Report and Recommendations on Fisheries Resource Data Production, Storage and Accessibility

ROSA Report 22-01

Responsible Offshore Science Alliance

September 2022

Background

The ROSA Advisory Council (AC), during discussions at its initial meeting in September 2020, established “data management and standardization” as a priority, and identified a role for ROSA in “setting protocols and formats.” This concept was further developed and prioritized as “Data Management” at the second AC meeting in November 2020, and a potential approach forward was developed, starting with establishing a ROSA committee to make recommendations on achieving this goal. The committee met in March 2021 and drafted a Request for Proposals (RFP), which was finalized and in April 2021. Four responses were received.

Following evaluation of all responses and selection of a contractor, a Statement of Work was developed and agreed with the contractor, RPS. A first draft report was received from RPS in October 2021, and was reviewed by ROSA staff. Corrections and suggestions were provided to RPS in November 2021. A revised final report was received in December 2021, and was shared with the committee (now called the “Data Accessibility” committee) for evaluation. A presentation of results was made by RPS at the December 2021 AC meeting, and feedback from the AC and other attendees was collected. This feedback and responses solicited from the committee were sent to RPS; these were incorporated into the final report in late May 2022. This report is included in full, below.

Recommendations were drafted, presented to the Data Accessibility committee, revised, and then reviewed by the committee. The recommendations were generally acceptable to the committee, although some dissent was expressed.

Report Description and Summary

RPS was contracted by the Responsible Offshore Science Alliance (ROSA) to create a general typology of the types of fisheries resources data collected in the Northeast and Mid-Atlantic by various entities, to summarize the range of sampling gear and monitoring methods in use, and review existing standards and databases to summarize their metadata and identify any gaps that might be addressed to improve accessibility and interoperability of fisheries-related data and its application to offshore wind energy (OWE) permitting, monitoring, and impact assessment.

Current available guidelines and state of knowledge on fisheries data management for surveys most relevant to OWE are reviewed and summarized in Section 2. Section 3 describes the range of fisheries data types and summarizes the metadata needs for various surveys and gear types. Detailed descriptions of existing databases and standards for raw data, metadata, oceanographic data, and derived data products are found in Section 4. These descriptions include information on data standards, accessibility, storage, and funding. Finally, opportunities for standardization between data gathering efforts and provide some general recommendations for fisheries data management are described in Section 5.

Summary of Findings

A brief summary of the report includes three conclusions:

1. Currently, privately collected data for which a database does not exist must be hosted on the developer’s website or made directly available to users by request. This includes most types of operational data.

2. Data should be collected in a format that is compatible with existing surveys and databases through development and inclusion of standardized protocols, effort data, and metadata.

3. Offshore wind developers should emulate sampling protocols and gear designs consistent with regional-scale data collection programs wherever possible, but must also include surveys that can detect effects at their specific sites.

ROSA Recommendations

Based on the report and consultation among the committee, the following four recommendations were developed:

1. The Statement of Work has been adequately addressed, and the report should be shared via the ROSA website and distribution to the ROSA network following addition of a disclaimer, recommended citation, summary of review process, and these recommendations.

2. The most critical regional need identified is storage, longevity, security, quality assurance and sharing of fisheries independent data related to offshore wind development. ROSA has begun working with relevant personnel at ACCSP and NEFSC and should continue this effort with other regional groups such as NEAMAP, SEAMAP, NROC and MARCO data portals, and IOOS, discussing lessons learned, Best Management Practices, data standards and next steps.

3. Building the structures that many stakeholders expect for OSW monitoring data will require dedicated time, money and investment including development of policies and agreements. This investment is beyond the scope of what ROSA can accomplish, and therefore ROSA will continue to advocate for inclusion of data handling and sharing plans by working with ROSA stakeholders, particularly developers and researchers, and via comments on draft documents, such as solicitations from state agencies for wind development, in meetings and elsewhere.

4. ROSA should also continue to expand the monitoring guidance by working to investigate, recommend, and, if necessary, develop data standards (data field requirements), and to encourage standardization of data collection, archiving, and access. ROSA will work with existing metadata guidance as the next step in this expansion. Examples of existing guidance and standards include the Darwin Core, ACCSP Standards, and the NEFSC Bottom Trawl Survey.

Contributions:

ROSA staff (in order of effort): Mike Pol, Research Director; Lyndie Hice-Dunton, Executive Director; Helen Henderson, Administrator

Committee (alphabetical): Bonnie Brady, Colleen Brust, Doug Christel, Tom Dameron, Greg DeCelles, Willy Goldsmith, Pat Halpin, Annie Hawkins, Fiona Hogan, Josh Kohut, Julia Livermore, Ruth Perry, Kathleen Reardon, Andy Lipsky, David Rudders, David Stormer, Kevin Wark, Carl Wilson

Disclaimer

The attached report by RPS Ocean Science has been reviewed by the Responsible Offshore Science Alliance (ROSA) staff and committee members and it has been approved for publication. The views and conclusions contained in the attached report are those of the authors and should not be interpreted as representing the opinions or policies of ROSA or the committee or their organizations.

Citation

Responsible Offshore Science Alliance (ROSA). 2022. Report and Recommendations on Fisheries Resource Data Production, Storage and Accessibility. ROSA Report 22-01. Prepared by M. Pol, ROSA, and Gabriella DiPreta, Alicia Morandi, Joseph Zottoli, and Stephen Davies, RPS Ocean Science, South Kingston, RI. rosascience.org/resources

FISHERIES RESOURCE DATA PRODUCTION, STORAGE, AND ACCESSIBILITY

Summary Report – Final

Prepared by:

RPS Ocean Science

Gabriella DiPreta, Alicia Morandi, Joseph Zottoli, and Stephen Davies

55 Village Square Drive

South Kingstown RI 02879

T +1 401 789 6224

E Alicia.Morandi@rpsgroup.com

Prepared for:

Responsible Offshore Science Alliance

Mike Pol and Lyndie Hice-Dunton

mike@rosascience.org Lyndie@rosascience.org

21-P-214525 ROSA Fisheries Resource Data Summary Report
V5
May 31, 2022

Contents

ACRONYM LIST

ACCSP: Atlantic Coastal Cooperative Statistics Program

ACT: Atlantic Cooperative Telemetry

ADEON: Atlantic Deepwater Ecosystem Observatory Network

ALSI: American Lobster Settlement Index

APAIS: Access Point Angler Intercept Survey

ASMFC: Atlantic States Marine Fisheries Commission

ATN: Animal Telemetry Network

ATN DAC: Animal Telemetry Network Data Assembly Center

AIS: Automatic Identification System

BOEM: Bureau of Ocean Energy Management

BRI: Biodiversity Research Institute

CMECS: Coastal and Marine Ecological Classification Standard

CFRF: Commercial Fisheries Research Foundation

CHTS: Coastal Household Telephone Survey

ComFIN: Commercial Fisheries Information Network

COP: Construction and Operations Plan

COPEPOD: Coastal and Oceanic Plankton Ecology, Production, and Observation Database

CS: Coastal Survey

CSDGM: Content Standard for Digital Geospatial Metadata

CT DEEP: Connecticut Department of Energy and Environmental Protection

DAC: Data Assembly Center

DE DFW: The Delaware Division of Fish and Wildlife

DOE: Department of Energy

eDNA: Environmental DNA

EM: Electric Monitoring

eVTR: electronic Vessel Trip Reports

ERDDAP: Environmental Research Division's Data Access Program

FACT: Florida Atlantic Coast Telemetry Project

FATE: Fisheries and the Environment

FES: Fishing Effort Survey

FHS: For-Hire Survey

FIN: Fisheries Information Network

FSCS: Fisheries Scientific Computer System

FWRI: Fish and Wildlife Research Institute

GA DNR: Georgia Department of Natural Resources

GAP: General Activities Plan

GARFO: Greater Atlantic Regional Fisheries Office

GBIF: Global Biodiversity Information Facility

GHRSST: Group for High Resolution Sea Surface Temperature

GMRI: Gulf of Maine Research Institute

GOOS: Global Ocean Observing System

GulfFIN: Gulf Fisheries Information Network

HMS: Highly Migratory Species

IOOS: Integrated Ocean Observing System

ISMN: Integrated Sentinel Monitoring Network

ISO: International Standardization Organization

IODE: International Ocean Exchange

LPS: Large Pelagics Survey

LPBS: Large Pelagics Biological Survey

LPIS: Large Pelagics Intercept Survey

LPTS: Large Pelagics Telephone Survey

MA DMF: Massachusetts Division of Marine Fisheries

MARMAP: Marine Resources Monitoring, Assessment, and Prediction

MassCEC: Massachusetts Clean Energy Center

MARACOOS: Mid-Atlantic Regional Association Coastal Ocean Observing System

MARMAP: Marine Resources Monitoring, Assessment and Prediction

MARCO: Mid-Atlantic Regional Council on the Ocean

MATOS: Mid-Atlantic Acoustic Telemetry Observation System

MBON: Marine Biodiversity Observation Network

ME DMR: Maine Department of Marine Resources

MD DNR: Maryland Department of Natural Resources

MOA: Memorandum of Agreement

MPA: Marine Protected Area

MRIP: Marine Recreational Information Program

MRFSS: Marine Recreational Fisheries Statistics Survey

MRRI: Marine Resources Research Institute

NCEI: National Centers for Environmental Information

NC CLS: North Carolina Coastal Longline Survey

NC DMF: North Carolina Division of Marine Fisheries

n.d: no date associated with a citation or website

NEAMAP: Northeast Area Monitoring Assessment Program

NEFOP: Northeast Fisheries Observer Program

NEFSC: Northeast Fisheries Science Center

NEODP: Northeast Ocean Data Portal

NERACOOS: Northeastern Regional Association of Coastal Ocean Observing Systems

NH MFD: New Hampshire Marine Fisheries Division

NMFS: National Marine Fisheries Service

NOAA: National Oceanic and Atmospheric Association

NODC: National Oceanographic Data Centre

NPS: National Parks Service

NREL: National Renewable Energy Laboratory

NRS: Ocean Noise Reference

NROC: Northeast Regional Ocean Council

NY DEC: New York Department of Environmental Conservation

NJ DEP: New Jersey Department of Environmental Protection

NYSERDA: New York State Energy Research and Development Authority

OBDBS: Observer and At Sea Monitor Database

OBIS: Ocean Biodiversity Information System

OBIS-SEAMAP: Ocean Biodiversity Information System – Spatial Ecological Analysis of Megavertebrate Populations

ORT: Ocean Report Tool

OSTIA: Operational Sea Surface Temperature and Ice Analysis

OTN: Ocean Tracking Network

OWE: Offshore wind energy

PSO: Protected Species Observer

PSS: Pamlico Sound Survey

RecFIN: Recreational Fisheries Information Network

RI DEM: Rhode Island Department of Environmental Management

RODA: Responsible Offshore Development Alliance

ROSA: Responsible Offshore Science Alliance

ROV: Remotely Operated Vehicle

SAFIS: Standard Atlantic Fisheries Information System

SAFMC: South Atlantic Fisheries Management Council

SAP: Site Assessment Plan

SC DNR: South Carolina Department of Natural Resources

SC DNR-MRD: South Carolina Department of Natural Resources – Marine Resources Division

SEAMAP: Southeast Area Monitoring and Assessment Program

SECOORA: Southeast Coastal Ocean Observing Regional Association

SEFIS: Southeast Fisheries Independent Survey

SEFSC: Southeast Fisheries Science Center

SERFS: Southeast Reef Fish Survey

SMAST: UMass Dartmouth School for Marine Science and Technology

SOA: Service Oriented Architecture

SPI/PV Sediment Profile Imaging and Plan View Imaging

SVDBS: Oracle Survey Database

THREDDS: Thematic Realtime Environmental Distributed Data Services

TNC: The Nature Conservancy

URI: University of Rhode Island

USFWS: U.S. Fish and Wildlife Service

VIMS: Virginia Institute of Marine Science

VMS: Vessel Monitoring System

VTR: Vessel Trip Reports

WEA: Wind Energy Area

WETO: Wind Energy Technologies Office

WoRMS: World Registry of Marine Species

WREN: Working Together to Resolve Environmental Effects of Wind Energy

1 INTRODUCTION AND SCOPE

RPS was contracted by the Responsible Offshore Science Alliance (ROSA) to create a general typology of the types of fisheries resources data collected in the Northeast and Mid-Atlantic by various entities, summarize the range of sampling gear and monitoring methods in use, and review existing standards and databases to summarize their metadata and identify any gaps that might be addressed to improve accessibility and interoperability of fisheries-related data and its application to offshore wind energy (OWE) permitting, monitoring, and impact assessment.

We reviewed and summarized the current available guidelines and state of knowledge on fisheries data management for surveys most relevant to OWE (Section 2). We describe the range of fisheries data types and summarize the metadata needs for various surveys and gear types (Section 3). We provide detailed descriptions of existing databases and standards for raw data, metadata, oceanographic data, and derived data products (Section 4). These descriptions include information on data standards, accessibility, storage, and funding. We compiled a list of over 110 current and historical surveys metadata information in an accompanying Excel file that contains links and various metadata recorded where possible to better view in one place the range of fisheries resource data collected. Finally, we summarize opportunities for standardization between data gathering efforts and provide some general recommendations for fisheries data management (Section 5).

2 FISHERIES DATA MANAGEMENT BACKGROUND

2.1 Data Collection Guidelines from BOEM for Offshore Wind Development and Monitoring

The Bureau of Ocean Energy Management (BOEM) has several guidelines available to help interpret regulatory requirements and clarify the survey and data needs for several aspects of renewable energy activities in the Outer Continental Shelf (OCS; BOEM 2021). BOEM refers to the Northeast Ocean Plan and the Mid-Atlantic Regional Ocean Action Plan as collections of best practices with respect to ocean science and use in these regions. The Northeast Ocean Data Portal and Mid-Atlantic Ocean Data Portal are companions to the plans that contain thousands of publicly available maps and spatial datasets that pertain to the marine environment (see Section 4.4.2 for details). BOEM relies on these portals in its decision-making and encourages lessees and applicants to make use of the datasets they contain for the analyses in their Site Assessment Plans, Construction and Operation Plans, and General Activities Plans (SAPs, COPs, and GAPs, respectively).

The guidelines within which fisheries-related data are discussed include:

1. Information Guidelines for a Renewable Energy COP (BOEM 2020a): These guidelines generally discuss the information required for submitting a COP. For fish resources, the guidelines state that

lessees should conduct pre-siting surveys to identify important, sensitive, or unique marine habitats near the project area. They also state that existing data may be used to fulfill this requirement if it is of sufficient quality and scope to allow BOEM to conduct their environmental review of potential impacts and mitigation needs, however, they do not go into detail on data standards or requirements.

2. Guidelines for Providing Information on Fisheries Social and Economic Conditions for Renewable Energy Development on the Atlantic OCS Pursuant to 30 CFR Part 585 (BOEM 2020b): These guidelines focus on writing a Fisheries Communication and Outreach Plan, a recommended best management practice for mitigating effects of OWE development on social and economic conditions and competing use of fish resources in the project area. The document cites several studies for lessees to review in order to understand stakeholder concerns and the potential impacts of their development on fisheries in their region but does not make any requirements or set standards for data management or delivery.

3. Guidelines for Providing Information on Fisheries for Renewable Energy Developments on the Atlantic OCS Pursuant to 30 CFR Part 585 (BOEM 2019); This document contains survey guidelines that rely heavily on a study titled “Developing Environmental Protocols and Modeling Tools to Support Renewable Energy and Stewardship” (McCann 2012) which contains information on relevant impact-producing factors of OWE on fish resources and appropriate protocols, equipment, and approaches for analysis.

4. Guidelines for Submission of Spatial Data for Atlantic Offshore Renewable Energy Development Site Characterization Surveys (BOEM 2013): This document outlines a framework for submitting spatial data that results from site characterization surveys, including benthic, geological, geophysical, hazards, archaeological, marine mammal, sea turtle, avian, and fisheries survey data. The purpose of the guidelines is to standardize data submission of digital maps with specific graphical elements and scales and a standardized spatial database.

The spatial data guidelines (BOEM 2013) also state that all biological data should be classified according to the Federal Geographic Data Committee’s approved Coastal and Marine Ecological Classification Standard (CMECS; FGDC 2012). CMECS is a hierarchical system of classification that organizes information about the marine environment and assigns classifications for the water column, geoform, substrate, biotic communities, biogeographic setting, and aquatic setting components. This system allows data collected by a variety of sensors and methods to be integrated into one database (Figure 1).

In addition, the spatial data guidelines (BOEM 2013) state that applicants should include metadata for each spatial feature in accordance with the FGDC Content Standard for Digital Geospatial Metadata (CSDGM) or International Standardization Organization’s (ISO) 19115 metadata format. The guidelines list several data portals with ocean data that may be relevant to OWE siting and baseline conditions (see Section 4.4) but do not indicate whether the portals will take survey data from OWE developers nor do the guidelines require OWE developers submit their data anywhere but to BOEM.

Recently, BOEM and NOAA Fisheries drafted a Federal Survey Mitigation Strategy to address data collection needs of offshore wind monitoring surveys and the long-running NOAA Fisheries federal survey programs, within which management of new data streams is mentioned briefly (Hare et al. 2022).

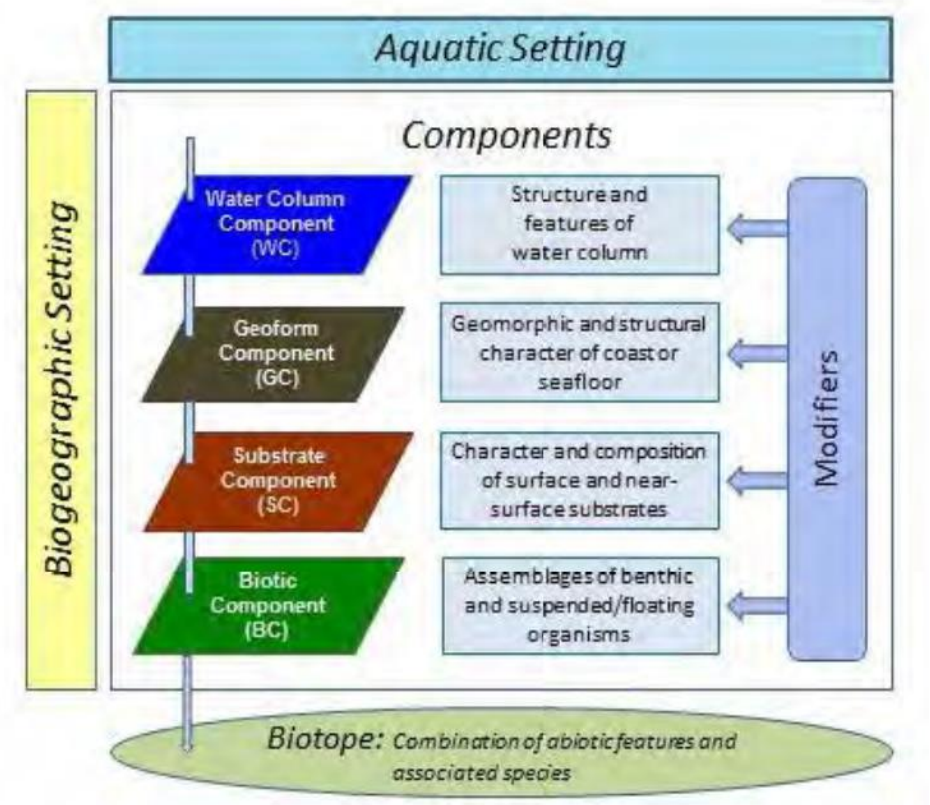


Figure 1. CMECS classification structure (FGDC 2012).

2.2 Studies of Fisheries Data Needs and Management

We reviewed several documents centered on fisheries or wildlife data needs, standardization, and management. As described in the International Council for the Exploration of the Sea User Handbook: Best Practice for Data Management (ICES 2019), successfully managed data should follow the FAIR principles:

- Findable – through documentation and metadata;
- Accessible – through licensing, formats, and data policies;
- Interoperable – through use of shared reference systems and services; and
- Reusable – by having known data quality and good documentation of any errors.

Data quality can be expressed through characteristics of timeliness, completeness, consistency, accuracy, and uniqueness/traceability. The documents reviewed in this section described various aspects of standardizing data quality and managing data according to FAIR principles.

2.2.1 NYSERDA/BRI Wildlife Data Standardization and Sharing

A study funded by New York State Energy Research and Development Authority (NYSERDA) and conducted by the Biodiversity Research Institute (BRI) reviewed key wildlife-focused databases to which raw or derived data products can be submitted (NYSERDA 2021). The goal was to facilitate transparency and sharing of environmental data for OWE development. Some of the databases the authors ranked and reviewed were relevant to fisheries resource data in addition to other wildlife (i.e., birds, bats, marine mammals, sea turtles). One of the main conclusions of the study was that "Benthos, zooplankton and fish data, Protected Species Observer (PSO) data, and some other data types are poorly served by extant databases (either because relevant databases do not exist, they do not accept private data, or do not permit public access to those data)" (NYSERDA 2021). Thus, raw fisheries resource data collected by OWE developers and other private entities on the east coast may not easily find an appropriate "home" for their data and run the risk of the data becoming unrecoverable or less useful to the region as a whole.

Of the many wildlife databases they reviewed, fifteen passed their criteria for relevance and utility such that the databases: 1) host data expected to be collected in large amounts by OWE developers, 2) have a public interface, 3) accept effort and metadata, 4) are easy to use, and 5) incorporate quality control processes. Six databases relevant to fisheries resource or habitat data met their criteria: one for passive acoustic monitoring (National Centers for Environmental Information (NCEI) Passive Acoustic Monitoring Archive, see Section 4.1.6); two for observational data (OBIS-SEAMAP for bony fishes and the National Database for Deep-Sea Corals and Sponges, see Section 4.1.4); and three databases for different types of tracking/telemetry data (see Section 4.1.7, and Section 4.1.8). None of the recommended databases house trawl, dredge, or pot surveys, which comprise the bulk of operational fisheries resource programs and monitoring and site assessment data collected for OWE.

The study concluded that data sharing plans agreements represent key opportunities to standardize data and make it available for meta-analyses or decision-making beyond the initial site assessment or monitoring uses. For projects selling power to New York State, a Data Availability Plan is required and must clearly describe the intended storage location and accessibility for all raw data, derived data products, and metadata (NYSERDA 2021).

2.2.2 NOAA/Ørsted Data Sharing Memorandum of Agreement

In 2021, National Oceanic and Atmospheric Association (NOAA) and Ørsted Wind Power North America LLC signed a Memorandum of Agreement (MOA) to create a framework for sharing, archiving, and distributing datasets created and owned by Ørsted, and for NOAA to share their publicly available data with Ørsted (NOAA and Ørsted 2021). The MOA states that "Data shared through this Agreement will assist Ørsted in its wind energy science needs and NOAA in meeting its mission and goals related to climate

adaptation and mitigation, weather-readiness, healthy oceans, and resilient coastal communities and economies."

Appendix A of the MOA details data sharing guidelines and best practices from NOAA for several kinds of environmental data, including air quality, water quality, emissions, meteorology, currents and waves, biological data, hydrographic surveys, mapping, and physical oceanography. The guidelines specify the file formats that are most suitable for long-term archiving, namely CSV, XML, SHP, ASCII, among others. The guidelines also state that biological data should be stored in tabular formats (spreadsheets and database tables) and be formatted following the Darwin Core standard, which facilities the sharing of information about biological diversity (TDWG 2021). Distinct events should be defined with a unique identifier like "sample_id" or "collection_event_id". For each taxa in the data, the common name, scientific name, and serial numbers/codes from either the ITIS (ITIS 2021) or World Registry of Marine Species (WoRMS) taxonomic databases should be included (WoRMS 2021).

Appendix A of the MOA also provides best practices for metadata and documentation. The ISO 19110 and 19115-2 standards are recommended for geospatial metadata and the Ecological Metadata Language (DCC 2021) is specified for ecological data. Additional guidance on creating machine-readable metadata can be found in the NOAA Data Documentation Procedural Directive (NOAA 2016).

Methods for providing data access include data access services, file transfer services, or direct hand-off of a hard copy of the data (least secure option). For *in-situ* observations and biological datasets in tabular form, the Environmental Research Division's Data Access Program (ERDDAP) should be used. ERDDAP is a NOAA-developed common data server that provides access to downloading and subsetting data and is open source so its appearance can be customized. It can also be linked to existing web services to access data (ERDDAP 2021). For gridded or model output data, the Thematic Realtime Environmental Distributed Data Services (THREDDS) can be used to access raster data stored in NetCDF formats (NOAA and Ørsted 2021). Once data is shared, NOAA may also permanently archive it into its repositories (NOAA NCEI, which accepts information from outside researchers, or other NOAA data centers) and make it available for public access with no restrictions on use or distribution.

2.2.3 Fishery Dependent Data Visioning Project

The Greater Atlantic Regional Fisheries Office (GARFO) and the Northeast Fisheries Science Center (NEFSC) are continuing work on a Fisheries Dependent Data Visioning Project to develop a data collection program that preserves archived data and ensures more timely data collection (GARFO and NEFSC 2017). The overall vision of the project is to develop a data structure to produce consistent and reliable data products using standardized codes, allow for easier access to data, and expedited access to trip level data (GARFO and NEFSC 2017). Not all fisheries may be represented as the project aims to incorporate federal and state data. The project focuses on data streams related primarily to electronic Vessel Trip Reports

(eVTR) and electronic monitoring of video footage aboard fishing vessels. The data flow aims to combine observer data, biological sampling, marine mammal takes, vessel monitoring data, permits, dealer and logbook accounts from different regions, and data managed by different entities into one warehouse to create comprehensive trip data (Douglas Christel, GARFO, personal communication; NOAA 2014). The goal is to track vessel landings through the development of a unique trip identifier that is automated and integrated through all of the fishery dependent data collection programs. The project involves collaboration between NMFS staff, state partners, fishery management councils and commissions, non-governmental organizations, fishing harvesters, dealers, and representatives, and the Atlantic Coastal Cooperative Statistics Program (ACCSP; see Section 4.1.1). The ACCSP will serve as the repository for all Federal and State fisheries dependent datasets (GARFO and NEFSC 2017).

2.2.4 Commercial Fisheries Research Foundation

A study funded by BOEM was conducted by the Commercial Fisheries Research Foundation (CFRF) and Cornell Cooperative Extension to create a best practices document for assessing impact of OWE development on fisheries resources in the Rhode Island/Massachusetts and New York Wind Energy Areas (WEAs; Petruny-Parker et al. 2015). This document includes suggested research protocols for pre-baseline, baseline, and ongoing monitoring surveys as well as specific species, life stages, and habitat types to investigate for impacts. The authors recommend leveraging existing sampling programs like the NOAA National Marine Fisheries Service (NMFS) NEFSC bottom trawl, scallop survey, and Northeast Area Monitoring Assessment Program (NEAMAP) surveys to detect regional-scale changes in fish community structure (see Section 4.1.2 for details). However, the authors highlight that the spatial scales and sampling designs are not sufficient for assessing individual OWE development impacts on fisheries resources, so targeted data collected within and around WEAs is still necessary. One of the report's major conclusions is that "Data management protocols need to ensure that all resultant data is publicly accessible and available for outside analysis" but do not further describe any protocols.

2.2.5 Responsible Offshore Development Alliance

The Responsible Offshore Development Alliance (RODA) is a coalition of fishing industry associations and fishing companies interested in improving the compatibility of OWE development with their businesses. RODA represents stakeholders who share a goal of coordinating science and policies to minimize conflicts of OWE development with existing, traditional, and historical fishing. To do this, they collaborate on several initiatives related to OWE and fisheries impacts (RODA 2021), including:

- Synthesis of the Science workshops,
- the Fisheries Knowledge Trust,

- research with the National Renewable Energy Laboratory (NREL), NYSERDA, NEFSC, and the Coonamessett Farm Foundation to document risk and constraints associated with fishing in and around fixed foundation OWE developments,
- partnering with the regional ocean councils to update the Northeast and Mid-Atlantic Ocean Data Portals with input from fishing industry representatives and organizations, and
- an ICES working group on OWE development and fisheries.

Many of these projects are currently underway and not yet published. Of most relevance to fisheries data management is the work on the Fisheries Knowledge Trust. This Trust is designed to allow fishermen the ability to maintain ownership and privacy of the data they collect, as well as use it to develop products in support of hypotheses that members want to investigate. NYSERDA has funded two pilot studies on surfclam/ocean quahog and herring/mackerel through which the foundation of the Trust was established, and the data standardization and platform will be developed.

2.2.6 Massachusetts Clean Energy Center Seafloor Habitat Data

Work is currently being conducted under a Massachusetts Clean Energy Center (MassCEC), Rhode Island Department of Environmental Management, and BOEM grant to standardize seafloor habitat data collection and workflow. After speaking with a staff member, RPS was informed that the MassCEC-funded project is still ongoing but a project page with updates is publicly available (Ribera et al. 2021). A working group update from June 2021 indicates that INSPIRE and the Northeast Regional Ocean Council (NROC) will test the developed workflow in a pilot project (Seafloor Habitat Data Work Group Update 2021). The workflow described in the working group update intends to use the CMECS standards for habitat classification and the Northeast Ocean Data Portal (NEODP) to disseminate composite regional habitat data and might include a password-protected option to access higher resolution data underlying the composite data products. This information will help inform Essential Fish Habitat assessments.

2.2.7 ROSA Interim Fisheries Resources Research, Survey, and Monitoring Guidelines

Currently, ROSA is collaborating with a diverse array of sectors involved in fisheries and wind development including state and federal government fisheries managers, fishing industry representatives, fisheries scientists, and offshore wind developers to build upon and update existing BOEM guidance for data maintenance and sharing to aid in the scientific information BOEM and other agencies require to understand how wind farms affect marine resources (ROSA 2021). The goal of these guidelines will be to outline the elements needed for successful surveys and monitoring plans in addition to identifying the primary resources to draft and review such plans. This living guidance document will continue to evolve as critical monitoring questions are established, and existing guidelines, methods, and best practices are refined as the offshore wind energy industry continues to expand. Overall, the guidance document will help to:

- Streamline survey/monitoring plan development and review by providing comprehensive standardized recommendations for monitoring fisheries resources within offshore wind development areas,
- Ensure survey/monitoring plans are effectively designed to generate meaningful results consistent with established BOEM, NMFS, and state guidelines; best practices; and decision maker data needs,
- Address the need to establish standardized protocols to collect and analyze biological and environmental data that can be integrated with existing survey data and other research,
- Support integration of monitoring efforts across multiple spatial and temporal scales (area/site-specific to regional/ecosystem and before/after construction),
- Focus monitoring efforts on finfish and invertebrates targeted by commercial and recreational fisheries or other sensitive species that may be impacted by or vulnerable to offshore wind development,
- Encourage proactive engagement, collaboration, and involvement among state and federal agencies, research institutions, wind developers, and fishery members and representatives.

2.2.8 Partners in Science Workshop: Identifying Ecological Metrics and Sampling Strategies for Baseline Monitoring During Offshore Wind Development

The 2021 Partners in Science Workshop took place on January 28, 2021 and was co-hosted by the Rutgers University Center for Ocean Observing Leadership and Rutgers Cooperative Extension to gather community input on sampling parameters, monitoring objectives, and data access and sharing for monitoring as it pertains to offshore wind farm development (Partners in Science Workshop 2021). The objective of gathering community input was to further define the parameters required to quantify baseline ecological variability that will enable the evaluation of potential impacts from offshore wind development. This input was gathered from a pre-workshop survey and through break-out discussions during the workshop. The attendees and survey respondents represented academic, state government, federal government, fishing industry, offshore wind industry, environmental NGOs, consultants, and other sectors. The main findings include but are not limited to:

- All fishing activity and marine fisheries resources must be considered during all phases of the life cycle of an offshore wind farm, including pre-construction through operations and decommissioning;
- Baseline studies should begin 2-3 years before construction with less frequent sampling during the life of the offshore wind farm;
- The broader stakeholder community should be engaged to develop survey designs and techniques that prevent disruption to existing survey methods once an offshore wind farm is built. These techniques could include new methods to fill gaps within wind farm areas and/or instrumentation on turbine platforms;

- Studies should be designed through a regional collaborative effort with industry, academia, state and federal government to coordinate and consolidate new and existing data;
- Fisheries surveys should address the gaps in existing research, prioritize species within a study based on site-specific vulnerability, and be hypothesis driven.

Attendees of the workshop also expressed that data collected from baseline and monitoring studies should be stored in an existing data portal which would allow a regional approach and coordination and accessibility of the data by the appropriate end-users. It was recommended that data gathered from monitoring and baseline studies of offshore wind farms should be incorporated within existing datasets, including the trawl surveys conducted by universities and federal and state scientists. However, it was noted that incorporating these datasets may present obstacles with standardization of methods and sharing of data.

3 FISHERIES DATA TYPES

This section outlines the range of research and monitoring methods applied in the Northeast and Mid-Atlantic U.S. regions and provides specific examples of surveys collected from a review of current and recent fisheries. A wide variety of fisheries resource data and survey types exist in the study area, defined as the East Coast of the U.S. from the shoreline to the 200-mile federal limit, from the Gulf of Maine to North Carolina. Data types reviewed include fisheries-independent operational surveys (trawls, traps, dredges, nets, etc.), observational studies (video or other visual surveys), tracking/tagging studies (telemetry or traditional tags), acoustic studies, fisheries-dependent data (observers, electronic monitoring, vessel trip reporting, socio-economic surveys), and recreational fisheries studies.

Some surveys are compatible and or collaborative, whereas others are independent efforts. For a survey to be replicated or expanded, it is vital to document clear methods and metadata. An accompanying Excel file was created to provide more comprehensive information about these surveys where possible. The most essential survey metadata are summarized in Table 1, which was adapted from the ACCSP Standard Measures for gear types. More details about gear data elements can be found in Appendix I: Standard Measurement for Gear Type/Gear Elements on the ACCSP website (ACCSP 2012).

In general, details on the specific survey and data QAQC methods were not shared and many of the research and monitoring methods reviewed store data in private databases that require personal contact to initiate a query. Collaborative surveys involving multiple stakeholders or organizations tend to provide frameworks that work better for coordinating baseline research and monitoring efforts for OWE impacts on fisheries resources.

Table 1. Important basic metadata to collect for standardizing different gear types and fisheries surveys (besides season, spatial location, sample strata, etc.).

Survey Type	Gear Type	Quantity	Fishing Time	Number of Sets	Mesh Size	Dimensions	Mensuration Equipment	Bait	Accessories	Sampling Time
Operational	Otter Trawl	# of nets towed	Total tow time and speed	# of tows	codend, main mesh	net type, shape, measurements, material, door shape and type, bridle and headrope lengths, line length and scope ratios	net mensuration equipment (shape), position loggers		cookies, ground wire, chains, temp loggers, etc.	day/night/both
Operational	Beam trawl	# of nets towed	Total tow time and speed	# of tows	codend, main mesh	net type, shape, measurements, material, bridle and headrope lengths, line length and scope ratios	net mensuration equipment (shape), position loggers		temp loggers	day/night/both
Operational	Traps and Pots	# of traps and pots pulled	Total soak time for each pot or trap	# of strings hauled	trap mesh	trap type, shape, measurements, string (trawl) configuration, net material	tilt meter (orientation)	type, amount container	turtle excluders, temp loggers, cameras, etc.	day/night/both
Operational	Dredges	# dredges pulled	Total tow time and speed	# of tows	Bar/liner/bag spacing	dredge type, shape, measurements, line length and scope ratios	tilt, hydraulic pressure sensors		temp loggers, cameras	day/night/both
Operational	Ichthyoplankton (net)	# nets used	Total tow time and depths	# of sets	codend, main mesh	net opening, length, shape, material	flowmeter			day/night/both
Operational	Hand Seine	# of nets pulled	Total tow lengths and times	# of pulls	main mesh	net measurements, net material				day/night/both

Survey Type	Gear Type	Quantity	Fishing Time	Number of Sets	Mesh Size	Dimensions	Mensuration Equipment	Bait	Accessories	Sampling Time
Operational	Gillnets	float line length for string	Total soak time	# of strings/hauls	main mesh	net measurements, net material			temp loggers	day/night/both
Operational	Longlines	# of gangions / hooks	Total soak time	# of hauls or # of strings hauled		mainline length, gangion length		type, amount	temp loggers	day/night/both
Operational	Hook and Line (Angling)	# of lines (# of hooks is secondary)	Total soak time					type, amount		
Operational	eDNA/Molecular	volume filtered								day/night/both
Tagging / Tracking	Acoustic Tag	# of tags	tag lifetime	# of receivers		tag size and type, receiver size and type, tag location on organism				
Tagging / Tracking	Conventional Marking Tags (eg., floy tag)	# of tags				tag size and location			incentives	
Visual	Airplane	# of transects	transect duration and speed	# of sampling flights		transect length, width			magnification aids/power	day/night/both
Visual	Drone	# of transects	transect duration and speed	# of sampling flights		transect length			magnification aids/power	day/night/both

Survey Type	Gear Type	Quantity	Fishing Time	Number of Sets	Mesh Size	Dimensions	Mensuration Equipment	Bait	Accessories	Sampling Time
Visual	Video	# of transects/quadrats	transect/quadrat duration and speed	# of sampling flights		transect/quadrat length	scaling		magnification aids	day/night/both
Acoustic	Acoustic (Active)	# of transects	transect duration and speed	# of sampling trips		transect length			sonar information	day/night/both
Acoustic	Acoustic (Passive)			# of receivers		receiver size and type				
Interactive	Telephone /Trip report/ In-Person Interview	il responses		# requests for response						

3.1 Operational Surveys

For this work, we defined operational studies as fishery-independent surveys that involve fishing gear that physically sample either single species or groups of species. Gear types can include otter trawls, beam trawls, traps or pots, dredges, seines, gillnets, ichthyoplankton samplers, longlines, hook and line angling, and newer methodologies like environmental DNA (eDNA). Operational surveys are conducted by federal, state, private, non-profit, or multi-agency collaborative organizations. Thus, there are a wide range of study designs, active and discontinued monitoring efforts, and important survey details (i.e., metadata) to collect and standardize for operational fisheries studies.

3.1.1 Trawl Surveys

Trawl surveys typically capture a wider variety of species than other gear types and can be designed to sample different habitats (demersal or pelagic) depending on gear type including pelagic trawls, demersal trawls, and beam trawls. Due to their broad catch capacity and common use as fishing gear they are commonly applied as a monitoring study and play an important role in fisheries management. At the federal level, the NEFSC independently conducts two seasonal trawl surveys annually in deeper continental shelf waters with additional trawl surveys that have been discontinued. Ongoing surveys include Spring and Fall Bottom Trawl Surveys while discontinued surveys include the Winter and Summer Bottom Trawl Surveys (InPort 2020a, InPort 2020b, InPort 2020c, InPort 2020d).

A variety of state, academic, and private operational surveys are used in nearshore waters to supplement federal survey data and monitor local populations. One of the largest efforts spatially is the NEAMAP which is comprised of three cooperative trawl surveys (NEAMAP - Maine / New Hampshire, NEAMAP - Massachusetts, and the NEAMAP - Mid Atlantic) in partnership with state agencies from Maine to North Carolina, the NEFSC, New England and Mid-Atlantic Regional Fishery Management Councils, U.S. Fish and Wildlife Service (USFWS), and Potomac River Fisheries Commission. The NEAMAP - Mid Atlantic survey is led by the Virginia Institute of Marine Science (VIMS) while the other two components are state-led (VIMS n.d.a). The NEAMAP - Maine / New Hampshire survey is also known as the Maine-New Hampshire Inshore Trawl Survey conducted jointly by the Maine Department of Marine Resources (ME DMR) and New Hampshire Marine Fisheries Division (NH MFD) and the NEAMAP – Massachusetts survey is also known as the Massachusetts Division of Marine Fisheries (MA DMF) Seasonal Bottom Trawl Survey.

Other state trawl surveys include: the Rhode Island Department of Environmental Management (RI DEM) Coastal Trawl Survey (RI DEM n.d.a), Connecticut Department of Energy and Environmental Protection (CT DEEP) Long Island Sound Trawl Survey (CT DEEP 2020), New York Department of Environmental Conservation (NY DEC) Nearshore Ocean Trawl Survey (NY DEC 2021), New Jersey Department of Environmental Protection (NJ DEP) Ocean Stock Assessment Bottom Trawl Survey (NJ DEP 2018), Delaware Division of Fish and Wildlife (DE DFW) Bottom Trawl Survey (DE DFW n.d.), Maryland

Department of Natural Resources (MD DNR) Coastal Bays Fisheries Investigation Trawl and Offshore Trawl Survey in coordination with commercial fishing (MD DNR n.d.a), and North Carolina Division of Marine Fisheries (NC DMF) Pamlico Sound Trawl Survey (part of the Southeast Area Monitoring and Assessment Program (SEAMAP)) and Estuarine Trawl Survey (NC DMF n.d.). A more southerly counterpart to the NEAMAP surveys that overlaps with the study area is the NMFS and South Carolina Department of Natural Resources (SC DNR) Coastal Trawl Survey (part of SEAMAP) spanning as far north as Cape Hatteras (SC DNR n.d.).

Several long-term trawl surveys exist that target specific species, life stages, or localized areas. The Atlantic States Marine Fisheries Commission (ASMFC) organizes two species-specific trawl surveys: the Northern Shrimp Survey in the Gulf of Maine (InPort 2020e) in collaboration with the NEFSC and Horseshoe Crab Trawl Survey targeting areas between New Jersey and Virginia (ASMFC 2021). Trawl surveys that target juvenile and estuarine fish and shellfish include the MD DNR Summer Blue Crab Trawl Survey (MD DNR n.d.b), Virginia Institute of Marine Science (VIMS) VA Juvenile Fish and Blue Crab Trawl Survey (VIMS n.d.b) in Chesapeake Bay, VIMS and Virginia Marine Resources Commission ChesMMAP Trawl Survey in Chesapeake Bay (VIMS n.d.c), NC DMF Pamlico Sound Trawl Survey, NJ DEP Juvenile Finfish Trawl survey in Delaware Bay (NJ DEP 2009), University of Rhode Island (URI) Graduate School of Oceanography and RI DEM URI Weekly Trawl Survey of Narragansett Bay (URI n.d.). Additionally, Rutgers has conducted a Long-Term Otter Trawl Survey during July and September since 1996 with a sample area which ranges from the upper reaches of the Mullica River, through Great Bay and Little Egg Harbor, and extends out into the ocean on a transect from Little Egg Inlet to the Rutgers LEO node (OBIS 2018).

Two short-term trawl surveys that are highly relevant to fisheries research efforts and OWE are the Vineyard Wind Demersal Otter Trawl Survey and the South Fork Wind Beam Trawl Survey described in each developer's respective fisheries monitoring plans (Vineyard Wind 2020; South Fork Wind 2020). Many other short-term trawl surveys have occurred as part of specific research projects not related to offshore wind. These surveys can provide insight into effective methods to answer specific research questions but are too numerous to provide a comprehensive list in this report. See the accompanying Excel database for a partial list of relevant trawl studies encountered as part of this work.

A full suite of biological data can be collected while sampling with trawls, including length, weight, age, stomach contents, sex, sexual maturity, reproductive status, and other tissue samples. In addition, meteorological and oceanographic (i.e., metocean) data are typically collected with water column profiles and weather observations during trawl surveys. These data can include water temperature, salinity, dissolved oxygen, pH, chlorophyl concentration, turbidity, depth, air temperature, sea state, time of day, and date. Trawl performance data are also important metrics for standardizing data through the use of net mensuration equipment and speed and positioning loggers.

3.1.2 Trap or Pot Surveys

Trap/pot surveys typically capture benthic fish and invertebrate species, especially those associated with structure. A variety of survey designs exist including vented and unvented fish pots and lobster pots that can be baited or unbaited. One of the largest studies in the study area is the ASMFC Coastwide Ventless Lobster Trap Survey that has included participation by the states of New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine in addition to some expansion work into federal waters by CFRF (CFRF n.d.a). This collaborative survey allows each participating state to complete their own survey and contribute the data for stock index calculation and analysis. BOEM, CFRF, and URI also collaborated to apply a similar survey design to the MA/RI Offshore Wind Development Area known as the Southern New England Cooperative Ventless Trap Survey (CFRF n.d.b). As part of fisheries monitoring plans, Vineyard Wind and South Fork Wind are also conducting ventless trap surveys based on the design of the Coastwide Ventless Lobster Trap Survey and the Southern New England Cooperative Ventless Trap Survey, respectively (Vineyard Wind 2020; South Fork Wind 2020).

Some ongoing fish pot surveys within the region include collaborative work as part of the Southeast Reef Fish Survey (see Section 4.1.3) and NJ DEP Artificial Reef Ventless Trap Survey (Jensen et al. 2018). Both Vineyard Wind and South Fork Wind are using fish pots as part of their fisheries monitoring plans with Vineyard Wind specifically targeting black sea bass (Vineyard Wind 2020; South Fork Wind 2020).

A suite of biological data can be collected while sampling with pots and traps, including length, weight, age, stomach contents, sex, sexual maturity, reproductive status, claw status, shell disease status, and other tissue samples. In addition, meteorological and oceanographic (i.e., metocean) data are typically collected with water column profiles and weather observations during pot hauling/setting and oceanographic data can be logged in traps during soaks. These data can include water temperature, salinity, dissolved oxygen, pH, chlorophyl concentration, turbidity, depth, air temperature, sea state, time of day, and date. Trap performance data are also important metrics for standardizing data through the use of soak time and tilt meters. Video cameras can be added to traps to provide additional qualitative and quantitative data. Overall, there are multiple ventless trap surveys and the design and protocols for each source or area requires data QC to confirm if the protocols align and if the data can be accessed together or if collaboration work may be necessary.

3.1.3 Dredge Surveys

Dredge surveys typically target bivalves living on or beneath the seafloor. Ongoing dredge surveys at the federal level include the NOAA NMFS NEFSC Sea Scallop Survey (also includes HabCam observational data; InPort 2020f) and the Atlantic Surfclam and Ocean Quahog Survey (InPort 2020g). State dredge surveys include ME DMR Sea Scallop Surveys (ME DMR n.d.a), RI DEM Shellfish Dredge Survey (RI DEM n.d.b), NY DEC Annual Surfclam Dredge Survey (NY DEC 2018), NJ DEP Surfclam Dredge Survey (NJ

DEP n.d.), and MD DNR/VIMS Blue Crab Winter Dredge Survey (MD DNR n.d.c). Many short-term dredge surveys have occurred as part of specific research projects, especially those funded by research set aside awards. These surveys can provide insight into effective methods to answer specific research questions and some are included in the accompanying Excel database.

The biological data collected while sampling with a dredge can include density, length, weight, age, reproductive status, bycatch, and other tissue samples. In addition, meteorological and oceanographic (i.e., metocean) data can be collected with water column profiles and weather observations. These data can include water temperature, salinity, dissolved oxygen, pH, chlorophyl concentration, turbidity, depth, air temperature, sea state, time of day, and date. Additional important metrics include dredge efficiency and dredge performance data. Dredge performance data is important for standardizing data through the use of tow times, inclinometers, pressure sensors (i.e., depth and pump pressure), and temperature loggers.

3.1.4 Gillnet Surveys

Gillnets can target a variety of species depending on gear type, especially mesh size and water column placement. Although gillnets are used as commercial gear within the region, their use in fisheries independent studies is limited. The NC DMF conducts a few multiple-mesh gillnet surveys including the Striped Bass Independent Gillnet Survey and Fishery Independent Assessment Survey (NC DMF n.d.). One short-term gillnet survey is the South Fork Wind Gillnet Survey described in the developer's fisheries monitoring plan (South Fork Wind 2020). Additionally, the NJ DEP conducts a River Herring Gill Net Survey in Maurice River (since 2013) and Great Egg Harbor River (since 2015) from March through May.

The full suite of biological data can be collected while sampling with gillnets, including length, weight, age, stomach contents, sex, sexual maturity, reproductive status, and other tissue samples. In addition, meteorological and oceanographic (i.e., metocean) data are typically collected with water column profiles and weather observations during net sets/hauls. These data can include water temperature, salinity, dissolved oxygen, pH, chlorophyl concentration, turbidity, depth, air temperature, sea state, time of day, and date. Temperature can be logged on the net during the duration of a soak. Soak time information is an important metric for standardizing catch data.

3.1.5 Small Seine Surveys

Many states and other organizations conduct regular small seine surveys to capture juvenile and estuarine fishes and invertebrates. These surveys are not expected to be widely used for monitoring OWE impacts and are therefore not covered in-depth in this report. These surveys include the NH MFD Estuarine Juvenile Finfish Survey (NH MFD 2019), RI DEM Narragansett Bay Juvenile Finfish Seine Survey (RI DEM n.d.c), CT DEEP Estuarine Seine Survey (CT DEEP 2019), MD DNR Beach Seine Survey (MD DNR n.d.a), MA DMF winter flounder young-of-year seine survey (MA DMF n.d.), and NC DMF Juvenile Anadromous

Survey and Fishery Independent Assessment Survey (NC DMF n.d.). Additionally, the NJ DEP conducts a Delaware River Striped Bass YOY Seine Survey from June through November since 1980 and a River Herring Seine Survey conducted July through October in Maurice River (since 2013) and Great Egg Harbor River (since 2015).

3.1.6 Plankton Surveys

A variety of fine mesh zooplankton nets are applied to sample planktonic (i.e., egg and larval) fishes and invertebrates (e.g., zooplankton). The nets can be towed, vertically deployed, drifted, or held at multiple depths depending on research question and study design. The NOAA NMFS NEFSC EcoMon survey collects plankton and acoustic hydrographic data (e.g., water depth and physical features of the seafloor) multiple times per year along the northeastern US shelf by vertically deploying double bongo nets to near the seafloor while recording oceanographic data with a CTD (NOAA 2018). The NOAA EcoMon plankton data are identified as NCEI Accession [187513] and are now publicly accessible online via an NCEI archive access portal at (https://accession.nodc.noaa.gov/0187513) with direct access to the original data files (including shapefiles) available here (https://accession.nodc.noaa.gov/0187513/data/0-data). The data comes from the four longest running programs which include the Marine Resources Monitoring, Assessment, and Prediction program (1977- 1987), Herring – Sandlance (1988 – 1994), Georges Bank Global Ocean Ecosystems Dynamics (1995 – 1999), and Ecosystem Monitoring (1992 – present). Additionally, an ongoing weekly timeseries run by Rutgers University also utilizes bongo nets to capture plankton from little Sheepshead Creek in New Jersey (Rutgers n.d.).

Lobster larvae are the target of multiple plankton surveys using towed neuston nets in the region including surveys completed by the ME DMR (ME DMR n.d.b), Vineyard Wind Fisheries Monitoring Plan (Vineyard Wind 2020), and a research project conducted by UMass Dartmouth School for Marine Science and Technology (SMAST) and Massachusetts Lobstermen's Association in the MA/RI Offshore Wind Development Area (MA CEC 2020). Similarly, the partners that collect data for American Lobster Settlement Index surveys post-larval lobsters also using air-lift suction to survey between Rhode Island and Maine annually.

The biological data collected while sampling with a plankton net can include species catch and length. In addition, metocean data can be collected with water column profiles and weather observations. These data can include water temperature, salinity, dissolved oxygen, pH, chlorophyl concentration, turbidity, depth, air temperature, sea state, time of day, and date. Sampled volume data are also important for standardizing catch through the use of flow meters.

3.1.7 Longline Surveys

Longlines can target a variety of species depending on gear configuration, especially bait type, hook size, and water column placement. The SEFSC Bottom Longline Survey covers a large area that intersects with the southern portion of the study region (NOAA 2019). Additional longline components of the Southeast Fishery-Independent Survey also intersect with the southern extent of the study area (NOAA 2013). The NEFSC has collaborated to help complete the Gulf of Maine Cooperative Bottom Longline Survey annually since 2014 (InPort 2020h) and a similar survey, the Eastern Gulf of Maine Sentinel Survey, has involved longlines since 2010 (MCCF n.d.). Additionally, since 1973, VIMS has conducted a Shark Longline Survey from June through September in fixed stations throughout the Chesapeake Bay and coastal Virginia waters (VIMS 2022).

A suite of biological data can be collected while sampling with longlines, including length, weight, age, stomach contents, sex, sexual maturity, reproductive status, and other tissue samples. In addition, meteorological and oceanographic (i.e., metocean) data are typically collected with water column profiles and weather observations during sets/hauls. These data can include water temperature, salinity, dissolved oxygen, pH, chlorophyl concentration, turbidity, depth, air temperature, sea state, time of day, and date. Temperature can be logged on the net during the duration of a soak and cameras can provide additional data. Soak time information is an important metric for standardizing catch data.

3.1.8 Other Surveys

Hook and line angling surveys are a potential gear type that could be used to safely collect fisheries data in close proximity to wind turbines. The Maine Center for Coastal Fisheries, the University of Maine, and The Nature Conservancy (TNC) have collaborated to complete the Eastern Gulf of Maine Sentinel Survey using hook and line anglers (MCCF n.d.). Additionally, South Fork Wind conducts an Atlantic Cod Spawning Survey and Rod and Reel study (South Fork Wind 2020). The Atlantic Cod Spawning Survey uses a hook and line method to assess the presence of Atlantic cod spawning activity during the winter and spring while the rod and reel study identifies spawning aggregations and spatial distribution of cod during spawning season in the winter, both conducted at the South Fork Wind Farm area and nearby locations (South Fork Wind 2020).

3.2 Observational Studies

A variety of observational methodologies are employed for habitat, fisheries, and wildlife monitoring in the region including video, still imagery, acoustics, and visual observations.

The HabCam developed by Woods Hole Oceanographic Institute (WHOI n.d.) is one of the most data-rich examples of still imagery collected for fisheries and habitat monitoring and has been applied in a variety of projects to survey sea scallops and benthic habitat through stereo still-imagery transects of the seafloor.

The SMAST Drop Camera surveys also targets benthic macroinvertebrates using imagery but with a quadrat approach. Both video transects and drop-down video have also been incorporated by offshore wind developers as part of their benthic habitat characterization surveys as described in SAPs and COPs available online on BOEM's website. Vineyard Wind plans to continue using video transects, video imagery associated with grab samples, SMAST's drop camera, and acoustic imagery to monitor impacts as part of their benthic habitat monitoring plan for OCS-A 501 (Vineyard Wind 2020). South Fork Wind plans to use Sediment Profile Imaging and Plan View Imaging (SPI/PV) and ROV video, and acoustic imagery to monitor impacts as part of their benthic habitat monitoring plan for OCS-A 517 (South Fork Wind 2020).

Aerial observation through the use of planes is applied by RI DEM as part of the RI Narragansett Bay Menhaden Monitoring Program (RI DEM n.d.d). A digital aerial baseline survey of marine wildlife conducted by NYSERDA, Normandeau, and APEM, Inc. applied aerial imagery from planes to survey large areas of continental shelf and was able to identify a variety of species groups including fishes (Robinson et al. 2021).

Visual observations are more commonly applied to wildlife, but the Delaware Bay horseshoe crab spawning survey (https://www.delawarebayhscsurvey.org/) and MA DMF horseshoe crab volunteer-based spawning beach surveys (https://www.mass.gov/service-details/horseshoe-crab-monitoring) are both examples of their application to monitoring fisheries.

Additionally, electrofishing is a technology applicable to freshwater environments and is applied in the DE DFW Delaware River Striped Bass Spawning Stock Survey and other anadromous fish work.

Environmental DNA (eDNA) is emerging as a viable technology for surveying all marine species including fishes present in an area using water samples (NYSERDA 2021). Although no long-term eDNA surveys were found in this work, a collaborative study between The Rockefeller University, Monmouth University, and the NJ DEP Ocean Stock Assessment Trawl Survey provides details about considerations and effectiveness for the implementation of eDNA monitoring in the region (Stoekle et al. 2021)

3.3 Tracking/Tagging

Acoustic telemetry, defined here as the use of sound emitting tags and listening receivers to track organisms, and ID tagging efforts occur inshore and offshore the East Coast from Maine to Florida. Acoustic telemetry and tagging campaigns are often collaborative efforts between federal and state entities, recreational and commercial fishermen, and various nonprofits, universities, and the private sector. These studies range in complexity from mark/recapture techniques employing Floy or similar ID tags to surgical implantation of transponders and installation of offshore acoustic receivers and use of hydrophones to passively and actively track tagged fish. These campaigns inform on stock structure, migration, abundance, age and growth rates, behavior, and mortality.

For over 10 years now, the NJ DEP has conducted a Delaware Bay Sturgeon Receiver Project from March through November in Delaware Bay utilizing acoustic receivers to track tagged sturgeon and other tagged organisms (NJ DEP 2021). The 19 receivers which are deployed in water depths less than 20 feet ensure complete coverage of the sampling area as they complement the existing receiver array within Delaware Bay, specifically on the New Jersey side (NJ DEP 2021). Starting in 1989, the NJ DEP also conducts striped bass tagging in the Delaware Bay from March through May as part of the Coastwide Cooperative Striped Bass Tagging Program which is coordinated by USFWS (Corbett 2008). The tagging program is a collaboration of several state and federal agencies from North Carolina to Massachusetts which submit annual tagging information to the USFWS which manages the coastwide database for information on all releases and recaptures (Corbett 2008).

The NOAA Integrated Ocean Observing System (IOOS; https://ioos.noaa.gov/data/) regionally tracks marine animals through its US Animal Telemetry Network (ATN; https://ioos.noaa.gov/project/atn/) with data inputs from regional data portals (https://ioos.noaa.gov/data/regional-data-portals/): Northeast Atlantic (NERACOOS), Mid-Atlantic (MARACOOS), and Southeast Atlantic (SECOORA). Additionally, the US ATN works collaboratively with Ocean Tracking Network (OTN; https://oceantrackingnetwork.org/), the joint Mid-Atlantic Acoustic Telemetry Observation System (MATOS) and Atlantic Cooperative Telemetry networks (ACT; https://matos.asascience.com/), and the Florida Atlantic Coast Telemetry network (FACT; https://secoora.org/fact/). Many tracking and tagging surveys have occurred as part of specific research projects funded through various means. Many of these surveys, while not specifically wind-related, may provide insight into marine animal migration through wind energy lease areas and are accounted for in these various data nodes including studies from over 140 researchers covering over 95 marine species including sharks, bony fishes, invertebrates, and sea turtles.

The NOAA cooperative tagging center tags highly migratory species (tunas and billfishes) using volunteer anglers and sport fishers. Further, the Cooperative Shark Tagging Program is a joint venture between recreational anglers, commercial fishing industry, and NOAA Fisheries (NEFSC 2020). Recent studies in WEAs include: a two-year acoustic tagging and tracking study of highly migratory species such as tuna and sharks at fishing spots in wind energy lease areas led by INSPIRE Environmental, with associated tracking data housed on the MATOS website; monitoring of Atlantic Sturgeon and commercially important finfish species in the Equinor lease area offshore New York by Stony Brook University and Monmouth University; and an acoustic telemetry study of Atlantic cod on Cox Ledge in Southern New England. Additional studies housed on the MATOS website include a study on the movement and habitat selection of migratory marine fishes within the Maryland wind energy area, conducted by the University of Maryland.

Due to its integration into regional (MATOS, ACT, FACT), national (Animal Telemetry Network Data Assembly Center (ATN DAC)), and international databases (OTN), telemetry data is some of the more interoperable and well-managed fisheries related data currently collected.

3.4 Acoustic Studies

Acoustic (non-telemetry) surveys include passive (i.e., listening) and active (i.e., transmission and interpretation of sound with echo sounders) monitoring of marine mammals and fish and invertebrate species; no tags are involved, and the movements of individual organisms are not tracked. The NOAA's Northeast Passive Acoustics Research Group studies the acoustic behavior of Atlantic cod and Haddock in Massachusetts Bay during spawning season using marine autonomous recording units and gliders to identify spawning activity. NOAA NMFS NEFSC used to conduct the Atlantic Herring Acoustic Survey, which was discontinued as of 2012, and an acoustic survey of northern shrimp (*Pandalus borealis*) distribution/abundance in relation to trap catches in Maine. Passive acoustic monitoring data may be added to the types of data that either the NOAA NCEI or ATN DAC can support (see Sections 4.1.6 and 4.1.8, respectively). Acoustic studies can also include the effects of anthropogenic sound on fish populations. Currently NOAA along with WHOI and BOEM are examining the effects that offshore wind farm construction noise has on black sea bass and longfin inshore squid (Mooney 2021).

South Fork Wind (2020) has outlined contributions to telemetry research within their Fisheries and Research Monitoring Plan. An ongoing study funded by BOEM, which includes scientists from MA DMF, UMass Dartmouth School for Marine Science and Technology, TNC, Woods Hole Oceanographic Institute, NEFSC, and Rutgers University, uses gliders to monitor the spawning activity and seasonal distribution of Atlantic cod on and around Cox Ledge which includes the South Fork wind farm area. Additionally, a second acoustic telemetry study has been initiated to examine the persistence and presence of Highly Migratory Species (HMS) in the wind farm area pre-construction (South Fork 2020).

3.5 Fisheries-Dependent Studies

Fisheries-dependent data are those collected from commercial and recreational fishing activities. Data can include information about landings, discards, bycatch, effort, location, gear types, metocean conditions, and other variables. Fishery dependent data can be further separated into recreational and commercial data depending on intent and both have multiple dedicated data collection efforts. These data typically have confidentiality aspects and require special permissions to access certain data.

3.5.1 Commercial

3.5.1.1 Observer Programs

The NEFSC Northeast Fisheries Observer Program (NEFOP) and At-Sea Monitoring oversees trained at-sea monitors to collect data during fishing operations. These observers and monitors are deployed on commercial fishing vessels to record commercial fishing gear, effort, catch, and bycatch of finfish and protected species. Observers can also be deployed to processing facilities and can collect biological samples (NOAA 2020a). Data are stored in the Observer and At Sea Monitor Database (OBDBS) with metadata available in NOAA's InPort metadatabase. Similar observer programs are operated by the Southeast Fisheries Science Center (SEFSC) including the Southeast Gillnet Observer Program and Southeast Shark Bottom Longline Observer Program. In the Gulf of Maine, individual state agencies provide the representative observer and port sampling coverage data which is used for lobster stock assessment as it provides continuous coverage since federal observer programs do not typically cover lobster trips on a regular basis.

3.5.1.2 Electronic Monitoring

GARFO, NEFSC, TNC, the Maine Coast Fishermen's Association, and the Cape Cod Commercial Fishermen's Alliance have been collaborating on electronic monitoring (EM) programs in the groundfish and herring/mackerel midwater trawl fisheries (GARFO and NEFSC 2017). NEFSC is working with an EM service provider to evaluate the usefulness of EM aboard midwater trawl vessels to monitor herring and mackerel fisheries. Beginning May 1, 2021, New England groundfish sector fishermen may choose electronic monitoring over human at-sea monitors if it is part of their sector's approved operations plan (NOAA 2020a).

3.5.1.3 Vessel Trip Reporting and Vessel Monitoring System

Vessel Trip Reports (VTRs) are mandatory for federally permitted vessels. Vessel operators are required to report standard information about their fishing trips including data about gear, location, catch, discards, and offload dealer/location. Historically, there was no VTR requirements for lobster unless a boat held another VTR permit. Currently, the percent of VTR coverage in southern New England is much higher than it is in the Gulf of Maine where the coverage is only 5-10% of more than 1400 permits. The eVTRs have been implemented in the Northeast since 2011, but it had been voluntary program with limited use among fishing industry vessels (GARFO and NEFSC 2017). However, eVTRs will be required as of November 2021 for several federally permitted commercial fisheries and for-hire vessels in the Northeast (GARFO 2021). Derived data products from commercial fishing VTRs are incorporated into the NEODP, see Section 4.4.2).

Vessel Monitoring Systems (VMS) track vessels as they move through an area through signals transmitted every 0.5-1 hour, depending on requirements (OLE 2021). These satellite tracking data are aggregated and interpreted to provide maps that represent the relative density of commercial fishing vessel presence within

an area. It is important to note that the density of vessel presence may not reflect exactly where fishing pressure is exerted as the vessels could be tracking at slower speeds for a variety of reasons and may just be transiting through an area, not fishing within it. These data are analyzed under strict confidentiality restrictions so that individually identifiable vessel positions are removed, and data are normalized across 100 m by 100 m density grids (NEODP 2021). The interpreted VMS data available on the NEODP includes all vessel trips that use a Northeast Multispecies VMS code for their permits, and thus exclude trips taken by fishing vessels that operate under a different code, and many New England fisheries are not captured within VMS data.

Additionally, all vessels over 65 feet are now required to have an automatic identification system (AIS) which monitors the location and characteristics about a specific ship including but not limited to the ship's name, size and draft, port of origin, and speed and heading (InPort 2021c). Together, BOEM and NOAA have collaborated to make the data from AIS receivers available (InPort 2021c).

3.5.2 Recreational Surveys

NOAA Fisheries Marine Recreational Information Program (MRIP) employs a variety of surveys with standardized procedures in collaboration with many organizations to collect data on recreational effort and catch. The Access Point Angler Intercept Survey (APAIS) intercepts anglers returning from fishing to collect data on catch, effort, and fishing mode. The Fishing Effort Survey (FES) replaced the Coastal Household Telephone Survey (CHTS) in 2018. The FES is a mail survey that collects similar data to the APAIS but also incorporates weather and outdoor activity to increase response rate. The Large Pelagics Survey (LPS) is composed of three components to collect information about tunas, sharks, billfishes, and other offshore fishes. The three components are the Large Pelagics Intercept Survey (LPIS) that intercepts anglers as they return from fishing to record catch and effort similar to the APAIS, the Large Pelagics Telephone Survey (LPTS) to record catch and effort data from those with highly migratory species permits, and the Large Pelagics Biological Survey (LPBS) that collects biological samples from anglers returning from fishing and at fishing tournaments. The For-Hire Survey (FHS) is a telephone survey that collects information from for-hire operators to estimate fishing effort from for-hire fisheries (i.e., charter boats). This survey is supplemented by VTRs from for-hire operators (NOAA 2020b).

In some states, MRIP surveys have been replaced or supplemented by other surveys. One relevant example is that from North Carolina to Florida, the Southeast Region Headboat Survey is used to monitor recreational headboat catch. Some other volunteer recreational data sources include the Maine Volunteer Angler Logbook Program, New Hampshire Striped Bass Volunteer Angler Survey, New Jersey Recreational Saltwater Volunteer Angler Survey, and Maryland Striped Bass Volunteer Angler Survey.

A recent recreational observation study was conducted by Sabo et al. (2020) to examine the effects of the Block Island Wind Farm on coastal resources. During June and July, point-count surveys of recreational

boating were conducted during the pre-construction, construction, and operation phases to collect data on vessel counts, activity, and location and provided direct observations of boating activity.

4 EXISTING DATABASES AND STANDARDS

This section summarizes databases which collect and store fishery-independent, fishery-dependent, metadata, and derived data products pertaining to fishery resource data. Additionally, oceanographic databases are included in this analysis to briefly describe its sources and data management. The value of these databases as potential repositories of raw fisheries related data for OWE will be discussed in Section 5 of this report.

4.1 Raw Data

4.1.1 Atlantic Coastal Cooperative Statistics Program (ACCSP)

URL: https://www.accsp.org/

Established in 1995, the ACCSP is a state-federal partnership and cooperative program which is composed of 23 entities including federal agencies, fishery management councils and commissions, and state agencies. The ACCSP serves as the principal source for commercial, recreational, and for-hire fisheries-dependent data for the Atlantic coast. Fisheries-dependent data are supplied by the 23 program partners and integrated into a single user-friendly database, known as the Data Warehouse, which is operated by permanent staff hired by ASMFC (ACCSP 2018a). The Warehouse works to ensure that coastwide, all stakeholders are presented with the same dataset.

The components of the ACCSP data collection and management process are designed as a modular system organized into catch and effort, permit, and vessel registration, biological, metadata, bycatch, releases and protected species interaction, and social and economic data (ACCSP 2018b). Currently, effort data which is associated with fishery sampling (not landings) is being added for lobster and Jonah crab. All data collected are uploaded into the Data Warehouse according to the appropriate data module standards and harmonized into a set of codes for variables including gear, fishing area, and species which allows for the combination of multiple datasets from varying sources. The data load process and corresponding timelines for the commercial, recreational, and biological and socioeconomic data can be seen in Figure 2. Note that data is not necessarily uploaded on an annual basis. Lobster data is requested prior to assessment deadlines as states collect and maintain observer data for the lobster fishery, though this data may likely be available in ACCSP in the future.

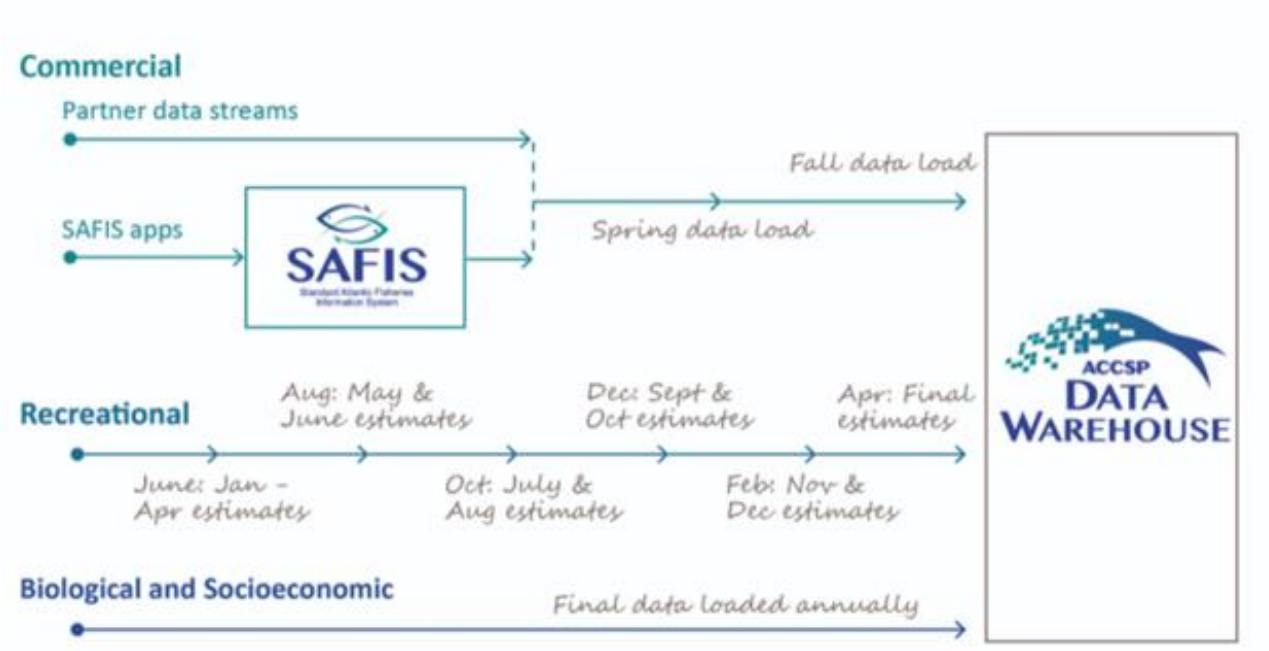


Figure 2. ACCSP data flow (ACCSP 2018c)

Non-confidential commercial landings and catch and effort data with associated warehouse codes can be accessed and queried through the Public Data Warehouse. No username or password are required, and data can be exported or downloaded as needed. Non-confidential commercial landings date back to 1950 and range from Maine through Florida. The commercial data for each year are added in April/May of the following year. This publicly available commercial landings data contains a compilation of state and federal landings which are submitted by both dealers and fishermen and contain the complete total value (in pounds and dollars; ACCSP 2018c). Non-confidential commercial catch and effort trip reports are logbooks or fisherman reports which contain area and gear effort data but do not represent 100% of the pounds landed or fishing activity. The Public Data Warehouse also provides MRIP and Marine Recreational Fisheries Statistics Survey (MRFSS) reports for recreational, trip, catch, and effort data.

Confidential data is not publicly available and requires a username and password to access the Data Warehouse. Authorization for accessing confidential data can be granted to an individual employed or affiliated with a program partner, or an individual whose job is related to fisheries management and conservation. The confidential data contains summaries and row-level data for the commercial landings and fishermen trip reports with vessel and individual identifiers which are not available to non-confidential users. Preliminary data that is collected under the Standard Atlantic Fisheries Information System (SAFIS) applications is available in real time to select partner personnel. The ACCSP employs a strict confidentiality

policy following the “Rule of 3”, in that three or more dealers, fishermen, and vessels must be included for a summary record to be presented.

The Fisheries Information Network (FIN) is another state-federal cooperative program which collects fishery-dependent data for the Southeast Region. Recreational Fisheries Information Network [RecFIN(SE)] was established in 1993 and the Commercial Fisheries Information Network (ComFIN) was established shortly after (Gulf States Marine Fisheries Commission 2021). ComFIN and RecFIN(SE) were combined in 1996 to form FIN. ACCSP was developed for the Atlantic coast with a similar data collection and data management program following the development of FIN. The Gulf Fisheries Information Network (GulfFIN) has a public data warehouse which is populated with Gulf coast fishery-dependent data supplied by program partners. This database will not be discussed in detail as it focuses on the Gulf states.

4.1.2 Northeast Area Monitoring and Assessment Program (NEAMAP)

URL: http://www.neamap.net/index.html

NEAMAP is an integrated cooperative state/federal data collection program. NEAMAP partners include state and fishery agencies from Maine through North Carolina, the ASMFC, NMFS NEFSC, the New England and Mid-Atlantic Fishery Management Councils, USFWS, Potomac River Fisheries Commission, and the District of Columbia (NEAMAP 2008). NEAMAP serves as a large-scale cooperative effort to collect and disseminate fishery-independent data obtained in the Atlantic coastal waters from the Gulf of Maine to Cape Hatteras, NC for use by states, federal fisheries management agencies, the commercial and recreational fishing industry, and researchers. Data is collected by the coordination among three large-scale fishery-independent surveys which promote consistent and comprehensive data collection by standardizing procedures and improving the data quality and accessibility (VIMS n.d.a) The three trawl surveys include NEAMAP-Southern New England and Mid-Atlantic, NEAMAP-Maine/New Hampshire, and NEAMAP-Massachusetts.

The NEAMAP Southern New England and Mid-Atlantic Nearshore Trawl Survey was initiated in 2007 and data were housed at VIMS to address sampling gaps in Mid-Atlantic waters. The NEAMAP-Massachusetts Bottom Trawl Survey began in 1978 with sampling conducted every spring and fall. The NEAMAP-Maine/New Hampshire Inshore Trawl Survey began in 2000 with sampling conducted every spring and fall. This is a multispecies survey with funding from Congress where lobsters, recreational finfish, and non-commercial species of interest are also examined. The Maine/New Hampshire Trawl Survey data are entered into a Maine based Oracle archive database known as MARVIN, which houses both fishery dependent and fishery independent data. Data products for the trawl survey are available through a password protected portal (https://mainedmr.shinyapps.io/MaineDMR_Trawl_Survey_Portal/; ME DMR n.d.c).

The data management procedures to compile existing data are currently in initial stages of development, including intellectual property protocols, a NEAMAP data element dictionary, and a database to store collected data (NEAMAP 2021). The discussions focused on data management have expressed preferred development of a single, centralized database (University of Maine 2020). Specific data management protocols have not been discussed but items brought up that NEAMAP is taking into consideration are database structure, data management responsibilities, and the location of the database. Suggestions have been made to locate the database in the same location as the ACCSP database which allows data to be queried on a web-based application (NEAMAP 2008). It has been discussed that the database should include existing surveys' data, with the responsibility of data entry and editing to be done by the survey. The finalized data would then be standardized and migrated to a centralized database. A committee has been tasked with addressing data management details including data handling and storage. Before data from existing surveys is moved into a NEAMAP database, all program partners must adapt the same protocols for data entry, quality assurance, data transfer, and data storage. A top priority of NEAMAP is to secure long-term funding support through Congressional allocations. If SEAMAP and NEAMAP in the future are combined into one program, funding priorities will be re-evaluated. Currently, the NEAMAP-Massachusetts Bottom Trawl Survey data are entered into the NEFSC fisheries scientific computer system (FSCS) and then loaded into the Oracle survey database (SVDBS) (2021).

4.1.3 Southeast Area Monitoring and Assessment Program (SEAMAP)

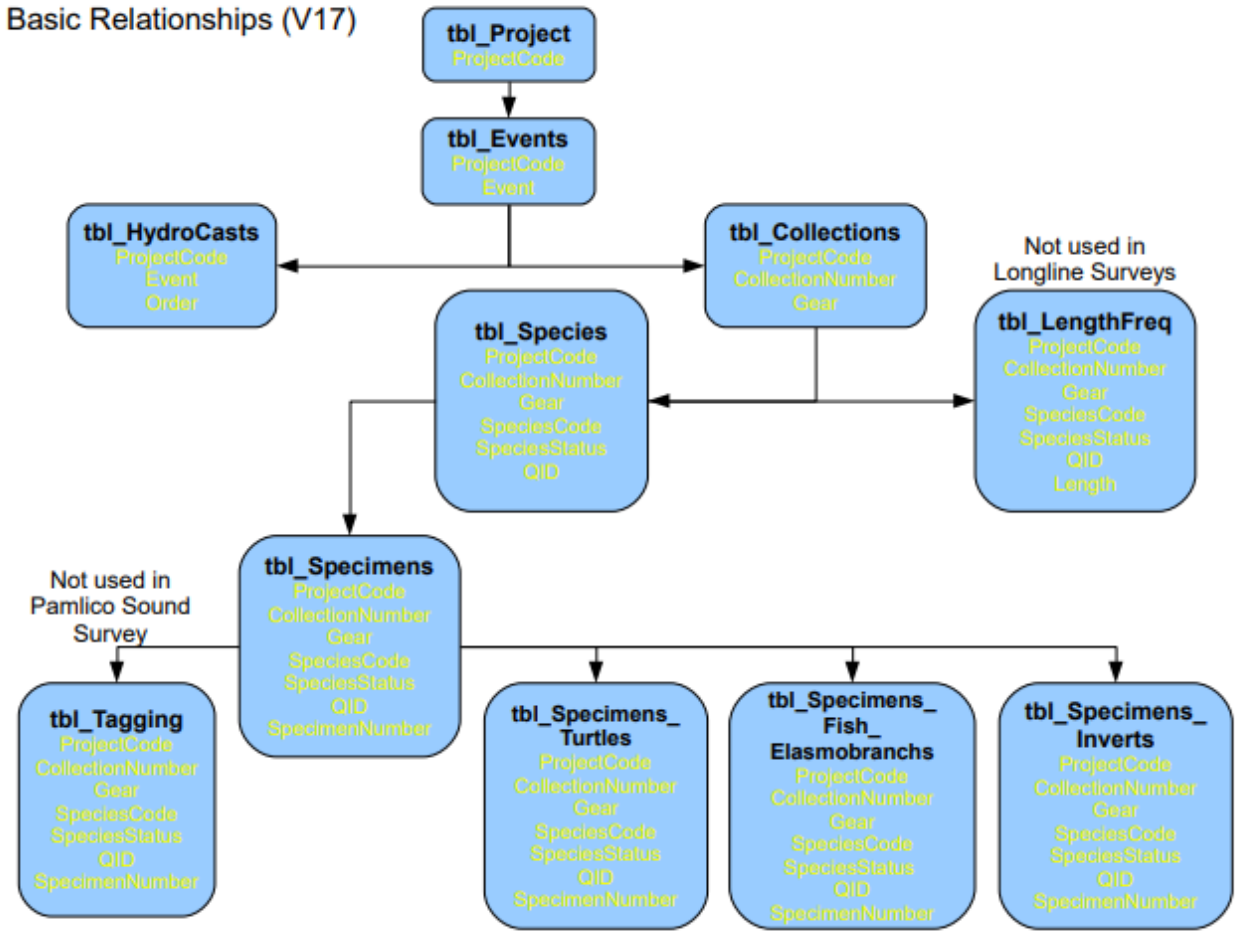
URL: http://www.seamap.org/index.html

Established in 1981, SEAMAP is a cooperative program composed of State, Federal, and University partners. SEAMAP collects long-term, standardized fishery-independent data consistent with established fisheries data systems, which allows for the coordination and deployment of sampling platforms to obtain regional, synoptic surveys and provide access to data that is collected through accessible databases and documents (SEAMAP 2021). SEAMAP has evolved into three operational components which cover three geographic regions in the southeastern U.S. and Caribbean. These components include SEAMAP-Gulf of Mexico, SEAMAP-South Atlantic, and SEAMAP-Caribbean. Each component operates independently to plan and conduct surveys and disseminate data following guidelines which have been established by NMFS (ASMFC 2021). For the rest of this report, the focus will be on SEAMAP- South Atlantic which was implemented in 1983.

The SEAMAP-South Atlantic conducts four surveys which collect data on the abundance and distribution of commercial and recreational species from North Carolina to Florida. The four surveys include SEAMAP-SA Coastal Trawl Survey, North Carolina Pamlico Sound Survey (PSS), SEAMAP-SA Longline Surveys, and SEAMAP-SA Reef Fish Survey. Funding and data management duties for the SEAMAP-SA are

administered through the SC DNR since 2007 with additional support from the NC DMF, Fish and Wildlife Research Institute (FWRI), and Georgia Department of Natural Resources (GA DNR). Data collected from the surveys is imported into the SEAMAP-SA Oracle Database on a yearly basis which is accessible by federal and state agencies as well as the public, with granted online access. Three ichthyoplankton datasets were added into the database in 2015, and there is future consideration for the addition of the Cooperative Winter Tagging Cruise data to be included.

Fisheries-independent data are supplied by the program partners into a central database where the data becomes integrated into one set of tables and codes for variables such as gear, species, and fishing grid (SEAMAP n.d.a). A Data Management Workgroup oversees the SEAMAP-SA Data Management System which is a web-based information system that facilitates data entry, error checking, data extraction, dissemination, and a summary of the fishery-independent data and information for all SEAMAP-SA surveys and special studies (SEAMAP n.d.b). Data in the database is subject to revisions. The data from the SEAMAP-SA independent surveys can be queried, filtered, and downloaded as a CSV file. When selecting data to query, the option is provided to download several variable types which include Event Information, Abundance and Biomass, Length Frequency, Individual Specimen, and Tagging Information. To reduce misinterpretation of the data due to variations in survey designs, SEAMAP-SA database operates on the relationship of event to collection to species to specimen. An overview of the data schema can be seen in Figure 3.



The bubble diagram shows the relationship of the different tables and variables to one another.

The database operates on the relationship of Event➔Collection ➔Species➔Specimen. For query requests, the selection or 'filtering' options Type of Data are organized in this same relationship, with choices of: Event Information, Abundance and Biomass, Length Frequency, Individual Specimen, or Specimen Tag Information. The output from the request is supplied as a .cvs file containing flat records constructed of the limited data variables from applicable data tables. For species included in an Abundance and Biomass query, the output will include the entire set of Events (effort) for the selection parameters in the query, whether or not the species of interest was taken in an Event (i.e. zero catches). This query also contains both the total CatchWeight (all species weights combined) as well as SpeciesTotalWeight (weight for a species in the sample). Additional information on the database schema and variable definitions can be found in SEAMAP-SA Data Management Guidance Plan.

Figure 3. SEAMAP database schema (SEAMAP 2021)

The Marine Resources Division of the South Carolina Department of Natural Resources conducts the SEAMAP-SA Coastal Trawl Survey which began in 1986 and was previously called the Shallow Water Trawl Survey. The sampling area ranges from the coastal zone of the South Atlantic Bight from Cape Hatteras, North Carolina, to Cape Canaveral, Florida. This survey provides long-term fishery-independent data on the biomass and seasonal abundance of various species. Data from this survey can be queried in the SEAMAP-SA database for South Carolina Department of Natural Resources – Marine Resources Division (SCDNR-MRD) Coastal Survey (CS) data.

The PSS is another fishery-independent trawl survey conducted since 1987 by the North Carolina Division of Marine Fisheries and funded by USFWS Sport Fishing Restoration. Sampling previously occurred in the Pamlico Sound, eastern Albemarle Sound and the lower Neuse and Pamlico rivers. Since 1990 however, all sampling only occurs in the Pamlico Sound and associated rivers. This survey provides data on the relative abundance, distribution, and size composition of decapod crustaceans and estuarine fish. Data from this survey can be queried in the SEAMAP-SA database for the NC DMF and PSS data.

The SEAMAP-SA Coastal Longline Surveys consist of three separately state-run surveys in North Carolina, South Carolina, and Georgia. For the rest of this report, the focus will be on the North Carolina Coastal Longline Survey (NC-CLS). The NC-CLS is funded by NMFS and has been conducted by NCDMF since 2007. This survey provides long-term fishery-independent data on target species and reports on the relative abundance, catch per unit effort, and size distribution of red drum and shark in Pamlico Sound. Data from this survey can be queried in the SEAMAP-SA database for NC DMF Red Drum Longline Survey data.

The SEAMAP-SA Reef Fish Survey is coordinated with the Marine Resources Monitoring, Assessment, and Prediction (MARMAP) and the Southeast Fisheries Independent Survey (SEFIS). Together, they are collectively referred to as the Southeast Reef Fish Survey (SERFS). MARMAP has conducted fishery-independent research for over 40 years providing data on stock assessments, long-term changes in relative abundance, length frequencies, and life history parameters and is housed at the Marine Resources Research Institute (MRRI) of the SC DNR. Starting in 2008, SEAMAP-SA provided funding to further complement the MARMAP program as it was the only long-term fishery-independent program collecting data to develop the indices of relative abundance for species in the South Atlantic Fisheries Management Council's (SAFMC) snapper-grouper species complex. SEAMAP-SA assisted with expanding the geographic coverage of sites sampled focusing on shallow or deep live-bottom areas and expanded sampling in marine protected areas (MPAs). Multiple gear types are used and include chevron traps, short bottom longline, and rod and reel. Oceanographic variables are collected as well. Data from the SEAMAP-SA Reef Fish Survey can be queried in the SEAMAP-SA database for the SCDNR-MRD Reef Fish Survey RFS data.

In 2018, SC DNR staff tested the feasibility of migrating the SEAMAP-SA database to the SECOORA Data Portal (SEAMAP n.d.b). The user capability within the SECOORA portal allows for advanced end-user

capabilities to summarize and combine datasets across multiple surveys which is a feature SEAMAP-SA database lacks. A pilot project was funded by SECOORA to successfully incorporate SEAMAP-SA Reef Fish Survey data available through the Oracle database into the SECOORA portal. The SC DNR portal will be disabled when the SECOORA portal for the SEAMAP-SA data is fully operational, and the migration has been completed.

4.1.4 Ocean Biogeographic Information System-Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP)

URL: https://seamap.env.duke.edu/

Ocean Biogeographic Information System—Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) was established in 2002 and serves as a spatially and temporally interactive online database for understanding the distribution and ecology of fishes (rays, sharks, and large bony fish), seabirds, sea turtles, and marine mammals (Halpin et al. 2009). The database is publicly accessible and contains data collected from animal telemetry, acoustic monitoring, photo identification and observational surveys, as well as oceanographic variables. Data can be easily downloaded into a suite of formats including CSV, ESRI file geodatabase or shapefile, Google Earth KML/KMZ, OGC WMS, or OGC WFS (OBIS-SEAMAP 2021).

Users can submit data in the form of a CSV, Excel, Access database, ESRI Shapefile, or ESRI Geodatabase to the Data Manager. The taxon name, latitude/longitude coordinates of the observation, and date/time information must be included, and effort data is optional. OBIS-SEAMP also accepts whole datasets including additional attributes of *in-situ* data such as sea surface temperature, salinity, and Beaufort Sea state. The data then goes through a data registration process where quality checks are applied upon a final review by the contributor before the data becomes freely available in the database. The data provider retains ownership of the data. The complete process for contributing data to OBIS-SEAMAP can be seen in Figure 4. It's important to note that data uploaded onto the OBIS-SEAMAP database is shared and uploaded (unless opted out) into Ocean Biogeographic Information System (OBIS) which serves as a parent node of OBIS-SEAMAP, and into the Global Biodiversity Information Facility (GBIF) as these three nodes are interconnected.

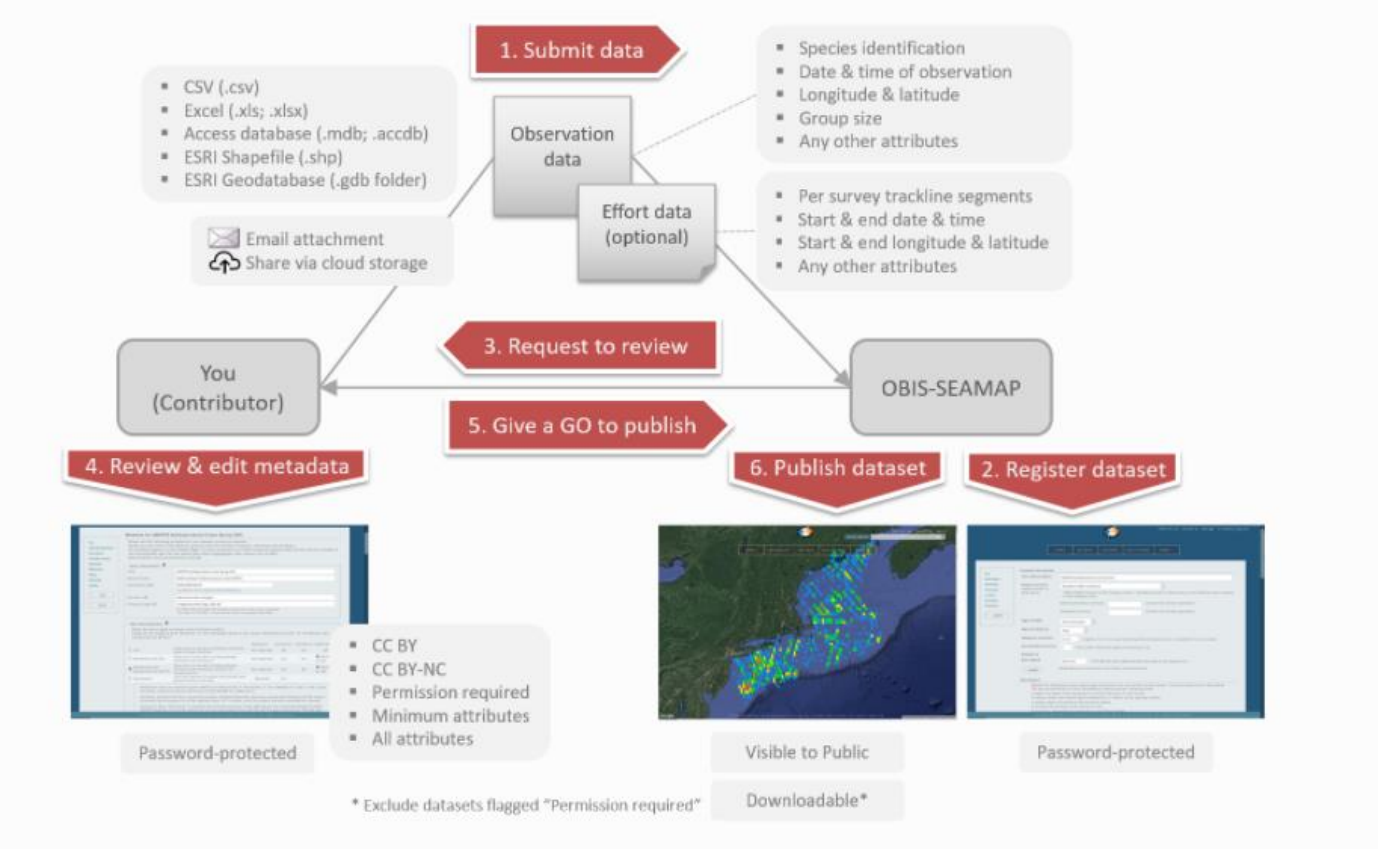


Figure 4. OBIS-SEAMAP data flow (OBIS-SEAMAP 2021)

4.1.5 American Lobster Settlement Index Web Portal (ALSI)

URLs: https://umaine.edu/wahlelab/american-lobster-settlement-index-alsi/
http://www2.gulfofmaine.org/esip/reporting/gmap2.php

Established in 1989, the American Lobster Settlement Index (ALSI) is an annual monitoring program in the Gulf of Maine (extending south to Rhode Island and north to Newfoundland) that measures the pulse of newly settled lobsters which repopulate rocky nursery grounds (University of Maine n.d.). The survey has since expanded to cover over 100 sites in lobster-producing regions. Survey participants include the University of Maine, ME DMR, MA DMF, RI DEM, New Hampshire Department of Fish and Wildlife, Department of Fisheries and Oceans Canada-Nova Scotia, -New Brunswick, -Prince Edward Island, University of New Brunswick, St. John, Guysborough County Inshore Fishermen's Association, and Prince Edward Island Fishermen's Association. Funding support is provided by National Science Foundation, NOAA National Undersea Research Program, NOAA Fisheries, and the Environment (FATE) Program,

Maine Sea Grant, Maine Department of Marine Resources, Rhode Island Division of Fish and Wildlife, Fishermen and Scientists Research Society, University of New Brunswick, and CFRF.

The ALSI is comprised of two data sources obtained from airlift suction sampling and vessel-deployed passive collectors (ALSI n.d.). Currently, each participating state runs separate annual settlement surveys using airlift suction sampling while government partners in Canada exclusively use collectors. Both methods collect lobster as the target species, but additional species collected such as Jonah crabs are reported as well. Together, both data sources quantify early settled young-of year and older juvenile lobsters.

The University of Maine manages the index and collaboration of data collected from individual state agencies while the ACCSP stores the data in a central database for current and historical data. The ALSI web portal is password protected and users with access can query the data to produce downloadable reports. The Gulf of Maine Council allows for public access to a subset of the ALSI data and users can graph data time series with additional parameters including climate and pollution indicators and map study areas. Additionally, the data collected by the individual state agencies is housed in internal state-specific databases and the lobster stock assessment committee has developed a direct pull from the partner states to combine data into a standard format.

4.1.6 National Centers for Environmental Information (NCEI) Passive Acoustic Monitoring Archive

URL: https://www.ncei.noaa.gov/

The NOAA NCEI currently hosts a national archive for passive acoustic data on marine mammals and fish from sources including BOEM, academia, the US Navy funded programs, National Parks Service (NPS), NOAA NMFS Alaska Fisheries Science Center, and NEFSC, among others. Currently, the archive holds over 100 TB of data which primarily consists of audio files and derived data products and is expected to grow in the upcoming years with the inclusion of petabytes collected by NOAA, BOEM, NPS, and US Navy funded programs (Wall et al. 2021).

The national archive was designed to hold extensive volumes of raw acoustic data and allow for a user-friendly query and accessibility of data through an ESRI web-based map service (NOAA NCEI, 2017). In 2018, a partnership was formed between NCEI and Google through the NOAA Big Data Program which allows for the immediate and free access to archived datasets on a Google cloud platform. Archived acoustic data and metadata can be accessed through the publicly available map viewer or a Google cloud platform. The archive hosts datasets from the ocean noise reference (NRS), the Atlantic Deepwater Ecosystem Observatory Network (ADEON), the Sanctuary Soundscape monitoring project (SanctSound) and NMFS. Received data are archived within 90 days and the data submitter must quality check the data before submission due to the lack of a quality control procedure. The archive does not currently accept raw

data and metadata collected by private parties but is open to conversations with OWE developers and may do so in the future (NYSERDA 2021).

4.1.7 Ocean Tracking Network (OTN) and US Regional Nodes

URLs: https://oceantrackingnetwork.org/
https://matos.asascience.com/
https://secoora.org/fact/

The OTN is a global research and technology development platform based in Canada which uses acoustic transmitters to study fish, invertebrates and marine mammals through acoustic tagging and sensors. A global network is created of compatible underwater receivers which record presence/absence data on organisms which have a coded acoustic tag, and compiles information from users into a common database. The data provides insight into the range of spatial and temporal scales of marine animal movements (Iverson et al. 2019) and allows for systematic tracking of animals which travel long distances. The OTN hosts a large repository of public and private acoustic telemetry data while maintaining linkages to sibling acoustic telemetry data centers globally and providing animal tracking data to OBIS (OTN n.d.a). Acoustic telemetry data for the Mid-Atlantic and Northeast states are uploaded to the ACT_MATOS website (MATOS 2021), which collects and distributes the data for the Northeast US (ACT) and Mid-Atlantic (MATOS) regional nodes of the OTN database. Another affiliated node of the OTN on the east coast of the U.S. is the FACT. Data is stored on the Microsoft Access database, VEMco Biotelemetry User Database, which holds receiver and sensor metadata, tagging metadata, and download logs (FACT 2021).

Universities and not-for-profit organizations can borrow equipment on a case-by base basis (OTN n.d.b). Scientists tag aquatic species with small electronic transmitters which typically are surgically implanted or attached externally. Acoustic receivers are arranged depending on the project goals, sea conditions and technology used. The data is downloaded from retrieved receivers and uploaded to the OTN Data Portal. Depending on the type of acoustic receiver, telemetry data is downloaded several ways including transmittal to a surface unit on demand without having to retrieve the unit, retrieved and brought to the surface for download, or some receivers have real-time communication paths to the receiver itself which enables researchers to easily monitor the status of deployed receives and upload data at any time (INNOVASEA 2021). Tags and receivers can also contain sensors to measure oceanographic variables such as temperature, depth, salinity, currents, chemistry, and other properties.

The OTN has a Data Policy which states that acoustic receiver metadata is to be made public as soon as practical while the detection data are not published immediately (Pye et al. 2018). The animal detections and sensitive metadata can be kept private for up to two years after the expiration of the animal-attached tag's battery. A request can be made to extend the embargo period, to be approved by the OTN Deployment Committee. Oceanographic observations are to be submitted in real-time to the appropriate International

Ocean Exchange (IODE) National Oceanographic Data Centre (NODC) who will be responsible for quality control and submission of the data to the Global Ocean Observing System (GOOS).

The ACT_MATOS data portal displays publicly available project pages from ACT and MATOS researchers who can adjust the visibility permissions as needed for uploaded raw data and metadata. The ACT and MATOS node is primarily focused on fish acoustic telemetry data. The database can store transmitter metadata, acoustic array deployment locations and time frames, and raw receiver download .vrl files (ACT_MATOS 2021). Once data is uploaded to the data portal, it is run through quality control scripts and then becomes ingested into the database. The ACT_MATOS database is a node of the OTN and developed as a joint effort from the MARACOOS, IOOS, ATN, OTN, and the NOAA Chesapeake Bay Office.

4.1.8 Animal Telemetry Network Data Assembly Center (ATN DAC)

URL: https://ioos.noaa.gov/project/atn/

The U.S. ATN was established in 2016 and is funded by the Integrated Ocean Observing System (IOOS) and Office of Naval Research (US ATN 2021). ATN is a multi-agency and research institution collaborative effort developed to connect the scientific community around marine animal telemetry data and infrastructure. The Data Assembly Center (DAC), which ATN now operates, builds on the existing US IOOS capabilities, and supports a wide range of tag types and datasets for species including large fishes, seabirds, sea turtles, and marine mammals.

The ATN DAC Data Portal also displays the Acoustic Telemetry Asset and Satellite Telemetry Project Inventories as map-based layers. This information is geared towards the ATN funding agencies, the telemetry research community, and the ATN Steering Group.

The ATN has implemented a multi-year program funded by the Office of Naval Research which will pay for the cost of Argos satellite data collection for marine animals. Researchers are eligible if they submit their R/T tracks and raw tag data to the DAC.

In recent ATN Steering Group Meetings updates were provided. Environmental layers have been added to the portal and include the IOOS global sensor, Group for High Resolution Sea Surface Temperature (GHRSST), and the Operational Sea Surface Temperature and Ice Analysis (OSTIA) sea surface temperature/sea ice. The ATN DAC also plans to begin hosting PAM data products in the future (NYSERDA 2021).

4.1.9 Marine Resources Monitoring, Assessment, and Prediction (MARMAP)

URL: https://www.st.nmfs.noaa.gov/copepod/data/us-05102/

The Marine Resources Monitoring, Assessment, and Prediction (MARMAP) is a sub-collection of North Atlantic plankton data from the Coastal and Oceanic Plankton Ecology, Production, and Observation Database (COPEPOD) (MARMAP 2019). NMFS provides the COPEPOD dataset which contains over 400,000 observations of plankton taxa along with co-sampled environmental meteorological and hydrographic data (COPEPOD 2021). The sub-collection of MARMAP data is publicly accessible and data can be browsed by downloading an entire dataset or browsing the data by individual cruises. Data is contributed to COPEPOD by the format chosen by the data contributor including formats such as spreadsheets or logbooks via electronic or paper form. Biological data that can be contributed to COPEPOD includes plankton abundance, biomass, and/or composition data. When contributing data to COPEPOD, the data contributors will receive the early notification of COPEPOD product releases and data, and full credit for their contribution.

4.2 Metadatabases

4.2.1 InPort

URL: https://www.fisheries.noaa.gov/inport/about

InPort was first described in 2003 and currently serves as a Metadata Catalog for NOAA Fisheries, the National Ocean Service (NOS), and their state and regional partners (InPort 2021a). InPort is funded under the Fisheries Information System (FIS) Program. Within InPort, each NMFS organization maintains its metadata collection and can store and share detailed information on metadata, and data holdings such as the completeness and quality of data, confidentiality policies, quality control procedures, and points of contact to obtain or better understand the data. The data sets in InPort can exported to an open metadata format of an ISO19115-2 or Dublin Core (XML). Catalog items can be exported as Dublin Core (XML) and Catalog Item Types can be exported as InPort XML. Select Libraries are publicly available, while some Libraries or portions of Libraries are only available to a user affiliated with NOAA or one of its participating partners. If a library is publicly available, this allows any user to browse through that organizations collection of metadata and data holding details. The documentation of data is a governmental mandate and the NMFS Data and Information Policy Directive (InPort 2021b) states “All data shall have a standard set of metadata…and an authoritative source for the data shall be identified.” Each NMFS organization is provided with a metadata rubric report to help ensure discoverability of their metadata in InPort.

InPort does not accept raw data submitted by private parties and does not make data publicly accessible upon request. The user must read the data accessibility requirements to determine if they are a qualified user upon reaching out to the point of contact for data requests. However, InPort does host select raw data from NMFS surveys such as the Fall and Spring Bottom Trawl Survey and compressed zipped folders of data can be downloaded.

4.2.2 Tethys Knowledgebase and OES-Environmental

URLs: https://tethys.pnnl.gov/
https://tethys.pnnl.gov/about-wren
https://tethys.pnnl.gov/oes-environmental-metadata

The Tethys Knowledgebase is a result of the Working Together to Resolve Environmental Effects of Wind Energy (WREN) initiative established by the International Energy Agency Wind committee in 2012 to address environmental impacts associated with land based and OWE development. The NREL, the Pacific Northwest National Laboratory (PNNL), and the US Department of Energy's (DOE) Wind Energy Technologies Office (WETO) support the effort. Most WREN content is publicly accessible, but some space is reserved for the 13 member countries to collaborate under password protection.

The Tethys Knowledgebase is a searchable database of papers, research, and reports relating to OWE or other kinds of marine renewable energy development (e.g., wave, current, tidal). It is a useful resource for staying up to date on the state of the science, includes a map viewer tool, and can be searched by title, author, date, country, content type, technology, stressor, or receptor. At the time of this writing, there are roughly 250 publications or reports relating to OWE and fish.

The OES-Environmental metadatabase is part of the Tethys website and collects and distributes metadata or information on research studies and site-specific projects investigating the potential environmental impacts of marine renewable energy devices (Tethys n.d.). The site requests annual updates for ongoing work to be sent via emailed metadata form. However, it appears to only contain metadata for studies pertaining to marine, tidal, and wave energy and not OWE. Expanding this metadatabase to also include OWE and fisheries resource data seems like it would be a useful enterprise, especially since it is so international in nature.

4.3 Oceanographic and Biodiversity Data

The NERACOOS, MARACOOS, and SECOORA provide real-time and near real-time oceanographic data in a standard format to meet federal standards and aid in summarizing real-time observations for management and planning purposes as part of the US IOOS.

4.3.1 NERACOOS

URL: http://www.neracoos.org/

NERACOOS contains data on the coastal waters from the Canadian Maritime Provinces to the New York Bight. Real-time data is provided by sensors and buoys that report on regular intervals to the data provider. An automated QC procedure is then applied creating real-time data which is ingested and processed by the NERACOOS Data Management System (NERACOOS 2017). Near real-time data is provided by

MODIS and AVHRR satellite imagery data which are processed by the University of Maine and then available through NERACOOS on a several day lag. The NERACOOS buoys provide climatology data which are near real-time data and are available as daily files or monthly files. Historical data is provided to NERACOOS as a full time series from buoy deployments that has undergone QAQC. Lastly, model data includes forecast products both from NERACOOS and federally funded partners. The data is available as time series and imagery within the portal and integrated into several data products. NERACOOS accepts data from three types of providers including NERACOOS-funded projects, federal and state providers, and private research. Data from private research comes from academic institutions, private industry, and NGOs and the data is not always continuous (i.e., tends to be shorter-term deployments). These data are not available in NERACOOS or its data products because they are often shorter-term projects, but they are made available through the ERDDAP data system (NERACOOS 2017).

NERACOOS funded providers are fully or partially funded and collect significant amounts of data which need to meet standard requirements for the file format, metadata and QAQC. The NERACOOS Data Management and Communication team (NERACOOS 2017) works with the data providers to produce regular, quality real time, and historic data. NERACOOS will also ingest data through standard web services from federal and state providers which provide independent QAQC procedures required by the agency which collects the data. The data from data providers is acquired through a Service Oriented Architecture (SOA) approach which provides high quality data to end-users by enabling the data contributors to expose data through standards-based web services (NERACOOS 2017). Figure 5 shows a schematic of how the database is designed to allow for the efficient, successful integration of new data providers.

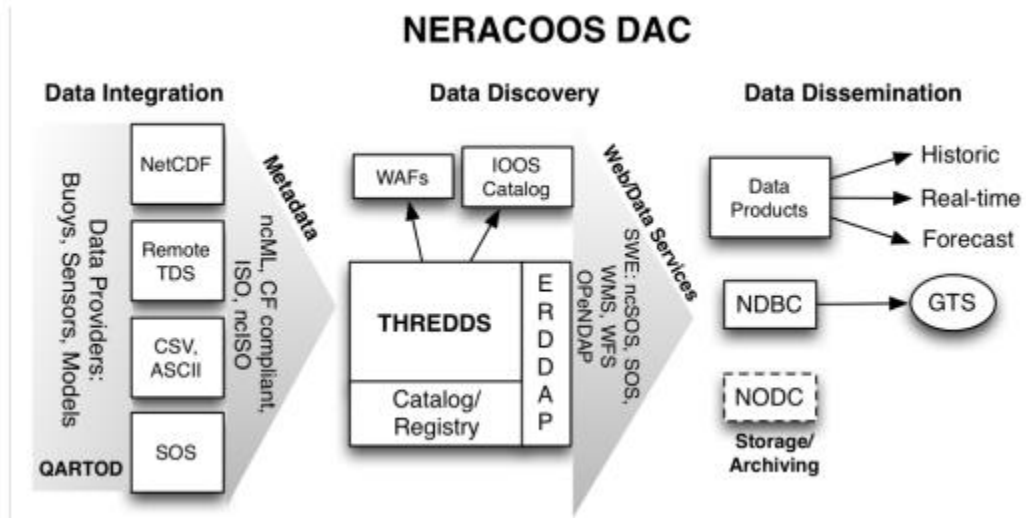


Figure 5. NERACOOS DAC data flow (NERACOOS 2017)

4.3.1 Integrated Sentinel Monitoring Network (ISMN)

URLs: https://www.gmri.org/projects/integrated-sentinel-monitoring-network-ismn/
https://marinebon.org//pages/gommbon/

In a collaboration between NERACOOS and NROC, the Integrated Sentinel Monitoring Network (ISMN) is currently being developed which is a repository and clearinghouse funded by the Marine Biodiversity Observation Network (MBON) to fill gaps about pelagic habitat biodiversity and ecosystem health from the Gulf of Maine MBON project. ISMN is planned to be established as a regional coordinating network which will serve the distribution of ecosystem and planktonic datasets and derived products. The data will be quality controlled and accessed using international standards. Through leverage of the NERACOOS data management system, GMRI (Gulf of Maine Research Institute) aims to develop a data portal for access and integration to projected data (GMRI 2021).

4.3.2 MARACOOS

URL: https://maracoos.org/

MARACOOS covers an area from Cape Cod MA to Cape Hatteras, NC and its five bays and urban estuaries. Current partners include academic, education and research institutions, federal, state, and local governments, industry, and non-governmental organizations. MARACOOS collects ocean and coastal data to create informative products to support the environment, economy, and safety for the Mid-Atlantic region. This is accomplished through the development of numerous data tools such as MARACOOS OceansMap, MARCO Portal, and NOAA CO-OPS and by providing real-time observing and forecasting assets using high-frequency radar, underwater gliders, weather stations, satellite ground stations, and ocean forecast models. (MARACOOS n.d.) Currently, MARACOOS has adopted a centralized data aggregation approach in the form of a regional DAC for remotely sensed observational and model data. In situ data is currently being implemented into a centralized approach. A secure offsite server farm hosts the centralized data storage system and allows for the management of data generated by MARACOOS partners and data collected by non-partner organizations (MARACOOS 2016). GliderDAC and the National High Frequency RADAR Network will be delivered to the national DAC's. With data both aggregated at national and regional DAC's open sharing is better enabled as data quality and distribution are managed. Each data stream provided to MARACOOS is unique, these include High Frequency Radar, Gliders, Advanced Very High-Resolution Radiometer, Moderate Resolution Imaging Spectroradiometer, Multi-scale, Ultra-high Resolution Sea Surface Temperature, the Hudson River Environmental Conditions Observing System, and the Maryland Department of Natural Resources. To see how each data stream is provided to MARACOOS please see MARACOOS Data Management Plan.

4.3.3 SECOORA

URL: https://secoora.org/

SECOORA is a not-for-profit and serves as the coastal observing system from the eastern side of Gulf of Mexico to the South Atlantic Bight. Data currently comes from in-situ stations, high-frequency radar, and the SECOORA Glider Observatory. Collected data is used to provide the SECOORA Data Catalog, SECOORA Data Portal, Marine Weather Portal, How's the Beach app, and the South Atlantic Bight and Gulf of Mexico Model. The Data Portal is publicly accessible and integrates datasets from real-time conditions, operational and research forecasts, satellite observations and other spatially references datasets which describe physical, biological, and chemical characteristics.

4.4 Derived Data Products

4.4.1 Marine Cadastre

URL: https://marinecadastre.gov/

Marine Cadastre is a collaborative partnership formed between BOEM and NOAA to provide federally sourced spatial data to the offshore energy and marine planning communities (Marine Cadastre 2021) The portal is part of the network of regional and national data portals to provide over 200 datasets which cover the US marine planning regions and cover regulatory, economic, physical, and biological themes. A combination of both regionally specific data and marine cadastral provides users with numerous data layers for planning efforts and renewable energy siting. Currently, there are 27 data providers which include Marine-Life Data and Analysis Team, Duke University Marine Geospatial Ecology lab, US National Park Service, US Environmental Protection Agency, among many others. Marine Cadastre is recognized as the central place for authoritative federal data with a combination of metadata, data, and map services integrated into Data Portals such as the Northeast and Mid-Atlantic Ocean Data Portals.

The data is publicly available and accessed through a registry which allows a user to create maps and perform various functions including downloading the data, sharing maps with others, rearranging layers, and changing the transparency. Data provided by other agencies is not stored in a central location. The provider must make the data available through standardized web services so Marine Cadastre can then consume the data within real time. If an agency has not implemented a web service yet, Marine Cadastre will either refer users to the authoritative source for download or harvest the data and publish the web service. The future vision for Marine Cadastre is for each agency to host and maintain their authoritative data sets. The types of web map services that are available through Marine Cadastre include ArcGIS server Dynamic, tile cache, and image services. Feature services have been added to the data registry and use the REST web standard. In anticipation of the new and upcoming map service types, standards such as WMS, KML, and GeoJSON will be compatible. There are several applications which incorporate Marine

Cadastre web map services, including ArcGIS.com, Bing Maps, Google Maps, Flex, Javascript, Silverlight, Google Earth, ArcGIS Explorer, NASA whirlwind, ArcMap, and QGIS.

The Marine Cadastre hosts multiple spatial tools which help ocean stakeholders streamline and standardize the data exploration process. These tools include the National Viewer web-mapping platform and the Ocean Report Tool (ORT). Data for the National Viewer are stored in an SQL Server database. Future updates and enhancements on the data registry, web map services, and web content will be published on the Marine Cadastre Updates Page.

4.4.2 Mid-Atlantic Ocean Data Portal and Northeast Ocean Data Portal

URLs: https://portal.midatlanticocean.org/
https://www.northeastoceandata.org/
https://www.northeastoceandata.org/data-explorer/?commercial-fishing|vessel-activity

The NEODP and the Mid-Atlantic Ocean Data Portal were established in 2009 and managed by the NROC and the Mid-Atlantic Regional Council on the Ocean (MARCO) as a result of the Northeast and Mid-Atlantic Ocean Plans (NROC 2009). Developed by the Northeast and Mid-Atlantic regional planning bodies, the primary purpose was to serve as a decision support tool and contain informative data portals that allow any user to easily explore a suite of ocean resources and human use information. The data portals were created to aid in the support of marine spatial planning along the Eastern US and are web-based systems which contain geocoded data layers that are relevant to marine decision-makers and stakeholders as well as coastal citizens. The portals are publicly accessible and provide interactive ocean-focused maps which contain data on the ocean ecosystem economy and culture of both the Northeast US and Mid-Atlantic regions. Data is provided by state and federal agencies, scientists, ocean industries, non-government organizations, and other entities. The maps are interactive so a user can view a specific dataset or combinations of data on a single map. The data is shareable and can be downloaded and used in GIS software (Longley-Wood 2016).

The NEODP contains a host of resource data organized into curated theme maps that present data on key topics of interest to the use community. The Commercial Fishing theme map shows vessel activity based on VMS data (see Section 3.5.1.3) for various fisheries, including multispecies groundfish, monkfish, scallop, surfclam, ocean quahog, and pelagic herring, squid, and mackerel. It also includes a Communities at Sea map based on the federal VTR data for fishers using various gear types (bottom trawl, dredge, gillnet, longline, pots and traps) to present a heat map of relative fishing density that represents the fishing places most important to local fishing communities. In addition to commercial fisheries information, the NEODP has a Marine Life and Habitat theme map for fish that includes environmental data such as species

richness, biotic abundance, habitat types, fish biomass, and more. These data products are based on national survey programs as well as fishery-dependent data (Ribera et al. 2021). BOEM recommends in their guidelines relying on these two regional data portals to support OWE baseline studies and permit applications (see Section 2.1). However, the Communities at Sea and VMS data layers have limitations due to fishery coverage and confidentiality (e.g., pot and trap data layer is included but with VTR's not required for all vessels, the data may have limitations).

4.4.3 The Nature Conservancy Marine Mapping Tool

URL: https://maps.tnc.org/marinemap/#7/42.8/-68

TNC has recently developed and published a marine mapping tool which aggregates ecological data from Maine to North Carolina with the intention of aiding decision makers to better understand natural resource interactions in a particular area of interest. Funding has been provided by the Gordon and Betty Moore Foundation with additional supplemental funding from the Virginia CZM program. The tool was developed as stakeholders have expressed difficulty in understanding the impacts of offshore wind energy projects and the effects different stages have on the environment and marine life. The tool summarizes data on species including fish, marine mammals, and invertebrates which depend on specific areas and sea floor properties to allow a user to get a detailed picture of the ecological and living marine resources that can be affected by the various stages of the offshore wind energy process such as before permitting processes to locate areas of less conflict, and during construction and operations during offshore wind energy development. The tool was developed through the collaboration of state agencies and created as the pace of offshore wind development along the east coast is occurring rapidly. The tool will help inform decisions about offshore wind energy in areas such as the Gulf of Maine where no offshore wind has been cited and rather only discussions on where facilities may be placed. The tool will additionally aid in allowing decision makers to determine how locations for proposed projects are ecologically important.

The data aggregated in the marine mapping tool comes from the NEODP and MARCO data portal. The data is publicly available and comes from authoritative data sources from universities and federal and state agencies. Data is then displayed on an interactive map which holds thousands of natural resource data layers.

5 SUMMARY

OWE development along the east coast of the US has the potential to impact fisheries resources. A comprehensive literature review was conducted by CFRF and the Cornell Cooperative Extension of Suffolk County Marine Program in which it was stated that the potential impacts of offshore wind energy development on fisheries resources are not well understood in the U.S. (Petruny-Parker et al. 2015). The

OWE industry is developing at a fast pace and as commercially and recreationally important fishery resource data are collected for OWE, it is imperative that raw or derived data products are consistent with and can be submitted to existing key databases or integrated into existing datasets. In order for data to be useful over the long-term, a project's algorithms, tools, workflows, and results should follow the FAIR Guiding Principles of scientific data management: Findability, Accessibility, Interoperability, and Reusability (Wilkinson et al. 2016). To be findable, data must have good metadata and be registered or indexed in a searchable resource. To be accessible, data or the metadata must remain accessible and access protocols should be free, open, and retrievable. To be interoperable, data must use a formal and broadly accepted format or standards and must reference other data or metadata. To be reusable, data must be richly described with accurate attributes, include a data usage license, and meet relevant community standards (Wilkinson et al. 2016, Go-FAIR n.d.). These principles enhance the ability of machines to automatically find and use data and makes the best use of datasets in data-rich environments.

This report is intended to facilitate the transparency and sharing of fishery resource data collected for commercially and recreationally important fishery resources for OWE development by reviewing 17 commercial and recreational fish and oceanographic focused databases, as well as the important data elements typically collected for a suite of fisheries surveys using a variety of gear types. As discussed in NYSERDA (2021), fisheries resources need to be better served by existing databases as many do not permit public access to the data, contain only fishery-dependent data, or do not accept private data.

We make three overall recommendations:

1. A substantial amount of data collected and planned to be collected by the OWE industry currently cannot be submitted to an existing database. A regional planning effort is recommended to define a pathway to securing, storing, and serving this data. This effort would likely face many significant challenges to be successful.

2. Offshore wind developers should emulate sampling protocols and gear designs consistent with regional-scale data collection programs such as NEAMAP, SEAMAP and the Southern New England Cooperative Ventless Trap Survey.

3. Data collected from these programs should be collected in a format that can be compiled with existing federal and state survey, fishery dependent, and oceanographic and biological databases through development and inclusion of standardized protocols, effort data, and metadata.

A summary of specific databases and protocols recommended for some of the major fisheries resource data types is presented in Table 2, with summary details for each data type provided in the following subsections.

Table 2. Summary of recommendations for data practices and databases for information relevant to OWE development

Data Type	Recommended Databases or Protocols	Gaps or Expansion Opportunities
Operational	NEAMAP trawl survey protocols SEAMAP trawl survey protocols Lobster ventless trap survey protocols MARMAP (plankton database)	No public warehouse for juvenile or adult fish data.
Observational	OBIS-SEAMAP	OBIS-SEAMAP applicable primarily to photo ID data of large fishes. No widespread, standardized protocols or warehouses identified for underwater video data.
Tagging and Acoustic	OTN (acoustic telemetry) ACT_MATOS (acoustic telemetry) FACT (acoustic telemetry) OBIS-SEAMAP (satellite telemetry)	No public warehouse for PAM data, but ATN DAC may be a possibility in future.
Fisheries Dependent	ACCSP Data Warehouse Fisheries Information Network (FIN) Derived products from VMS and VTR available on NEODP	ACCSP cannot currently accept private/OWE industry data.
Metadata	OES-Environmental metadatabase (in Tethys Knowledgebase)	InPort only accepts federal metadata.
Oceanographic and Biodiversity	OBIS-SEAMAP database MARACOOS OceansMap web portal NERACOOS ERRDAP	May expand the MBON project to include biodiversity data accessible on the ERRDAP server. Mayflower Wind buoy data may be provided on ERRDAP server in future.
Derived Data Products	Northeast Ocean Data Portal (NEODP) Mid-Atlantic (MARCO) Data Portal	Currently only house derived data products but could possibly be expanded to host raw data and/or private/OWE industry data.

5.1 Operational Data

NEAMAP is a large-scale cooperative effort to collect and disseminate fishery-independent data obtained in the Atlantic coastal waters. Three large-scale fishery independent surveys coordinate data collection using a standardized set of protocols and gear that is identical to NMFS to aid in comprehensive and consistent data collection. Currently, Vineyard Wind conducts annual trawl surveys following the NEAMAP protocols (Vineyard Wind 2020). Vineyard Wind conducts seasonal trawl surveys 4 times a year to collect baseline data on commercially important fish species spatial distribution, species abundance, length-weight relationship, and size structure in lease areas 501 and 522. The sampling intensity is increased in 501N and a nearby control area for the BACI study design. By emulating NEAMAP protocols, Vineyard Wind ensured consistency with NEAMAP surveys, NMFS spring and fall trawl survey, and state trawl surveys such as the MA DMF trawl survey. To facilitate sharing and integration of data with federal and state agencies and allow for the data collected to be incorporated into existing datasets, Vineyard Wind adapted existing methodology consistent with other ongoing surveys of nearby study areas but increased resolution. The otter trawl used by Vineyard Wind is identical to the trawls used in the NEAMAP surveys.

SEAMAP, which is the second fishery-independent data collection program coordinated by the ASMFC, is similar to NEAMAP in that it conducts long-term standardized surveys but in the Southeastern US. It is recommended that OWE developers in the southeast emulate the SEAMAP protocols and methodologies when sampling to facilitate sharing and integration of data and allow for the possibility of collected data to be incorporated into existing datasets. It is necessary to determine if the SEAMAP-SA repository will accept data submitted by private parties and if the data will be publicly accessible. Currently SEAMAP-SA data is being migrated to the SECOORA portal and once fully operational, the SC DNR portal will become disabled. Until the migration is complete, follow up discussions could additionally be had to determine if SECOORA will accept data from private parties.

The American lobster represents a valuable commercial fishery in Lobster Management Area 2 and the RI/MA wind energy area. As the life cycle of the lobster transforms from larval dispersal and settlement to a juvenile, and then to adult abundance, it has been shown that impacts from offshore wind development can occur during each life history stage which has important implications for population level effects (Gill et al. 2020). Additionally, species specific findings have found that after speaking with stakeholders, scientists, and members of the fishing industry, crustacean species such as the American lobster are most prevalent within WEAs and are crucial to monitor for potential impacts (Petruny-Parker et al. 2015).

Federal and state trawl surveys and Coastwide ventless trap surveys serve as important annual/bi-annual surveys and assessment data for lobster. More recently, the Southern New England Ventless Trap Survey was started in 2006 with a continuation survey funded by CFRF in 2018. SMAST and the Massachusetts Lobstermen's Association conducted a ventless lobster trap and tagging survey in Vineyard Wind's Lease

Area OCS-A 0501 on the outer continental shelf (UMASS Dartmouth -SMAST 2020). Ventless trap surveys are now widely accepted for examining lobster populations and have proven to be successful in the pre-construction monitoring of the RI/MA WEA located on Cox's Ledge (Collie and King 2016), and in assessing the impact of the Block Island Wind Farm abundance from 2013-2018 (Griffin et al. 2019). Thus, lobster survey sampling protocols should mimic the Southern New England Cooperative Ventless Trap Survey (Petruny-Parker et al. 2015). However, there currently is no repository to hold data on the Ventless Trap Surveys from developers. Additionally, ventless trap surveys and state inshore trawl surveys are conducted for the Gulf of Maine but are less likely to overlap with offshore wind areas due to the distance from shore. However, the protocols and methods used could be expanded and applied to potential offshore wind areas. Currently, state ventless trap data can be submitted to ACCSP, but the lobster stock assessment committee has developed a direct pull from the partner states to combine the data into a standard format.

5.2 Tagging and Acoustic Data

Telemetry tag data are fairly standardized already and the current databases that store this information seem sufficient. ACT_MATOS, FACT, and other regional nodes of OTN are well-developed systems for uploading, storing, and sharing telemetry data as MATOS stores primarily fish-focused acoustic telemetry data for the US Atlantic Coast. The OBIS-SEAMAP database houses satellite tracking data for large bony fishes. For passive acoustic data, the NCEI PAM database doesn't accept non-NMFS data but a conversation about funding to support archiving and storage of private data would be beneficial. The ATN DAC is also planning to start hosting PAM data, so this could be a future option storing developer-collected acoustic data (NYSERDA 2021). A recent ATN Steering Group Meeting notes provided an update that there is work being done to unify the ATN and MBON data programs in IOOS (US ATN 2021).

5.3 Fisheries Dependent Data

The ACCSP houses fishery-dependent data supplied from 23 program partners which comprise federal agencies, councils, state agencies, and commissions. The ACCSP Data Standards document states that fisheries-independent data are not currently included in the Program scope as the ACCSP's first goal was to address the complexity centered around the collection and dissemination of fishery-dependent data and combining both programs may dilute resources. Secondly, ACCSP identified that fisheries-dependent data should have a separate initiative; thus, we do not currently recommend the ACCSP Data Warehouse as a repository for OWE developers to submit collected fisheries data because it does not accept fisheries independent or private data at this time, but it is the recommended database for fishery dependent data. The ACCSP has noted that if dependent data does not provide the information needed to fill gaps and remove bias, then ACCSP will consider developing an independent data module. There are currently no finalized plans to incorporate fishery-independent data, but there have been suggestions made to develop ACCSP as a centralized data warehouse for fisheries data collected from private parties (NYSERDA 2021).

5.4 Metadata

In addition to raw data, comprehensive metadata submission provides important information about associated raw data. InPort and the OES-Environmental metadatabase, which is part of the Tethys Knowledge Base, were both summarized in this report as databases for storing metadata. InPort is not recommended for OWE developers to submit metadata as it is federally managed and does not currently accept data from non-NMFS organizations and does not permit public access to all the metadata currently available in the libraries. It is however recommended that OWE developers submit data to the OES-Environmental metadatabase. The metadata are publicly accessible and interested users can find and access relevant data and identify data collected at the project site.

5.5 Oceanographic and Biodiversity Data

Having a repository for developers and their contractors to store oceanographic data is imperative, as OWE can impact the physical oceanography around WEA's (Petruny-Parker et al. 2015). Oceanographic data are fairly standardized already and the current databases that store this information seem sufficient. OBIS-SEAMAP, MARACOOS OceansMap, and NERACOOS are good repositories for real-time oceanographic data. Although the OBIS-SEAMAP database stores spatial data, in-situ data such as sea surface temperature, salinity, and Beaufort Sea state is accepted as well. Quality checks are run on the data upon a final review by the data contributor before data becomes freely available on the database, and the data provider retains ownership of data. The MARACOOS OceansMap serves as a data visualization tool and combines near real-time observational assets along with model forecasts to aid in the Mid-Atlantic region ocean monitoring. Additionally, Mayflower Wind has recently partnered with NERACOOS to share real-time ocean and weather data collected by the buoy and has been integrated into the NERACOOS Mariners' Dashboard (Mayflower Wind 2021).

5.6 Derived Data Products

While most of this report was primarily focused on repositories for raw data, derived data products were summarized which include TNC Marine Mapping Tool, Marine Cadastre, and the Mid-Atlantic and Northeast Ocean Data Portals which can aid in initial risk assessments. The derived data products are peer-reviewed and aid in facilitating decision-making mainly used to inform fisheries management, OWE development, and ocean planning. Sources like Marine Cadastre serve as a starting point of the federally sourced data products which exist. Derived data products serve as excellent sources for siting OWE projects and with marine spatial planning tools such the TNC Marine Mapping Tool, initial assessments can be conducted to identify important species and trends to use the best available science to make decisions. The Marine Mapping Tool is unique in that when a user draws an area of interest, a data summary is instantly generated of all relevant species within the area, times of year they occur as well as abundance. With the data summaries, marine flags are generated and provide data on potential conflicts to allow the user to dive into

the topics separately to examine which species will be impacted. However, the Marine Mapping Tool fish data is sourced from fishery-independent surveys as commercial fisheries data are not included within the tool. Although there are advantages to using derived data products, raw data ensures long-term relevance and maximizes the utility of data for different research and analysis purposes.

New databases or expansions to databases relevant to the marine environment are expected as OWE industry continues to develop. Currently, the Northeast Ocean Data Portal and the Mid-Atlantic Ocean Data Portal Councils are considering expanding the portals to house and display OSW developer survey data and integrate the raw data into regional data products (NYSERDA 2021). This would allow the Portal to host data for taxa which lack a dedicated repository such as fish, zooplankton, and marine invertebrates.

6 REFERENCES

Note: "n.d." = "no date" associated with a citation or website

ACCSP. 2012. Appendix I: Standard Measurements for Gear Types / Gear Data Elements. 27 pp. Available: https://www.accsp.org/what-we-do/data-standards/

ACCSP. 2018a. History. Available: https://www.accsp.org/who-we-are/history/

ACCSP. 2018b. Five-Year Strategic Plan 2019-2023. Available: http://www.asmfc.org/files/pub/2019-2023StrategicPlan_Final.pdf

ACCSP. 2018c. Data Warehouse. Available: https://www.accsp.org/what-we-do/data-warehouse/

ACT_MATOS. 2021. Database User Agreement and Data Policy Version 1.2 Available: https://matos.asascience.com

ALSI. n.d. The American Lobster Settlement Index: An Early Warning System? Available: https://umaine.edu/wahlelab/wp-content/uploads/sites/449/2015/09/ALSI-Factsheet.pdf

ASMFC. 2021. Fisheries Resource Surveys. Available: https://www.asmfc.org

BOEM. 2013. Guidelines for Submission of Spatial Data for Atlantic Offshore Renewable Energy Development Site Characterization Surveys. February 1, 2013. 6 pp.

BOEM. 2019. Providing Information on Fisheries for Renewable Energy Developments on the Atlantic OCS Pursuant to 30 CFR Part 585. June 2019. 14 pp.

BOEM. 2020a. Information Guidelines for a Renewable Energy Construction and Operations Plan (COP). Version 4. May 27, 2020. 63 pp.

BOEM. 2020b. Guidelines for Providing Information on Fisheries Social and Economic Conditions for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585. May 27, 2020. 8 pp.

BOEM. 2021. Available: https://www.boem.gov/renewable-energy/regulatory-framework-and-guidelines

CFRF. n.d.a. Expansion of the Coastwide Ventless Lobster Trap Survey in Southern New England. Available: http://www.cfrfoundation.org/expansion-of-the-coastwide-ventless-lobster-trap-survey-in-southern-new-england

CFRF. n.d.b. Southern New England Cooperative Ventless Trap Survey. Available: http://www.cfrfoundation.org/snecvts

Christel, D. 2021. Personal Communication, October 12, 2021.

Collie, J.S. and King, J.W. 2016. Spatial and Temporal Distributions of Lobsters and Crabs in the Rhode Island Massachusetts Wind Energy Area. US Dept. of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region, Sterling, Virginia. OCS Study BOEM BOEM 2016-073. 48 pp

COPEPOD. 2021. Available: https://www.st.nmfs.noaa.gov/copepod/about/index.html

Corbett. H. 2008. New Jersey Fish and Wildlife Digest; 2008 Marine Fishing Issue. Available: https://www.nj.gov/dep/fgw/pdf/2010/artdel_fishtraveled.pdf

CT DEEP. 2020. Long Island Trawl Survey. Available: https://portal.ct.gov/DEEP/Fishing/Fisheries-Management/Long-Island-Sound-Trawl-Survey

CT DEEP. 2019. Estuarine Seine Survey. Available: https://portal.ct.gov/-/media/DEEP/fishing/publications/EstuarineSeineSurveypdf.pdf

DCC. 2021. Available: https://www.dcc.ac.uk/resources/metadata-standards/eml-ecological-metadata-language

DE DFW. n.d. Delaware's Trawl Survey Program. Available: https://documents.dnrec.delaware.gov/fw/SiteCollectionDocuments/FW%20Gallery/Research/trawl%20doc.pdf

ERDDAP. 2021. Available: https://coastwatch.pfeg.noaa.gov/erddap/index.html

FACT. 2021. Acoustic Telemetry Resources. Available: https://secoora.org/fact/projects-species/projects/acoustic-telemetry-resources/

FGDC. 2012. Coastal and Marine Ecological Classification Standard. Publication# FGDC-STD-018-2012. https://www.fgdc.gov/metadata/iso-standards

GARFO. 2021.Available: https://www.fisheries.noaa.gov/new-england-mid-atlantic/resources-fishing/vessel-trip-reporting-greater-atlantic-region

GARFO and NEFSC. 2017. Electronic Technologies Implementation Plan Progress Report. Available: https://media.fisheries.noaa.gov/dam-migration/garfo_nefsc_et_regional_implementation_plan_2017-05_update.pdf

Gill, A.B. S. Degraer, A. Lipsky, N. Mavraki, E. Methratta, and R. Brabant. 2020. Setting the Context for Offshore Wind Development Effects on Fish and Fisheries. Oceanography, 33(4), pg. 118-127.

Go-FAIR. n.d. FAIRification Process. Available: https://www.go-fair.org/fair-principles/fairification-process/

Gulf States Marine Fisheries Commission. 2021. Fisheries Information Network. Available: https://www.gsmfc.org/fin.php

GMRI. 2021.Integrated Sentinel Monitoring Network (ISMN) - Gulf of Maine Research Institute: Available: https://gmri.org/projects/integrated-sentinel-monitoring-network-ismn/

Griffin, M., Read, L., Carey, D. A. 2019. Block Island Wind Farm Annual Report May 2018-October 2018.

Halpin, P.N., Read, A.J., Fujioka, E., Best, B.D., Donnelly, B,. Hazen, L.J., Kot, C., Urian, K., LaBrecque, E., Dimatteo, A., Cleary, J., Good, C., Crowder, L.B., and Hyrenbach, K.D., 2009. OBIS-SEAMAP: The world data center for marine mammal, sea bird, and sea turtle distributions. Oceanography 22(2):104-115

Hare, J., Blythe, B., Ford, K., Hooker, B., Jensen, B. Lipsky, A., Nachman, C., Pfeiffer, L., Rasser, M., and K. Renshaw. 2022. NOAA Fisheries and BOEM Federal Survey Mitigation Implementation Strategy – Northeast U.S. Region. DRAFT March 2022. 35 pp.

ICES. 2019. ICES User Handbook: Best practice for Data Management. Copenhagen, Denmark, International Council for the Exploration of the Sea, 16pp. DOI: http://doi.org/10.17895/ices.pub.4889

Inport. 2020a. Winter Bottom Trawl Surveys. Available: https://www.fisheries.noaa.gov/inport/item/22563

Inport. 2020b. Summer Bottom Trawl Surveys. Available: https://www.fisheries.noaa.gov/inport/item/22562

Inport. 2020c. Spring Bottom Trawl Surveys. Available: https://www.fisheries.noaa.gov/inport/item/22561

Inport. 2020d. Fall Bottom Trawl Surveys. Available: https://www.fisheries.noaa.gov/inport/item/22560

Inport. 2020e. Shrimp Survey Data. Available: https://www.fisheries.noaa.gov/inport/item/25087

Inport. 2020f. Sea Scallop Survey. Available: https://www.fisheries.noaa.gov/inport/item/22564

Inport. 2020g. Atlantic Surf Clam and Ocean Quahog Survey. Available: https://www.fisheries.noaa.gov/inport/item/22565

Inport. 2020h. Gulf of Maine Cooperative Bottom Longline Survey Database. Available: https://www.fisheries.noaa.gov/inport/item/27731

InPort. 2021a. About InPort. Available: https://www.fisheries.noaa.gov/inport/about

InPort. 2021b. Why Metadata? Available: https://www.fisheries.noaa.gov/inport/help/why-metadata

InPort. 2021c. Nationwide Automatic Identification System. Available: https://www.fisheries.noaa.gov/inport/item/65082

INNOVASEA. 2021. Acoustic Receivers. Available: https://www.innovasea.com/fish-tracking/products/acoustic-receivers/

ITIS. 2021. Available: https://www.itis.gov

Iverson, S.J., Fisk, A.T., Hinch, S.G., Mills Flemming, J., Cooke, S.J. and Whoriskey, F.G., 2019. The Ocean Tracking Network: Advancing frontiers in aquatic science and management. Canadian Journal of Fisheries and Aquatic Sciences,*76*(7), pp.1041-1051

Jensen, O.P., Zemeckis, D., & Clarke, P. 2018. Year 3 Report: A Pilot Trap Survey of Artificial Reefs in New Jersey for Monitoring of Black Sea Bass, Tautog, and Lobster. Submitted to the New Jersey Department of Environmental Protection, Division of Fish and Wildlife. *32 pp.*

Longley-Wood, K. 2016. Creating and Using Data Portals to Support Ocean Planning: Challenges and Best Practices from the Northeast U.S. and Elsewhere. SeaPlan 27 pp.

MA CEC. 2020. Massachusetts, Rhode Island, BOEM Award $1.1 Million for Regional Fisheries Studies to Guide Offshore Wind Development. Available: https://www.masscec.com/about-masscec/news/massachusetts-rhode-island-boem-award-11-million-regional-fisheries-studies-guide

MA DMF. n.d. Resource Assessment Project. Available: https://www.mass.gov/service-details/resource-assessment-project

MARACOOS. n.d. Tools. Available: https://maracoos.org/tools.shtml

MARACOOS. 2016. MARACOOS Strategic Operational Plan 2016-2021. Available: https://maracoos.org/certification/doc/MARACOOSStrategicOperationalPlanFINAL.pdf

MARMAP. 2019. Available: https://www.st.nmfs.noaa.gov/copepod/data/us-05102/

Marine Cadastre. 2021. Available: https://marinecadastre.gov/

MATOS. 2021. Available: https://matos.asascience.com/

Mayflower Wind. 2021. Available: https://mayflowerwind.com/our-commitment/marine-sciences/

McCann. J., 2012. Developing Environmental Protocols and Modeling Tools to Support Ocean Renewable Energy and Stewardship. US Dept of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA., OCS Study BOEM 2012-082, 626 pp.

MCCF. n.d. Eastern Gulf of Maine Sentinel Survey. Available: https://coastalfisheries.org/collaborative-research/sentinel-survey/

MD DNR. n.d.a. Coastal Bays Fisheries Investigation. Available: https://dnr.maryland.gov/fisheries/pages/coastal/investigations.aspx

MD DNR. n.d.b. 2020 Blue Crab Summer Trawl Survey. Available: https://dnr.maryland.gov/fisheries/pages/blue-crab/trawl.aspx

MD DNR. n.d.c. 2021 Blue Crab Winter Dredge Survey. Available: https://dnr.maryland.gov/fisheries/pages/blue-crab/dredge.aspx

MDMF. 2021. Available: https://www.mass.gov/service-details/review-trawl-survey-updates

ME DMR. n.d.a. Maine Sea Scallop Research and Survey Reports. Available: https://www11.maine.gov/dmr/science-research/species/scallops/research/index.html

ME DMR. n.d.b. DMR Larval Lobster Surveys. Available: https://www.maine.gov/dmr/science-research/species/lobster/research/larval-survey.html

ME DMR. n.d.c. Maine – New Hampshire Inshore Trawl Survey Data Portal. Available: https://mainedmr.shinyapps.io/MaineDMR_Trawl_Survey_Portal/

Mooney, T.A. 2021. BSB responses to noise. Woods Hole Oceanographic Institution. Available: https://www2.whoi.edu/site/amooney/2021/03/17/bsb-responses-to-noise/

NC DMF. n.d. Independent Sampling Programs Pick Up. Available: https://deq.nc.gov/about/divisions/marine-fisheries/news-media/insight-newsletter/june-2018/independent-sampling-programs-pick

NEFSC. 2020. Cooperative Shark Tagging Program. Available: https://www.fisheries.noaa.gov/resource/document/cooperative-shark-tagging-program

NEAMAP. 2008. Near Shore Trawl Survey Peer Review Documentation. Available: http://neamap.net/publications/VIMS_NEAMAP_Peer_Review_Documents.pdf

NEAMAP Data Management. 2021. Available: http://neamap.net/dataManagement.html

NERACOOS. 2017. NERACOOS Data Management Plan-Version 2. Available: http://neracoos.org/sites/neracoos.org/files/documents/DMAC/NERACOOS_DMAC_Plan_V2.5_June_2017.pdf

NH MFD. 2019. Estuarine Survey of Juvenile Finfish. Available: https://www.wildlife.state.nh.us/marine/documents/estuarine-juv-finfish-survey.pdf

NJ DEP. 2021. Atlantic Sturgeon Research in Delaware Bay Continues in 2021. Available: https://www.nj.gov/dep/fgw/news/2021/sturgeon_research21.htm

NJ DEP. 2018. Ocean Stock Assessment Program. Available: https://www.nj.gov/dep/fgw/ocestock.htm

NJ DEP. 2009. Another of New Jersey's Priceless Resources - Studying the Delaware Bay. Available: https://www.njfishandwildlife.com/artdelstudy09.htm

NJ DEP. n.d. Bureau of Shellfisheries. Available: https://www.state.nj.us/dep/fgw/shelhome.htm

NOAA and Ørsted. 2021. Ørsted and NOAA Sign Industry First Data Sharing Agreement. Available: Orsted and NOAA Sign Industry First Data Sharing Agreement

NOAA. 2013. Southeast Fishery Independent Survey. Available: https://repository.library.noaa.gov/view/noaa/16448

NOAA. 2014. NOAA. Northeast Federal Fishery Dependent Data Visioning Project Industry Workshop. Available: http://134.209.208.5/sites/default/files/resource/final_fdd_workshop_report_91014.pdf

NOAA. 2016. Available: https://nosc.noaa.gov/EDMC/PD.DD.php

NOAA. 2018. Monitoring the Northeast Shelf Ecosystem. Available: https://www.fisheries.noaa.gov/feature-story/monitoring-northeast-shelf-ecosystem

NOAA. 2019. SEFSC Longline Surveys. Available: https://media.fisheries.noaa.gov/dam-migration/sefsc_longline_survey_2019.pdf

NOAA. 2020a. Available: https://www.fisheries.noaa.gov/new-england-mid-atlantic/fisheries-observers/fisheries-monitoring-operations-northeast#:~:text=Northeast%20Fisheries%20Observer%20Program%20Our%20observers%20collect%20catch%2C,for%20a%20variety%20of%20scientific%20and%20management%20analyses

NOAA. 2020b. Available: https://www.fisheries.noaa.gov/recreational-fishing-data/types-recreational-fishing-surveys.

NOAA National Centers for Environmental Information. 2017. Passive Acoustic Data Collection. Asheville, NC: NOAA National Centers for Environmental Information.

Northeast Ocean Data Portal (NEODP). 2021. Commercial Fishing: Vessel Activity. Available: https://www.northeastoceandata.org/data-explorer/?commercial-fishing|vessel-activity

Northeast Ocean Planning. 2021. Seafloor Habitat Data. Available: https://neoceanplanning.org/data-issues/seafloor-habitat-data/

NROC (Northeast Regional Ocean Council). 2009. Available: www.northeastoceandata.org.

NY DEC. 2021. Ocean Monitoring Projects. Available: https://www.dec.ny.gov/lands/111178.html

NY DEC. 2018. Ocean and Ecosystem Based Fisheries. Available: https://www.dec.ny.gov/lands/111148.html

NYSERDA. 2021. Wildlife Data Standardization and Sharing: Environmental Data Transparency for New York State Offshore Wind Energy. NYSERDA Report 21-11. Biodiversity Research Institute, Portland ME. nyserda.ny.gov/publications

OBIS-SEAMAP. 2021. Contributing Data to OBIS-SEAMAP. Available: https://seamap.env.duke.edu/content/provider_faq

OBIS. 2018. Long-term Otter Trawl Survey. Available: https://obis.org/dataset/2ed3cb38-e033-491d-95a7-5ae37f1f1904

Office of Law Enforcement (OLE). 2021. Regional Vessel Monitoring Information. Available: https://www.fisheries.noaa.gov/national/enforcement/regional-vessel-monitoring-information

OTN. n.d.a. Global Ocean Projects. Available: https://members.oceantrack.org/OTN/projects

OTN. n.d.b. OTN Equipment Loaner Program. Available: https://members.oceantrack.org/data/otn-equipment-loaner-program

Petruny-Parker M, Malek A, Long M, Spencer D, Mattera F, Hasbrouck E, Scotti J, Gerbino K, and Wilson J. 2015. Identifying Information Needs and Approaches for Assessing Potential Impacts of Offshore Wind Farm Development on Fisheries Resources in the Northeast Region. US Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2015-037. 79 pp.

Pugh, T.L., and Glenn, R. P. 2020. Random Stratified Ventless Trap Survey for American Lobster 2006-2016. Massachusetts Division of Marine Fisheries Technical Report TR-71. June 2020. New Bedford, MA.

Pye, J., Bajona, L., Townsend, B., and Whoriskey, F., 2018. Ocean Tracking Network Data Policy. Available: https://members.oceantrack.org/data/policies/otn-data-policy-2018_signature.pdf

RI DEM. n.d.a. Coastal Trawl Survey. Available: http://www.dem.ri.gov/programs/marine-fisheries/surveys-pubs/coastal-trawl.php

RI DEM. n.d.b. Shellfish Dredge Survey. Available: http://www.dem.ri.gov/programs/marine-fisheries/surveys-pubs/shellfish-dredge.php

RI DEM. n.d.c. Narragansett Bay Juvenile Finfish Seine Survey. Available: http://www.dem.ri.gov/programs/marine-fisheries/surveys-pubs/narrabay-seine.php

RI DEM. n.d.d. Narragansett Bay Menhaden Monitoring Program. Available: http://www.dem.ri.gov/programs/marine-fisheries/surveys-pubs/menhaden-monitoring.php

Ribera, M., Pinsky, M., Richardson, D. 2021. Distribution and biomass data for fish species along the U.S. east coast from about Cape Hatteras north to Canadian waters, created by The Nature Conservancy for the Marine-life and Data Analysis Team. Available: http://www.northeastoceandata.org/data-explorer/?fish

RODA. 2021. Responsible Offshore Development Alliance. Available: https://rodafisheries.org/about-us/

ROSA. 2021 Offshore Wind Project Monitoring Framework and Guidelines. Available: https://www.rosascience.org/_files/ugd/99421e_b8932042e6e140ee84c5f8531c2530ab.pdf

Rutgers. n.d. Ongoing Projects. Available: https://www.fisheries.noaa.gov/feature-story/monitoring-northeast-shelf-ecosystem

Robinson Willmott J, Clerc J, Vukovich M, Pembroke A. 2021. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy. Overview and Summary. Report to New York State Energy Research and Development, Contract no. 95764 RODA. 2021. Available: https://rodafisheries.org/

Sabo, S. D. Carey, M. Griffin, and D. Wilber. 2020. Effects of the Block Island Wind Farm on Coastal Resources: Lessons Learned. Oceanography (Washington D.C.). 33. 70-81.

SC DNR. n.d. Coastal Trawl Survey (CTS) and Data Management. Available: https://www.dnr.sc.gov/marine/mrri/CoastalResearch/SEAMAP/index.html

Seafloor Habitat Data Work Group Update. 2021. Available: https://neoceanplanning.org/wp-content/uploads/2021/07/Seafloor-Habitat-Data-Work-Group-Update-June-2021.pdf

SEAMAP. 2021. Available: http://www.seamap.org/datapage.html

SEAMAP. n.d.a. SEAMAP- South Atlantic Data Query. Available: http://www.seamap.org/datapage.html

SEAMAP. n.d.b. 2011-2015 Management Plan. Available: https://www.gsmfc.org/publications/SEAMAP/2011-2015_SEAMAP_Management_Plan_Web.pdf

South Fork Wind. 2020. South Fork Wind Fisheries Research and Monitoring Plan September 2020. Available: https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/SFW01-Fisheries-Research-Monitoring-Plan.pdf

Stoeckle MY, Adolf J, Charlop-Powers Z, Dunton KJ, Hinks G, VanMorter SM. 2021. Trawl and eDNA assessment of marine fish diversity, seasonality, and relative abundance in coastal New Jersey, USA , ICES Journal of Marine Science, 78(1):293–304.

Tethys. n.d. OES-Environmental Metadata. Available: https://tethys.pnnl.gov/oes-environmental-metadata

TDWG. 2021. Darwin Core Standard. Available: https://dwc.tdwg.org/

UMASS Dartmouth -SMAST. 2020. American Lobster, Black Sea Bass, Larval Lobster Abundance Survey, And Lobster Tagging Study of the 501N Study Area. Available: https://static1.squarespace.com/static/5a2eae32be42d64ed467f9d1/t/5efe5958396e36705dac7d0a/1593727323206/SMAST+VentlessTrap+501N+2019+Final+Report_6-28-20.pdf

University of Maine. n.d. The Wahle Lab. Available: https://umaine.edu/wahlelab/american-lobster-settlement-index-alsi/

University of Maine. 2020. Development of a Cooperative State/Federal Fisheries Independent Sampling Program Part 1, 3/25/03. Available: https://digitalcommons.library.umaine.edu/cgi/viewcontent.cgi?article=1026&context=maine_env_fisheries

URI. n.d. Fish Trawl Survey. Available: https://web.uri.edu/gso/research/fish-trawl/

U.S. ATN. 2021. US Animal Telemetry Network Steering Group Meeting SG-9. Available: https://cdn.ioos.noaa.gov/media/2021/05/ATN-SG-9-Minutes_Final.pdf

VIMS. n.d.a. What is NEAMAP? Available: https://www.vims.edu/research/departments/fisheries/programs/multispecies_fisheries_research/neamap/index.php

VIMS. n.d.b. Juvenile Fish and Blue Crab Trawl Survey. Available: https://www.vims.edu/research/departments/fisheries/programs/juvenile_surveys/index.php

VIMS. n.d.c. What is ChesMAPP? Available: https://www.vims.edu/research/departments/fisheries/programs/multispecies_fisheries_research/chesmmap/index.php

VIMS. 2022. VMS Longline Survey. Available: https://www.vims.edu/research/departments/fisheries/programs/sharks/programs/longline/index.php

Vineyard Wind. 2020. Draft Construction and Operations Plan Volume III Appendices Available: https://www.boem.gov/sites/default/files/documents/renewable-energy/Vineyard-Wind-COP-Volume-III-Appendix-III-D_1.pdf

Wall, C.C., Haver, S.M., Hatch, L.T., Miksis-Olds, J., Bochenek, R., Dziak, R.P., and Gedamke, J. 2021. The Next Wave of Passive Acoustic Data Management: How Centralized Access Can Enhance Science. Frontiers in Marine Science.

Wilkinson et al. 2019. Comment: The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data. 3:160018. Available: http://www.nature.com/scientificdata

Woods Hole Oceanographic Institute (WHOI). n.d. HabCam: Habitat Mapping Camera System. Available: https://habcam.whoi.edu/

WoRMS. 2021. World Register of Marine Species. Available: http://www.marinespecies.org/aphia.php?p=match