



**FISH AND FISHERIES
OFFSHORE WIND
RESEARCH GAPS
ANALYSIS**

U.S. ATLANTIC COAST

FINAL REPORT

MARCH 2026

ROSA
Responsible Offshore
Science Alliance

Fish and Fisheries Offshore Wind Research Gaps Analysis

U.S. Atlantic Coast

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How to Use the Research Gaps Analysis Report

A guide to navigating the ROSA FishFORWRD Research Gaps Analysis, connecting offshore wind fisheries research needs with funded science along the U.S. Atlantic Coast.

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Executive Summary

Offshore wind development along the U.S. Atlantic Coast has accelerated rapidly over the past decade, bringing increased attention to the interactions between offshore wind infrastructure, marine ecosystems, and fisheries. In parallel, a growing body of research and monitoring has emerged to better understand these interactions. However, this work is funded and conducted by a wide range of entities, including federal and state agencies, offshore wind developers, research institutions, and non-profit organizations, making it challenging to assess the overall state of knowledge and identify remaining research needs.

To address this challenge, the Responsible Offshore Science Alliance (ROSA) developed the Fish and Fisheries OffshoRe Wind Research Database (FishFORWRD), a regional platform that catalogs research and monitoring projects alongside documented research needs related to offshore wind and fisheries interactions.

The Research Gaps Analysis presented in this report builds upon the FishFORWRD database to systematically evaluate how existing research aligns with identified research needs across the U.S. Atlantic Coast offshore wind–fisheries research landscape.

The analysis draws on 240 research and monitoring projects cataloged in FishFORWRD and 323 individual research needs compiled from 17 research prioritization documents produced by federal and state agencies, fishing industry organizations, and regional management bodies. Through a structured review process, these individual research needs were consolidated into 70 Summarized Research Needs (SRNs), which represent broader scientific questions and priorities within 11 research categories ranging from ecological impact mechanisms (e.g., habitat modification, sound, electromagnetic fields) to fisheries-related impacts (e.g., fishing access and socioeconomic effects) and cross-cutting coordination topics (e.g., data management and cumulative impact assessments).

Each research and monitoring project was evaluated and mapped to one or more SRNs they address, enabling an assessment of whether each research need is currently being explored by one or more projects or remains unaddressed. A peer review process involving 15 subject matter experts from academia, government agencies, industry, and consulting organizations validated that the SRNs collectively capture the research needs of the offshore wind–fisheries space and that projects are appropriately assigned to those SRNs.

The final peer-reviewed results indicate that:

- 70 Summarized Research Needs structure the offshore wind fisheries research landscape
- 240 research and monitoring projects currently address these needs
- 8 research needs remain unaddressed, representing research gaps

The Gaps Analysis shows that research activity is concentrated in several areas, particularly species distribution and habitat-related studies, in part due to required monitoring associated with offshore wind project development. Other areas, such as cumulative impact assessment frameworks, regional monitoring coordination, and the integration of offshore wind impacts into fisheries management, remain comparatively underdeveloped.

Importantly, the Gaps Analysis evaluates research coverage rather than research conclusions. A research need classified as “under exploration” indicates that one or more projects are addressing the topic, but does not imply that the research question has been fully resolved. Similarly, a designation as a “research gap” does not necessarily indicate importance or priority, but rather highlights research needs with no projects addressing the topic within the current project portfolio in FishFORWRD,

By synthesizing ongoing research and documented research needs, this report provides a transparent, regional overview of offshore wind fisheries science along the U.S. Atlantic Coast. The results are intended to support strategic coordination among research funders, scientists, fishing industry stakeholders, offshore wind developers, and resource managers. In doing so, the Research Gaps Analysis helps ensure that future research investments build upon existing work, address remaining knowledge gaps, and advance a shared understanding of offshore wind development and fisheries in the region.

Background

The Responsible Offshore Science Alliance (ROSA) serves as a regional science entity that coordinates research and monitoring across the U.S. Atlantic Coast to advance the understanding of the complex intersection of offshore development and fisheries, particularly offshore wind development. As offshore wind planning and development has expanded rapidly across the region, so too has the volume and diversity of offshore wind fisheries science. This work is funded by multiple entities with varying processes, timelines, and stakeholder-driven priorities. Without a centralized mechanism to track and synthesize efforts, it becomes difficult to identify what research is occurring, where gaps remain, and how efforts may align across projects and regions.

Recognizing this challenge, ROSA in conjunction with WSP USA, Inc. developed the Fish and Fisheries OffshoRe Wind Research Database [1] (FishFORWRD) to provide a platform for interested stakeholders to view and learn of research projects and stated research needs in the offshore wind fisheries space on the U.S. Atlantic Coast. FishFORWRD is a tool that catalogs all research, monitoring efforts, programs, and stated research needs for offshore wind development, fish, and fisheries. The objective of FishFORWRD is to increase awareness of ongoing work, avoid duplication of efforts, and create a common understanding of research needs. Intended end-users of this tool include research funders, fisheries and offshore wind researchers, offshore wind developers, fishery industry members and the public.

FishFORWRD features (1) research and monitoring “projects” that include both ongoing and completed research efforts and programs as well as each individual offshore wind project-level monitoring survey conducted under implemented offshore wind developers’ federally-required fisheries monitoring plan and benthic monitoring plan as part of Construction and Operation Plans [2] approved by the Bureau of Ocean Energy Management (BOEM); (2) individual research needs¹ compiled from 17 research prioritization documents released by state, federal, fishing industry and regional management bodies (Appendix A); and (3) the results of the Research Gaps Analysis described herein. FishFORWRD is maintained through updates by ROSA staff, direct project submissions [3] and corrections [4] from the research community, and collaborative information-sharing via the Offshore Atlantic Research Funder Coordination Working Group [5] hosted jointly by ROSA and the Regional Wildlife Science Collaborative (RWSC).

Within FishFORWRD, projects and individual research needs are organized into 11 research categories (Table 1) representing the range of topics relevant to offshore wind and fisheries interactions. These categories were derived from the research prioritization documents referenced above (Appendix A). The categories encompass biophysical impact producing factors, such as noise, electromagnetic fields (EMF), and habitat alteration; human and operational dimensions such as fisheries access, fisheries engagement and capacity building,

¹ Some sources use the term “research priorities” which we have re-named “research needs.”

and socioeconomic and sociocultural impacts; and cross-cutting, system-level topics, including cumulative impacts, fisheries management implications, data management, and regional monitoring. Each project and research need record includes detailed metadata (Table 2) to allow users to search and filter projects and research needs based on their specific areas of interest including receptor (affected resource), location, funder, and more. Full detail on database structure and attributes is available in Appendix B.

However, cataloging projects and research needs alone does not fully illuminate how current research aligns with identified needs, nor does it reveal where additional investment could be meaningful. A more systematic comparison between research needs and projects was therefore necessary to support strategic coordination and informed investment across the region. To fill this gap, ROSA conducted a **Research Gaps Analysis** to systematically evaluate the relationship between documented research needs and the body of funded research catalogued in FishFORWRD. Through the Research Gaps Analysis process and peer review described herein, a set of “Summarized Research Needs” were developed to efficiently structure the offshore wind fisheries research and monitoring landscape around shared priorities and common scientific objectives. The purpose of the peer review was to assess the methods used to conduct the analysis and validate the results. The final Research Gaps Analysis results are presented below.

History of FishFORWRD

FishFORWRD v1.0 was first released on ROSA’s website in 2022 as a spreadsheet complete with tables of ongoing research and research needs, as well as a pivot table to provide a gaps analysis of which research needs were currently being addressed by funded projects and which research needs still remained. This effort was in partnership with WSP USA, Inc. and the associated report [6] outlines how to use this first version of the database and how the database was created. Beginning in 2024, ROSA worked to update the data within FishFORWRD, develop and release FishFORWRD as a webtool, and revisit the methods of the Research Gaps Analysis.

FishFORWRD v2.1.0

Released July 2024 - v2.1.0 marked the initial launch of the FishFORWRD webtool. This version included 173 research projects funded to date and an updated list of individual research needs. FishFORWRD was initially populated through a review and synthesis of relevant sources, biannual convening of the ROSA Offshore Wind Fisheries Funder Coordination Forum² held with all U.S. East Coast offshore wind fisheries research funders, and one-on-one meetings held with representatives from each offshore wind developer with an active lease. The associated executive summary [7] describes the FishFORWRD database structure and webtool user manual.

² The Forum has evolved into the broader Offshore Atlantic Research Funder Coordination Working Group [5].

FishFORWRD v2.1.1

Released January 2025 - v2.1.1 added 54 research and monitoring projects. Many of these projects were previously funded projects that had not been captured in the initial launch, along with several newly initiated projects. The associated executive summary [8] lists the projects added as part of this update.

FishFORWRD v2.2.0

Released October 2025 - v2.2.0 incorporated 22 new projects submitted through the form within FishFORWRD, shared through biannual ROSA Offshore Wind Fisheries Funder Coordination meetings or other ROSA coordination activities. ROSA also incorporated any corrections to projects provided by the research community. This version introduced the Research Gaps Analysis Tab which presented preliminary gaps analysis results following peer review but prior to this report. These preliminary results were shared to support coordination among funders and researchers. The associated executive summary [9] lists newly added projects and provides an overview of the research gaps analysis methodology and guidance for using the research gaps analysis tab within FishFORWRD.

During preparation of this report, the peer-reviewed Summarized Research Needs (SRNs) were further refined to improve clarity and consistency across research categories. As a result, SRN numbering presented in this report may differ slightly from the numbering currently displayed in FishFORWRD as of March 2026. The next update to FishFORWRD will incorporate the final results below. As new research and monitoring projects come online, ROSA will continue to add projects to FishFORWRD and assign them to the relevant SRNs to maintain an updated Gaps Analysis.

Table 1. Definition of each research category in FishFORWRD

Research Category	Definition
Cumulative Impacts & Fisheries Management Implications	This category encompasses two related, but distinct research needs: (1) understanding the effects of multiple offshore wind projects accumulating across spatial and temporal scales. This includes consideration of how offshore wind effects interact with other natural and anthropogenic ongoing pressures such as climate change, existing fisheries management measures, and broader ocean-use constraints. (2) translating understanding of offshore wind impacts into fisheries science and management decision making.
Data Management	Efforts to organize, store, manage, and/or create increased utility for offshore wind fisheries data for cumulative impacts assessments and fisheries management.

Regional Resource Monitoring	The design and integration of monitoring systems that support long-term, regional-scale understanding of marine resources
Species Distribution/Composition	Changes in target fish abundance, distribution, taxonomic composition, and or/behavior as a direct or indirect result of offshore wind energy development phases.
Habitat Fragmentation/Modification	Physical and ecological changes to marine habitats associated with offshore wind infrastructure and activities, including changes to habitat size, composition, structure, connectivity, or function.
Electromagnetic Fields (EMF)	The effects of electromagnetic fields (EMF) on fisheries species and ecosystems, including interference with bioelectric and geomagnetic sensing marine organisms. EMF is generated by cables that carry electricity from and between energy sources, such as wind turbines to power stations.
Sound/Vibration Impacts	The effects of underwater sound and vibration (includes both sound pressure and particle motion) on fisheries species and ecosystems, including potential behavioral, physiological, and ecological responses. Sound and vibration are generated during offshore wind site characterization, construction, and operation and can be sensed by organisms using hearing, the lateral line in fishes, and/or depth regulating organs.
Fisheries Engagement & Capacity Building	Methodology for bidirectional exchange of information between the commercial and/or recreational fishing communities, agency representatives, and offshore wind developers. Capacity building refers to the process of obtaining or improving the knowledge or skills needed to participate effectively in the offshore wind development process and/or understand science and management around fisheries and offshore wind.
Fishing Access	Changes to commercial and recreational fishing access and operation within and around offshore wind farms, including gear development to maintain access, safety considerations, displacement and/or changes in location and timing of commercial and recreational fishing efforts, and the topic of Fisheries Enhancement as a mitigation tool.
Socioeconomic & Sociocultural Impact	Changes to the economic value of commercial and recreational fishing industries, effects to shoreside infrastructure, and social and cultural changes in fishing communities due to offshore wind development.
Survey Adaptation	Alteration or creation of new survey methodology to allow for fisheries data collection within and around offshore wind farms.

Table 2. Project and Need Metadata in FishFORWRD

Research and Monitoring Project Ex-##	Individual Research Need RN-##	Summarized Research Need SRN-##
Project ID # Research Category Developer Fisheries Monitoring Plan (Y/N) Fixed or Floating Windfarm Development Stage Spatial Scale Location Project Title Lead Entity Partner Entities Project Objectives Methodology Receptor Project Start Year Estimated Project End Year Funder Additional Funding Entities Project Website PI Name	Research Need ID # Research Category Source of Identification Spatial Scale Fixed or Floating Location Receptor Summary of Research Need	Summarized Research Need ID # Research Category Summarized Research Need Full Description of Research Need Existing Projects Addressing Need Research Needs Captured Gap Analysis Score

Characterization of the Current Research and Monitoring Portfolio

At the writing of this final report, FishFORWRD holds 240 research and monitoring projects that were used in the Research Gaps Analysis and following peer review. The metadata accompanying these projects allows characterization of the research portfolio relevant to U.S. Atlantic Coast offshore wind development. Of the 240 “projects”, 81 project records represent individual surveys conducted for implemented fisheries monitoring plans and benthic monitoring plans across 12 offshore wind projects. Visit FishFORWRD and filter the “Developer Fisheries Monitoring Plan” attribute to “Yes” to view all offshore wind project-level fisheries monitoring plan surveys. The other 159 project records represent both ongoing and completed research and monitoring efforts funded across multiple entities including federal and state agencies, non-profit organizations, research collaboratives, and offshore wind developers.

$$\begin{array}{ccccc} \mathbf{240} & & \mathbf{81} & & \mathbf{159} \\ \text{Total Projects in} & \mathbf{=} & \text{Implemented Developer} & \mathbf{+} & \text{Funded Research and} \\ \text{FishFORWRD} & & \text{Fisheries Monitoring} & & \text{Monitoring Projects} \\ & & \text{Plan Surveys} & & \end{array}$$

The research and monitoring projects catalogued in FishFORWRD address all 11 research categories (Figure 1). Species Distribution/Composition and Habitat Fragmentation/Modification research categories account for the largest proportion of projects, in part because many of the 81 individual surveys conducted under offshore wind fisheries monitoring plans and benthic monitoring plans were assigned to these categories. Following these categories, projects are most concentrated in Fishing Access and Socioeconomic & Sociocultural Impact research categories.

FishFORWRD documents the breadth of approaches used across research and monitoring projects with modeling methods and acoustic telemetry among the most frequently employed methodologies (Figure 2). The broad range and high number of methods overall reflect the decision to catalogue each individual offshore wind project-level monitoring survey within each developer’s fisheries monitoring plan and benthic monitoring plan. As such, many of the methodologies listed focus on extractive or field-based techniques. This level of specificity allows individual surveys to be distinguished from one another and informed parallel efforts within the ROSA Data Governance Program [10] to determine appropriate data standards and harmonization across survey types. Larger research projects, particularly those not structured as individual surveys, often employ multiple methodologies, however, each project in FishFORWRD is assigned a single primary methodology. The provided project objectives for each record help to capture additional methodologies that may be used in a project. Projects listed as using “Other” methodology (28%) span multiple research categories and include, but

are not limited to, desktop studies, literature reviews, framework development, and field experiments. The relatively high proportion of “Other” methodology classification creates an opportunity to further refine the methodology metadata as part of future improvements to FishFORWRD.

As with methodologies, each project is assigned one primary receptor group, recognizing larger research projects employing multiple methodologies, particularly those not structured as individual surveys, may target multiple receptor groups. The provided project objectives for each record help to capture additional receptor groups, as well as the individual species, targeted in a project. Demersal/Groundfish/Squid, the Fishing Industry, and Habitat are the most frequently targeted receptor groups (Figure 3) reflecting FishFORWRD’s inclusion of both fish and fisheries research and monitoring, and the consideration of fishing activity and businesses as a key impact receptor.

Aligned with the development of offshore wind on the U.S. Atlantic Coast, many projects in FishFORWRD are conducted in Southern New England (n=105; Figure 4A) and focus on fixed-bottom offshore wind infrastructure (Figure 4B). Thirty-five different funding entities and programs across the federal government, state agencies, offshore wind developer companies, non-profits and research collaboratives have provided or administered funding for offshore wind fisheries research and monitoring (Figure 5A). Offshore wind developers support the largest proportion of projects in FishFORWRD, driven in part by the individual surveys cataloged for each offshore wind project’s fisheries monitoring plans, followed by different programs or offices of federal agencies and state agencies, with additional contributions by non-profits and research consortiums (e.g., ROSA, National Offshore Wind Research and Development Consortium) (Figure 5B). In addition to the required fisheries and benthic monitoring at an offshore wind project lease site, many offshore wind developers have funded research and monitoring efforts beyond their regulatory obligations. To explore these, visit FishFORWRD and filter the “Developer Fisheries Monitoring Plan” attribute to “No” and the “Funder” attribute to different offshore wind companies to view these instances.

Research activity across categories has grown over time, though the pace of growth differs by topic (Figure 6). Some research categories may have only begun to be addressed recently, but all are being considered to a greater or lesser extent. Species Distribution/Composition projects have come online most consistently, reflecting the implementation of required offshore wind project-level monitoring after COP approval, alongside investments from federal and state agencies to establish baseline information on species distribution and habitat use. This collective investment supports the call for baseline fisheries species and habitat information [11, 12, 13] in order to assess potential impacts and inform decision making by offshore wind and fisheries regulators, managers, and industry.

Just over half of the 240 projects within FishFORWRD were scheduled to be completed by the end of 2025 and completion status varies across research categories (Figure 7). Projects with

estimated end dates in 2025 or earlier were categorized as completed (n = 131), while those with end dates in 2026 or later, as well as projects with an undetermined end date, were categorized as ongoing (n = 109). Note that some projects categorized as completed may have unpublished results, be ongoing through project extensions, or have been terminated prematurely. Socioeconomic & Sociocultural Impact and Sound/Vibration Impacts research categories show a high proportion of completed projects, whereas Species Distribution/Composition and Habitat Fragmentation/Modification, the largest categories by total project count, include a greater share of ongoing efforts. Many of the offshore wind project-level surveys are ongoing, while others have been discontinued due to changes in offshore wind project development timelines [14] or adaptation of survey methodologies. Overall, ecological monitoring categories tend to have more active projects, while several applied categories show a stronger base of completed work.

All charts below have been generated from data available on FishFORWRD.

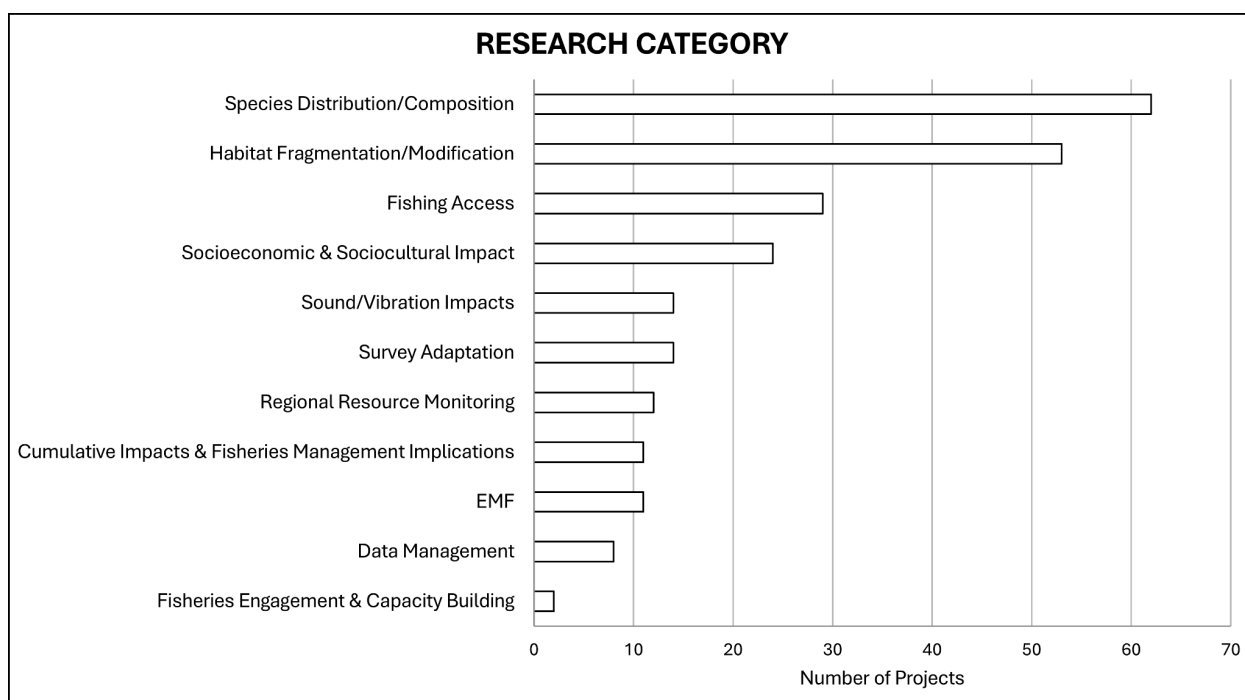


Figure 1. Distribution of Projects by Research Category. Total number of projects categorized by research category.

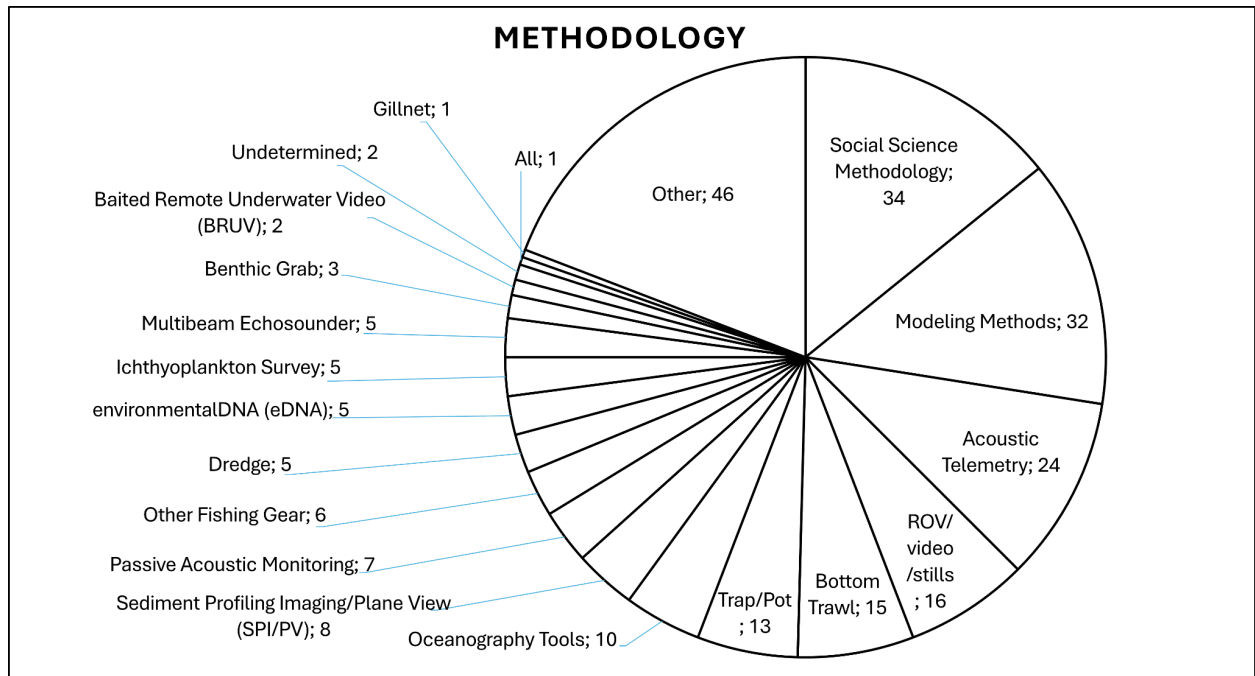


Figure 2. Methodologies Used Across Projects. Distribution of primary methodologies assigned to projects.

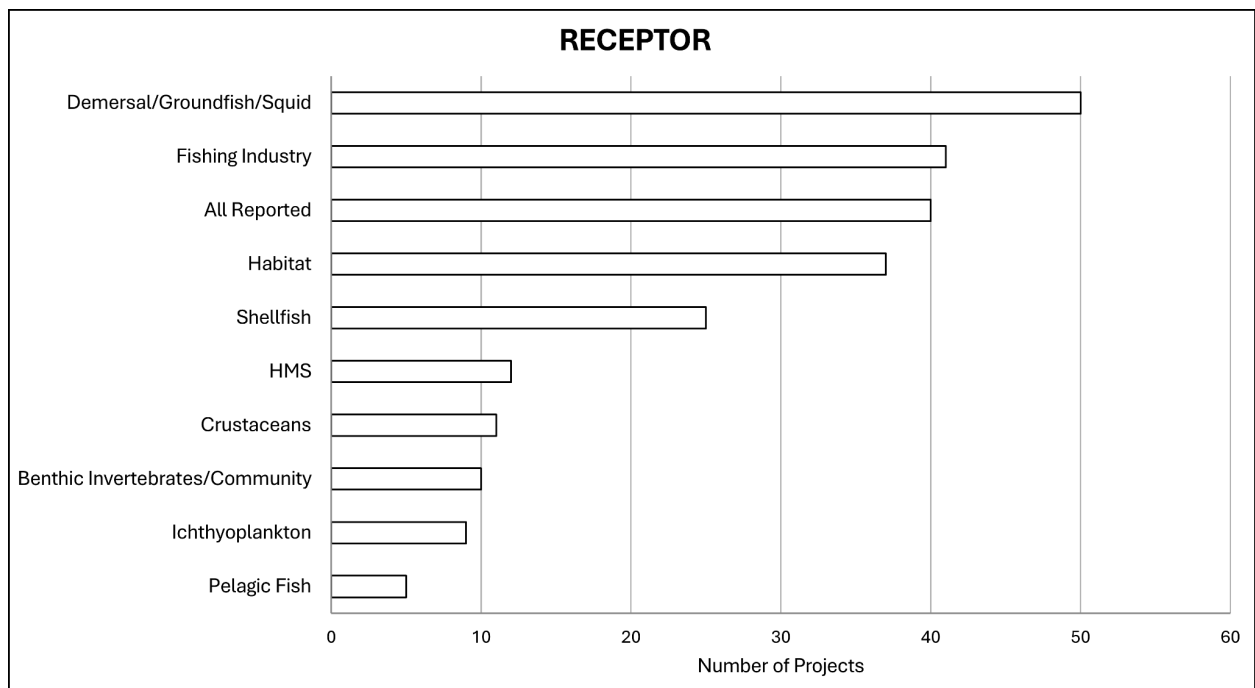


Figure 3. Receptor Groups Targeted Across Projects. Number of projects assigned to primary receptor groups.

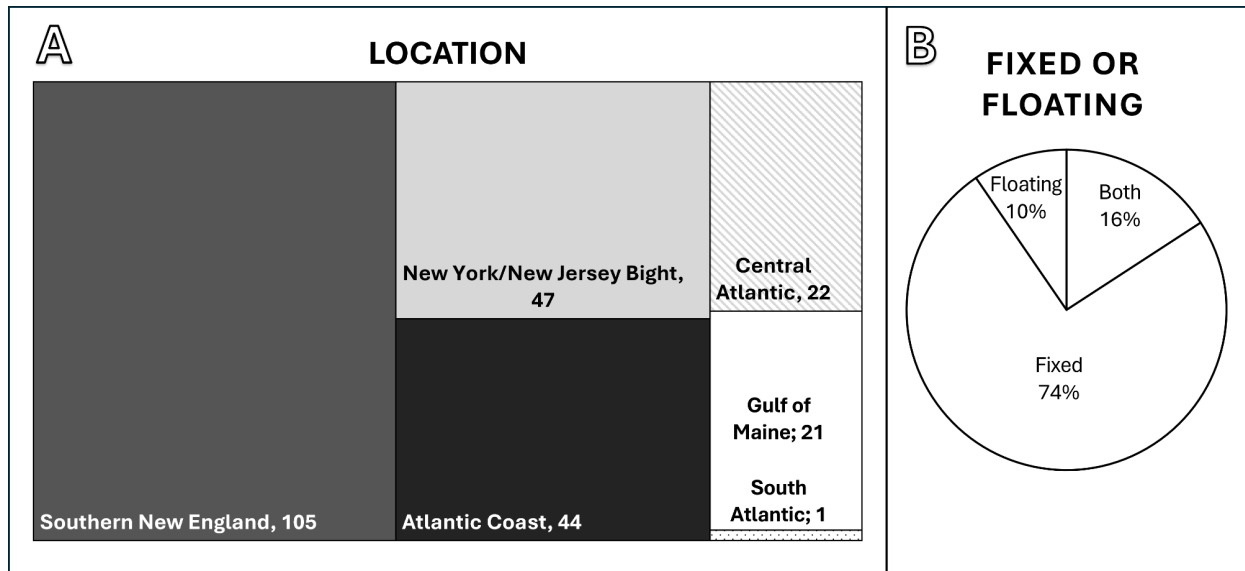


Figure 4. (A) Project Locations. Geographic distribution of projects by region and the number of projects located in those regions. (B) Fixed vs. Floating Offshore Wind Context. Proportion of projects focused on fixed-bottom, floating, or both offshore wind technologies

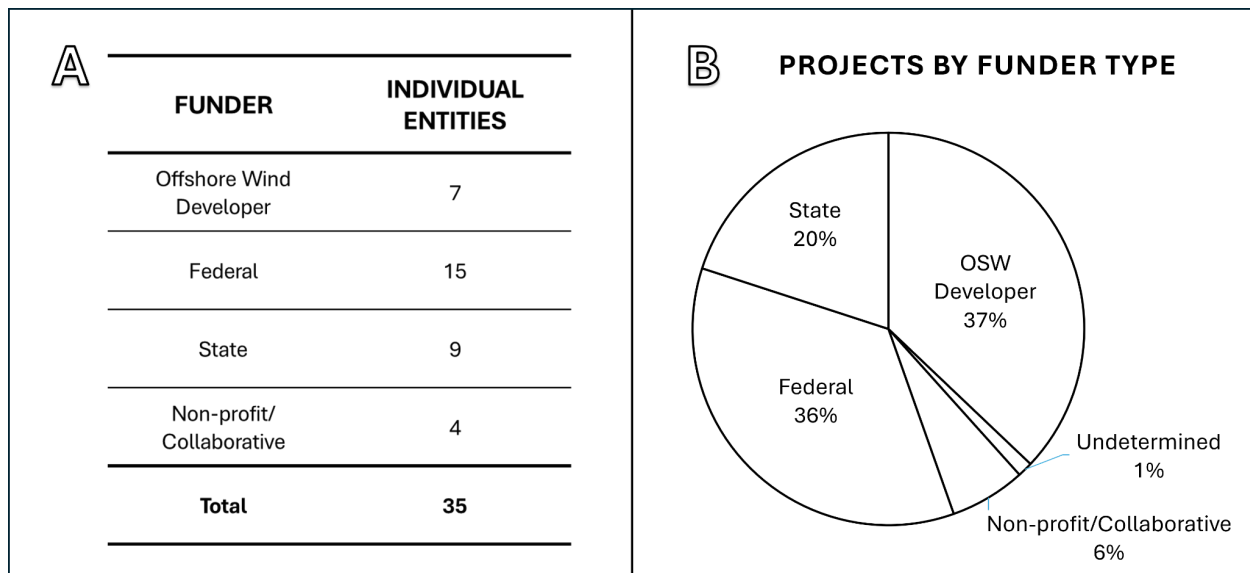


Figure 5. Types of Funders. (A) Number of individual funding entities and programs per funder type. (B) Distribution of projects by funder.

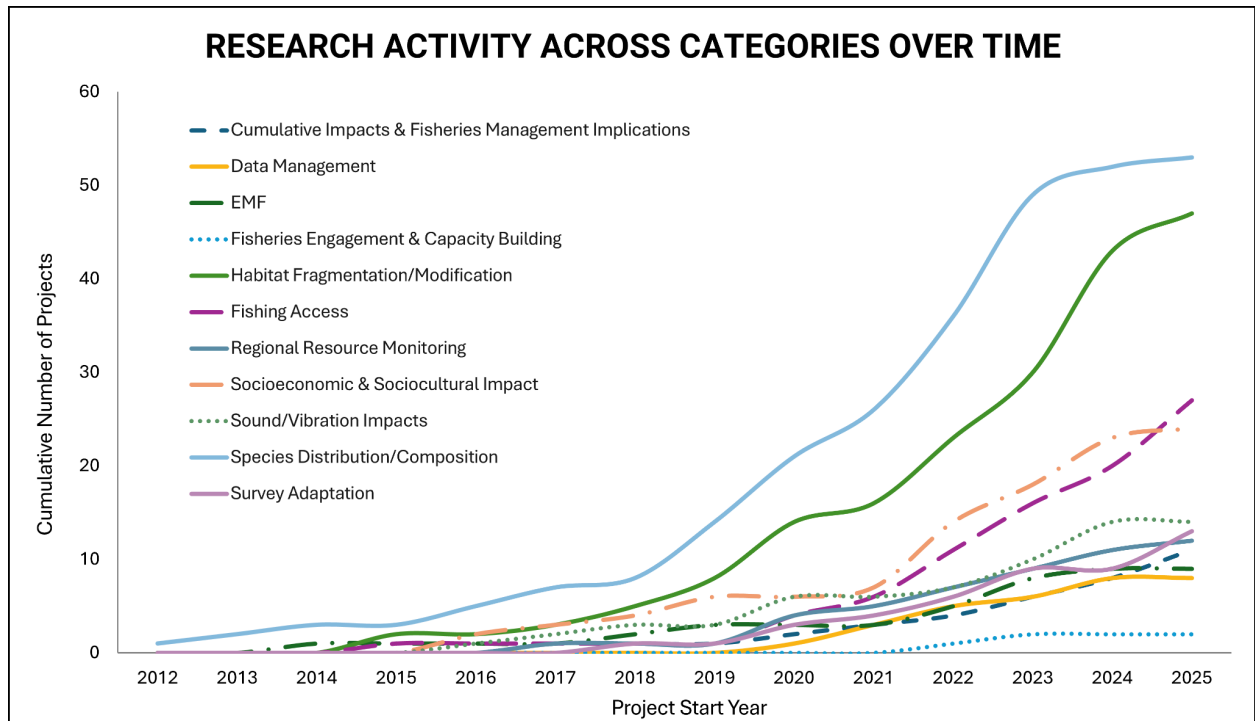


Figure 6. Research Activity Over Time. Cumulative number of projects per research category.

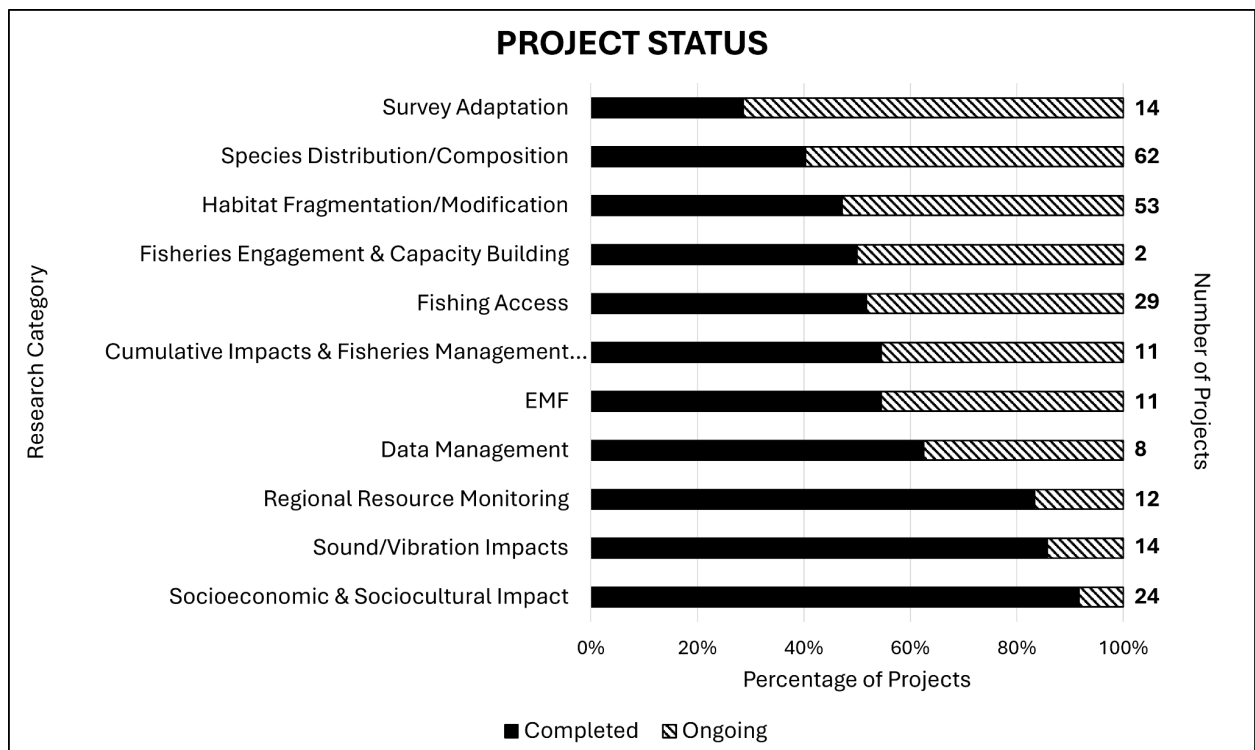


Figure 7. Project Completion Status. Proportion of projects completed (estimated end date of 2025 or sooner) by research category and the number of projects per research category.

Research Gaps Analysis

Methodology

The ROSA Research Gaps Analysis (herein Gaps Analysis) was designed to identify which ongoing and completed offshore wind fisheries research and monitoring efforts explore the stated research needs of the offshore wind fisheries community, revealing progress made on those research needs and where further investment may still be needed (Figure 8).

Using the project and research need data within FishFORWRD, ROSA collaborated with our partner, WSP USA, Inc., to perform a Gaps Analysis. This analysis included consolidating duplicative research needs into “Summarized Research Needs” and matching project objectives to those Summarized Research Needs. More specifically, we:

1. Consolidated the total of 323 individual research needs compiled within FishFORWRD into a set of Summarized Research Needs (SRNs). This consolidation involved systematically reviewing each individual research need across each of the 11 research categories and combining duplicative or highly specific needs (e.g., species specific) to create broader, distinct SRNs. Creating these distinct SRNs enables the Gaps Analysis to be completed, by allowing for projects to be matched with needs that they are addressing.
2. Reviewed the objectives and metadata of each research and monitoring project cataloged within FishFORWRD to map each project to the appropriate SRN(s). Projects could be assigned to multiple SRNs within a research category or to SRNs across research categories, depending on their scope and relevance.
3. As a result of this matching process, classified each SRN as either “Under Exploration”, indicating that one or more projects are currently exploring it, or a “Research Gap”, indicating that no projects were identified as exploring that SRN

Research Gaps Analysis Process

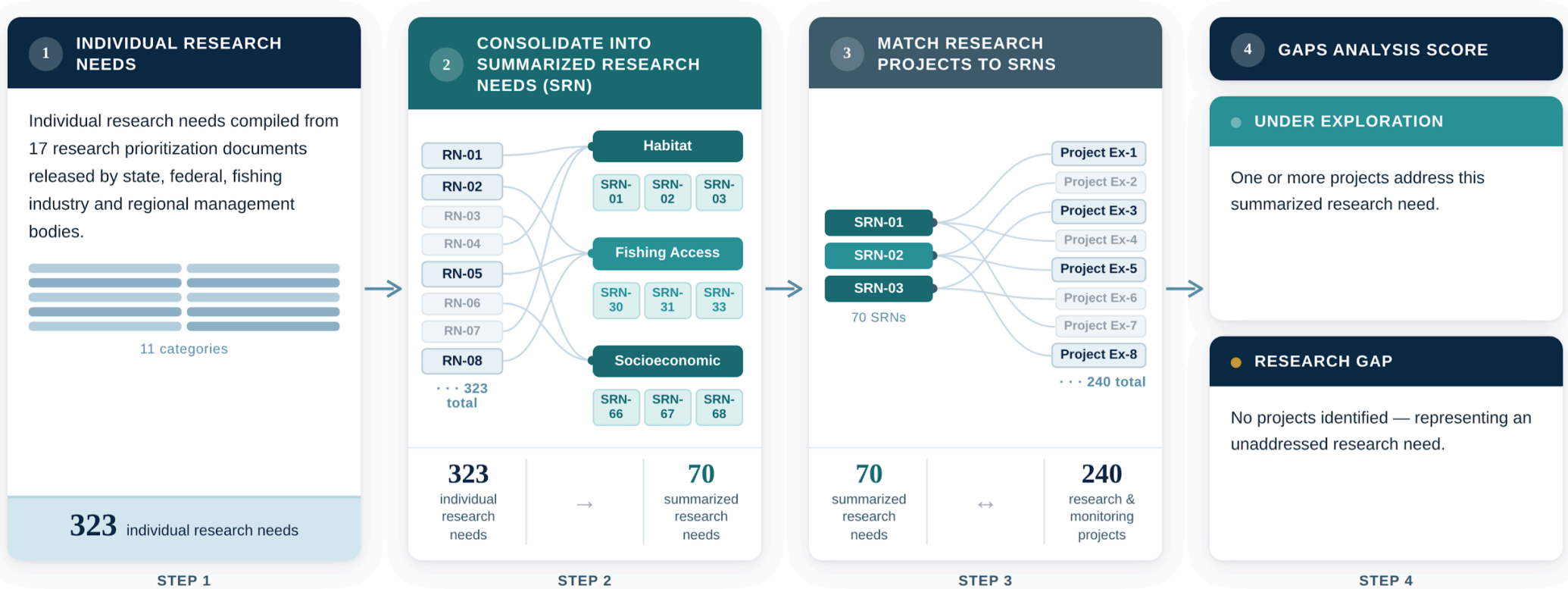


Figure 8. Research Gaps Analysis Methodology Infographic.

Gaps Analysis Peer Review

To validate the Gaps Analysis process and its findings, ROSA held a peer review engaging 15 subject matter experts from the ROSA Research Advisors [15] and beyond, representing academia, federal agencies, consultant firms, fishery management councils, and fishing industry advocacy groups. Reviewers were organized into six teams (Table 3) that grouped the 11 research categories (Table 1) based on conceptual similarity and alignment with reviewer expertise, allowing the process to leverage specialized knowledge.

Reviewers were tasked with two objectives:

(1) Consider whether the proposed SRNs appropriately consolidated and represented duplicative or highly specific research needs, and

(2) Assign projects to one or more SRNs based on the project metadata available in FishFORWRD. Many projects include linked publications or project websites, which reviewers could choose to consult as needed to inform accurate project assignments.

Reviewers were provided with the SRNs for their assigned research category(ies), along with the individual research needs that had been consolidated within each SRN. This information allowed reviewers to evaluate whether research needs were assigned to the appropriate research category, whether any research needs were missing, and whether the research needs had been grouped appropriately to form each SRN. In some cases, reviewers recommended further consolidation of similar needs, while in others, suggested refining SRNs to better distinguish distinct research needs.

Although ROSA and WSP USA, Inc. had previously conducted an internal matching of projects to research needs as part of the preliminary Gaps Analysis, these assignments were not shared with peer reviewers. After evaluating the SRNs, reviewers independently assigned projects to one or more SRNs based on the project metadata available in FishFORWRD. Reviewers were instructed to assign projects to multiple SRNs within the research category when appropriate and to flag projects that likely addressed SRNs in other research categories outside of the scope of their assigned team. These flagged projects were then brought to the relevant team meetings for consideration and potential assignment.

Reviewers first completed the assigned objectives individually, followed by a team meeting to compare results, discuss discrepancies between reviewers' results, and reconcile differences between reviewer assignments and ROSA's internal analysis. Following team-level discussions, a full-group meeting with all peer reviewers was held to share cross-category findings and discuss overarching observations and next steps. The end results represent the consensus opinions of the reviewers and ROSA staff. During preparation of this report, the peer-reviewed Summarized Research Needs (SRNs) were further refined to improve clarity and consistency

across research categories. As a result, SRN numbering presented in this report may differ from the numbering currently displayed in FishFORWRD as of March 2026.

Table 3. Research category groupings for peer review.

Team	Research Categories Reviewed
1	Cumulative Impacts & Fisheries Management Implications
	Data Management
2	Electromagnetic Fields (EMF)
	Sound/Vibration Impacts
3	Fisheries Engagement & Capacity Building
	Socioeconomic & Sociocultural Impact
	Fishing Access
4	Habitat Fragmentation/Modification
5	Species Distribution/Composition
6	Survey Adaptation
	Regional Resource Monitoring

Interpretation of Results

The Gaps Analysis assesses research coverage, but does not fully consider research conclusions. Projects were assigned to Summarized Research Needs (SRNs) based on the project's objectives and other metadata included in FishFORWRD, not necessarily on the results of the research or monitoring effort.

The Gaps Analysis scores SRNs as:

- (1) Research Gaps - SRNs with no projects currently addressing them
- (2) Under Exploration - SRNs with one or more projects addressing them

Individual research needs, spanning both general and highly specific research questions, were intentionally consolidated into broader SRNs, meaning that even an "explored" SRN may have components that remain entirely unstudied. Projects assigned to a particular SRN may be limited to specific geographic regions, species coverage or study design. Thus, a SRN categorized as "Under Exploration" may still warrant further research to achieve broader regional or taxonomic representation to advance fundamental understanding of the research need. The Research Gaps Analysis tab on FishFORWRD (Appendix C) allows users to explore how existing projects address each SRN to examine the coverage of a particular SRN by the receptor group studied, methodology applied, and geographic location.

No ranking or prioritization is implied by the score of each SRN or by the number of projects assigned to it. A designation as a "gap" does not imply that funding or research effort should automatically be directed toward that topic. Rather, the Gaps Analysis is intended as a tool for funders and other users described below to inform their own decision-making and relevant processes.

Lastly, the Gaps Analysis reflects available and reported data at the time of review. Projects not included in FishFORWRD or outside the current scope of FishFORWRD are not represented. As the portfolio of research and monitoring projects continues to grow with new project investments, ROSA will add them to FishFORWRD and assign them to the relevant SRNs to maintain an updated Gaps Analysis.

Recommended Uses of Results

Funders and Regulators

- Identify underrepresented topics or regions to prioritize in future funding opportunities or monitoring requirements.
- Avoid duplication by confirming whether proposed work overlaps with active or completed projects in FishFORWRD.

- Support coordination across funding programs, ensuring investments complement existing efforts by other agencies or developers.

Researchers

- Understand the current research landscape, including what methods, regions, and receptors are already being studied.
- Identify collaboration opportunities with teams addressing related research categories or specific summarized research needs, or operating in similar regions.
- Design proposals that fill clearly-defined knowledge gaps or connect fragmented lines of work.
- Access detailed project metadata, methodologies, and contact information for fine-scale project coordination.

Fishing Industry Members

- See which fisheries, regions, and receptors have ongoing or completed research, and where questions important to fishing operations remain unaddressed.
- Engage with researchers and developers on projects linked to specific summarized research needs that affect their fisheries or gear types.
- Stay informed about research timelines and outcomes that could inform management or access decisions.
- Document new observations [\[16\]](#) to support new research needs representing fishing community priorities in future updates to FishFORWRD.

Offshore Developers

- Identify which research needs relevant to their project areas are already under exploration, and where critical knowledge gaps remain that could affect permitting or stakeholder engagement.
- Prioritize voluntary research investments in areas where gaps align with their project footprint, receptor types, or fisheries interactions, demonstrating proactive stewardship to regulators and communities.
- Identify researchers and institutions with relevant expertise and established methodologies to support project-specific monitoring and impact assessment needs.
- Strengthen Environmental Impact Statements and mitigation plans by grounding them in the broader research landscape, including what is known, what is actively being studied, and what remains unresolved.
- Engage fishing industry stakeholders and co-develop research around summarized research needs that intersect with commercial or recreational fishing activity in their lease areas.

Research Need Coverage Across Categories

Final peer reviewed Gaps Analysis results include 70 Summarized Research Needs (SRNs). Of these 70 SRNs, 5 new needs were defined and 8 needs were deemed unaddressed (Table 4). Habitat Fragmentation/Modification (n=18) and Socioeconomic & Sociocultural Impact (n=11) categories have the most number of distinct SRNs while other categories average around 5 distinct SRNs. SRNs are presented in abbreviated form throughout this report and within FishFORWRD for clarity and readability; full descriptions are provided in Appendix D.

Table 4. Number of Summarized Research Needs (SRNs), unaddressed needs of those SRNs (ie., research gaps), and number of individual projects addressing each SRN. (Note: projects could be assigned to multiple SRNs within and across research categories).

Research Category	SRNs	Unaddressed Needs	Indiv. Projects Addressing SRNs
Cumulative Impacts & Fisheries Management Implications	5	3	15
Data Management	4	0	10
Regional Resource Monitoring	5	2	18
Species Distribution/Composition	3	0	68
Habitat Fragmentation/Modification	18	2	59
Electromagnetic Fields (EMF)	4	0	11
Sound/Vibration Impacts	5	0	15
Fisheries Engagement & Capacity Building	4	0	3
Fishing Access	6	0	38
Socioeconomic & Sociocultural Impact	11	0	26
Survey Adaptation	5	1	16
TOTAL	70 SRNs	8 Gaps	

Cumulative Impacts Across Research Categories

Cumulative impact considerations underpin nearly all research categories in this Gaps Analysis, however Cumulative Impacts & Fisheries Management Implications is designated as a distinct research category with, *SRN-1* and *SRN-2* articulating the need for regional-scale cumulative impact assessments and associated frameworks. Peer review panels consistently returned to the question of how individual stressors, such as EMF, sound, or habitat modification, interact with other stressors to affect fisheries resources and communities at broader spatial and temporal scales, such as at the stock or population level.

Each of the research categories ultimately supports cumulative impact questions: how do multiple offshore wind-related pressures across multiple offshore wind projects combine to influence fisheries and ecosystem function? Similarly, socioeconomic and human dimensions research supports understanding of cumulative effects on the fishing industry: how do multiple offshore wind projects and regulatory changes compound to affect fishing access, profitability, or community resilience?

Because these interconnections are ubiquitous, not every research category explicitly defines a separate cumulative impact SRN. Instead, each contributes a component (e.g., data, modeling frameworks, or conceptual understanding) needed to evaluate cumulative impacts comprehensively. This interconnection further highlights the importance of developing standardized frameworks that maintain methodological flexibility to address different questions and are capable of integrating results across categories to perform regional-scale cumulative impact assessments (CIAs).

Results By Research Category

Research categories are presented in a conceptual sequence. The first group includes cross-cutting and system-level topics that support coordination and interpretation of offshore wind fisheries research, including cumulative impacts, fisheries management implications, data management, and regional monitoring. The second group includes research categories addressing offshore wind impact producing factors and ecological changes, such as species distribution, habitat modification, electromagnetic fields, and sound/vibration impacts (i.e., noise). The final group focuses on fisheries-related impacts and responses, including fisheries engagement, fishing access, socioeconomic and sociocultural impacts, and survey adaptation.

Cumulative Impacts & Fisheries Management Implications

Definition: This category encompasses two related, but distinct research needs:

(1) understanding the effects of multiple offshore wind projects accumulating across spatial and temporal scales. This includes consideration of how offshore wind effects interact with other natural and anthropogenic ongoing pressures such as climate change, existing fisheries management measures, and broader ocean-use constraints.

and

(2) translating understanding of offshore wind impacts into fisheries science and management decision making.

SRN-ID	Summarized Research Need (SRN)	Contributed Research Needs	Projects Addressing
1	Cumulative Impact Assessment Framework/Guidance	3	GAP
2	Cumulative Impact Assessments	19	9
3	Policy Alignment Across Ocean Sectors Relative to Offshore Wind Fisheries Science Objectives	NEW*	GAP
4	Priority Data Needs and Impacts for Stock Assessment	3	6
5	Risk and Mitigation for Councils/Commissions	4	GAP

*New research need identified by Gaps Analysis peer reviewers.

SRNs in this category capture both the technical requirements for conducting cumulative impact assessments (CIAs) and the institutional and analytical needs required to incorporate offshore wind impacts into fisheries management frameworks.

Many individual research needs contributed to *SRN-2: Cumulative Impact Assessments* and identified key considerations for meaningful CIAs, including spatial and temporal scales, fishery-level impacts, ecosystem-level impacts, inclusion of greenhouse gas analyses, the adaptive capacity of fisheries, and disentangling environmental variability. *SRN-3: Policy Alignment Across Ocean Sectors Relative to Offshore Wind Fisheries Science Objectives* is a new need identified by peer reviewers that calls on policy makers and scientists to consider the broader policy landscape, enquiring into alignment and/or conflicts between different policy drivers such as energy, fisheries, defense and biodiversity conservation. The research need at present is a structured approach to considering policy implications and outcomes, matched to a fair means of assessing and communicating trade-offs.

To our knowledge, no broadly accepted CIA framework specific to offshore wind and fisheries currently exists for the U.S. Atlantic coast, however, several funded projects have begun developing components that could contribute to a holistic framework. Most efforts to date are species-focused (*Ex-46: Surfclam Fishing and Windfarms in the Future Ocean: Interactive effects of wind farms and future ocean conditions on the surfclam fishery* & *Ex-80: Assessing Cumulative Impact of Offshore Wind Energy Development on Sea Scallop Laval Transport and Settlement in Southern New England Waters*) though at least one project in the Gulf of Maine evaluates cumulative impacts with the fishing industry the the center (*Ex-70: Gulf of Maine Integrated Ecosystem Assessment*).

Contributing individual research needs to fisheries management SRNs include identifying thresholds of change and the implications for state or federal Fisheries Management Plans, including the need for mitigation measures. Clear gaps remain for evaluating the implications of offshore wind on fisheries management strategies.

To date, exploration of offshore wind impacts to stock assessment and fisheries management has been limited to a few Mid-Atlantic species (*Ex-86: Evaluate Offshore Wind Farm Impacts to Mid-Atlantic Fishery Stock Assessment* & *Ex-48: Understanding Economic Impacts to the Commercial Surfclam Fishing Industry from Offshore Wind Energy*). While fishery management councils and commissions acknowledge the potential impacts of offshore wind on both fisheries science and management (see inclusion of offshore wind in council research priorities [17, 18]), practical exercises on how management could or should adapt/respond to offshore wind driven impacts has not been largely explored. Projects addressing *SRN-4: Priority Data Needs and Impacts for Stock Assessment*, *SRN-67: Impacts on Fisheries-Independent Surveys* in the Survey Adaptation research category (p. 49), and *SRN-49: Spatial and Temporal Change in Fishing Behavior* in the Fishing Access category (p. 44) represent important first steps.

Peer Reviewer Discussion Highlights

Cumulative Impact Assessment (CIA) Frameworks: Neutrality & Utility

- CIA definition, guidance and frameworks most suitable and applicable to U.S. Atlantic coast fisheries dynamics and fisheries management systems are needed to standardize CIAs and best inform future offshore wind planning and permitting processes.
 - Time invested in defining CIA questions and objectives is well spent, to define what should be included in an assessment and boundaries for the assessment.
 - International learning could be built upon [\[19\]](#) and development by a neutral, trusted source would likely increase buy-in across sectors (e.g., fishing industry, regulators, developers, residential communities).
- CIAs should focus on receptors (e.g., species or fishing community), meaning that the range of pressures acting on valued receptors are considered. CIAs should make use of baseline studies and historical data (e.g., historical landings and population size, species' response to climate impacts) to generate meaningful timeseries and baselines against which to consider and measure impacts against.
- Determination of “significant” impact may be better decided by regulatory authorities, including fisheries authorities, where these regulators have a broader perspective beyond individual development projects.

Scale & Resolution

- Scale of assessment is critical; consideration should be given to how assessment scales can mask localized impacts.
- CIAs at the project level are of limited value unless aligned with a strategic-scale assessment that can provide the spatial and temporal insights to understand cumulative consequences of development. Ideally, project-level impact assessments should feed up into a strategic-scale CIA.
- Scale mismatches are a key challenge for CIAs. A disconnect exists between project-scale environmental impact assessments and regional-scale fisheries management frameworks, including differences in the spatial and temporal scales at which data are collected and decisions are made.

Future Directions

- The ICES Working Group on Offshore Wind Development and Fisheries (WGOWDF) [\[20\]](#) currently has a Term of Reference focused on applying a systems approach to understand the cumulative impact of offshore wind expansion on commercial fisheries
- Progress on CIAs could inform fishery management decision making around offshore wind.
- Establishing thresholds that trigger management action can be difficult, especially when they extend beyond those already defined through stock assessments. The *State*

of the Ecosystem Report [21] compiles indicators used in fisheries management annual risk assessments to track ecosystem change and inform whether a Management Strategy Evaluation (MSE) may be warranted. A key question is: how might offshore wind development influence these biological thresholds or accelerate the conditions that cause them to be reached?

Data Management

Definition: Efforts to organize, store, manage, and/or create increased utility for offshore wind fisheries data for cumulative impacts assessments and fisheries management.

SRN-ID	Summarized Research Need (SRN)	Contributed Research Needs	Projects Addressing
6	Enhance Application of Fishery Dependent Data	3	5
7	Centralized Database of Ongoing Research and Monitoring	1	1
8	Enhance Data Governance	6	3
9	Data Integration and Tool Building	NEW*	3

*New research need identified by Gaps Analysis peer reviewers.

As demonstrated by the 200+ projects within FishFORWRD, data collection to assess the effects of offshore wind development is occurring along the U.S. Atlantic Coast by a wide range of actors, including multiple state and federal agencies, university researchers, contractors hired by offshore wind developers, nonprofit organizations, and others. Data governance develops and provides consistent policies, processes, tools, and technical implementation practices that can increase data value through expanded usability and usefulness. SRNs in this category separate fisheries-dependent and fisheries-independent data.

SRN-7: Centralized Database of Ongoing Research and Monitoring is addressed by FishFORWRD, housing research and monitoring projects, research needs, and the results of this Gaps Analysis. Development of policies and processes for different types of offshore wind fishery-independent data is the focus of *Ex-199: ROSA Data Governance Program* [10] and other projects addressing *SRN-8: Enhance Data Governance*. To further enhance the utility of these data, several projects are integrating datasets and developing broadly accessible tools (*SRN-9*) such as *Ex-165: RWSC Research Planning Map*. Projects exploring improved

accessibility and utility of fishery dependent data (SRN-6) aim to support responsible and responsive offshore wind planning and development.

Peer Reviewer Discussion Highlights

- Addressing Data Management needs supports all research categories and the interoperability across them.

Regional Resource Monitoring

Definition: The design and integration of monitoring systems that support long-term, regional-scale understanding of marine resources.

SRN-ID	Summarized Research Need (SRN)	Contributed Research Needs	Projects Addressing
10	Design and Evaluate Strategies for Regional Scale Monitoring	11	10
11	Data Integration Across Methods to Model Species Distribution and Movement	3	2
12	Regional Acoustic Receiver Array	8	6
13	Use of Monitoring to Evaluate Effectiveness of Mitigation Strategies	2	GAP
14	Use of Historical Datasets to Generate Baselines	2	2

This research category is distinct in that its SRNs and associated projects do not represent the direct collection of resource monitoring data (those activities are largely captured within the Species Distribution/Composition (p. 32) and Habitat Fragmentation/Modification (p. 35) research categories). Instead, Regional Resource Monitoring addresses the strategic programs required to connect, harmonize, and operationalize monitoring efforts into coherent regional science. This category emphasizes the development of monitoring frameworks, shared infrastructure, data integration approaches, and analytical tools that allow project-level observations to be translated into regional-scale understanding and decision support.

Earlier iterations of this category included more practical monitoring protocols (e.g., diet analysis, stable isotope studies to analyze trophic interactions, and methods to detect non-native and invasive species) that may be advisable or required. Although peer reviewers acknowledged the importance of these approaches, these protocol-level topics were ultimately grouped with their corresponding research questions within other categories.

SRN-13: Use of Monitoring to Evaluate Effectiveness of Mitigation Strategies is particularly focused on applied science, to use monitoring data to determine whether intended impact reductions are being achieved. Although *SRN-12: Regional Acoustic Receiver Array* is more specific than other SRNs, peer reviewers strongly supported retaining it as a standalone need. Numerous projects already contribute to this SRN, and despite this activity, the need continues to warrant future investment.

SRN-10: Design and Evaluate Strategies for Regional Scale Monitoring is currently the most extensively addressed SRN within this category, with multiple projects contributing to the development of best practices, standardization, and monitoring designs that support regional-scale analysis. Projects include guidance from ROSA (*Ex-175: ROSA Offshore Wind Project Monitoring Framework and Guidelines*) and NOAA Fisheries (*Ex-241: Draft Regional Standards for Offshore Wind Project-Level Monitoring*), as well as insights from individual research efforts such as *Ex-214: Small Effect Sizes Are Achievable in Offshore Wind Monitoring Surveys* and *Ex-79: Establishing Standard Methods to Assess the Biological Condition of Sea Scallops Before and After Offshore Wind Farm Development*.

Peer Reviewer Discussion Highlights

- Historical datasets provide an opportunity to strengthen baseline characterization (*SRN-14*), particularly given the relatively short baseline periods required for offshore wind projects. Long-term datasets, such as the NOAA NEFSC Bottom Trawl Survey, provide critical context for understanding historical variability relative to changes observed during project-level monitoring.
- “Good COP, Bad COP.” *SRN-13: Use of Monitoring to Evaluate Effectiveness of Mitigation Strategies* highlights the significant potential utility in enabling systematic evaluation of Construction and Operations Plans (COPs) and associated mitigation measures. Such evaluations are essential for informing offshore wind development best practices and supporting regulatory decision-making by agencies such as BOEM.

Species Distribution/Composition

Definition: Changes in target fish abundance, distribution, taxonomic composition, and or/behavior as a direct or indirect result of offshore wind energy development phases.

SRN-ID	Summarized Research Need (SRN)	Contributed Research Needs	Projects Addressing
15	Changes to Biological Indicators of Incidence, Local Abundance and Distribution, Habitat Suitability, and Community Structure	14	49
16	Changes to Growth, Feeding, Reproduction, Recruitment, and Mortality	4	6
17	Effects of Offshore Wind Development Phases on Spatial Behavior	3	21

The three SRNs in this research category are informed by the conceptual structure of NOAA's Essential Fish Habitat (EFH) tiers of designation [22], which characterize habitat through metrics of fish incidence (i.e., presence/absence), density, and production. Certain closely related research topics, such as artificial reef effects (SRN-19), changes in trophic interactions (SRN-26), and larval transport (SRN-23), are assigned to the Habitat Fragmentation/Modification category (p. 35). This placement reflects the hypothesis-driven nature of those studies, where new or altered habitat created by offshore wind infrastructure is considered the primary driver of observed ecological effects. However, larval field surveys, including *Ex-31: Sunrise Wind Ichthyoplankton Survey*, *Ex-145: Vineyard Wind 1 Lobster Larvae Survey*, and *Ex-186: Marine Research Array Zooplankton & Larval Lobster Survey*, are included under *SRN-17: Effects of Offshore Wind Development Phases on Spatial Behavior* in this research category, as they directly address incidence and spatial distribution. Notably, *SRN-17: Effects of Offshore Wind Development Phases on Spatial Behavior* encompasses research addressing both horizontal and vertical movements, including changes in migration, residency, and fine-scale habitat use.

The categorization of the research need related to invasive species generated substantial discussion. While colonization of offshore wind structures by native, non-native, and invasive species is often tracked through benthic monitoring, and therefore linked to habitat processes, the detection of invasive fish species is more closely associated with incidence and distribution, aligning the idea conceptually with this category and within *SRN-15: Changes to Biological Indicators of Incidence, Local Abundance and Distribution, Habitat Suitability, and Community*

Structure. Monitoring surveys included within this research category could indeed detect invasive fish species, but to date, no projects have been funded that specifically target invasive fish species in offshore wind contexts. Therefore, to maintain the clarity and utility of the Gaps Analysis, colonizing invasive species are explicitly referenced within the Habitat Fragmentation/Modification category (*SRN-25: Colonization of Non-Native and Invasive Species*, p. 35), but the research need is not separately enumerated within this category.

Additionally, investigations on catch composition are not included here, but rather are included within the Fishing Access category (p. 44), where it is considered in the context of fishing behavior.

Projects assigned to this category are predominantly monitoring-based studies, largely driven by regulatory requirements of offshore wind Construction and Operations Plans (COPs) to implement project-level fisheries monitoring surveys. 68 unique projects address the three SRNs of this research category with 42 of those being project-level surveys. These efforts employ a variety of methods to describe species presence and spatial behavior, such as acoustic telemetry, bottom trawl, pot gear, dredge gear, gillnet, bongo nets (for ichthyoplankton surveys), environmental DNA (eDNA), ROV/video/stills (i.e., HabCAM for sea scallop abundance [23]), baited remote underwater video (BRUV), and multibeam echosounder. Receptors for these surveys vary and are dependent on key commercial and recreational target species and activity that occurs within each offshore wind project's lease area. In contrast, the project-level fisheries monitoring surveys by the offshore wind developer US Wind, a lease holder off of Maryland, (*Ex-141 and Ex-142: MarWin Recreational and Commercial Fishery Resource Monitoring*) have primary objectives that are not related to species presence and behavior, and focus instead on how fishing practices adapt to offshore wind infrastructure and are therefore categorized under Fishing Access (p. 44).

While guidance and standards [2, 12, 26] exist or are in further refinement for fisheries monitoring plans, much of this resource monitoring work is currently conducted in isolation by individual developers, resulting in inconsistent methodologies and missed opportunities for the regional synthesis. See the Regional Resource Monitoring research category (p. 30) for initiatives focused on improving coordination across projects and enabling regional synthesis of monitoring data.

Peer Reviewer Discussion Highlights

Refinement of Questions

- Projects in this category are dominated by traditional monitoring approaches focused on detecting changes in incidence and density (i.e., “is there a change in species distribution/composition: yes/no”), whereas other research categories (e.g., Sound/Vibration, EMF) are more explicitly hypothesis-driven. Offshore wind

project-level fisheries monitoring surveys may not clearly articulate the mechanisms responsible for observed changes beyond the presence of offshore wind infrastructure.

- To strengthen the results of the Gaps Analysis, the 49 projects and surveys addressing *SRN-15: Changes to Biological Indicators of Incidence, Local Abundance and Distribution, Habitat Suitability, and Community Structure* may have the ability to get more specific. There may be some surveys that do have underlying hypotheses that are not clear in the objectives provided in FishFORWRD and ROSA should consider exploring how to get more specificity around hypotheses that may be included in the fisheries monitoring plan surveys.
- The Gaps Analysis reveals that this research category is dominated by Before-After Control-Impact (BACI) and Before-After-Gradient (BAG) study designs. Expanding beyond detection-focused monitoring and toward studies capable of identifying the drivers of observed changes would improve understanding of causal mechanisms.
- Analysis of data collected in projects assigned to this category has been published [24] or recently funded [25] that could inform the next generation of fisheries monitoring plans, improving their ability to detect and explain ecological effects.
- Community-level composition should be given a greater emphasis in fisheries monitoring surveys, recognizing this can be influenced by survey gear and methods (e.g., acoustic telemetry vs. environmental DNA (eDNA)). While benthic monitoring commonly focuses on community structure, this category remains largely species-centric, particularly for telemetry studies. This focus has been shaped in part by fishing industry priorities and practical constraints, recognizing that comprehensive monitoring of all species is not feasible.

Regional Coordination

- Similar to discussions within the Habitat Fragmentation/Modification research category (p. 35), questions remain on whether each offshore wind project needs to conduct identical surveys, particularly in neighboring areas. While regional differences are already reflected in survey methods (e.g., trawl surveys in Southern New England, pot surveys in the Mid-Atlantic), reviewers recommended exploring more fine-scale, impact-focused studies and greater coordination of survey design across projects, while still meeting COP regulatory requirements.
 - This perspective is consistent with the National Marine Fisheries Service (NMFS) draft Regional Standards for Offshore Wind Project-level Monitoring [26] which emphasize targeted, impact-driven studies rather than project-wide species abundance surveys.

Habitat Fragmentation/Modification

Definition: Physical and ecological changes to marine habitats associated with offshore wind infrastructure and activities, including changes to habitat size, composition, structure, connectivity, or function.

SRN-ID	Summarized Research Need (SRN)	Contributed Research Needs	Projects Addressing
18	Gradient of Change at Turbine/Farm Scale	2	6
19	Artificial Reef Effect on Fish	8	9
20	Decommissioning Effects	1	GAP
21	Thermal Effects of Offshore Wind Infrastructure	1	1
22	Local and Regional Changes to Ocean Hydrodynamics	8	10
23	Larval Transport and Recruitment Effects	12	9
24	Effects on Spawning Timing, Location, and Habitat Use	6	2
25	Colonization of Non-Native and Invasive Species	3	4
26	Changes in Trophic Interactions	9	4
27	Changes to Light Conditions	3	GAP
28	Effect of Artificial Substrate on Benthic and Epibenthic Community	4	9
29	Turbine Spacing and Connectivity of Fish Communities	2	3
30	Nature-Inclusive Design	6	4

31	Baseline Benthic and Water Column Habitat	6	15
32	Cable Installation Impacts	NEW*	5
33	Cable Protection Impacts	NEW*	2
34	Change in Water and Sediment Quality	1	1
35	Effects of Boulder Relocation	2	3

*New research need identified by Gaps Analysis peer reviewers.

SRNs in this research category consider the effects of offshore wind infrastructure on marine habitat from the surface through the benthos, and the resulting implications for species life history, habitat use, trophic interactions, and habitat connectivity. The SRNs are organized around habitat-driven impact pathways, such as artificial reef effects, hydrodynamic alteration, substrate addition or relocation, cable-related disturbance, and changes to water and sediment quality. While relevant to this research category, the potential influence of benthic habitat modification on fish condition was ultimately captured under the Species Distribution/Composition research category (*SRN-16: Changes to Growth, Feeding, Reproduction, Recruitment, and Mortality*, p. 32), reflecting stronger alignment with biological responses rather than habitat processes alone.

As part of each offshore wind project's Construction and Operations Plan (COP), developers are required to implement a benthic monitoring plan. These plans, and their individual survey components, are cataloged within FishFORWRD under the Habitat Fragmentation/Modification research category (p. 35) and incorporated into the Gaps Analysis. Rather than grouping all benthic monitoring activities under *SRN-31: Baseline Benthic and Water Column Habitat*, individual benthic surveys are assigned to the specific SRNs corresponding to the ecological processes or impacts targeted by the survey. These include, but are not limited to: *SRN-18: Gradient of Change at the Turbine/Farm Scale* (e.g., *Ex-118: Revolution Wind Soft Bottom Monitoring*), *SRN-19: Artificial Reef Effect on Fish* (e.g., *Ex-119: Revolution Wind Hard Bottom Monitoring*), *SRN-28: Effect of Artificial Substrate on Benthic and Epibenthic Community* (e.g., *Ex-61: Empire Wind Epifaunal Growth on Novel Hard Bottom Structures*), *SRN-32: Cable Installation Impacts* (e.g., *Ex-150: Vineyard Wind 1 Infauna and Epifauna Survey - Cable Route*), *SRN-33: Cable Protection Impacts* (e.g., *Ex-103: South Fork Hard Bottom Monitoring*), and *SRN-35: Effects of Boulder Relocation* (e.g., *Ex-119: Revolution Wind Hard Bottom Monitoring*). This approach allows FishFORWRD and the Gaps Analysis to better reflect the functional intent of benthic surveys and their relevance across multiple impact pathways.

Outside of offshore wind project-level benthic monitoring plan surveys, projects have been funded to collect or gather baseline habitat data (SRN-31) and explore connectivity of fish communities (SRN-29), nature-inclusive design (SRN-30), the impact of offshore wind on hydrodynamics (SRN-22) and the downstream effects on larval transport and early life stages (SRN-23), although coverage of these larval impacts has been limited to only a few species.

Outside of offshore wind project-level benthic monitoring plan surveys, projects included within FishFORWRD and assigned to the Habitat Fragmentation/Modification research category (p. 35) are relevant to fisheries species and their habitat. As such, not all offshore wind habitat-related projects may be included in FishFORWRD. The Regional Wildlife Science Collaborative (RWSC) has a Research Database [27] that also catalogs habitat-related projects, supported by the Habitat & Ecosystem Subcommittee [28] with expertise in seafloor characterization, benthic ecology, oceanography, hydrodynamics, and pelagic processes and biota. This subcommittee shares information about ongoing and planned research, identifies key data gaps, and helps maintain alignment and coordination among research and data collection teams. Interested stakeholders should utilize resources from regional science entities when considering habitat impacts and responses from offshore wind development.

Peer Reviewer Discussion Highlights

Regional Benthic Assessments

- Most projects addressing habitat-related SRNs are conducted at the individual project scale, resulting in highly localized impact assessments. Reviewers emphasized the value of comparative analyses across project sites to better understand variability in habitat responses and infrastructure effects.
- Large-scale regional assessments are complicated by strong site-specific controls on species distributions and habitat suitability. Reviewers suggested that regional analyses should group ecologically similar areas with comparable habitat characteristics rather than treating the continental shelf as a homogeneous system to better inform research needs such as *SRN-22: Local and Regional Changes to Ocean Hydrodynamics* and *SRN-29: Turbine Spacing and Connectivity of Fish Communities*.
- High-quality studies on benthic habitat change exist that are ecologically relevant but not directly associated with offshore wind development. Reviewers recommend integrating broader benthic science into offshore wind impact frameworks and assessments.
- Benthic monitoring plans have become increasingly standardized across offshore wind projects, however, questions remain about whether repeating identical survey designs at nearby sites yields sufficient new information. Consideration should be given to exploring more adaptive and efficient monitoring strategies, including aligning sampling frequency with the expected rates of habitat change. For example, long-term

monitoring could be structured around intervals such as Years 1, 5, 15, and 30, rather than annual sampling, where scientifically justified.

Prioritization

- Since several research needs within this category will be required to be explored by offshore wind developers through benthic monitoring plans, regional funders might consider focusing on questions not being addressed by monitoring that is required of developers, such as cumulative and regional-scale analyses across multiple research needs.
- Existing studies on boulder relocation primarily focus on epifaunal colonization, with limited attention to changes in broader seafloor physical complexity and its ecological consequences. Additional research is needed at relocated boulder sites to evaluate changes in structural complexity and associated effects such as artificial reef formation and habitat connectivity, directly addressing *SRN-35: Effects of Boulder Relocation* and its interaction *SRN-19: Artificial Reef Effect on Fish* and *SRN-28: Effect of Artificial Substrate on Benthic and Epibenthic Community*.
- Uncertainty exists around the fate of increased benthic productivity associated with offshore wind structures, including whether gains are transferred to higher trophic levels or remain concentrated within lower trophic communities, directly linking to *SRN-26: Changes in Trophic Interactions*.
- Cross-panel peer reviewer discussions identified potential chemical releases and oil leaks from offshore wind infrastructure as an area of concern; these potential impacts are considered captured within *SRN-34: Change in Water and Sediment Quality*.

Electromagnetic Fields (EMF)

Definition: The effects of electromagnetic fields (EMF) on fisheries species and ecosystems, including interference with bioelectric and geomagnetic sensing marine organisms. EMF is generated by cables that carry electricity from and between energy sources, such as wind turbines to power stations.

SRN-ID	Summarized Research Need (SRN)	Contributed Research Needs	Projects Addressing
36	Characterization of EMF Exposures for OSW	9	3
37	Characterization of EMF Effects for Fisheries Species	10	11

38	Population, Community and Ecosystem-level EMF Impacts to Fisheries	3	6
39	Ecological Risk Assessment Approaches, Methods, and Models	NEW*	1

*New research need identified by Gaps Analysis peer reviewers.

SRNs in this category build sequentially from the characterization of EMF exposure levels produced by offshore wind energy infrastructure, to understanding whether and how detectable EMF may cause effects in individual organisms, and ultimately to assessing potential population- and community-level effects.

Within FishFORWRD, literature reviews have characterized EMF exposure levels associated with offshore wind development and summarized known biological responses among fisheries species (e.g., *Ex-2: Evaluation of Potential EMF Effects on Fish Species of Commercial or Recreational Fishing Importance in Southern New England*, *Ex-201: Electromagnetic Fields: Background and Potential Impacts of Offshore Wind Farms on Marine Organisms*). Field studies investigating EMF effects have been limited to export cable route surveys, exclusively conducted under offshore wind developer fisheries monitoring plans (*Ex-106: South Fork Export Cable Route Trawl Survey*, *Ex-107: South Fork Export Cable Route Telemetry Studies*, *Ex-120: Revolution Wind State Water Ventless Trap Survey - Export Cable*, *Ex-129: Sunrise Wind Export Cable Acoustic Telemetry Studies - Lobster, Horseshoe Crab*). These efforts employ a variety of methods, such as acoustic telemetry, bottom trawl, and pot gear, to describe species presence and behavior near cables, and target crustaceans, elasmobranchs, and demersal fish. The intent is that these localized observations will contribute to a broader understanding of EMF impacts at population and community scales.

SRN-39: Ecological Risk Assessment Approaches, Methods, and Models is a new need identified by peer reviewers. Ecological Risk Assessment offers a systematic, unifying framework for organizing existing EMF exposure and effects research and identifying the most consequential data gaps. By applying this type of framework through targeted case studies, managers and researchers can sift through research findings, evaluate the strength of evidence across stressors, and determine additional research to best support decision-making.

Peer Reviewer Discussion Highlights

State of the Field

- Research progress remains constrained by the limited amount of laboratory-based work, including controlled exposure and dose-response studies that can isolate behavioral or physiological mechanisms and provide empirical benchmarks needed to interpret and validate field observations and modeling approaches.

- A lot of studies, data, and research exist around EMF impacts, especially outside of the U.S., however studies measure and describe results differently. Comparisons across studies, therefore, prove challenging.
- Given the few species that have been studied to date, the National Marine Fisheries Service (NMFS) is interested in using spatial exposure [29] of commercially important species with sensitivity analyses to create a vulnerability matrix as a framework to prioritize EMF-sensitive species and direct further research on potential effects of EMF.

Appropriate Scale for Framing EMF Effects

- EMF studies and discussion need to be framed to the appropriate scale of effects. For example, EMFs created by lower voltage Alternating Current (AC) interarray and export cable EMFs are generally weaker and smaller, while high-voltage Direct Current (DC) transmission cables generate larger and stronger EMFs more detectable by EMF-sensitive species. Minor biological or behavioral effects may occur at the individual cable scale, but assessment should consider: what are the cumulative effects of repeated/chronic exposure over the broader regional scale of EMF producing offshore wind infrastructure (i.e., multiple projects, multiple cables)?

Ecological Risk Assessment

- Although Ecological Risk Assessment originated in the context of chemical contaminants, the approach is well-suited to offshore wind-related stressors, including EMF, and could support the development of shared criteria for risk retirement, where specific concerns are deemed low-risk based on available evidence.
- Ecological Risk Assessment on project-related EMF effects was used for the Construction and Operation Plans of Beacon Wind 1 and Beacon Wind 2 offshore wind projects [30].
- Distinguishing between research and monitoring results for cables in the water column (i.e., for floating offshore wind) and cables buried in or laid on the seafloor (i.e., for fixed-bottom offshore wind) is particularly important for this specific research category.

Sound/Vibration Impacts

Definition: The effects of underwater sound and vibration (includes both sound pressure and particle motion) on fisheries species and ecosystems, including potential behavioral, physiological, and ecological responses. Sound and vibration are generated during offshore wind site characterization, construction, and operation and can be sensed by organisms using hearing, the lateral line in fishes, and/or depth regulating organs.

SRN-ID	Summarized Research Need (SRN)	Contributed Research Needs	Projects Addressing
40	Characterization of Sound Pressure, Motion and Seabed Vibration	3	8
41	Effects of Offshore Wind Sound on Behavior and Physiology of Fish and Shellfish	22	12
42	Alteration of Natural Soundscape	2	6
43	Strategies for Mitigation from Sound and Vibration Impacts	6	1
44	Population, Community and Ecosystem-level Impacts from Sound Pressure, Particle Motion and Seabed Vibration	1	2

SRNs in this category build sequentially from characterization of the sound and vibration produced from offshore wind development, to how that sound affects individuals, to the population level, to the ecosystem level. *SRN-41: Effects of Sound on Behavior and Physiology of Fish and Shellfish* is intended to capture both field-based and laboratory-based projects that have or could be funded. *SRN-41* is also intended to include two fundamental physiological questions specific to properties of offshore wind sound: (1) understanding the hearing/sound capabilities of marine species to sound/vibration related to offshore wind development; (2) understanding which offshore wind related acoustic signals animals detect and cue towards.

Projects addressing these research needs focus exclusively on sound impacts associated with fixed-bottom offshore wind development. Within FishFORWRD, research on acoustic effects includes controlled laboratory studies (e.g., *Ex-170: Sound sensitivity of the giant scallop (*Placopecten magellanicus*) is life stage, intensity, and frequency dependent*) as well as a growing number of field-based efforts, including smaller-scale experimental studies (e.g., *Ex-202: Impulsive pile driving sound does not induce hearing loss in the longfin squid (*Doryteuthis pealeii*)*) and monitoring initiatives implemented as part of offshore wind developer fisheries monitoring plans (e.g., *Ex-105: South Fork Wind Spawning Cod Monitoring*; *Ex-116: Revolution Wind Spawning Cod Monitoring*; *Ex-128: Sunrise Wind Spawning Cod Monitoring*). Receptors explored include shellfish, crustaceans and demersal groundfish.

Peer Reviewer Discussion Highlights

- Priority research needs reflect two complementary questions necessary for understanding sound impacts: characterization of the offshore wind sound itself

(SRN-40), as this information informs sound/vibration studies on animals; and the population-, community-, and ecosystem-level impacts of sound disturbance (SRN-44), as the impacts on these scales are more aligned with management decisions.

Sound Measurement

- The development of a highly instrumented monitoring system for offshore wind has been consistently called for [31], but practical and financial feasibility remain real challenges.
- Relevant data addressing *SRN-40: Characterization of Sound Pressure, Motion and Seabed Vibration* and *SRN-42: Alteration of Natural Soundscape* may be collected for research outside of fish and fisheries (i.e., marine mammals)
- A potential research gap exists related to operational-phase offshore wind noise, which appears less studied than construction-phase sound impacts.

Population Effects

- Offshore wind construction activities have already occurred or are occurring. There is a need to assess whether population- or community-level effects from sound and vibration are observable to date, and whether existing monitoring programs are designed to detect such effects.
- Sound and vibration studies and discussion need to be framed to the appropriate scale of effects. There may be minor biological or behavioral effects at the individual project scale, but the question for assessment is: what are the cumulative effects of repeated exposure over the broader regional and temporal scales of offshore wind construction and operational noise?

Fisheries Engagement & Capacity Building

Definition: Methodology for bidirectional exchange of information between the commercial and/or recreational fishing communities, agency representatives, and offshore wind developers. Capacity building refers to the process of obtaining or improving the knowledge or skills needed to participate effectively in the offshore wind development process and/or understand science and management around fisheries and offshore wind.

SRN-ID	Summarized Research Need (SRN)	Contributed Research Needs	Projects Addressing
45	Strategies, Resources, and Mechanisms for Building Capacity Across Sectors	2	2

46	Qualitative Analysis Informing Effective Fishery Stakeholder Engagement	3	1
47	Local Ecological Knowledge Methodology Development and Integration	1	1
48	Social Networking and Knowledge Sharing	1	1

SRNs in this category aim to enhance engagement of fishing communities in offshore wind development and to distinguish among different approaches for analyzing the exchange of information.

Reviewers emphasized that *SRN-45: Strategies, Resources, and Mechanisms for Building Capacity Across Sectors* should be explicitly framed as a cross-sector, bidirectional process, recognizing that fishing communities already possess substantial knowledge and experience in engaging. Rather than continuing to treat engagement as a one-directional transfer of information, this SRN is intended to capture the resources, tools, and strategies needed for all sectors to engage productively together.

Three individual projects explore the four SRNs in this category, meaning the same projects explore more than one SRN. These projects include efforts evaluating communication and messaging networks (*Ex-22: Evaluating Messaging, Communication Networks, And Public Engagement On Offshore Wind Development In Southern New England*), initiatives designed to build inclusivity for fishing community engagement in the Gulf of Maine offshore wind development process (*Ex-9: Fostering Capacity for Fishing Communities to Engage Effectively and Constructively in Offshore Wind Development in the Gulf of Maine*), and the development of a data trust to steward fishermen's local ecological knowledge (*Ex-89: Creation of a Data Trust to Include Fishermen's Knowledge in Offshore Wind Energy Decision Making*).

Peer Reviewer Discussion Highlights

- While the importance of engagement and capacity building is widely acknowledged, this category remains relatively lightly explored compared to others, and additional research and applied investment may be needed to better understand which engagement approaches are most effective across regions, fisheries, and development contexts.

Fishing Access

Definition: Changes to commercial and recreational fishing access and operation within and around offshore wind farms, including gear development to maintain access, safety considerations, displacement and/or changes in location and timing of commercial and recreational fishing efforts, and the topic of Fisheries Enhancement as a mitigation tool.

SRN-ID	Summarized Research Need (SRN)	Contributed Research Needs	Projects Addressing
49	Spatial and Temporal Change in Commercial and Recreational Fishing Behavior	11	16
50	Spatial Operation Needs Within and Around Wind Farms	7	10
51	Gear Modification, Fisheries Enhancement, and Other Fisheries Development to Allow Co-Use	1	10
52	Fishing Interaction with Cable Protection Measures	2	1
53	Impacts of Boulder Relocation on Fishing	1	1
54	Navigation and Safety	3	3

SRNs in this category address how fishing activity may be affected by offshore wind development and pathways to support continued fishing operations through adaptation, mitigation, and co-use strategies.

SRN-49: Spatial and Temporal Change in Commercial and Recreational Fishing Behavior captures research needs at broad spatial and temporal scales, focused on understanding how fishing activity may shift regionally in response to offshore wind development, climate change, or other factors. This SRN is closely tied to offshore wind siting and planning, and emphasizes the importance of establishing robust baselines of fishing activity and behavior to inform impact avoidance and minimization. Research under this SRN considers how changes in fishing behavior may accumulate across space and time and how outcomes differ for recreational and commercial fishing.

In contrast, *SRN-50: Spatial Operation Needs Within and Around Wind Farms* addresses more localized, operational impacts. This SRN focuses on the practical requirements for fishing within constrained spatial environments, including vessel- and gear-specific considerations, and encompasses research needs related to both needed empirical studies and perceived risk and decision-making. Projects assigned to this SRN aim to inform mitigation and adaptation strategies that may enable continued activity for certain fisheries in and around offshore wind projects.

SRN-54: Navigation and Safety captures a distinct set of research needs related to vessel safety and navigational risk and is treated separately from fishing spatial operations due to its unique objectives and risk considerations. Building on these operational considerations, *SRN-51: Gear Modification, Fisheries Enhancement, and Other Fisheries Development to Allow Co-Use* reflects research needs centered on innovation and adaptation aimed at resolving displacement, operational constraints, and safety concerns.

Projects assigned to this category collectively address these research needs through baseline data collection, modeling, and applied field studies. Several projects use baseline fishing activity and behavior data to predict and evaluate potential spatial and temporal changes in fishing behavior (e.g., *Ex-74: Using fine-scale fishery data to evaluate and predict the potential impact of offshore wind energy development on fishery operations*). Other projects focus on identifying spatial operation needs within offshore wind projects, including studies examining both fixed-bottom (e.g., *Ex-215: Spatial analysis of fishing tows with Automatic Identification System (AIS) data to inform offshore wind layouts*) and floating offshore wind configurations (e.g., *Ex-37: Co-Design Solutions for U.S. Floating Offshore Wind Farms and Fishing Compatibility*). Given the longer development timelines for floating offshore wind along the U.S. Atlantic coast, early-stage research and co-design efforts are contributing foundational information to inform future project development.

There has also been notable investment in *SRN-51: Gear Modification, Fisheries Enhancement, and Other Fisheries Development to Allow Co-Use*, particularly in relation to the surfclam fishery, with 8 out of 10 projects assigned to this SRN supporting surfclam fisheries enhancement. As offshore wind projects move through construction and into operation, projects have been initiated to examine realized and potential interactions between fishing operations and installed infrastructure, including cable protection measures (*Ex-245: Offshore Wind Submarine Cabling Overview*) and boulder placement (*Ex-231: Uniting knowledge from fishing communities and offshore wind developers to improve boulder relocation practices*).

Peer Reviewer Discussion Highlights

Drawing Distinctions

- Maintaining clear distinctions between regional-scale changes in fishing behavior (SRN-49) and localized spatial operation needs (SRN-50) is important as these SRNs address different scales and decision-making contexts.
- *SRN-49: Spatial and Temporal Change in Fishing Behavior* and *SRN-50: Spatial Operation Needs Within and Around Wind Farms* are equally important and should be studied concurrently, as regional displacement dynamics and project-level operational adaptation are interrelated. Changes in spatial fishing behavior have direct implications for fisheries management and governance.
- Patterns of change in fishing behavior may differ substantially for floating offshore wind compared to fixed-bottom offshore wind, particularly given longer development timelines and lags between installation and observable changes in fishing behavior.

Prioritization

- Cable protection measures and boulder relocation were repeatedly identified as priority concerns for the fishing community, reinforcing the utility of separating these ideas into two separate SRNs.
- *SRN-54: Navigation and Safety* as a distinct SRN is crucial as the research need is separate from fishing spatial operations, and operational safety risks, particularly those associated with weather conditions, remain underexplored within the current body of research.
- As fixed-bottom offshore wind projects move from construction to operation, there is now a meaningful opportunity to more effectively investigate many of the research questions within this category using real-world conditions and observed fishing activity.

Socioeconomic & Sociocultural Impact

Definition: Changes to the economic value of commercial and recreational fishing industries, effects to shoreside infrastructure, and social and cultural changes in fishing communities due to offshore wind development.

SRN-ID	Summarized Research Need (SRN)	Contributed Research Needs	Projects Addressing
55	Secondary and Tertiary Effects to Supply Chains and Supporting Businesses	3	3

56	Marine Spatial Planning and Use Tradeoffs	3	2
57	Approaches to, Data Inputs for, and Assessment of Compensatory Mitigation Programs	3	3
58	Costs and Benefits Associated with Recreational Fishing	7	6
59	Impacts on Commercial Fishermen's Occupational Structure, Labor Markets, and Workforce	15	11
60	Methods for Evaluating Socioeconomic/Sociocultural Impact	3	5
61	Impacts on Seafood Value, Marketability, and Quality	2	4
62	Changes to Vessel Insurance Costs and Availability	1	1
63	Offshore Wind Interaction with Fisheries Infrastructure in Ports	9	1
64	Effects on Cultural Identity, Individual Well-Being, Place Attachment, and the Social Fabric of Fishing Communities	8	4
65	Fishing Community Environmental Justice Concerns	3	1

As a result of peer review, the research category title was expanded to explicitly include Sociocultural Impacts. Accordingly, this category encompasses both socioeconomic research needs (SRNs 55–63) and sociocultural research needs (SRNs 64–65). The SRNs capture impacts across multiple scales: individual fishermen; businesses and labor markets; ports, supply chains, and supporting infrastructure; and finally community-level social and cultural dimensions. This structure recognizes that different impact pathways require distinct research approaches and methodologies.

In particular, the SRNs separate impacts to individual fishermen and communities (e.g., *SRN-64: Effects on Cultural Identity, Individual Well-Being, Place Attachment, and the Social Fabric of Fishing Communities*) from impacts to business structures and labor markets (e.g., occupational structure, workforce dynamics, recreational fishing costs and benefits; *SRNs 58-59*). This distinction reflects both conceptual differences and the expectation that these impacts will be evaluated using different qualitative and quantitative methods.

Several SRNs explicitly cover how impacts are measured and addressed, including *SRN-60: Methods for Evaluating Socioeconomic/Sociocultural Impact* and the design of sustainable and effective compensatory mitigation approaches (*SRN-57: Approaches, Data Inputs, and Assessment of Compensatory Mitigation Programs*). Perceived capacity to adapt is reflected in sociocultural research focused on individual and community resilience (*SRN-64: Effects on Cultural Identity, Individual Well-Being, Place Attachment, and the Social Fabric of Fishing Communities*), while research needs related to perceived risk and decision-making are captured within SRNs addressing recreational and commercial fishing behavior in the Fishing Access research category (p. 44). *SRN-61: Impacts on Seafood Value, Marketability, and Quality* is intentionally broad, encompassing quality, marketability, and potential changes in value associated with certification status (e.g., Marine Stewardship Council certification).

Each SRN in this category is being explored by at least one project. A small number of projects have adopted a regional perspective, examining impacts across multiple offshore wind projects and/or fisheries (e.g., *Ex-139: Assessing stranded capital and capital devaluation in the seafood industry due to offshore wind energy development*, *Ex-69: Socioeconomic Impacts of Atlantic Offshore Wind Development*, *Ex-194: Socio-Economic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic, Volume I—Report Narrative*). However, fishery-specific projects have mostly focused on surfclam and scallop fisheries, reflecting both their economic importance and the concern over exposure and sensitivity to offshore wind development.

Sociocultural research has been most concentrated in the Gulf of Maine, followed by Southern New England. Research in the Gulf of Maine, supported in part by the Maine Offshore Wind Research Consortium [32], has focused on establishing baseline socioeconomic and sociocultural data and assessing the sensitivity of existing datasets to detect offshore wind-related impacts.

Peer Review Discussion Highlights

Prioritization

- Port-level, community-level, and secondary market impacts, including labor markets, dock space availability, and shoreside infrastructure constraints remain largely

unexplored. These impacts extend beyond fishing behavior and are among the least studied aspects of offshore wind fisheries interactions.

- Mixed confidence was expressed in the extent to which additional research investment could influence federal decision-making around marine spatial planning (SRN-56). Notably, there has been increased efforts by NOAA National Centers for Coastal Ocean Science (NCCOS) in the Gulf of Maine [33] and Central Atlantic [34] offshore wind planning process.
- *SRN-65: Fishing Community Environmental Justice Concerns* was identified as a critical need, but underfunded.
- Overall, the SRNs in this research category are incredibly important and addressing these questions across multiple fisheries and regions will require significant, sustained investment.

Capacity & Actionable Results

- The capacity to conduct socioeconomic and sociocultural research exists within the region, including academic researchers, university-based cohorts, and standing committees (e.g., Atlantic States Marine Fisheries Commission committees). However, these groups may not yet be fully engaged in offshore wind-related research, and targeted funding will be necessary to activate and sustain this capacity.
- To increase the actionability of research results, funders should consider incorporating requirements into solicitations that encourage early engagement with management and regulatory bodies and explicitly support pathways for translating research findings into decision-making. Reviewers also emphasized the importance of allowing adequate budget for these coordination and translation activities.

Survey Adaptation

Definition: Alteration or creation of new survey methodology to allow for fisheries data collection within and around offshore wind farms.

SRN-ID	Summarized Research Need (SRN)	Contributed Research Needs	Projects Addressing
66	Alternate and Advanced Technologies and Survey Techniques	9	11
67	Impacts on Fisheries-Independent Surveys	5	5

68	Development of Interim Provisional Survey Indices	1	GAP
69	Project-Level Monitoring Data to Fill Regional Scientific Survey Data Needs	2	1
70	New Fishery Observer Protocols to Address Questions	1	GAP

The SRNs within this category focus on understanding how offshore wind development affects existing fisheries data collection and identifying alternative methods, technologies, and data pathways that can mitigate those impacts. Economic data collection and associated survey-improvement research needs are cataloged separately within the Socioeconomic & Sociocultural Impacts category (p. 46) under *SRN-60: Methods for Evaluating Socioeconomic & Sociocultural Impact*. The Survey Adaptation research category is also distinct from the category of Regional Resource Monitoring (p. 30), which is focused on strategic programming to integrate resource monitoring efforts. Lastly, a key distinction within this category exists between *SRN-68: Development of Interim Provisional Survey Indices* and *SRN-69: Project-Level Monitoring Data to Fill Regional Scientific Survey Data Needs*. *SRN-68* focuses on the development of interim provisional indices, using available datasets to maintain continuity in scientific information where traditional surveys are disrupted. *SRN-69*, by contrast, focuses on developing formal pathways for integrating offshore wind project-level monitoring data into regional scientific survey frameworks to support longer-term data needs.

Most projects currently assigned to this category concentrate on *SRN-66: Alternate and Advanced Technologies and Survey Techniques*. These efforts are being pursued through offshore wind developer fisheries monitoring plans (e.g., *Ex-148: Vineyard Wind 1 Video Trawl Survey - Pilot Study*) and through the pilot of new surveys [35] supported by the NOAA Northeast Fisheries Science Center, in alignment with the NOAA Fisheries and BOEM Federal Survey Mitigation Implementation Strategy [36]. While survey mitigation plans exist for all of the NEFSC surveys, FishFORWRD and the Gaps Analysis currently include mitigation surveys that are actively under development or implementation, including *Ex-71: Trap Video Survey Mitigation Plan*, *Ex-72 Hook and Line Survey Mitigation Plan*, and *Ex-73: eDNA Survey Mitigation Plan*.

Peer Reviewer Discussion Highlights

- Relevant research is emerging from the ICES Working Group on Offshore Wind Development and Fisheries [37] (WGOWDF) including:

- Lipsky et al., 2024: *Fisheries Independent Surveys in a New Era of Offshore Wind Energy Development* [38]
 - Workshop to Develop and ICES Survey Mitigation Strategy [39]
- Project-level monitoring cannot independently replace NMFS surveys to answer population-level questions. Reviewers noted, however, a strong potential for spatiotemporal integration of high-density offshore wind monitoring datasets into regional resource assessments and scientific analyses, which could significantly enhance the resolution and interpretability of regional monitoring programs. Overall, reviewers expressed confidence that these data can meaningfully support responsible offshore wind development as well as fisheries science and management, provided that effective frameworks are developed to stitch together disparate datasets into a coherent regional understanding of cumulative impacts.

Conclusion

The ROSA Research Gaps Analysis provides the most comprehensive picture to date of meaningful progress and critical knowledge gaps on this subject. Of the 70 SRNs identified, 8 are currently unaddressed, and many that are "Under Exploration" still lack the geographic breadth, taxonomic coverage, or regional coordination needed to fully inform management decisions. Only *SRN-7: Centralized Database of Ongoing Research and Monitoring* was considered fully addressed through the creation of FishFORWRD. Across categories, a consistent theme emerges: project-level research is accumulating rapidly, but translating that work into regional-scale cumulative impact assessments, standardized monitoring frameworks, and actionable fisheries management guidance remains an urgent and largely unmet need. As FishFORWRD continues to grow and is updated biannually, the Gaps Analysis will serve as a dynamic resource enabling funders, researchers, developers, and fishing industry members to align investments, avoid duplication, and collectively advance the rigorous, regionally coordinated science that responsible offshore wind development demands.

The Gaps Analysis was developed following ROSA's guiding principles of being scientific, collaborative, objective, and transparent. All known prioritization documents related to fisheries and offshore wind along the U.S. Atlantic Coast were included from the start, and the synthesis of these research topics into SRNs was subject to both internal and independent external review. The overall process was presented and consented to over multiple instances by the multi-stakeholder ROSA community.

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Appendices

Appendix A. Research Prioritization Documents

This appendix includes references to research prioritization documents from which individual research needs were drawn to develop the SRNs and inform research category designations.

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Appendix B. FishFORWRD Database Structure and Attributes

FishFORWRD contains 4 tabs.

1. Welcome Page

The Welcome Page tab features a description of the purpose of the database, instructions for use, and a description of other tabs. Statistics of information within the database are featured on the side.

2. Research Projects & Needs

The Research Projects & Needs tab holds full information on all research and monitoring projects and programs, individual research needs, summarized research needs, acronyms list, definition of terms, and references for research needs. Detailed information on attributes and definitions is explained below (Table B1, B2, B3)

3. Research Gaps Analysis

The Research Gaps Analysis tab houses the results of this report and is designed to help users quickly understand how research needs are currently being addressed by projects within FishFORWRD and support highlighting where critical needs remain across offshore wind fisheries science. See Appendix C for further information.

4. Submit Project

The Submit Project tab holds links to submission forms for new projects, new research needs, and corrections. There are also additional links to other relevant databases and tools a user may be interested in.

The attributes associated with Projects, Individual Research Needs, and Summarized Research Needs, are described below and form the data structure that supports the Research Gaps Analysis tool.

Table B1. Projects

Attribute	Selections
Research Category	Cumulative Impacts & Fisheries Management Implications Data Management EMF Fisheries Engagement & Capacity Building Fishing Access Habitat Fragmentation/Modification Resource Monitoring Socioeconomic & Sociocultural Impact

	Sound/Vibration Impacts Species/Distribution/Composition Survey Adaptation
Developer Fisheries Monitoring Plan	Yes No
Fixed or Floating	Fixed Floating Both
Wind Farm Development Phase	Preconstruction Construction Operation/Maintenance Decommissioning
Spatial Scale	Offshore Wind Project State Regional National
Location	Gulf of Maine Southern New England New York/New Jersey Bight Central Atlantic South Atlantic Atlantic Coast
Project Title	
Lead Entity	
Partner Entities	
PI Name	
Project Objectives	
Methodology	All Acoustic Telemetry Baited Remote Underwater Video (BRUV) Benthic Grab Bottom Trawl Dredge eDNA Gillnet Ichthyoplankton Survey Modeling Methods

	Multibeam Echosounder Oceanography Tools Other Fishing Gear PAM ROV/video/stills SPI/PV Social Science Methodology Trap/Pot Other
Receptor	All Reported Demersal/Groundfish/Squid Crustaceans HMS Pelagic Fish Shellfish Benthic Invertebrates/Community Ichthyoplankton Habitat Fishing Industry
Project Start	
Estimated Project End	
Funder	
Funding Partners	
Project Website	

Table B2. Individual Research Needs

Attribute	Selections
Research Category	Cumulative Impacts & Fisheries Management Implications Data Management EMF Fisheries Engagement & Capacity Building Fishing Access Habitat Fragmentation/Modification Resource Monitoring Socioeconomic & Sociocultural Impact Sound/Vibration Impacts

	Species/Distribution/Composition Survey Adaptation
Source of Identification	<i>See Appendix A</i>
Spatial Scale	Offshore Wind Project State Regional National
Summary of Need	
Location	Gulf of Maine Southern New England New York/New Jersey Bight Central Atlantic South Atlantic Atlantic Coast
Fixed or Floating	Fixed Floating Both
Receptor	Demersal/Groundfish/Squid Crustaceans HMS Pelagic Fish Shellfish Benthic Invertebrates/Community Ichthyoplankton Habitat All Reported Fishing Industry

Table B3. Summarized Research Needs

Attribute	Selections
Research Category	Cumulative Impacts & Fisheries Management Implications Data Management EMF Fisheries Engagement & Capacity Building Fishing Access Habitat Fragmentation/Modification Resource Monitoring

	Socioeconomic & Sociocultural Impact Sound/Vibration Impacts Species/Distribution/Composition Survey Adaptation
Summarized Research Need	
Full Description	
Existing Projects Addressing Need ID Numbers	
Individual Research Needs Captured	
Data Gap Analysis Score	Under Exploration Not Addressed

Appendix C. Using the Research Gaps Analysis Tool on FishFORWRD

The Research Gaps Analysis tab on FishFORWRD allows users to explore Summarized Research Needs by research category and filter by “Under Exploration” and “Not Addressed”. Users can then view which projects are addressing a particular Summarized Research Need (SRN) and how by receptor, methodology, and location.

FishFORWRD Database Welcome Page Research Projects & Needs **Research Gaps Analysis** Submit Project

Summarized Research Needs

Srn Id	Rsrch. Category	Srn	Score
SRN-1	Habitat Fragmentation/Modification	Gradient of Change at Turbine/Farm Scale	Under Exploration
SRN-2	Habitat Fragmentation/Modification	Artificial Reef Effect on Fish	Under Exploration
SRN-3	Habitat Fragmentation/Modification	Decommissioning Effects	Not Addressed
SRN-4	Habitat Fragmentation/Modification	Thermal Effects of Offshore Wind Infrastructure	Under Exploration
SRN-5	Habitat Fragmentation/Modification	Local and Regional	Under Exploration

This view displays the results of ROSA's Research Gaps Analysis.

- On the left, you'll find the full list of Summarized Research Needs (SRN) organized by research category. Filter the Score to NOT ADDRESSED to view research gaps. Note: Some SRNs marked as UNDER EXPLORATION may still have unmet needs, such as for specific receptors and locations.
- Below, you'll see all Explored Research Needs — needs that are currently being addressed by ongoing or completed projects. Match your SRN of interest on the left to the corresponding SRN on the below to see how specific needs are being explored and by which projects.

Explored Research Needs

Srn Id	Rsrch. Proj. Id	Receptor	Methodology	Location
SRN-1	Ex-60	Habitat	SPI/PV	New York/New Jersey Bight
SRN-1	Ex-61	Habitat	ROV/video/stills	New York/New Jersey Bight
SRN-1	Ex-102	Habitat	SPI/PV	Southern New England
SRN-1	Ex-118	Habitat	SPI/PV	Southern New England

Figure C1. Screenshot of the Research Gaps Analysis Tab in FishFORWRD

How to Use

1. On the Left: The full list of Summarized Research Needs (SRNs) organized by research category. Use the Score filter to select NOT ADDRESSED to view research gaps, SRNs with no associated projects. Filter to UNDER EXPLORATION to view SRNs with at least one project addressing them. Note: Some SRNs marked as UNDER EXPLORATION may still have unmet coverage, such as for specific receptors, locations, or methods.
2. On the Right, All SRNs UNDER EXPLORATION. These are explored research needs that are currently being addressed by ongoing or completed projects.
3. Match your SRN number of interest on the left to its corresponding number on the right to see how that specific need is being explored and by which projects.
4. For more details on any listed project, match the project number to project number on the Research Projects & Needs tab.

A short video of this process can be found on our website here:

<https://www.rosascience.org/wp-content/uploads/2022/11/FishFORWRD-Gaps-Analysis-Tab-Overview-1.mp4>

Example

A user is interested in the research category of electromagnetic fields (EMF).

The user navigates to the Research Gaps Analysis Tab on FishFORWRD and chooses the EMF research category on the left table to view the summarized research needs for EMF.

FishFORWRD Database Welcome Page Research Projects & Needs **Research Gaps Analysis** Submit Project

Summarized Research Needs

Srn Id	Rsrch. Category	Srn	Score
All	EMF	All	All
SRN-26	EMF	Characterization of EMF Exposures for OSW	Under Exploration
SRN-27	EMF	Characterization of EMF Effects for Fisheries Species	Under Exploration
SRN-28	EMF	Population, Community and Ecosystem-level EMF Impacts to Fisheries	Under Exploration
SRN-29	EMF	Ecological Risk Assessment Approaches, Methods and Models	Not Addressed

This view displays the results of ROSA's Research Gaps Analysis.

- On the left, you'll find the full list of Summarized Research Needs (SRN) organized by research category. Filter the Score to NOT ADDRESSED to view research gaps. Note: Some SRNs marked as UNDER EXPLORATION may still have unmet needs, such as for specific receptors and locations.
- Below, you'll see all Explored Research Needs — needs that are currently being addressed by ongoing or completed projects. Match your SRN of interest on the left to the corresponding SRN on the below to see how specific needs are being explored and by which projects.

Explored Research Needs

Srn Id	Rsrch. Proj. Id	Receptor	Methodology	Location
All	All	All	All	All
SRN-1	Ex-60	Habitat	SPI/PV	New York/New Jersey Bight
SRN-1	Ex-61	Habitat	ROV/video/stills	New York/New Jersey Bight
SRN-1	Ex-102	Habitat	SPI/PV	Southern New England
SRN-1	Ex-118	Habitat	SPI/PV	Southern New England

The user is interested in learning more about which projects are exploring SRN-27:

Characterization of the EMF Effects for Fisheries Species. The user chooses SRN-27 from the SRN ID list on the right table to view the projects

FishFORWRD Database Welcome Page Research Projects & Needs **Research Gaps Analysis** Submit Project

Summarized Research Needs

Srn Id	Rsrch. Category	Srn	Score
All	EMF	All	All
SRN-26	EMF	Characterization of EMF Exposures for OSW	Under Exploration
SRN-27	EMF	Characterization of EMF Effects for Fisheries Species	Under Exploration
SRN-28	EMF	Population, Community and Ecosystem-level EMF Impacts to Fisheries	Under Exploration
SRN-29	EMF	Ecological Risk Assessment Approaches, Methods and Models	Not Addressed

This view displays the results of ROSA's Research Gaps Analysis.

- On the left, you'll find the full list of Summarized Research Needs (SRN) organized by research category. Filter the Score to NOT ADDRESSED to view research gaps. Note: Some SRNs marked as UNDER EXPLORATION may still have unmet needs, such as for specific receptors and locations.
- Below, you'll see all Explored Research Needs — needs that are currently being addressed by ongoing or completed projects. Match your SRN of interest on the left to the corresponding SRN on the below to see how specific needs are being explored and by which projects.

Explored Research Needs

Srn Id	Rsrch. Proj. Id	Receptor	Methodology	Location
SRN-27	All	All	All	All
SRN-27	Ex-11	HMS	Acoustic Telemetry	Atlantic Coast
SRN-27	Ex-106	Demersal/Groundfish/Squid	Bottom Trawl	Southern New England
SRN-27	Ex-107	Demersal/Groundfish/Squid	Acoustic Telemetry	Southern New England
SRN-27	Ex-120	Crustaceans	Trap/Pot	Southern New England
SRN-27	Ex-129	Crustaceans	Acoustic Telemetry	Southern New England
SRN-27	Ex-130	HMS	Acoustic Telemetry	Southern New England

The user finds that there are several projects addressing this SRN. Most projects are in Southern New England. Methodologies currently being used to characterize the effects of EMF on fisheries species include acoustic telemetry, bottom trawl, and trap/pot, suggesting many of these projects are field based. These projects are characterizing the effects of EMF on several different types of fish and invertebrate species including highly migratory species (HMS), demersal fish, and crustaceans. The user now understands that while there is some exploration of this research need, gaps may remain in receptors such as shellfish (e.g., sea scallops, surfclam)

The user wants to find more information about the project using acoustic telemetry to explore the characterization of EMF on crustaceans (Ex-129). The user navigates to the Research Projects & Needs tab and chooses the project Ex-129 from the project list.

The screenshot shows the FishFORWRD Database interface. The 'Research Projects & Needs' tab is selected. A 'Download as CSV' button is visible. The table below lists research projects. The 'Rsrch. Proj. Id' dropdown is set to 'Ex-129'. The table entry for 'Ex-129' is highlighted.

Rsrch. Proj. Id	Proj. Title	Rsrch. Category	Proj. Objectives	Developer Fisheries Monitoring Plan
Ex-129	Sunrise Wind Export Cable Acoustic Telemetry Studies - Lobster, Horseshoe Crab	EMF	Sunrise Wind will work with researchers at Stony Brook University, Cornell Cooperative Extension, and the Shark Research and Education Program at the South Fork Natural History Museum to conduct a multi-year acoustic telemetry study to assess the potential impacts of the SRWEC on the behavior and migratory patterns of commercially and ecologically important species in coastal waters south of Long Island. The specific objectives associated with this monitoring study are as follows: 1. Implant or attach acoustic transmitters on lobsters, horseshoe crabs, winter skates, smooth dogfish, sandbar sharks, dusky sharks, and sand tiger sharks. 2. Deploy an acoustic receiver array at the nearshore area of the SRWEC landfall that extend outside of the existing	Yes

*Note: During preparation of this report, the peer-reviewed Summarized Research Needs (SRNs) were further refined to improve clarity and consistency across research categories. As a result, SRN numbering presented in this report may differ slightly from the numbering currently displayed in FishFORWRD as of March 2026.

Appendix D. Summarized Research Needs (SRNs): Abbreviated and Full Descriptions

This appendix provides both the abbreviated and full descriptions of the Summarized Research Needs (SRNs) developed through the Research Gaps Analysis peer review. The abbreviated SRNs are used throughout this report and in the Research Gaps Analysis tab within FishFORWRD to improve readability in figures and tables, while the full SRN descriptions reflect the original language developed during the peer review process.

SRN ID	Summarized Research Need	Full Description
SRN-1	Cumulative Impact Assessment Framework/Guidance	CIA framework or guidance to enable consistency across approaches and identification of appropriate methodologies to respond to specific CI questions
SRN-2	Cumulative Impact Assessments	Cumulative Impacts Assessments
SRN-3	Policy Alignment Across Ocean Sectors Relative to Offshore Wind Fisheries Science Objectives	State of policy-delivery alignment across sectors (OW and other) relative to OW/fisheries/ecosystem objectives
SRN-4	Priority Data Needs and Impacts for Stock Assessment	Identify priority data requirements and assess cumulative offshore wind impacts on stock assessments
SRN-5	Risk and Mitigation for Councils/Commissions	Evaluation of risk and mitigation specifically focused on actions that Councils/Commissions might consider to address potential impacts of OSW development (e.g., increased scientific uncertainty, potential effects on species distribution, etc.)
SRN-6	Enhance Application of Fishery Dependent Data	Enhance the accessibility, quality, and fit-for-purpose application of fisheries-dependent data (FDD) to support offshore wind research and planning.
SRN-7	Centralized Database of Ongoing Research and Monitoring	Centralized database of ongoing research projects, including details of scope and timelines, to reduce

		redundancies and increase collaboration among researchers.
SRN-8	Enhance Data Governance	Promote regional consistency in governance of fishery independent OSW research and monitoring data and metadata, including standardization of data collection methods, processing, analysis, database management, and QA/QC. Support data security, data sharing and Findable, Accessible, Interoperable, and Reusable (FAIR) data principles across sectors.
SRN-9	Data Integration and Tool Building	Data Integration and tool building
SRN-10	Design and Evaluate Strategies for Regional Scale Monitoring	Design monitoring strategies and best practices that support long-term, regional-scale data collection across multiple uses and sectors, incorporating flexible approaches to meet regulatory and research needs.
SRN-11	Data Integration Across Methods to Model Species Distribution and Movement	Integrating data from multiple methods across scales to model baseline species' distribution and movement using oceanographic variables and other contextual information (e.g., quantifications of vessel traffic). The modeling framework should be applicable to individual projects and at regional scales such that consistent approaches are used across projects, and eventually in other regions
SRN-12	Regional Acoustic Receiver Array	Design a distributed region wide system of receiver arrays that serve as the backbone for projects throughout the region. This includes receivers offshore/along the shelf, which are limited in the current project landscape.
SRN-13	Use of Monitoring to Evaluate	resource monitoring to evaluate

	Effectiveness of Mitigation Strategies	effectiveness of mitigation strategies to inform future development
SRN-14	Use of Historical Datasets to Generate Baselines	Identify and use historical data collections from multiple sources (e.g., data affiliated with offshore wind projects, coastal and estuarine data collection efforts, and NOAA Fisheries long-term surveys) to generate a baseline.
SRN-15	Changes to Biological Indicators of Incidence, Local Abundance and Distribution, Habitat Suitability, and Community Structure	During phases of OWF development, what are changes to biological indicators of incidence, local abundance and distribution, habitat suitability and community structure?
SRN-16	Changes to Growth, Feeding, Reproduction, Recruitment, and Mortality	During phases of OWF development, how are local populations impacted through changes in growth, feeding, reproduction, recruitment, and mortality?
SRN-17	Effects of Offshore Wind Development Phases on Spatial Behavior	What are the effects on phases of OWF development on spatial behaviors?
SRN-18	Gradient of Change at Turbine/Farm Scale	What is/will be the gradient of change as you move away from individual turbines and/or wind farm areas with particular emphasis on succession-driven change? What is the effect type and size and distance of detectable habitat changes?
SRN-19	Artificial Reef Effect on Fish	Study relative abundance and spatial distribution of species attracted to turbines to examine aggregation/artificial reef effects and scour impacts.
SRN-20	Decommissioning Effects	Evaluate the effect of decommissioning (removal of offshore wind turbines and associated structures) on marine species
SRN-21	Thermal Effects of Offshore Wind Infrastructure	Evaluate OSW cable and substation thermal regimes, taking into account

		natural variability of local sediment types and water velocities.
SRN-22	Local and Regional Changes to Ocean Hydrodynamics	Changes to local and regional oceanographic conditions
SRN-23	Larval Transport and Recruitment Effects	Investigate how offshore wind structures alter local and regional hydrodynamics—such as currents, stratification, and turbulence—and assess the resulting impacts to commercially and recreationally important species on larval transport and recruitment
SRN-24	Effects on Spawning Timing, Location, and Habitat Use	For offshore wind farms that overlap with spawning grounds, assess how offshore wind development affects the timing, location, and habitat use of fish spawning—particularly for species using benthic or hard-substrate habitats.
SRN-25	Colonization of Non-Native and Invasive Species	Investigate how offshore wind structures influence the colonization and spread of non-native and potentially invasive species and assess the ecological impacts on native species
SRN-26	Changes in Trophic Interactions	Changes in trophic interactions around OSW
SRN-27	Changes to Light Conditions	Understand and quantify changing light conditions due to the suspension of sediment and possible changes in primary production within OSW areas.
SRN-28	Effect of Artificial Substrate on Benthic and Epibenthic Community	Evaluate the net ecological effects of offshore wind structures introducing artificial hard substrate on benthic and epibenthic communities.
SRN-29	Turbine Spacing and Connectivity of Fish Communities	Examine how the spacing of turbine foundations and surrounding habitat types influence the ecological connectivity of fish communities within

		and between offshore wind farms
SRN-30	Nature-Inclusive Design	Evaluate how nature-based design can be used to enhance habitat value, biodiversity, and ecosystem services.
SRN-31	Baseline Benthic and Water Column Habitat	Evaluate baseline benthic habitat, vulnerable resources, and water column habitat in various areas; compare to post-construction.
SRN-32	Cable Installation Impacts	Cable installation impacts to natural/native benthic habitat
SRN-33	Cable Protection Impacts	Cable protection impacts on benthic habitat - epifauna and fish-use
SRN-34	Change in Water and Sediment Quality	Water and Sediment Quality
SRN-35	Effects of Boulder Relocation on Habitat	Evaluating the Effect of Displaced Boulders on Habitat from Offshore Wind Cable Installation and Lease Site Preparation
SRN-36	Characterization of EMF Exposures for OSW	Characterization of EMF Exposures for OSW
SRN-37	Characterization of EMF Effects for Fisheries Species	Characterization of EMF Effects for Fisheries Species
SRN-38	Population, Community and Ecosystem-level EMF Impacts to Fisheries	Population, Community and Ecosystem-level EMF Impacts to Fisheries
SRN-39	Ecological Risk Assessment Approaches, Methods and Models	Ecological Risk Assessment Approaches, Methods and Models Used to Assess Impacts from OSW EMF
SRN-40	Characterization of Sound Pressure, Motion and Seabed Vibration	Characterization of sound pressure, particle motion and seabed vibration across all stages of offshore wind
SRN-41	Effects of Offshore Wind Sound on Behavior and Physiology of Fish and Shellfish	Experiments that investigate the effects of OSW sounds on the behavior, physiology, and anatomy of marine animals.

SRN-42	Alteration of Natural Soundscape	Quantify how OSW sounds alter the natural soundscape and background noise levels
SRN-43	Strategies for Mitigation from Sound and Vibration Impacts	Strategies for avoidance, minimization, mitigation and monitoring of impacts associated with sound pressure, particle motion and seabed vibration
SRN-44	Population, Community and Ecosystem-level Impacts from Sound Pressure, Particle Motion and Seabed Vibration	Population, community and ecosystem-level impacts to fisheries from sound pressure, particle motion and seabed vibration
SRN-45	Strategies, Resources, and Mechanisms for Building Capacity Across Sectors	Strategies, resources, and mechanisms for building capacity across sectors to improve engagement of fishing communities in OWD
SRN-46	Qualitative Analysis Informing Effective Fishery Stakeholder Engagement	Qualitative analysis to inform strategies for effective fishery stakeholder engagement
SRN-47	Local Ecological Knowledge Methodology Development and Integration	LEK methodology development and case studies of integration of LEK into offshore wind development processes.
SRN-48	Social Networking and Knowledge Sharing	Conduct studies on social networking and knowledge sharing with the development of OSW
SRN-49	Spatial and Temporal Change in Commercial and Recreational Fishing Behavior	Spatial and Temporal Change in Fishing Behavior
SRN-50	Spatial Operation Needs Within and Around Wind Farms	Spatial operation needs for fishing operating around turbines and within wind arrays for commercial fisheries (all gear types), including empirical studies and codesign projects
SRN-51	Gear Modification, Fisheries Enhancement, and Other Fisheries Development to Allow Co-Use	Gear modification, conservation engineering, and fisheries development to allow to co-existence or mitigation from the effects of offshore wind

SRN-52	Fishing Interaction with Cable Protection Measures	Evaluating impact of bottom tending gear (trawl, dredge, etc) over interarray and export cable protection measures (e.g., traditional burial, mattresses, rocks/boulders, and other)
SRN-53	Impacts of Boulder Relocation on Fishing	Assessing the Impact of Boulder Size, Weight and Placement on Commercial Fishing Activities
SRN-54	Navigation and Safety	Navigation and safety
SRN-55	Secondary and Tertiary Effects to Supply Chains and Supporting Businesses	What are the secondary and tertiary effects to the supply chain and what are the potential and realized economic impacts? Secondary: support businesses and shoreside fishing business revenue, sales, employment (processors, bait and tackle, markets, vertically integrated businesses), gear makers, welders, electronics, mechanics. Tertiary: retail markets, restaurant, supporting community businesses
SRN-56	Marine Spatial Planning and Use Tradeoffs	Marine spatial planning / analysis of tradeoffs regarding use of ocean space for different economic activities
SRN-57	Approaches to, Data Inputs for, and Assessment of Compensatory Mitigation Programs	Which impacts should be included in compensatory mitigation programs (e.g., vessels, crew, shoreside)? What data are available and what methods should be used when evaluating revenue impacts, costs, and losses for compensatory mitigation programs? How should cumulative impacts be considered in compensatory mitigation programs? How should impacts be monitored and compensation estimates re-evaluated to ensure that estimates are accurate and effective?

SRN-58	Costs and Benefits Associated with Recreational Fishing	Investigate the impacts of offshore wind on individual recreational fishermen and fishing business occupational structure, labor markets, and workforce sustainability within fishing communities.
SRN-59	Impacts on Commercial Fishermen's Occupational Structure, Labor Markets, and Workforce	Investigate the impacts of offshore wind on individual commercial fishermen and fishing business occupational structure, labor markets, and workforce sustainability within fishing communities.
SRN-60	Methods for Evaluating Socioeconomic/Sociocultural Impact	Develop and refine methods for evaluating direct, indirect, and cumulative socioeconomic and sociocultural impacts of offshore wind development on commercial and recreational fisheries
SRN-61	Impacts on Seafood Value, Marketability, and Quality	Overlap and impacts of OWD on seafood value, marketability, and quality, and resulting implications for local food systems
SRN-62	Changes to Vessel Insurance Costs and Availability	Summarize and evaluate changes to vessel insurance policies, costs, availability related to offshore wind
SRN-63	Offshore Wind Interaction with Fisheries Infrastructure in Ports	How will offshore wind interact with fisheries infrastructure in ports? Can fisheries benefit from wind industry-funded updates to aging infrastructure? Will wind exacerbate existing gentrification pressure? How will wind affect existing port conflicts between recreational and commercial fishing (i.e., an increase in recreational fishing around turbines increases recreational industry/tourism/ infrastructure)?
SRN-64	Effects on Cultural Identity, Individual Well-Being, Place Attachment, and the	Assess the impacts of offshore wind development on cultural identity,

	Social Fabric of Fishing Communities.	individual well-being, place attachment, and the social fabric of fishing communities.
SRN-65	Fishing Community Environmental Justice Concerns	What are the environmental justice concerns in fishing communities (place based and communities of practice)? Are underserved communities displaced due to OWD? Are disadvantaged communities provided with the resources and empowered to participate in the process? How do underserved communities receive information? What resources are/can be made available to these communities? What are the best practices of procedural and distributive justice?
SRN-66	Alternate and Advanced Technologies and Survey Techniques	Can alternate methods and advanced technologies augment or replace existing survey activity while maintaining time series, precision, and accuracy? Includes exploring whether or not given methods can be operationalized.
SRN-67	Impacts on Fisheries-Independent Surveys	Evaluate the impacts of offshore wind energy development on fisheries-independent surveys (e.g., implications for data collection efforts, survey design, and uncertainty)
SRN-68	Development of Interim Provisional Survey Indices	Develop interim provisional survey indices: Develop interim indices from existing data sets to partially bridge the gap in data quality and availability between pre-construction and operational periods while new approaches are being identified, tested, or calibrated.
SRN-69	Project-Level Monitoring Data to Fill Regional Scientific Survey Data Needs	Wind energy monitoring to fill regional scientific survey data needs: Apply new statistical designs and carryout sampling

		methods to effectively mitigate survey impacts due to offshore wind activities for the 30+ year operational life span of offshore wind energy projects.
SRN-70	New Fishery Observer Protocols to Address Questions	Add observer coverage/new protocols to commercial fisheries to address specific wind farm-related questions.