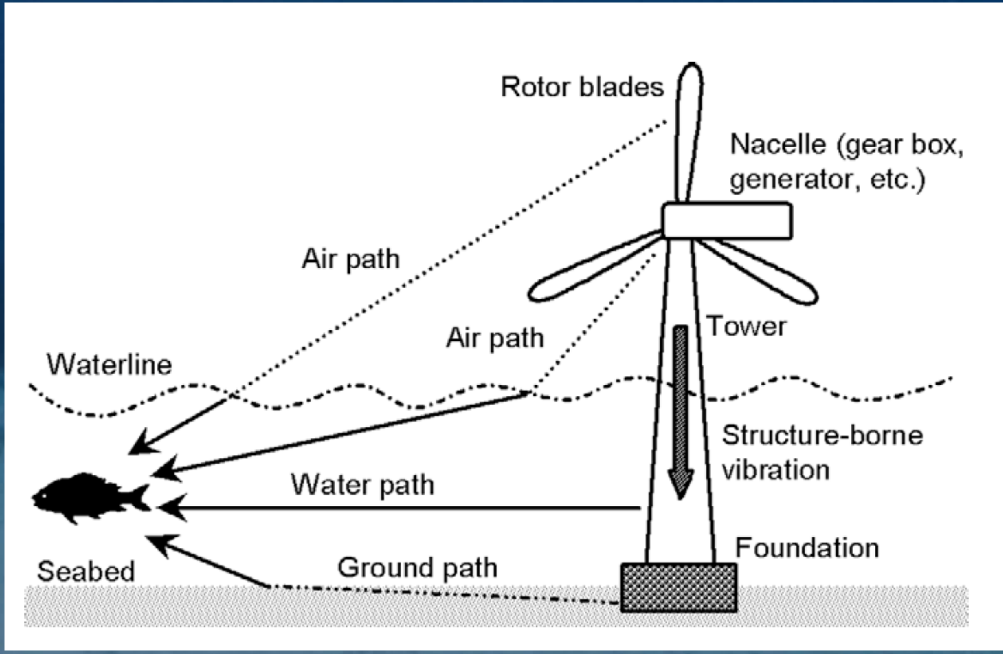
Scientists can use sounds to remotely monitor the presence and activity of many fish species

Evaluating Wind Energy Impacts

1) Assessing Risk

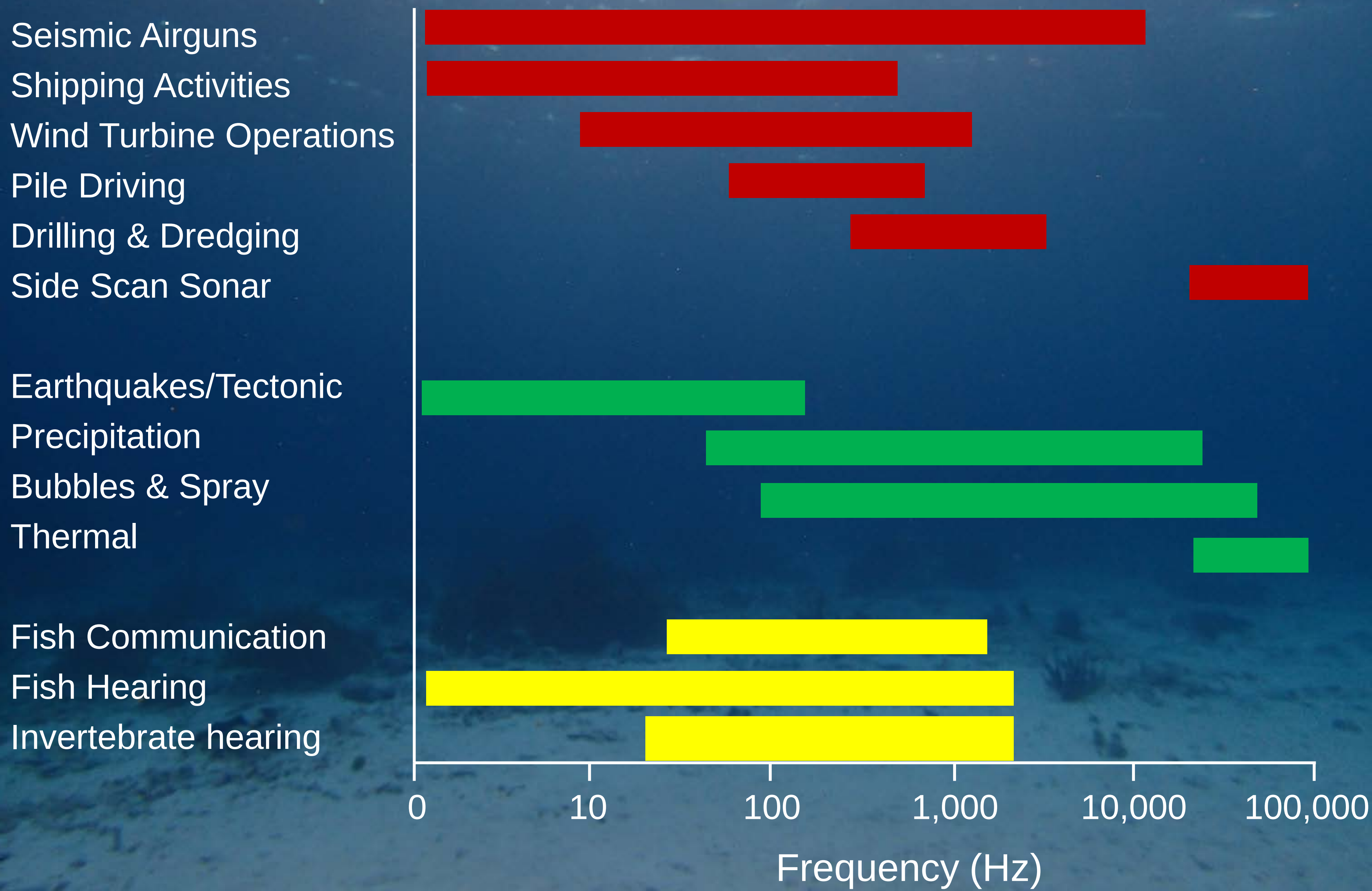
2) Assessing Baseline Activity
- Seasonal behaviors – spawning/migration

3) Assessing Impact/Change



(Kikuchi 2010)

Ocean Sound Frequency Ranges



What are fish listening to?

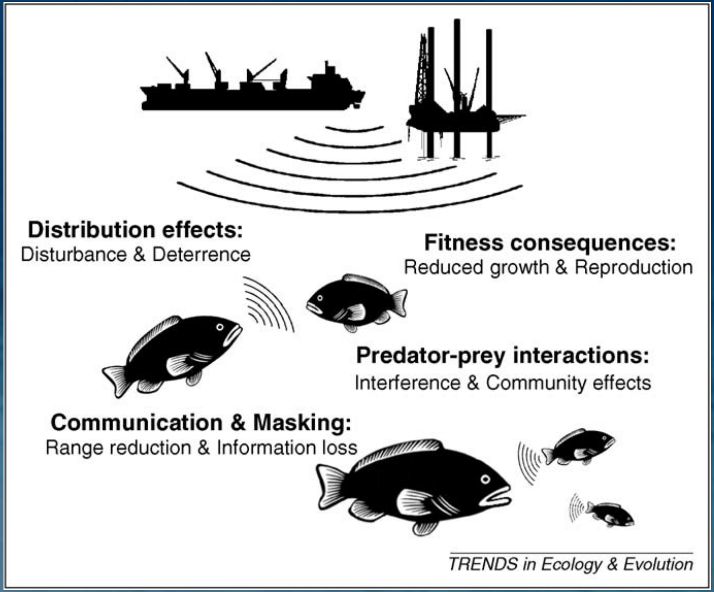
Auditory Scene Analysis

Communication

- Acoustic communication is widespread across fishes

Localization/homing

- Attraction: reef larvae, coral larvae, sharks



(Slabbekoorn et al. 2010)

Possible Fish Responses to Windfarm Development/Operation

Acute Impacts

- Lethal with sound exposure >229 dB (Wardle et al. 2001)
- Deafness (temporary threshold shifts) (Popper et al. 2005)
- Damage to ears (detectable for 58 days after exposure) (McCauley et al. 2003)
- Physiological stress responses (Santulli et al. 1999)

Chronic Impacts

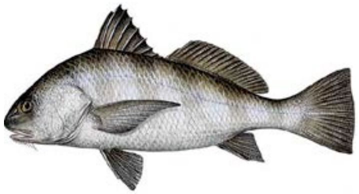
- Long-term behavioral or physiological stress
- Masking (following Clark et al. 2009)
- Disrupted reproductive behaviors => lower spawning success

The long-term consequences of marine construction/operation on fish populations is not known.

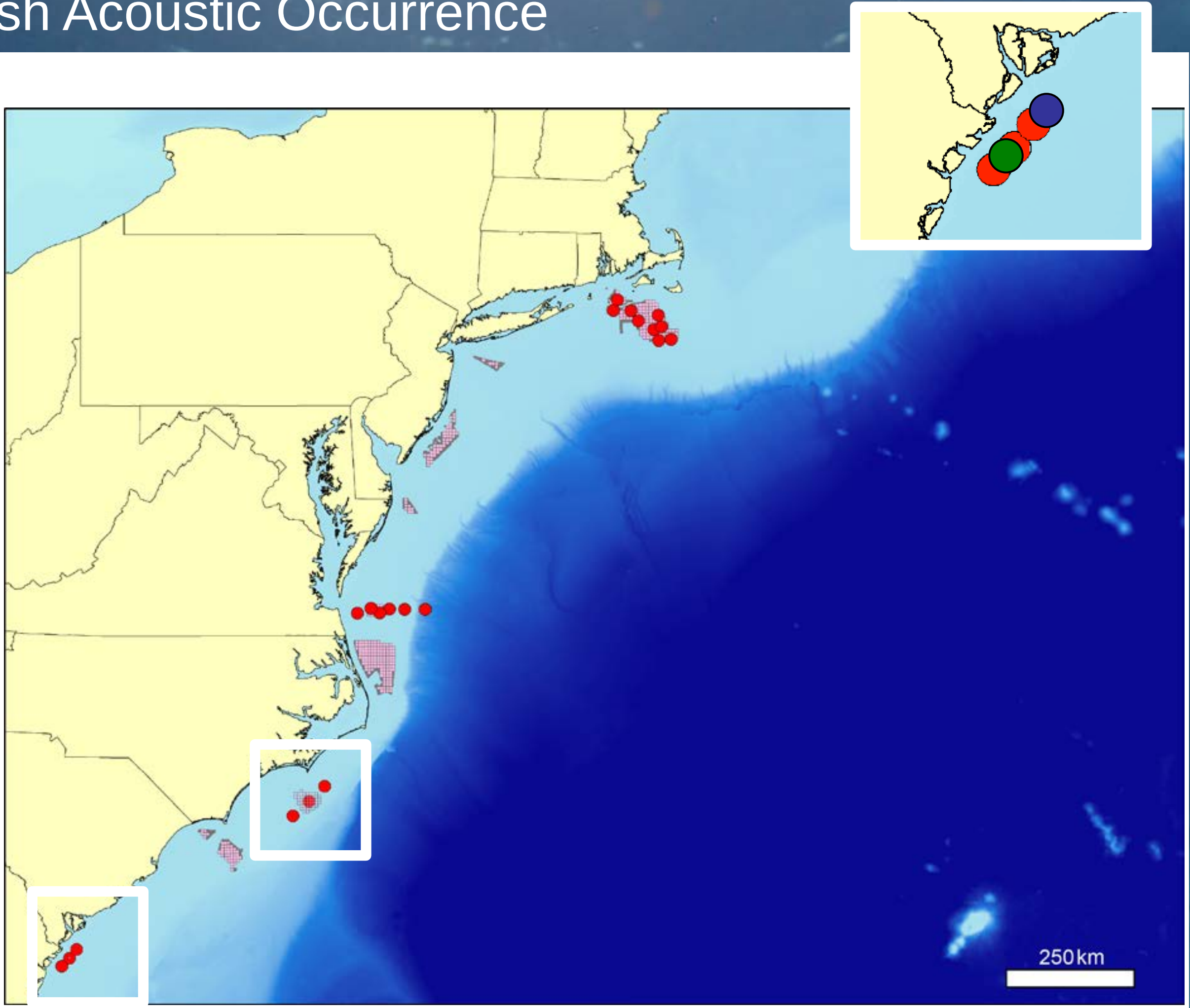
Baseline Site Characterization (BOEM OCS 2015-026)

South Atlantic Fish Acoustic Occurrence

Black drum
(*Pogonias cromis*)

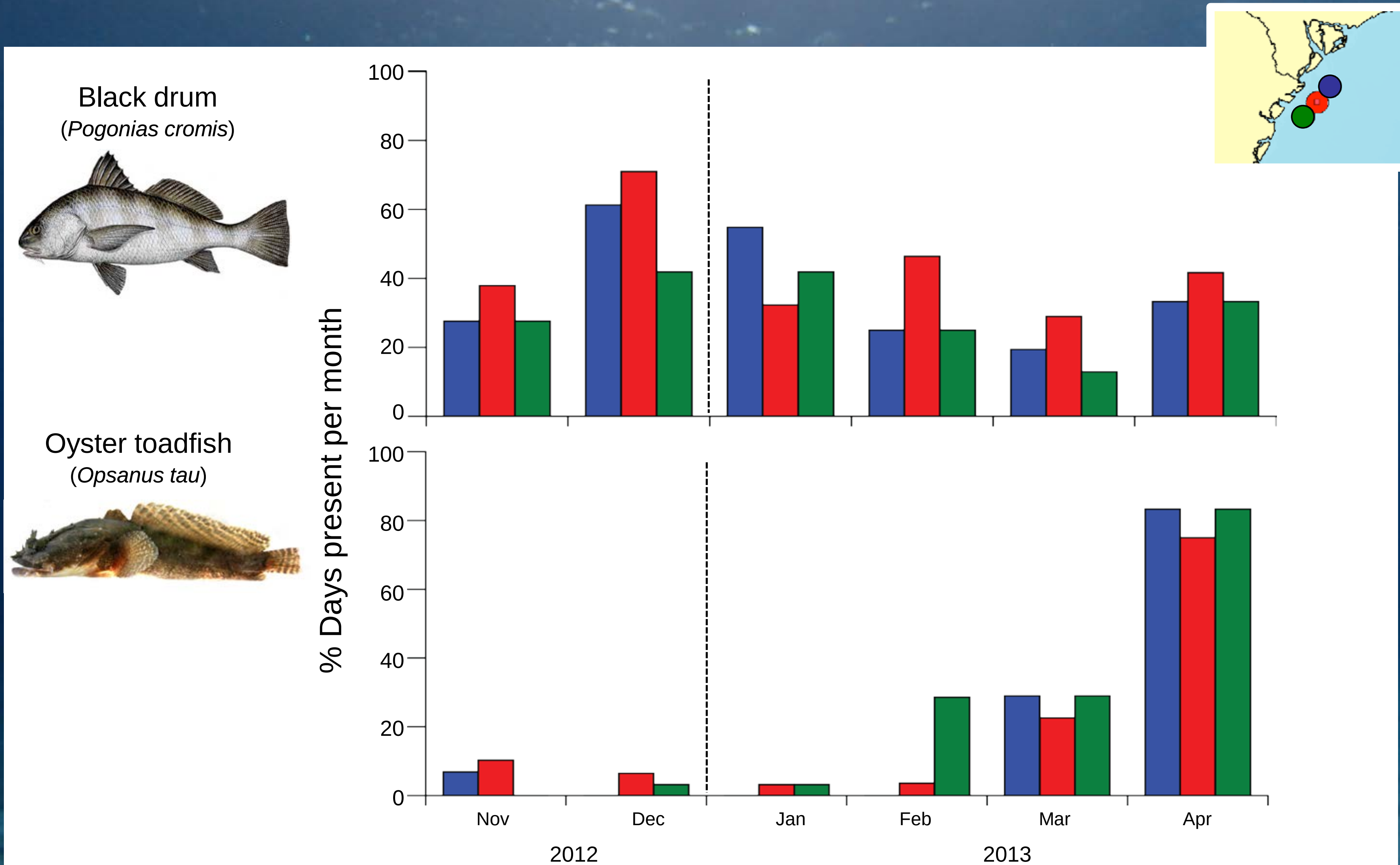


Oyster toadfish
(*Opsanus tau*)



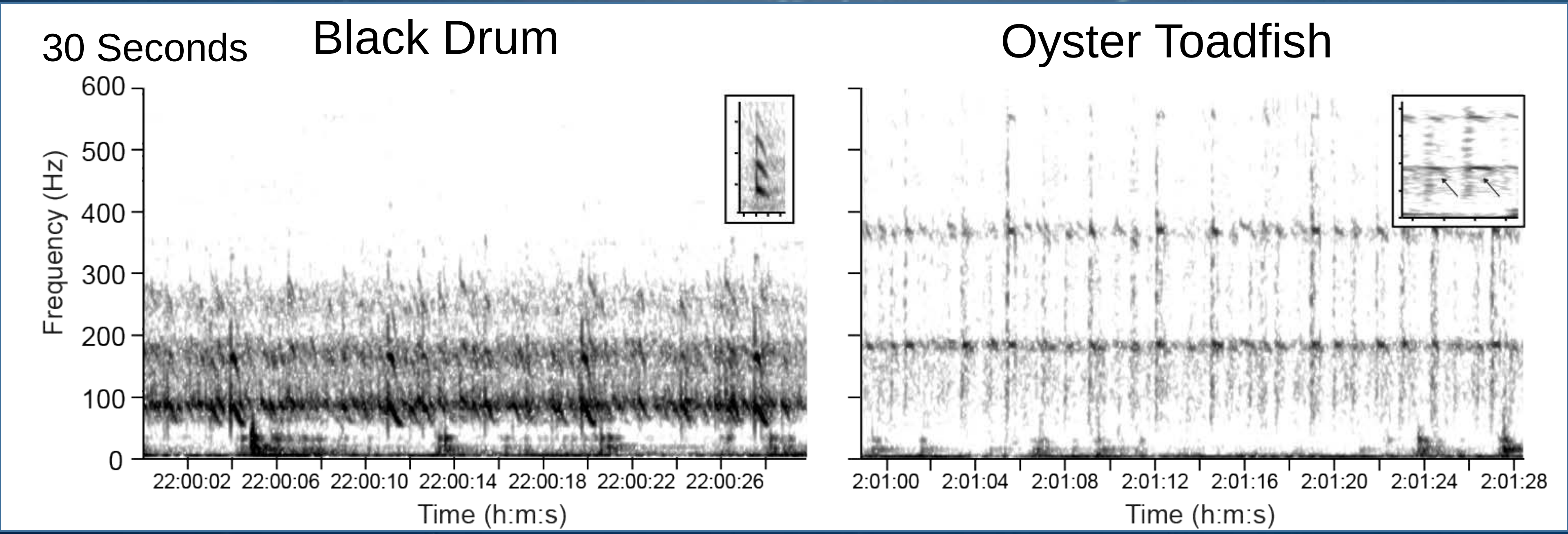
(Rice et al. 2016)

Georgia WEA Fish Acoustic Occurrence



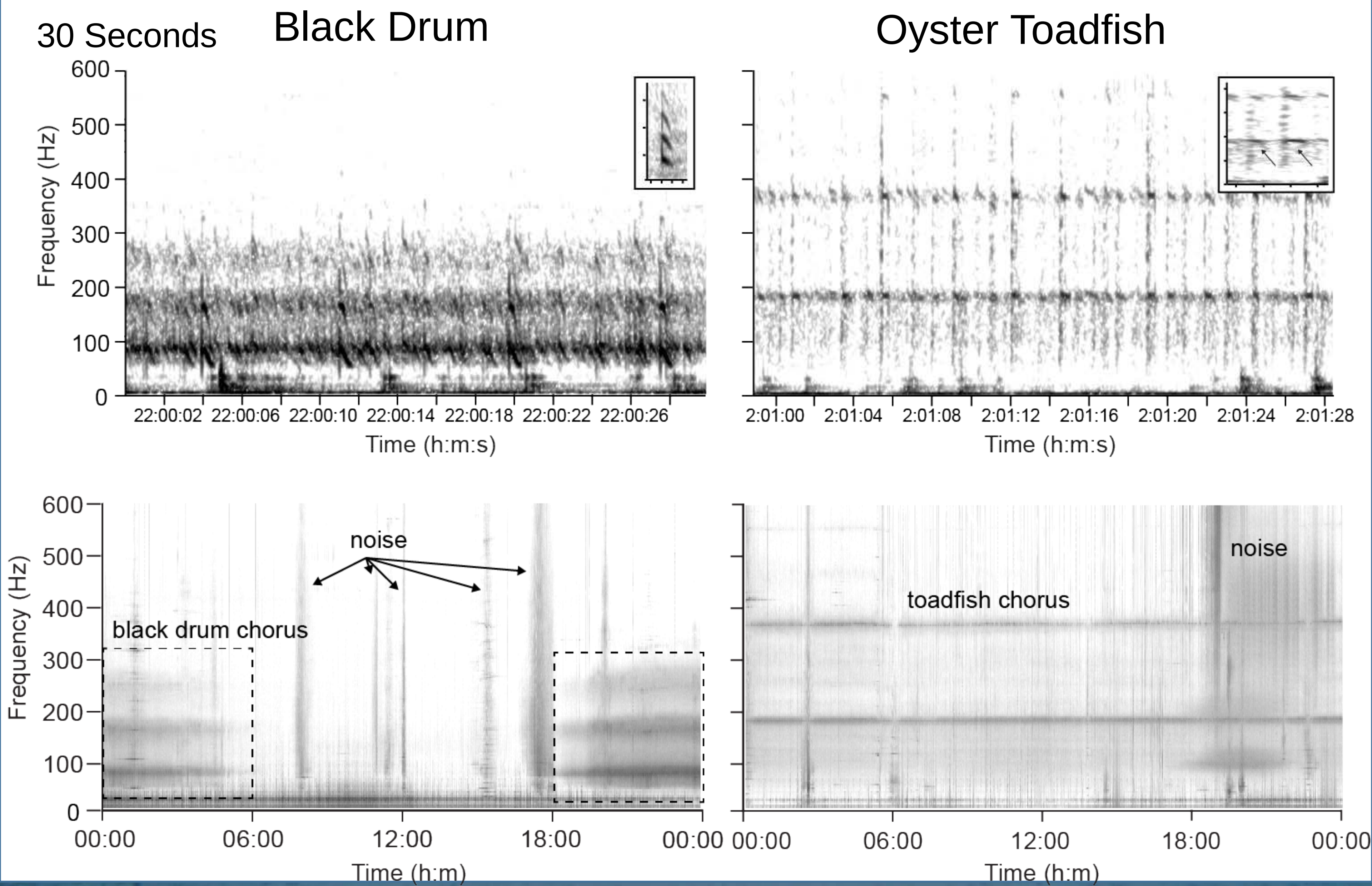
(Rice et al. 2016)

Understanding the Acoustic Environment



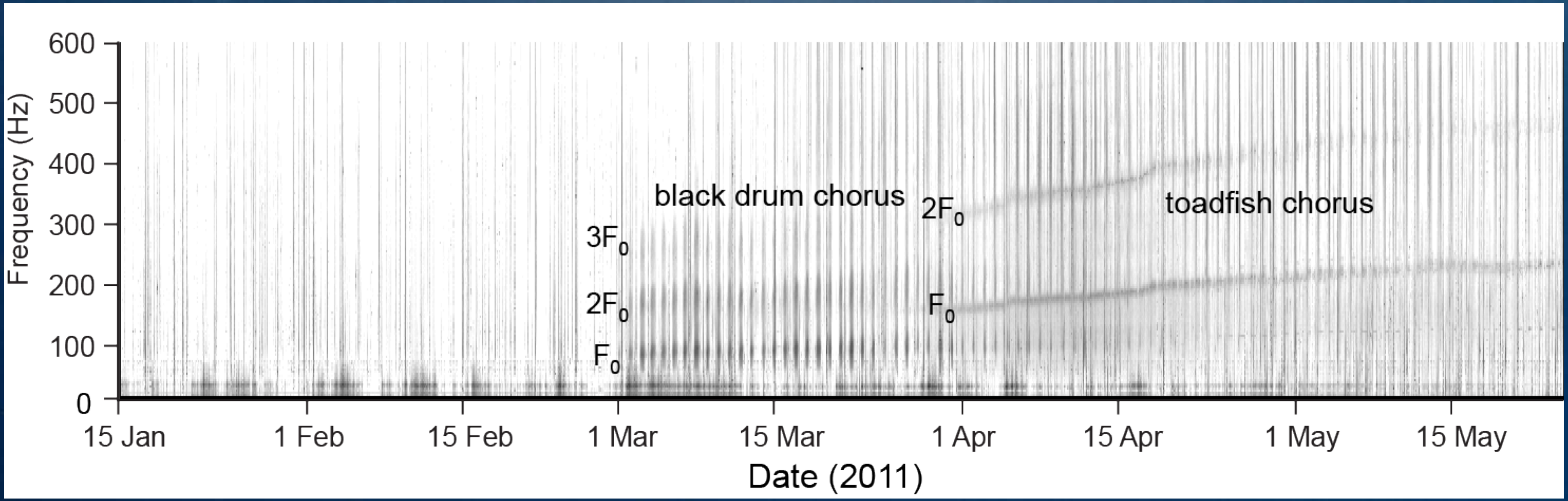
(Rice & Morano 2015, Rice et al., in prep)

Understanding the Acoustic Environment



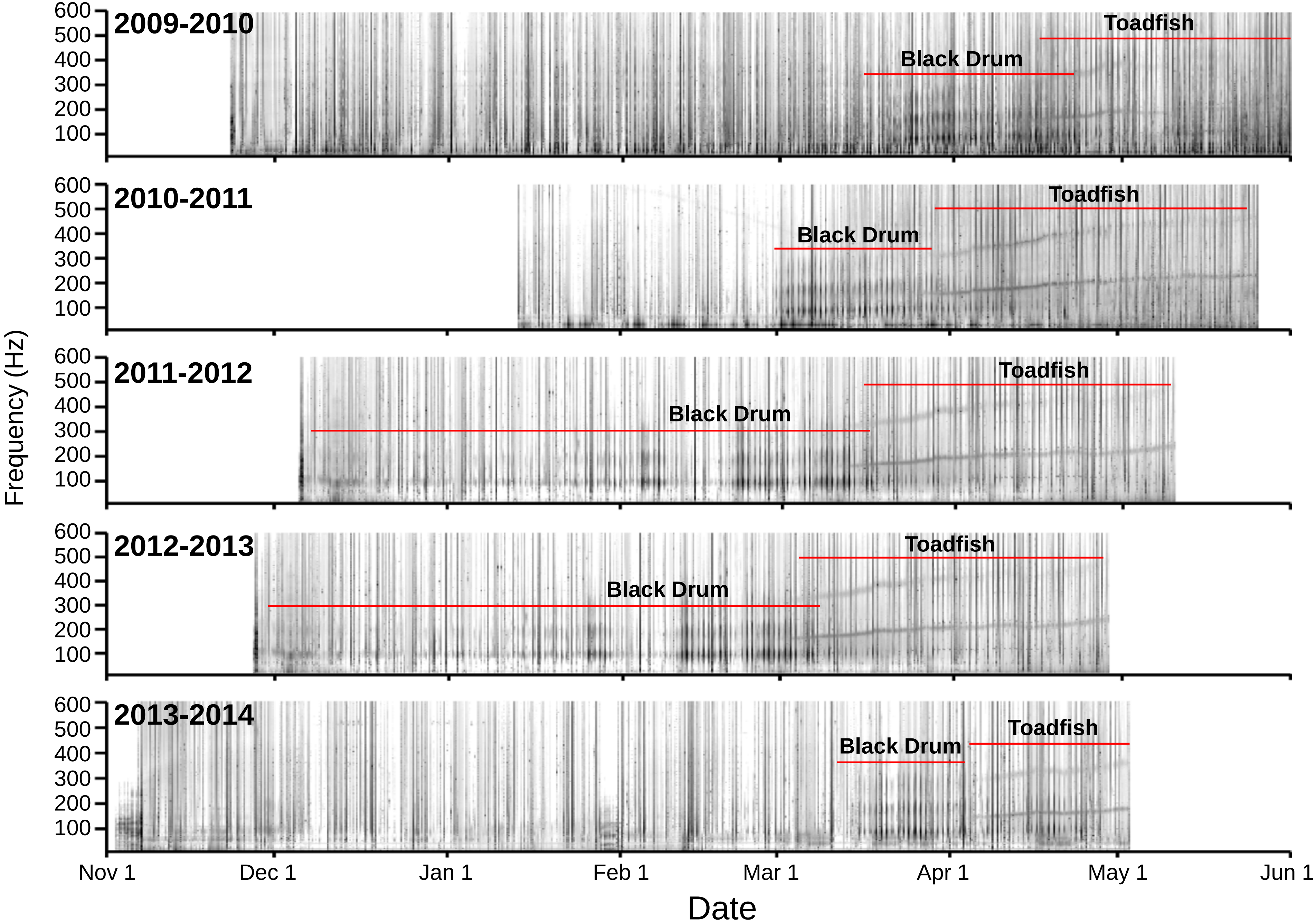
(Rice & Morano 2015, Rice et al., in prep)

6 Months of Sound

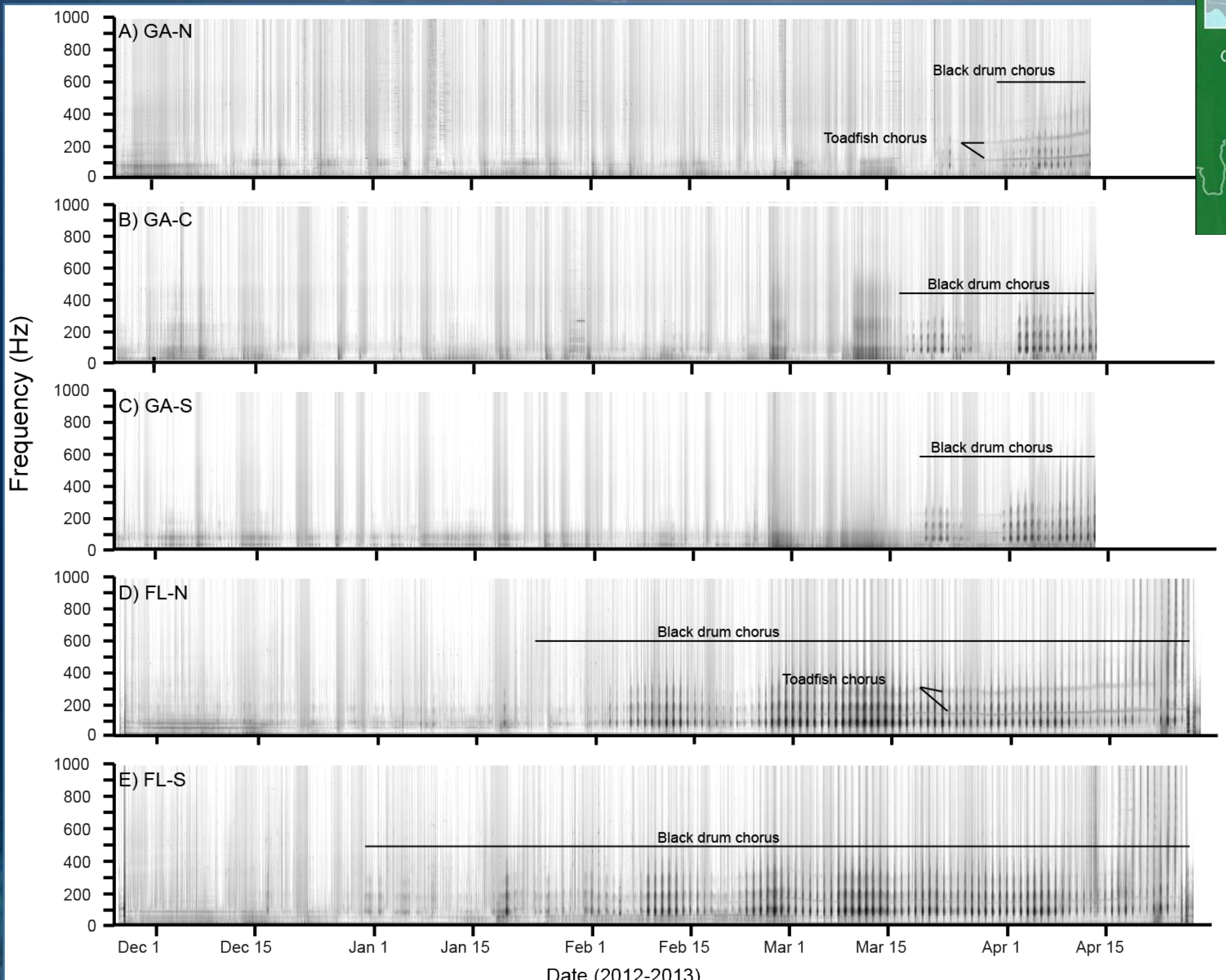


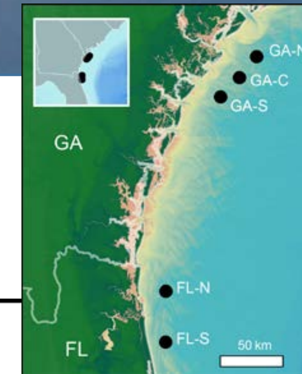
(Rice & Morano 2015, Rice et al., in prep)

5 Seasons of Acoustic Data – Jacksonville, FL



Acoustic Survey Data (2012-2013) – GA, FL





(Rice, Soldevilla, Quinlan, In Review)

What’s Needed/What’s Next?

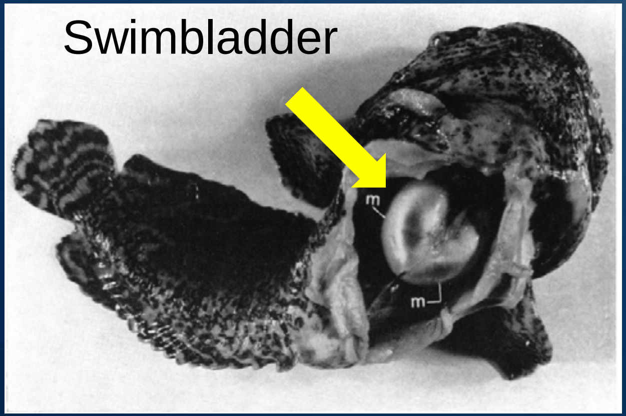
- MANY data gaps (particularly for invertebrates) (see Hawkins et al. 2014)
  - what is “normal” behavior?
  - translating lab studies to field settings
  - how to evaluate changes/perturbations?
  - what is the role of particle motion? (e.g., Sigray & Andersson 2011)

- Short and long term consequences unclear
  - mortality
  - stress
  - reproductive success
  - population viability

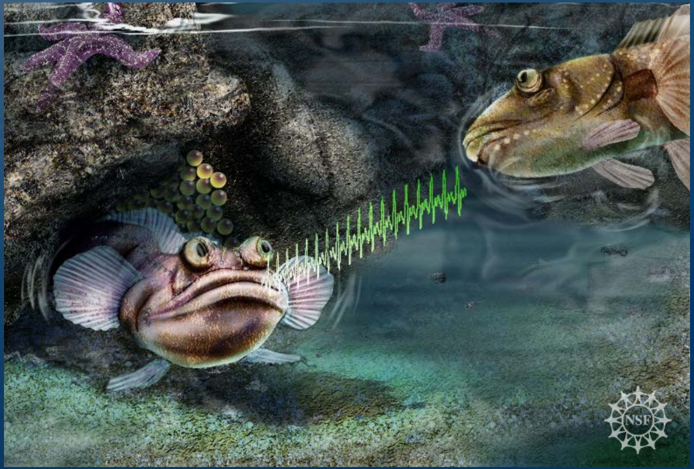
- Effects of cumulative stressors? (e.g., Pine et al. 2014)
  - anthropogenic noise
  - habitat disruption
  - climate change

Integrating Physiology, Behavior, and Ecology

Physiology



Behavior



Population Ecology

(Rice & Morano 2015)

NOAA
FISHERIES
SERVICE

Science, Service, Stewardship

NOAA

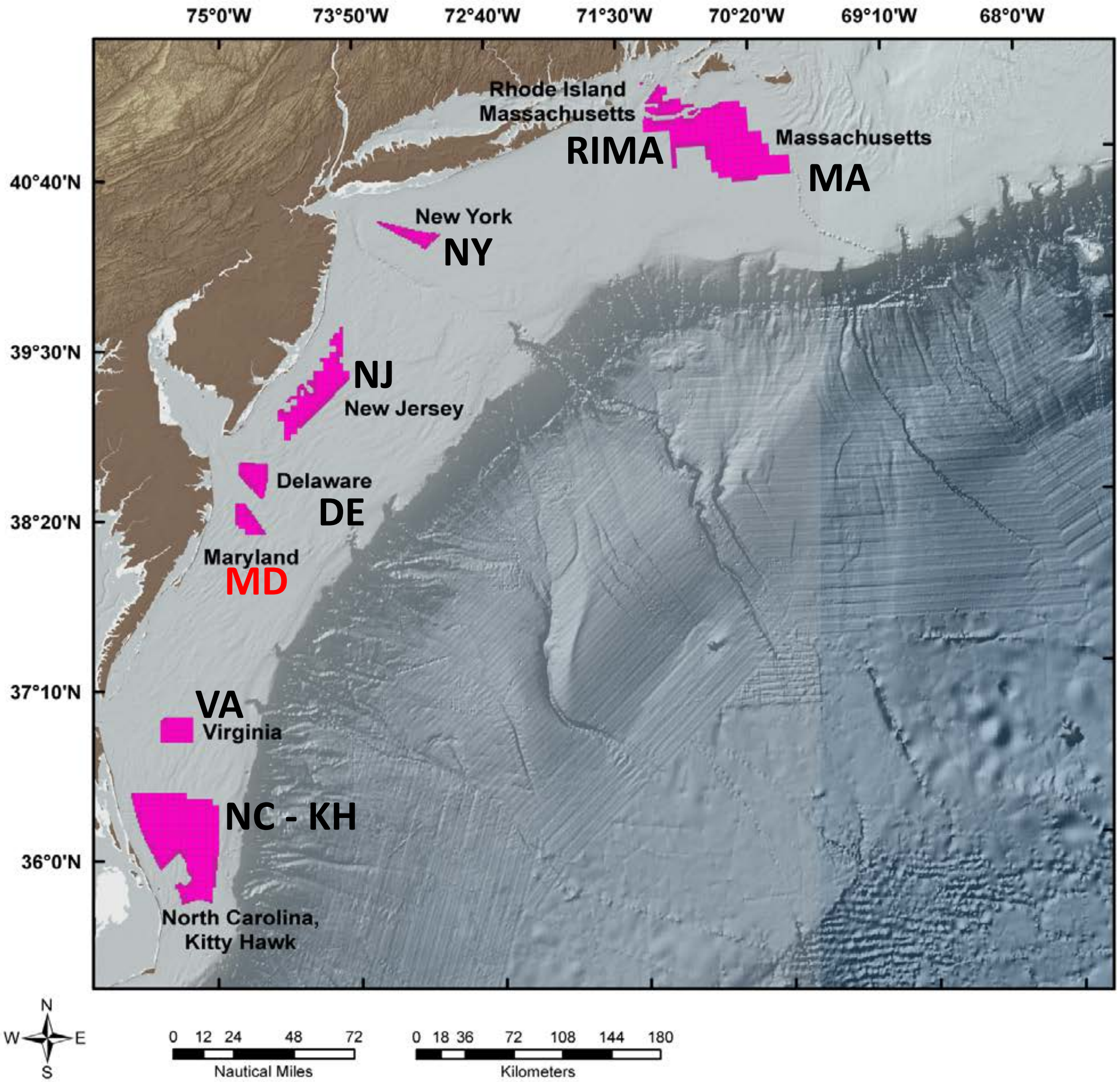
Biogeography of Fish Susceptibility to Noise Disturbance from Offshore Wind Development: Which Fish, Where and When?

Vincent G. Guida - NMFS, NEFSC
J.J. Howard Lab (Sandy Hook)

Contact: Vincent.Guida@noaa.gov

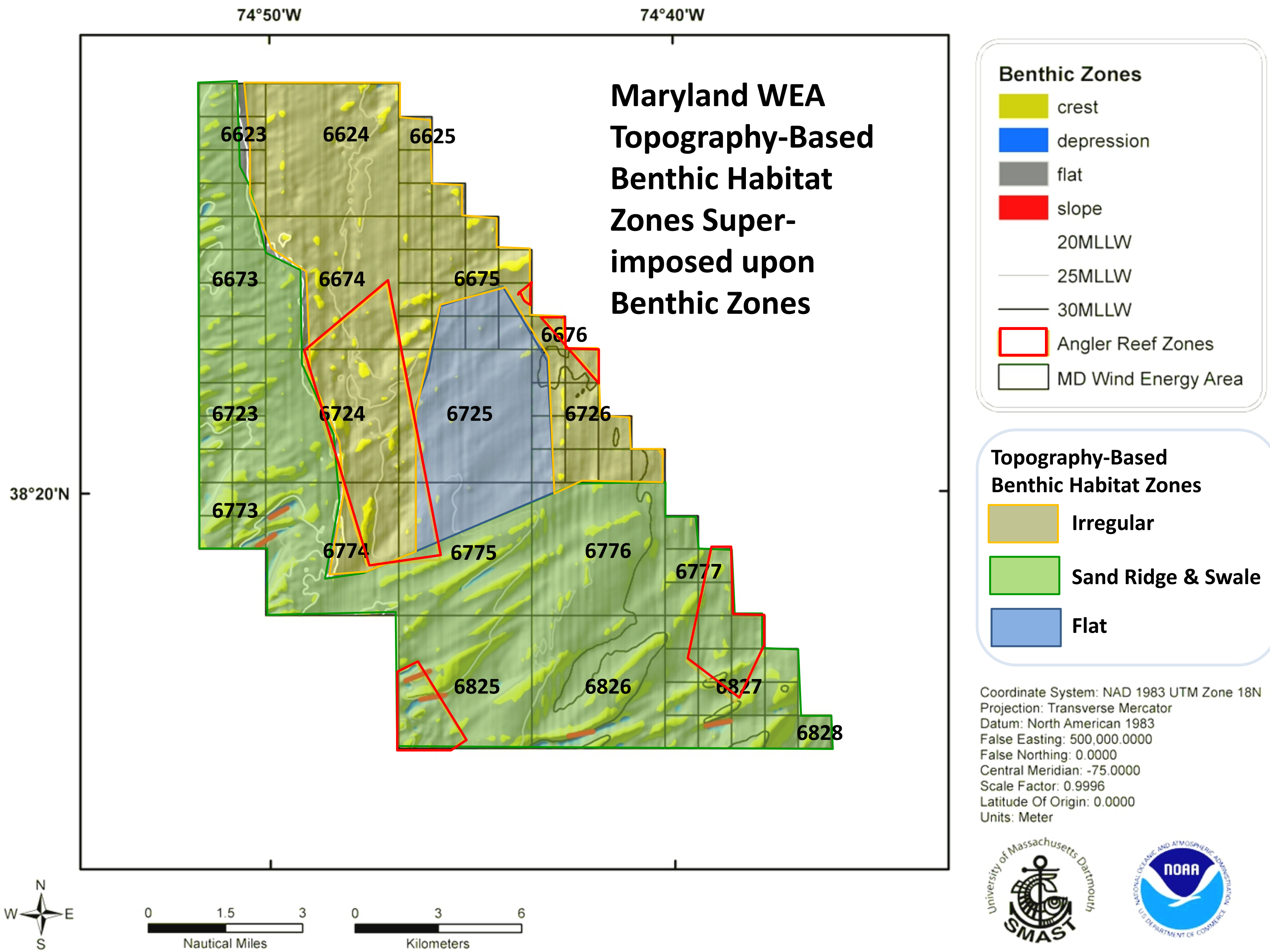
http://www.treehugger.com

8 WIND ENERGY AREAS ~2.6 million acres



Coordinate System: NAD 1983 UTM Zone 18N
Projection: Transverse Mercator
Datum: North American 1983
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -75.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter


SANDY HOOK IMAGE
& MODELING
ANALYSIS GROUP
(IMAG) LABORATOTRY



Maryland WEA Topography-Based Benthic Habitat Zones Super-imposed upon Benthic Zones
74°50'W
74°40'W
38°20'N
6623
6624
6625
6673
6674
6675
6676
6723
6724
6725
6726
6773
6774
6775
6776
6777
6825
6826
6827
6828
Benthic Zones
crest
depression
flat
slope
20MLLW
25MLLW
30MLLW
Angler Reef Zones
MD Wind Energy Area
Topography-Based Benthic Habitat Zones
Irregular
Sand Ridge & Swale
Flat
Coordinate System: NAD 1983 UTM Zone 18N
Projection: Transverse Mercator
Datum: North American 1983
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -75.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
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Kilometers

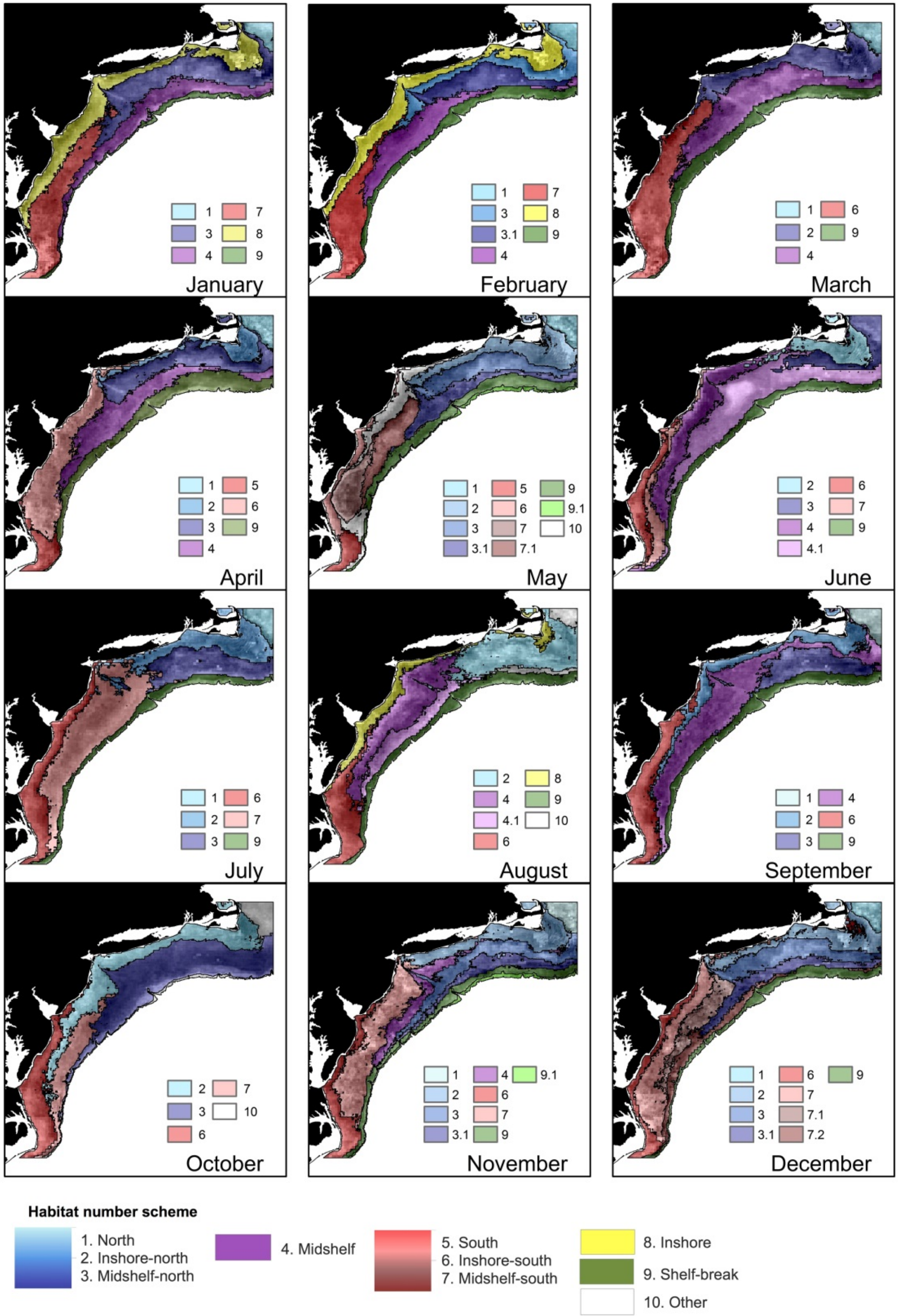

JENN McHENRY & HEATHER WELCH
ABOARD HABITAT CRUISE ON *HENRY B. BIGELOW*: AUGUST, 2015
NOAA

WHAT IS HABITAT?

RESULTS

Monthly Assemblage Maps: Connecting Individual Species Habitat Suitability with Ecosystem Fisheries Patterns

- 85 distinct species
- Internal variation in suitability



NOAA
FISHERIES
SERVICE

WHAT FISH SHOULD WE BE CONCERNED WITH AND WHEN AND WHERE?

- WELL-KNOWN SONIFEROUS FISH
- FISH OF INTEREST TO FISHERIES
- SEASONAL PATTERNS WITH RESPECT TO DESIGNATED WIND ENERGY AREAS
- UTILIZING NEFSC SPRING AND FALL TRAWL SURVEY DATA

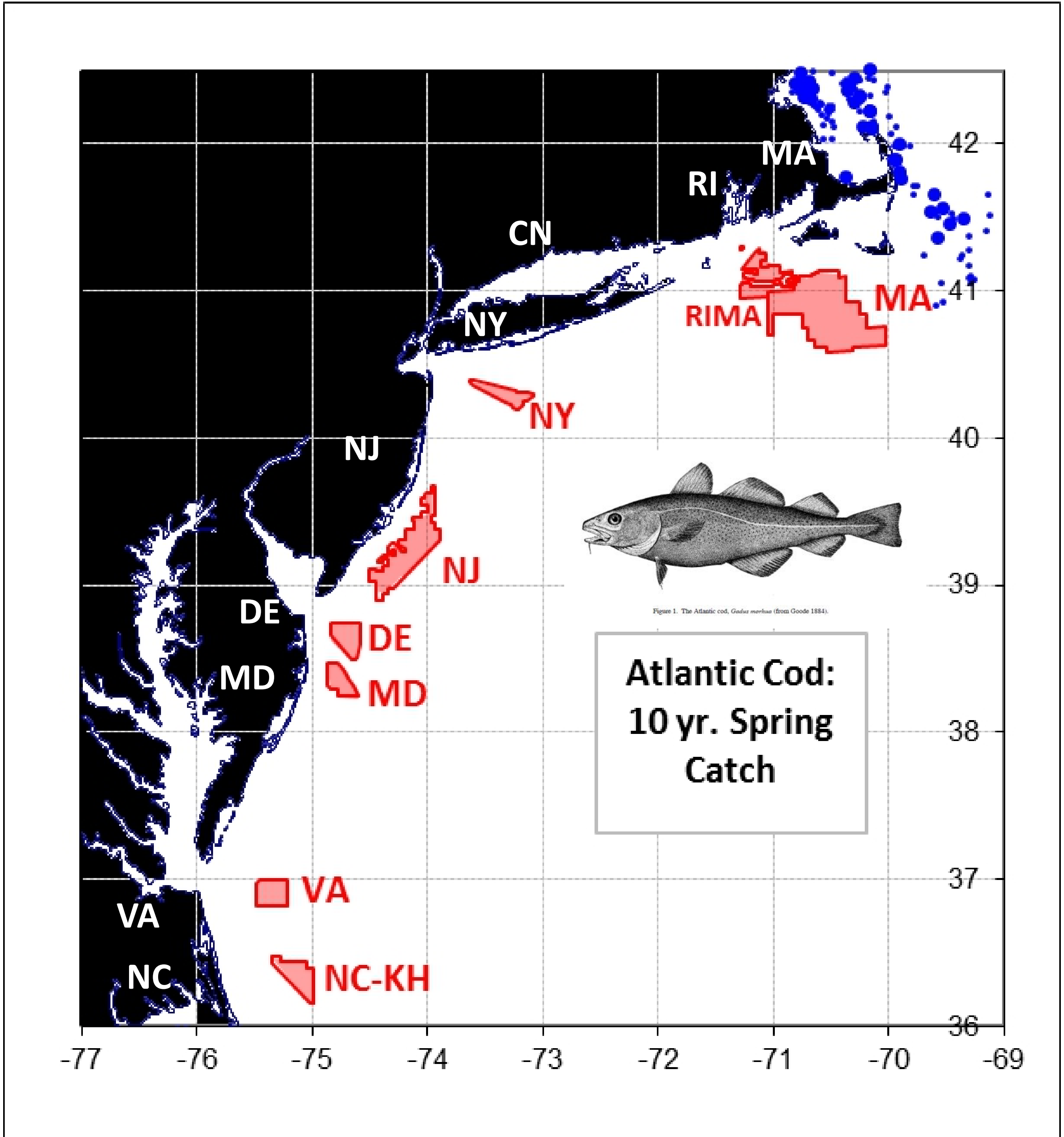

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Figure 1. The Atlantic cod, Gadus morhua (from Goode 1884).
Atlantic Cod: 10 yr. Spring Catch
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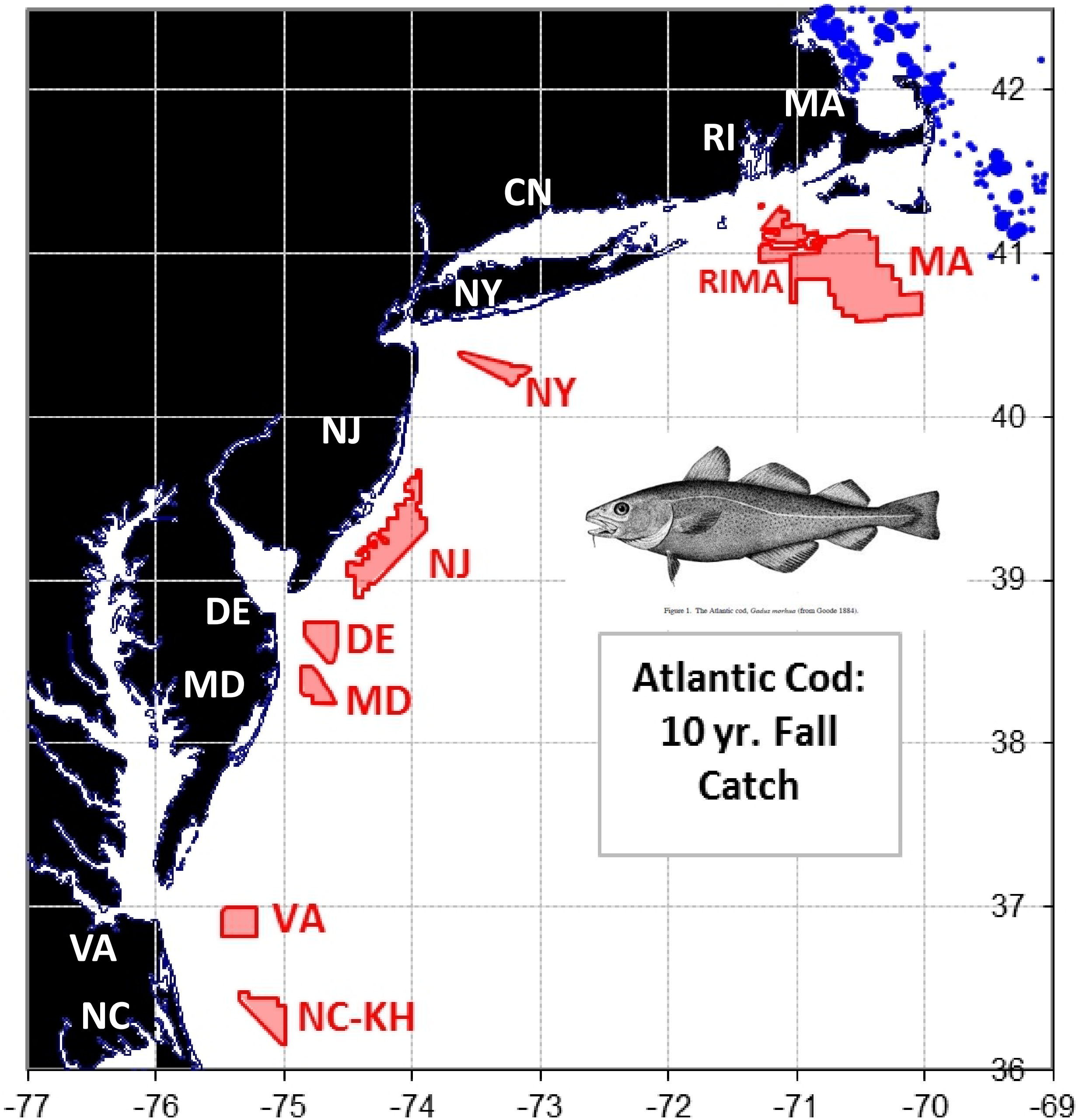

Atlantic Cod:
10 yr. Fall
Catch
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NC-KH
Figure 1. The Atlantic cod, Gadus morhua (from Goode 1884).
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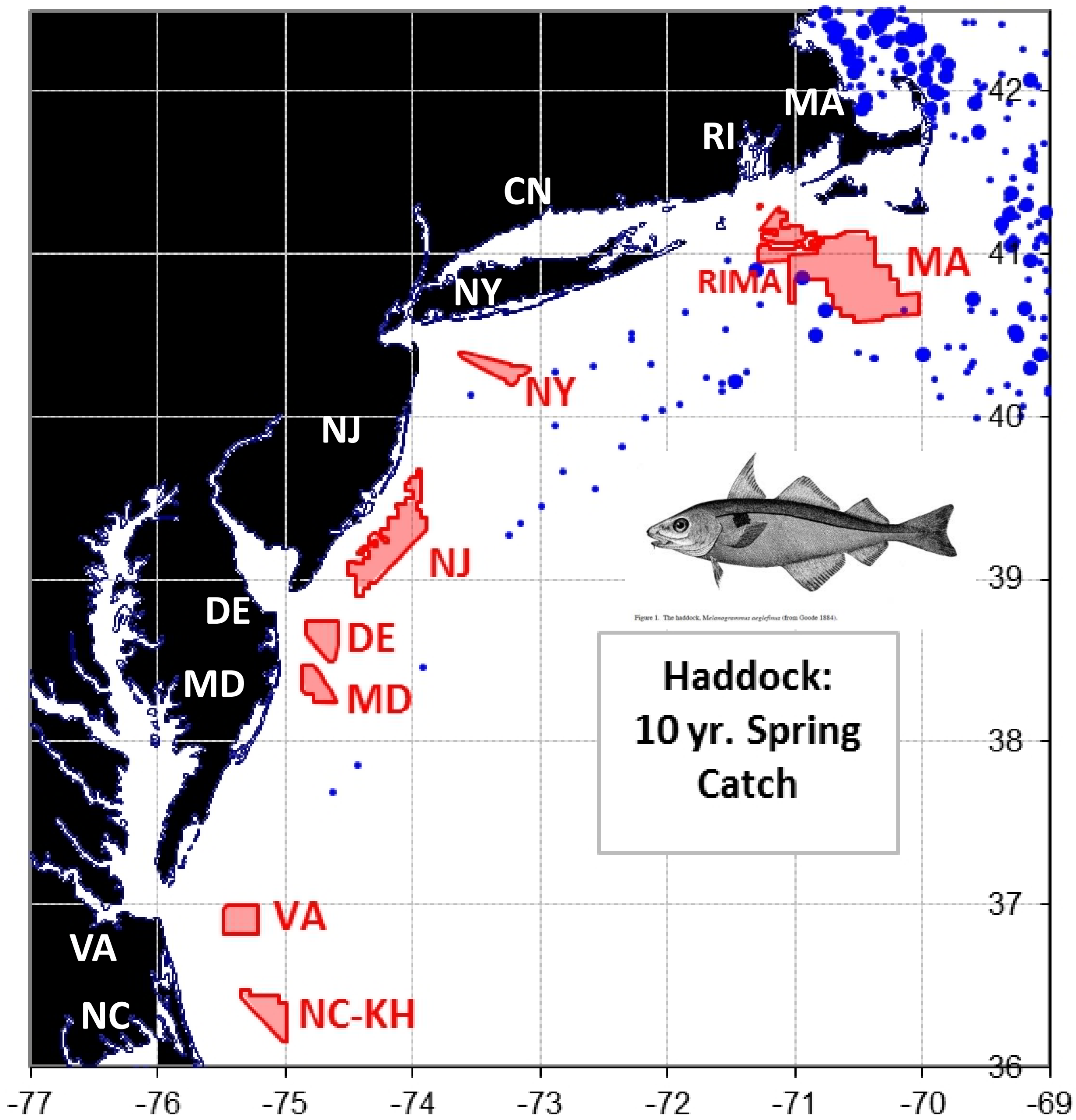

Haddock:
10 yr. Spring Catch
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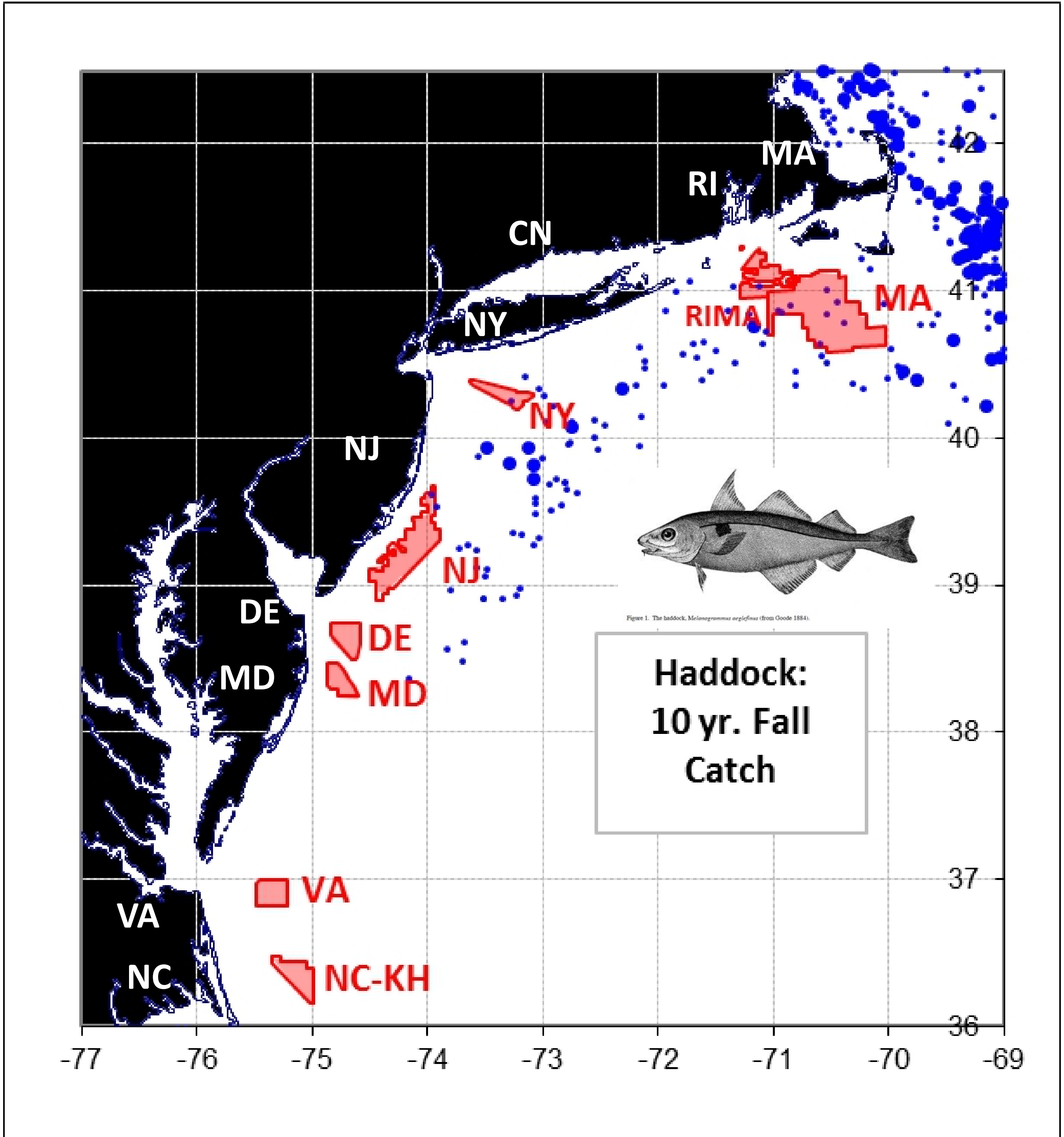

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Haddock:
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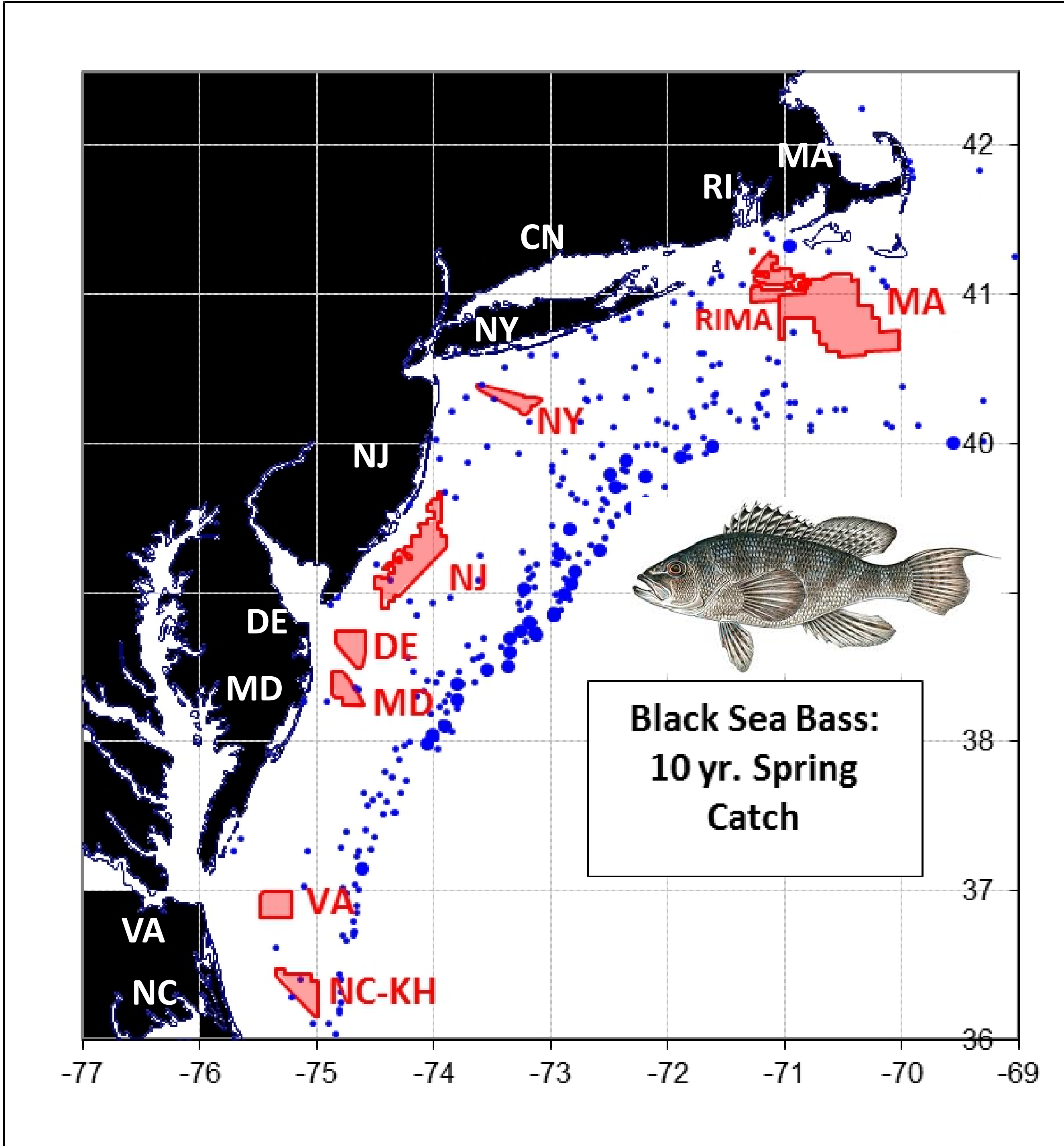

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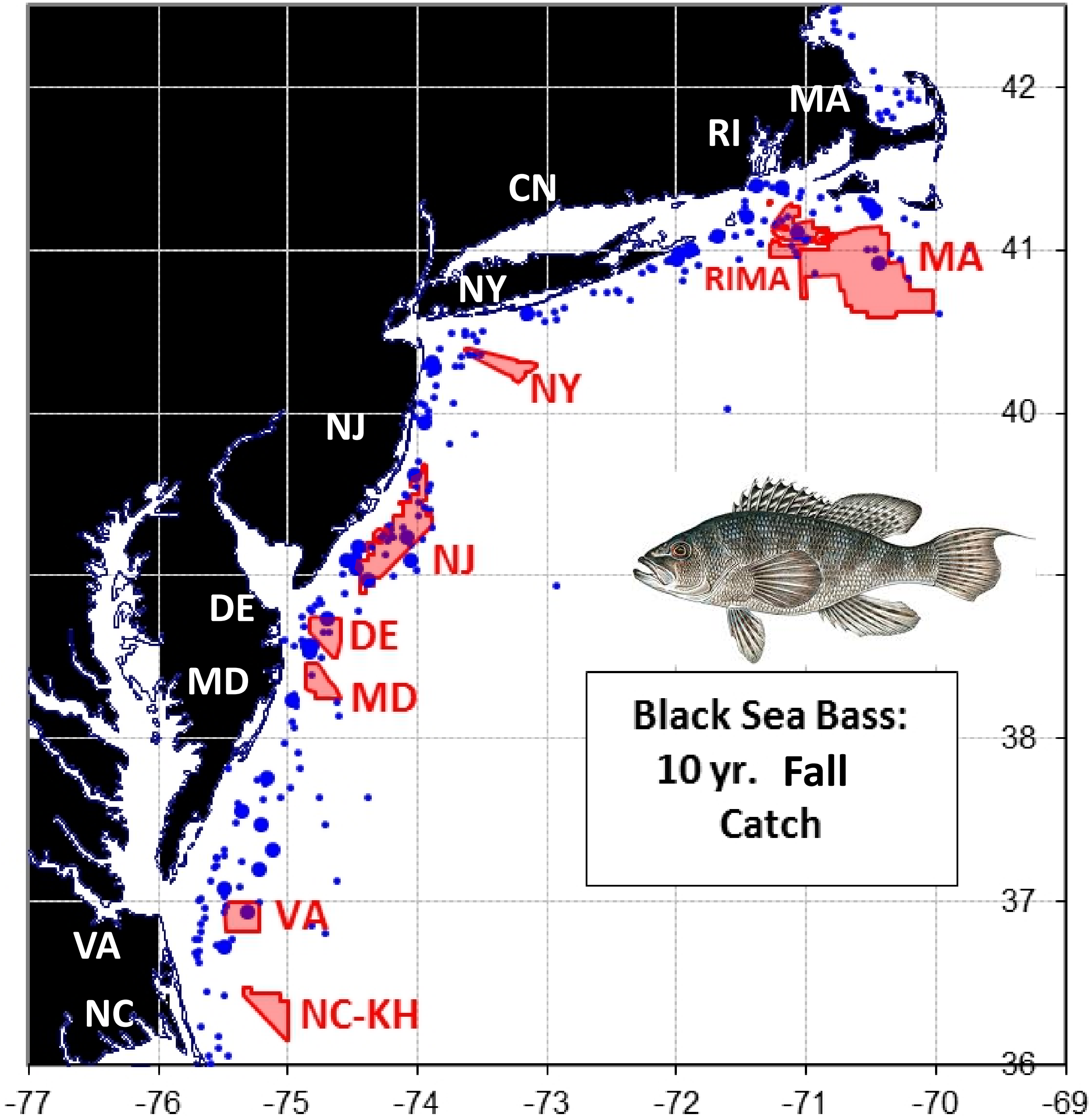
Black Sea Bass:
10 yr. Spring
Catch



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Black Sea Bass:
10 yr. Fall
Catch
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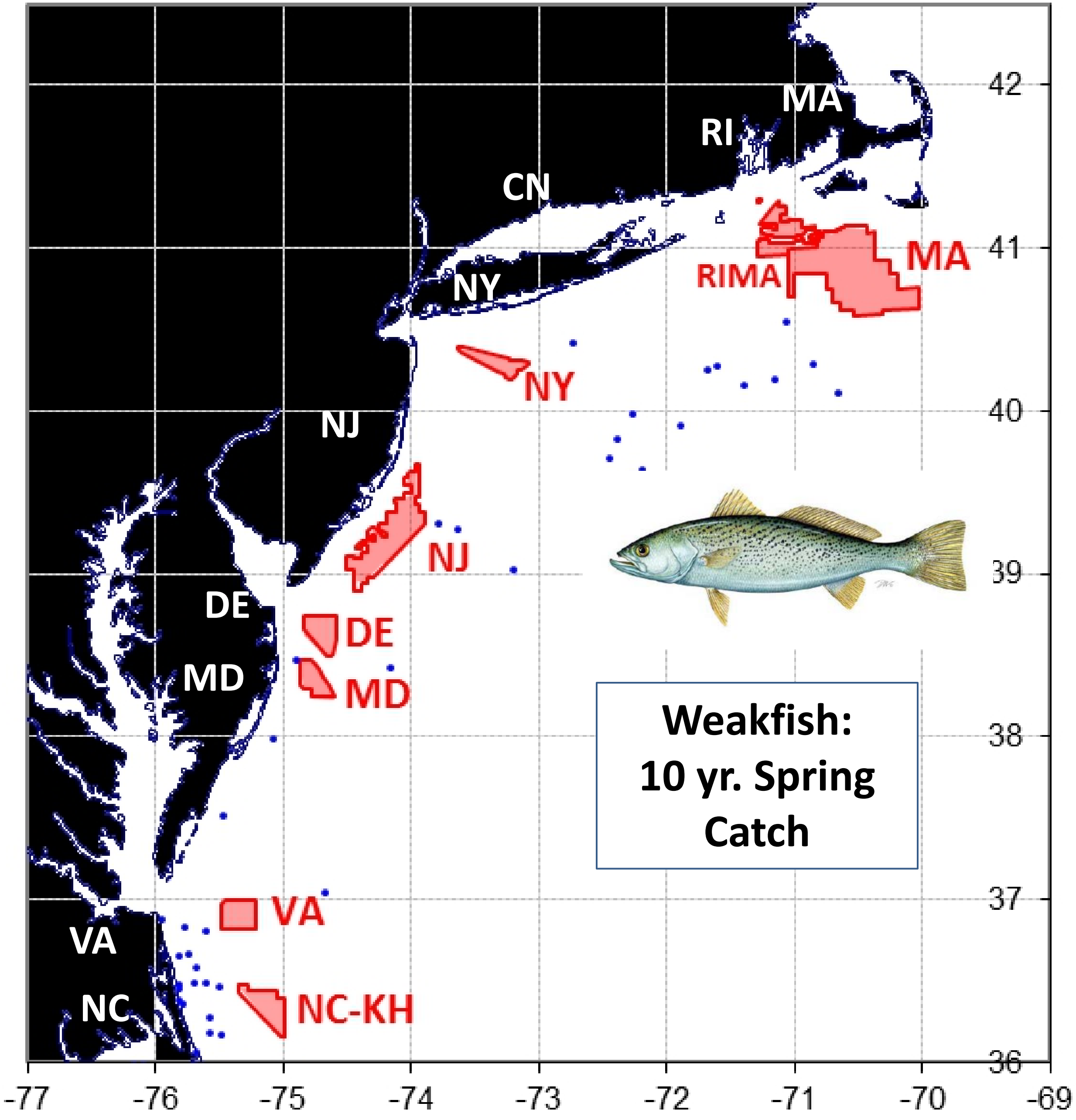
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Weakfish:
10 yr. Spring
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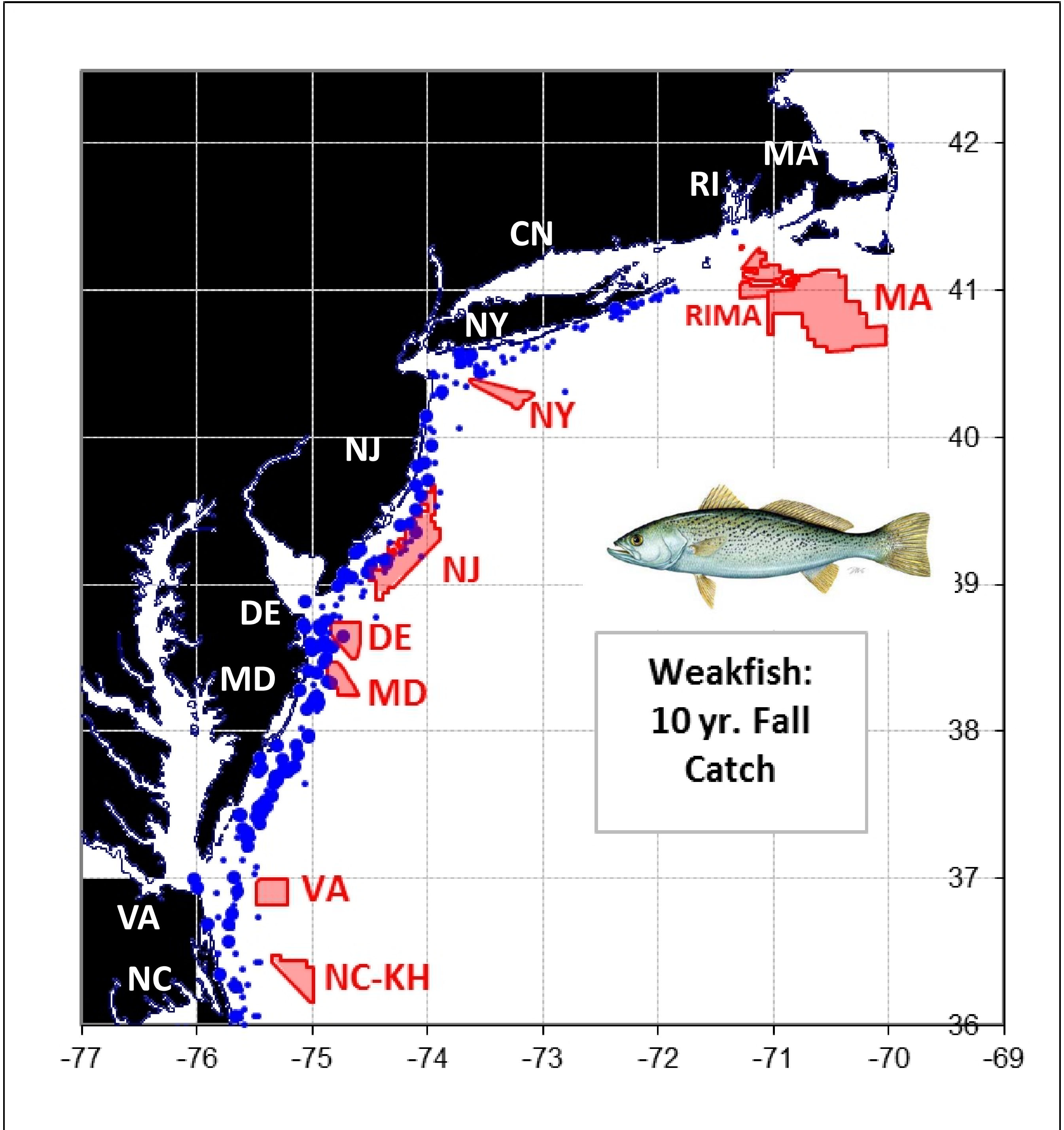

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Weakfish:
10 yr. Fall
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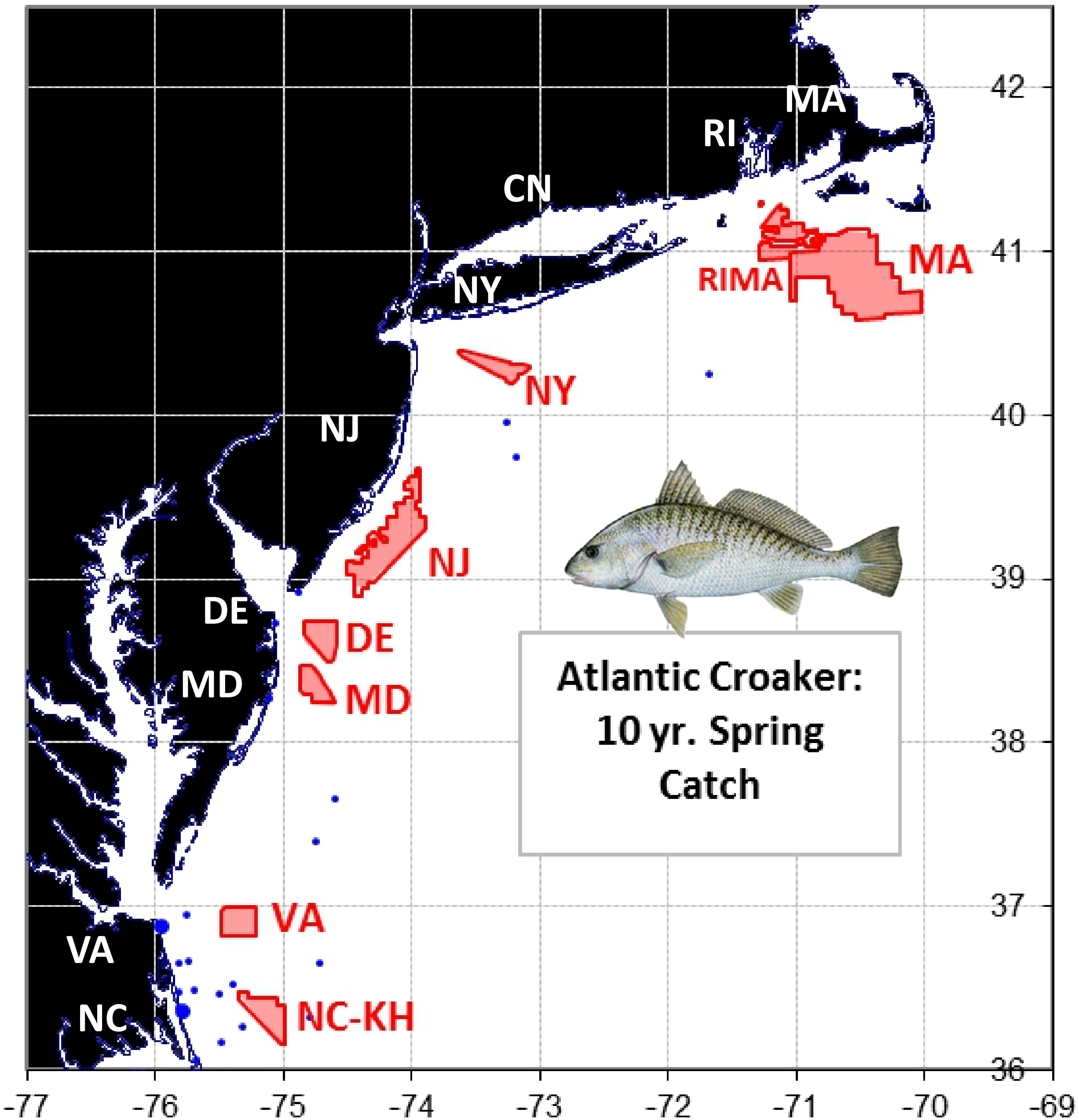
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Atlantic Croaker:
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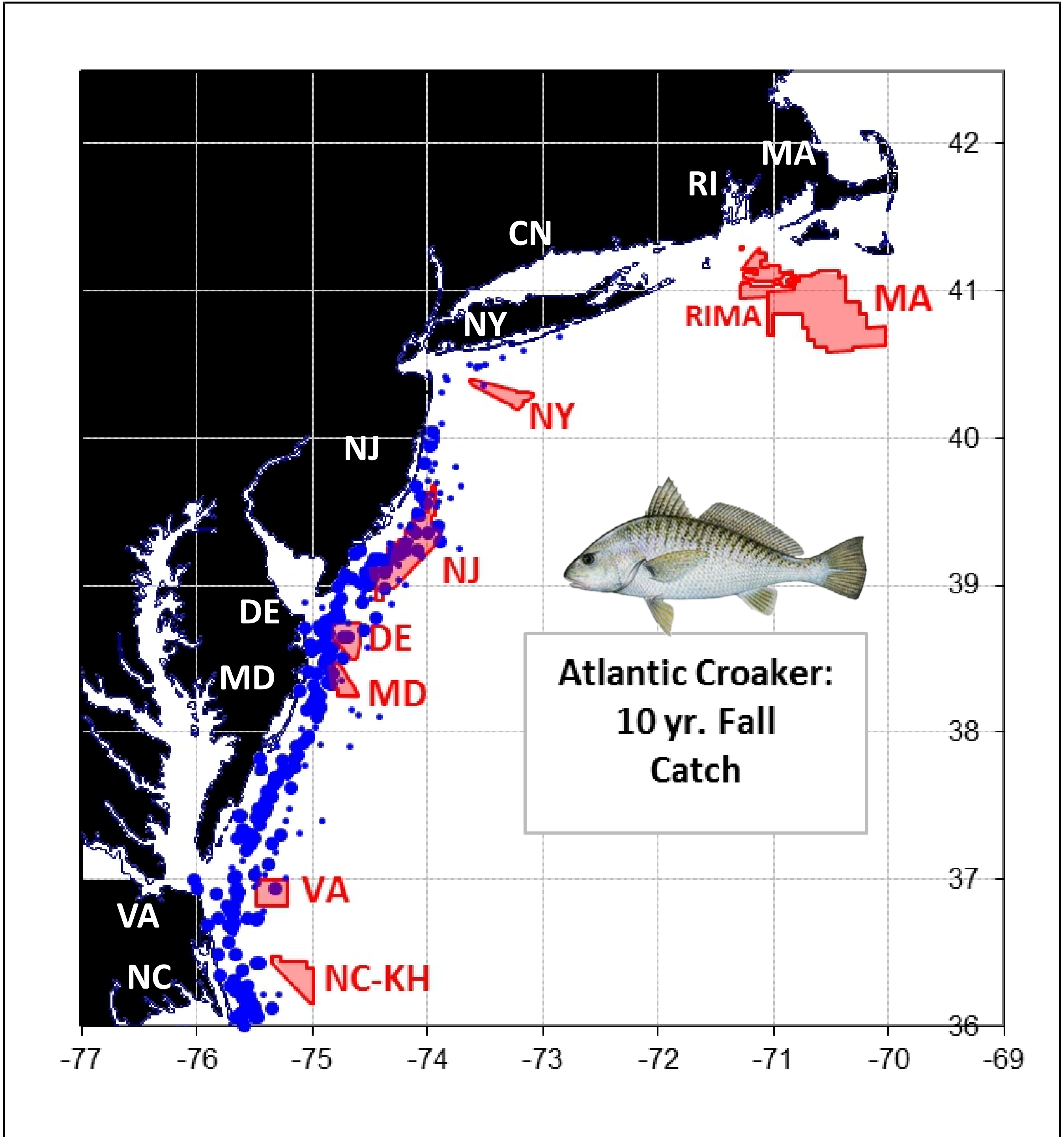

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Atlantic Croaker:
10 yr. Fall
Catch
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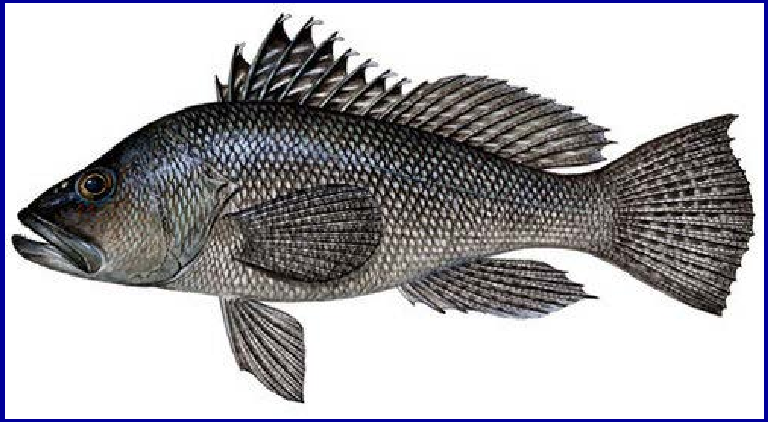
Which Fish, Where & When?

- **BLACK SEA BASS DURING WARM SEASON IN MOST WEAs, but ESPECIALLY NJ, DE & MD**

- **DRUM FAMILY (SCIAENIDS: WEAKFISH, CROAKER) IN WARM SEASON SOUTH FROM NJ SOUTH**

BLACK SEA BASS RESEARCH



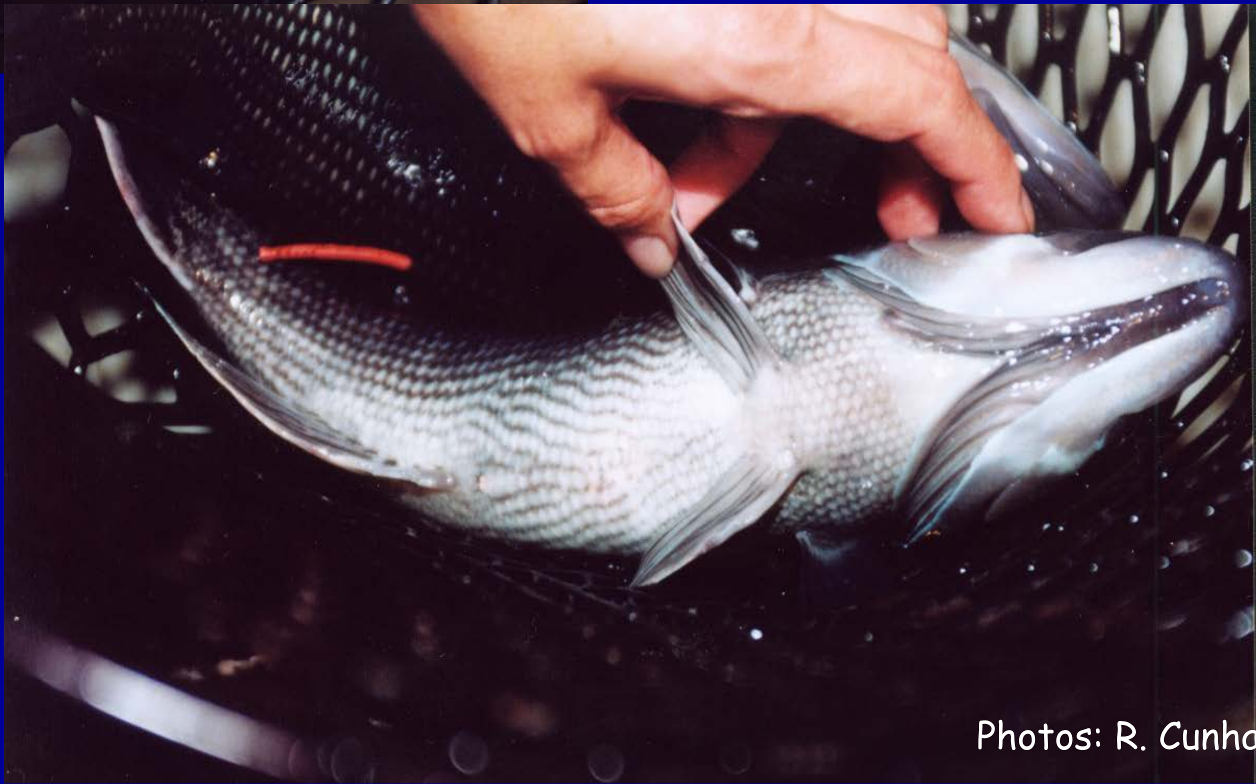
Beth Phelan, Ph.D.
Howard Marine Sciences Lab
Sandy Hook, New Jersey
Northeast Fisheries Science Center
NOAA,NMFS


Hudson River
Connecticut
Long Island
NYC
New Jersey
Inner Shelf
Hudson Shelf Valley
Hudson Canyon

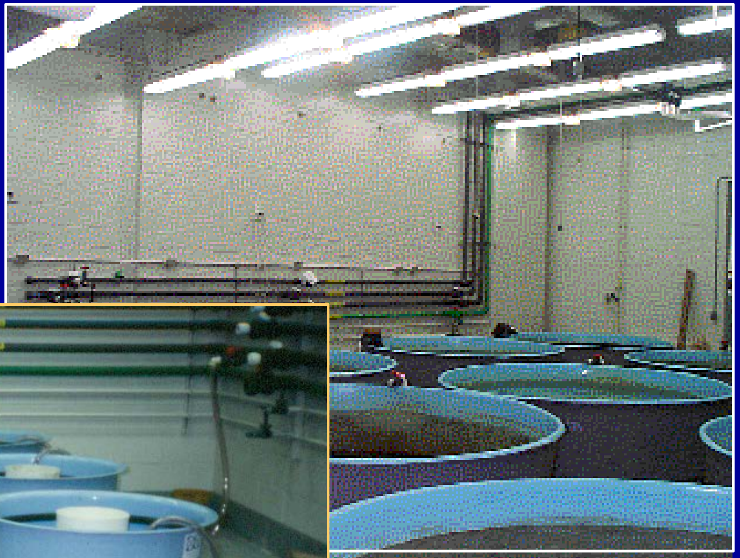
Moored Observation Systems

~5-6 weeks post-surgery

~7-8 weeks post-surgery



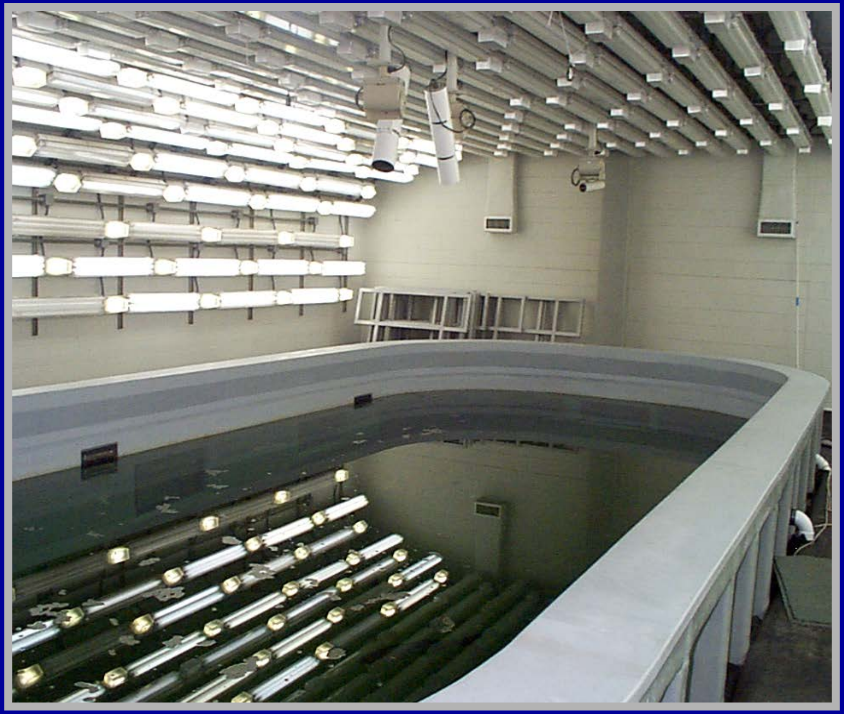
Photos: R. Cunha

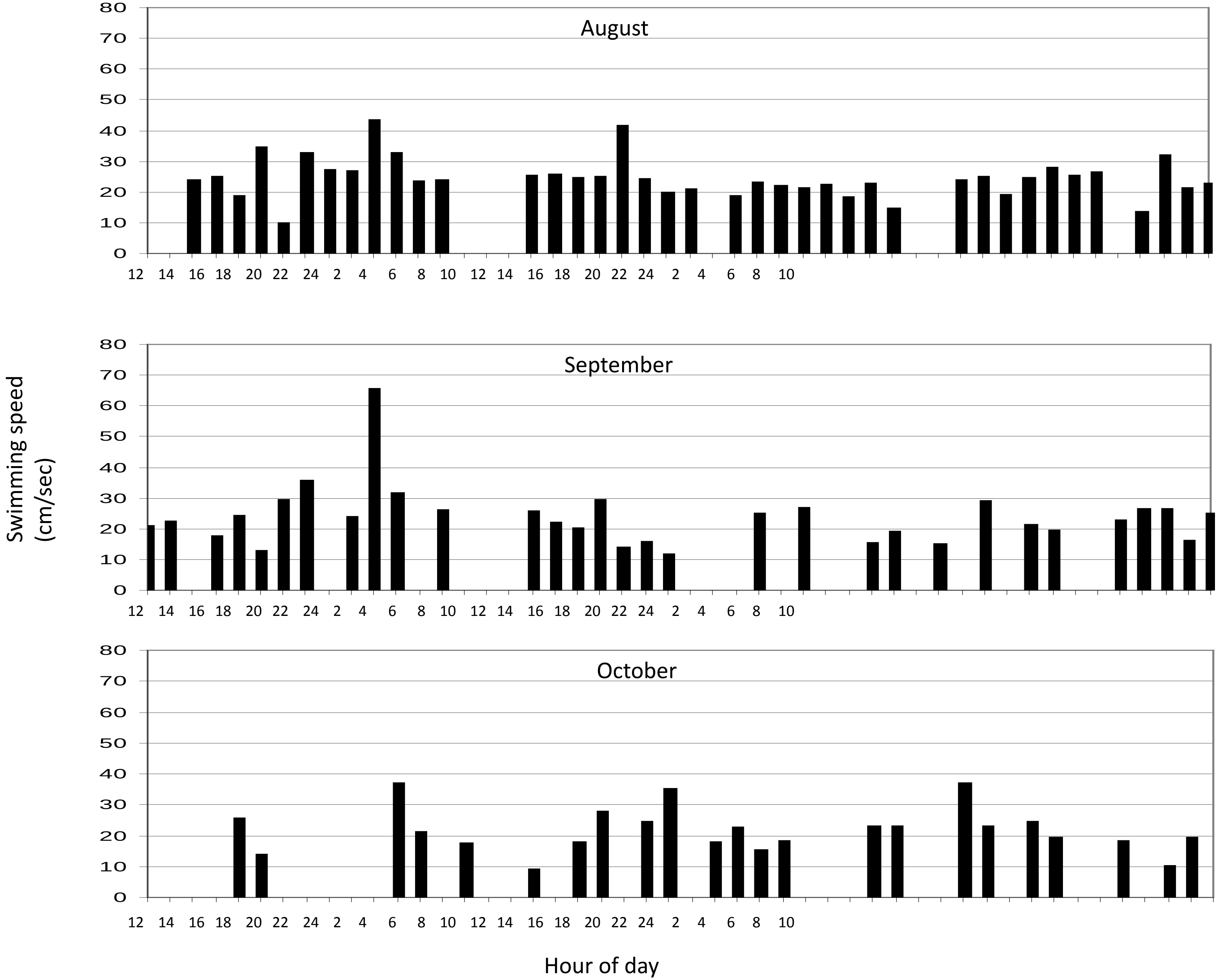


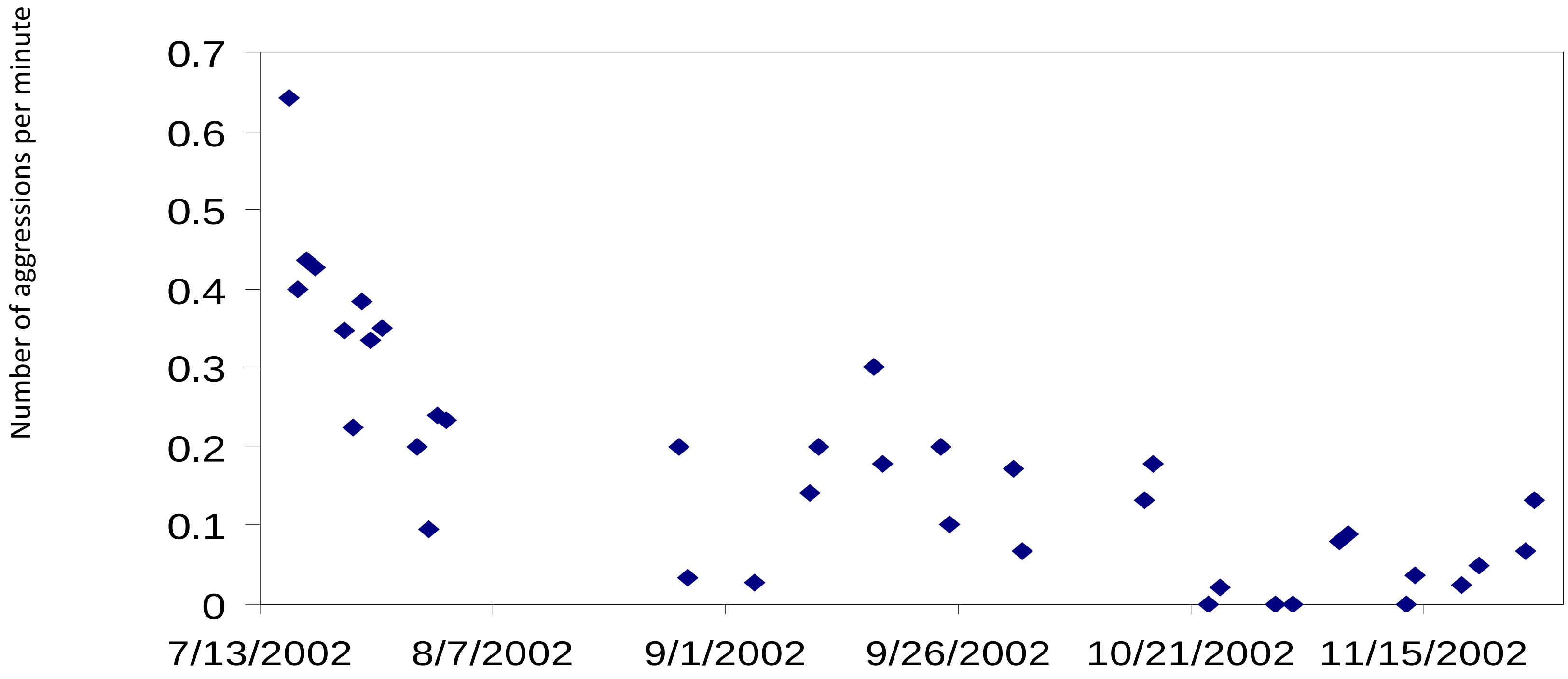
Habitat Studies – Black Sea Bass Behavior

Behavior of post-reproductive black sea bass

- observations on fish held in captivity --
  - activity levels
  - swimming speeds
  - territoriality
  - aggression



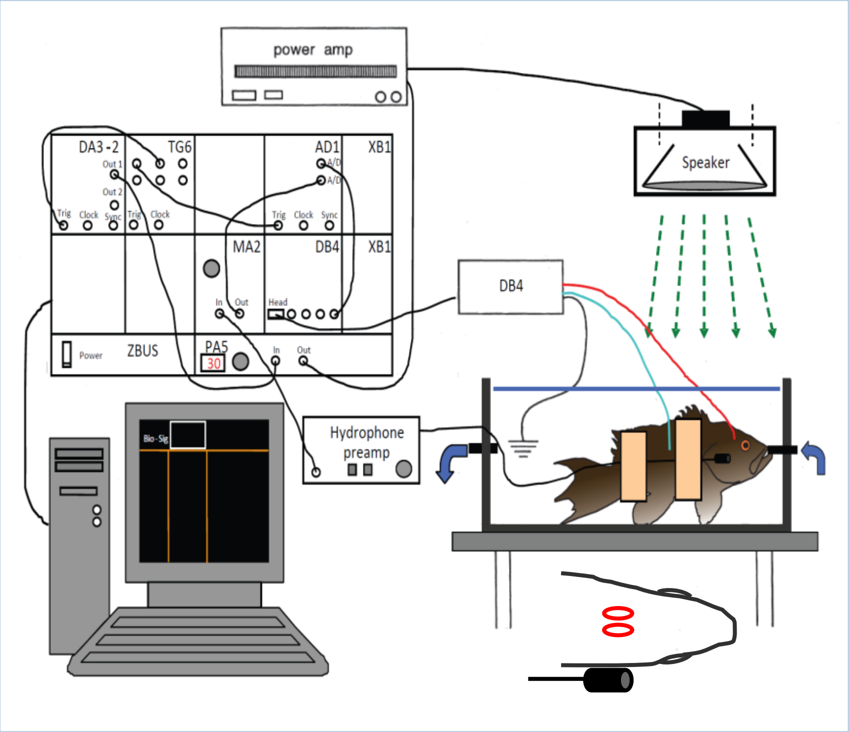

August
September
October
Swimming speed (cm/sec)
Hour of day
0 10 20 30 40 50 60 70 80
12 14 16 18 20 22 24 2 4 6 8 10 12 14 16 18 20 22 24 2 4 6 8 10



Number of aggressions per minute
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
7/13/2002
8/7/2002
9/1/2002
9/26/2002
10/21/2002
11/15/2002

Hearing

- Sensitivity to range of frequencies (pitch)
- Intensity threshold (faint/loud)
- Response to pressure & particle motion stimuli



Auditory Brainstem Response (Auditory Evoked Potentials)

Response of brain to sounds varying in frequency and intensity

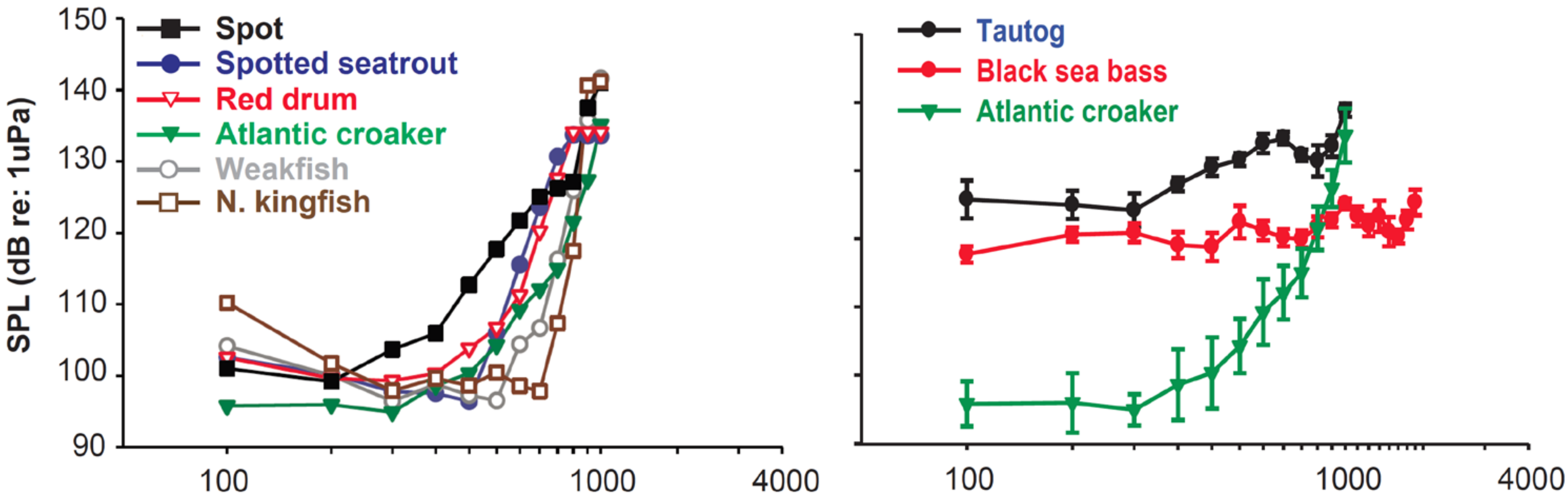
Vision and Hearing in Virginia's Sportfishes

Andrij Horodysky[1*], Cedric Shamley[1], Malik Breland[1], Elizabeth Seagroves[1], & Richard Brill[2]

[*]*VIMS Graduate, M.S. in Marine Science 2004, PhD in Marine Science 2009 • PhD work conducted at the VIMS Eastern Shore Lab (unpublished).*

Hearing Results

- Most VA sportfishes hear from 100-1500 Hz; sound-producing species hear their own sounds best
- Species with special connections between the swim bladder and ear hear better than those without



Vision and Hearing in Virginia's Sportfishes

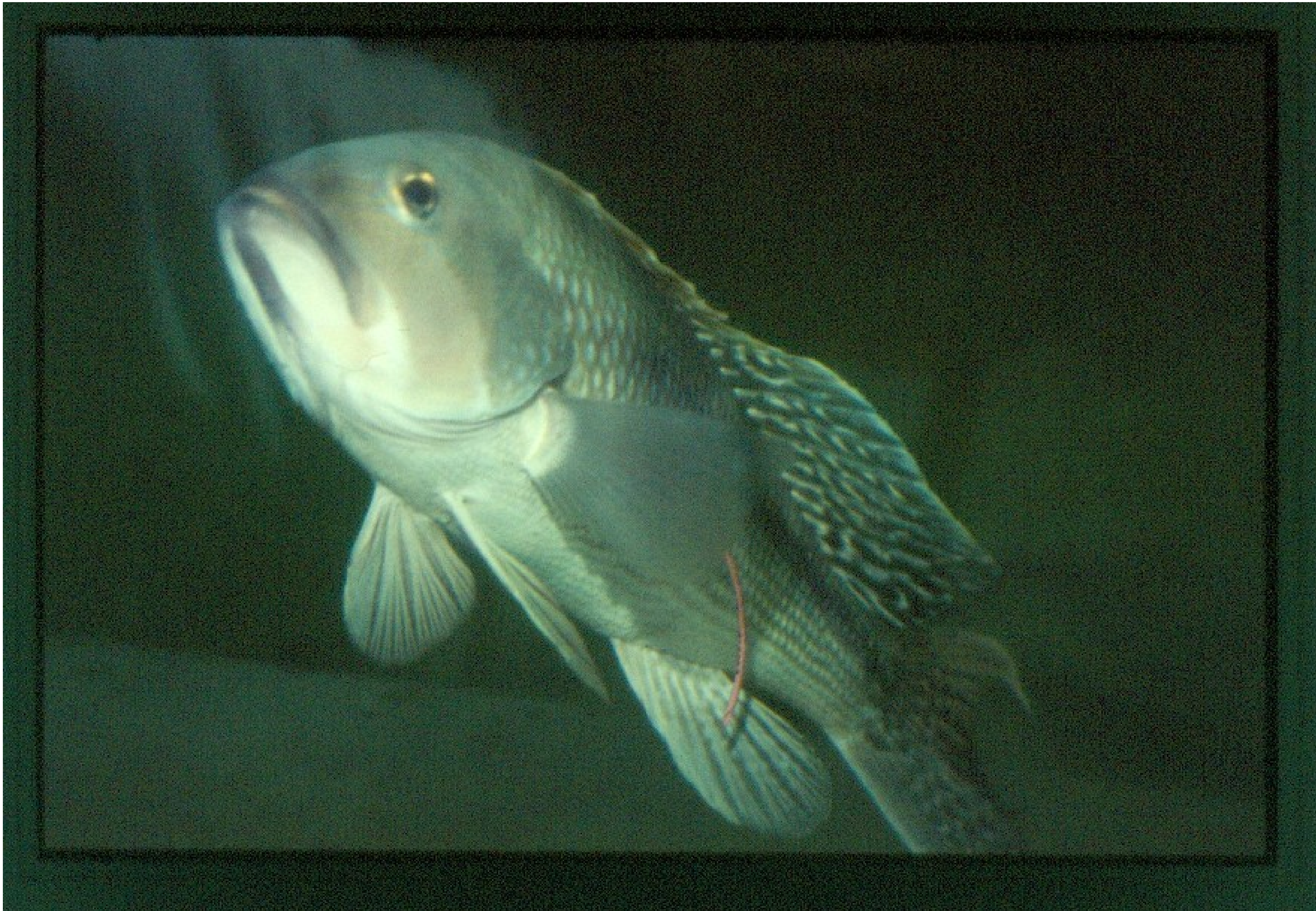
Andrij Horodysky[1*], Cedric Shamley[1], Malik Breland[1], Elizabeth Seagroves[1], & Richard Brill[2]

[*]VIMS Graduate, M.S. in Marine Science 2004, PhD in Marine Science 2009 • PhD work conducted at the VIMS Eastern Shore Lab (unpublished)

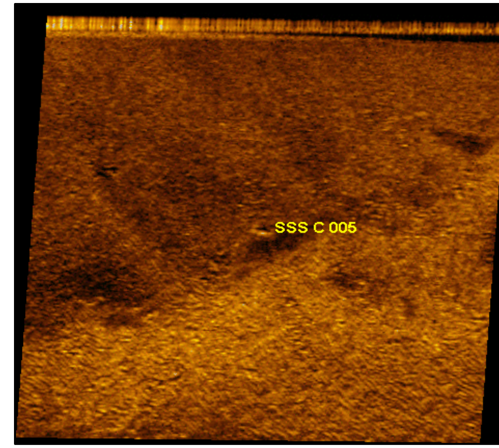
videoplayback (2).mp4

07_13_2010.01bottomspawn (1).mpeg

https://www.youtube.com/watch?v=1TM-AlQ-gz0&feature=em-share_video_user



Marine Minerals Program – Environmental Studies



Restoring and Protecting Our Nation's Coasts through Stewardship of OCS Resources

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MMP Staff

- **Office of Strategic Resources/Leasing Division/Marine Minerals Branch**
  - Jeff Reidenauer, PhD (Biological Oceanography) - Branch Chief
  - Jeff Waldner, PG (MS, Geology/Engineering) - Marine Geologist
  - Lora Turner (MS, Physical Oceanography) - Physical Oceanographer
  - Paul Knorr, PhD (Geology) – Marine Geologist
  - Leighann Brandt , PG (MS, Geology) – Geologist
  - Doreen Vega (Political Science, Ethnic Studies and History) – Program Analyst
  - Margaret Thomas – Program Specialist

- **Office of Environmental Programs/Division of Environmental Assessment**
  - Geoff Wikel (MS, Marine Science) – Branch Chief
  - Jennifer Bucatari, PhD (Biology) – Oceanographer
  - Doug Piatkowski, (MS, Marine Biology) – Physical Scientist
  - Deena Hansen, (MS, Marine Science) - Oceanographer

- **Gulf of Mexico, Marine Minerals Program**
  - Mike Miner, PhD, P.G (Geology) – Environmental Scientist
  - Ken Ashworth, PhD (Archeology) – Environmental Scientist
  - Jessica Mallindine (MS, Marine Biology) – Environmental Scientist
  - Bridgette Duplantis (MS, Molecular Biology) – Environmental Scientist

U.S. DEPARTMENT OF THE INTERIOR
MARCH 3, 1849

Stewardship Role

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Mission of BOEM's Marine Minerals Program

The mission of BOEM's Marine Minerals Program is to facilitate access to and manage the Nation's Outer Continental Shelf (OCS) non-energy marine minerals, particularly sand and gravel, through environmentally responsible stewardship of resources, prudent assessments of exploration and leasing activities, coordination with governmental partners, engagement of stakeholders, strategic planning, and mission-focused scientific research to improve decision-making and risk management.

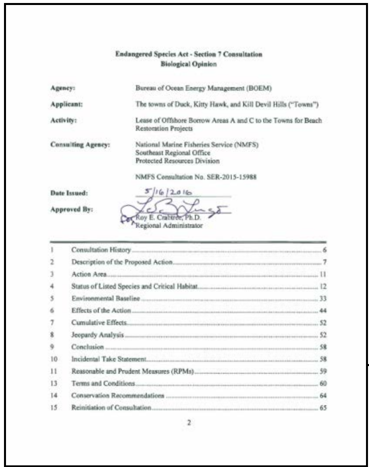
Vision of BOEM's Marine Minerals Program

The vision of the Marine Minerals Program is to serve as the lead federal agency and liaison in support of the Nation's current and long-term interests in OCS non-energy marine minerals. This vision is realized through the following core values:

- The MMP will act as the Nation's steward and scientific expert for OCS non-energy marine mineral resources, particularly sand and gravel used to foster coastal resiliency.
- The MMP will proactively identify, assess, and sustainably manage resources to ensure future availability.
- The MMP will promote strategic stakeholder engagements to facilitate planning and information sharing.
- The MMP will develop forward-looking science strategies to fulfill data needs.
- The MMP will foster ecosystem health and restoration while supporting the Nation's evolving marine mineral resource needs.
- The MMP will prepare comprehensive marine resource impact assessments, adopt integrated adaptive resource management principles, and develop practicable mitigations to avoid and/or minimize impacts.

https://www.boem.gov/Marine-Minerals-Program/

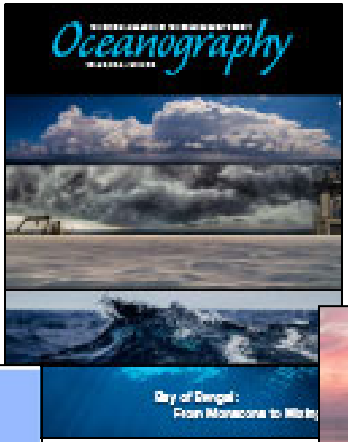
- Environmental Studies
  - $40 million spent on non-energy OCS resources since 1992
  - More than 40 site-specific and programmatic studies

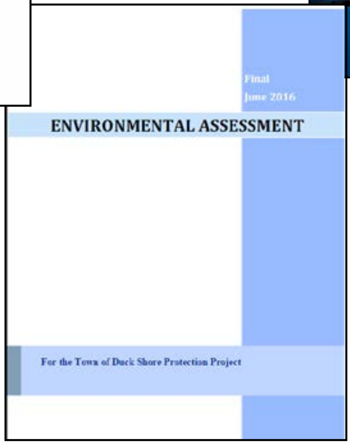


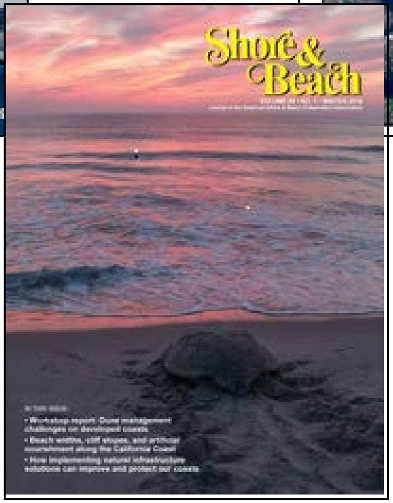
Endangered Species Act - Section 7 Consultation
Biological Opinion

Agency:	Bureau of Ocean Energy Management (BOEM)
Applicant:	The towns of Duck, Kitty Hawk, and Kill Devil Hills ("Towns")
Activity:	Lease of Offshore Borrow Areas A and C to the Towns for Beach Restoration Projects
Consulting Agency:	National Marine Fisheries Service (NMFS) Southeast Regional Office Protected Resources Division
	NMFS Consultation No. SER-2015-15988
Date Issued:	5/16/2016
Approved By:	for Roy E. Crabtree, Ph.D. Regional Administrator

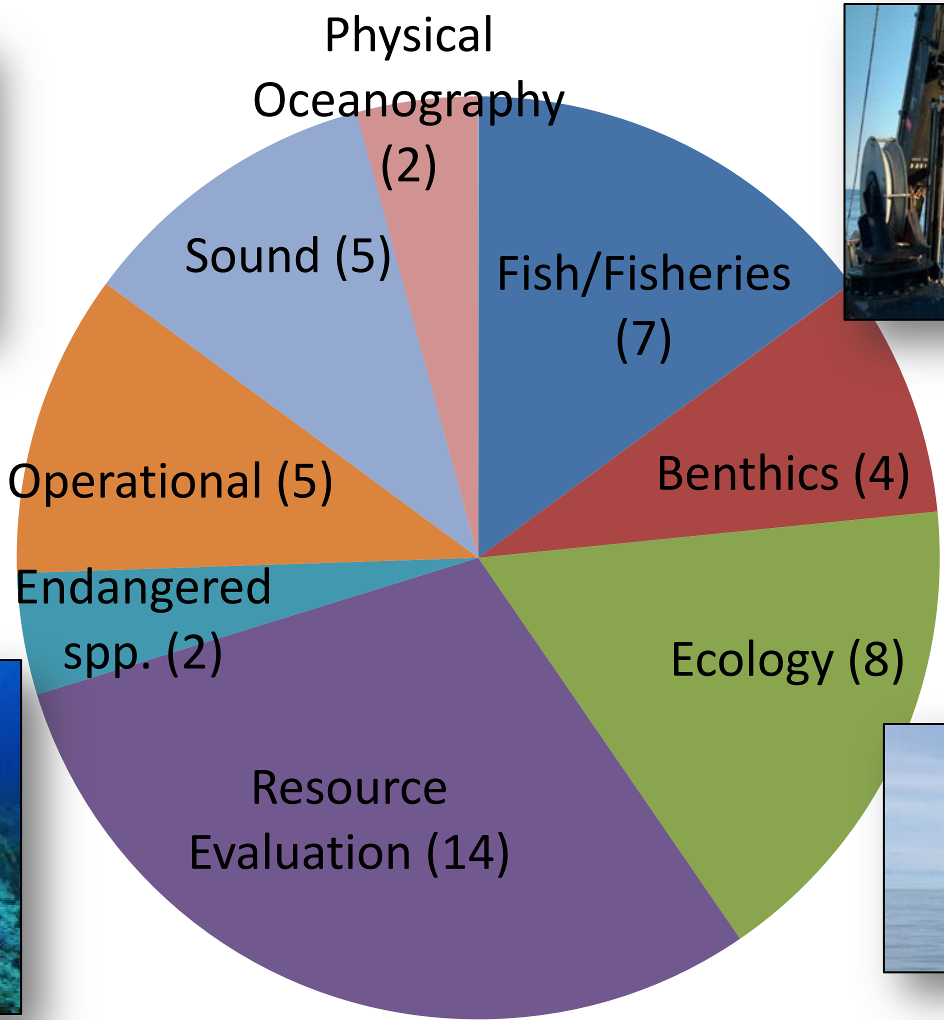
2







Ongoing Studies (2012 – Present)



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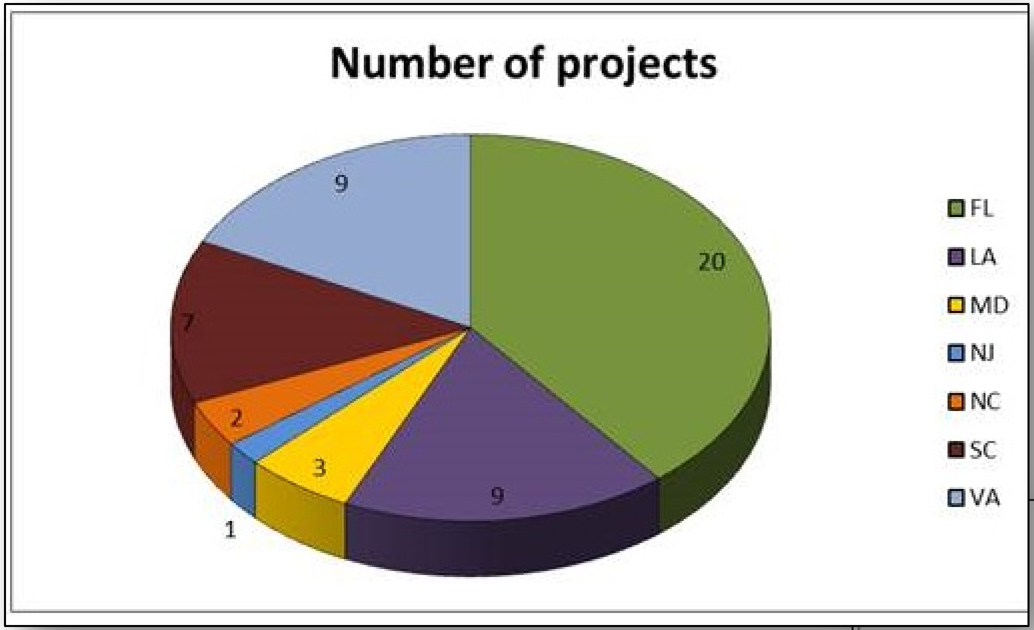
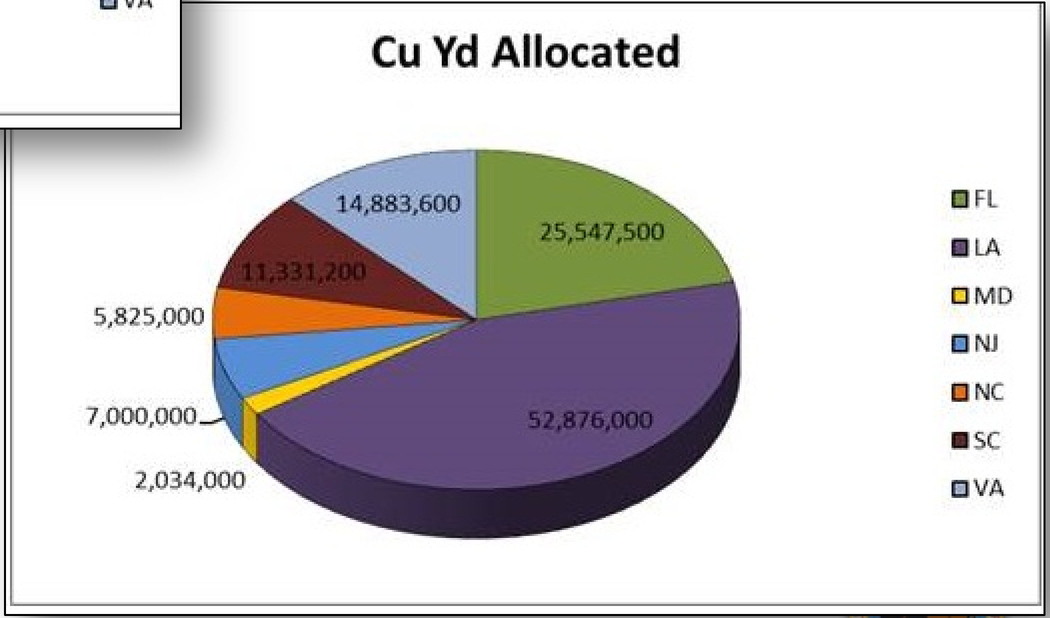
Current Statistics





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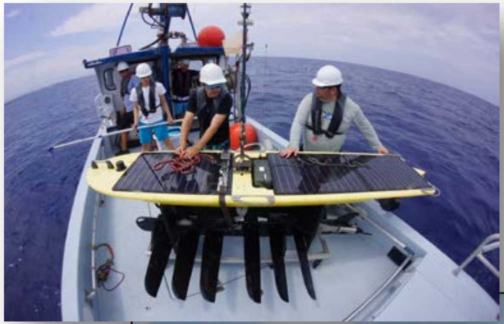
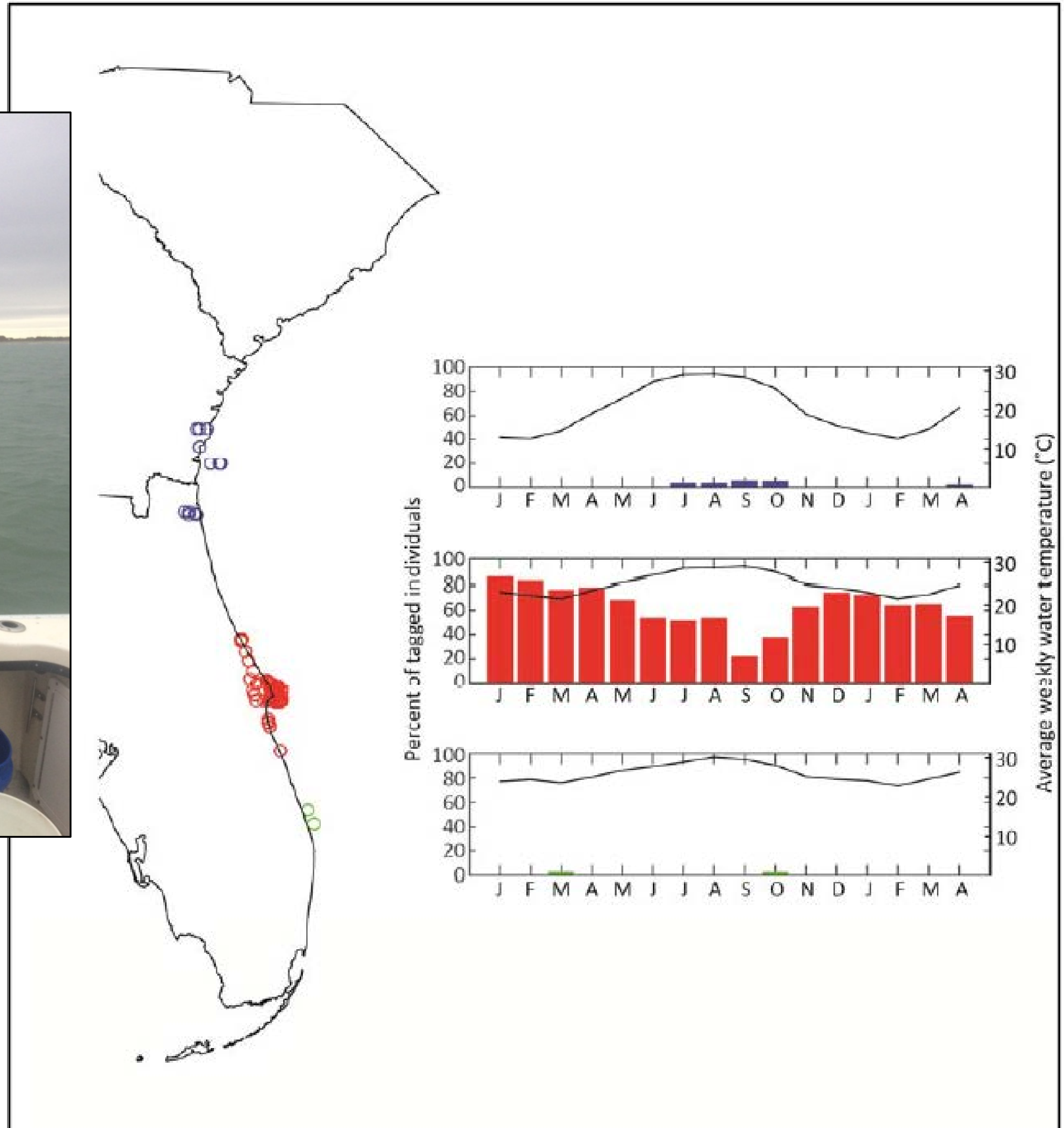
Ongoing Studies

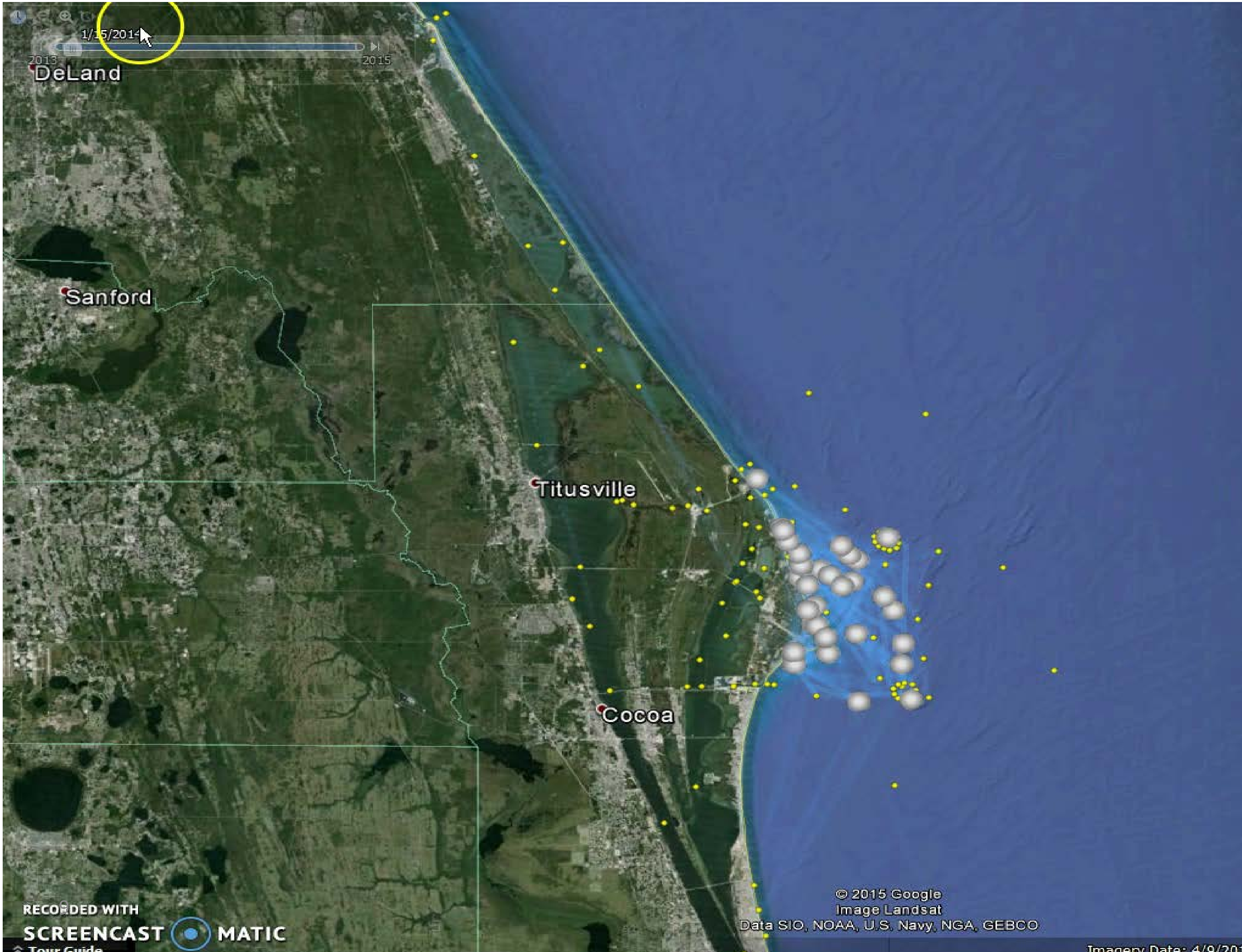
- Natural Habitat Associations and the Effects of Dredging on Fish at the Canaveral Shoals, East-central Florida. Navy Interagency Agreement; **Glider-based fish tracking**
- Sediment sorting during coastal restoration projects: implications for resource management, environmental impacts, and multiple use conflicts
- Discerning behavioral patterns of sea turtles in the Northern Gulf of Mexico to inform management decisions



Red Drum



Percent of tagged individuals
Average weekly water temperature (°C)
J F M A M J J A S O N D J F M A



1/15/2014
2013
2015
DeLand
Sanford
Titusville
Cocoa
© 2015 Google
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
RECORDED WITH
SCREENCAST MATIC
Tour Guide
Imagery Date: 4/9/2013

Ongoing Studies

Development of a Decision Support Tool To Reduce Sea Turtle Dredging Entrainment Risk

(http://arcg.is/298s5BO)

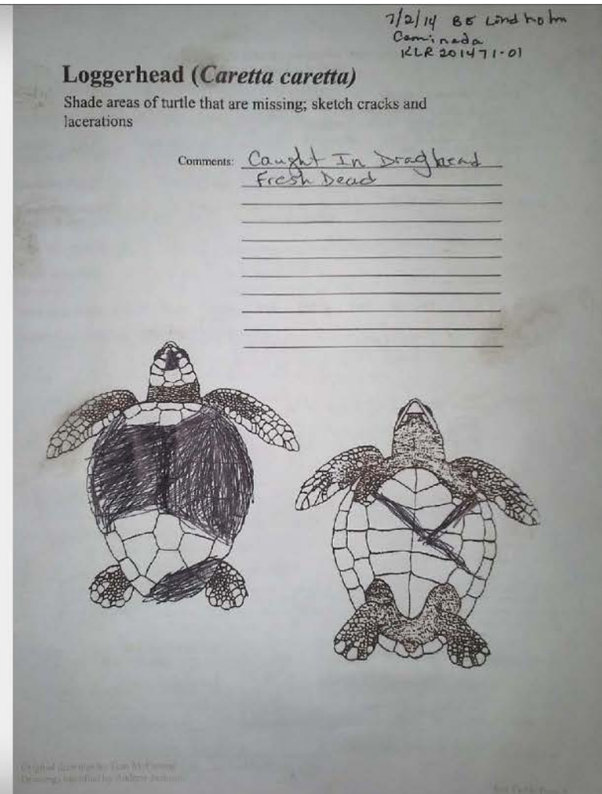
Bureau of Ocean and Energy M...

Development of a Decision Support Tool to Reduce Sea Turtle Dredging Entrainment Risk

A collaborative effort to minimize sea turtle entrainment risk from Trailing Suction Hopper Dredges (TSHDs) in Atlantic and Gulf of Mexico Outer Continental Shelf (OCS) waters.

Photo Credit: Jake Levenson

Incidental take form developed by USACE, completed by Coastwise Consulting



New Starts

- Regional Essential Fish Habitat Geospatial Assessment and Framework of Offshore Sand Features

- Ecological Function and Recovery of Biological Communities within Sand Shoal Habitats within the Gulf of Mexico

- Assessing biological processes that drive fisheries productivity on New England Sand Shoals, determining costs to fisheries as a result of sand mining.

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Research Needs

Note to Stakeholders Oct. 26, 2015

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Bureau of Ocean Energy Management

BOEM invites ideas for Environmental Studies, Fiscal Year 2017

Good morning,

The Bureau of Ocean Energy Management (BOEM) is responsible for ensuring that the effects on the natural and human environment are taken into consideration during the leasing and development of oil, natural gas, renewable energy and marine mineral resources on the Outer Continental Shelf (OCS).

Pacific waves

To help inform management decisions affecting the OCS, BOEM develops, oversees and funds the collection of environmental information as directed by the Outer Continental Shelf Lands Act through its Environmental Studies Program (ESP). The ESP focuses on applied science, including baseline information about the environment and the effects from activities that result from the leasing and development processes under our authority. The goals of the ESP are to establish the information needed to assess, predict, monitor and manage environmental impacts on marine biota and the human, marine and coastal environments. BOEM is beginning to formulate its FY 2017 Environmental Studies Development Plan covering all BOEM energy and minerals activities.

BOEM invites your input in identifying potential study ideas for consideration on Alaska, Atlantic, Gulf of Mexico and Pacific OCS areas. BOEM's ESP is

- Solicit input from stakeholders
- Fill data gaps identified through past study investments
- Internal and external collaboration
- Ideas????

THANK YOU

ADDITIONAL BACKGROUND & FACT SHEETS:

Website: http://www.boem.gov/Marine-Minerals-Program/

Fact sheets: http://www.boem.gov/BOEM-Fact-Sheets/

- MARINE MINERALS FACT SHEET
- HURRICANE SANDY FACT SHEET
- ATLANTIC SAND ASSESSMENT FACT SHEET
- SEA TECHNOLOGY MAGAZINE ARTICLE BY DIRECTOR HOPPER

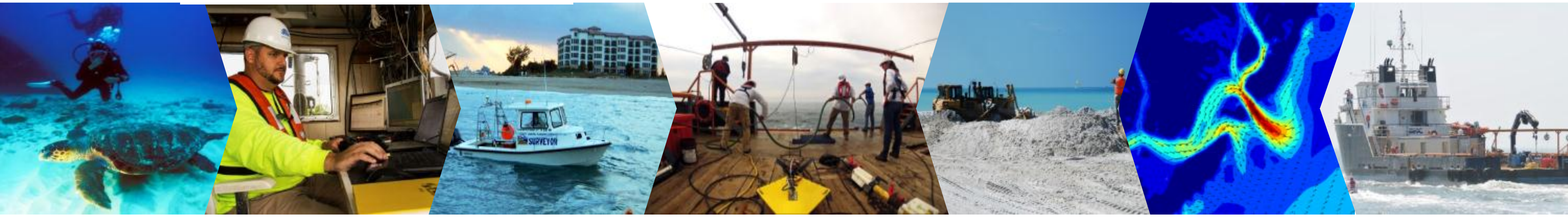
Contact us: MarineMinerals@boem.gov

Preliminary Results of the Bureau of Ocean Energy Management's Atlantic Sand Assessment Project

Bureau of Ocean Energy Management
Atlantic Ocean Energy and Mineral Science Forum
Sterling, Virginia
November 17, 2016

Joe Maloney
Geologist, BOEM
Sterling, Virginia

Beau C. Suthard, PG
Client Program Manager, CB&I
St. Petersburg, Florida

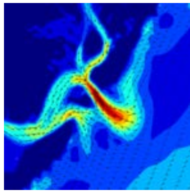


Outline

1) BOEM MMP Introduction
2) CB&I Introduction
3) Project Description
4) Project Milestones
5) Geophysical Survey Equipment
6) 2015 Reconnaissance Survey Results
7) 2016 Design Level Survey Results

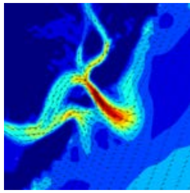


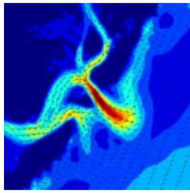


BOEM Introduction

- Responsible for managing energy and mineral resources on the Outer Continental Shelf (OCS)
- Marine Minerals Program (MMP) is responsible for managing non-energy minerals (primarily sand and gravel) on the OCS in a safe and environmentally sound manner
- Identify sand resources on the OCS to provide to Federal, state and local agencies for coastal restoration projects
- Sand is required to assist in recovery from acute events (storms) and chronic erosion
- Promote long-term sustainability of communities and ecosystems





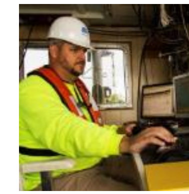
- *CB&I* (NYSE: CBI) has designed, permitted, implemented, and monitored over 75 coastal restoration projects, more than any other firm in the US, having identified billions of cubic yards of sand resources on the Inner and OCS.

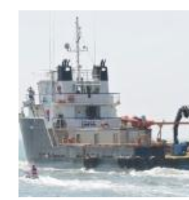
- *CB&I* is the most complete energy infrastructure focused company in the world. With 125 years of experience and the expertise of approximately 55,000 employees, CB&I provides reliable solutions while maintaining a relentless focus on safety and an uncompromising standard of quality.

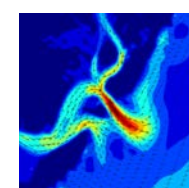
NATIONAL SAFETY COUNCIL "GREEN CROSS FOR SAFETY" 2015 RECIPIENT

Hurricane Sandy Funding

- **$342 Million Allocated to DOI for Hurricane Sandy Recovery**
- **$13.6 Million to BOEM**
  - $5 million for Atlantic Sand Assessment Project (ASAP)
  - $3 million for initial round of State Cooperative Agreements
  - $1.5 million for second round of State Cooperative Agreements (in 2016)
  - $3.1 million to Division of Environmental Assessment
    - Environmental Assessment and monitoring





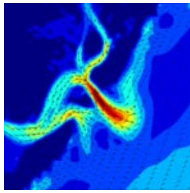


Project Description

Project Scope:

- Collection of a minimum of 5,600 km of geophysical data on the OCS
  - Between 3-8 nm (4.8-12.9 km) from the shoreline
  - To a water depth of approximately 90 ft (27.5 m)
  - Geophysical data will not be processed and interpreted (except for QA/QC subset)

- Collection of 350 geotechnical samples
  - 250 vibracores
    - Cores will be split, logged, sampled/analyzed, and photographed
  - 100 grab samples

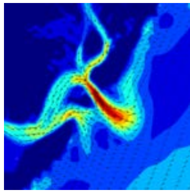


Geophysical and Geotechnical Survey

- The geophysical and geotechnical survey was conducted under two (2) phases totaling 5,600 km of data and 350 geotechnical samples:
  - **Reconnaissance level (2015):** Approximately 4,200 km of geophysical data and 260 geotechnical samples (160 vibracores, 100 surface grab samples) from FL to MA.
  - **Design level (2016):** Approximately 1,400 km of geophysical data and 90 geotechnical vibracore samples in NY & NJ.
- Contract requirement maintained focusing a total effort of 40% offshore NY & NJ.





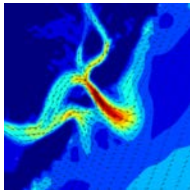



Survey Milestones

- Project Kickoff: *November 19, 2014*
- State/Stakeholder Meetings: *January/February 2015*
- 2015 Reconnaissance Geophysical Survey **(Complete)**
  - Data Collection Began Offshore FL: *April 19, 2015*
  - Completed Geophysical Survey Offshore MA: *July 26, 2015*
- 2015 Reconnaissance Geologic Sampling Cruise **(Complete)**
  - First Sample Collected Offshore FL: *July 29, 2015*
  - Completed Geologic Sample Collection Offshore MA: *December 13, 2015*
- 2016 Design-Level Geophysical Survey **(Complete)**
  - Data Collection Began Offshore NY: *May 29, 2016*
  - Completed Geophysical Survey Offshore NJ: *August 21, 2016*
- 2016 Design-Level Geologic Sampling Cruise **(Complete)**
  - First Sample Collected Offshore NJ: *August 9, 2016*
  - Completed Geologic Sample Collection Offshore NY: *September 2, 2016*





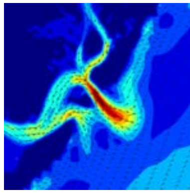
Positioning

- Augmented differential global navigation satellite system (DGNSS)
- Dual frequency satellite corrections
- Integrated into Hypack Navigation station

- Motion reference unit mounted to the survey vessel
- Attitude, heading, heave, position and velocity
- Combining GPS with inertial measurements

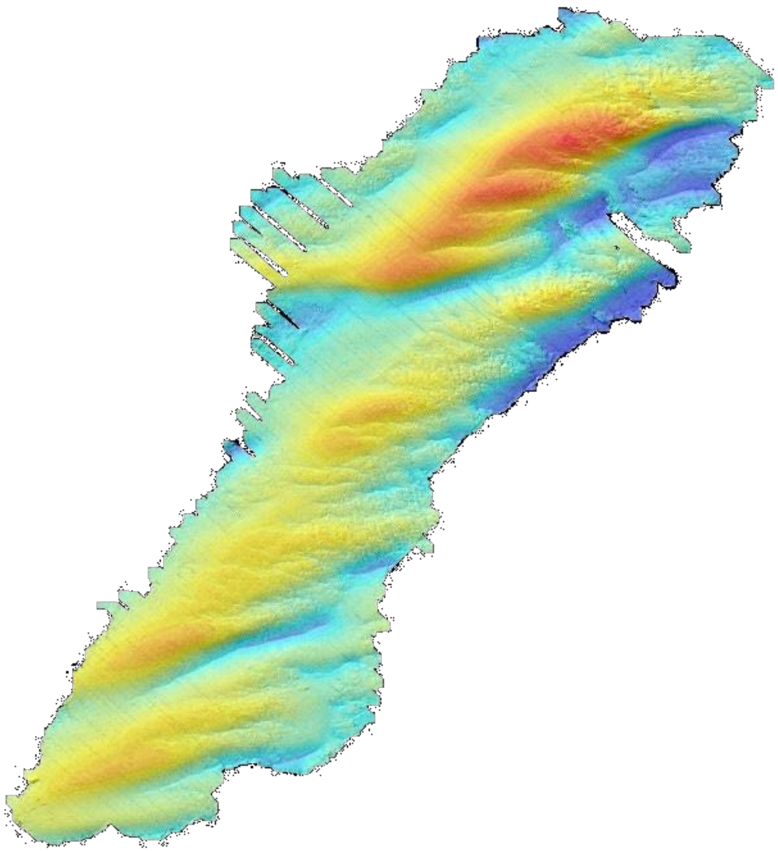


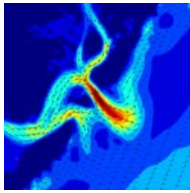


EdgeTech 6205 Interferometric Sonar

- Pole mounted bathymetry and backscatter acquisition
- Chirp pulse modulation
- Integrate different data sources
  - Sound velocity
  - Altimeter
  - Motion reference unit
- *.jsf* - backscatter
- *X/Y/Z* - processed bathymetry

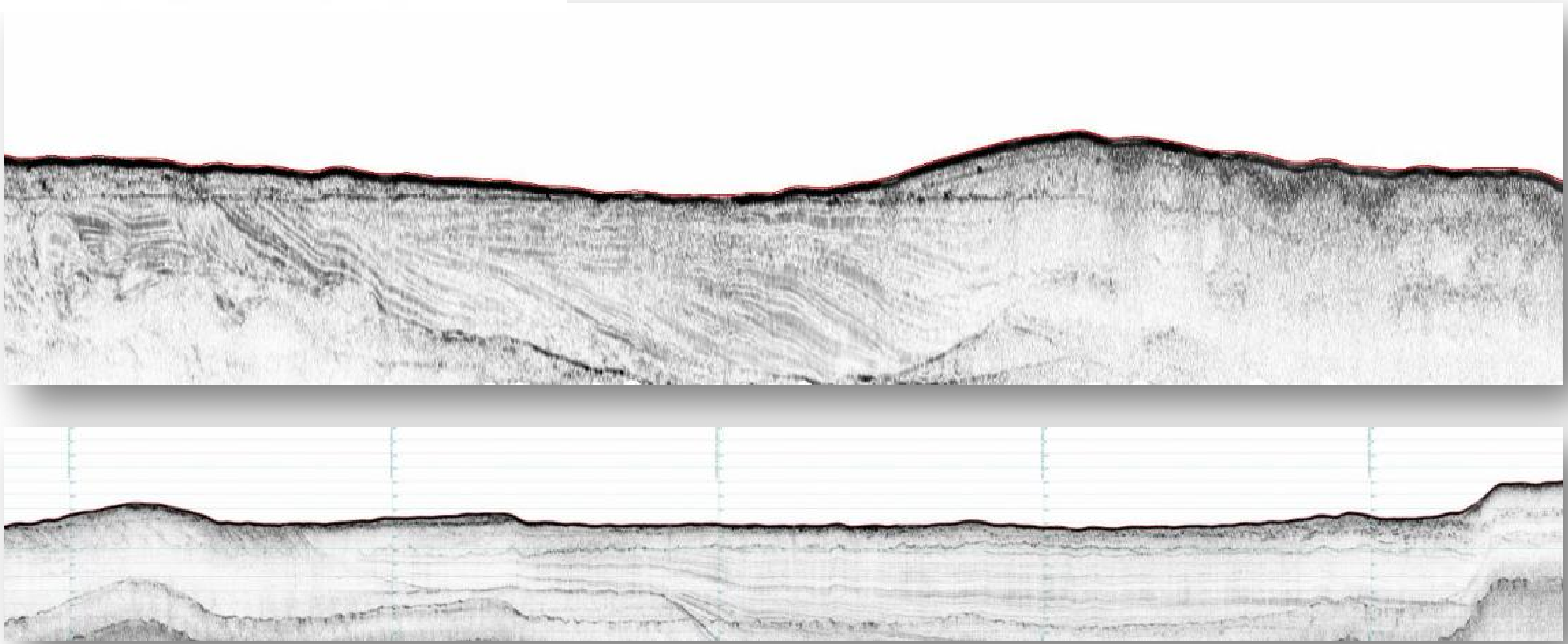




	Bathymetry		Sidescan sonar		
Power	230 kHz	550 kHz	230 kHz	550 kHz	1600 kHz
Swath	350 m	150 m	450 m	250 m	70 m
Range Resolution	3 cm	1 cm	3 cm	1 cm	0.6 cm

EdgeTech 3200 Seismic Sub-Bottom with 512i Towfish

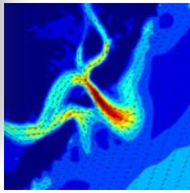
- High-resolution seismic reflection profile data
- Frequency Modulated pulse
- Full spectrum of frequency range
- Resolution: 0.06 to 0.10 m
- *.jsf* file format



EdgeTech 3200 data examples from the Atlantic Outer Continental Shelf offshore NC (top) and VA (bottom)



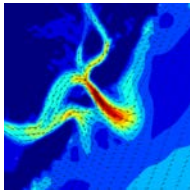


EdgeTech 4200-HFL Sidescan Sonar





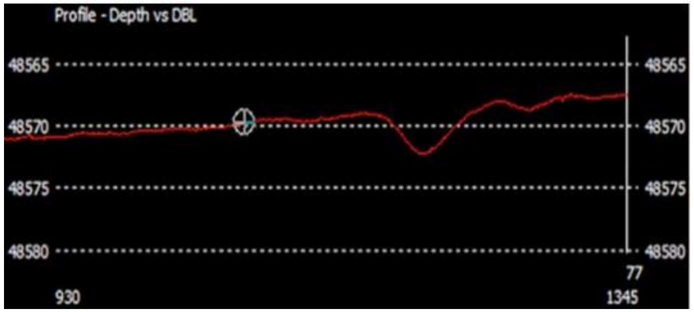
- Dual acquisition system
- 300/600 kHz
- Controlled by a topside box running Discover software
- *.jsf* file format

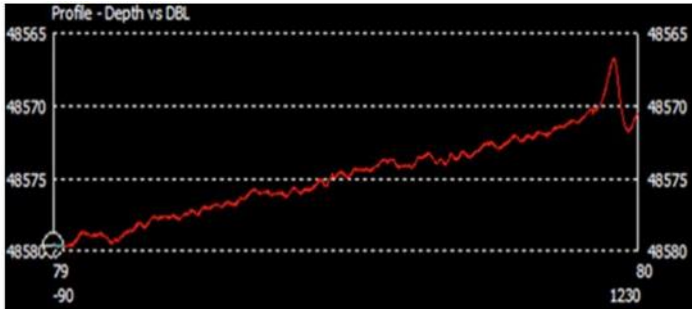
Resolution	300kHz	600kHz
Along Track	1.3 m at 150 m	0.45 m at 100 m
Across Track	3 cm	1.5 cm


Image of the EdgeTech 4200 Sidescan Sonar towfish (left) and data example depicting a shipwreck and adjacent seafloor from the northern Gulf of Mexico, offshore Louisiana in approximately 35 ft of water depth (right).

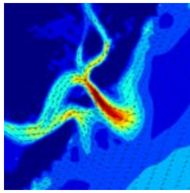
Geometrics G-882 Cesium Marine Magnetometer

- Used to identify magnetic anomalies within the study area
  - Potential hazards and cultural resources
- Necessary for geotechnical sample collection site clearance by a qualified archaeologist
- Hypack *.raw* file format



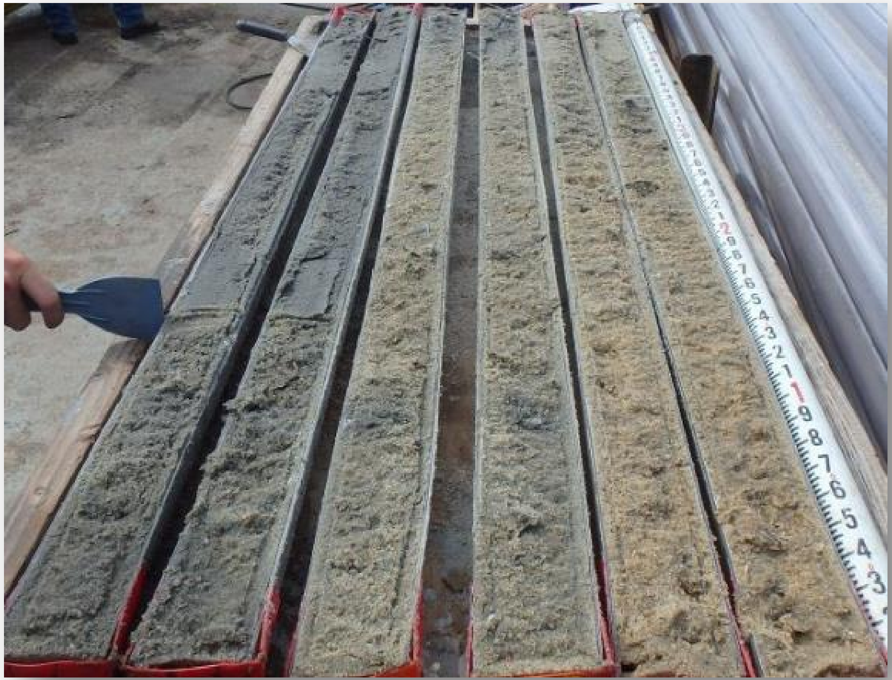


Geometrics G882 magnetometer (top) and magnetometer data examples (bottom) from the Maryland Outer Continental Shelf in approximately 20 m of water depth. Examples show a small magnitude multicomponent target (left) and a small magnitude dipolar target (right)

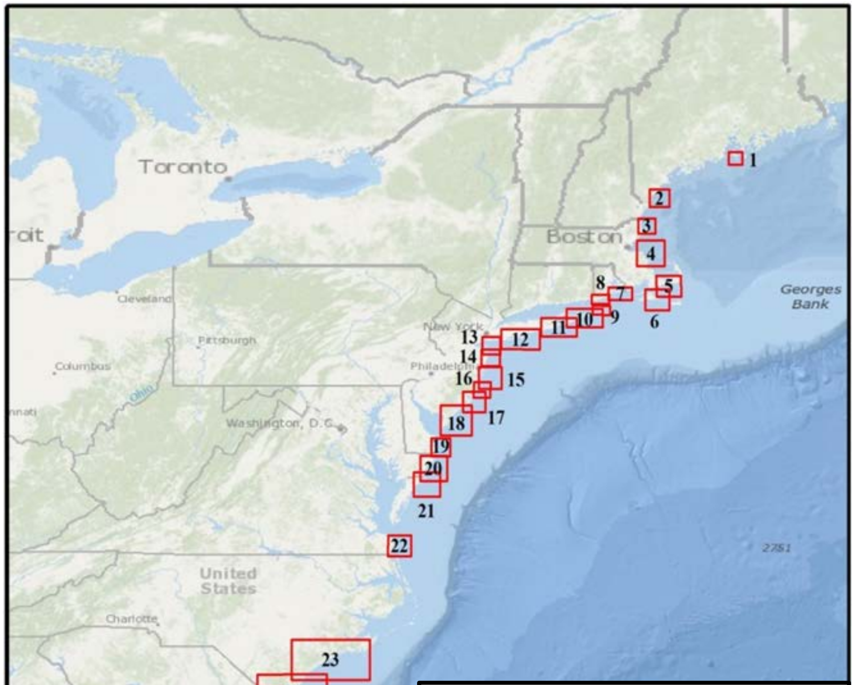
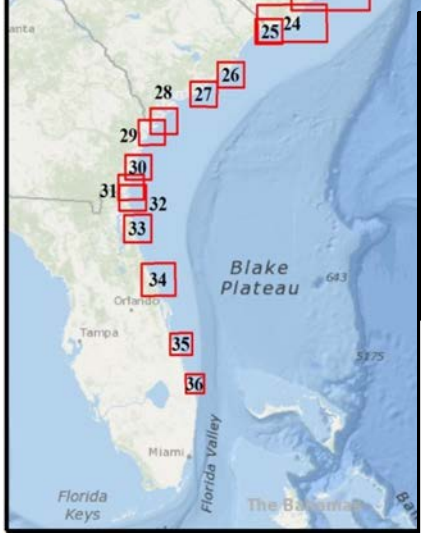


271B Pneumatic Vibracore System

- Air-driven vibratory hammer, aluminum H-beam and drilling bit with a cutting edge
- Core sample: 6.09 m (20 ft) in length, 10.16 cm (4 inches) in diameter
- gINT file format



What's Been Done?

State	*Geophysical*		*Geological*		
	Planned	*As-Run*	*Cores*	*Surface*	*Total*
MA	210	216	7	7	14
RI	50	54	6	4	10
NY	700	768	31	18	49
NJ	950	969	32	20	52
DE	200	203	5	3	8
MD	100	100	5	3	8
VA	200	201	6	4	10
NC	575	587	23	14	37
SC	475	511	19	11	30
GA	200	203	7	5	12
FL	490	527	19	11	30
Totals	**4150**	**4339**	**160**	**100**	**260**

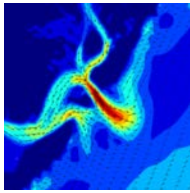
CB&I processed and analyzed 885 geologic samples

- 785 samples selected from vibracores
- 100 samples selected from surface grab samples

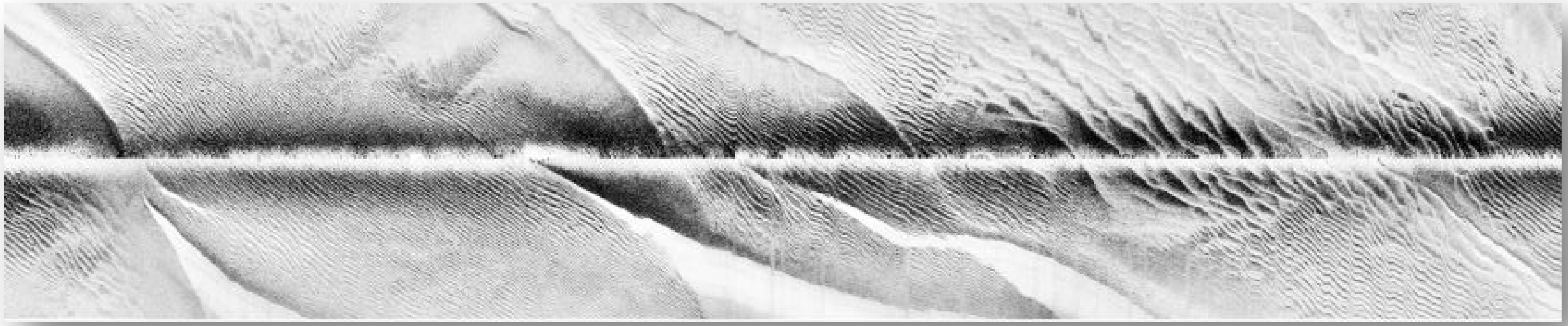
Categorized vibracore samples based on geologic character, % of sand, silt, shell & rock within the entire core sample

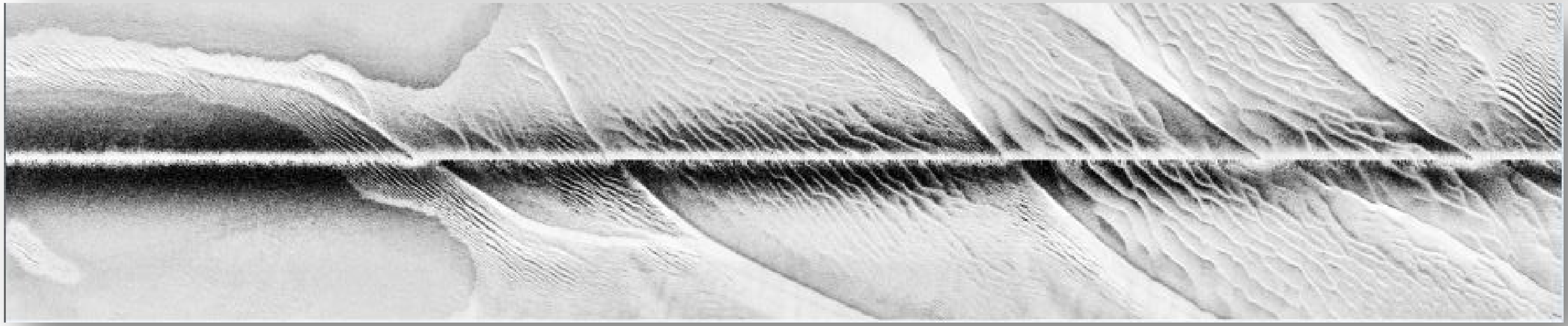




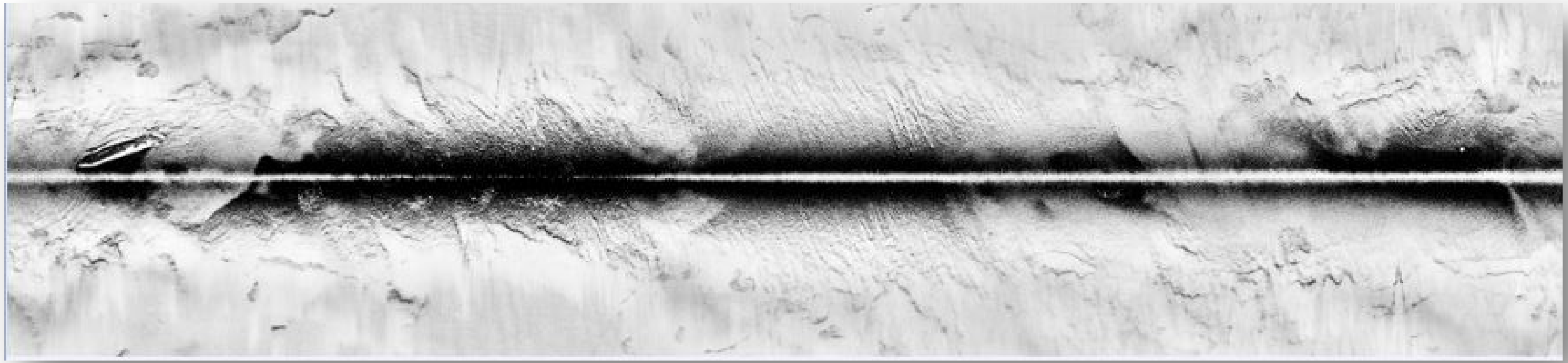



BOEM_Line_NY_107

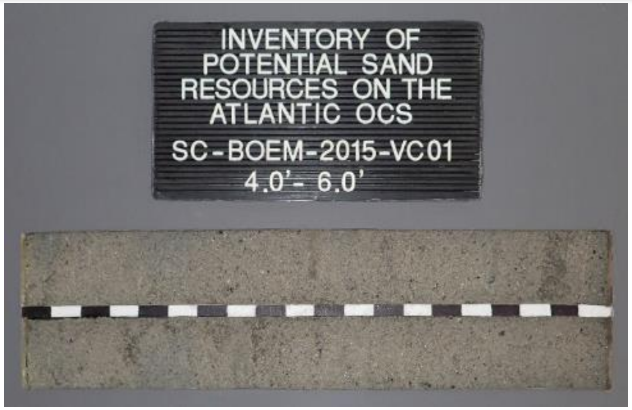


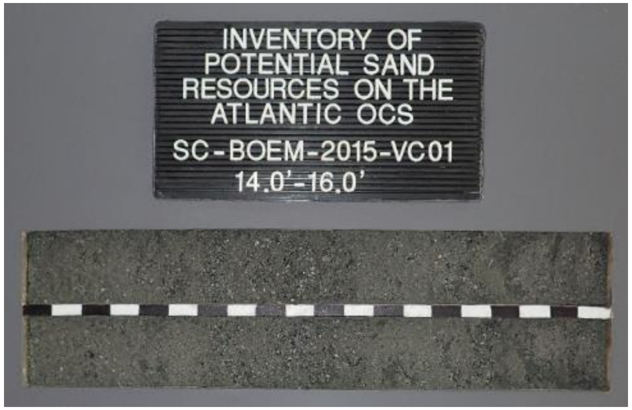


BOEM_Line_NJ_107

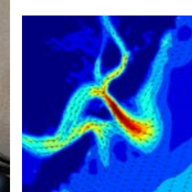


SC Vibracore Example





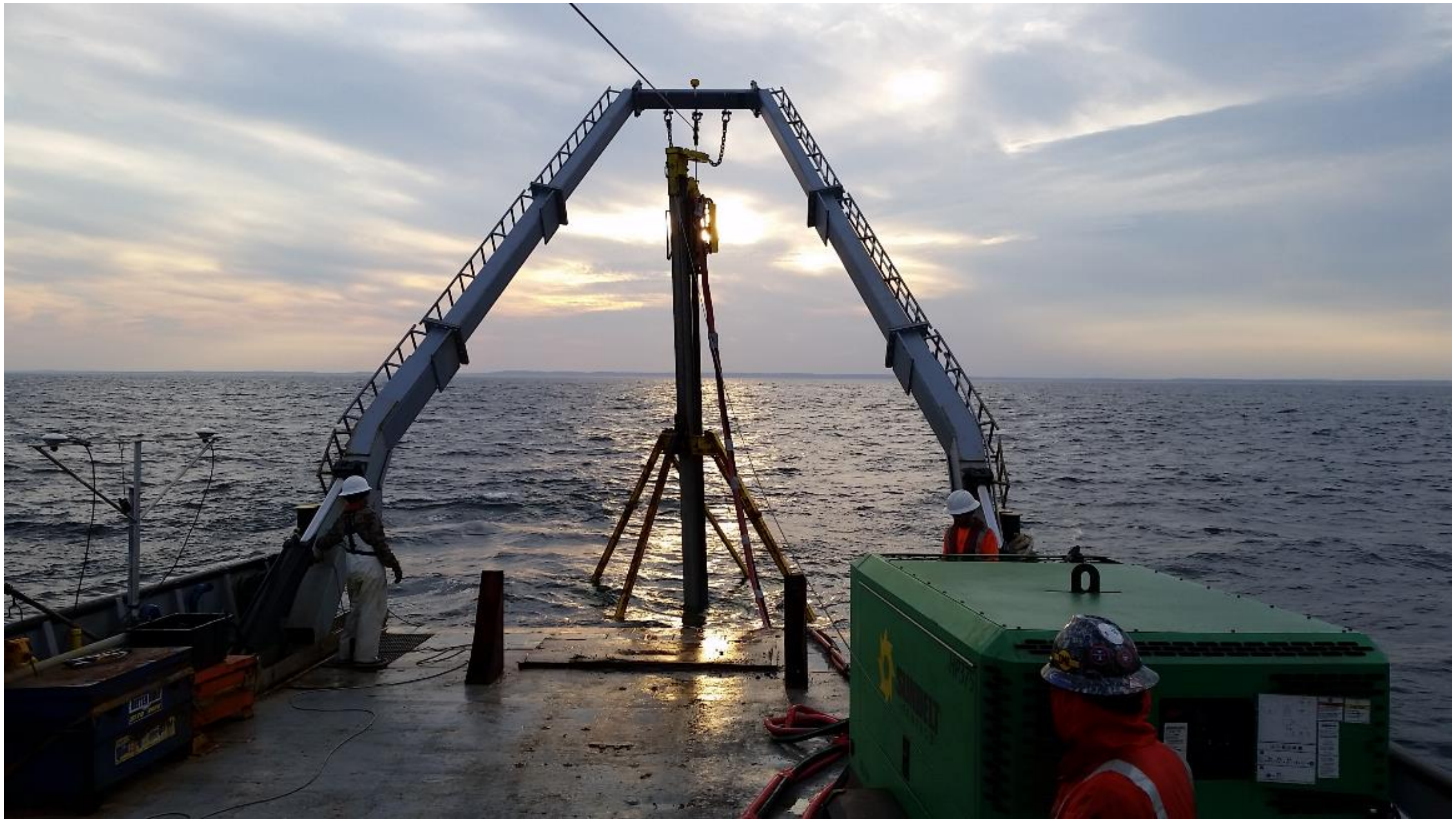
Design-Level Survey Site Selection

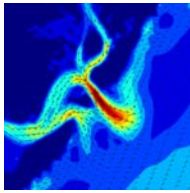


- Geophysical Survey
  - Total contracted survey effort (**5,600** km’s) less 2015 planned reconnaissance effort (**4,262** km’s) allows planned 2016 design level effort (**1,338** km’s)
  - 2016 planned design level effort (**1,338** km’s) plus Maine’s allocation (**50** km’s) totals adjusted 2016 design level effort (**1,388** km’s)
  - **1,388** km’s of geophysical data
    - **554** km’s to NY & NJ to satisfy 40% total effort stipulation
    - **834** km’s remained to allocate
  - Actually collected 1,843 km (great weather!)

Design-Level Survey Site Selection

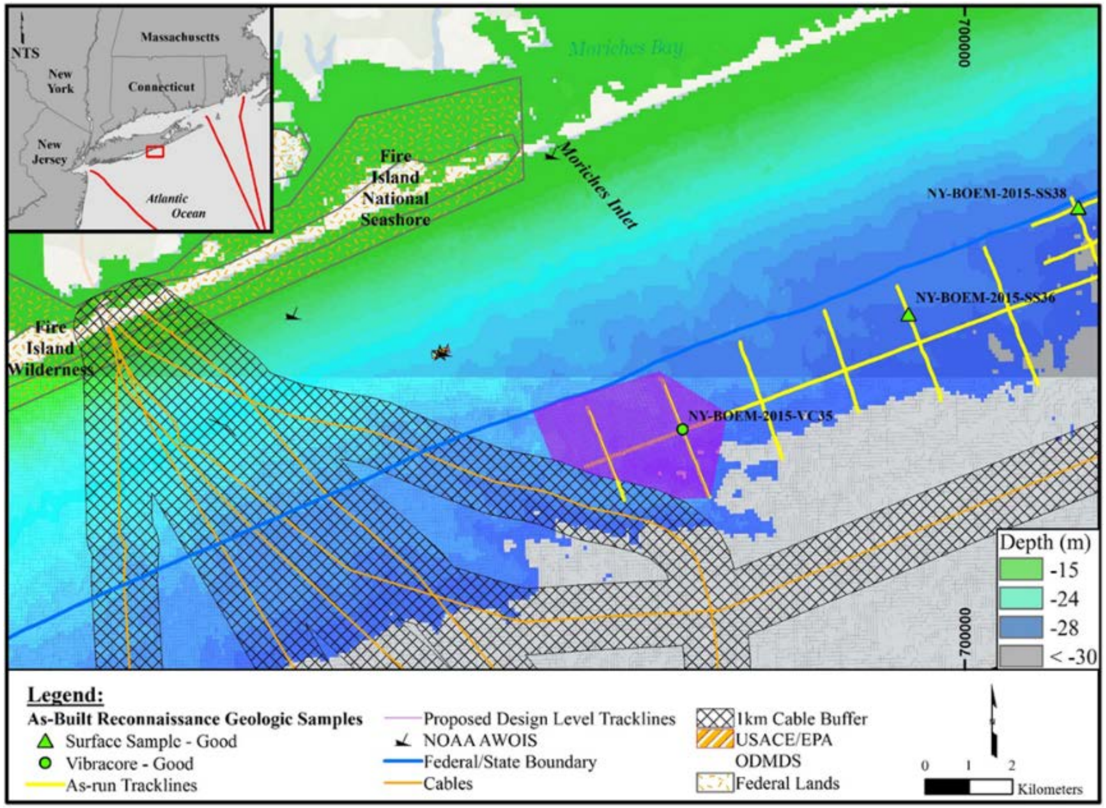
- Geologic Sampling
  - **350** total samples
  - Less **260** reconnaissance samples
  - Allows **90** samples for design level geologic sampling effort
  - All design-level samples were vibracores (no surface grab samples)





Design-Level Survey Site Selection – New York

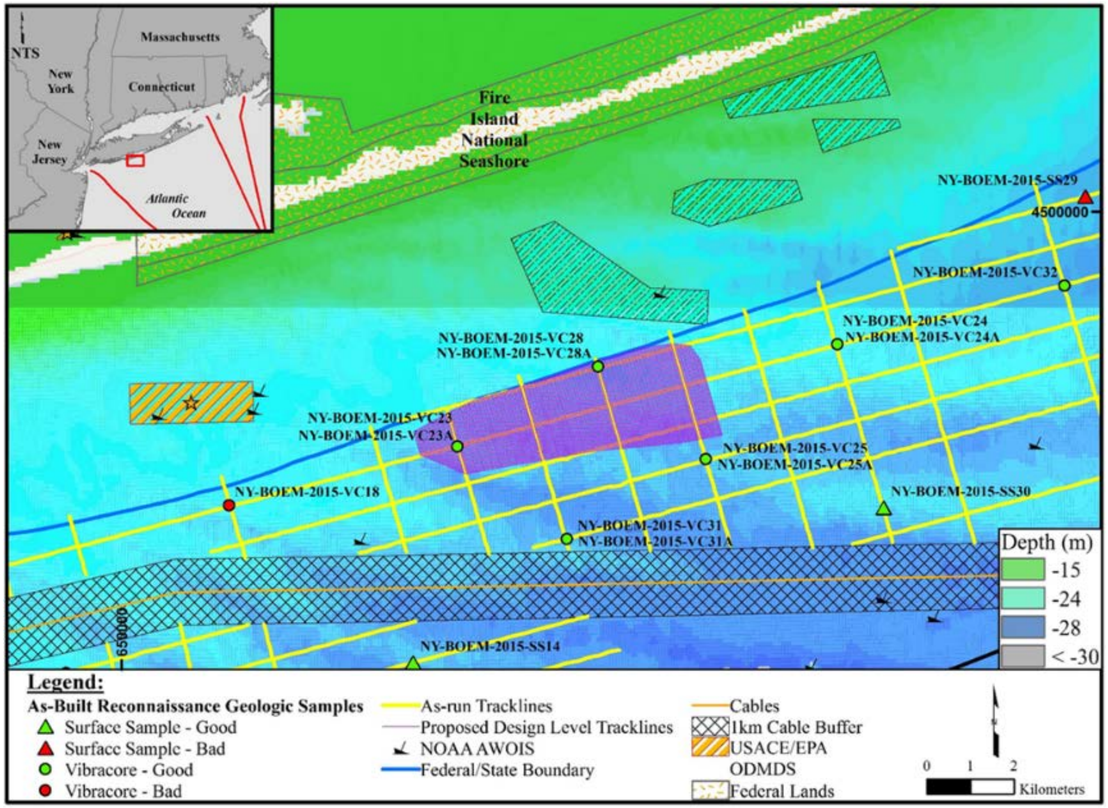
Moriches Inlet Design Area



- Appx. 285 km planned line mileage within 8.8 square km
- Bathymetric high
- Acoustic properties consistent with potential sand resources up to 10’ thick
- Sediment analysis results of NY-BOEM-2015-VC35
  - Mean grain size 0.26 mm – 0.44 mm

Design-Level Survey Site Selection – New York

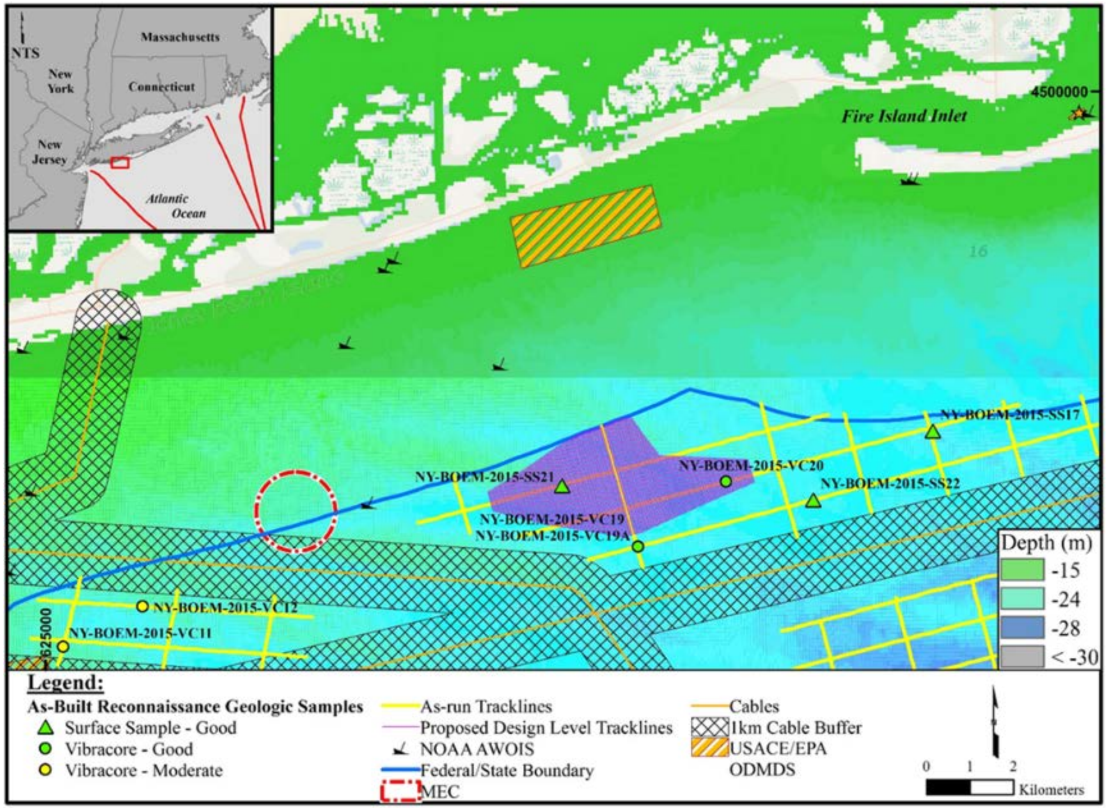
Fire Island Design Area



- Appx. 409 km planned line mileage within 12.5 square km
- Bathymetric high
- Acoustic properties consistent with potential sand resources up to 18’ thick
- Sediment analysis results of NY-BOEM-2015-VC23, VC23A, VC28, VC28A
  - Mean grain size 0.22 mm – 0.44 mm above a non-homogenous lithographic unit at 11’

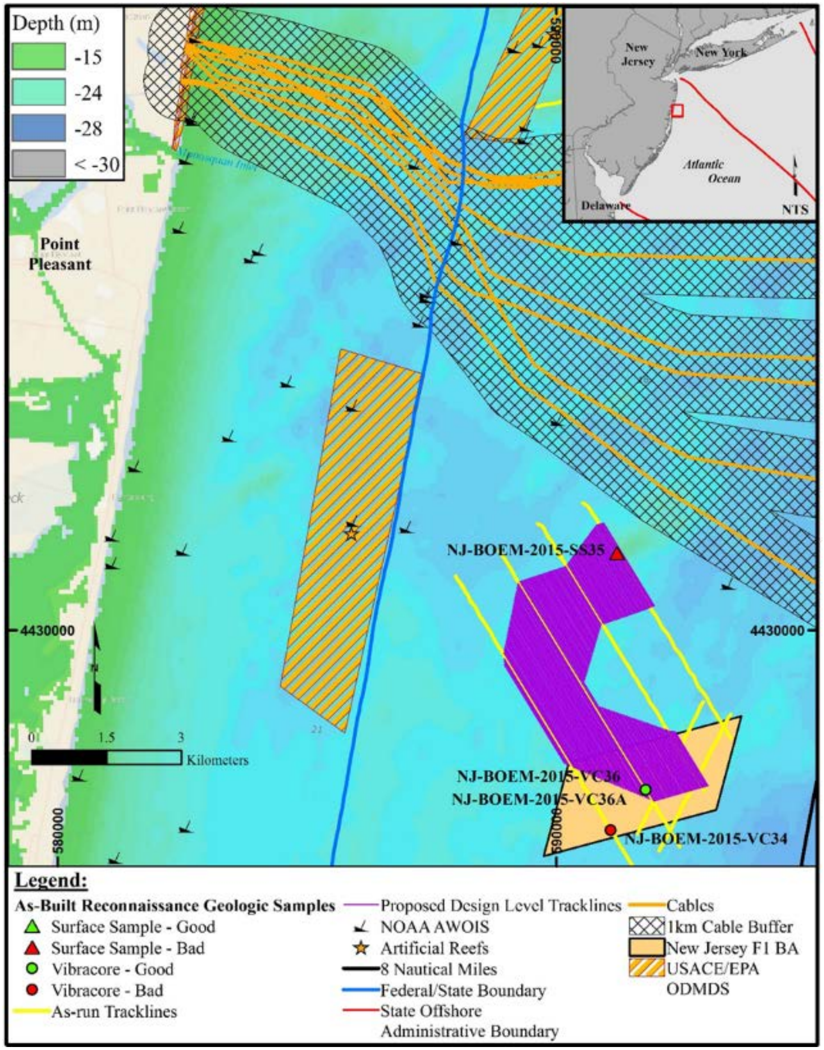
Design-Level Survey Site Selection – New York

Fire Island Inlet Design Area



- Appx. 312 km planned line mileage within 9.4 square km
- Bathymetric high
- Acoustic properties consistent with potential sand resources up to 15' thick
- Sediment analysis results of NY-BOEM-2015-VC20 & SS21
  - Mean grain size 0.17 mm – 0.64 mm

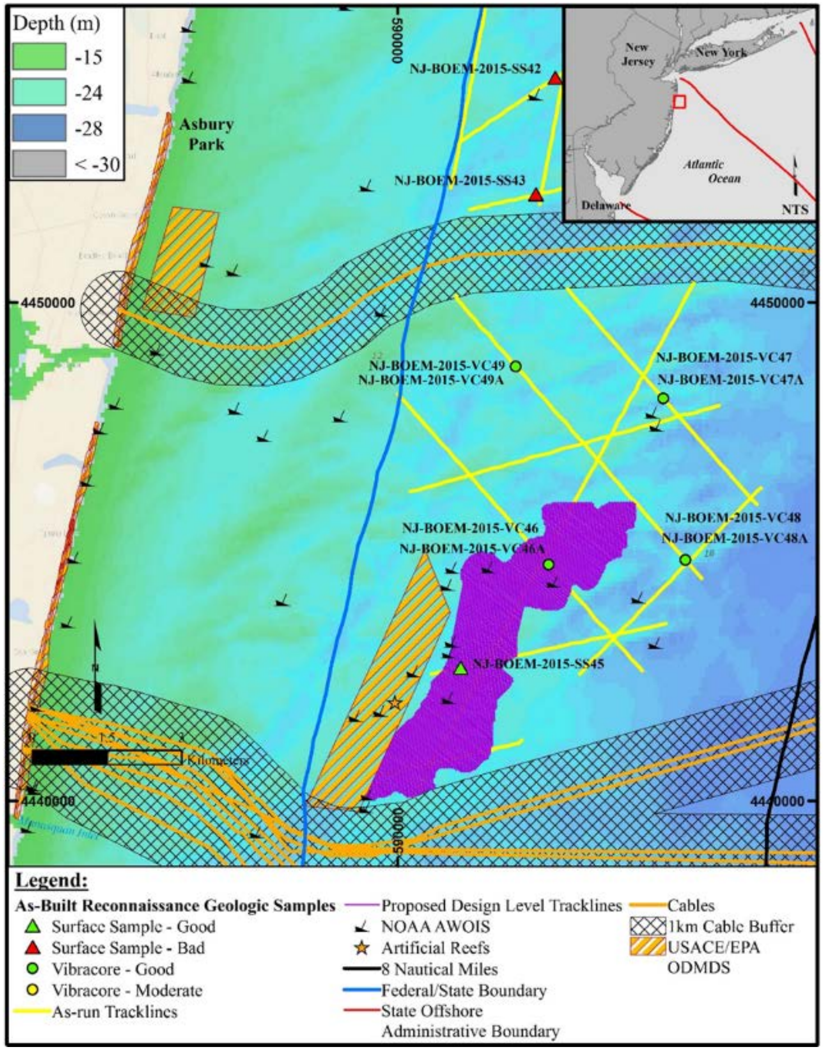
Design-Level Survey Site Selection – New Jersey



F1 Design Area

- Appx. 327 km planned line mileage within 10 square km
- Series of bathymetric highs
- Acoustic properties consistent with potential sand resources up to 20' thick
- Sediment analysis results of NJ-BOEM-2015-VC36, 36A & SS35
- Mean grain size 0.35 mm – 0.99 mm

Design-Level Survey Site Selection – New Jersey



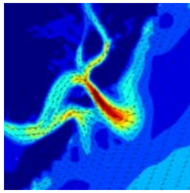
MON-2/MON-4 Design Area

- Appx. 353 km planned line mileage within 10.6 square km
- Series of bathymetric highs
- Acoustic properties consistent with potential sand resources up to 15’ thick
- Sediment analysis results of NJ-BOEM-2015-VC46, 46A & SS45
- Mean grain size 0.27 mm – 0.68 mm

Preliminary Design-Level Survey Results





- Full vibracore coverage at 1,000 ft spacing was not possible to cover all DIA's
  - 442 vibracores needed for full coverage
  - 90 available for design-level geologic sampling

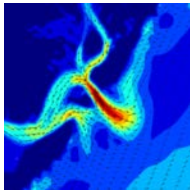
State	Design Investigation Area (DIA)	Area (m^2)	Average Thickness (m)	Volume (m^3)	Volume (y^3)	# of Cores (1000 ft Spacing)
New York	Moriches Inlet East	1,397,717	1.9	2,641,685	3,455,195	23
New York	Moriches Inlet West	1,009,266	2.1	2,099,274	2,745,747	15
New York	Fire Island East	5,907,476	2.1	12,405,700	16,226,047	80
New York	Fire Island West	1,267,160	2.5	3,129,886	4,093,737	18
New York	Fire Island Inlet East	7,286,123	6.3	45,975,437	60,133,619	98
New York	Fire Island Inlet West	298,204	4.8	1,416,470	1,852,673	5
New Jersey	F1 North	2,987,701	2.7	8,156,424	10,668,203	42
New Jersey	F1 South	2,563,606	3.2	8,126,630	10,629,234	36
New Jersey	MON-4	2,859,231	4.4	12,494,842	16,342,641	39
New Jersey	MON-2 North	4,242,569	3.6	15,358,099	20,087,641	59
New Jersey	MON-2 South	2,057,649	3.6	7,304,656	9,554,131	27
			Total	***119,109,101***	***155,788,868***	***442***

Preliminary Design-Level Survey Results

- Subsets of larger DIA's selected to allow for borrow area design
- Moriches Inlet DIA – Omitted due to:
  - Smaller and thinner area of potentially project compatible material
  - Some areas laterally restricted by non-homogenous deposit
- Fire Island Inlet DIA – Omitted due to:
  - Complex fluvial channels containing fines throughout deposit
- Mon-2/Mon-4 DIA – Omitted due to:
  - Bound to the west by DMDS
  - Extensive artificial reefs
  - Presence of significant historic vibracores





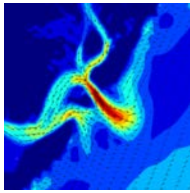
Preliminary Design-Level Survey Results

- Fire Island DIA – Three shoal deposits
  - Fire Island East – 46 vibracores at full design-level coverage
    - One large, wide shoal reaching 4m in thickness
    - One smaller attached shoal reaching 2.5m in thickness
  - Fire Island West – 13 vibracores at full design-level coverage
    - One large shoal reaching over 4m in thickness
- F1 South DIA
  - F1 North – Omitted due to proximity to submarine cable
  - F1 South – 31 vibracores at full design-level coverage
    - Large broad shoal approaching 6m in thickness

State	*Design Investigation Area (DIA)*	*Area (m^2)*	*Average Thickness (m)*	*Volume (m^3)*	*Volume (y^3)*	*# of Cores (1000 ft Spacing)*
New Jersey	F1 South	2,244,380	3.28	7,361,565	9,628,566	31
New York	Fire Island East	3,588,492	4.1	14,712,816	19,243,642	46
New York	Fire Island West	909,147	2.52	2,291,051	2,996,583	13
			Total	***24,365,432***	***31,868,791***	***90***

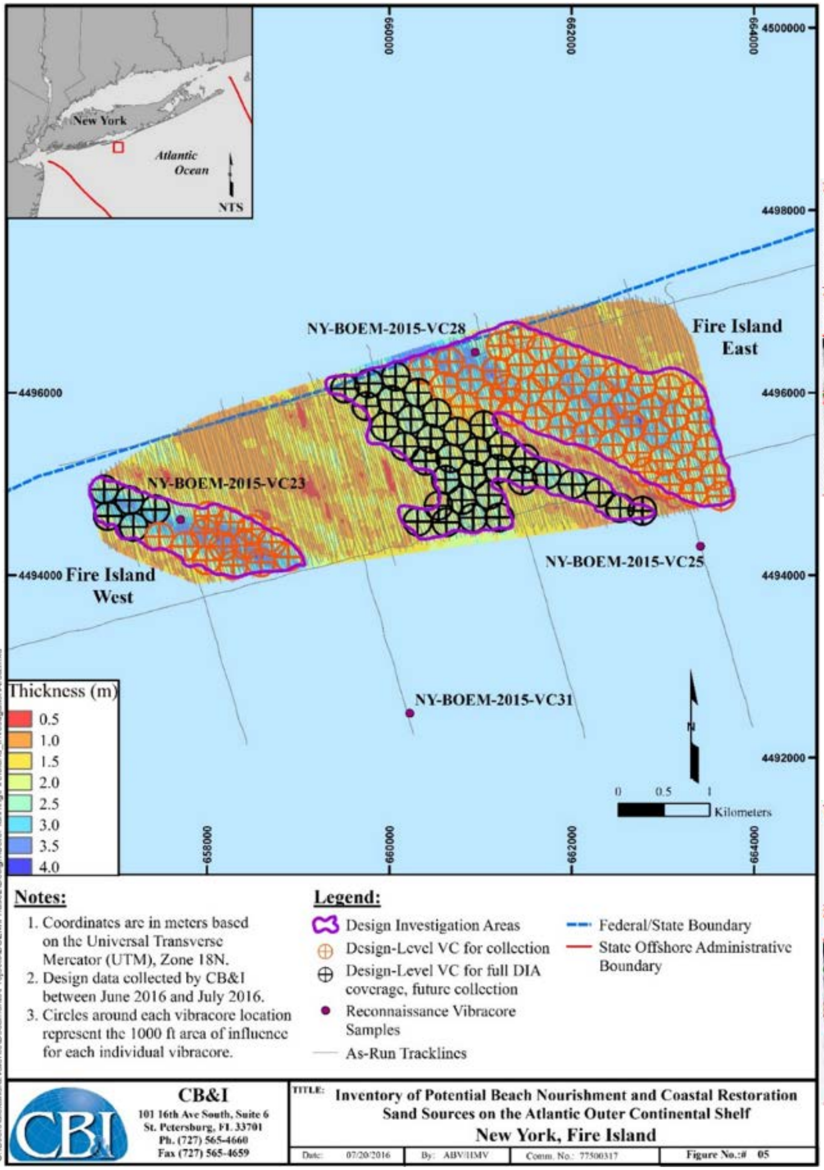




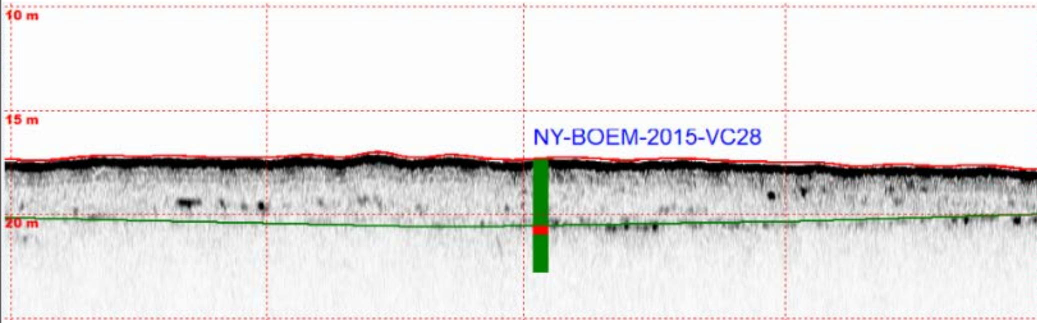



CB&I BOEM Bureau of Ocean Energy Management

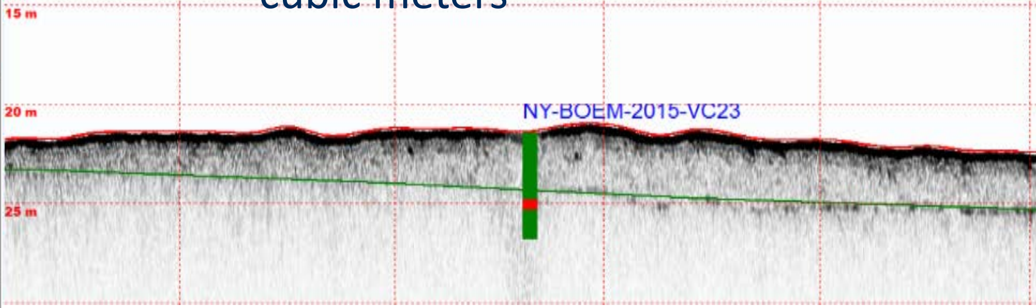
New York - Fire Island DIA



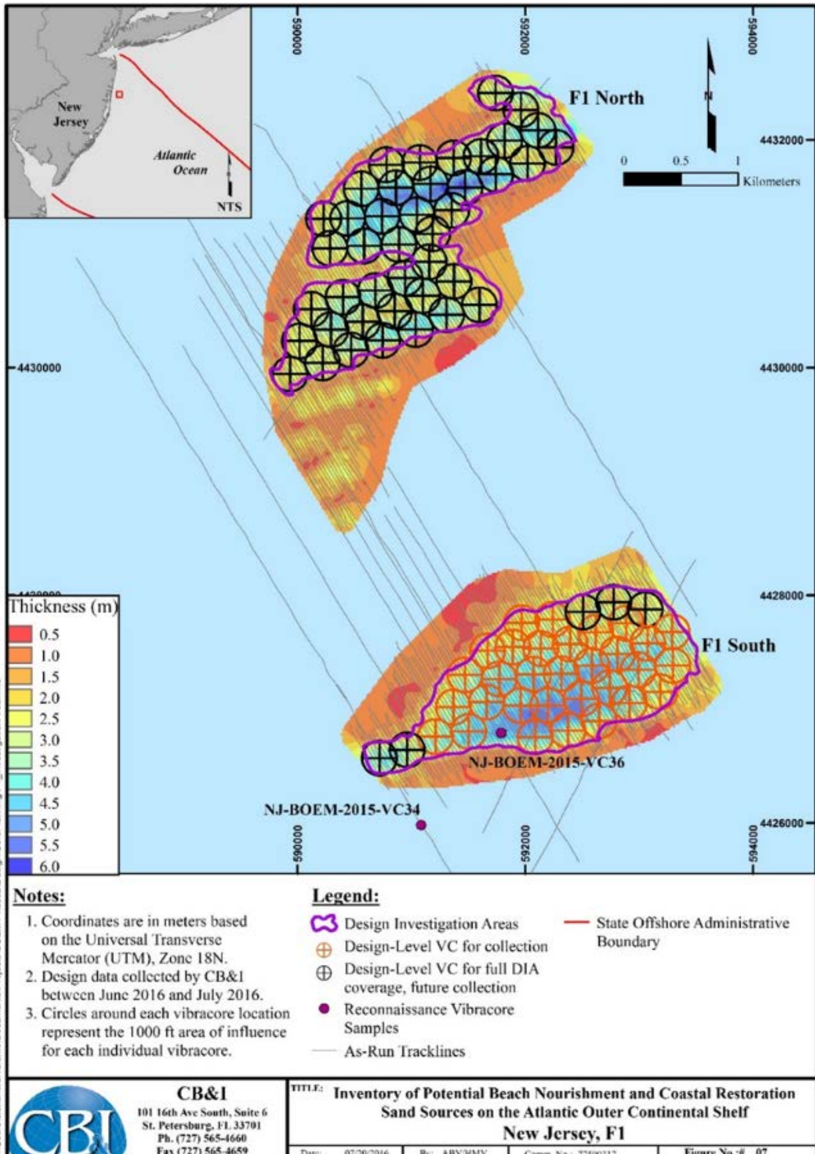
- Fire Island East – 46 vibracores
  - Potential volume = 14,712,816 cubic meters



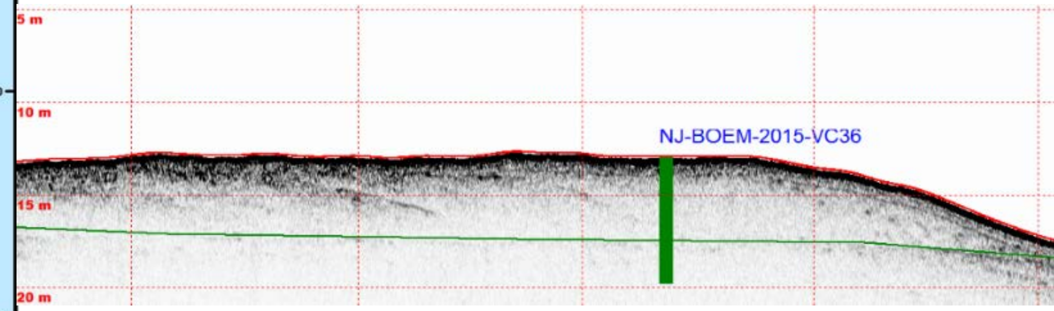
- Fire Island West – 13 vibracores
  - Potential volume = 2,291,051 cubic meters



New Jersey – F1 South DIA



- F1 South– 31 vibracores
  - Potential volume = 7,361,565 cubic meters

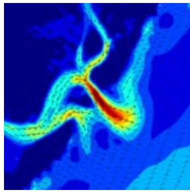


What’s Next?

- Finish processing 2016 design-level vibracores
- Collect additional, 2017 design-level data
  - 820 km of geophysical data
  - 90 vibracores
- Submit final design-level geophysical data, geologic sample analysis results and draft project report
- Finalize and submit CB&I’s final report
- “Reap the everlasting benefits of a large, consistent Atlantic sand database”





Thank You!

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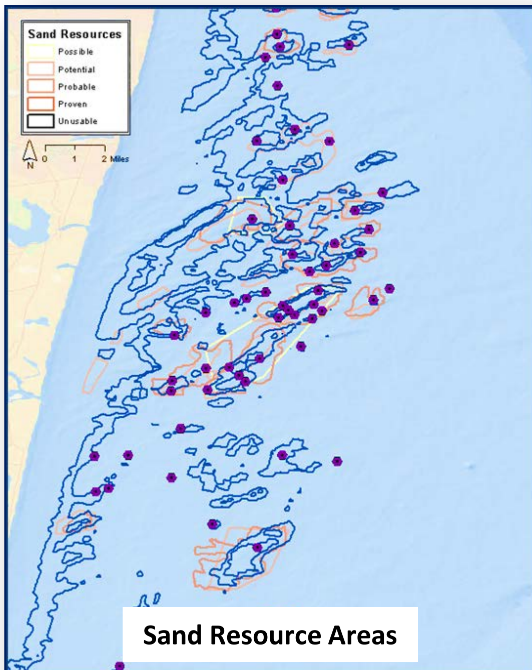
(703) 787-1820
Joe.Maloney@boem.gov

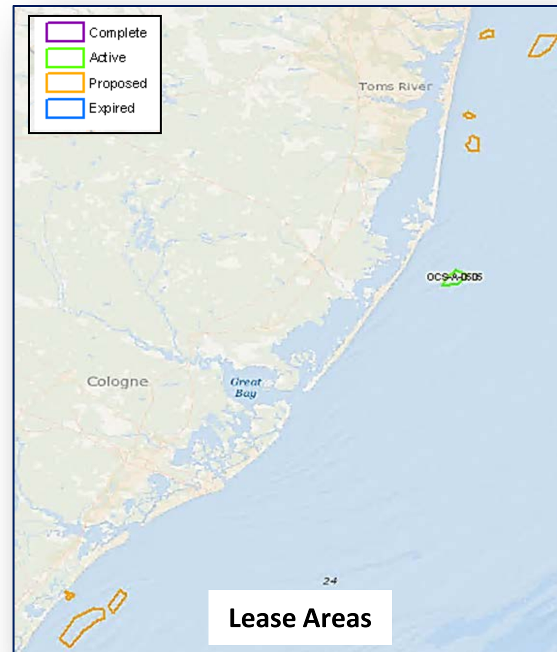
BOEM
Bureau of Ocean Energy Management

Beau C. Suthard, PG
(727) 565-4660
Beau.Suthard@cbi.com

CB&I

A National Outer Continental Shelf Sand / Sediment Inventory





Lora Turner, Alexa Ramirez, and Leighann Brandt

November 17, 2016

Restoring and Protecting Our Nation's Coasts through Stewardship of OCS Resources

Agenda

MMPGIS Overview

Sand Resource Analysis Tool Prototype

- —How the tool works
- —Preliminary results

Collaboration

- —Partner data incorporated into the MMPGIS
- —Managing multiuse conflicts

Future

MMPGIS Overview

What problem are we trying to solve by developing a Marine Minerals Geodatabase?

The need to know where compatible sand / sediment resources in the OCS to support coastal restoration and marine spatial planning.

What questions will the MMPGIS support?

- Where are the OCS sand / sediment resources to inform management decisions within ocean planning and lease use?
- What is the extent of compatible sand / sediment resources in the OCS to support restoration?
- Where is the authoritative source data for sand resources?
- What vital marine mineral products and data on national, regional, and local scales do managers, planners, and scientists need?
- How do we improve sharing marine mineral datasets with our partners?

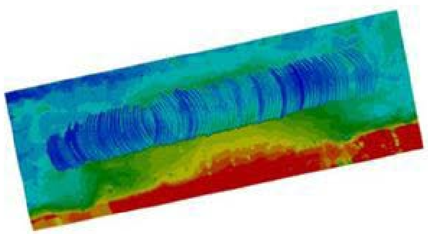
MMPGIS will provide capability for a National OCS Sand / Sediment Inventory

MMPGIS Overview

Developing a Marine Minerals Enterprise Geodatabase

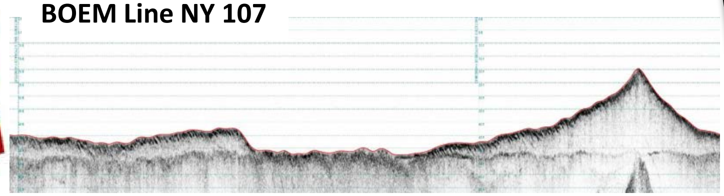
Collect, Analyze, and Process

Bathymetry



Sub-bottom seismic

BOEM Line NY 107



Sidescan

BOEM Line NY 102 East Montauk

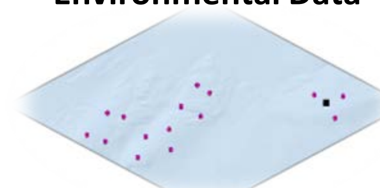
Vibracores

M M P G I S

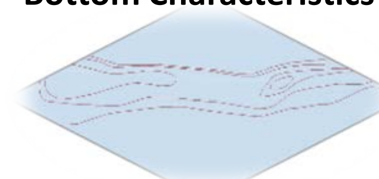
Transform

Bathymetry & Backscatter

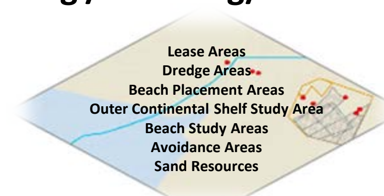
Environmental Data



Bottom Characteristics

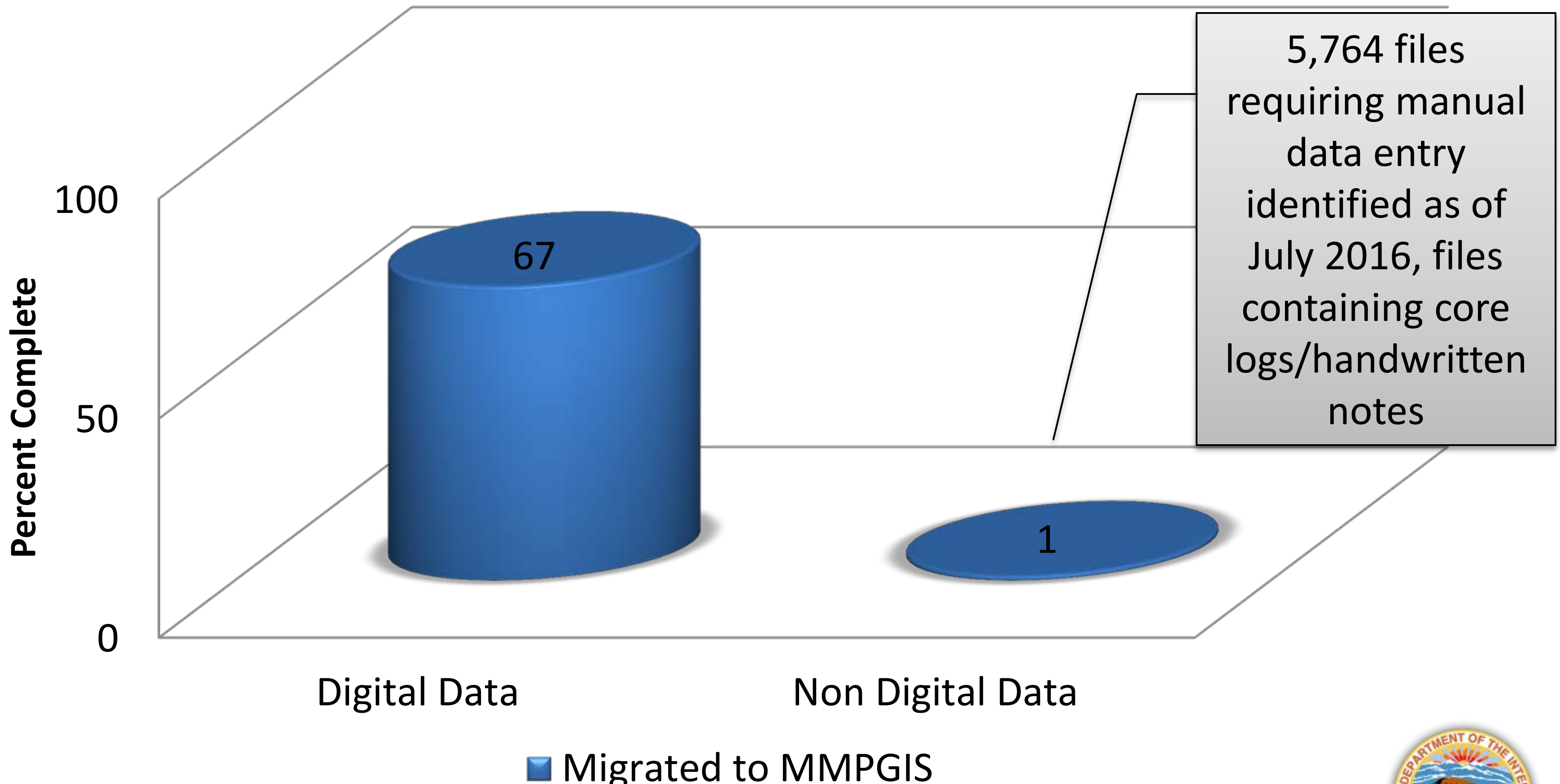


Leasing / Planning/Construction



MMPGIS Overview

MMP Historical and New Cooperative Agreement Data Development
(Leasing Projects, Studies, Cooperative Agreements)



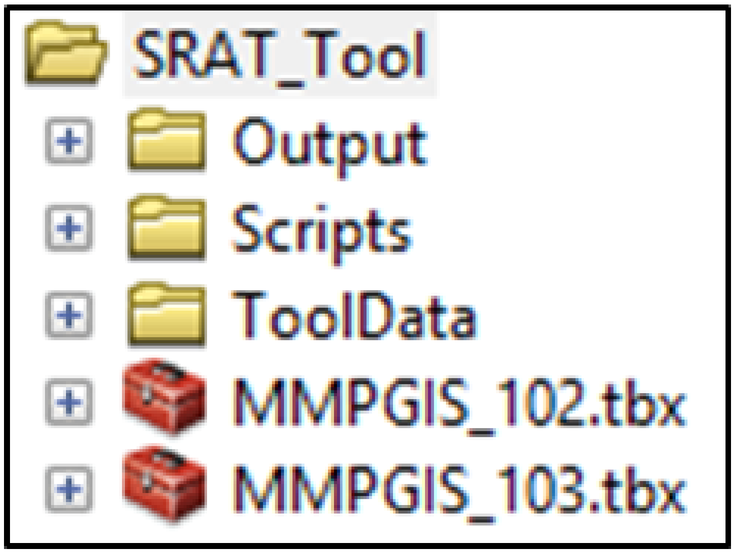
16% of the data inventoried still requires manual extraction

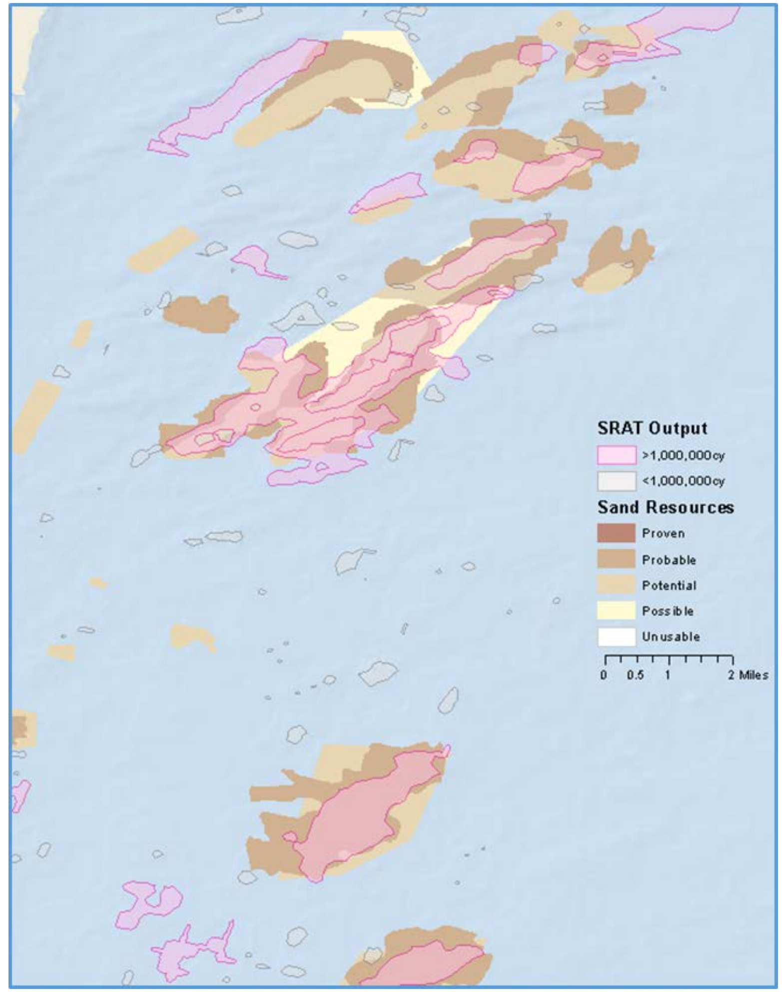
MMPGIS Overview

BOEM
Bureau of Ocean Energy Management

quantum SPATIAL

Sand Resource Analysis Tool

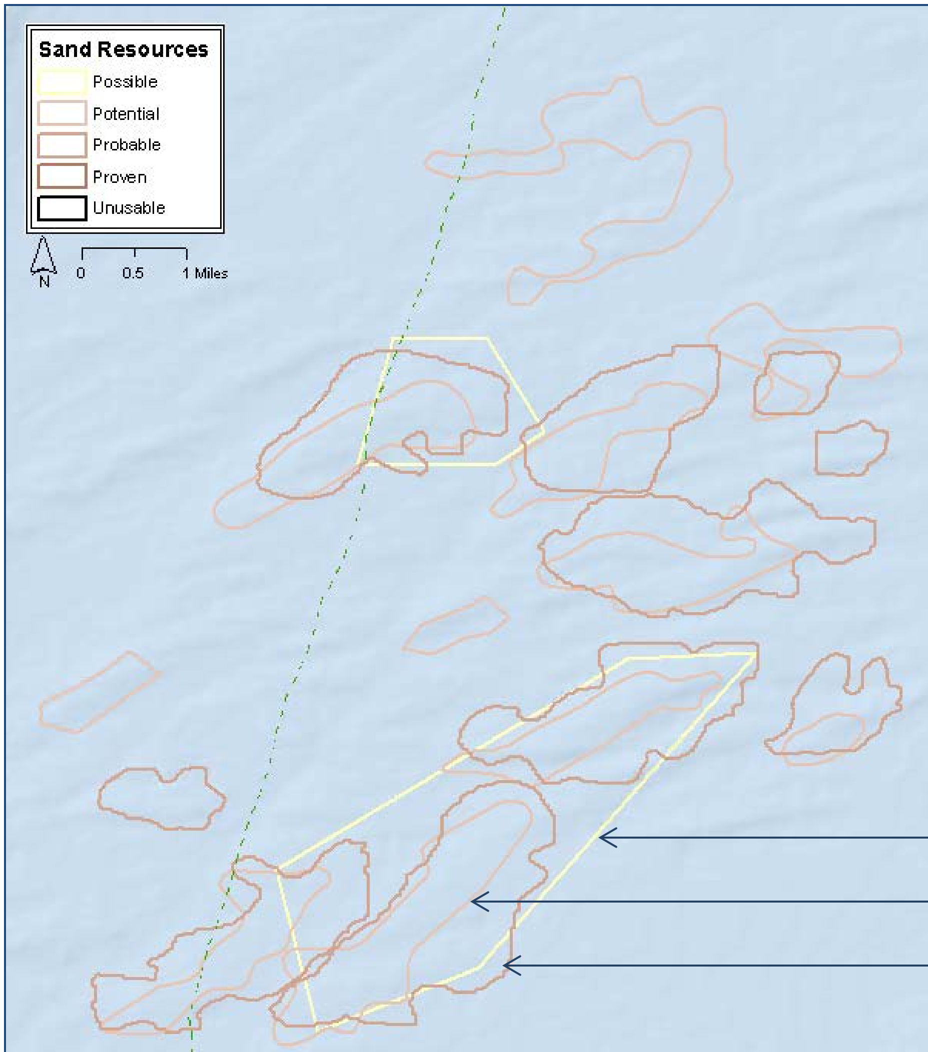




SRAT to support the National OCS Sand / Sediment Inventory

Historical Data

New Jersey Sediment Resources



Tracking Sediment Resources through Time

2004, 12.4 mcy

2007, 17.9 mcy

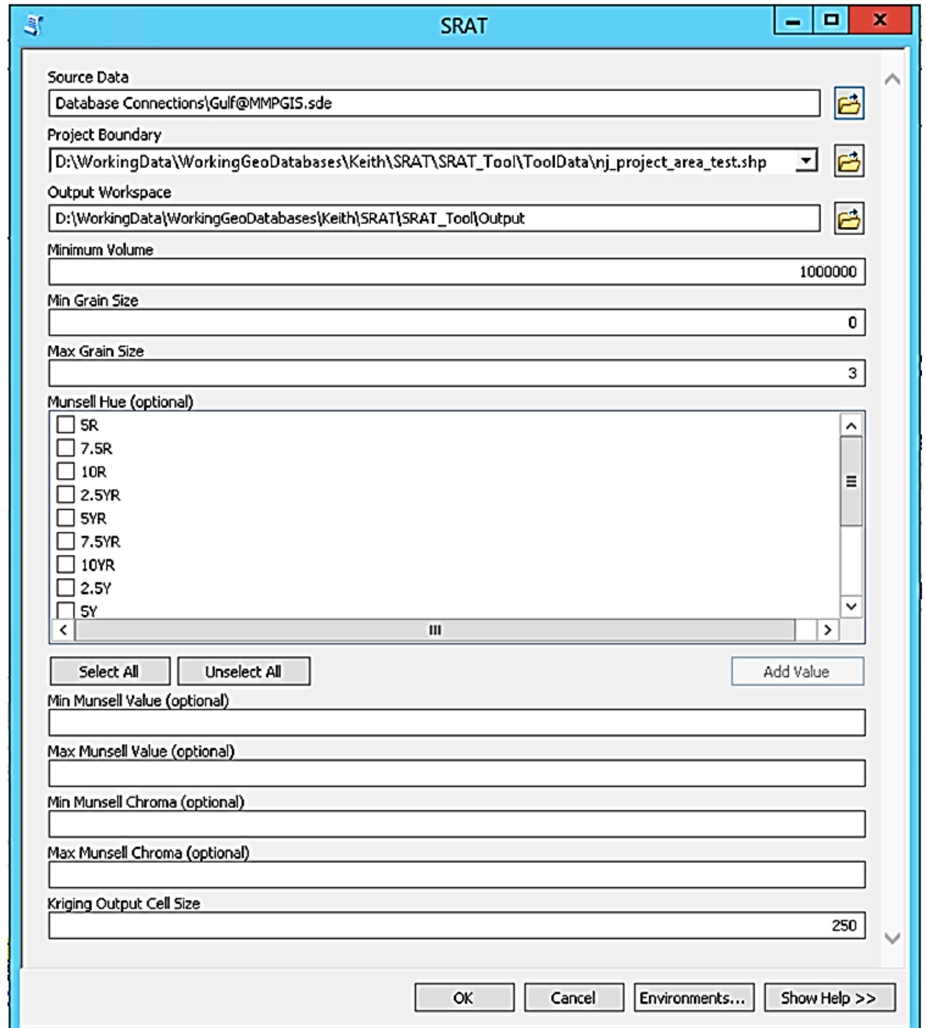
2015, 31.3 mcy

Prototype

Sand Resource Analysis Tool

Inputs

- Minimum Volume
- Min Grain Size
- Max Grain Size
- Munsell



Reconnaissance look at finding potential sediment resources for coastal restoration

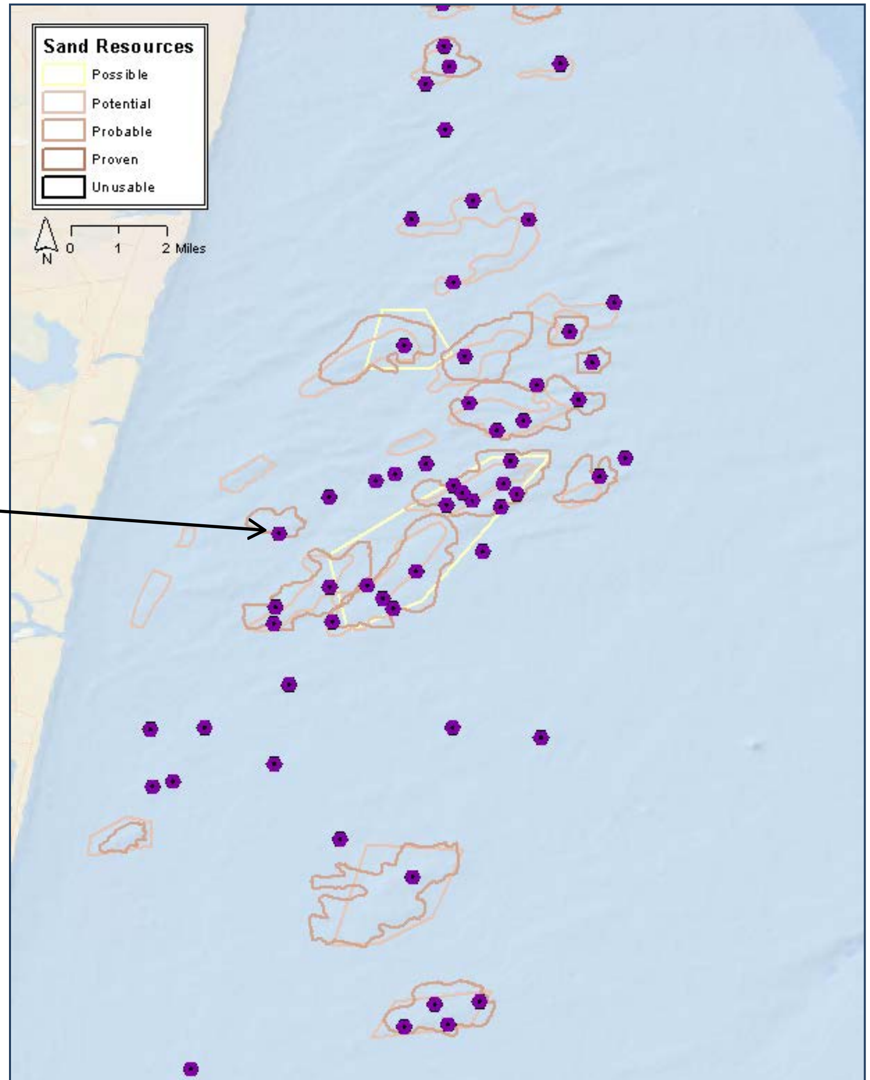
Prototype

Sand Resource Analysis Tool

Core Samples
- 37
  - Core Layers
  - LinkDocumentsTable
  - MMPGIS.DBO.Sample
    - 37000
    - 37030
    - 37060
    - 37090
    - 37120
    - 37150
    - 37180
    - 37210
    - 37240
    - 37270
    - 37300
    - 37330
    - 37360
    - 37390
    - 37420
    - 37450
    - 37480
    - 37510
    - 37540
    - 37570

Location: -73.969243 40.134202 Decimal Degrees

Field	Value
OBJECTID	6779
Core ID	37
State	NJ
Study ID	M14AC00002
Sample Date	<null>
Time	<null>
X	640517.4
Y	474241.7
Coordinate System	NAD_1983_StatePlane_Ne
Method of Core Sample	Vibracore
Sampler Device	<null>
Water Depth (ft)	53.3
Penetration Depth (ft)	19.23
Recovered Length (ft)	<null>
Percent Recovered	<null>
Core Diameter (in)	<null>
Depth Rock (ft)	<null>
Agency ID	NJGWS
Contact ID	<null>
Contact Name	Michael Schumacher



CoresWithBottom 0-3phi
- 37

Location: -73.969243 40.134202 Decimal Degrees

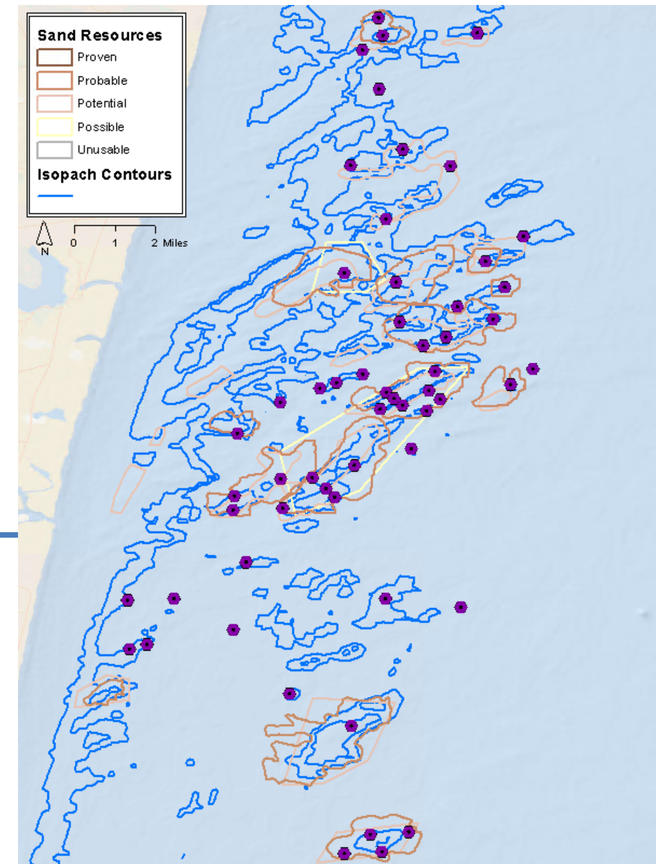
Field	Value
Longitude (DD)	-73.969243
Latitude (DD)	40.134202
Global Sample ID	{149F2D44-5E18-4C89-9CA1-BD269958601D}
Global Link ID	{08F8B83C-8788-4C77-B808-F4137728AAC9}
RuleID	Core Samples
GlobalID	{B12985FB-B610-4F4A-8CE5-26683626725F}
Comments	
BottomElev_ft	-69.21207
PhiMean	1.556965

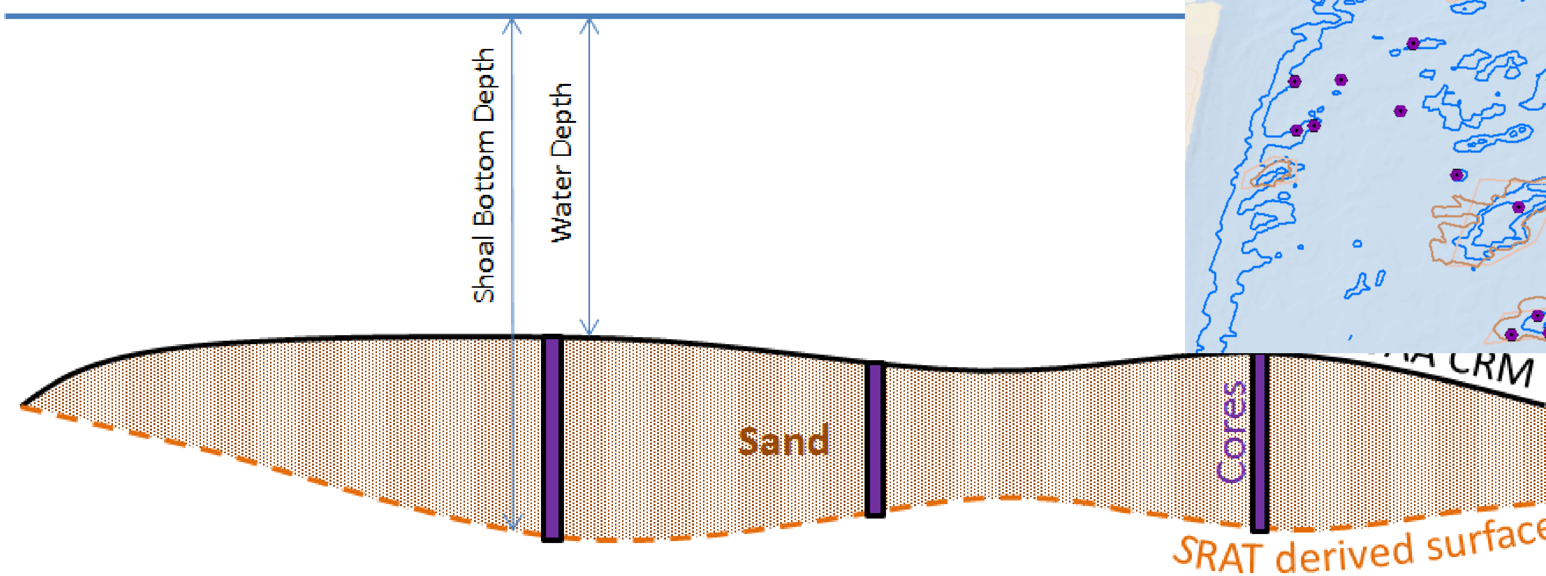
Prototype

Sand Resource Analysis Tool

X,Y, New Z → Bottom horizon surface raster

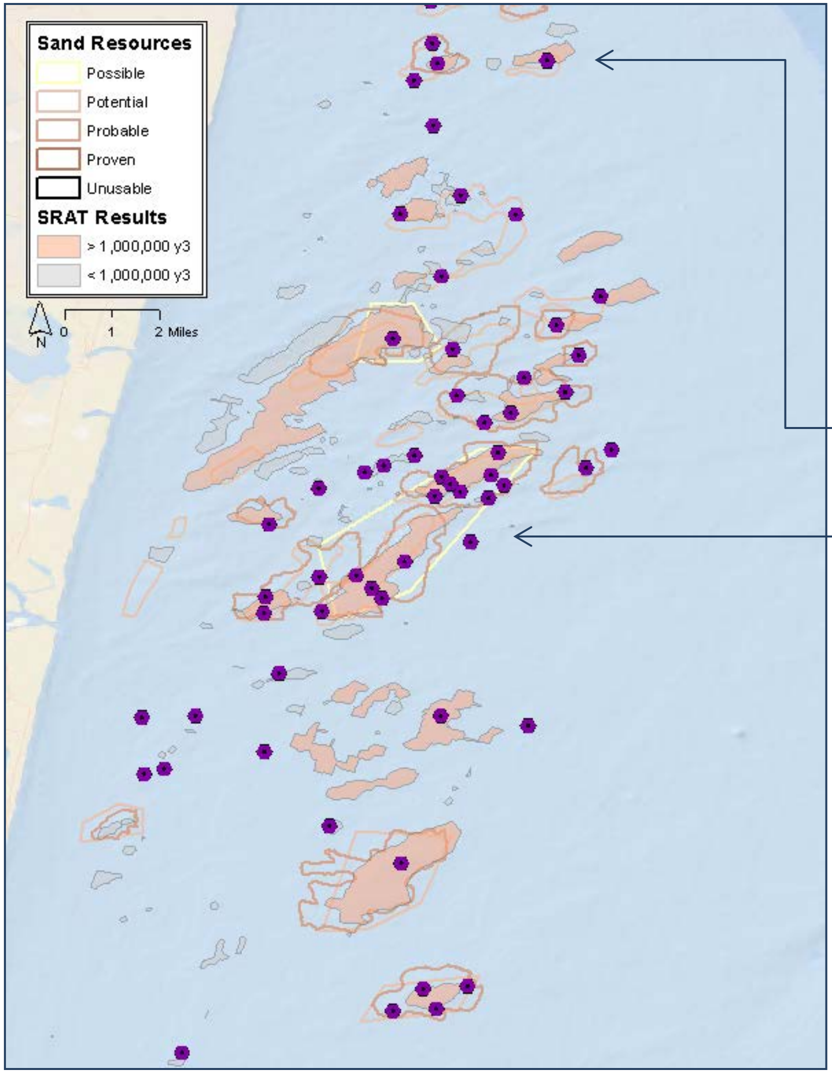
Coastal Relief Model – New Raster → Isopach raster

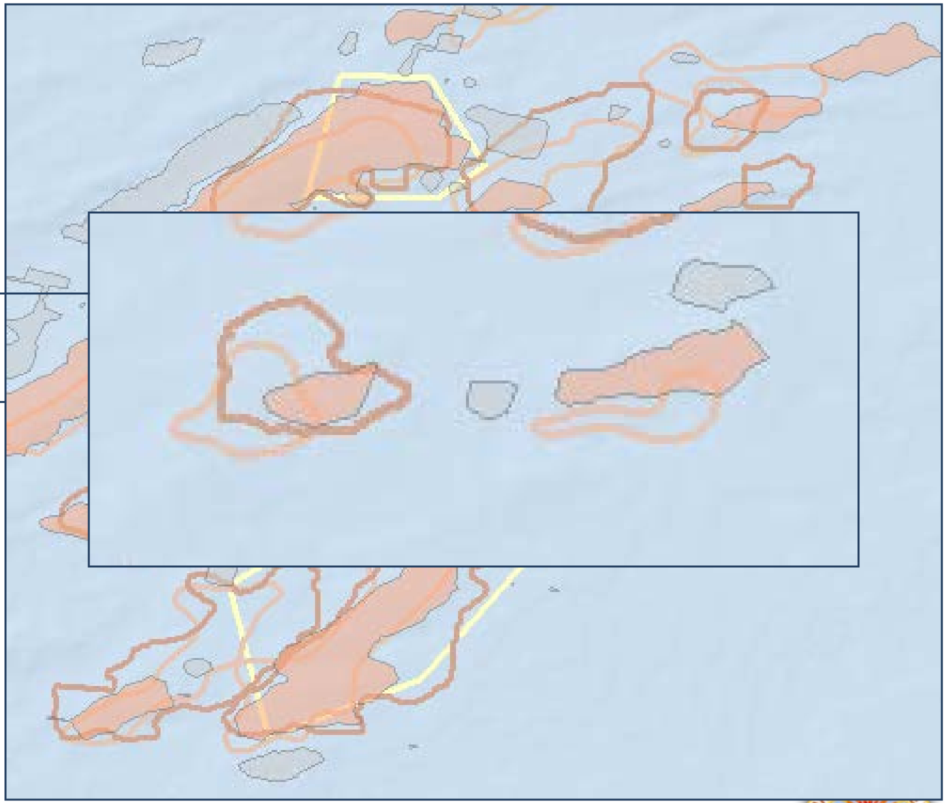




Prototype

Sand Resource Analysis Tool





Prototype

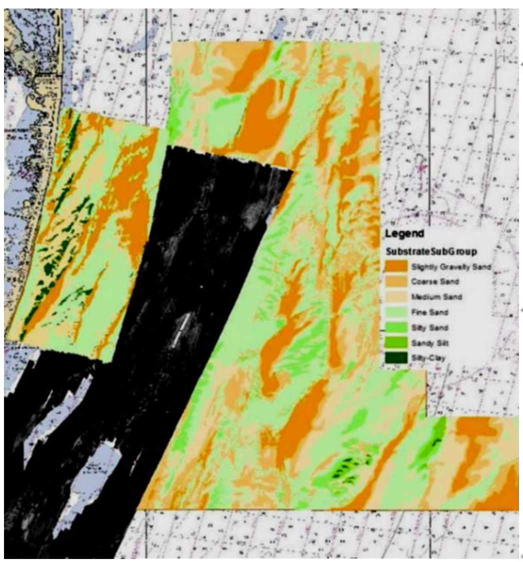
Sand Resource Analysis Tool

- With only limited core samples, able to identify major resources
- Still in prototype
- Need to incorporate more data into MMPGIS
  - Additional core data
  - Manual data entry of current core data supporting documents
- Version 2
  - Input bathymetry raster
  - Additional criteria
  - Output report with summary statistics

Collaboration

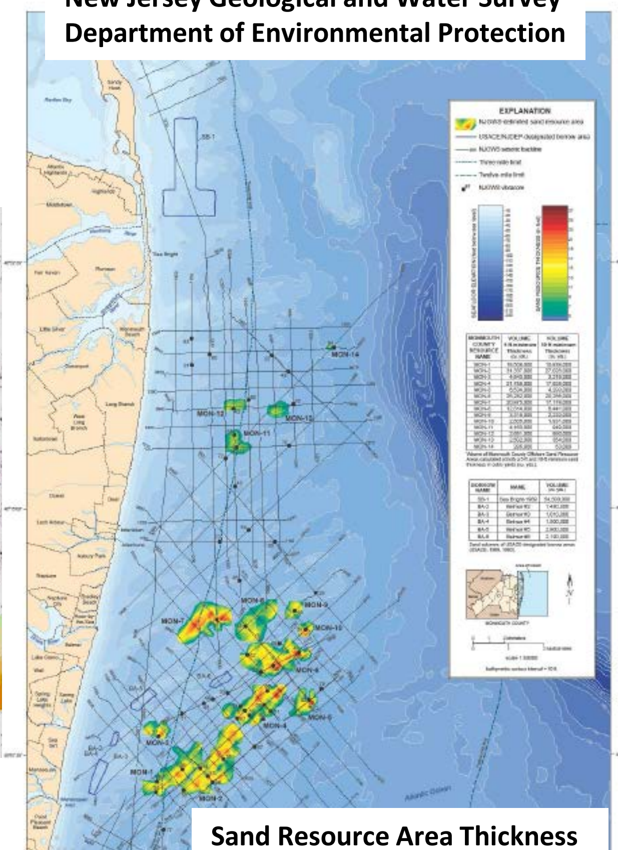
Developing a Marine Minerals Enterprise Geodatabase

Maryland Department of Natural Resources, Maryland Geological Survey
Baseline Acoustic Seafloor Classification of Offshore Borrow Area



Bottom Classification

New Jersey Geological and Water Survey
Department of Environmental Protection



Sand Resource Area Thickness

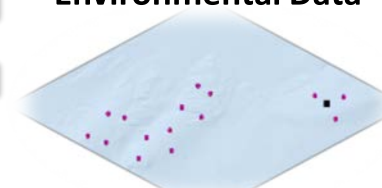
Figure 1. Significant Sand Resource Areas in State and Federal Waters offshore Monmouth County, GMS 15-3, Plate 1.

Organize

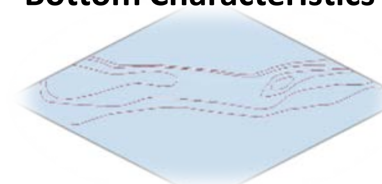
M
M
P
G
I
S

Bathymetry & Backscatter

Environmental Data



Bottom Characteristics

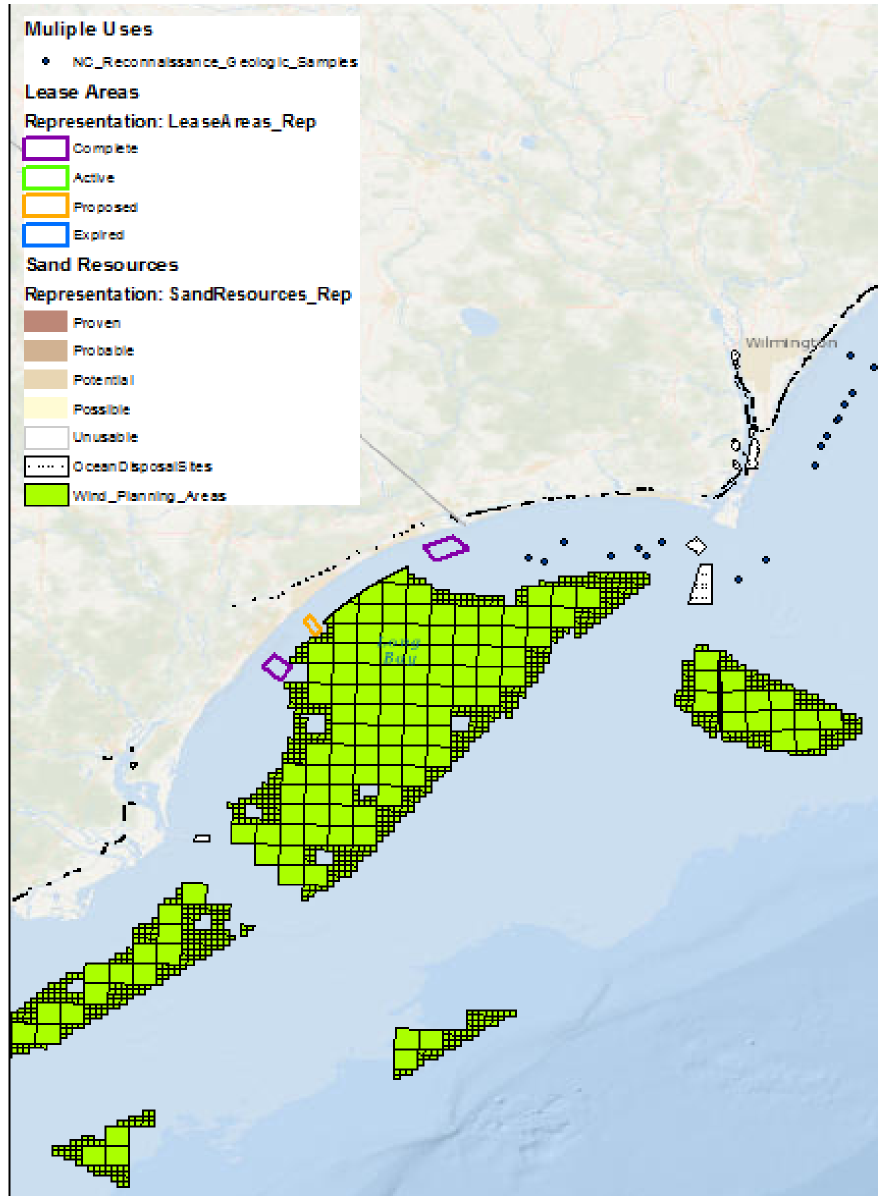


Leasing / Planning/Construction

Collaboration

Marine Spatial Planning

M
M
P
G
I
S



Collaboration

Knowing where resources are allows for faster engagement with other OCS stakeholders

In the Atlantic

Renewable Industry
- Wind Planning Areas
- Renewable Leases
- Hydrokinetic Leases

Telecom Industry
- Submarine Cables

Shipping Industry
- Shipping Channels

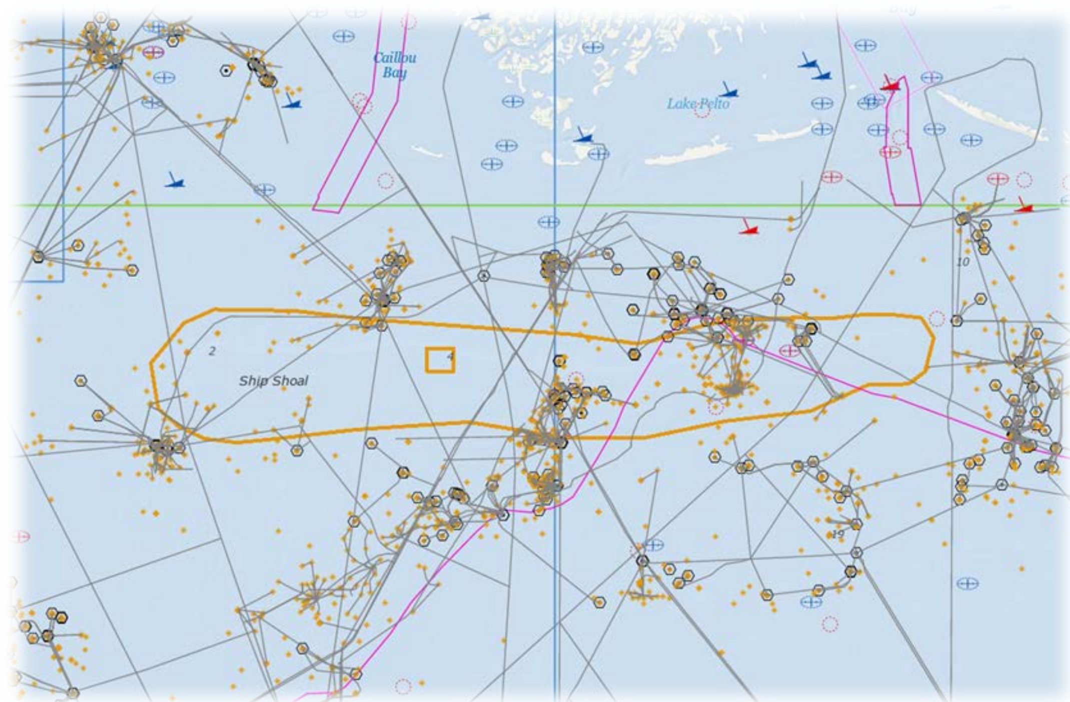
Dredging Operations

Fishing Industry

Collaboration

Knowing where resources are allows for faster engagement with other OCS stakeholders

In the Gulf of Mexico



Oil and Gas Industry
- Wells
- Platforms
- Pipelines

Telecom Industry
- Submarine Cables

Shipping Industry
- Shipping Channels

Dredging Operations

Fishing

Collaboration

Federal Agencies

- BOEM
- BSEE
- DOI OCIO
- USACE
- USGS
- NOAA

State Entities

- New Jersey Department of Environmental Protection
- New York State Department of State
- Virginia Department of Mines, Minerals and Energy
- Maryland Department of Natural Resources
- Florida Department of Environmental Protection
- South Carolina Department of Natural Resources
- Maine Geological Survey
- Louisiana Geological Survey
- Geological Survey of Alabama
- Mississippi Department of Marine Resources

Educational Institutions

- University of Delaware - Delaware Geological Survey
- University of Rhode Island
- University of New Hampshire
- University of Massachusetts Amherst - Massachusetts Geological Survey
- Dept of Geological Sciences, East Carolina University & UNC Coastal Studies Institute
- Skidway Institute of Oceanography, University of Georgia
- Louisiana State University
- The University of Texas
- Texas A&M University

Industry

- Coastal Engineering Consulting Firms
- Geospatial Services
- Cloud Services

Collaboration

Future

2017 – 2018 Objectives	Success Measures
Integrate MMP and partner agency geospatial data and related non-geospatial information into a uniform data model that enables MMP to characterize and delineate sand resources on the Outer Continental Shelf (OCS) and support resource decisions	MMP Relational Geodatabase capability utilized by BOEM within 2 years
Create an OCS sand resource inventory for MMP	Establish a national inventory in 2017 for the Gulf of Mexico and Atlantic
Create custom reporting and analysis tools to facilitate use by scientists, managers, and planners	Applications realized within 3 years
Establish data stewardship and data structure for the Marine Minerals Program (Leverage historic data by converting to a standardized, digital format)	85% of digital data structured and 10% of manual core data incorporated by 2017 Sand Resource Area datasets (authoritative data) registered on Marine Cadastre / Data.gov
Support productive local, state, and Federal collaboration and geospatial information exchange across all levels of government	Data retrieveable by BOEM offices within 3 years and our Federal / State partners within 4 years

Thank you

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Ecological Function and Recovery of Biological Communities within Dredged Ridge-Swale Habitats in the South-Atlantic Bight

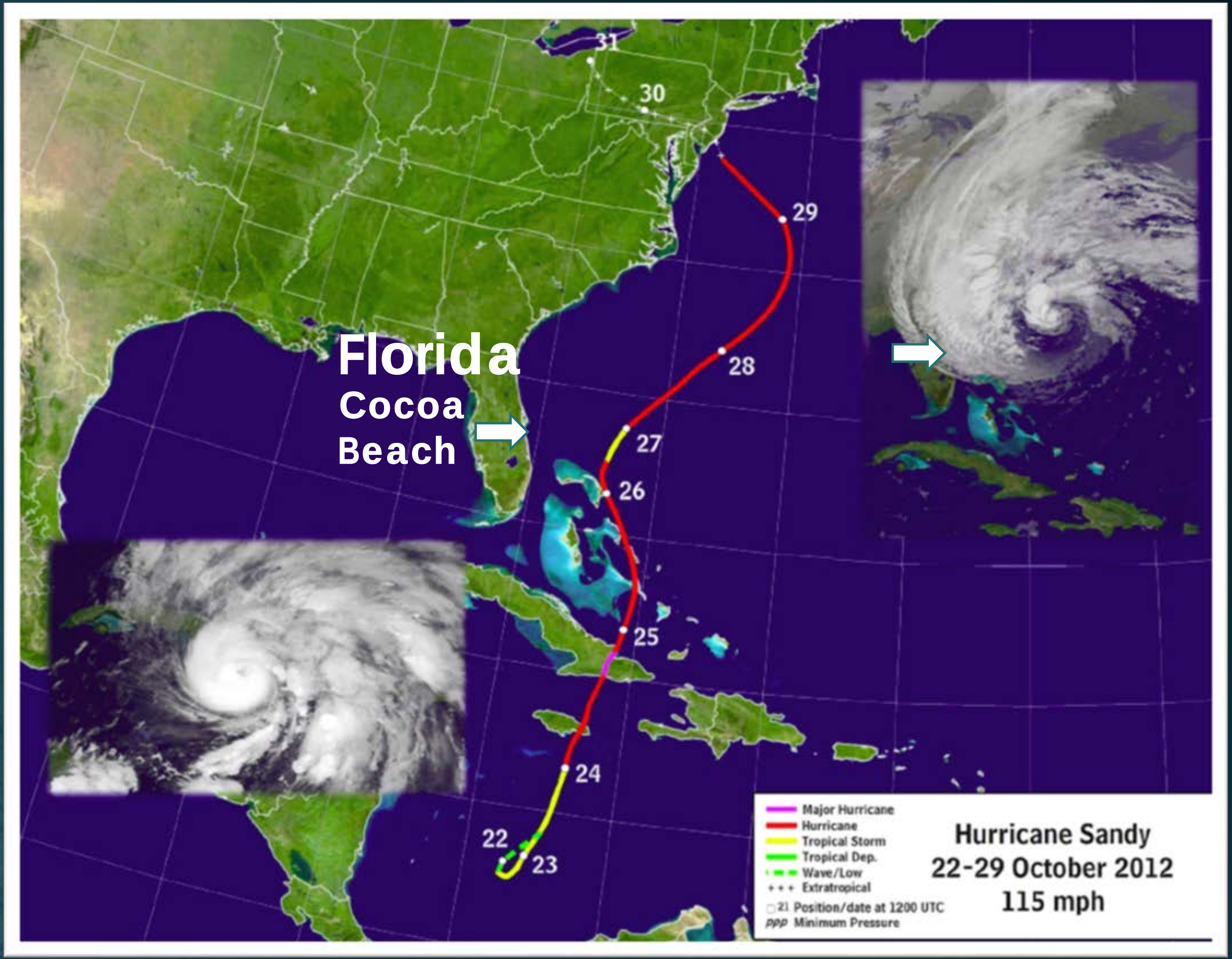
CESU: Cooperative Ecological Studies Unit

University of Florida and BOEM

UF CESU Collaborative Team

- UF Fisheries & Aquatic Sciences Program, SFRC
  - Debra Murie
  - Robert Ahrens
  - Patrick Baker
  - Don Behringer
  - Ed Phlips
  - Daryl Parkyn
  - Michael Dickson/Linda Jordan (Project Biologists)
- UF Department of Geological Sciences
  - Peter Adams
- UF Civil & Coastal Engineering Department
  - Arnoldo Valle-Levinson

Path of Hurricane Sandy (Oct 2012)



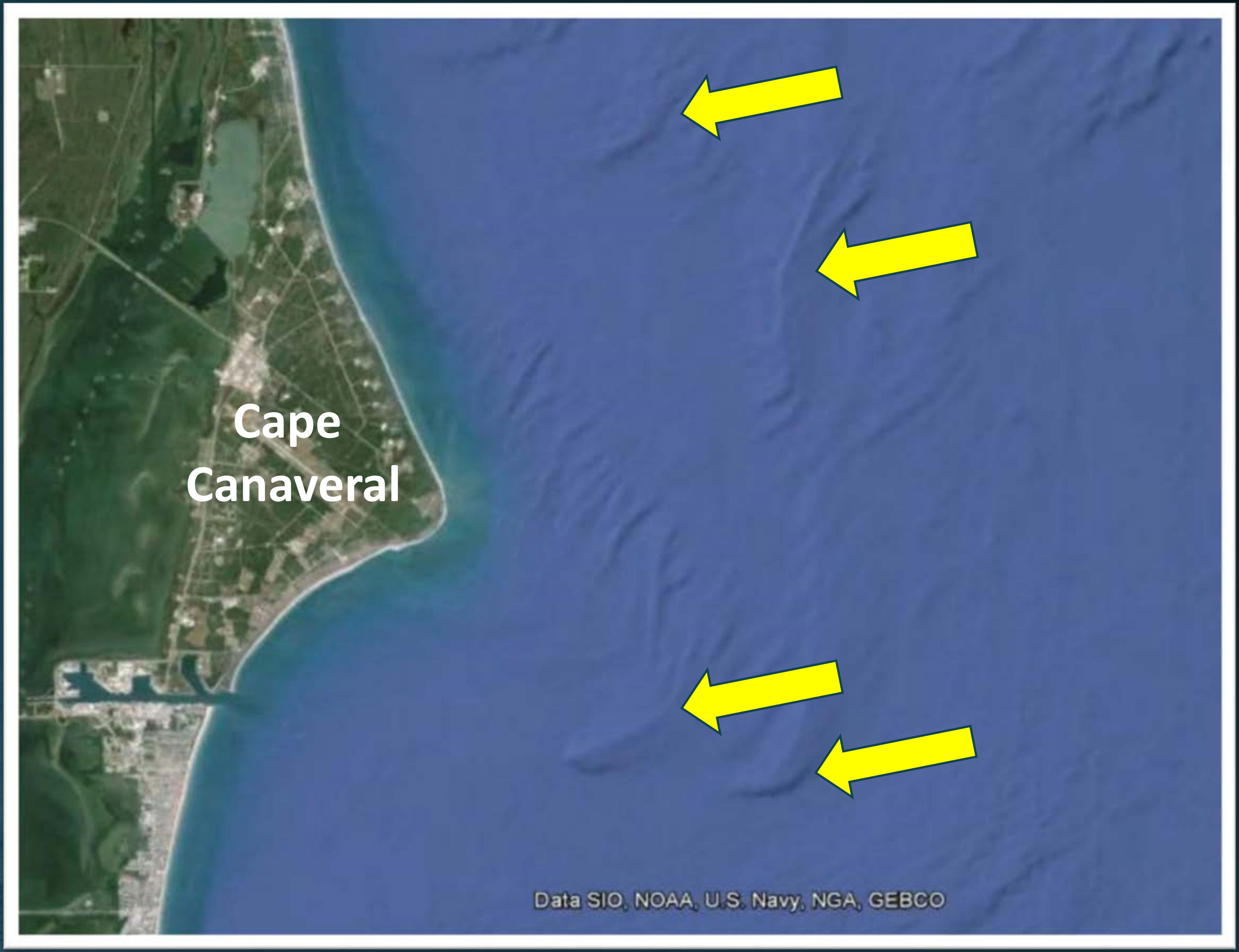
(Photo Credit: Eric Blake, National Hurricane Center)

Cocoa Beach, Florida

Before Hurricane Sandy....and After

(Photo Credit: Paula Berntson, Brevard County Natural Resources Management Dept)

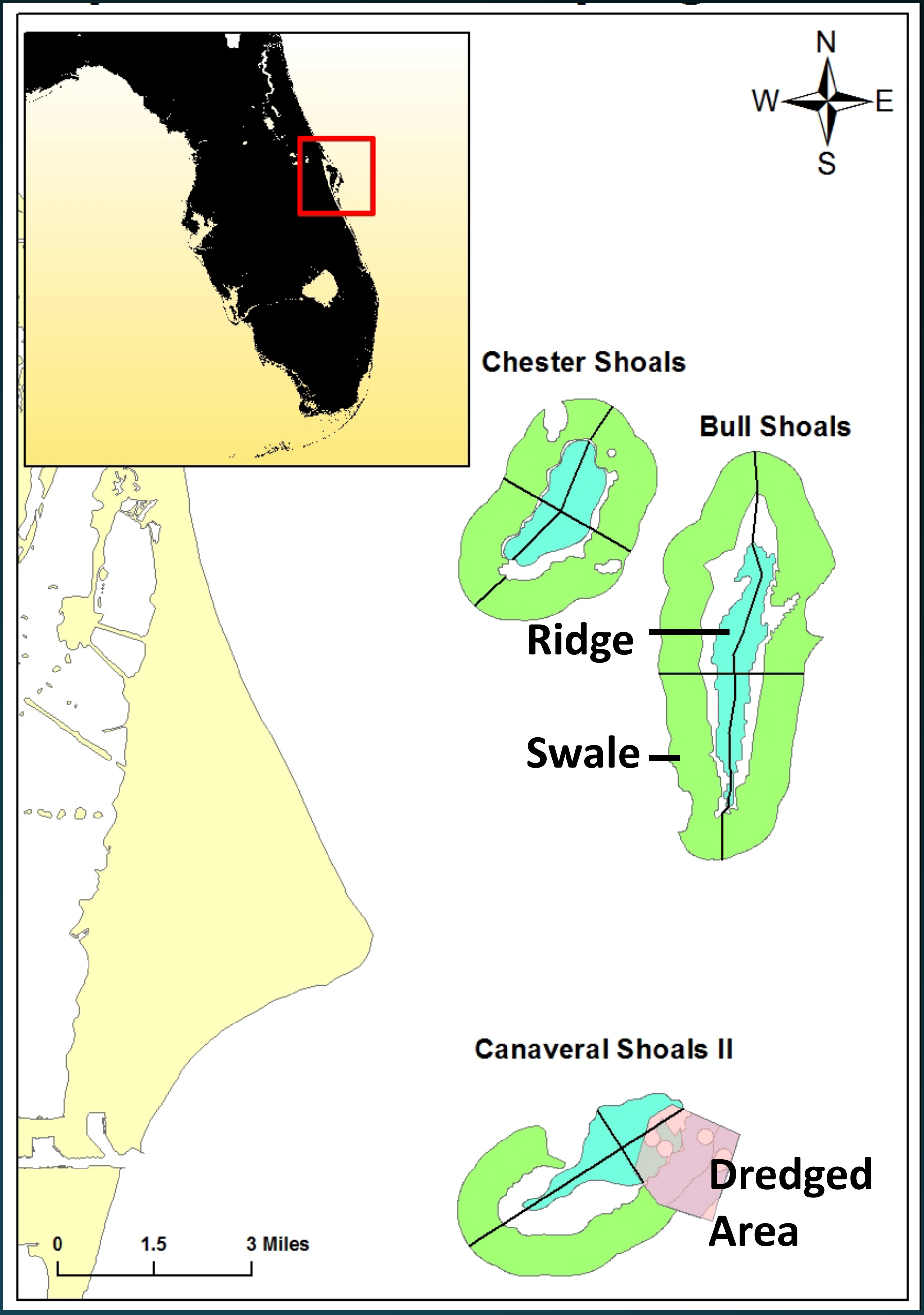
Offshore sand shoals



Sand shoals off Cape Canaveral

Reference Shoals

Dredged Shoal



Dredge vessel off Canaveral Shoal II (Nov 2013-March 2014)

Study Goals

- Monitor the effects and recovery of sand dredging activities on biological communities of ridge-swale habitats
- Determine functional biological services that are potentially compromised by dredging sand; determine degree of impact
- Investigate the mechanism of recovery of invertebrate and fish communities associated with the ridge-swale habitats

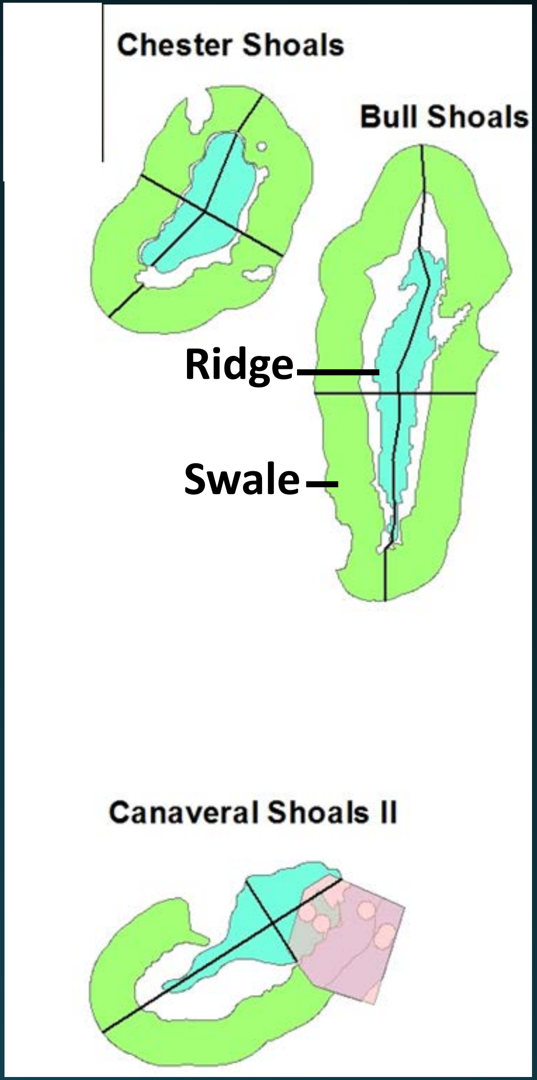
Biological Sampling

Temporal Framework:

- Annual
- Seasonal (Spring, Summer, Fall, Winter)
- Diel (Day/Night differences)

Spatial Framework:

- Reference Shoals versus Dredged Shoal
- Ridge versus Swale



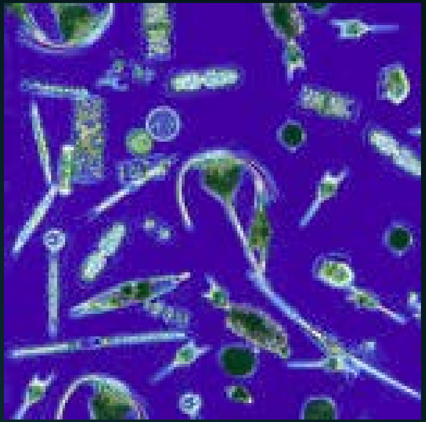
Biological Sampling

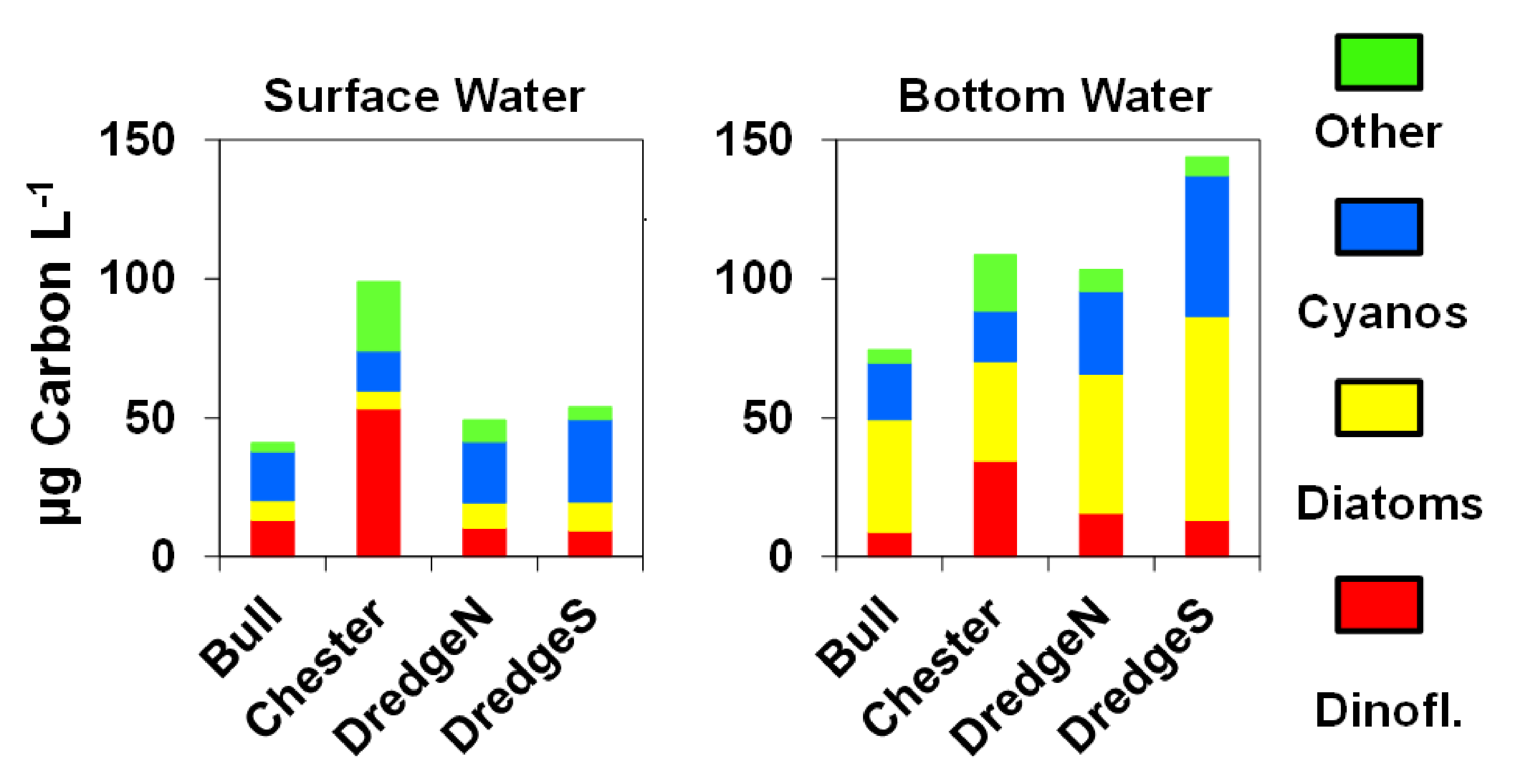
Approach focused on the trophic interactions among biota with an emphasis on the dynamics of prey availability, patterns of habitat use, and biomass and bioenergetic coupling.

Food Web Components:

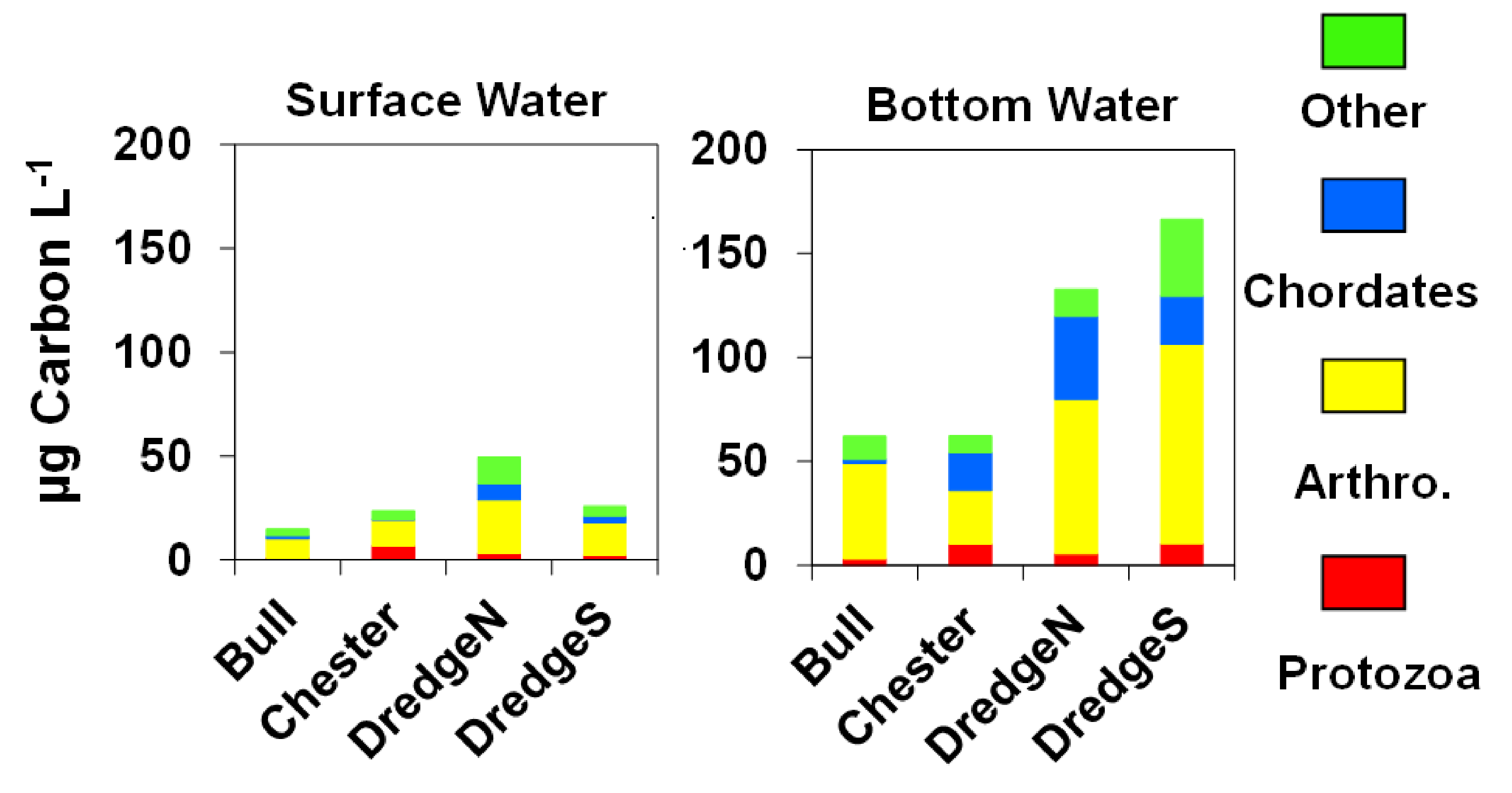
- Phytoplankton
- Zooplankton
- Invertebrates
- Fishes

Phytoplankton Biomass (Summer 2014)





Zooplankton Biomass (Summer 2014)



Benthic Invertebrates

Modified Young Grab

Benthic Grab Sampling

Taking cores before disturbing grab

Washing sediment through sieve series

Polychaetes

- Polychaete worms are one of the two dominant groups
- Count data extremely variable, but at the upper end, 100s/m^2 for a single species
- Several methodological problems with worms
- Several abundant families

Onuphidae

Chaetopteridae

Oweniidae

Crustacea: Amphipoda

- Comparable to polychaetes in numerical abundance, taxonomic diversity, and biomass
- Difficult to identify but less fragmented than polychaetes

Bathyporeiidae

Haustoriidae

Phoxocephaliidae

Mollusca

- Most common mollusks are much less abundant (by counts) than polychaetes
- Large body mass; may dominate by biomass

Gastropoda: Olivellidae

Gastropoda: Nassariidae

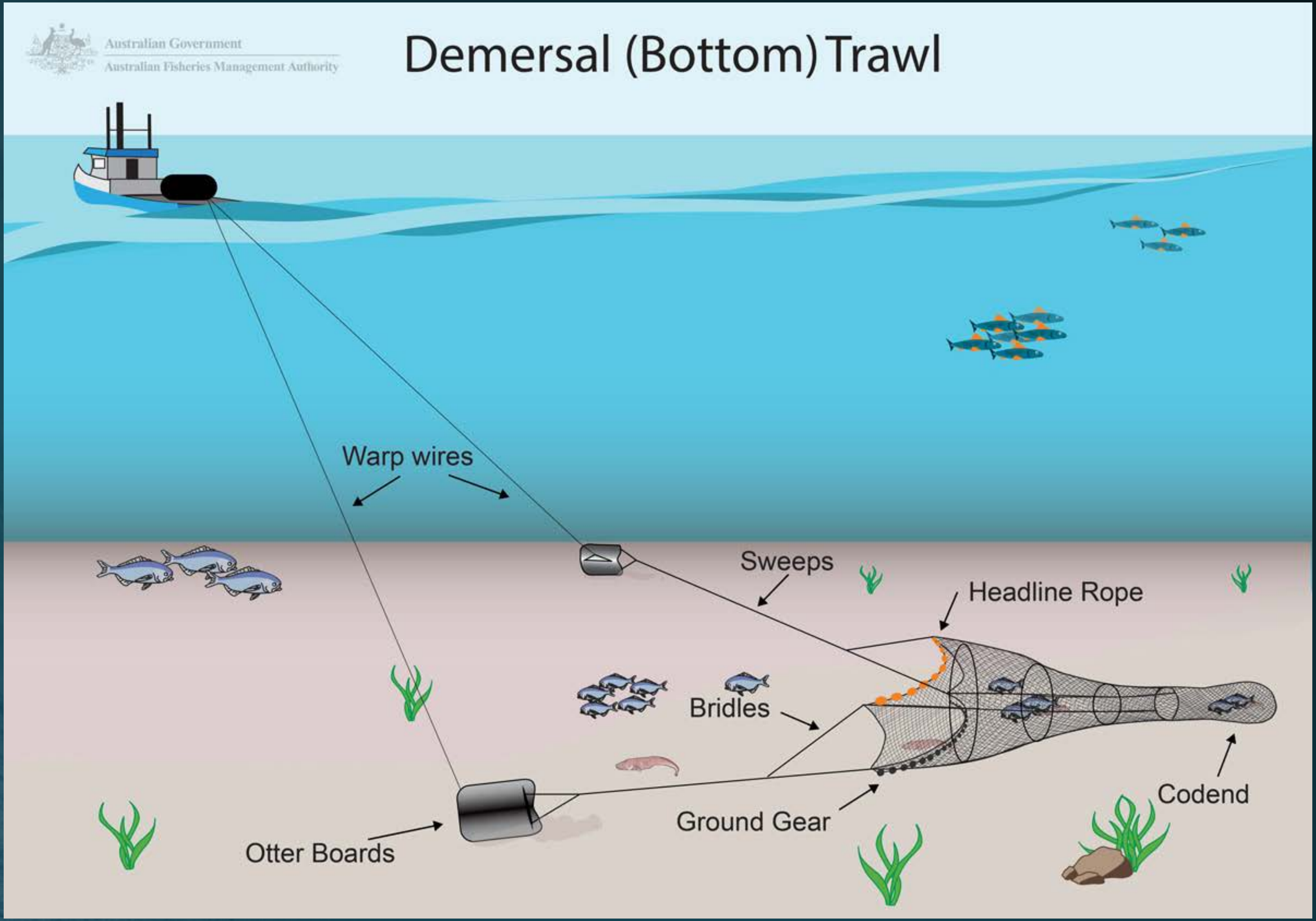
Bivalvia: Tellinidae

© Gustav Paulay

Scaphopoda: Dentallidae

www.jaxshells.org

Invertebrates and Fishes



Trawl Invertebrates
Acetes americanus

Trawl Invertebrates

Various small shrimp species

Roughneck Shrimp

Gastropods and hermits crabs

Photo Credit: Danielle Plus)

Trawl Fishes: Sciaenidae
Croakers

Atlantic Croaker

Spot Croaker

Trawl Fishes: Sciaenidae (plus larval sciaenids)

Photo Credit: Brenda Bowling, Texas Parks & Wildlife

Banded Drum

Photo Credit: Jim Franks, GCRL

Silver Seatrout

Common Trawl Fishes

Leopard Searobin

Photo Credit: Brenda Bowling, Texas Parks & Wildlife

Band Cuskeel

Photo Credit: Fishbase.org

Lizardfish

Photo Credit: flickr.com

Common Trawl Fishes

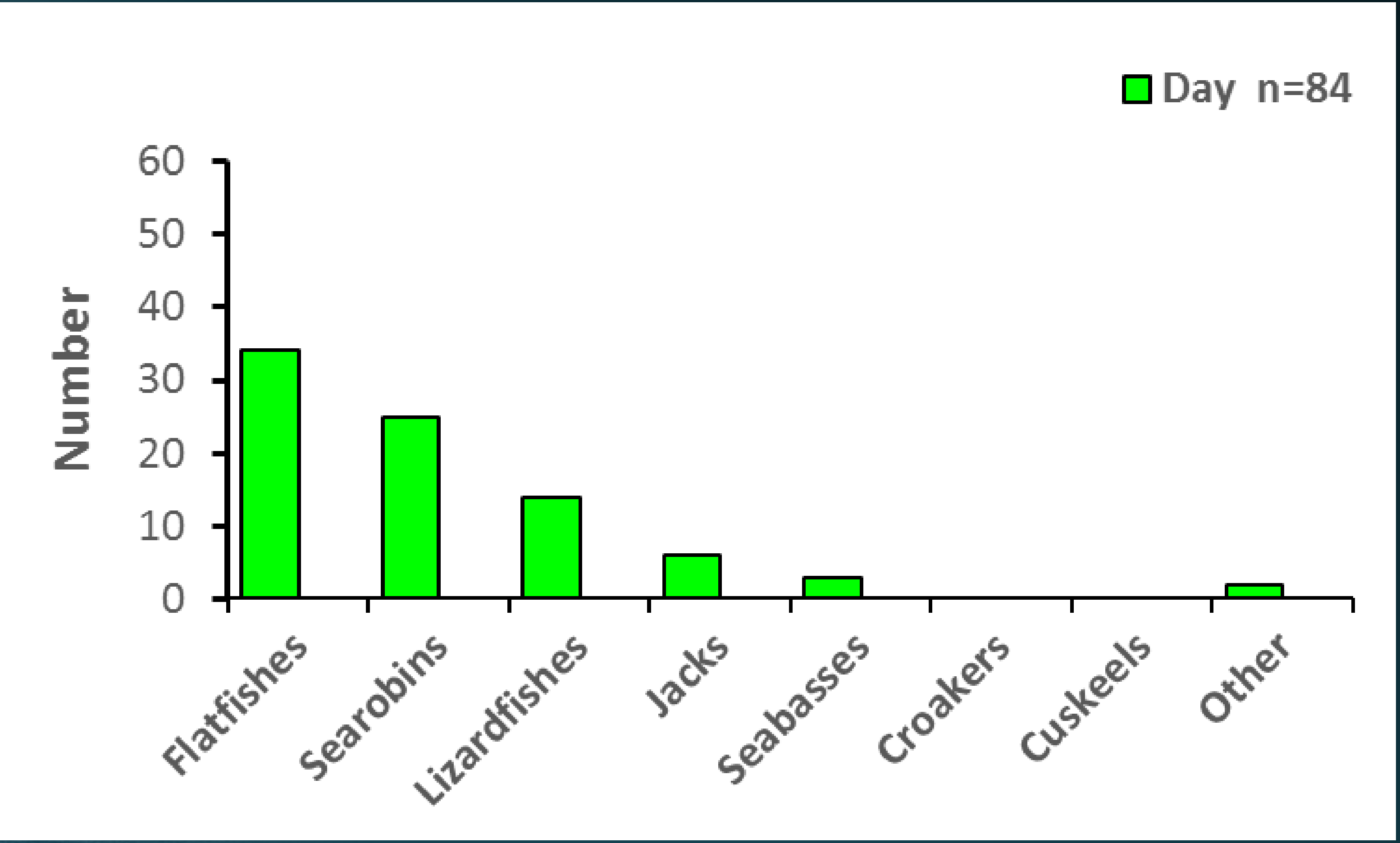
Fringed Flounder

Blackcheek Tonguefish

Atlantic Moonfish

Atlantic Bumper

Winter Trawling: Bull Shoal
(Abundance: 31 species total)



Winter Trawling: Bull Shoal
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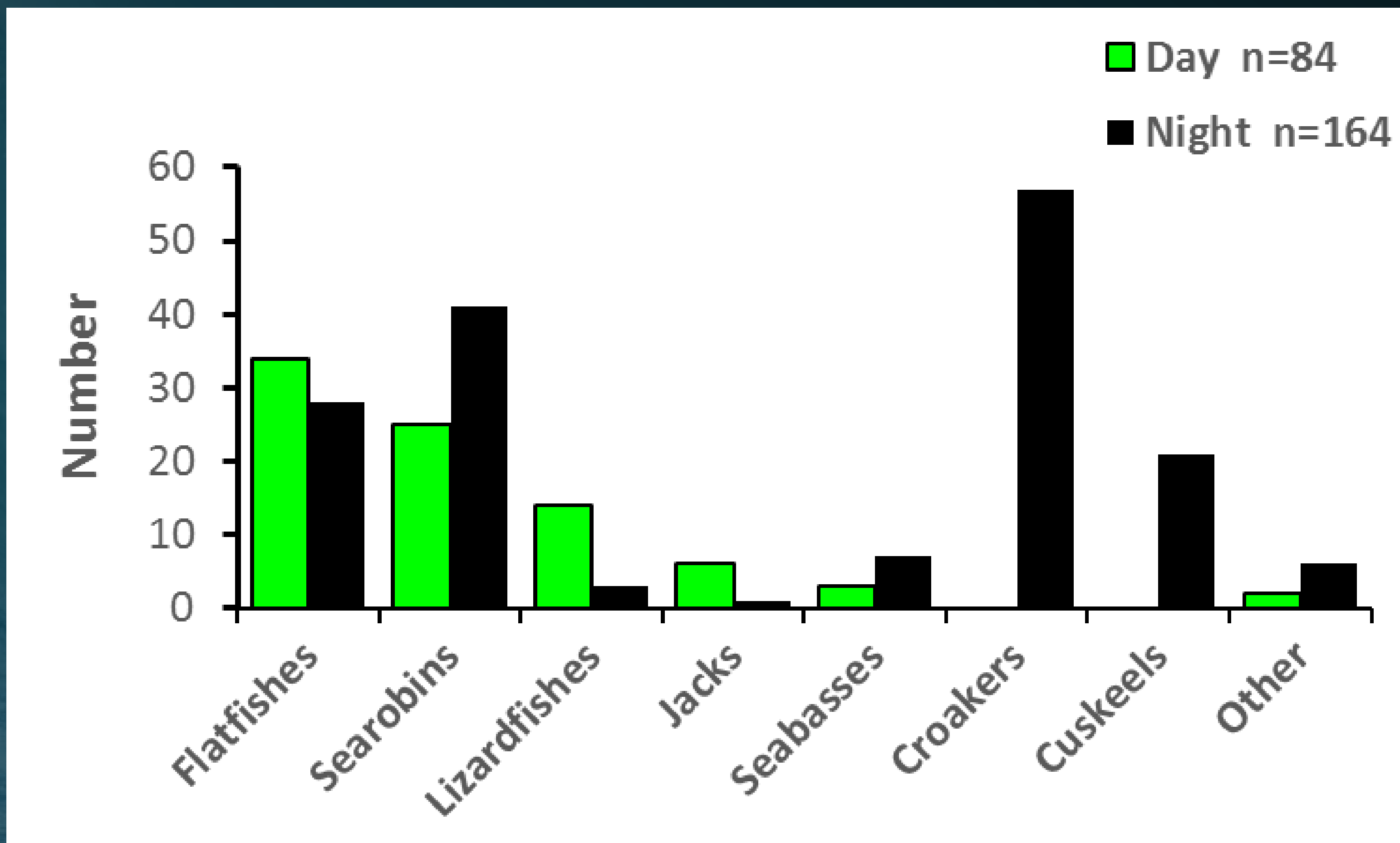
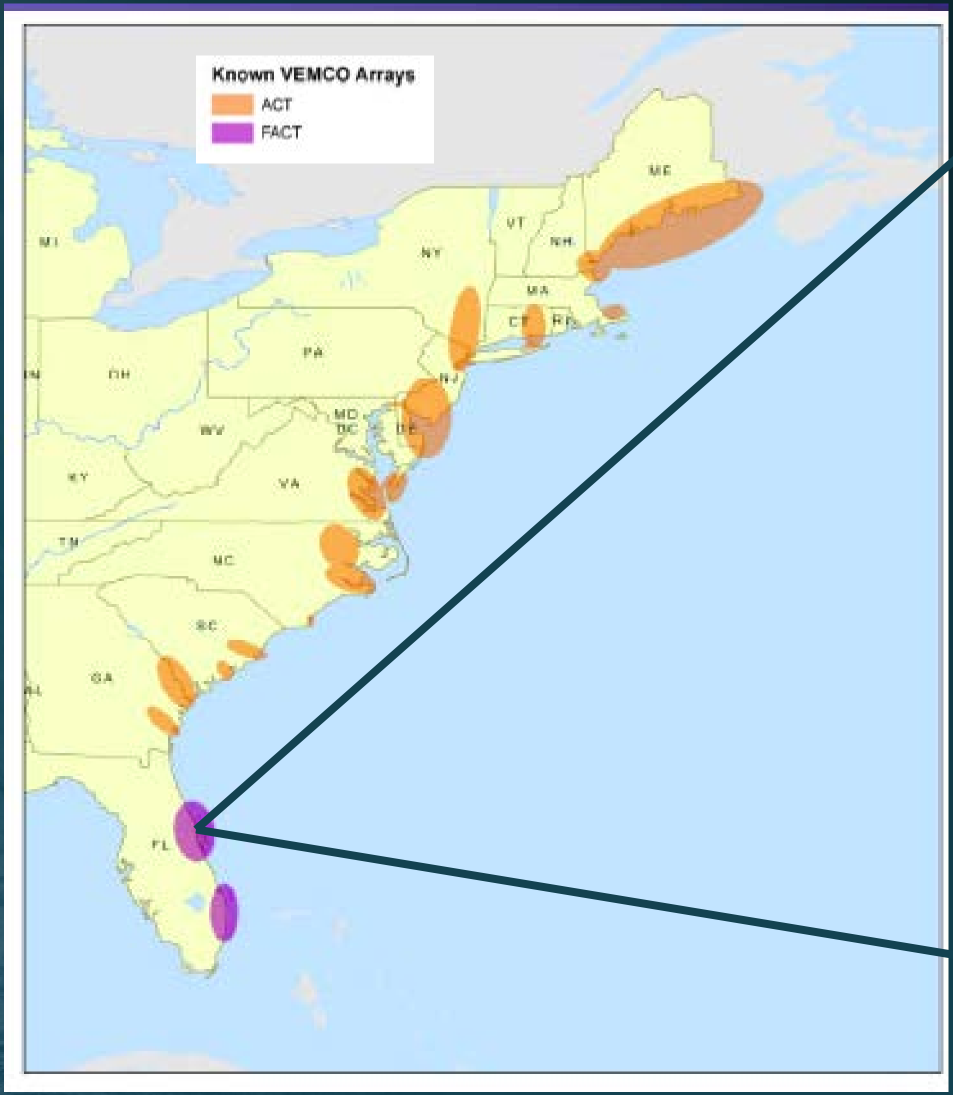


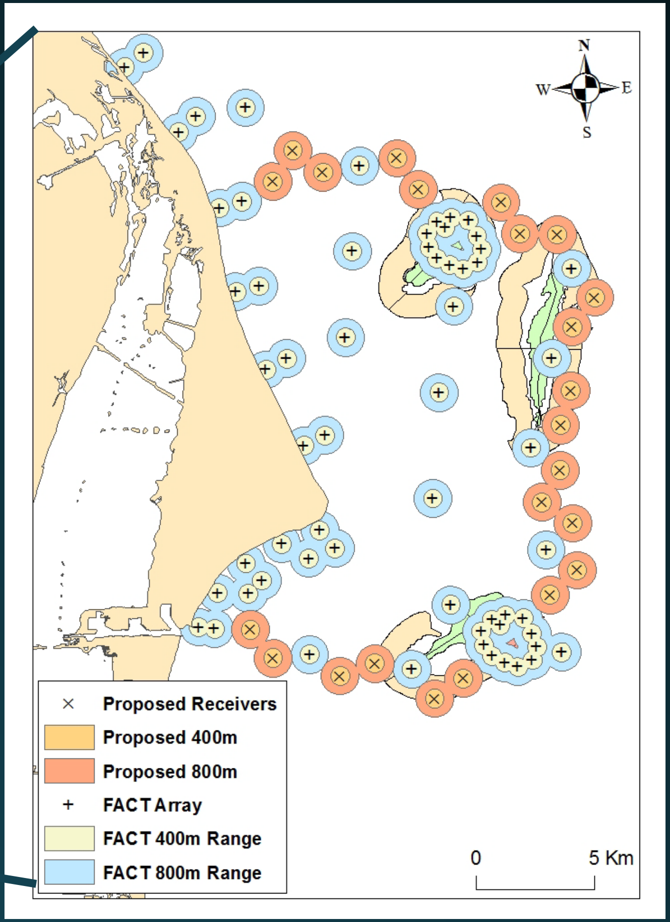
Target Species for Acoustic Tagging

Smooth Butterfly Ray

Summer Flounder

Receiver Arrays to Dectect Acoustically Tagged Fish





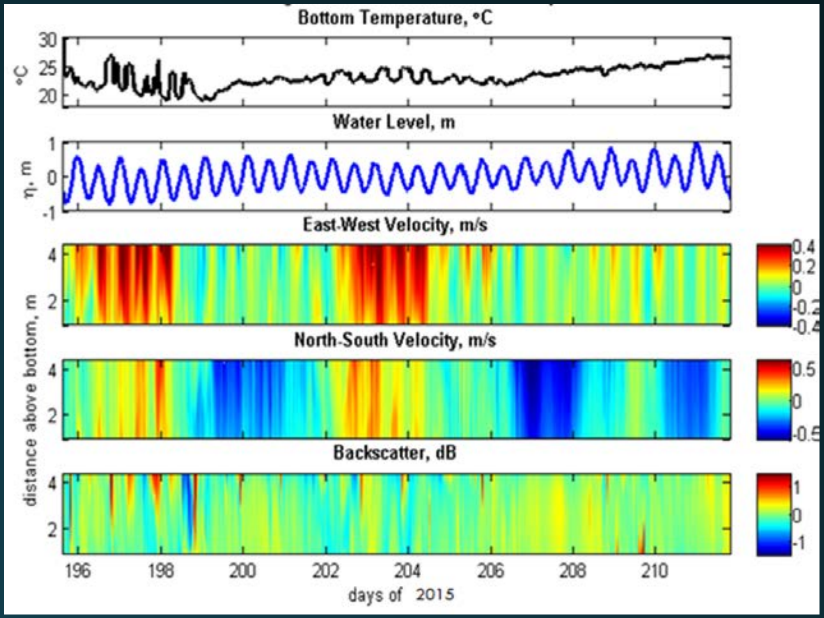
Environmental and Oceanographic Sampling

What are the physical changes that occur as a result of sand dredging and subsequent recovery?

- Water quality
- Bathymetry changes
- Habitat classification based on sediments, depth…
- Sand movement: currents, tides, storm events…

Oceanography
Acoustic Doppler Current Profilers (Towed and Moored)

Moored Upward-facing ADCP



Temperature, water velocity and direction, sediment transport

Recovery?

Return to pre-dredge community assemblages?

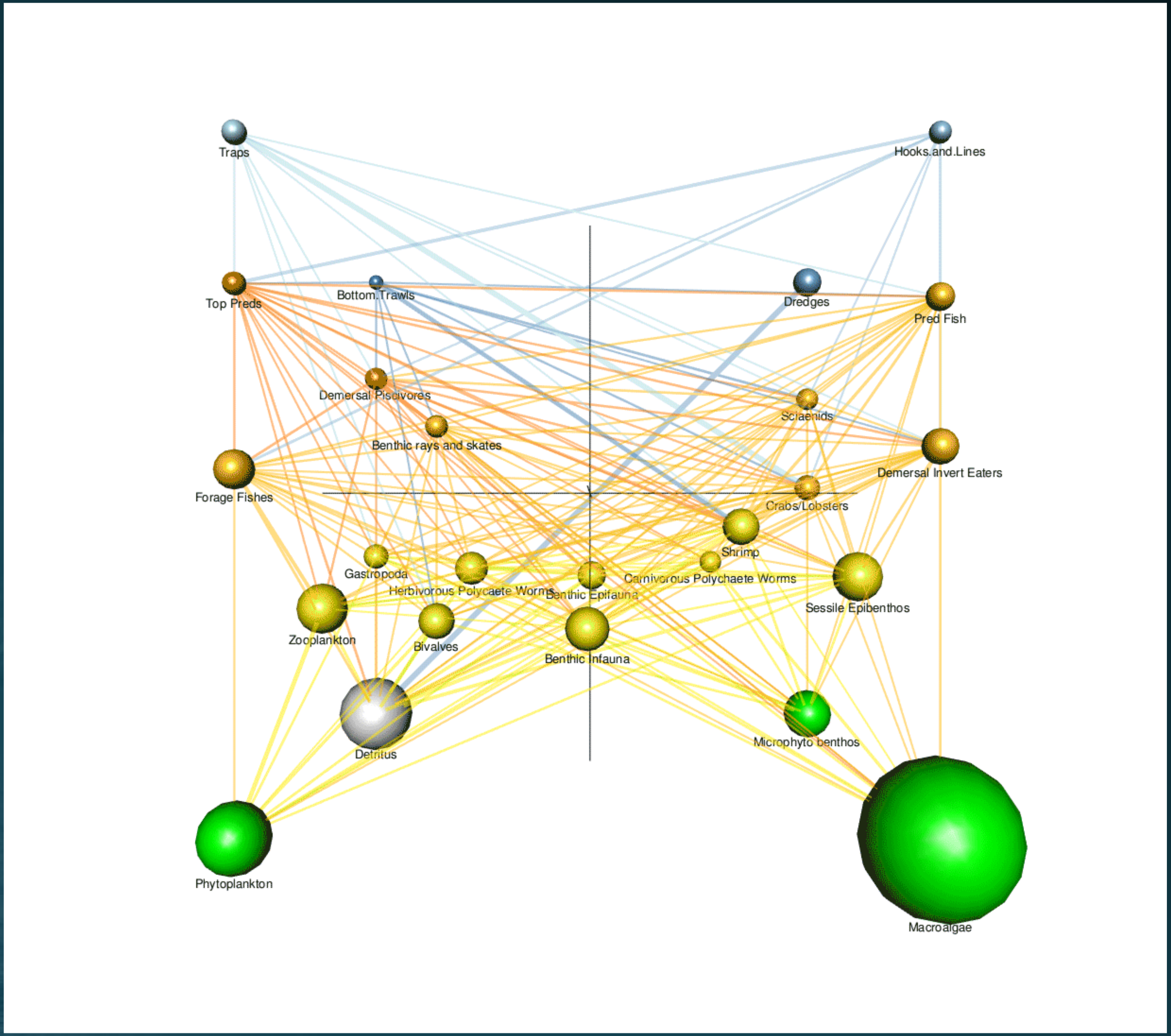
or

Return to comparable, functional community assemblages?

Ecosystem Analyses

- Trophic pathways using isotopes
- Trophic pathways using Ecopath-Ecosim-Ecospace models
  - Compare short-term versus long-term recovery trajectories for dredged area

Example of a Food Web using Ecopath with Ecosim



Labor-intensive study…..

Thanks to all of our biologists, technicians, and students for field and lab assistance.

Collaborators:

Jennifer Culbertson and Geoff Wikel (BOEM)

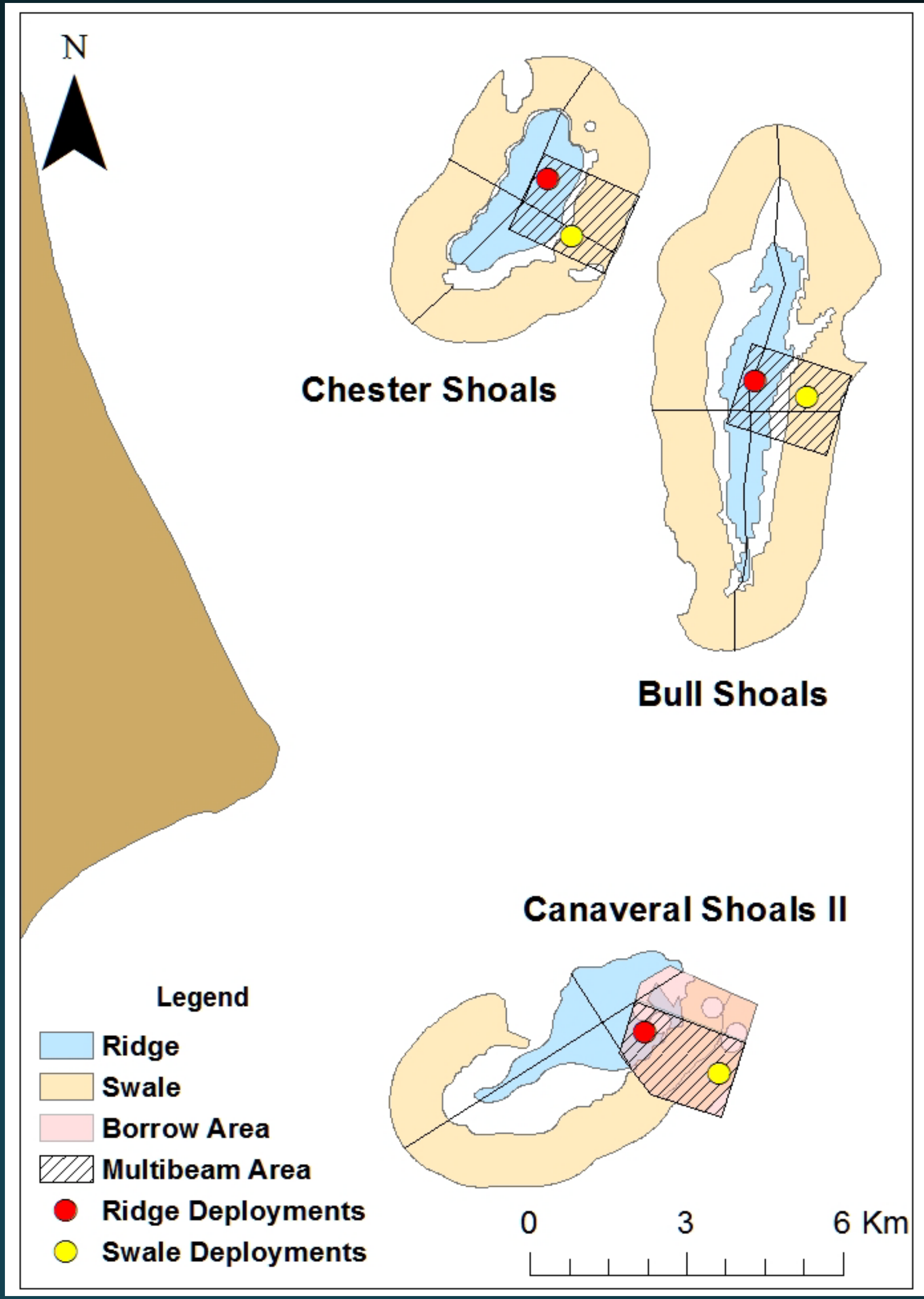
Eric Reyier and Doug Scheidt (Kennedy Space Center)

Joe Iafrate and Stephanie Watwood (Naval Undersea Warfare Center, Newport)

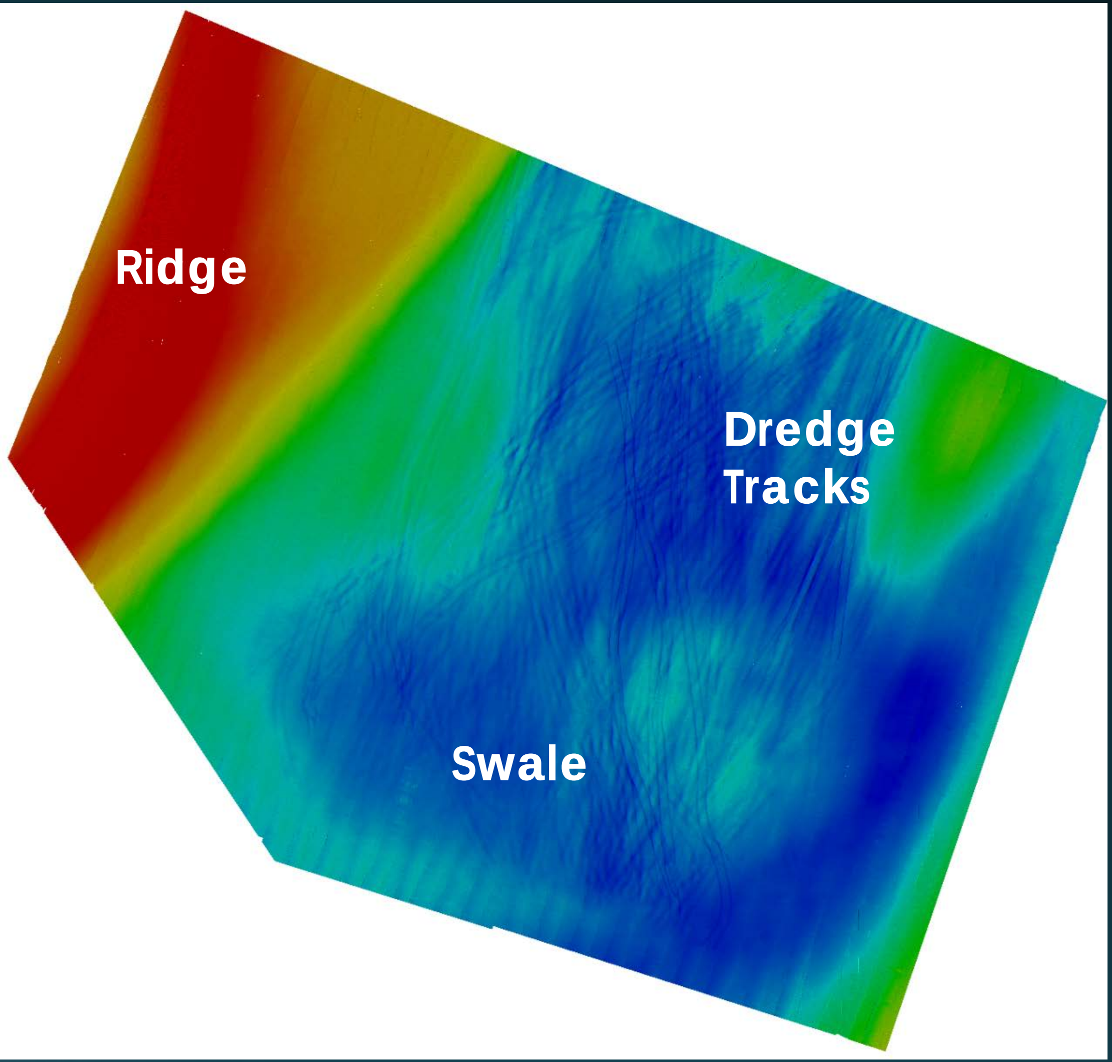
Multibeam hydroacoustic surveys

Reference Shoals

Dredged Shoal



Multibeam Hyrdroacoustics for Bathymetry: Canaveral Shoals



Benthic Grab Sampling
Habitat Classification

Benthic Grab Sampling
Habitat Classification

Atlantic Ocean Energy and Minerals Science Forum
November 16 - 17, 2016
Washington, DC

Characteristics of Sounds Emitted During High-Resolution Marine Geophysical Surveys

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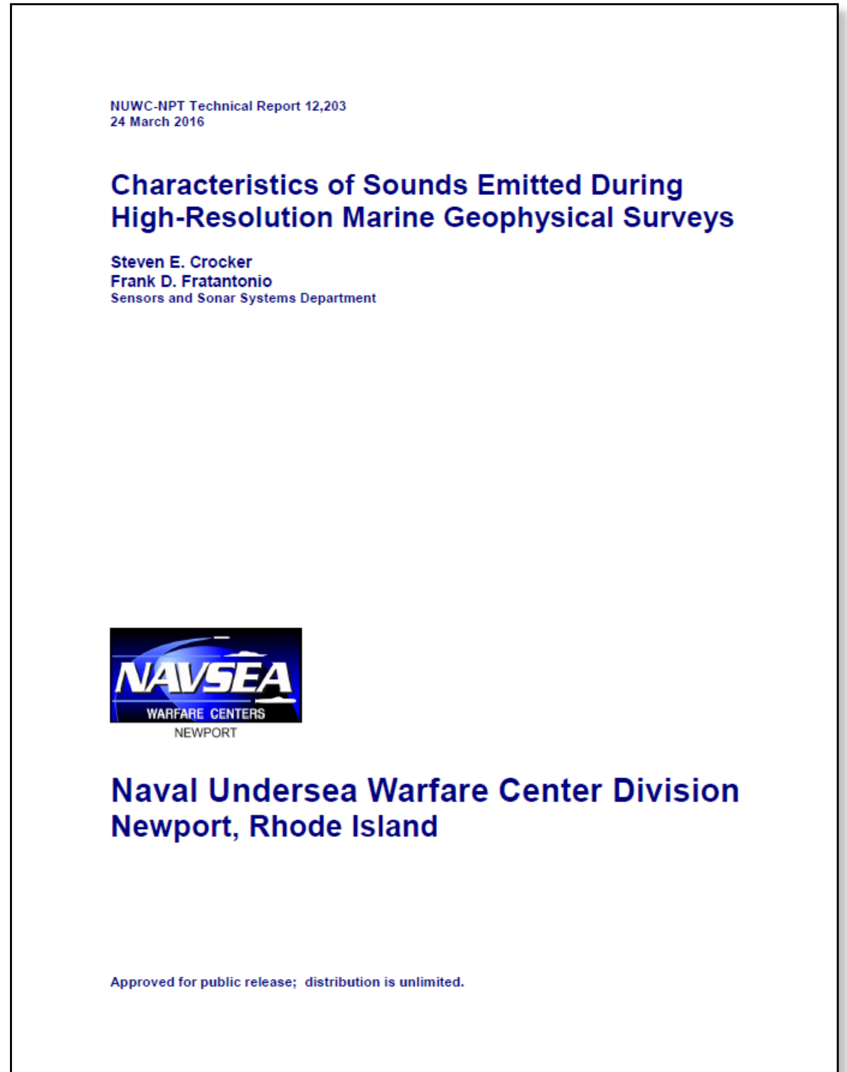
The United States Geological Survey (USGS) was essential in this study with their contribution of equipment, manpower and technical expertise during the testing.

- Naval Undersea Warfare Center
  - Underwater Sound Reference Division
- U.S. Geological Survey
  - Coastal and Marine Geology Program
- Woods Hole Oceanographic Institution



NUWC-NPT Technical Report 12,203
24 March 2016

Characteristics of Sounds Emitted During High-Resolution Marine Geophysical Surveys

Steven E. Crocker
Frank D. Fratantonio
Sensors and Sonar Systems Department

NAVSEA WARFARE CENTERS NEWPORT

Naval Undersea Warfare Center Division Newport, Rhode Island

Approved for public release; distribution is unlimited.

Background

Marine Mammal Protection Act

The MMPA prohibits, with certain exceptions, the **"take"** of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.

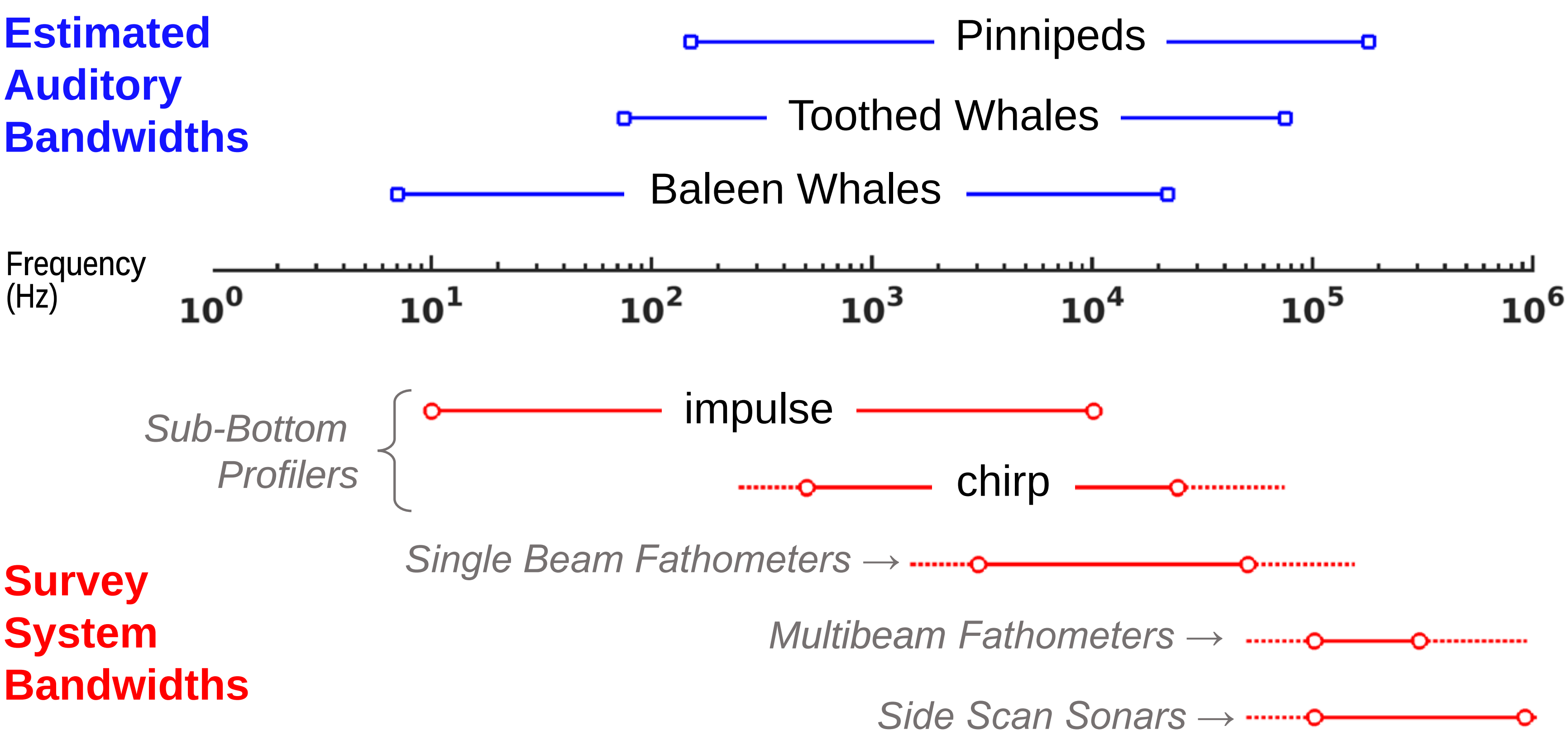
Definitions

Take: To harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.

Harass: Any act of pursuit, torment, or annoyance which - (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B].

Sources: Marine Mammal Protection Act (MMPA) Sec. 3 (18); http://www.nmfs.noaa.gov/pr/laws/mmpa/; http://www.boem.gov/BOEM-Science-Note-March-2015/

Background



Ref: Southhall et. al., 2007

Background

- **BOEM needed to address the following issues**
  - Project support for BOEM's 3 programs
    - Oil & Gas, Marine Minerals and Renewable Energy
  - Wide range of source types and models
    - Seafloor mapping and sub-bottom profiling systems
  - Concentrate on shallow water
    - U.S. Exclusive Economic Zone (EEZ)
  - Calibrated acoustic data
    - Validate future analyses
    - Environmental compliance documents
  - Examine current "hot" issues
    - Harmonics, sub-harmonics, SPL, SEL, etc.

Study Scope

Sea Floor Mapping		Sub-Bottom Profiling	
System	**Description**	**System**	**Signal**
Echotrac CV100	Single-Beam Echosounders	AA* 200	Impulse
Reson 7111	Multibeam Echosounders	AA* 251	Impulse
Reson T20-P	Multibeam Echosounders	AA* S-Boom	Impulse
Bathyswath SWATHPlus-M	Interferometer	FSI** Bubble Gun	Impulse
Klein 3000	Side-Scan Sonar	SIG ELC 820 Spark	Impulse
Klein 3900	Side-Scan Sonar	AA* Dura Spark	Impulse
EdgeTech 4200	Side-Scan Sonar	AA* Delta Spark	Impulse
		Sercel GI Airgun	Impulse
		EdgeTech 424	FM Chirp
		EdgeTech 512i	FM Chirp
		Knudsen 3202	FM Chirp

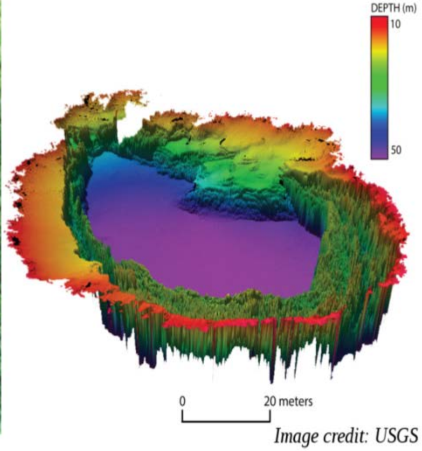
*Applied Acoustic Engineering, Ltd.
**Falmouth Scientific, Inc.

Study Scope

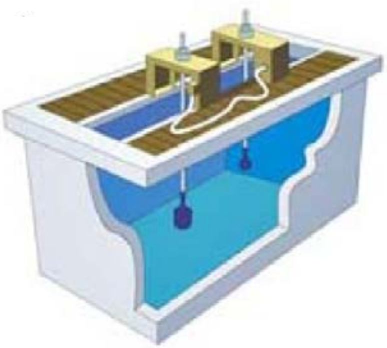
Source level (rms 90%)	dB re 1μPa@1m
Peak acoustic pressure	dB re 1μPa@1m
Peak-to-peak acoustic pressure	dB re 1μPa@1m
Sound exposure level	dB re 1μPa^2s@1m
Spectrum level	dB re 1μPa^2/Hz@1m
Effective (90%) pulse width	second
Half-power (3 dB) bandwidth	Hz
Beam patterns	dB
Half-power (3 dB) beam width	degree
10 dB beam width	degree
Principal side lobe level	dB
Principal side lobe location	degree

Acoustic Test Facilities

NUWC, Leesburg, FL



NUWC, Newport, RI



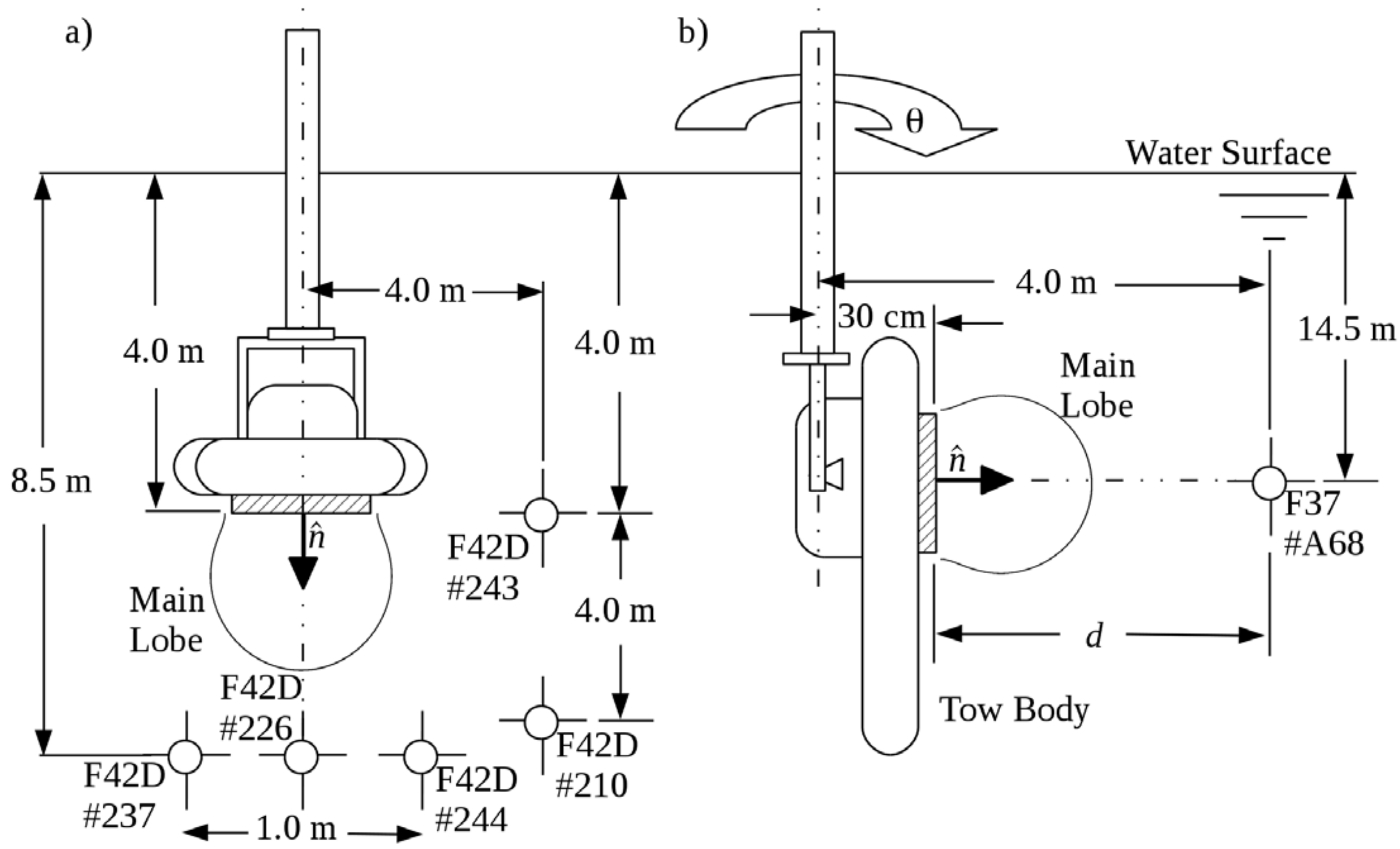
WHOI, Woods Hole, MA

EdgeTech 512i
Sub-Bottom Profiler

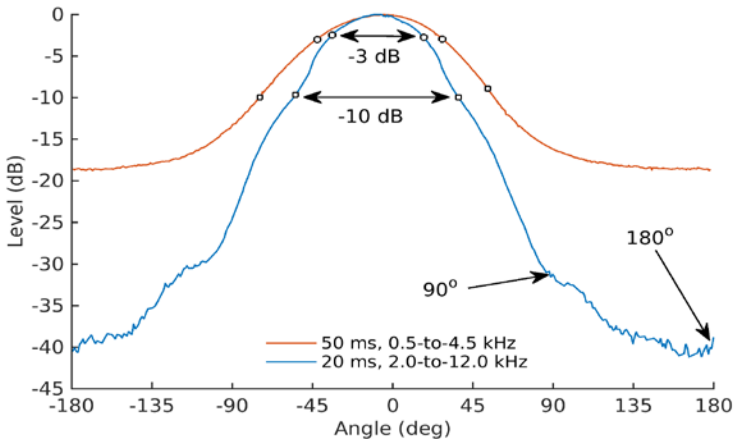
a) Source Levels

b) Beampatterns

EdgeTech 512i
Sub-Bottom Profiler



EdgeTech 512i Sub-Bottom Profiler



Source Settings			Beamwidth (degrees)		Gain (dB)	
Power (%)	Pulse Width (ms)	Bandwidth (kHz)	-3 dB	-10 dB	90°	180°
100	20	2.0 to 12.0	51	91	-31	-40
100	40	1.0 to 6.0	66	112	-27	-31
100	5	1.0 to 10.0	65	110	-29	-32
100	20	0.7 to 12.0	60	99	-26	-29
100	5	0.5 to 8.0	70	108	-25	-26
100	30	0.5 to 7.2	71	112	-24	-26
100	20	0.5 to 7.0*	71	127	-20	-26
100	9	0.5 to 6.0	65	108	-23	-25
100	50	0.5 to 4.5	70	128	-16	-19
100	40	0.4 to 4.0*	80	153	-15	-20
100	100	0.5 to 2.7	74	150	-16	-22

* Wideband

Source Settings			Source Level (dB re 1µPa@1m)				Pulse Width (ms)	Bandwidth 3 dB (kHz)
Power (%)	Pulse Width (ms)	Bandwidth (kHz)	Pk-Pk	Pk	RMS	SEL		
50	40	1.0 to 6.0	182	176	170	152	15.0	3.2 to 4.4
50	5	1.0 to 10.0	182	176	172	145	2.0	4.0 to 7.7
50	20	2.0 to 12.0	183	177	173	152	9.0	5.7 to 8.9
50	40	0.4 to 4.0	177	172	165	149	25.4	1.1 to 2.1
50	100	0.5 to 2.2	178	173	166	152	42.3	1.2 to 1.9
50	50	0.5 to 4.5	176	170	164	149	27.9	2.4 to 3.6
50	9	0.5 to 6.0	181	175	169	145	3.9	2.8 to 4.7
50	20	0.5 to 7.0	184	178	171	153	14.4	3.3 to 5.5
50	30	0.5 to 7.2	182	176	171	151	11.6	3.3 to 4.8
50	5	0.5 to 8.0	184	176	171	143	1.9	2.7 to 6.2
50	20	0.7 to 12.0	183	177	172	152	9.0	5.2 to 8.6
75	40	1.0 to 6.0	185	179	174	155	14.4	3.2 to 4.4
75	5	1.0 to 10.0	186	180	175	148	2.0	4.0 to 7.7
75	20	2.0 to 12.0	187	181	176	156	9.1	5.7 to 9.0
75	40	0.4 to 4.0	183	178	169	153	25.6	1.1 to 1.8
75	100	0.5 to 2.2	182	176	170	156	40.2	1.3 to 1.8
75	50	0.5 to 4.5	179	173	167	152	27.8	2.4 to 3.4
75	9	0.5 to 6.0	186	181	173	148	3.7	2.7 to 4.7
75	20	0.5 to 7.0	187	182	175	157	14.7	3.4 to 6.0
75	30	0.5 to 7.2	186	180	174	155	11.2	3.4 to 4.9
75	5	0.5 to 8.0	186	180	174	147	1.8	2.7 to 6.3
75	20	0.7 to 12.0	187	181	176	156	9.0	5.2 to 8.6
100	40	1.0 to 6.0	189	183	176	158	14.4	3.2 to 4.5
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100	20	2.0 to 12.0	190	184	179	159	9.1	5.7 to 9.0
100	40	0.4 to 4.0	188	184	172	156	25.2	1.0 to 1.9
100	100	0.5 to 2.2	187	181	175	160	35.7	1.4 to 1.8
100	50	0.5 to 4.5	182	176	170	154	27.8	1.8 to 3.6
100	9	0.5 to 6.0	190	185	175	151	3.6	2.7 to 4.8
100	20	0.5 to 7.0	191	186	178	159	14.6	1.8 to 6.0
100	30	0.5 to 7.2	191	184	177	157	11.3	3.3 to 5.2
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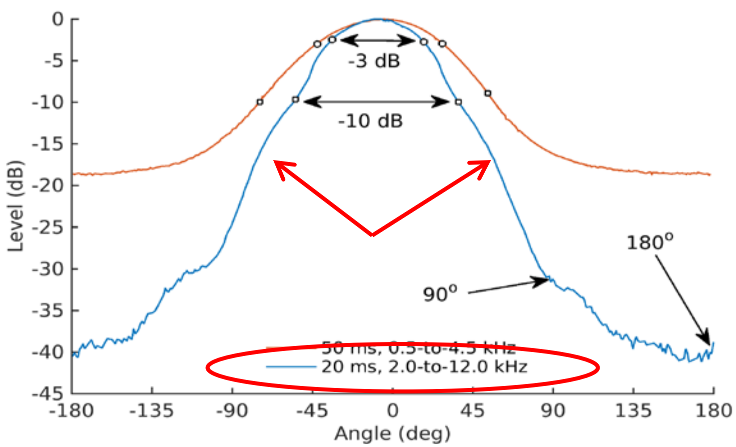
* Wideband

EdgeTech 512i Sub-Bottom Profiler



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50	100	0.5 to 2.2	178	173	166	152	42.3	1.2 to 1.9
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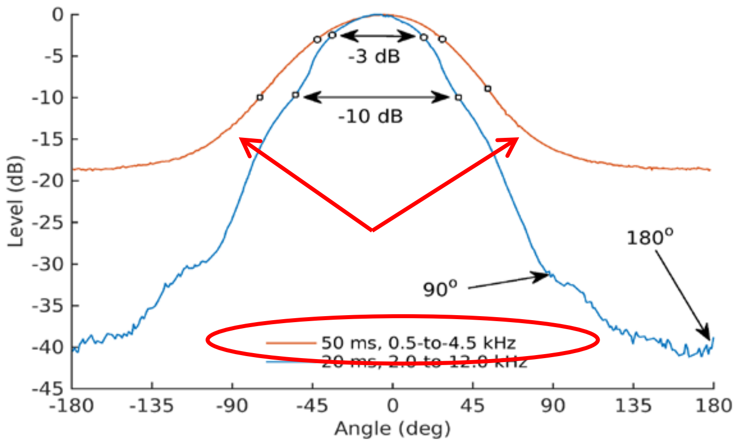
50	20	0.7 to 12.0	183	177	172	152	9.0	5.2 to 8.6
75	40	1.0 to 6.0	185	179	174	155	14.4	3.2 to 4.4
75	5	1.0 to 10.0	186	180	175	148	2.0	4.0 to 7.7
75	20	2.0 to 12.0	187	181	176	156	9.1	5.7 to 9.0
75	40	0.4 to 4.0	183	178	169	153	25.6	1.1 to 1.8
75	100	0.5 to 2.2	182	176	170	156	40.2	1.3 to 1.8
75	50	0.5 to 4.5	179	173	167	152	27.8	2.4 to 3.4
75	9	0.5 to 6.0	186	181	173	148	3.7	2.7 to 4.7
75	20	0.5 to 7.0	187	182	175	157	14.7	3.4 to 6.0
75	30	0.5 to 7.2	186	180	174	155	11.2	3.4 to 4.9
75	5	0.5 to 8.0	186	180	174	147	1.8	2.7 to 6.3
75	20	0.7 to 12.0	187	181	176	156	9.0	5.2 to 8.6
100	40	1.0 to 6.0	189	183	176	158	14.4	3.2 to 4.5
100	5	1.0 to 10.0	188	182	178	151	2.0	4.0 to 7.7
100	20	2.0 to 12.0	190	184	179	159	9.1	5.7 to 9.0
100	40	0.4 to 4.0	188	184	172	156	25.2	1.0 to 1.9
100	100	0.5 to 2.2	187	181	175	160	35.7	1.4 to 1.8
100	50	0.5 to 4.5	182	176	170	154	27.8	1.8 to 3.6
100	9	0.5 to 6.0	190	185	175	151	3.6	2.7 to 4.8
100	20	0.5 to 7.0	191	186	178	159	14.6	1.8 to 6.0
100	30	0.5 to 7.2	191	184	177	157	11.3	3.3 to 5.2
100	5	0.5 to 8.0	191	184	177	150	1.8	2.8 to 6.6
100	20	0.7 to 12.0	189	183	179	158	9.0	5.2 to 8.6

* Wideband

EdgeTech 512i Sub-Bottom Profiler



Source Settings			Beamwidth (degrees)		Gain (dB)	
Power (%)	Pulse Width (ms)	Bandwidth (kHz)	-3 dB	-10 dB	90°	180°
100	20	2.0 to 12.0	51	91	-31	-40
100	40	1.0 to 6.0	66	112	-27	-31
100	5	1.0 to 10.0	65	110	-29	-32
100	20	0.7 to 12.0	60	99	-26	-29
100	5	0.5 to 8.0	70	108	-25	-26
100	30	0.5 to 7.2	71	112	-24	-26
100	20	0.5 to 7.0*	71	127	-20	-26
100	9	0.5 to 6.0	65	108	-23	-25
100	50	0.5 to 4.5	70	128	-16	-19
100	40	0.4 to 4.0*	80	153	-15	-20
100	100	0.5 to 2.7	74	150	-16	-22

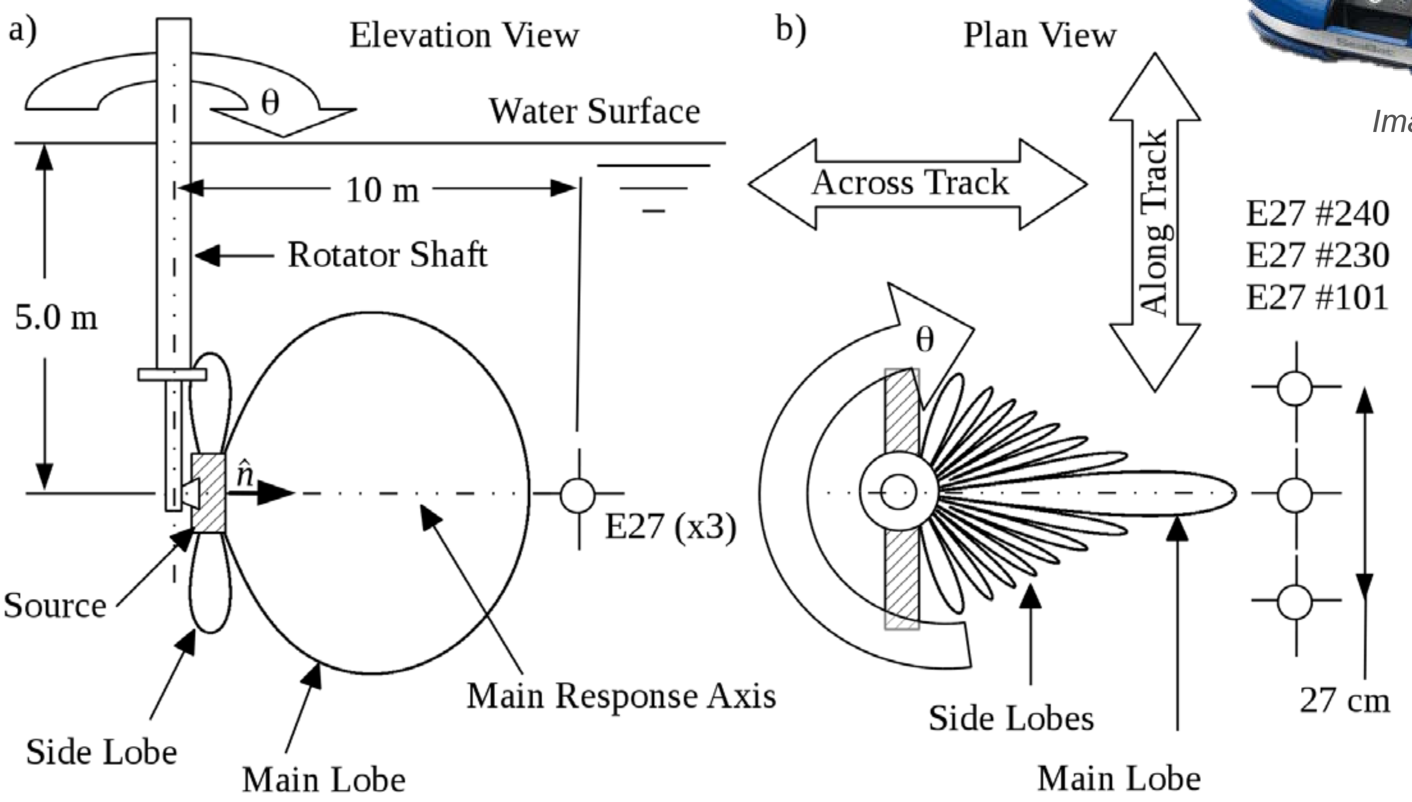
* Wideband

Source Settings			Source Level (dB re 1μPa@1m)				Pulse Width (ms)	Bandwidth 3 dB (kHz)
Power (%)	Pulse Width (ms)	Bandwidth (kHz)	Pk-Pk	Pk	RMS	SEL		
50	40	1.0 to 6.0	182	176	170	152	15.0	3.2 to 4.4
50	5	1.0 to 10.0	182	176	172	145	2.0	4.0 to 7.7
50	20	2.0 to 12.0	183	177	173	152	9.0	5.7 to 8.9
50	40	0.4 to 4.0	177	172	165	149	25.4	1.1 to 2.1
50	100	0.5 to 2.2	178	173	166	152	42.3	1.2 to 1.9
50	50	0.5 to 4.5	176	[illegible]	164	149	27.9	2.4 to 3.6
50	9	0.5 to 6.0	181	175	169	145	3.9	2.8 to 4.7
50	20	0.5 to 7.0	184	178	171	153	14.4	3.3 to 5.5
50	30	0.5 to 7.2	182	176	171	151	11.6	3.3 to 4.8
50	5	0.5 to 8.0	184	176	171	143	1.9	2.7 to 6.2
50	20	0.7 to 12.0	183	177	172	152	9.0	5.2 to 8.6
75	40	1.0 to 6.0	185	179	174	155	14.4	3.2 to 4.4
75	5	1.0 to 10.0	186	180	175	148	2.0	4.0 to 7.7
75	20	2.0 to 12.0	187	181	176	156	9.1	5.7 to 9.0
75	40	0.4 to 4.0	183	178	169	153	25.6	1.1 to 1.8
75	100	0.5 to 2.2	182	176	170	156	40.2	1.3 to 1.8
75	50	0.5 to 4.5	179	[illegible]	167	152	27.8	2.4 to 3.4
75	9	0.5 to 6.0	186	181	173	148	3.7	2.7 to 4.7
75	20	0.5 to 7.0	187	182	175	157	14.7	3.4 to 6.0
75	30	0.5 to 7.2	186	180	174	155	11.2	3.4 to 4.9
75	5	0.5 to 8.0	186	180	174	147	1.8	2.7 to 6.3
75	20	0.7 to 12.0	187	181	176	156	9.0	5.2 to 8.6
100	40	1.0 to 6.0	189	183	176	158	14.4	3.2 to 4.5
100	5	1.0 to 10.0	188	182	178	151	2.0	4.0 to 7.7
100	20	2.0 to 12.0	190	184	179	159	9.1	5.7 to 9.0
100	40	0.4 to 4.0	188	184	172	156	25.2	1.0 to 1.9
100	100	0.5 to 2.2	187	181	175	160	35.7	1.4 to 1.8
100	50	0.5 to 4.5	182	[illegible]	170	154	27.8	1.8 to 3.6
100	9	0.5 to 6.0	190	185	175	151	3.6	2.7 to 4.8
100	20	0.5 to 7.0	191	186	178	159	14.6	1.8 to 6.0
100	30	0.5 to 7.2	191	184	177	157	11.3	3.3 to 5.2
100	5	0.5 to 8.0	191	184	177	150	1.8	2.8 to 6.6
100	20	0.7 to 12.0	189	183	179	158	9.0	5.2 to 8.6

* Wideband

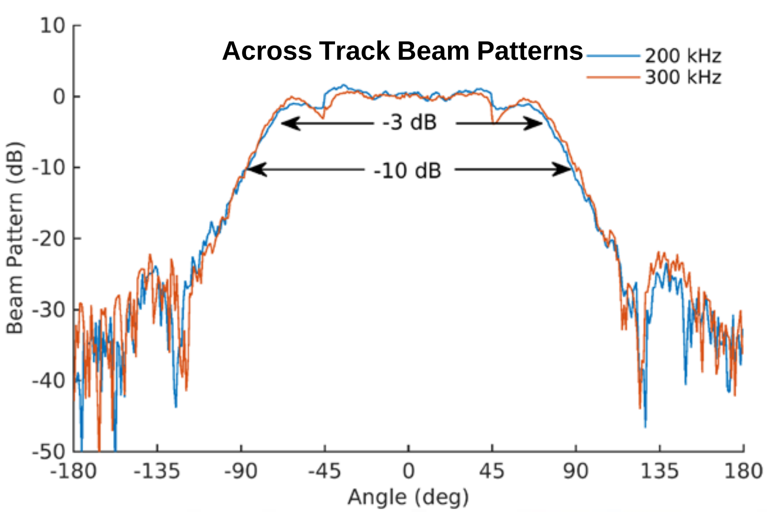
Seabat T20-P Multibeam Fathometer

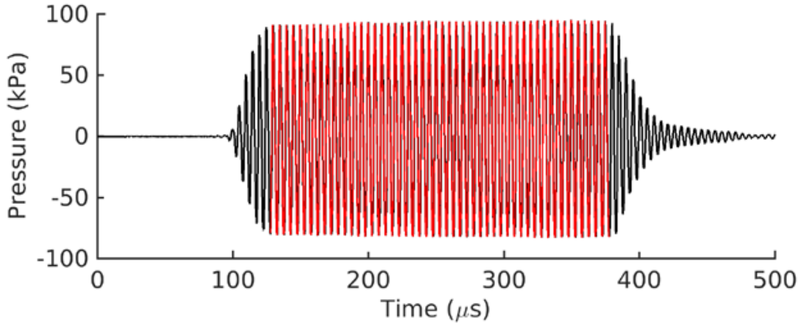
Image: Teledyne Reson

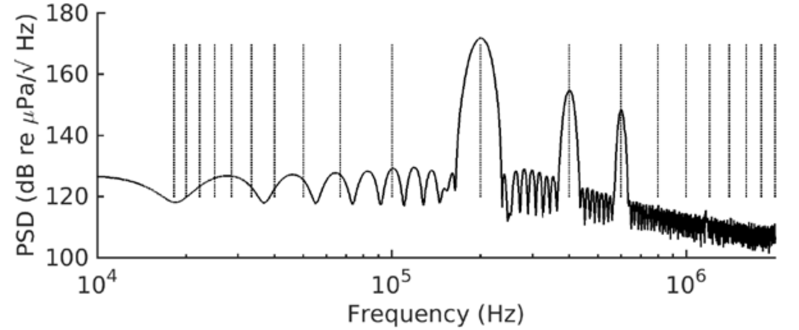


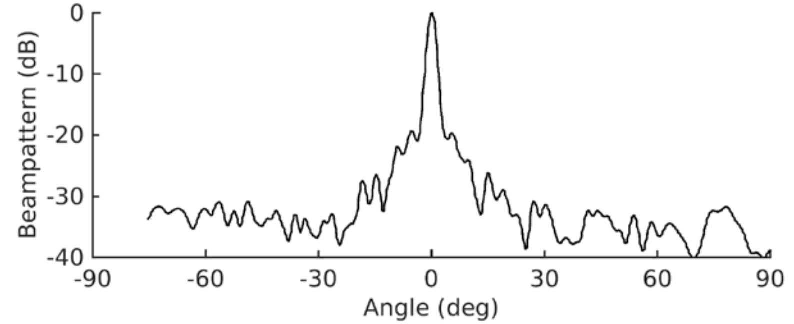
Seabat T20-P Multibeam Fathometer

Source Settings			Source Level (dB re 1µPa@1m)				Effective Pulse Width (µs)
Freq. (kHz)	Source Level (dB)	Pulse Width (µs)	Pk-Pk	Pk	RMS	SEL	
200	220	300	226	221	218	182	250
200	205	300	213	208	204	168	248
200	190	300	193	187	184	150	254
300	220	300	232	227	221	185	253
300	205	300	215	210	205	169	252
300	190	300	197	191	185	149	254
400	220	300	229	223	220	184	254
400	205	300	214	208	204	168	257
400	190	300	197	191	185	150	269



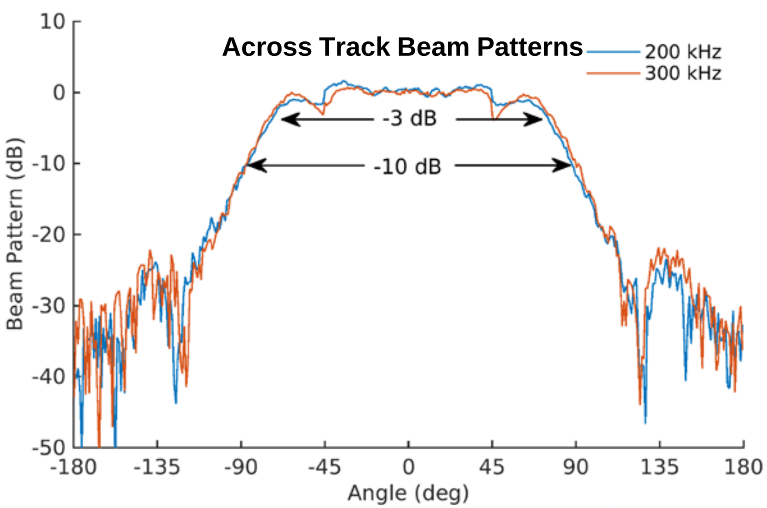


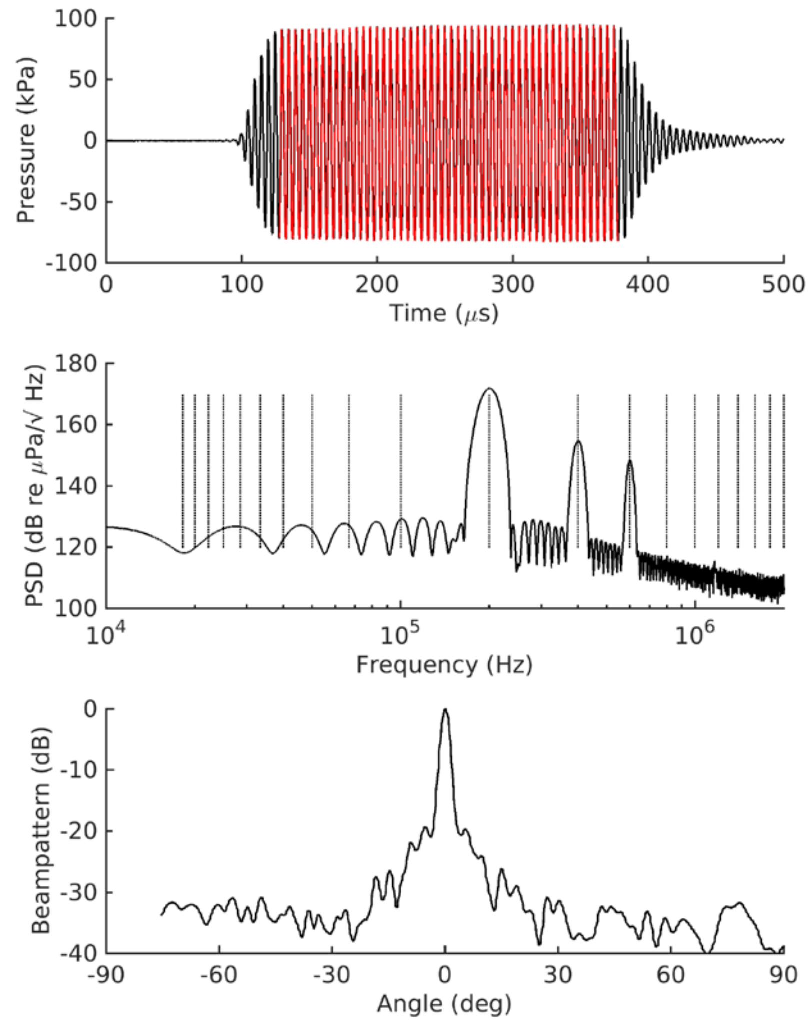




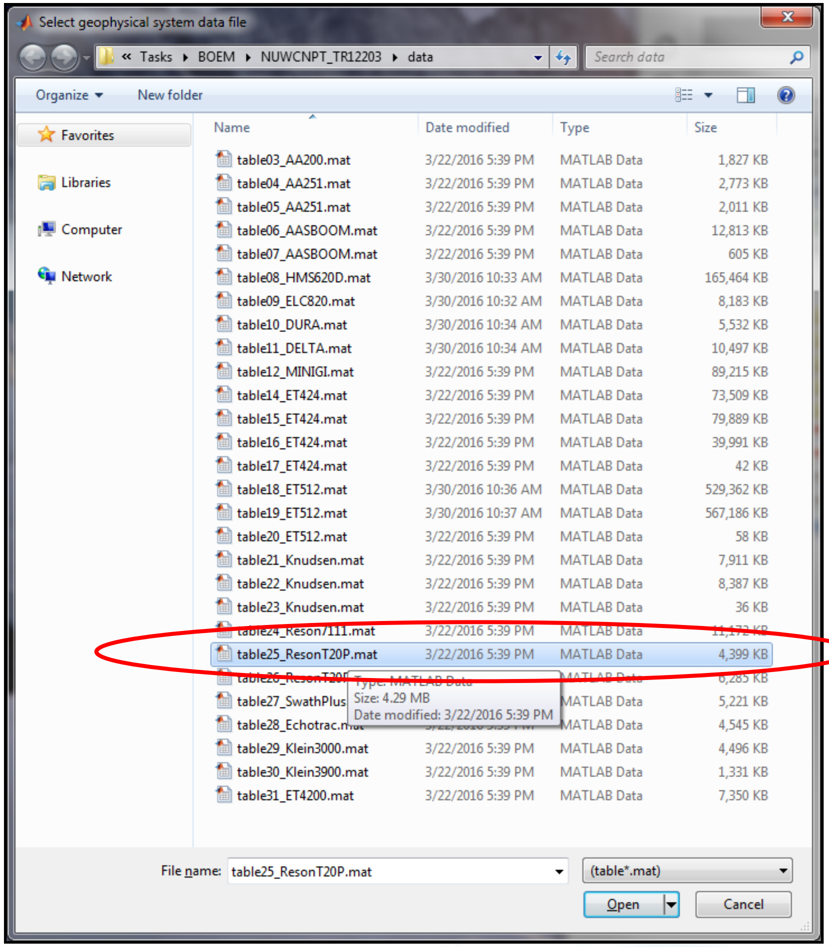
Seabat T20-P Multibeam Fathometer

Source Settings			Source Level (dB re 1μPa@1m)				Effective Pulse Width (μs)
Freq. (kHz)	Source Level (dB)	Pulse Width (μs)	Pk-Pk	Pk	RMS	SEL	
200	220	300	226	221	218	182	250
200	205	300	213	208	204	168	248
200	190	300	193	187	184	150	254
300	220	300	232	227	221	185	253
300	205	300	215	210	205	169	252
300	190	300	197	191	185	149	254
400	220	300	229	223	220	184	254
400	205	300	214	208	204	168	257
400	190	300	197	191	185	150	269





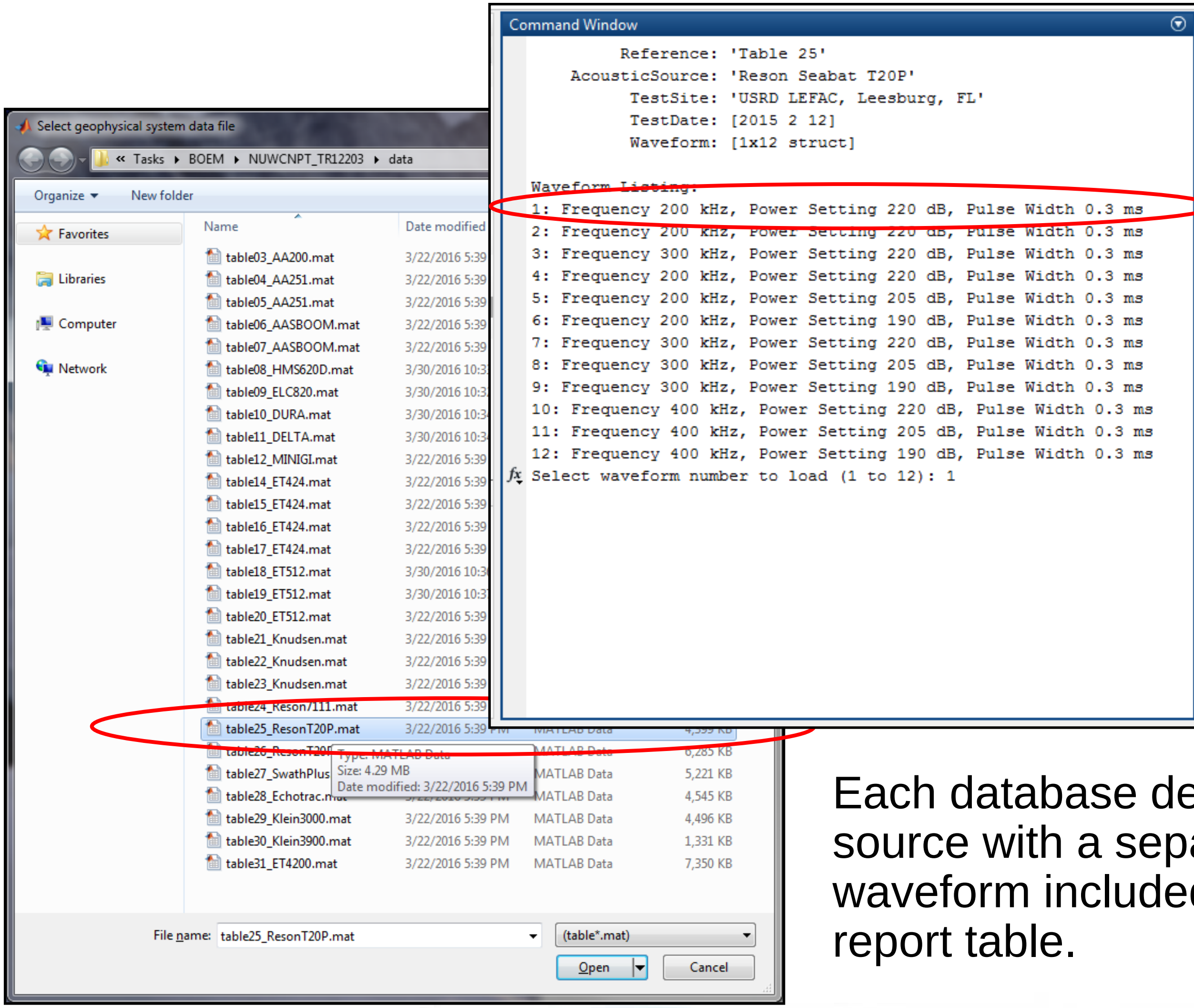
Seabat T20-P Multibeam Fathometer



A comprehensive database of calibrated acoustic data for all survey systems included in the study were delivered.

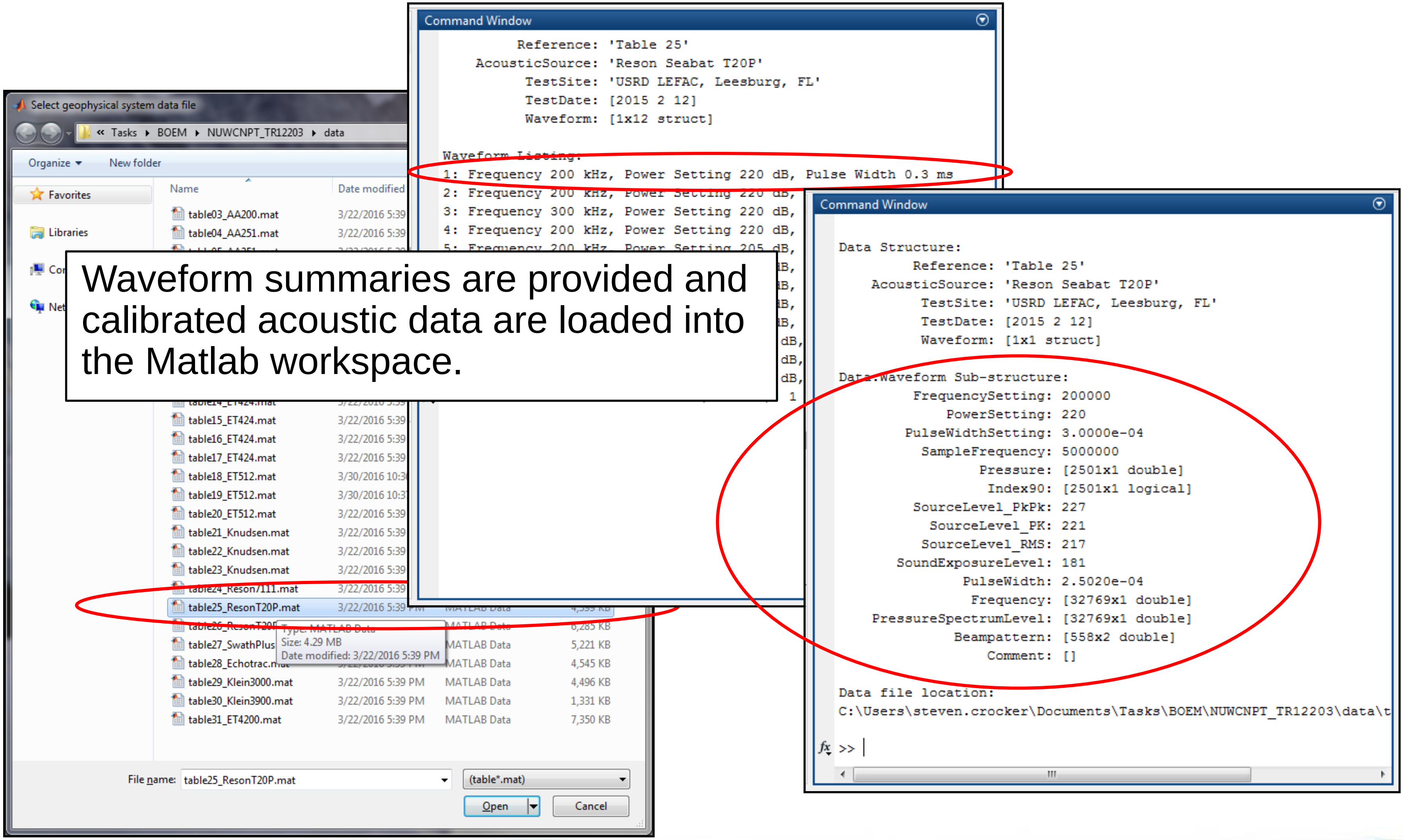
Individual databases are cross-referenced to data tables included in the final report.

Seabat T20-P Multibeam Fathometer



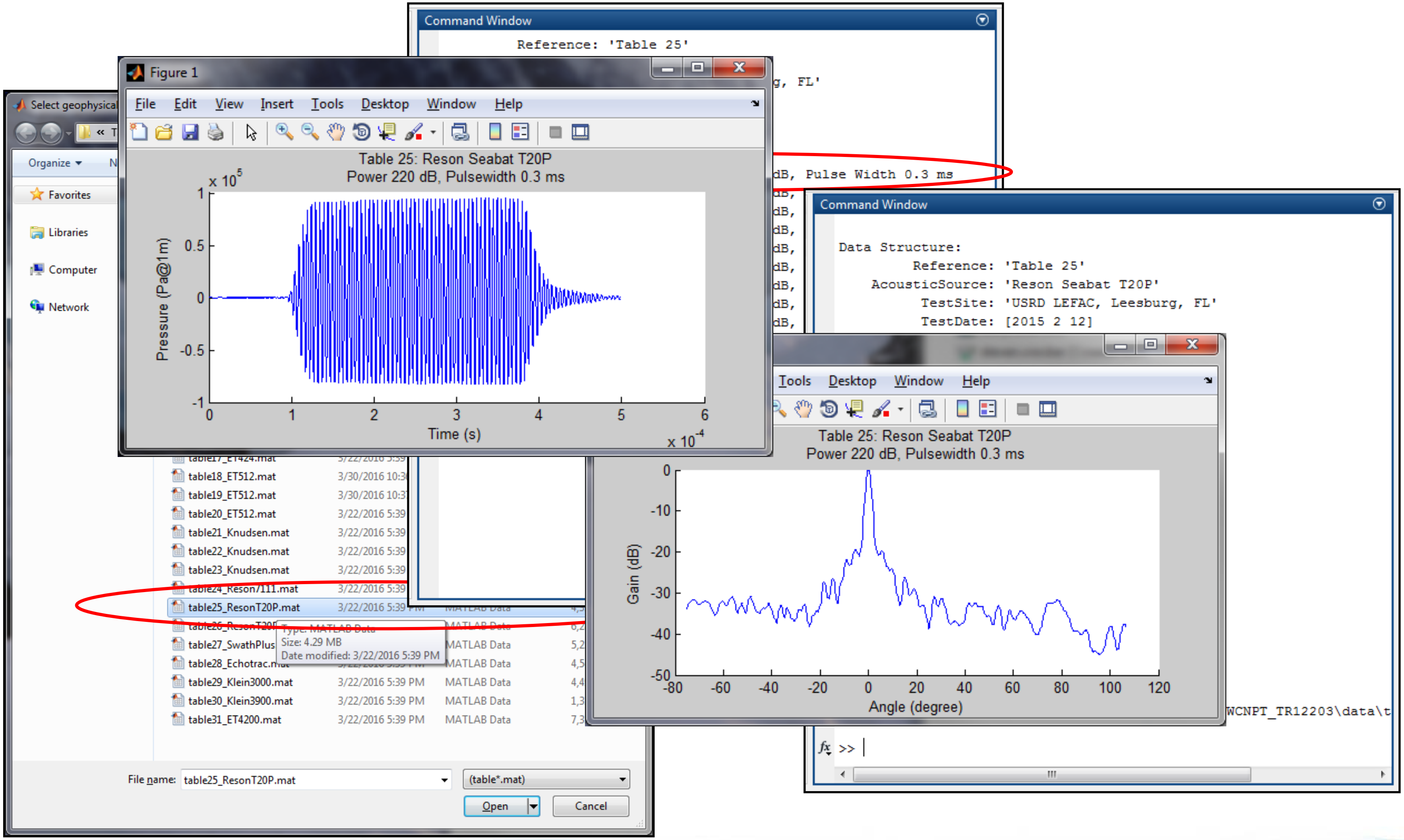
Each database describes a single source with a separate record for each waveform included in the corresponding report table.

Seabat T20-P Multibeam Fathometer

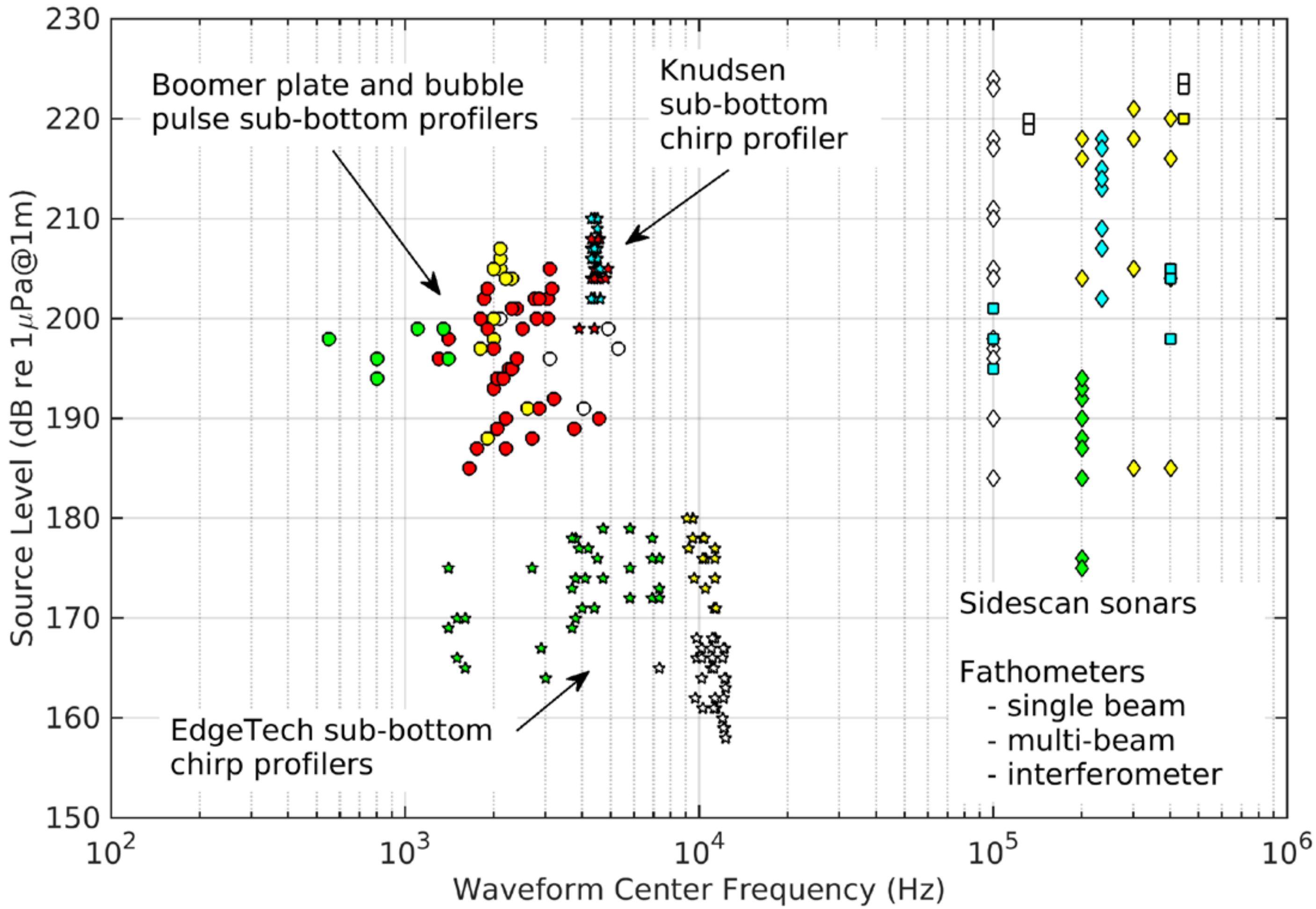


Waveform summaries are provided and calibrated acoustic data are loaded into the Matlab workspace.

Seabat T20-P Multibeam Fathometer



Measurement Summary



Conclusion

The Bureau of Ocean Energy Management funded a study, performed by the U.S. Navy and U.S. Geological Survey to acquire and analyze calibrated acoustic source data for a number of commonly used geophysical survey systems.

The report provides detailed acoustic characterizations for a wide variety of commercial survey systems. The full report will be available at: http://www.boem.gov/Studies/

In addition, a database of calibrated acoustic waveform data was delivered to aid in future studies to understand the potential ecological risks posed by the operation of certain high-resolution marine geophysical survey systems.

Science-Informed Decisions from Use-Inspired Research

BOEM's Environmental Studies Program

Dr. Brad Blythe
Chief, Branch of Biological and Social Sciences

BOEM MISSION

Manage ocean energy and mineral resources on the Outer Continental Shelf in a safe and environmentally sound manner.

PROGRAM AREAS

Oil & Gas

5-year leasing plan

Regional lease sales

Renewable Energy

Site identification through stakeholder input and state task forces

Marine Minerals

Through negotiated agreement with state and local entities

ENVIRONMENTAL PROGRAMS MISSION

To study and prevent environmental harm from energy development and minerals extraction on the Outer Continental Shelf



ENVIRONMENTAL STUDIES PROGRAM PRINCIPLES

Remain **use-inspired** to apply results towards management decisions

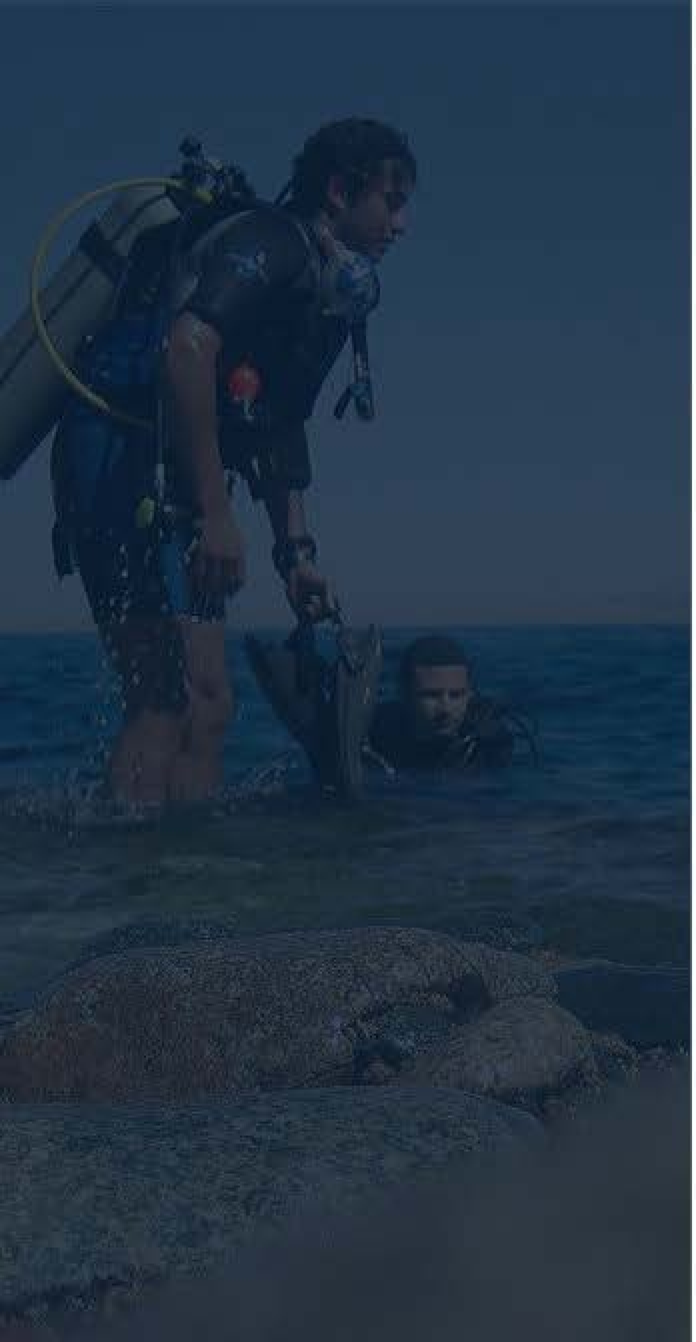
Adhere to the utmost levels of **scientific integrity** and credibility

Seek partnerships to leverage funds and maximize utility of results

Engage regularly with stakeholders and public educational outreach for quality assurance, peer-review planning, and data dissemination

Seek Stakeholder Input

- **Science** Forums
- Annual Request for **Study Ideas**
- **Regional** and **Office** Engagement
- **Public Meetings** Task forces



STUDY DEVELOPMENT PLAN

Allows **ideas to flow**
with a look toward the future

FY17/FY18 Proposed Studies

- Continuing Nanotag studies to include interactions with Block Island Wind Farm
- Studying Fish Auditory Thresholds
- Improving detection and data analysis of acoustic methods

FY17/FY18 Proposed Studies

- Addressing risk assessment of activities on whales
- Ecological function and recovery at sand shoals
- Biogliders: marine animals as telemetry sensors

FY17/FY18 Proposed Studies

- Continuing Deepwater coral studies
- Ecosystem services approach to assessing impacts
- Development of an Atlantis Model for strategic planning and cumulative impacts

Break Out Groups

- Divide into 4 groups, generally you can stay where you are sitting
- Spend approximately 20 minutes hearing suggestions for future directions
- Reconvene and hear summaries from each group

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under US administration.

The Bureau of Ocean Energy Management

As a bureau of the Department of the Interior, the Bureau of Ocean Energy (BOEM) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS) in an environmentally sound and safe manner.

The BOEM Environmental Studies Program

The mission of the Environmental Studies Program (ESP) is to provide the information needed to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments.