Empire Wind 2024 Acoustic Telemetry Study

Annual Report

Prepared for:

Empire Offshore Wind LLC
Stamford Office - 600 Washington Blvd. - Suite 800
Stamford, CT 06901

Prepared by:

Monmouth University
West Long Branch, New Jersey

and

INSPIRE Environmental
513 Broadway
Newport, RI 02840

June 2025

REVISION HISTORY

Date	Revision	Note	Prepared	Reviewed	Approved
04/23/2025	0	Draft report for client review.	DW	CC/BG	BG
06/10/2025	1	Revision submittal.	DW	CC/BG	BG

PROJECT DISTRIBUTION LIST

Name	Project Role	Email	Company
Michelle Fogarty	Environmental Surveys Manager and Company Representative to Contract		Equinor
Ashanti Storr	Marine Operations Project Engineer		Equinor
Elizabeth Kordowski	Fisheries Liaison Officer		Equinor
Brian Gervelis	Program and Contract Manager		INSPIRE
Keith Dunton	Associate Professor/Acoustic Telemetry Lead		Monmouth University

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND TERMS

BOEM	Bureau of Ocean Energy Management
BRUV	baited remote underwater video
cm	centimeter(s)
eDNA	environmental DNA (deoxyribose nucleic acid)
Empire Wind	Empire Offshore Wind LLC
EW 1	Empire Wind 1
EW 2	Empire Wind 2
F/V	fishing vessel
FBMP	Fisheries and Benthic Monitoring Plan
ft	feet
GPS	Global Positioning System
HMS	highly migratory species
INSPIRE	INSPIRE Environmental, Inc.
km	kilometer(s)
m	meter(s)
mg/L	milligrams per liter
mi	mile(s)
nm	nautical mile(s)
MATOS	Mid-Atlantic Telemetry Observing System
NYSERDA	New York State Energy Research and Development Authority
NJDEP	New Jersey Department of Environmental Protection
OWF	offshore wind farm
ROSA	Responsible Offshore Science Alliance
R/V	research vessel
SD	standard deviation
STCW	Standards of Training, Certification and Watchkeeping

1.0 INTRODUCTION

Empire Offshore Wind LLC (Empire Wind) proposes to construct and operate an offshore wind farm located in the designated Renewable Energy Lease Area OCS-A 0512 (Empire Wind Lease Area). The Empire Wind Lease Area covers approximately 79,350 acres (32,112 hectares) and is located approximately 14 statute miles (mi) (12 nautical miles [nm], 22 kilometers [km]) south of Long Island, New York and 20 mi (17 nm, 32 km) east of Long Branch, New Jersey (Figure 1-1). The Empire Wind Lease Area will be developed as two wind farms, known as Empire Wind 1 (EW 1) and Empire Wind 2 (EW 2). Monitoring efforts are combined for the proposed wind farms, covering the entire Empire Wind Lease Area and along both proposed export cable routes as described in the Empire Wind Fisheries and Benthic Monitoring Plan (FBMP) (INSPIRE 2023). This report pertains to the acoustic telemetry efforts conducted across the entire Empire Wind Lease Area and along both proposed export cable routes (Project Area).

The New York Bight supports diverse fish and invertebrate assemblages (Guida et al. 2017; Thorne et al. 2020; NJDEP 2022). Fisheries monitoring was designed to assess potential impacts of construction and operation activities within the Lease Area on these biological communities. A monitoring plan was developed in accordance with recommendations made by the Bureau of Ocean Energy Management's (BOEM) Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf (BOEM 2023), New York State Energy Research and Development Authority's (NYSERDA) New York State Offshore Wind Master Plan: Fish and Fisheries Study (NYSERDA 2017), and the Responsible Offshore Science Alliance's (ROSA's) Offshore Wind Project Monitoring Framework and Guidelines (ROSA 2021). The FBMP was created using an iterative process with the Empire Wind team coordinating with regional fishing organizations, working groups, and individual fishermen. In addition, through the permitting and development process the Empire Wind team consulted with state and federal fisheries resource management agencies and solicited feedback directly from stakeholders. The FBMP outlines several survey types designed to monitor potential Empire Wind impacts on fish and invertebrates while, when practicable, limiting the impacts of the monitoring itself. Fisheries surveys outlined in the FBMP for Empire Wind monitoring include the use of a bottom trawl, baited remote underwater video (BRUV), environmental DNA (eDNA), scallop plan view camera surveys, and acoustic telemetry (INSPIRE 2023).

A summary of the first and second year of the acoustic telemetry monitoring effort in the Project Area is provided in this report. This study is designed to document habitat use, movement, residency patterns, and relative abundance of several federally protected, prohibited, and commercially and recreationally important species in the Project Area. Acoustic telemetry is an effective method of studying the spatial movements of fish in the marine environment (Keller et al. 2017; Hogan et al. 2023) and has been used to document coastal migratory activity (e.g., Kneebone et al. 2014; Haulsee et al. 2018) and seasonal migrations through wind energy areas (Ingram et al. 2019; Rothermel et al. 2020; Secor et al. 2020; Gervelis and Kneebone 2022). Acoustic telemetry surveys are also useful for examining fish responses to disturbances such as noise (McQueen et al. 2023) and have been used to assess the potential impacts of several European offshore wind farms (OWFs). These European studies include examinations of the movement and distribution of Atlantic cod (Reubens et al. 2013), flatfish (Buyse et al. 2023), and European lobster (Thatcher et al. 2023) relative to OWF construction and/or operation. These studies have found various spatial and temporal habitat uses within the OWF and their associated structure (e.g. rubble piles around monopiles). Similar to artificial reefs, OWFs alter the environment through the introduction of structure, but OWFs also introduce additional changes (e.g., electromagnetic fields, noise, vibrations, etc.), which could potentially affect biological resources. Therefore, acoustic telemetry studies at OWFs provide essential information about fish habitat use that cannot reliably be inferred from other studies in other systems.

The Empire Wind Lease Area is located within the migratory routes of several species of concern. For example, Frisk et al. (2019) used acoustic telemetry to monitor habitat use of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), black sea bass (*Centropristis striata*), striped bass (*Morone saxatilis*), summer flounder (*Paralichthys dentatus*), winter flounder (*Pseudopleuronectes americanus*), and several species of elasmobranchs in the Lease Area. The current acoustic telemetry monitoring study will add baseline information to the pre-construction findings of Frisk et al. (2019) and will continue during construction and post-construction time periods to better understand movements and utilization of the Project Area by these species.

1.1 Overview

Acoustic hydrophones, or receivers, passively record the presence and relative abundance of animals tagged with acoustic transmitters. Detection data are used to calculate periods of presence and absence, residency (time spent in regions), and movement rates of animals within monitored regions. The focal fish species tagged in this study include those of ecological, commercial and recreational significance. These include, but are not limited to, the federally endangered Atlantic sturgeon, federally prohibited coastal sharks (e.g., dusky shark [*Carcharhinus obscurus*], sand tiger [*Carcharias taurus*], and sandbar shark [*Carcharhinus plumbeus*]), and other elasmobranchs (e.g., winter skate [*Leucoraja ocellata*], smooth dogfish [*Mustelus canis*], and spiny dogfish [*Squalus acanthias*]). Additionally, commercially and recreational valuable finfish species – such as winter flounder, summer flounder, black sea bass, striped bass, and tautog (*Tautoga onitis*), will be tagged, along with highly migratory species (HMS) including bluefin tuna (*Thunnus thynnus*) and the shortfin mako shark (*Isurus* *oxyrinchus*). Acoustic tags, or transmitters, have an operating life of two to ten years (depending on transmitter size appropriate for each species) and can provide successful long-term data collection for decision-making activities. This acoustic telemetry study complements an existing regional infrastructure of acoustic telemetry arrays that are currently deployed by state, federal, and academic institutions and include detection coverage in and around the Project Area. Monmouth University is collaborating with INSPIRE Environmental Inc. (INSPIRE) to deploy acoustic receivers as well as tag and monitor a variety of focal fish species identified for the Empire Wind acoustic telemetry study.

This report documents the first (2023) and second (2024) years of pre-construction acoustic telemetry monitoring in the Project Area to satisfy the following goals of providing:

- Site-specific information about commercially and recreationally important fish species baseline movements, usage, and residency patterns.
- Baseline data to be used to examine potential spatial and/or temporal shifts in fish movements and usage patterns that may be associated with offshore wind construction or operation activities.

The acoustic telemetry study detailed in the FBMP includes two years of monitoring prior to offshore construction, two years sampling during construction, and two years of post-construction monitoring in accordance with the guidance of NYSERDA (NYSERDA 2017) and ROSA (ROSA 2021). In addition, the use of acoustic telemetry to census a select number of marine fishes aligns with existing guidelines and best practices for offshore wind fisheries monitoring from BOEM and ROSA (BOEM 2023; ROSA 2021). This method meets ROSA's objectives by providing a reliable index of changes in community composition while having a minimal impact on fisheries, as it is a no-take method.

2.0 METHODS

All Monmouth University staff and students are trained and certified to conduct research on fish through the Monmouth University Institutional Animal Care and Use Committee (1903). Additionally, all staff associated with the project completed relevant coursework on safety and survival training, either through the Standards of Training, Certification and Watchkeeping (STCW) basic training or equivalent courses while working offshore.

2.1 Tagging

Fish were targeted using a variety of fishing methods including rod and reel, bottom trawl, gillnet, and longline. After capture and prior to internal implantation of acoustic transmitters, fish were placed in a large live well of circulating ambient water and anesthetized with a non-lethal dose (~70 milligrams/liter [mg/L]) of tricaine methane sulfonate (MS-222). Following sedation, fish were immobilized by being placed upside down in a padded surgery cradle (Figure 2-1). A small area was swabbed with the antiseptic betadine and a lateral incision approximately one to two centimeters (cm) in length was made on the specimen's midline that was anterior to the pelvic fin. An Innovasea acoustic transmitter (Model V9 or V16; Boston, MA) was then inserted into the body cavity and the incisions were closed with a minimum of two interrupted sutures. Post surgery, the incision area was treated again with betadine. For Atlantic sturgeon, a betadine/petroleum ointment was also used on the sutures and site of the incision to aid in the recovery of the animals and to deter bacterial infection. The total length and fork length of all fish were measured to the nearest half centimeter. Fish were also externally tagged with conventional tags, either a T-bar, stainless, or dart tag, to facilitate identification if fish were opportunistically recaptured after release. Fish were monitored in the live well to ensure survivability before being released overboard.

2.2 Acoustic Telemetry Receivers

Innovasea acoustic release receivers (Model VR2AR) were rigged with a recoverable acoustic release mooring system from Mooring Systems Inc. This system included two flotation buoys attached to a canister containing 200 feet (ft; 61 meters [m]) of Dyneema rope, secured with 6-ft (1.8-m) tethers, and anchored to the seabed using a 100-pound (lb; 45-kilogram [kg]) pyramid anchor (Figure 2-2).

Briefly, the VR2AR receiver has a built-in transmitter that enables remote communications from the surface with deployed receivers using the Innovasea VR100 mobile tracking receiver equipped with an omni-directional hydrophone. This setup allows the receiver to be retrieved remotely via an integrated acoustic release, typically within one minute, which eliminates the need for large concrete blocks that were typically used in studies previously conducted, which could have impacted commercial fishing in the region. Retrieval of VR2AR receivers is performed aboard the vessel with communication from a VR100 and a hydrophone that triggers the release mechanism and allows the unit to float to the surface to be recovered. The VR100 receiver not only detects receivers that are within range of the hydrophone but also estimates the distance between the VR2AR and VR100 to provide a successful recovery. The receiver's internal transponder allows for remote monitoring of tilt, temperature, battery level, available storage space, and noise levels, reducing the number of times the receiver needs to be hauled to the surface for operational checks and redeployed with new Global Positioning System (GPS) coordinates. Once the receiver is signaled to release, it floats to the surface and is retrieved. An onboard pot hauler is used to recover the moorings.

In the event that an acoustic receiver is not detected at the site of deployment, the VR100 is used to attempt to locate the missing VR2AR. The VR100 detects the receivers that are within range of the VR100 and estimates the distances to the unit so if a unit is not communicating with the VR100, a systematic search within a 1-km radius of the epicenter of deployment is conducted to locate the receiver. Once the VR100 is within range, the VR2AR can be released from the mooring. However, if an acoustic receiver cannot be detected with the VR100 after extensive search efforts, no alternative methods are available for locating the receiver. Therefore, to maximize opportunistic recovery of these receivers, each receiver station is marked with information ("If found, please keep and contact…"). Given the FBMP's five-year duration, planned service visits to the last known location may allow for opportunistic recovery by Equinor or third parties, with recovered units being returned to Monmouth University. If a receiver remains missing, search efforts will continue during routine servicing of the acoustic receiver stations. The acoustic release battery is expected to last five to six years, while acoustic telemetry receiver batteries typically last up to two years. As a result, there remains potential for future recovery. Search efforts will continue until the release battery is no longer functional or the unit is found.

While capable of being deployed for up to 16 months (one battery cycle), the acoustic array for the current study was planned to be recovered, downloaded, and maintained on a biannual basis (i.e., late spring and late fall) to ensure successful data retrieval and collection after expected peak fish migrations through the region.

3.0 RESULTS

3.1 Tagging

Overall, 366 individuals across 14 fish species were captured using a variety of methods including rod and reel, bottom trawl, and gillnet methods and surgically implanted with acoustic transmitters. Tagged fish species included Atlantic cod (*Gadus morhua*), Atlantic sturgeon, black sea bass, dusky shark, grey triggerfish (*Balistes capriscus*), sand tiger shark, sandbar shark, smooth dogfish, spiny dogfish, striped bass, summer flounder, tautog, winter flounder, and winter skate (Table 3-1).

3.2 Acoustic Telemetry Receiver Deployment

A total of 47 VR2AR receivers were deployed within the Project Area during 2023 (Figure 1-1; Table 3-2). In brief, 23 receivers were deployed in a triangular-shaped grid pattern, widening in an eastward direction, and spaced at approximately 2.5 mi (4 km) intervals within the Lease Area. Receivers were also positioned along the EW 1 (n=10) and EW 2 (n=4) proposed cable routes at approximately 5 mi (8 km) intervals. An array of receivers (n=10) bracketed the eastern and western portions of the EW 2 proposed cable landing site within New York state waters.

Receivers in the Lease Area and along the proposed EW 1 export cable route were initially deployed on 25-27 October 2023 and receivers along the proposed EW 2 export cable route and the onshore landing area were initially deployed on 13 December 2023 from Monmouth University's research vessel (R/V) *Heidi Lynn Sculthorpe*. Receivers in the Lease Area and along EW 1 export cable route were serviced in the spring/summer 2024 and fall/winter of 2024/2025. Receivers initially deployed along the proposed EW 2 export cable route (n=4) and the onshore landing area (n=10) within New York state waters were removed during the summer of 2024 and maintained in dry storage per Equinor's request.

3.3 Acoustic Telemetry Detection Data

A total of 2,114,295 detections from 2,137 unique transmitters were recorded and downloaded from the deployed acoustic receivers deployed within the Project Area (Table 3-3). At the time of the initial analysis with immediate collaborating partners, only 3% of recorded detections were successfully identified and connected to ongoing acoustic monitoring efforts in the region. Specifically, 62,514 detections from 961 unique transmitters were linked to 27 different fish species and 22 organizations and agencies. The top identified species include Atlantic sturgeon (n=337), striped bass (n=200), sandbar shark (n=93), dusky shark (n=83), smooth dogfish (n=54), and sand tiger shark (n=46) (Table 3-4). The acoustic receiver stations along the EW 1 and EW 2 proposed export cable routes recorded the highest number of detections (Figure 3-1). Preliminary data analyses identified species detections over time showed strong seasonal distributions (Figure 3-2).

With recent data sharing agreements, all acoustic detection data from the current study will be shared with the Mid-Atlantic Telemetry Observing System (MATOS; Project Code – MUEMPIRE, https://matos.asascience.com/project/detail/307) network to identify unknown transmitter codes as well as acquire detection data of fish tagged in the current study that were observed beyond the deployed array. Although acoustic detection data from the current study were uploaded to MATOS on 17 March 2025, the incorporation of additional tag detections from other regional acoustic arrays into current data analyses will be delayed until MATOS completes their dissemination efforts.

3.4 Challenges Encountered

3.4.1 Equipment Delays

Challenges in the initial purchase and receipt of acoustic telemetry equipment resulted in unanticipated delays in 2023. In particular, the manufacturer of the recoverable acoustic release mooring systems had major delays in supply chain shortages of key components (anchors and Dyneema rope) as well as COVID-19 related staffing issues in their manufacturing facility. All equipment was received in November 2023 and after the receipt of necessary equipment, deployments were mobilized in under a week.

3.4.2 Receiver Issues

Issues with the deployment and recovery of VR2AR receivers occurred during 2023 and 2024 receiver monitoring efforts. For instance, although the receiver at station "Empire Wind Array 03" was deployed initially on 25 October 2023, it released prematurely on the initial deployment date and was found roughly 900 m away from the planned deployment location. Equinor was notified of the premature deployment and requested that this receiver be moved as it potentially interrupted other operations in the Project Area. A Monmouth University small craft vessel was mobilized on 6 November 2023 and the receiver was redeployed to the agreed-upon latitude and longitude.

Several protocols are already in place to prevent complete loss of acoustic receivers. For instance, receivers were affixed with a 25 lb (11 kg) anchor, which was greater than the manufacturer's recommendations, to prevent the movement of moorings during intense oceanographic conditions. In the event an acoustic was lost, custom lobster trap tags (www.Floytag.com) and labels permanently affixed to all pieces of equipment that reads "If Found Please Keep and Contact Keith Dunton Monmouth University kdunton@monmouth.edu 732 752-4432." This direct contact information allows the recovery of equipment when found, should it have broken free from its mooring or had physical interaction (e.g. dredge, trawl) by a commercial fisherman. This protocol has already been successful and led to the recovery of two other receivers by third parties. For lost or missing receivers that are not detectable through communication with the acoustic release receiver, Monmouth University continues to expand out searches for those receivers as they likely have been dragged from their original location by anthropogenic activities. Monmouth University also shares information with various stakeholder groups to support receiver searches. Missing receiver locations are disseminated to captains and other ocean users through Local Notice to Mariners. Receiver serial numbers are provided to Stony Brook University, a project partner doing similar research in the area. This information allows Stony Brook University personnel to identify and share the location of project equipment if found through communication with the acoustic release.

However, the recovery of some receivers was impeded by various factors. Biofouling, for instance, is a recurring problem on deployed receivers where the rapid growth of mussels and/or barnacles can inhibit an immediate release response from the acoustic telemetry mooring system by restricting the receiver from releasing by effectively biological adhering the units together (e.g. byssal threads from mussels and barnacles overgrowing seams of equipment) (Figure 3-3). Wave action has aided in the release of units that are stuck due to biofouling by jostling the receivers free. However, because this process can take hours to occur, project personnel would notify other vessels working for Empire Wind and collaborators to keep watch for said receiver, and we return to the station's position as soon as possible to continue searching. Limited battery life from previous expected deployments, coupled with colder water temperatures (causing low voltage), were also observed to inhibit immediate responses from receivers or prevent receiver recovery via inability to communicate/trigger the acoustic release mechanism. Seven receivers were lost at the end of 2024 due to limited battery life, but the project team will continue to search for them and resolve this issue by servicing equipment more frequently.

In instances where receivers could not be communicated with at the site of deployment, project personnel followed a systematic approach to maximize retrieval. First, vessel would navigate around the site of deployment to visually confirm its position on the seafloor using the vessel's sonar-based fish finder. If a receiver was visually confirmed on the fish finder and not communicating, a grappling hook was deployed overboard to recover the non-communicating receivers. If receivers were not visually confirmed on the fish finder and not communicating, systematic searches using the VR100-300 (and fish finder) were conducted in 1 km increments North, East, South, and West in attempt to locate the receiver in the event it was moved by an anthropogenic source. If equipment was not found, project personnel continually searched for the units with all work conducted within this region. For receivers officially identified as unrecoverable, marine debris reports are filed for the various components of equipment lost.

3.4.3 Gear Interactions

On 12 December 2023, it was reported that a commercial fishing vessel (dredged up a single receiver (Station Empire Wind Array 15). The receiver was returned to the Point Pleasant Packing Plant where Monmouth University staff met with the vessel captain to recover the receiver and discuss project activities on 11 December 2023. A similar receiver interaction occurred on 6 June 2024 with a commercial trawling vessel. The receiver was returned to the Belford Seafood Co-Op Fish Market, Belford N.J. where Monmouth University staff met with the vessel captain and staff of the co-op to recover the receiver and discuss project activities and offshore wind fisheries monitoring strategies. Another receiver (Station EW 2 Export Landing East 2) washed ashore after a record-breaking storm that produced waves over 20 ft (6.1 m) in height. The receiver and anchor were recovered on 7 January 2024 by Long Beach Island Facilities maintenance workers during routine beach patrols.

3.4.4 Weather Delays

Continuous and intense storms occurred during 2023 and 2024, which interfered with the deployment and maintenance schedule of acoustic receivers during critical fall/winter download intervals. Large swells prevented the deployment of receivers at locations furthest from shore.

3.4.5 Administrative Delays

Monmouth University had challenges with receiver deployment and recovery efforts when long-term captain retired in March 2024. Monmouth University immediately hired a new captain who then resigned from the post at the end of the summer of 2024. Challenges in the immediate hiring of a vessel captain persisted at the start of the academic semester, which delayed previously scheduled fall 2024 acoustic receiver maintenance and fish tagging/sampling efforts with the approved Monmouth University vessels. Monmouth University's current captain started in early December 2024 at which time receiver downloading continued.

Table 3-1. Number and Mean Total Length (Nearest Half Centimeter) of Fish Species Captured and Surgically Implanted with Acoustic Transmitters in 2023-2024. Standard Deviation (SD) is Provided with all Total Length Estimates.

Common Name	Scientific Name	Transmitters Deployed (#)	Mean Total Length (cm) ± SD
Atlantic cod	*Gadus morhua*	1	43.0 ± 0.0
Atlantic sturgeon	*Acipenser oxyrinchus*	49	130.0 ± 22.0
Black sea bass	*Centropristis striata*	36	31.0 ± 6.5
Dusky shark	*Carcharhinus obscurus*	1	149.0 ± 0.0
Grey triggerfish	*Balistes capriscus*	6	37.5 ± 6.5
Sand tiger shark	*Carcharias taurus*	11	198.0 ± 78.0
Sandbar shark	*Carcharhinus plumbeus*	28	177.0 ± 18.5
Smooth dogfish	*Mustelus canis*	23	71.0 ± 19.5
Spiny dogfish	*Squalus acanthias*	2	76.0 ± 1.5
Striped bass	*Morone saxatilis*	82	83.0 ± 20.0
Summer flounder	*Paralichthys dentatus*	67	39.5 ± 6.0
Tautog	*Tautoga onitis*	57	28.0 ± 6.0
Winter flounder	*Pseudopleuronectes americanus*	2	27.5 ± 1.0
Winter skate	*Leucoraja ocellata*	1	58.5 ± 0.0
	Total	**366**	

Table 3-2. Initial Deployment of Acoustic Receivers in 2023 within the Empire Wind Lease Area and Proposed Export Cable Routes

Station	Abbreviation	Deployed Date and Time	Latitude (DD)	Longitude (DD)	Bottom Depth (m)	Receiver Depth (m)
Empire Wind Array 03	EWA 03	2023-11-06 16:27:00	40.3677	-73.5548	23.0	21.2
Empire Wind Array 04	EWA 04	2023-10-25 09:47:00	40.3576	-73.5173	26.5	24.7
Empire Wind Array 05	EWA 05	2023-10-25 10:14:00	40.3464	-73.4783		
Empire Wind Array 06	EWA 06	2023-10-25 10:35:00	40.3333	-73.4365	29.6	27.7
Empire Wind Array 07	EWA 07	2023-10-25 10:54:00	40.3172	-73.4176	29.9	28.0
Empire Wind Array 08	EWA 08	2023-10-25 11:12:00	40.3336	-73.3805		
Empire Wind Array 09	EWA 09	2023-10-25 13:32:00	40.2989	-73.3835	34.4	32.6
Empire Wind Array 10	EWA 10	2023-10-25 13:13:00	40.3060	-73.3538	32.9	31.1
Empire Wind Array 11	EWA 11	2023-10-25 12:35:00	40.3224	-73.3207	30.2	28.3
Empire Wind Array 12	EWA 12	2023-10-25 12:59:00	40.2798	-73.3452		
Empire Wind Array 13	EWA 13	2023-10-25 13:25:00	40.2965	-73.3069	33.2	31.4
Empire Wind Array 14	EWA 14	2023-10-25 13:39:00	40.3128	-73.2717	37.5	35.7
Empire Wind Array 15	EWA 15	2023-10-26 11:03:00	40.2615	-73.3007	37.2	35.4
Empire Wind Array 16	EWA 16	2023-10-25 14:16:00	40.2857	-73.2594	35.1	33.2
Empire Wind Array 17	EWA 17	2023-10-25 13:58:00	40.3032	-73.2235	36.9	35.1
Empire Wind Array 18	EWA 18	2023-10-26 11:17:00	40.2398	-73.2690	36.6	34.7
Empire Wind Array 19	EWA 19	2023-10-26 11:33:00	40.2584	-73.2302	37.5	35.7
Empire Wind Array 20	EWA 20	2023-10-26 11:46:00	40.2751	-73.1972	37.5	35.7
Empire Wind Array 21	EWA 21	2023-10-26 12:00:00	40.2912	-73.1616	38.7	36.9
Empire Wind Array 22	EWA 22	2023-10-26 13:08:00	40.2217	-73.2227	24.4	22.6
Empire Wind Array 23	EWA 23	2023-10-26 12:53:00	40.2401	-73.1896	38.7	36.9
Empire Wind Array 24	EWA 24	2023-10-26 12:35:00	40.2648	-73.1494	39.0	37.2
Empire Wind Array 25	EWA 25	2023-10-26 12:17:00	40.2854	-73.1116	38.7	36.9
EW1 Export Cable Route 1	EW1 ECR 1	2023-10-27 10:58:00	40.6582	-74.0219		
EW1 Export Cable Route 2	EW1 ECR 2	2023-10-27 10:37:00	40.6314	-74.0428	11.6	9.8
EW1 Export Cable Route 3	EW1 ECR 3	2023-10-27 09:43:00	40.5885	-74.0146	10.4	8.5
EW1 Export Cable Route 4	EW1 ECR 4	2023-10-27 09:10:00	40.5506	-74.0224	7.9	6.1
EW1 Export Cable Route 5	EW1 ECR 5	2023-10-27 08:39:00	40.5207	-73.9813	11.0	9.1
EW1 Export Cable Route 6	EW1 ECR 6	2023-10-26 17:17:00	40.4921	-73.9033	6.4	4.6
EW1 Export Cable Route 7	EW1 ECR 7	2023-10-26 16:48:00	40.4807	-73.8039	13.7	11.9
EW1 Export Cable Route 8	EW1 ECR 8	2023-10-26 16:16:00	40.4504	-73.7082	25.9	24.1
EW1 Export Cable Route 9	EW1 ECR 9	2023-10-26 15:44:00	40.4440	-73.6056	26.8	25.0
EW1 Export Cable Route 10	EW1 ECR 10	2023-10-26 15:11:00	40.4335	-73.5053	21.9	20.1
EW2 Export Cable Route 1	EW2 ECR 1	2023-12-13 12:03:00	40.5343	-73.5368	14.3	12.5

Station	Abbreviation	Deployed Date and Time	Latitude (DD)	Longitude (DD)	Bottom Depth (m)	Receiver Depth (m)
EW2 Export Cable Route 2	EW2 ECR 2	2023-12-13 12:38:00	40.4962	-73.4776	22.2	20.4
EW2 Export Cable Route 3	EW2 ECR 3	2023-12-13 13:17:00	40.4524	-73.4274	22.9	21.0
EW2 Export Cable Route 4	EW2 ECR 4	2023-12-13 13:55:00	40.4096	-73.3749	29.6	27.7
EW2 Export Landing East 1	EW2 ELE 1	2023-12-13 10:40:00	40.5800	-73.6210	6.4	4.6
EW2 Export Landing East 2	EW2 ELE 2	2023-12-13 10:59:00	40.5696	-73.6179	8.2	6.4
EW2 Export Landing East 3	EW2 ELE 3	2023-12-13 11:09:00	40.5591	-73.6149	10.4	8.5
EW2 Export Landing East 4	EW2 ELE 4	2023-12-13 11:18:00	40.5496	-73.6111	10.1	8.2
EW2 Export Landing East 5	EW2 ELE 5	2023-12-13 11:29:00	40.5379	-73.6083	14.9	13.1
EW2 Export Landing West 1	EW2 ELW 1	2023-12-13 10:23:00	40.5775	-73.6779	7.8	5.9
EW2 Export Landing West 2	EW2 ELW 2	2023-12-13 10:14:00	40.5669	-73.6749	10.1	8.2
EW2 Export Landing West 3	EW2 ELW 3	2023-12-13 10:04:00	40.5564	-73.6717	13.1	11.3
EW2 Export Landing West 4	EW2 ELW 4	2023-12-13 09:55:00	40.5455	-73.6686	15.8	14.0
EW2 Export Landing West 5	EW2 ELW 5	2023-12-13 09:45:00	40.5344	-73.6652	16.8	14.9

DD=Decimal Degrees

Table 3-3. Summary of Unique Acoustic Transmitter Detections and Associated Tagging Metadata (e.g., Agency and Species) Identified by the Empire Wind Acoustic Telemetry Array and with Input from Regional Collaborators

Organization	Common Name	Scientific Name	Unique Transmitters (#)	Detections (#)
Atlantic Shark Institute	Atlantic sturgeon	*Acipenser oxyrinchus*	1	6
Atlantic Shark Institute	Sand tiger shark	*Carcharias taurus*	1	8
Delaware Division of Fish and Wildlife	Striped bass	*Morone saxatilis*	10	250
Delaware State University	Atlantic sturgeon	*Acipenser oxyrinchus*	34	819
U.S. Army Engineer Research and Development Center (ERDC)	Hickory shad	*Alosa mediocris*	1	12
Massachusetts Marine Fisheries	White shark	*Carcharodon carcharias*	1	1
Marine Biological Laboratory	Striped bass	*Morone saxatilis*	26	768
Maryland Department of Natural Resources	Atlantic sturgeon	*Acipenser oxyrinchus*	2	43
Monmouth University	Atlantic sturgeon	*Acipenser oxyrinchus*	67	6,247
Monmouth University	Black sea bass	*Centropristis striata*	5	62
Monmouth University	Blacktip shark	*Carcharhinus limbatus*	1	12
Monmouth University	Clearnose skate	*Rostroraja eglanteria*	1	3
Monmouth University	Dusky shark	*Carcharhinus obscurus*	7	237
Monmouth University	Roughtail stingray	*Dasyatis centroura*	1	3
Monmouth University	Sand tiger shark	*Carcharias taurus*	3	25
Monmouth University	Sandbar shark	*Carcharhinus plumbeus*	47	4,408
Monmouth University	Smooth dogfish	*Mustelus canis*	9	376
Monmouth University	Striped bass	*Morone saxatilis*	90	5,744
Monmouth University	Summer flounder	*Paralichthys dentatus*	13	614
Monmouth University	Tautog	*Tautoga onitis*	5	122
Monmouth University	Winter flounder	*Pseudopleuronectes americanus*	2	53
New England Aquarium	Bluefin tuna	*Thunnus thynnus*	19	443
New England Aquarium	Common thresher	*Alopias vulpinus*	4	46
New England Aquarium	Dusky shark	*Carcharhinus obscurus*	1	12
New England Aquarium	Shortfin mako	*Isurus oxyrinchus*	5	508
OCEARCH/Jacksonville University	White shark	*Carcharodon carcharias*	3	39
Rhode Island Department of Environmental Management, Division of Marine Fisheries	Shortfin mako	*Isurus oxyrinchus*	1	3
Rutgers University	Atlantic sturgeon	*Acipenser oxyrinchus*	3	200
SC Department of Natural Resources	Atlantic sturgeon	*Acipenser oxyrinchus*	3	10
Smithsonian Environmental Research Center	Alewife	*Alosa pseudoharengus*	7	45
Smithsonian Environmental Research Center	Cownose ray	*Rhinoptera bonasus*	3	54

Organization	Common Name	Scientific Name	Unique Transmitters (#)	Detections (#)
Smithsonian Environmental Research Center	Spinner shark	*Carcharhinus brevipinna*	1	15
South-East Zoo Alliance for Reproduction & Conservation	Sand tiger shark	*Carcharias taurus*	1	7
Stony Brook University	Atlantic sturgeon	*Acipenser oxyrinchus*	197	11,577
Stony Brook University	Black sea bass	*Centropristis striata*	8	1,330
Stony Brook University	Blacktip shark	*Carcharhinus limbatus*	2	40
Stony Brook University	Bluefish	*Pomatomus saltatrix*	4	295
Stony Brook University	Clearnose skate	*Rostroraja eglanteria*	9	373
Stony Brook University	Dusky shark	*Carcharhinus obscurus*	75	5,543
Stony Brook University	Sand tiger shark	*Carcharias taurus*	37	397
Stony Brook University	Sandbar shark	*Carcharhinus plumbeus*	46	2,263
Stony Brook University	Scup	*Stenotomus chrysops*	1	25
Stony Brook University	Shortfin mako	*Isurus oxyrinchus*	1	1
Stony Brook University	Smooth dogfish	*Mustelus canis*	45	2,340
Stony Brook University	Smooth hammerhead	*Sphyrna zygaena*	2	15
Stony Brook University	Striped bass	*Morone saxatilis*	72	2,355
Stony Brook University	Summer flounder	*Paralichthys dentatus*	1	39
Stony Brook University	Unknown	*N/A*	25	2,680
Stony Brook University	Weakfish	*Cynoscion regalis*	1	50
Stony Brook University	White shark	*Carcharodon carcharias*	4	130
Stony Brook University	Winter skate	*Leucoraja ocellata*	2	39
U.S. Department of the Navy	Atlantic sturgeon	*Acipenser oxyrinchus*	2	25
Chesapeake Biological Laboratory of the University of Maryland Center for Environmental Science	Striped bass	*Morone saxatilis*	2	13
US Geological Survey – Biological Resources Division	Shortnose sturgeon	*Acipenser brevirostrum*	15	10,822
Virginia Commonwealth University	Atlantic sturgeon	*Acipenser oxyrinchus*	14	288
Virginia Institute of Marine Science William & Mary	Atlantic sturgeon	*Acipenser oxyrinchus*	14	666
Wildlife Conservation Society	Sand Tiger shark	*Carcharias taurus*	4	13
		Subtotal	**961**	**62,514**
Unknown transmitters at time of report, pending data sharing with MATOS			1,176	2,051,781
		Total	**2,137**	**2,114,295**

Table 3-4. Summary of Unique Acoustic Transmitter Detections by Species Identified by the Empire Wind Acoustic Telemetry Array and Input from Regional Collaborators (Tagging Agencies Combined)

Common Name	Scientific Name	Unique Transmitter (#)	Detections (#)
Atlantic sturgeon	*Acipenser oxyrinchus*	337	19,881
Striped bass	*Morone saxatilis*	200	9,130
Sandbar shark	*Carcharhinus plumbeus*	93	6,671
Dusky shark	*Carcharhinus obscurus*	83	5,792
Smooth dogfish	*Mustelus canis*	54	2,716
Sand tiger shark	*Carcharias taurus*	46	450
Bluefin tuna	*Thunnus thynnus*	19	443
Shortnose sturgeon	*Acipenser brevirostrum*	15	10,822
Summer flounder	*Paralichthys dentatus*	14	653
Black sea bass	*Centropristis striata*	13	1,392
Clearnose skate	*Rostroraja eglanteria*	10	376
White shark	*Carcharodon carcharias*	8	170
Alewife	*Alosa pseudoharengus*	7	45
Shortfin mako	*Isurus oxyrinchus*	7	512
Tautog	*Tautoga onitis*	5	122
Common thresher	*Alopias vulpinus*	4	46
Bluefish	*Pomatomus saltatrix*	4	295
Blacktip shark	*Carcharhinus limbatus*	3	52
Cownose ray	*Rhinoptera bonasus*	3	54
Winter skate	*Leucoraja ocellata*	2	39
Winter flounder	*Pseudopleuronectes americanus*	2	53
Smooth hammerhead	*Sphyrna zygaena*	2	15
Hickory shad	*Alosa mediocris*	1	12
Roughtail stingray	*Dasyatis centroura*	1	3
Spinner shark	*Carcharhinus brevipinna*	1	15
Weakfish	*Cynoscion regalis*	1	50
Scup	*Stenotomus chrysops*	1	25
Subtotal		**936**	**59,834**
Unknown transmitters at time of report, pending data sharing with MATOS		1,201	2,054,461
Total		**2,137**	**2,114,295**

4.0 SUMMARY and DISCUSSION

The acoustic telemetry survey for Empire Wind was successfully initiated in 2023, where the initial acoustic receiver array consisted of 47 stations. The EW 2 Cable Route and Landing stations (n=14) were permanently removed in summer 2024, with three receivers lost and 11 successfully recovered. Servicing and downloading equipment have been completed twice (summer 2024 and winter 2024/2025) on the EW 1 Cable Route, EW 1 Lease, and EW 2 Lease. The monitoring effort experienced receiver loss in each of these areas that have been replaced with new units, and there are currently only a few inactive stations in the array. Overall, the acoustic telemetry survey has been highly successful with the deployment of 366 transmitters across 14 different species to better understand how the Project Area is being used by these species.

Receiver detection data were downloaded from early spring through fall 2024 and winter of 2025 to coincide with known seasonal migratory activity of focal fish species. To date, all detection data and fish tagging data have been uploaded into the MATOS telemetry network allowing data exchange among researchers. Given the MATOS telemetry network's data sharing efforts, information on the timing and duration of fish habitat use in the Lease Area and along the planned export cable routes will not only be obtained from fish currently tagged within this study but also from fish in the Project Area with compatible transmitters. Monitoring efforts have generated a large volume of detection data, i.e., over 2 million detections, that can be referenced with 27 different species and 22 organizations and agencies (Tables 3-3 and 3-4). Acoustic receiver stations along EW 1 and EW 2 proposed export cable routes recorded the highest number of detections, likely due to the ecological significance of the New York/New Jersey Harbor and natural bottleneck for marine species. The most frequently identified species included Atlantic sturgeon (n=337), striped bass (n=200), sandbar shark (n=93), dusky shark (n=83), smooth dogfish (n=54), and sand tiger shark (n=46), all of which are known to regularly use estuarine and coastal marine habitats for migratory or reproductive purposes. While the Project Area recorded over 2 million detections, a significant portion of the tagged individuals remain unidentified. The recent data-sharing agreement through the MATOS network will enhance collaboration, building upon efforts from 22 participating organizations and agencies. These data sharing efforts will provide deeper insights into which species are using the Project Area and help to answer key questions about their seasonal movements and habitat use.

5.0 REFERENCES

Bureau of Ocean Energy Management (BOEM). 2023. Guidelines for providing information on fisheries for renewable energy development on the Atlantic outer continental shelf pursuant to 30 CFR Part 585. Office of Renewable Energy Programs. June 2019.

Buyse, J., J. Reubens, K. Hostens, S. Degraer, J. Goossens, and A. De Backer. 2023. European plaice movements show evidence of high residency, site fidelity, and feeding around hard substrates within an offshore wind farm. ICES J. Mar. Sci. DOI: 10.1093/icesjms/fsad/179.

Frisk M.G., M.C. Ingram, and K. Dunton. 2019. Monitoring Endangered Atlantic Sturgeon and Commercial Finfish Habitat Use in the New York Lease Area. Stony Brook (NY): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-074. 88 pp.

Gervelis, B. and J. Kneebone. 2022. Passive acoustic telemetry as a tool to monitor the baseline presence and persistence of highly migratory fish species in popular recreational fishing grounds within the southern New England wind energy area. Newport (RI): U.S. Department of the Interior, Bureau of Ocean Energy Management. 40 p. Report No.: OCS Study BOEM 2022-059 Agreement No.: M20AC00006.

Guida, V., A. Drohan, H. Welch, J. McHenry, D. Johnson, V. Kentner, J. Brink, D. Timmons, and E. Estela-Gomez. 2017. Habitat Mapping and Assessment of Northeast Wind Energy Areas. Sterling, VA: US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2017-088. 312 pp.

Haulsee, D.E., M.W. Breece, L.M. Brown, B.M. Wetherbee, D.A. Fox, and M.J. Oliver. 2018. Spatial ecology of *Carcharias taurus* in the northwestern Mid-Atlantic coastal ocean. Mar. Ecol. Prog. Ser. 597: 191-206.

Hogan, F., B. Hooker, B. Jensen, L. Johnston, A. Lipsky, E. Methratta, A. Silva, and A. Hawkins. 2023. Fisheries and Offshore Wind Interactions: Synthesis of Science. NOAA Technical Memorandum NMFS-NE-291. 388 pp.

Ingram, E.C., R.M. Cerrato, K.J. Dunton, and M.G. Frisk. 2019. Endangered Atlantic sturgeon in the New York Wind Energy Area: implications of the future development in an offshore wind energy site. Sci. Rpts. 9:12432.

INSPIRE Environmental. 2023. Empire Wind Fisheries and Benthic Monitoring Plan. Prepared for Equinor, Empire Offshore Wind LLC. May 2023. 76 pp.

Keller, K., J.A. Smith, M.B. Lowry, M.D. Taylor, and I.M. Suthers. 2017. Multispecies presence and connectivity around a designed artificial reef. Mar. Fresh. Res. 68: 1489–1500.

Kneebone, J., J. Chisholm, and G. Skomal. 2014. Movement patterns of juvenile sand tigers (*Carcharias taurus*) along the east coast of the USA. Mar. Biol. 161: 1149−1163.

McQueen, K., J.E. Skjaeraasen, D. Nyqvist, E.M. Olsen, O. Karlsen, J.J. Meager, P.H. Kvadsheim, N.O. Handegard, T.N. Forland, K. de Long, and L.D. Sivle. 2023. Behavioural responses of wild, spawning Atlantic cod (*Gadus morhua* L.) to seismic airgun exposure. ICES J. Mar. Sci. 80: 1052−1065.

New Jersey Department of Environmental Protection (NJDEP). 2022. Open Stock Assessment Program. Accessed August 2022. https://dep.nj.gov/njfw/fishing/marine/ocean-stock-assessment-program/.

New York State Energy Research and Development Authority (NYSERDA). 2017. New York State Offshore Wind Master Plan: Fish and Fisheries Study. NYSERDA Report 17-25j. 140 pp.

Responsible Offshore Science Alliance (ROSA). 2021. Offshore wind project monitoring framework and guidelines. March 2021. Available online at Resources | ROSA 2021 Updated (rosascience.org).

Reubens, J.T., F. Pasotti, S. Degraer, and M. Vincx. 2013. Residency, site fidelity and habitat use of Atlantic cod (*Gadus morhua*) at an offshore wind farm using acoustic telemetry. Mar. Env. Res. 90: 128−135.

Rothermel, E.R., M.T. Balazik, J.E. Best, M.W. Breece, D.A. Fox, B.I. Gahagan, D.E. Haulsee, A.L. Higgs, M.H.P. O'Brien, Oliver MJ, et al. 2020. Comparative migration ecology of striped bass and Atlantic sturgeon in the US southern mid-Atlantic flyway. PLoS One. 15:e0234442.

Secor, D., M. O'Brien, E. Rothermel, C. Wiernicki, and H. Bailey. 2020. Movement and habitat selection by migratory fishes within the Maryland Wind Energy Area and adjacent reference sites. Sterling (VA): US Dept Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study, BOEM 2020-030.

Thatcher, H., T. Stamp., D. Wilcockson, and P.J. Moore. 2023. Residency and habitat use of European lobster (*Homarus gammarus*) within an offshore wind farm. ICES J. Mar. Sci. doi: 10.1093/icesjms/fsad067.

Thorne, L., J. Nye, J. Warren, and C. Flagg. 2020. Development and implementation of an ocean ecosystem monitoring program for New York Bight. Annual Report, MOU #AM10560 NYS DEC & SUNY Stony Brook for the period January 1, 2020 – December 31, 2020. New York State Environmental Protection Fund Ocean and Great Lakes Program and Stony Brook University School of Marine and Atmospheric Sciences. https://www.dec.ny.gov/docs/fish_marine_pdf/dmrsomasmonitoring.pdf.

Empire Wind 2024 Acoustic Telemetry Study

Annual Report

FIGURES

Prepared for:

equinor

Empire Offshore Wind LLC
Stamford Office - 600 Washington Blvd. - Suite 800
Stamford, CT 06901

Prepared by:

Monmouth University
West Long Branch, New Jersey

and

INSPIRE Environmental
513 Broadway
Newport, RI 02840

June 2025

LIST OF FIGURES

Figure Page

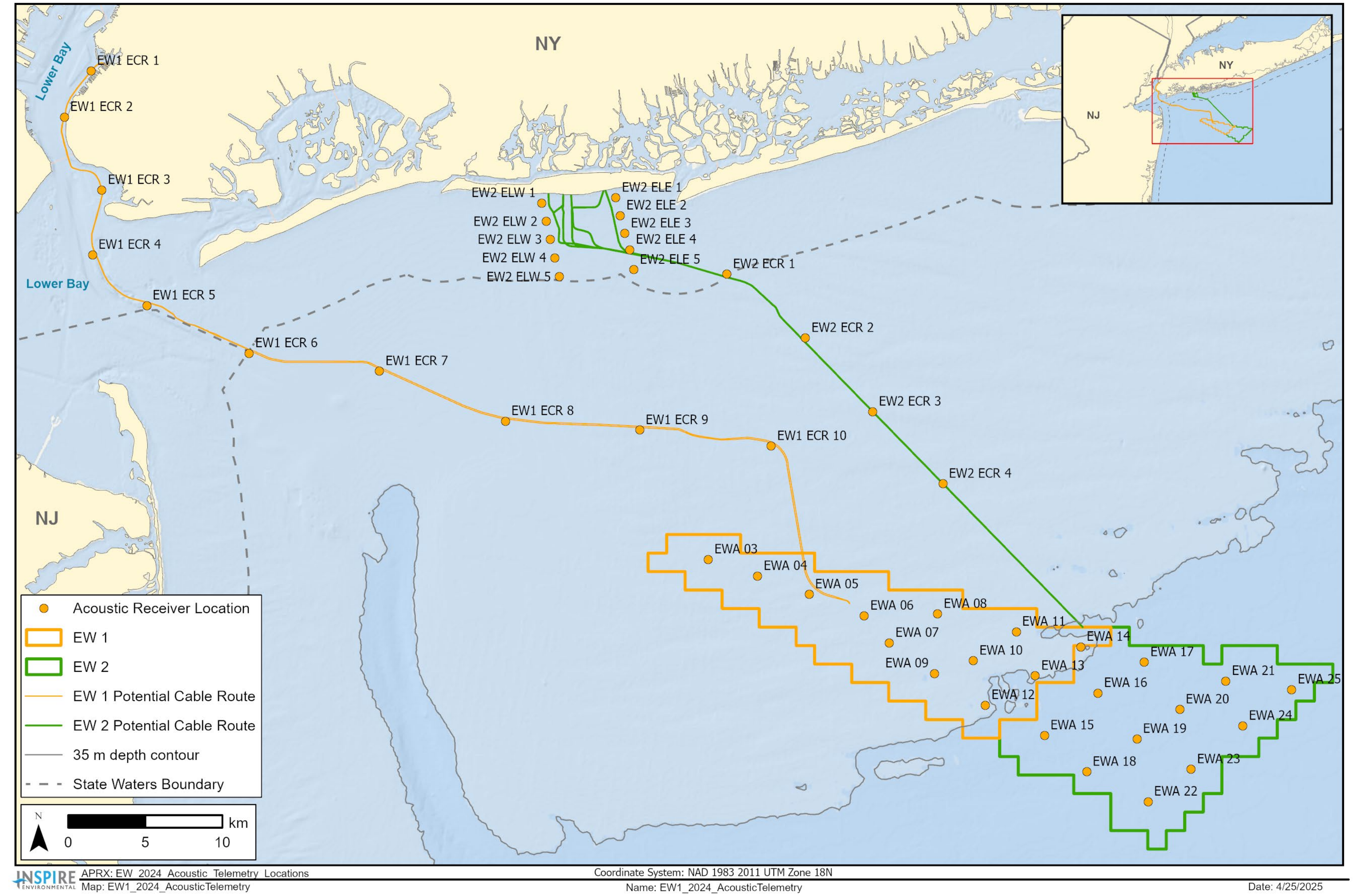

Figure 1-1. Deployed Innovasea VR2AR receivers along the various components of the Empire Wind acoustic telemetry study

Figure 2-1. A striped bass immobilized in a padded surgery cradle before the insertion of an acoustic transmitter tag

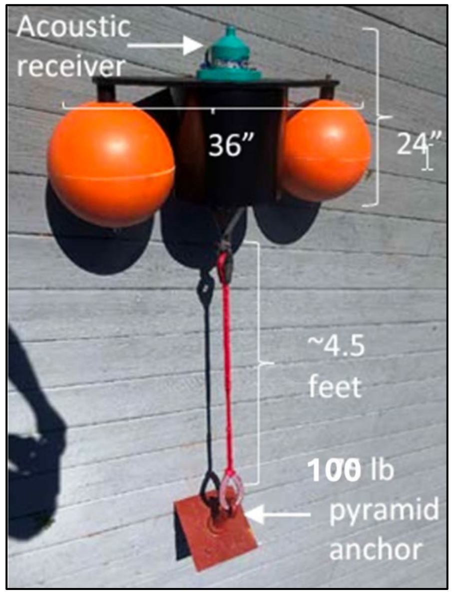

Figure 2-2. The acoustic release receiver system includes a 12x12x12-inch, 100-lb Dor-Mor pyramid anchor made of cast iron. The upper portion of the system measures 3x2x2 feet and contains an identifying plastic plate, an acoustic receiver, and two 12-inch trawl floats.

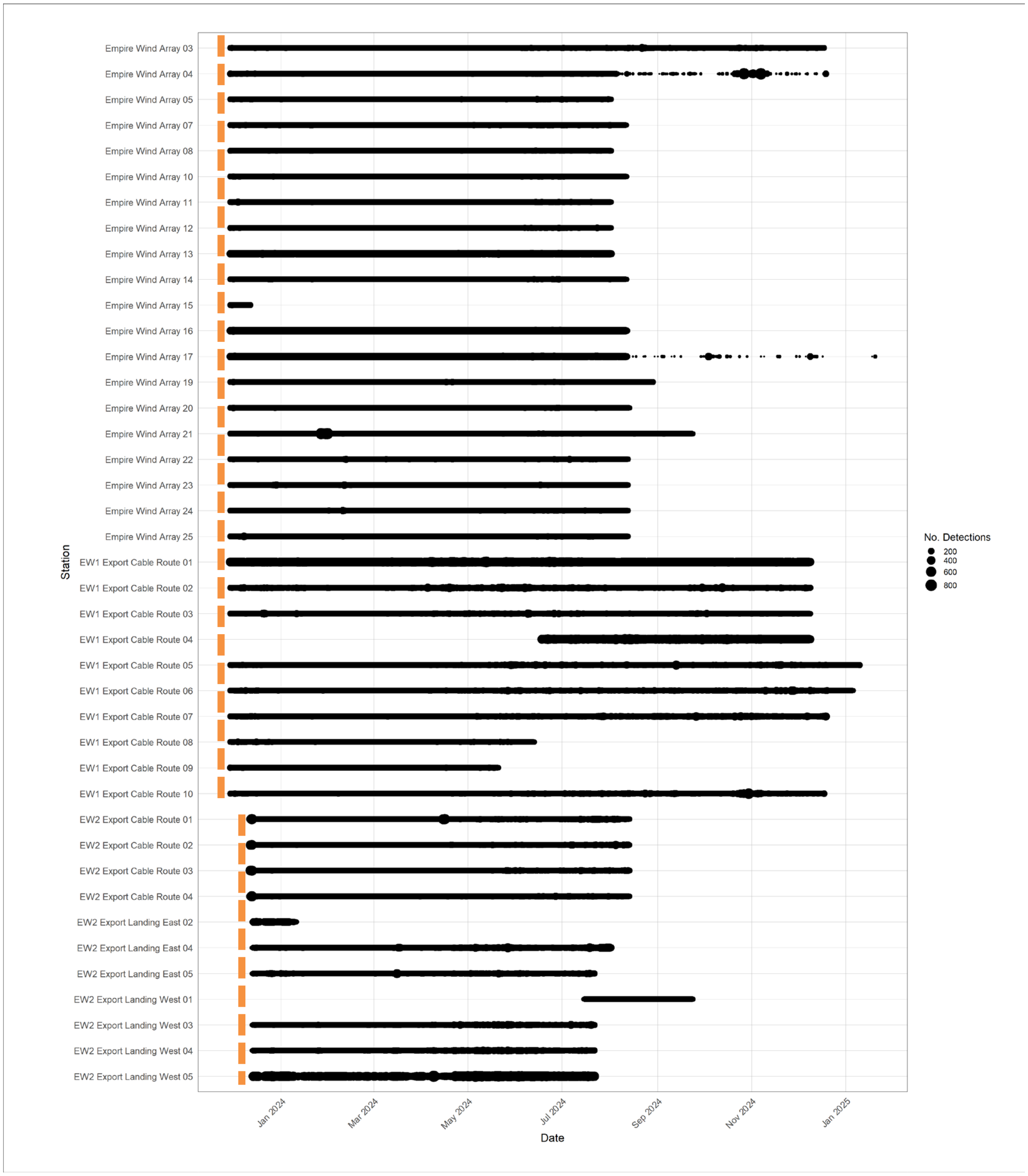

Figure 3-1. Daily detection histories of acoustic receivers deployed between 2023 and 2025 in the Empire Wind acoustic telemetry array and input from regional collaborators. Gaps in detection histories represent time periods when a receiver was not found during downloading efforts or they were not downloaded yet (orange lines indicate deployment dates).

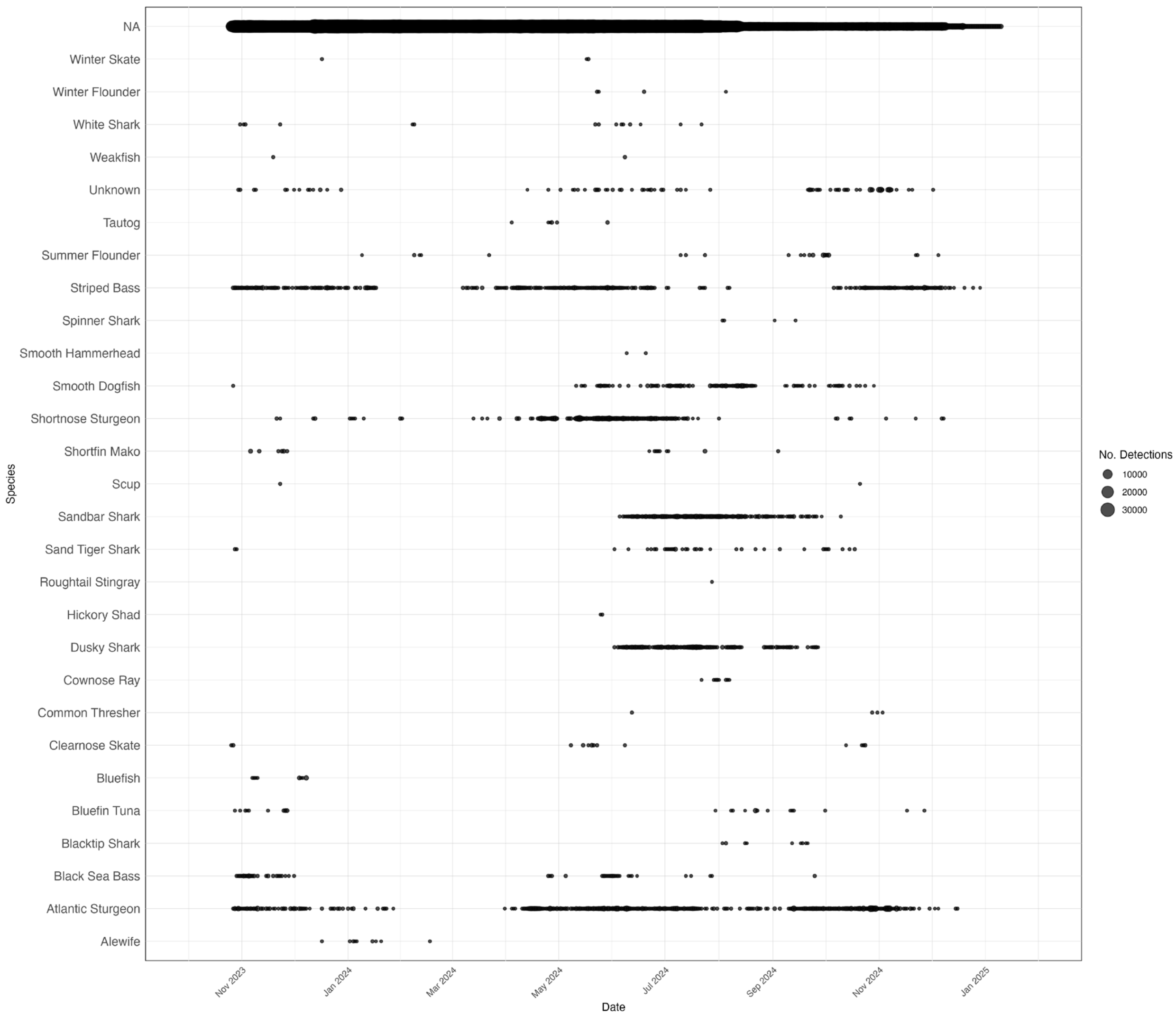

Figure 3-2. Daily detection histories of tagged fish species identified between 2023 and 2025 in the Empire Wind acoustic telemetry array. The size of circles represents a range of detections recorded for a given day.

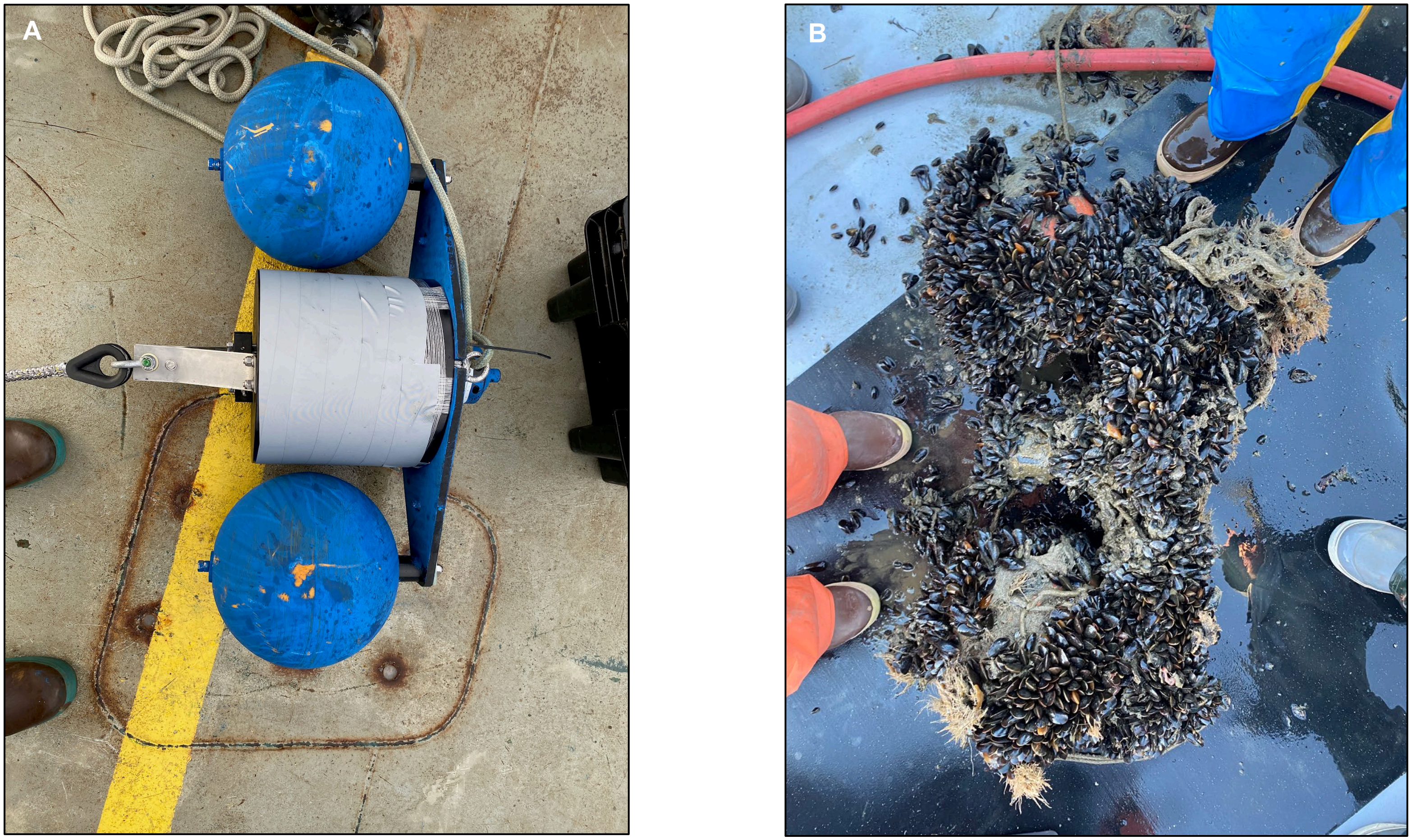

Figure 3-3. Comparison of an Innovasea VR2AR acoustic receiver with a recoverable acoustic release mooring system (A) before and (B) after deployment in terms of biofouling. All receivers and mooring systems are treated with an antifouling ablative paint to inhibit growth prior to release.