Required RMI Proposal Elements
5/18/2022

1. **Title:** Acoustic telemetry, an innovative, non-extractive approach for monitoring protected, prohibited, and commercially/recreationally important species within a major migratory corridor through Wind Lease Areas and cable landing sites along the NJ coast.

2. **Investigator(s) name(s) and institution(s):**

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3. **Motivation/Objective**:

This proposed project will complement existing regional infrastructure of acoustic telemetry (the remote monitoring of a species through the use of transmitters and receivers) currently heavily utilized by other state, federal, and academic institutions (Figure 1) to provide coverage in and around New Jersey Wind Energy Areas (lease areas and export cable routes) and other areas of biological significance (i.e. migration corridors) to monitor important marine species of commercial, recreational, and/or ecological significance (Figure 2A). Acoustic telemetry is a proven <u>non-extractive</u> methodology used to track and delineate spatial/temporal habitat use of marine organism and provides invaluable data on species abundance and behaviors. This method is rapidly evolving as a powerful tool in the study of marine species due to advances in technology and cost effectiveness to obtain 24/7 continuous monitoring of tagged species. This leads to a large amount of high quality data from tagged animals, not obtained solely by traditional fishery sampling approaches (e.g. trawling, gillnetting). Because these are passive devices that are moored to the sea floor or structures, they can remain in place uninterrupted and continuously monitoring throughout all phases of offshore wind development. This makes an excellent mechanism to support the RMI initiatives to provide a rigorous approach to research and monitoring within key regions of the coastline to provide detailed information on relative abundance, behavior during the development, construction, operation and decommissioning of offshore wind as recommended in the New Jersey Offshore Wind Strategic Plan.

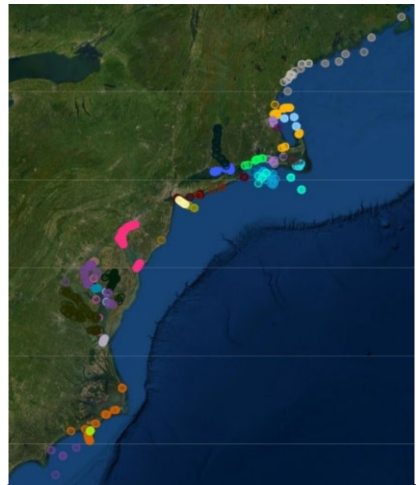

Figure 1. Distribution of coast-wide receivers in the ACT_MATOS Acoustic Telemetry network (https://www.theactnetwork.com/). Colored dots represent different researchers acoustic arrays.

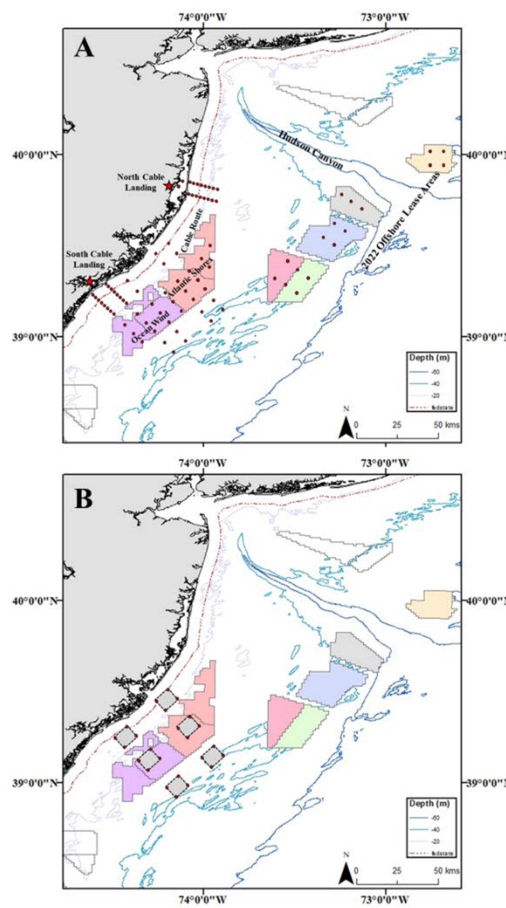

Figure 2. (A) Concept deployment of an 82 Vemco acoustic receiver array (red dots) in key regions related to offshore wind development in NJ. (B) Highlighting the cross-shelf gradient comparisons (Grey boxes; red dots are receivers) in Atlantic Shores and Ocean Wind arrays.

Purpose:

The proposed acoustic telemetry project will support a fisheries monitoring network suited for the monitoring of rapid and continued development of wind energy in New Jersey (NJ) coastal waters (Fig. 2). The purpose of this study will be to use acoustic telemetry to identify and gain baseline information on the spatial/temporal habitat use, movements, residency patterns, and relative abundances of federally protected, prohibited, and commercially and recreationally important species within areas of interest for New Jersey. This project directly addresses multiple NJ RMI Research Priorities including:

- #7 Examining the effects of OSW on the distribution/connectivity of fish and invertebrate species and communities (e.g., acoustic tags for horseshoe crabs or species with obligate migration paths)
- #12 Adapt DEP trawl survey design to allow for comparison of biases/limitations in and outside of OSW development areas and calibrate new time series
- #14 Develop and implement methods to assess impact of OSW on recreational fisheries (e.g., changes in access within the WEAs).

In addition, the use of acoustic telemetry as a method to census a selected number of marine fishes is consistent with existing guidelines for offshore wind fisheries monitoring from BOEM and the Responsible Offshore Science Alliance (BOEM 2019, ROSA 2021), and meets ROSA's objectives by providing a reliable index of changes in community composition that has zero impact on fisheries because it is a no-take methodology. This methodology is currently being used in pre-during-post Fisheries Monitoring plans with a number of offshore developers coast-wide because of its ability to generate high quality data on fishes.

Background

Acoustic telemetry has become an essential and powerful tool in fisheries science for examining migration patterns, spatial-temporal habitat use/preferences, assessing mortality (e.g., natural mortality, fishing mortality), analyzing stock structure/management units, and general population monitoring. Currently, there is a growing interest in and need to improve the integration of acoustic telemetry science into decision-making and policy development. With the overall type and quality of data provided by acoustic telemetry arrays (e.g., high-resolution data on animal location over extended time periods), telemetry data can easily guide this process on a variety of animals. Examples of this include federal and state agencies that utilize acoustic data on the federally endangered Atlantic sturgeon to help determine and guide work windows on construction projects (e.g., dredging, pipelines, cable landings, and offshore wind) and assess overall impacts of stressors on this species. Further, because acoustic tags can generate up to 10 years of data, telemetry has become an important non-extractive long-term monitoring tool for evaluating individual and population-level impacts of pre-during-post construction of offshore wind. The compatibility of acoustic telemetry equipment (e.g., tags and receives) also permits integration, cooperation, collaboration, data sharing, and consistency between telemetry-based monitoring projects occurring in offshore wind areas along the east coast of the US, Canada, Gulf of Mexico, and beyond (Bangley et al. 2020).

The coastal waters off New Jersey are a highly productive area and provide important habitat for a variety of marine fishes (Levesque 2019; NJDEP EBS Report). Temporal and spatial distributions and abundance of fish species within this region are largely controlled by environmental conditions (e.g. water temperature) as well as day length, which highly influence migratory behaviors within many fishes with southerly movements in the fall and northerly movements in spring (Rothermel et al. 2020). The New Jersey Coast, currently has a critical-data gap in acoustic telemetry equipment, yet represents a key region in this North-South migratory corridor for many fish populations that undergo these seasonal migrations while also undergoing development of Wind Leases. This makes understanding the possible impacts of the constructed turbines within this region an urgent priority. This critical region of coast, located between two major river systems (Delaware River and Hudson River), is particularly important for anadromous fish species (e.g., Atlantic Sturgeon, Striped Bass, American Shad) that make extensive migrations along the Mid-Atlantic Bight; northward in the spring, and southward in the fall. In particular the use of acoustic telemetry is critical to understanding the offshore habitat use of Atlantic sturgeon because the conservation of marine endangered and rare species can be complex due to low abundances, broad distributions, and migrations, therefore making the understanding of spatial-temporal movement and habitat use is critical in the conservation, recovery, and management of endangered species. The delineation of critical habitat towards the development of management plans, reduction of negative anthropogenic interactions, and protection of vital habitat to assist recovery, is a requirement under the U.S. Endangered Species Act. This coastline is also essential in the migratory routes of federally prohibited coastal sharks (Sand tiger, Sandbar, Dusky, and White) and other elasmobranchs (Winter Skate, Smooth Dogfish, and Spiny Dogfish) which are data-limited within this region. Other commercial-recreational species exhibit seasonal inshore-offshore migrations across the shelf in this region (e.g., summer flounder, monkfish, Atlantic Angel Shark, Roughtail Stingrays). This region also represents a dynamic area that has experienced shifts in species distributions likely due to climate change. A greater "influx" of southern species as well as a northward shift of those species associated with cooler water, is displayed in a variety of species and has been documented in both larval (Sciaenidae) and adult life stages (Blacktip sharks), further supporting the use of acoustic telemetry as a tool to document these changes.

Figure 3. (A and B) Island Beach State Park, site of the northern cable landing, examples of intensity of recreational fishing efforts during the fall striped bass season (Copyrighted photos by Tom Lynch – Angry Fish Galleries, used with permission) (C) Acoustic tagging striped bass with representatives of the recreational industry Tak Waterman, Berkely Striper Club, and Reel Therapy fishing guide service (D) Capturing and tagging Atlantic sturgeon with commercial partner Kevin Wark

Specific project objectives include gaining baseline information on the spatial and temporal presence of select marine species in key inshore/offshore areas related to offshore wind development in NJ:

H: Abundance, movements, residency, and behavior of teleost and elasmobranch species will vary seasonally and differ among the 2 proposed inshore connecting cable arrays, inshore-offshore wind energy areas, and gradient arrays.

4. **Proposed Research**

Methodology:
Overview: Acoustic receivers will passively record the presence/absence/relative abundance, of acoustic tagged animals. Using this detection data we can additionally calculate residency (time spent in regions), and movement rates of animals within the proposed monitoring regions. Proposed fishes tagged within this study would primarily focus on species that are ecologically, commercially, and recreationally important. Species would include but not be limited to the federally endangered Atlantic sturgeon (*Acipenser oxyrhinchus*), federally prohibited coastal sharks (e.g., dusky, sand tiger, sandbar), other elasmobranchs (e.g., winter

skate, smooth dogfish, and spiny dogfish), horseshoe crabs, commercially and recreationally important finfish species (e.g., summer flounder, black sea bass, tautog, etc.) and Highly Migratory Species (HMS; e.g., Bluefin tuna, Mako). Current and proposed tags have an operating life of 2-10 years (depending on tag size appropriate for each species), providing successful long-term data collection over time. Tagging for this project will be conducted directly within the proposed project area, but and additional thousands of previously tagged fish from other agencies and institutions can also be included in reporting requirements for this study, including more than 500 sharks, sturgeon, and striped bass tagged by Monmouth University and its collaborators (Stony Brook University, NY Department of Environmental Conservation, New England Aquarium) and more than 3,000 fish tagged in the ACT_MATOS contributing to the greater success and importance of this study. Working with the ACT_MATOS network we will work to identify all the species that are tagged by other researchers that we detect in our acoustic array and approvals will be sought out to utilize detection data used.

Capturing of Animals:
Capturing of animals tagged within this study will be successfully completed through a variety of proven fishery sampling techniques, including otter trawl, gillnet, long line, rod-and-reel, and/or pots. Each gear type and fishing method is species specific (e.g. Atlantic sturgeon captured by gillnets; Coastal sharks by long line and rod-reel) and our targeted sampling efforts look to maximize tagging success by focusing on when are target species are seasonal abundant (Table 1). Fish will be targeted and released throughout the proposed arrays; including the cable landings, Inshore and Offshore Wind Arrays (Figure 2). Locations of tagged fish will be dependent on their spatial abundance at the time of capture but all fish will be released close to the point of capture. In the event our target species cannot be captured within the proposed arrays, we will seek additional regional ongoing sampling opportunities as close to the proposed acoustic arrays as possible at no additional cost to the project (e.g, coastal shark sampling in Cape May, NJDEP trawl survey, other ongoing fisheries sampling projects). Fish will be retained in onboard tanks filled with ambient seawater and will have either aeration or continuous flowing seawater to ensure survival or alongside the boat during the tagging process. Although we have full capacity to capture and tag fishes on this proposed project, our approach looks to collaborate and be industry based and directly involve representatives within both the recreational and commercial industries (Figure 3). This approach will further allow engagement and outreach to these user groups by allowing them to contribute toward the science of natural resources in this region.

Recreational angler partnership: Monmouth University will engage and work cooperatively with various representatives of the recreational community including tackle shop owners, fishing clubs, and fishing guides to address their specific concerns. Previous industry partners that Monmouth University has worked directly in the past include; Fishermen's Headquarter, TAK Watermen, Berkeley Striper Association, Jersey Shore Surfcasters, Fishhead Greg Charters, etc… (Figure 3A-C). Specifically, we will engage with, various fishing clubs and recreational anglers that primarily focuses on the capture and release of striped bass through surf-fishing on Long Beach Island primarily focused near the northern proposed cable landing (Figure 3A-B). Engagement of anglers in this region is essential, as this area heavily criticizes the effects of offshore wind-development along their coast, and involving anglers in this study helps gives then ownership in evaluating this resource.

Commercial fishing partnership: We will be working with a variety of industry partners and as well as trying to train/collaborate additional commercial partners (as they show interest) to have more involvement in the process. Our lead commercial partner is Kevin Wark, F/V Dana Christine II from Barnegat Light. Kevin is a prominent leader in the fishing industry and is active in fishing and management (e.g., Fishery Management Councils, NOAA Cooperative Research). Kevin will lead Atlantic Sturgeon and Coastal sharks sampling with K. Dunton through gillnetting (sturgeon) and long lining (sharks) (Figure 3D). Kevin Wark and his vessel are the only approved commercial vessel/fishermen that can participate in directed Atlantic Sturgeon research by NOAA Office of Protected Resources. Because his vessel and himself, are already approved on another federal sampling permit, this will make sampling Atlantic Sturgeon and addition under K. Dunton/Stony Brook University approved NOAA Endangered Species permit through a minor amendment. To vet a new commercial fishermen to target Atlantic sturgeon could take a very long time under the ESA permit/process. We will directly target the endangered Atlantic sturgeon within the proposed cable landing and offshore area, utilizing Kevin's experience as a previous sturgeon commercial fisherman and researcher. Once the project becomes established we would like to engage additional commercial fisherman, who show interest in participating, to assistant in efforts associated with this project. We have previously identified, Bill Leach of the F/V Dream Warrior (Viking Village) as potential partner on species capture through bottom trawling to help tag benthic species like flounders, skates etc.... In addition to commercial fishing partners we will also be utilizing other charter type captains for additional tagging efforts (e.g. sharks, flounder, seabass).

Biological Sampling: Fished captured during this proposed work will be measured for length and weight, visual inspected for previous tags, and a small fin clip (1cm x 0.5cm) of the caudal or dorsal fin ray will be retained for future genetic analysis (to determine the origin of fish tagged that might further explain migratory anomalies). All fish acoustic tagged will also undergo external conventional tagging techniques with a variety of fisheries approved dart or t-bar tags (www.floytag.com). All tags will be injected using stainless steel applicators provided from the tagging company into the dorsal musculature of the fish through the pterygiohores for maximum retention. Tags are uniquely numbered and have reporting information on them in the event a fish is captured. When reported this will allow us to know if and when a tagged fished is captured and/or harvested (assuming it is reported). All non-target species (by-catch) captured during sampling efforts will be recorded and when sampling time permits, they will be measured and externally tagged with conventional dart tags (http://www.floytag.com/) as well, providing additional fishery information for this project.

Acoustic Tagging: Overall, all tagging efforts will focus on tagging a distribution of size/age classes representative of the normal population structure captured within this region, as well as individuals that are best suited for the acoustic tags on pre-ordered for that species. Since tag size impacts tag life, we try and choose a tag size that is larger enough to maximize data collection while maintaining the rule that tags must account for less than 2% body weight. Individuals will be surgically implanted with various Innovasea (formerly Vemco) acoustic transmitters depending on the size of the fish. Over the duration of the project we plan to tag 330 individuals per year, tagging 30-40 individuals per species in year 1 and again in year 2. Larger individuals (e.g. Striped bass (n=30/year; n=60 total), Coastal sharks (n=30/year each), Atlantic sturgeon[1] (n=30/year;l n=60 total), winter skate (n=30 /year; n=60 total) and HMS (n=30/year; n=60 total), will be implanted with a V16 ultrasonic transmitter (69 kHz, high-power output = 158 dB re 1 µPa at 1 m, random transmitter delay = 120 s, life span = 2,435 d; note final operating life span of the tag will be determined at tag programming and manufacturing). These larger tags with long durations (greater than 6 years) will be available to be detected beyond the scope of this proposed 2 year project, if acoustic telemetry monitoring programs continues, adding to continued data collection. Medium to small individuals (Summer flounder (n=40/year), Black Sea Bass (n=40/year), Tautog (n=30/year) will be tagged with either a V13 (69 kHz, high-power output = 151 dB re 1 µPa at 1 m, random transmitter delay = 180 s life span = 648 d) or a V9 (69 kHz, high-power output = 152 dB re 1 µPa at 1m, random transmitter delay = 120 s life span = 520 d). Once the transmitter has been inserted, the incision will be closed with a minimum of three absorbable interrupted sutures. The incision area will then be cleaned once more with betadine. A betadine/petroleum ointment will also be put on sutures and site of the incision to aid in the recovery of the animals to deter bacterial infection.

Horseshoe crabs will be externally tagged with V13 or V16-4H acoustic tags (n=40/year; n=80 total) according to methods developed by Brousseau et al. (2004) and utilized heavily in successfully studying horseshoe crab movements (Brousseau et al. 2014; Bopp et al. 2021; James-Pirri 2010). To attach the tag, adhesive Velcro (1.4 cm wide 3 7 cm long) will be glued to the convex area medial to a compound eye using quick-setting cyanoacrylate. An acoustic tag will be attached to the mating half of Velcro with cyanoacrylate and a cable tie. The halves of the Velcro will then be mated together via the cyanoacrylate securing the tag to the carapace of the crab. To ensure we do not tag crabs prior to molting, tagging efforts will focus on end-stage molt crabs (e.g. large individuals) that show no signs of molting (e.g. split carapaces).

Additionally, fish tagged in other projects by Monmouth University and collaborators (Stony Brook University and New England Aquarium) can be synergistically utilized within analyses to increase statistical power for a variety of fish species including sharks, sturgeon and striped bass. Currently, Monmouth University has <200 fish tagged that will allow for immediate project success (mostly sharks). Overall and final # of species and individuals tagged within this project will be finalize before purchasing tags based on current tagging efforts within this region, in order to decreased duplication while maximize tagging efforts, sample sizes, and statistical power. Working with the ACT_MATOS network we will work to identify all the species that are tagged by other researchers that we detect in our acoustic array and seek approvals to utilize detection data for publications. All detected fish however can be used in reporting for this project

Acoustic arrays and experimental design: The proposed RMI acoustic array system consists of five components to investigate the presence/absence of tagged species,

[1] Keith Dunton is currently the “responsible party” on a valid and active National Marine Fisheries Service Permit for directed research activities in NJ on endangered Atlantic sturgeon including capture (gillnet or trawl) and acoustic tag implantation that will be used within this proposal.

spatial/temporal migratory movements, and residencies of acoustically tagged animals in the cable landing areas and the wind lease areas. The design includes five arrays (north cable landing, south cable landing, inshore wind array (Atlantic Shores and Ocean Wind), cross-shelf gradient in inshore wind area, and offshore array (2022 lease area) in order to maximize monitoring while achieving a rigorous design in data collecting baseline information to determine species' use, behavior, and distributions of these areas pre-construction (Figure 2). The array design has a three-fold approach; 1) north-south cable landing capturing the North-South migration of species, position of movement as a distance from shore and the wind areas, as well as determining the residency/movement patterns and rates inside the cable landing routes and 2) determining the migrations and patterns of presence-absence of species in the inshore and offshore Wind Arrays which will also allow us to examine the offshore-inshore movements of species 3) examining a cross-shelf gradient, Inshore-Wind Area-Offshore, in Atlantic Shores and Ocean Wind sites to evaluate potential migratory behavior patterns related to distance from impacted areas as well as environmental variables. (Figure 2B) (Rothermal et al. 2020).

The cable landing approaches occupy and cover the area from the surf-zone through 10 miles offshore, creating an acoustic "gate" that the fish have to migrate through and will be detected. The overall design of the arrays can be flexible and scaled (up/down accordingly) and configured in # of arrangements, but we highly recommend the 76 -82 acoustic array of VR2AR-X acoustic release omnidirectional hydrophones (receivers) to provide maximum coverage for robust and rigorous reporting along the coast of NJ (Figure 2 shows 82 receiver concept.) The VR2AR-X receivers can detect a telemetered individual from a radius of 700 to 1100 m from the receiver location depending on sea conditions, ambient noise, and transmitter strength. Previous, ocean arrays maintained by the PIs suggest an average of 1km. Each receiver will therefore continuously monitor an area of approximately 2 to 3 km^2 over the course of the proposed study. While the VR2AR-X receivers represent a significant cost to this project, they were chosen to increase safety by 1) eliminating vertical lines through the water column and potential impacts to marine mammals (e.g North Atlantic Right Whale, Humpback Whale, Finback Whale), which have been shown to occupy this region and 2) increase the success of recovering equipment by eliminating the need for SCUBA divers to dive and find receivers that were moored on the bottom without surface floats marking their position. Within the inshore wind array, the receivers will be placed approximately 12 km apart. Although this arrangement will create areas where fish can swim undetected, this design maximizes spatial coverage/monitoring, while still allowing rigorous scientific design, and balancing cost throughout the proposed study area. Receiver coverage within the offshore array will be less dense than the inshore arrays and focus more on baseline information since this region is not well studied. Within the cable landing areas, receivers will be placed on either side of the proposed cable landing, parallel to shore within 1.2km of each other to achieve near overlapping detection range and therefore more complete monitoring of animal presence and movement along or over electrical transfer cables. This array design (parallel to

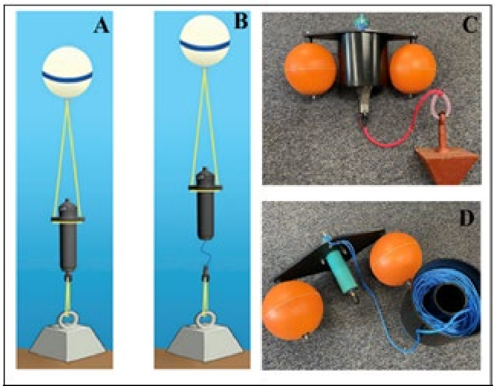

Figure 4: Diagram of Vemco VR2AR (**A**coustic **R**elease) receiver submerged and triggered to release. Mooring Systems recovery mooring acoustic release (C-D) system showing canister and recoverable pyramid anchor. D) Show "triggered" VR2AR trailing a high strength Dynema rope allowing us to retrieve, recover, and redeploy the whole mooring system.

shore) will allow us to also calculate residency times within the proposed cable landing areas prior to electrification. This deployment methodology is preferred for detecting coastal migrations since it has previously been highly successful off the coast in NJ 2010-2013 (Dunton 2014; Melynchuk 2017; and is still currently deploy in NY waters this way for the last 15+ years (Dunton designed, deployed, and maintained these oceanic arrays). A cross-shelf gradient design successfully used in Maryland Wind Energy Area, will also be used to evaluate potential changes in migratory routes of key fishes (e.g., striped bass, Atlantic Sturgeon, Coastal Sharks) within the two immediate inshore wind lease areas (Methratta 2020, Rothermal et al. 2020) (Figure 2B). This approach will provided information to facilitate the comparisons of migrations along the gradient (across the wind lease sites and shelf) while also evaluating environmental conditions (e.g, depth, temperature) and seasonal changes (Figure 2B).

Retrieval of VR2ARs is performed aboard the vessel with communication from a VR100 (already owned by Monmouth University) and an omni-directional transponding hydrophone that triggers the release mechanism which allows the unit to float to the surface to be recovered. The VR100, detects which receivers that are within range of the hydrophone, and also estimates distance between the VR2AR and VR100, to provide a successful recovery. The receivers will be rigged on short lines with a floatation buoy positioned roughly 2 m off the sea floor moored with a 125lb. pyramid anchor, which will bring the released receiver to the surface for recovery and data download (Figure 4AB). We propose to also utilize a mooring recovery systems (Mooring Systems, Inc) which allows us to retrieve and redeploy the same mooring onsite (Figure 4.) This system streamlines the deployments into a small "package" with a minimal ocean footprint while also eliminating the repeated deployment of large concrete blocks (previous deployment method) that could impact commercial fishermen fishing within this region. Once downloaded, receiver and mooring will be redeployed back on the site.

Fisherman outreach and communication

Prior to deployment, Monmouth University and collaborators will also consult and communicate with the commercial industry to specifically address any concerns industry may have with the various proposed locations presented in the concept deployment (Figure 2). We will present concept maps of receiver deployments to regional commercial industries and work to attempt to accommodate potential conflicts. Additionally, we will provide receiver locations to industry fishery liaisons' to ensure communication. Where appropriate, receivers will be placed near known "hangs" or areas fishermen avoid that regional fishermen provide. We will also notify and coordinate directly with developers to coordinate fishery monitoring. Final receiver layouts once everything is taken into consideration will be presented to NJDEP and BPU for approval before deployment.

Once receiver locations are finalized, exact receiver locations will be distributed through "Notice to all Mariners" as well as being provided directly to Commercial fishing organizations. Latitude and Longitude coordinates can be provided in variety of formats that can uploaded into various GPS Plotters using SeaMarks (Andren Software Co.). Paper printouts of the receiver array will also be provided to fishermen as requested. We will continue to engage the industry throughout the project as well as reposting in "Notice to All Mariners".

Environmental Monitoring
Innovasea VR2AR receivers have built in temperature sensor on each receiver. Temperature will be a key variable in evaluating fish migrations as well as incorporation into any models. In addition to temperature, Innovasea aquaMeasure sensors will be deployed at each major site to get an average environmental parameters within each location. Sensors that we will include are Turbidity Optical Back-Scatter Based (0-200 Nephelometruc Turbidity Unit) NTU, Dissolved Oxygen (O – 150%), and Salinity (0-40PSU) sensors will be deployed as a single package in the center of each of the four arrays to provide year round baseline parameters for the locations. Environmental CTD (conductivity, temperature, depth) data (https://www.sontek.com/castaway-ctd) will also be collected for all fishery sampling events and receiver downloading events.

In addition, each VR2AR receiver also records noise (average of 60 samples @ 1 sample/minute) and tilt and rotational angle. These parameters can impact detection ranges/efficiencies and can be used to evaluate receiver performance (e.g, evaluating poor detections).

Data collection
Acoustic arrays can be deployed for up to 16 months (one battery cycle), but we will recover, download, and maintain the array twice per year (late spring and late fall) to ensure successful data retrieval and collection after expected peak migrations of fishes through this region. Receivers will be downloaded and information will be filtered using VUE software provided by Innovasea. RAW data will be downloaded and stored in ACCESS and analyzed in the software R. Detection data will be checked for false detections using VUE and those data will be eliminated from the databases. A valid detection is considered three detections in the array during a 24-hour period and spaced further apart than the minimum tag delay. The database will contain detection histories including depth and acceleration and receiver-based temperature measurements. Data archiving and storage will be on a Synology DS920+ network-attached storage solution with a mirrored drive already purchased K. Dunton and is housed and stored in Monmouth University within Division of Information Management to ensure continuous operations.

Acoustic Data Sharing and Synergistic Activities
Detection data from receivers installed in this project and from regional infrastructure from other research agencies, also us to develop multi-state and multi-agency collaboration as well as engaging in a regional standardized monitoring framework. Regionally, the addition of this infrastructure will significantly add to fisheries monitoring along the coast in key regions. Currently, K. Dunton maintains an array of VR-2W receivers within Sandy Hook/Raritan Bay/Lower NY Harbor that could provide additional information on Northward migrating fish into the Hudson River and/or along the NY Coast and this data will be incorporated into any reports from this project. This region and array, has a high concentration of anadromous fish (e.g. striped bass, sturgeon, river herrings) species in the spring and fall. If this proposal is funded, K. Dunton will install an additional 5-10 VR-2W receivers within Barnegat Bay to monitor the cable installation at Oyster Creek onshore interconnection point. We will also collaborate with NJDEP, who maintains an array of 19

VR-2W receivers in Delaware Bay aimed at monitoring Atlantic Sturgeon but also detects many species including prohibited sharks and striped bass that will capture Southward migration of species tagged in this proposal, into the Delaware River. We will also coordinate with NJDEP (Mike Celestino NJDEP, personal communication) on placement of 5 acoustic telemetry receivers that NJDEP will be purchasing for oceanic deployment, to complement and enhance data collection within this study area. Proposed deployments as of now are being proposed to be inshore of Ocean Wind and Atlantic Shores which will greatly add to this proposed project. The Atlantic Cooperative Telemetry Network and the Mid-Atlantic Acoustic Telemetry Observation System (ACT_MATOS) is a network of 60 researchers following 45 species, and is itself part of a global monitoring network, the Ocean Tracking Network (OTN). Participation within these telemetry networks benefits and maximizes proposed projects like this one two fold; 1) allowing us to capitalize on direct connections with researchers who are actively using acoustic telemetry to study marine organisms and we will be able to determine the species that carries any transmitter that is detected by our acoustic array (a fish tagged by another agency and swims in our array) and 2) we will be able to obtain information on the fish tagged within this study that may swim or migrate outside the tagging area with active participating researchers spanning from Canada through the Gulf of Mexico (fish tagged in this survey and swims somewhere outside of our array). Specifically, project collaborators Stony Brook University and New England Aquarium, other key institutions that maintain large acoustic arrays many with wind industry; Stony Brook University maintains 100s of receivers along the coast of Long Island while NEAQ has a vast network of receiver off the coast of Massachusetts. Working with SBU and NEAQ will allow us to work collaboratively toward a regional standardized monitoring framework. In addition to the ACT_MATOS and currently funded industry projects, we would be able to analyze acoustic tags and detection data also collected during ongoing autonomous glider missions (one project funded through this RMI) that are equipped with Vemco telemetry equipment, therefore expanding the overall spatial coverage in surveying animal habitat use in areas not covered by proposed fixed stationary acoustic receivers within this region.

Additional synergistic activities include pairing the collected acoustic telemetry with proposed eDNA sampling (RMI Concept sketch submitted) to further evaluate and calibrate eDNA to an additional sampling methodology. These non-extractive approaches, can be compared by examining # of acoustic detections for species vs. total # of reads of eDNA for each species over the project. Acoustic detections have been shown to be positively correlated with eDNA detections for endangered Atlantic sturgeon in shallow river systems, but needs to be further evaluated for marine environments (Plough et al. 2021). Recently our group completed a comparison of eDNA to fisheries independent trawl surveys off of NJ, that demonstrated the effectiveness and reliability of the eDNA approach by showing a strong correlation between relative abundances of the two techniques.

Data Analysis: Analysis of acoustic data will be consistent with previous large scale telemetry projects including recent studies evaluating the use of Wind Energy Areas (Ingram et al. 2019; Haulsee et al. 2020; Rothermel et al. 2020; Rulifson et al. 2020). We will establish baseline levels on several standard metrics related to the presence/residency and movements for each species throughout the proposed receiver arrays including: minimum, maximum, and mean annual/seasonal residency times, presence in relation to environmental conditions (e.g., surface and bottom water temperature), nature of movement (e.g., long-term presence vs. transit/migratory corridor), and inter-annual patterns in presence/residency or movement (e.g., present in acoustic array annually, or sporadic, inconsistent presence over multiple years) (Figure 5 and 6). Spatial patterns and comparisons of the two proposed cross-shelf gradients (Inner-Wind-Outer) will be analyzed using a variety of statistical approaches ArcGIS spatial analyst (Optimize hotspot tool to examine broad-scale difference in the # of detections, # of individuals, # of tagged species present, residency, and movement rates; will be conducted amongst the Inner-Wind-Outer "boxes" (Figure 2B) as well as each other (Outer vs. Outer; Inner vs. Inner; Wind vs. Wind). Generalized linear models (GLMs) can be used to provide a flexible approach that allows for continuous and categorical predictors response variables, including count, proportions, presence-absence, and continuous data and environmental data. These metrics can later be utilized and compared with any future deployments as the basis of a Before-after-gradient (BAG) approach to examine behavioral impacts on species post offshore wind development (Methratta 2020, Rothermal et al. 2020) analyzing the cable landing arrays, gradients, and by directly comparing the data collected at each stage of the installation. Should an acoustic telemetry array continue after this initial deployment during and post construction, analyses could be used to 1) identify differences in residency patterns and of rate of movements within the cable landings and wind arrays 2) evaluate changes in relative abundance and counts of species and individuals 3) shifts in behavior patterns. We will inform statistical analyses with information on environmental conditions in the project area (e.g., bottom water temperature (measured hourly by each receiver), season (or month), water depth, photoperiod (calculated) to examine the influence of physical processes and environmental conditions on each metric.

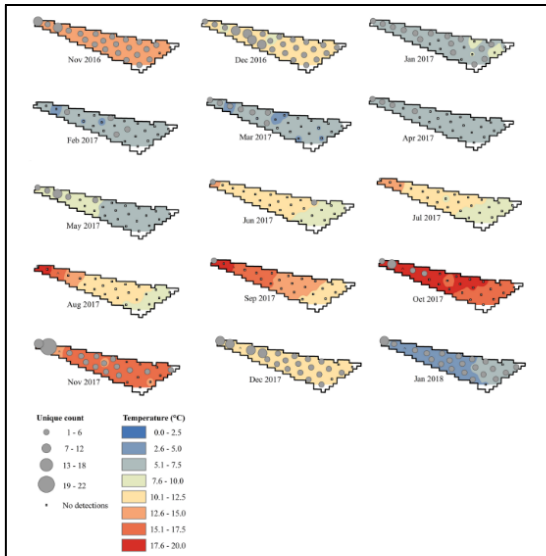

Figure 5. Sample dataset from endangered Atlantic sturgeon monitoring in a wind lease area in NY, showing the seasonal abundance, occurrence, and residency of sturgeon within the lease site (figure from: Ingram et al. 2019)

Deliverables and Regional Cooperation: We will work with Regional Groups (e.g. ROSA, ACT_MATOS) and ongoing industry funded projects to develop and ensure data standardization of raw and processed collected data to allow for data to be stored, formatted, and made available to agencies, researchers, and the public. Deliverables will include detailed detection history that include relative abundance plots for each tagged individual that depict all detections logged for an animal by individual receivers as well as all RAW datafiles. Summary tables and figures will be generated that describe: the total number of receivers an individual and/or species was detected, the number of times each fish was detected by each receiver, movements between individual receivers and project areas, and monthly/seasonal/annual patterns in presence and persistence in relation to environmental conditions (e.g., sea surface or bottom water temperature, photoperiod).

Schedule of Activities and Key Project tasks

See detailed project schedule in Appendix. Start of activities would highly depend on when contracts would be initiated, so the overall proposed project schedule would be dependent upon the project initiation date.

Expected Outcomes:
Success of the project relies on the successful deployment of acoustic tags and receivers. Metrics of success and outcomes can be seen in table 1, but will largely be measured by successful tagging expeditions and recovery and re-deployment of acoustic receivers on their scheduled recoveries. Additionally the creation of a databases, reports, and other materials to be shared with the Project managers RMI steering committee, the Final Report and Data to offshore wind regional coordination entities (NYSERDA, ROSA, RWSE)

5. **Budget**: Overall proposed budget total: $1,840,121 for a 76 receiver array. Overall project can be scaled (up or down) accordingly.

6. **Expertise**: Please See Abridged CV(s) in Appendix below, but briefly, Key Project Personal are listed below:
PI Dr. Keith Dunton: Dr. Dunton is a fisheries ecologist with 17 years' experience working on fisheries, community ecology, and ecosystem dynamics and is an expert in acoustic telemtry. He has authored 17 peer-reviewed papers and contributed to over 40 professional talks at professional conferences related to fisheries biology, ecology, and management. Over the last ten years he maintained several large acoustic telemetry arrays (NY, NJ, and DE) and has surgically implanted over 700 fish on a variety of species including Atlantic sturgeon, Coastal sharks, winter skates, striped bass, monkfish, flounders, horseshoe crabs and dogfish including wind specific projects (see summary below). Current research focuses on monitoring and acoustic tagging Atlantic sturgeon at Naval Weapons Station Earle, working with recreational anglers to acoustic and Satellite tag sharks to monitor post-release effects and mortality, evaluating species relative abundance and richness within Orsted Ocean Wind using eDNA samples, and evaluating the effects of EMF from wind energy cable landings on marine fish migrations in New York. Currently, he serves on the ACT_MATOS Network Steering committee for offshore wind and acoustic telemetry as well as serving at a Research Advisor for the Responsible Offshore Science Alliance.
Specifically he has extensive experience designing, installing, and maintaining acoustic telemetry oceanic arrays that include :
1) 68 acoustic receiver telemetry array along the coast of Long Island (NOAA funded)
2) 54 receiver acoustic telemetry array along the coast of NJ (NOAA Funded)
3) 24 receiver acoustic telemetry array with the Empire Wind Site (BOEM Funded)
4) 41 receiver acoustic telemetry array and VPS system cable landing site for Orsted South Fork (Orsted funded; Designed only)
5) 28 acoustic receiver VPS-telemetry array off the Delaware Coast (Saltonstall-Kennedy)
6) 21 acoustic receiver telemetry array in Raritan/Sandy Hook Bay (US NAVY/Monmouth University)

Project co-PI, Dr. Jason E. Adolf, has 20 years' experience working in the field of biological oceanography since obtaining his PhD in that field. He has successfully managed or co-managed several large projects from state and federal funding agencies including National Science Foundation, NOAA, EPA, and NJ DEP. Most recently, he was part of a team of scientists working together with the NJ DEP bi-monthly trawl survey to investigate the relationship between eDNA and trawl measurements of marine fish abundance and community composition. This resulted in a peer-reviewed publication in ICES J Marine Science (Stoeckle et al. 2020b) and has spurned numerous other projects within this general area of inquiry. Adolf will help lead environmental analyses

Project Collaborator, Dr. Jeff Kneebone has expertise in the fields of fish biology, ecology, and physiology as well as fisheries science. He has authored or co-authored over 30 peer-reviewed manuscripts on these disciplines and has active research projects investigating topics such as movement ecology, population structure, post-release/discard mortality, and life history. He actively participates in regional and national fishery management programs as a member of the New England Fishery Management Council Skate Advisory Panel and the US ICCAT Advisory Committee. He also possesses 13 years of experience tracking various fish species using passive acoustic telemetry and is well versed in the methods available to analyze telemetry data, particularly in the context of offshore wind monitoring.

Specifically he has extensive experience designing, installing, and maintaining acoustic telemetry oceanic arrays that include:
1) 33 acoustic receiver telemetry array in Plymouth Bay, Massachusetts (MA state funded)
2) 70 acoustic receiver telemetry array in Boston Harbor (MA state funded, managed 5 receivers, assisted with full array design)
3) 77 acoustic receiver telemetry array in the MA/RI offshore wind energy area (Funding from Mass Clean Energy Center, Vineyard Wind, Avangrid Renewables, Mayflower Wind, Equinor Wind, Orsted)
4) 28 acoustic receiver telemetry array in Nantucket Sound, MA (New England Aquarium funded)
5) 6 acoustic receiver telemetry array off coastal NJ (New England Aquarium funded)

Project Collaborator, Dr. Michael Frisk has expertise in the fields of modelling and statistics, fish biology, ecology, and science. He has authored or co-authored over 50 peer-reviewed manuscripts on these disciplines and has active research projects investigating topics such as movement ecology, population structure, modelling, and life history. He actively participates in regional and national fishery management programs and is currently a member of the Mid-Atlantic Fishery Management Council Scientific and Statistical Committee and Director of the New York Living Marine Resources Institute. Dr. Frisk's lab currently maintains multiple large acoustic arrays along the coast of Long Island, NY.

Captain Kevin Wark (commercial fishing collaborator), is a prominent leader in the fishing industry and is active in fishing and management (e.g., Fishery Management Councils, NOAA Cooperative Research). Kevin is a well-respected and active commercial fishermen within this region and will also serve as liason to the commercial fishing industry distributing key information at all phases of this project to the commercial industry. This will include talking with industry and notifying them of locations of our equipment to prevent interactions.

7. **Resources**: Monmouth University currently owns a VR-100 hydrophone needed to trigger VR2ARs, and operates 25 acoustic receivers, with 10 currently deployed in Raritan/Sandy Hook Bay that will be added under the scope of this project. If this proposal is funded, K. Dunton will install an additional 5-10 VR-2W receivers within Barnegat Bay to monitor the cable installation at Oyster Creek onshore interconnection point. Monmouth University also has over 200 acoustic tags currently deployed that will remain active through at least 2024, which will add to the data collection. Dunton also is Co-PI with Stony Brook University on large acoustic telemetry wind energy project with a developer in NY and Kneebone operates multiple developer funded arrays in MA. Combined we already have contributed significant tagging efforts on a variety of species that can be utilized that will allow for an immediate success within this project. Monmouth University also owns oceanographic sampling equipment (CTDs, YSIs,) and all software (ArcGIS, SigmaPlot) needed for reporting.

8. **Reporting Requirements**: Applicant(s) must deliver:
   a) Final Project Plan, Detailed Quality Assurance Project Plan, and Health and Safety Plan. These Plans, described below, should be submitted for review at least sixty days prior to commencement of data collection.
      i. *Final Project Plan.* The project plan should provide a comprehensive overview of the work after any required revisions to the submitted Proposal from the RMI team. This may include a request for additional information about methods, staffing, schedule, budget, etc.
      ii. *Quality Assurance Project Plan.* A Quality Assurance Project Plan (QAPP) to cover all aspects of the project, from project design to final report. The QAPP should include how the success of the proposed work will be evaluated, sources of error and potential effects on results, and should include field work and data collection (*e.g.*, standard operating procedures, data recording, instrument calibration, etc.), data analysis activities (*e.g.*, data quality objectives, modeling, statistical procedures).
      iii. *Health and Safety.* Projects involving laboratory or field research shall prepare a Health and Safety Plan that describes hazards of the work, how risks will be reduced to ensure the continued health and safety of all personnel, how personnel will be informed and prepared, communication in the field, emergency response, and required personal protective equipment.

   b) Quarterly Performance and Financial Reports. Performance and financial reports are required to be submitted to the DEP on a quarterly basis to provide an update and explanation of the project status. These reports are vital to the success of the project and shall be submitted complete and on time for payments to be made under this agreement. Failure to submit timely and complete reports may result in non-payment. Quarterly Performance Reports are required to be submitted in digital format. All interim work products, deliverables, as well as the Quarterly Financial Reports with documentation (receipts, vouchers, etc.) are required to be submitted with the appropriate Quarterly Performance Report.

c) Draft Final Report. An electronic copy of the draft final report shall be submitted to the State Contract Manager. The Draft will be reviewed by the RMI steering committee and comments will be provided to the Project Manager.

d) Final Report. An electronic copy of the final report shall be submitted by the Project Manager upon the completion of the project. The final report will include resolution of all comments made to upon the draft final report.

e) Data. See Data Sharing above. Additionally, a database consisting of all qualitative and quantitative information recorded as part of the study shall be submitted with the final report. In addition to the data tables, the database should include a codebook that describes the data [e.g. variable names, descriptions, format (number, data, text), units], metadata (e.g. personnel, any relevant site conditions not included as variables), and GIS files.

f) Regional Coordination. The PIs will provide the Final Report and Data to offshore wind regional coordination entities (NYSERDA, ROSA, RWSE) and/or any relevant offshore wind data sharing platforms that are developed and accepting submissions.

Evaluation Criteria:

Appendix

Table 1. Project milestones and timeline

Project Month	1	2	3	4	5	6	7	8	9	9	10	11
Month and Year	Jun 2022	Jul 2022	Aug 2022	Sep 2022	Oct 2022	Nov 2022	Dec 2022	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023
Goals	Initiate grant and finalize forms. Begin hiring process of technician Acquire POs for tagging and acoustic receiver equipment. Outreach of project with commercial/recrea tional fishermen, wind developers, management agencies	Notify USCG, Wind Developers, and commercial fishermen of final acoustic receiver locations. Begin building equipment.	Commence tagging as soon as tags come in. Begin deployment of acoustic receivers.	Continue tagging and deployment of acoustic receivers.	Continue tagging				Build and prepare for receiver array maintenance. Order Year 2 tagging equipment and supplies	Begin Download and maintenance of acoustic array.	Continue downloads and maintenance of acoustic array if needed. Continue tagging efforts; focus on Atlantic sturgeon and striped bass.	Begin analysis of download 1 acoustic data. Continue tagging efforts focus on Atlantic sturgeon and striped bass.
12	13	14	15	16	17	18	19	20	21	22	23	24
Jun 2023	Jul 2023	Aug 2023	Sep 2023	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024	May 2024	Jun 2024
Continue tagging efforts focus on horseshoe crabs and summer flounder.	Continue tagging efforts focus on summer flounder and sharks.	Continue tagging efforts focus on summer flounder and sharks.	Continue tagging efforts focus on striped bass.		Begin Download and maintenance of acoustic array, including yearly changing of batteries.	Continue downloads and maintenance of acoustic array including yearly changing of batteries if needed.	Begin analysis of download 2 acoustic data.					Begin final download and removal of equipment. Begin write up of final report
25	26	27										
July 2024	Aug 2024	Sep 2024	Oct 2024									
Continue downloading equipment Begin analyzing data	Continue analyzing data	Draft Final Report submitted to NJDEP/BP U Submission of Manuscript in Peer Review Journal	Submit Final report after incorporation of comments from Project Managers RMI steering committee									

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