



# Insights from AI for Passive Acoustic Monitoring (PAM) in offshore wind farms

Innovative RUBHY<sup>AI</sup> buoys from RTsys Underwater Technologies are setting new standards in marine protection during offshore wind construction. These operationally proven devices help ensure regulatory compliance while protecting sensitive marine ecosystems.

A pioneering offshore wind project along the US coast is accelerating the nation's shift towards clean energy. Once fully operational, it will generate enough electricity to power hundreds of thousands of homes, contributing significantly to regional energy independence and sustainability goals.

Located far enough offshore to remain out of sight from land, the wind farm takes advantage of strong, consistent ocean winds to maximize energy production. This strategic placement optimizes efficiency while reducing visual impact, marking an important step in integrating large-scale offshore wind into the national power grid.

Beyond its energy benefits, the project also supports regional economic growth and long-term environmental stewardship.

As part of the construction phase, PAM for protected species detection played a critical role in assessing and mitigating potential environmental impacts, particularly on marine life.



permitting process for the commercial project, a comprehensive evaluation was carried out to confirm that the project's developer and its partners employed the most effective sound mitigation technologies. Additionally, substantial monitoring measures were established to continue safeguarding marine mammals.

This article provides a detailed technical overview of the PAM operation for protected species detection conducted during a major US offshore wind project, with a specific focus on the performance of the RUBHY<sup>AI</sup> acoustic monitoring buoys developed by French company RTsys Underwater Technologies.

### Pioneering US offshore wind project using advanced PAM

#### Operational requirements and deployment strategy

The offshore wind farm construction required continuous and real-time acoustic data collection to monitor underwater noise levels and detect the presence of marine mammals. The PAM system had to operate in challenging offshore conditions while ensuring compliance with environmental regulations.

RTsys' RUBHY<sup>AI</sup> buoys were selected by RPS due to their advanced capabilities, including real-time acoustic data streaming via satellite communication, automated marine mammal detection algorithms to identify species of concern, and robust endurance and energy efficiency suitable for long-term offshore deployment.

The deployment strategy involved positioning multiple RUBHY<sup>AI</sup> buoys at key locations around the wind farm construction site to ensure optimal acoustic coverage while minimizing data gaps. Each moored buoy is equipped with broadband hydrophones for continuous underwater monitoring.

RTsys and its partners carried out a preliminary study to analyze the theoretical

detection ranges according to the species. The modelling incorporated water temperature, seabed composition and seabed topography, which then made it possible to position the buoys up to 6 km apart.

This analysis helped determine the optimal number of buoys and their positioning strategy, based on a detailed understanding of detection range and site conditions.

This PAM system incorporates an AI neural network featuring species-specific detectors, including clicks, whistles, buzzes or calls from North Atlantic right whales, Delphinidae, sei whales, blue whales, fin whales and humpback whales.

When marine mammal vocalizations are detected, the system automatically alerts onshore stationed PAM operators. These operators then review the detected pitch tracks, spectrograms focused on the suspected vocalization, and corresponding audio files to either confirm or reject the detection.

By streamlining data processing, this system reduces the analytical workload compared to traditional PAM methods, allowing operators to efficiently manage and interpret data from multiple sources without being overwhelmed.

For this project, six buoys were strategically deployed within the lease area to optimize detection coverage for ten kilometer mitigation zones around upcoming piling sites. These buoys are repositioned as necessary to enhance monitoring efficiency. Additionally, a spare buoy remains onsite, ready for rapid deployment in case of any damage that cannot be resolved remotely.

At any given time, three buoys remain active, continuously recording and transmitting detection data to the operators. The active buoys are selected based on the locations of ongoing piling activities to ensure comprehensive monitoring of the mitigation zone for North Atlantic right whales.

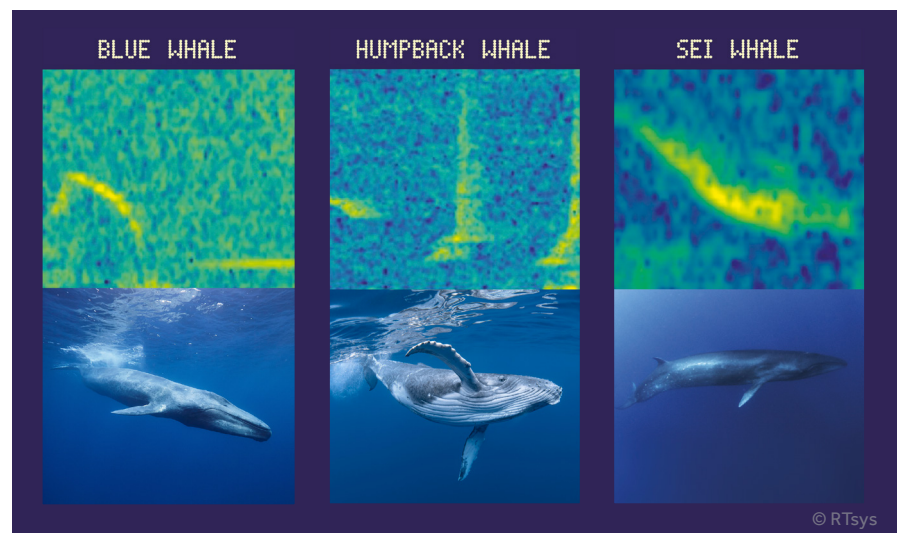
The whales have been listed as endangered under the Endangered Species Act since 1970.

The Atlantic Coast's waters host a diverse range of marine life. Recognizing this, the team behind the offshore wind project has partnered with its Engineering, Procurement, Construction and Installation (EPCI) contractor to deploy high-performance measures, ensuring construction proceeds in compliance with regulatory requirements designed to minimize impact on marine ecosystems.

The operational team also includes nine certified Protected Species Observers (PSOs) provided by RPS, a Tetra Tech company, who are on duty during piling activities. Observers stationed on the main installation vessel and two dedicated auxiliary vessels continuously monitor for marine mammals and will suspend work if any species are detected within the exclusion zones. All personnel aboard the vessels receive environmental training, including instruction on identifying certain marine species and the team also monitors underwater sound in real time.

In addition to the seasonal piling ban, a double bubble curtain is deployed during piling operations. This technique uses multiple air compressors to form two walls of air bubbles, which act as a noise barrier, reducing sound waves created by pile driving the foundation into the ocean floor and protecting marine mammals.

During the National Oceanic and Atmospheric Administration (NOAA)



There are approximately 370 individuals remaining, including about 70 reproductively active females.

**Performance evaluation of RUBHY<sup>AI</sup> buoys**

The RTsys detection system has operated continuously, 24/7, producing 1,138 days of uninterrupted recordings. During this time, 514,000 spectrograms and 17,800 audio clips were transmitted, all enabled by the impressive performance of the embedded AI within the moored buoys.

All of this was achieved while demonstrating strong resilience to harsh weather conditions: the buoys withstood winds exceeding 100 km/h and waves over 5.8 m. This performance highlights the precision and efficiency of the acoustic monitoring technology, which plays a crucial role in protecting marine wildlife while supporting the safety of maritime operations.

The data collected offers unprecedented insights into the behavior of marine species and reinforces RTsys’s leadership position in the development of environmentally responsible solutions.

During the installation campaigns, the buoys demonstrated outstanding reliability and data accuracy. The key performance indicators assessed include detection sensitivity, real-time data transmission, environmental robustness, and energy efficiency.

The hydrophones successfully detected a range of frequencies relevant to marine mammal monitoring, with a high signal-to-noise ratio. The satellite communication system provided stable data transfer, allowing for immediate analysis by onshore teams.

Despite harsh weather conditions, including high winds and turbulent waters, the buoys maintained continuous operation without significant data loss. The solar powered



system ensured sustainable performance over extended deployment periods.

**Regulatory compliance and impact on mitigation measures**

The RUBHY<sup>AI</sup> buoys played a critical role in ensuring this pioneering offshore wind project met all federal and state environmental regulations during construction.

Real-time monitoring allowed for adaptive mitigation, such as halting pile driving when marine mammals were detected in critical zones. This guaranteed compliance with the Marine Mammal Protection Act (MMPA).

Continuous acoustic data collection also supported thorough impact assessments and reporting, meeting the Bureau of Ocean Energy Management (BOEM) and National Environmental Policy Act (NEPA) requirements.

The integration of RTsys’s technology in the PAM framework provided a high level of confidence to regulatory bodies and stakeholders, demonstrating a commitment to environmental stewardship.

**Advantages of RUBHY<sup>AI</sup> buoys over traditional PAM systems**

Compared to conventional PAM solutions, the system offers several distinct advantages. It features automated AI-driven detection and classification, reducing reliance on manual data analysis.

Its compact design and autonomous operation allow for greater deployment flexibility while keeping the requirements for robustness, power endurance and data storage capabilities for long-term projects.

Real-time alerts and remote diagnostics enable rapid response to critical acoustic events. The system is scalable for large offshore wind projects requiring extensive monitoring coverage.

The successful implementation of these buoys in large-scale offshore wind construction demonstrates their critical value for acoustic monitoring in the sector.

Their ability to provide high-fidelity, real-time acoustic data has proven essential for regulatory compliance, marine mammal protection and environmental impact assessment.

For future offshore wind projects, investing in advanced PAM solutions like RUBHY<sup>AI</sup> will not only ensure adherence to environmental regulations but also enhance operational efficiency and stakeholder confidence.



[rtsys.eu](https://rtsys.eu)

[tetratech.com](https://tetratech.com)