

Passive Acoustic Monitoring Survey Mitigation Plan

I. Purpose of the survey

What data is collected?

Archival and real-time passive acoustic monitoring (PAM) recording technologies are used to evaluate the presence, distribution, and behavior of marine mammals and soniferous fish as well as the level of anthropogenic activity (e.g., vessels, pile driving, other wind related site evaluation and construction surveys) and ambient ocean sound levels. The former recording type requires retrospective analyses of the data, while the latter can provide instantaneous understanding of species presence. PAM data is routinely used for understanding protected species distributional changes, to evaluate risk of vessel strike, and to inform species stock assessments. However, these data are increasingly being used to inform management and mitigation needs such as understanding the impacts of anthropogenic sounds produced by wind energy development activities, delineating spawning areas for essential fish species, and mitigating the impact of construction activities.

Currently, we collect and integrate:

1. archival and real-time passive acoustic recordings from 10Hz to up to 48kHz, with occasional data collection up to 96kHz;
2. active acoustic telemetry and temperature data collected in conjunction with these recordings;
3. oceanographic data routinely collected alongside these data during shipboard surveys (e.g., Atlantic Marine Assessment Program for Protected Species [AMAPPS]) and glider surveys – this can include temperature, salinity, and prey information; and
4. visual data from aerial and shipboard surveys which are invaluable to help strengthen the interpretation of PAM data.

What specific products use this survey?

Products that use this survey include biological opinions, permit requirements for lease holders, Endangered Species Act (ESA) consultations, ship strike regulations, impact assessments, Marine Mammal Protection Act (MMPA) and ESA research, Essential Fish Habitat criteria, and National Marine Fisheries Service (NMFS) stock assessments amongst others. The MMPA, ESA statutes, and North Atlantic right whale (*Eubalaena glacialis*; NARW) regulations require these data to be collected.

Which assessments/science advice pathways currently use this survey?

These surveys are currently used by NMFS headquarters (HQ) and the Greater Atlantic Regional Fisheries Office (GARFO) for NARW management and vessel strike mitigation. They also inform NMFS stock assessment surveys for all marine mammal species. Our historical Passive Acoustic Cetacean Map (PACM) is widely used by management when trying to understand protected species overlap with intended human activity areas (e.g., construction, aquaculture development). More broadly, PAM data are used by NMFS HQ, GARFO, and the Bureau of Ocean Energy Management (BOEM) to help guide the

monitoring and mitigation plans for scientific needs as well as requirements for wind energy area (WEA) lease holders. They help inform leaseholder mitigation requirements, operational development, and monitoring plans. PAM data currently helps to improve management needs and provide recommendations on best practices for wind development. In addition, these data provide baseline data that will help inform and evaluate the potential impacts of WEA development. Lastly, the PAM survey data form part of the NOAA Ocean Noise Strategic data collection effort aimed at long-term data recordings for evaluating changes in climate, ocean sound levels, and species distributions.

Are there any formal quality standards (e.g., operational/gear requirements or standard operating procedures) for the survey that need to be considered?

Data standards for both collecting and processing passive acoustic recordings exist and are identified in Van Parijs et al. (2021). The link to this article can be found here:

[NOAA and BOEM Minimum Recommendations for Use of Passive Acoustic Listening Systems in Offshore Wind Energy Development Monitoring and Mitigation Programs](#)

Evaluation of industry/-researcher-developed acoustic software is done through our annotated acoustic data which we provide for software evaluation of acoustic analyses of baleen whales available through NOAA's National Centers for Environmental Information (NCEI) repository:

[NOAA NEFSC North Atlantic Right Whale Acoustic Data and Annotations](#)

All WEA companies are required to provide acoustic detection results, and researchers or collaborators can share their data products with us for display on the PACM ([Passive Acoustic Cetacean Map | NOAA NEFSC](#)). The available data templates for providing standardized collected data can be found here:

[Passive Acoustic Reporting System Templates | NOAA Fisheries](#)

Further standards are being developed through the Regional Wildlife Science Collaborative and other entities that build on those provided above.

Are there added values that cannot be met without this survey?

Yes, PAM is an ideal way to collect long-term baseline and/or impact data as it allows for a non-invasive methodology and continuous data collection. In addition, the ensuing recording is archived and can be re-analysed for other purposes many times over. Real-time PAM has become an effective vessel strike mitigation tool, and without these survey efforts, this highly effective mitigation approach would be lost.

How does offshore wind energy impact survey objectives going forward?

Offshore wind operations will put our recorders at risk from trawling or removal due to WEA activities. In addition, the location of the recorders will be affected both by wind energy operations and the placement of turbines. The extensive construction and operational activities will require additional monitoring both from the lease block perspective as well as regionally in order to evaluate any changes in soundscapes and marine mammal population distribution and occurrence. The positive impacts of WEA development are that there are increased PAM efforts on numerous fronts that can help add additional data to our data repository as long as the data is shared and made publicly available.

II. Survey Details

Beginning Year: 2006

Frequency: Year-round

Season: Year-round

Geographic Scope: Western North Atlantic Ocean/northeast U.S. coastal waters (Gulf of Maine to Florida)

Platform(s): Charter vessels (e.g., *Saints and Angels*, *Buckeye*, R/V *Tiago*, R/V *NOAA Auk*, and opportunistic charter vessels as needed)

Statistical Design: PAM recorder placement predominately follows our PAM regional framework plan (see map below), and moving recorders to alternative locations can result in gaps in our coverage and therefore the ability to evaluate the impacts or resulting changes in species distribution.

Methods: Passive acoustic recorders – bottom-mounted archival acoustic recorders and real-time acoustic recorders. These varying types are routinely deployed and retrieved in areas of interest. Archival recorders are deployed and retrieved every 4-5 months while real-time gliders are deployed for 3-month periods and real-time moorings need servicing every 6 months. Currently, we have 2 cruises that cover different regions for the archival recorders every 5 months while the real-time recorders are serviced by the Woods Hole Oceanographic Institution (WHOI).

III. Effect of Four Impacts

1. **Preclusion** of NOAA Fisheries sampling platforms from the wind development area because of operational and safety limitations.

The vessel surveys, cable laying, and scouring of the sea bed; the vessel operations during construction; and the placement of wind turbines will all affect where we can or cannot safely place recorders. Servicing activities should not be affected since vessels can navigate between turbines safely. Communication between our research needs and the company responsible for the relevant WEA is needed. Underwater gliders (AUVs) are less impacted by turbine location as they can navigate around them; however, with increased vessel traffic, there is an increased risk of vessel strike to these vehicles. Therefore, clear communication between the companies and our research efforts are needed.

Currently, we are in regular communication with the lease holders in and around the areas we are monitoring to try and prevent loss of equipment.

2. **Impacts on the statistical design of surveys** (including random-stratified, fixed station, transect, opportunistic, and other designs), which are the basis for scientific assessments, advice, and analyses.

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As mentioned above, the operations and turbine placement is likely to affect our ability to monitor in certain areas. Gaps in our sampling will impact our ability to draw inference with regard to distribution or behavioral changes in species distributions.

3. **Alteration of benthic and pelagic habitats** in and around the wind energy development, requiring new designs and methods to sample new habitats.

See above.

4. **Reduced sampling productivity** caused by navigation impacts of wind energy infrastructure on PAM surveys.

Both operation and turbine placement will restrict where vessels can go and where we can place our recorders, thereby affecting our Regional PAM framework design (See Figure 1. Van Parijs et al. 2021 - Supplemental I), as well as increasing risk of loss of instrumentation.

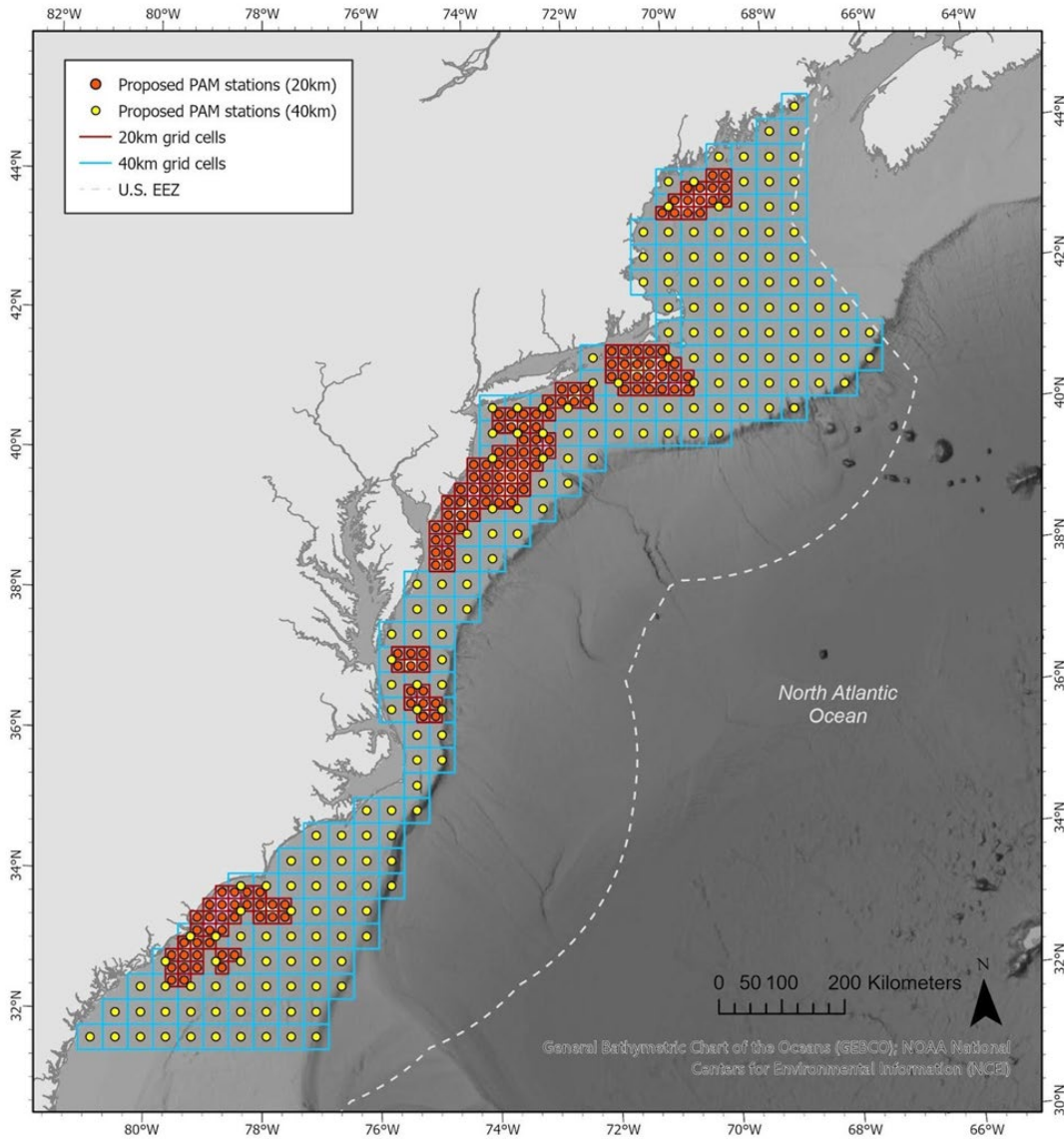


Figure 1. (Van Parijs et al. 2021 - Supplementary Figure SI-1). This diagram depicts the average listening radius over which a NARW upcall can be heard. It also depicts the 20-m grid cell (dark blue) and the 10-km listening radius (light blue) created around the vocalizing NARW for the purpose of designing PAM monitoring within a given area. This is the recommended listening radius; however, each PAM plan should build in a methodology for evaluating the detection range across their specific area, because bathymetry, depth, ocean temperature amongst other variables can influence how far a target sound can be heard.

IV. Mitigation Planned, as per Six Elements

1. *Evaluation of survey designs*

PAM surveys provide an essential data collection technique for monitoring and mitigating WEA activities. PAM is essential for evaluating WEA impacts and development with

regard to protected species, ocean sound levels, vessel traffic, and WEA survey and construction activities. PAM provides advice to management through both archival data analyses and real-time mitigation measures to reduce the impact on protected species.

Approaches needed to evaluate and quantify the impacts on the survey design include:

- evaluating how much the restrictions in placement/siting of recorders and risk of vessel strike during operation are going to restrict our ability to collect data;
- evaluating how to best keep lease holders informed of our activities so as to minimize impact on survey design; and
- understanding how turbine placement will restrict vessel access and mooring of PAM recorders in each of the lease areas.

2. *Identification and development of new survey approaches*

PAM recommendations outlined in Van Parijs et al. (2021) and adherence to the design outlined in the map above provide examples of statistical design and protocols for collecting the best available science for providing robust management advice.

New designs are continuously being discussed and developed; some areas/regions need more dense PAM coverage than others. New approaches are being discussed in collaboration with BOEM and the RWSC.

3. *Calibration and integration of new survey approaches*

PAM calibration of sound sources across different regions will be imperative so that we can understand the distance over which we can hear protected species and they can hear WEA construction and other noise sources. We have started this approach by using playback experiments to evaluate and calibrate our analyses in the Southern New England (SNE) WEA. These efforts will continue elsewhere. We have also grown our set of data management tools for our PAM recorders by incorporating a hydrophone “health check,” using a calibration tone, to allow us to evaluate equipment failure or degradation over time. We continue to work to ensure continuity and accuracy of data products.

4. *Development of interim provisional survey indices*

We have invested in PAM baseline monitoring throughout the SNE WEA as this was set for first development. This will allow us to assess changes in species distribution, vessel traffic, and ocean noise levels pre-construction. These analytical methods are standardized across all recordings to facilitate comparisons across spatial and temporal scales. Data during operational periods are currently being collected in the SNE WEA.

5. *Wind energy monitoring to fill regional scientific survey data needs*

We will need to evaluate whether a changed survey design will impact our ability to understand how construction and operation affect our statistical designs for monitoring acoustic impacts. See #3 above.

6. *Development and communication of new regional data streams*

Currently we are working closely with BOEM's Center for Marine Acoustics, NMFS HQ, GARFO, and the RWSC to form a cohesive plan for PAM monitoring that we all agree on and that can continue to provide direct research and management impact. Key constituents include wind industry developers, and we will continue to dialogue with the Essential Fish Habitat (EFH) team at GARFO and to engage with BOEM, RWSC, and other entities on PAM monitoring and recommendations. We will need help communicating our need to deploy our recorders in and around lease areas

There are new processes that we are working on, primarily migrating our data to the Cloud for storage as well as processing and moving our database and PACM web viewer to the Cloud. This is definitely going to take some time and need specific Information Technology Division (ITD) support to make it happen.

Data management needs are going to grow exponentially, and support is needed for data acquisition (purchasing recorder and vessel time to deploy and retrieve data), data management (databasing, quality assurance/quality control [QAQC] of data, data storage, and ITD support), data analysis and processing (analyst time, adequate computer processing speeds, ITD support), and dissemination (continued support of our PACM web browser development to meet WEA needs).

We need ITD support to explore the options for increased data volume storage and processing. We are going to start exploiting Cloud storage and processing options. However, these come at a cost, and if this is the right path to take, then we will need to find a long-term funding solution to be able to support this.

V. Proposed Schedule for Implementation

The work will follow the timing outlined in the Gantt chart:

[PAM WIND Gantt Chart.xlsx](#)

1. Evaluation of survey design

This is a requirement that will need to be conducted on a yearly basis to review the priorities for data sampling given the available equipment and potential conflict between WEA operations and fishing. Coordination will be needed between all other parties engaged in PAM operations.

2. Developing new PAM approaches for improved fish assessment

PAM placement will need to be thought of as part of this data collection. New methodologies and analytical approaches for integrating PAM information into fisheries assessment will need to be explored throughout WEAs.

This will include:

- PAM data collection focused on answering fish assessment questions.
- Collaborating with other researchers to add telemetry and other components to the data sampling.

- Analysis of data to demonstrate how PAM data can be integrated and be relevant to fish assessment and monitoring changes resulting from WEA development and climate change.

3. Annual and seasonal monitoring for protected species

We will continue supporting equipment purchase for, data collection of, and analysis of PAM data. Outcomes will be an improved understanding of:

- effects on distribution, behavior, and occurrence of protected species (marine mammal and fish species);
- changes in ambient sound measurements;
- impacts of construction and non-construction sound sources on protected species; and
- improved mitigation and monitoring guidance for NMFS and BOEM permitting and requirements.

4. Developing and communicating new streams of PAM data

- This effort will focus on improving data storage and processing capabilities on site (NEFSC) as well as in the Cloud.
- It will also focus on expanding the capabilities for ingesting PAM data products more readily into our PACM web tool and expand the utility of PACM itself.

VI. Links to Other Surveys

- We already closely link to other Protected Species Division (PSD) activities (e.g., eDNA, visual data collection) and work with the Fisheries Sampling Branch (FSB) to use their available boats to go and retrieve acoustic recorders that are trawled and come loose at sea.
- We are providing our temperature data to augment ocean model data at the NEFSC.
- We provide our telemetry data to the Mid-Atlantic Acoustic Telemetry Observation System (MATOS) network (see Turtle Ecology Survey mitigation plan).
- We are working on providing our bottom ocean temperature data collected on all of our recorders to those engaged in modeling climate change, species distributions and stock assessments at the NEFSC, the Environmental Research Division Data Access Program (ERDDAP), and others.

VII. Adaptive Management Considerations/ Opportunities

We are currently heavily engaged in adaptive management considerations as we plan a large-scale collaborative PAM data collection effort across the Northeast region. As part of this collaboration, we have formed relationships with BOEM, RWSC, and other agencies, institutions, and universities (see Figure 2) PAM data collection which will shift and change as capacity and baseline, construction, or operational priorities for wind farm data collection Do.

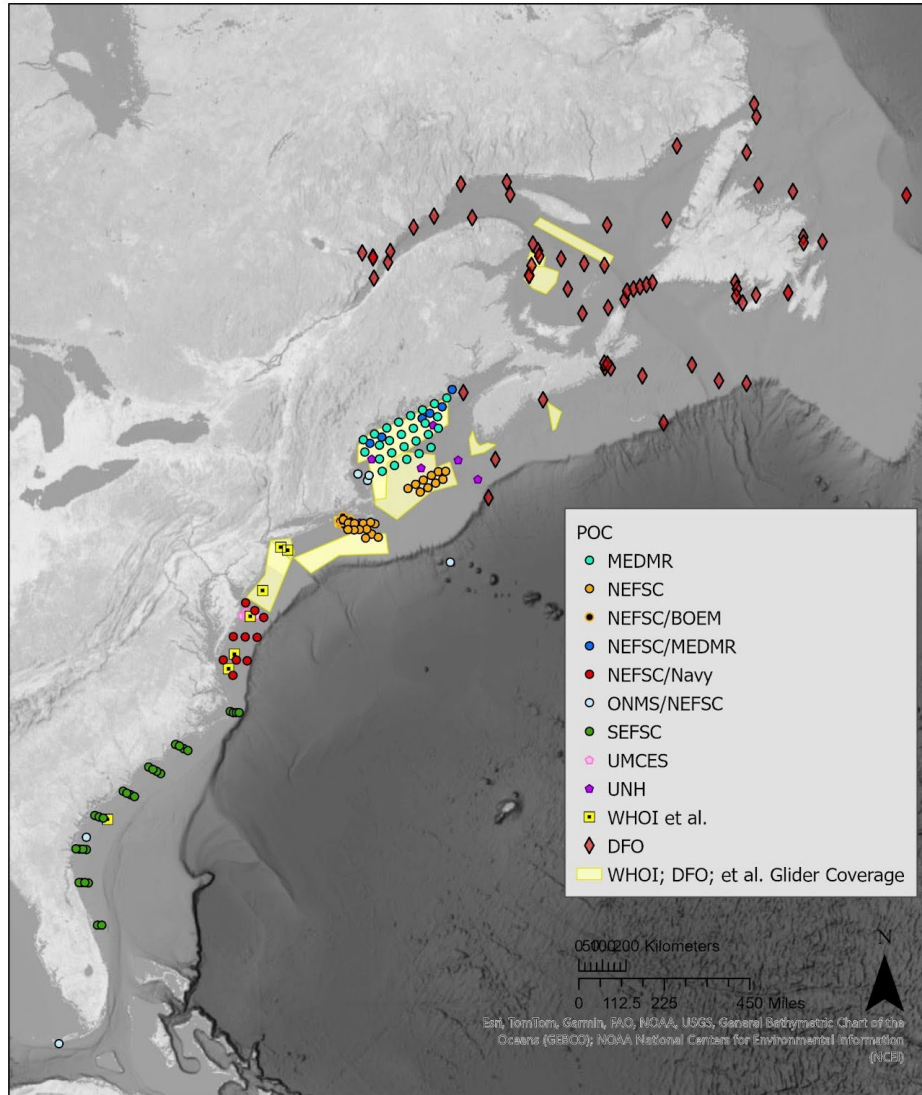


Figure 2. This map represents the extent of both archival and real time passive acoustic monitoring that is being undertaken throughout the northwestern Atlantic Ocean as of March 2024. This effort focuses on many wind energy lease areas that are either currently being developed or planned to be developed.

VIII. Statement of Peer-Review Plans

Our PAM standards are published in [Van Parijs et al. 2021](#) and we have 4 publications that focus on collecting baseline information prior to WEA development ([Van Parijs et al. 2023](#)) with additional attention given to sperm whales, (*Physeter macrocephalus*; [Westell et al. 2024](#)), North Atlantic right whales ([Davis et al. 2023](#)), and harbor porpoise ([Holdman et al. 2023](#); *Phocoena phocoena*). We will continue to publish and have our research peer reviewed through journal publication and conference presentations.

IX. Performance Metrics

Our performance metrics can be evaluated by our ability to accurately measure impacts of WEAs prior to, during, and after construction events. This will require sufficient data sampling within the area in order to be able to draw inference that is robust.

In addition, our performance is contingent on ITD being able to support our data storage and processing needs. Without this support, we will not be able to produce our data products.

X. References

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