Environmental Monitoring

DEEP DIVE

*The **DMEC Deep Dives**, taking place on 3 March 2026 covers the topic Environmental Monitoring. What precisely is environmental monitoring, why is it an important element in the operational & maintenance procedure of offshore wind farms? Check out this wrap up report to learn more!*

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Image: DMEC

Environmental Monitoring - Whys?

As offshore wind parks develop, the discussion about their positive & negative impacts on the ecosystem grows.

The energy transition and sustainable blue economy requires significant contributions from offshore renewable energy, for example from offshore wind farms. At the same time, biodiversity crises are present across not only the EU waters but on a global scale. Environmental monitoring can help us understand how we can achieve an energy transition that has minimal negative and even positive effects for marine ecosystems.

The evidence on the impact of offshore wind farms remains partly ambiguous, for instance, on the interpretation of the new habitats that build around the infrastructure - whether it's positive that fish find refuge in offshore wind farms or if this acts as a stepping stone for the distribution of invasive alien species. Open questions also remain on the effect of the offshore wind farms versus natural variability, on long-term effects as well as cumulative effects.

To answer these questions, we need more, better, and probably different environmental monitoring. Dive in!

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Balancing ecological protection & energy transition goals

The North Sea stands at the crossroads of two urgent imperatives: accelerating the offshore wind energy transition and protecting its fragile marine ecosystems. The Offshore Wind Ecological Programme (Wozep), led by Rijkswaterstaat, embodies this delicate balance, transforming scientific research into actionable policy insights. By focusing on the cumulative impacts of wind farms comprehensively, Wozep examines how underwater noise, physical structures, and operational activities affect species from birds and bats to marine mammals and benthic life. Their mission ensures that the energy transition doesn't come at nature's expense, but instead aligns with ecological preservation.

Developing innovations such as AI-driven video analysis, radars, and the Framework for Assessing Ecological and Cumulative Effects (KEC), the programme models how wind farms influence food chains, hydrodynamics, and species behavior over time. Research isn't confined to direct impacts; it also explores indirect effects, such as how changes in fish populations might cascade through the ecosystem. Wozep results in insights into area effects, impact assessment, policy, mitigation of negative impacts, spatial choices, advice for ecological tenders; all while ensuring that decisions are based on latest scientific findings via the collaboration of many scientists and the openness and transparency with the public on a national & international level.

For the offshore sector, Wozep's work is a blueprint for sustainable development. It proves that energy transition and ecological protection aren't opposing forces, but complementary goals. By fostering alliances across research, policy, and industry, the programme is helping to write a new narrative for the North Sea - one where every turbine installed reflects a commitment to both clean energy and a thriving marine world. In this balance lies the key to a future where progress and preservation go hand in hand.

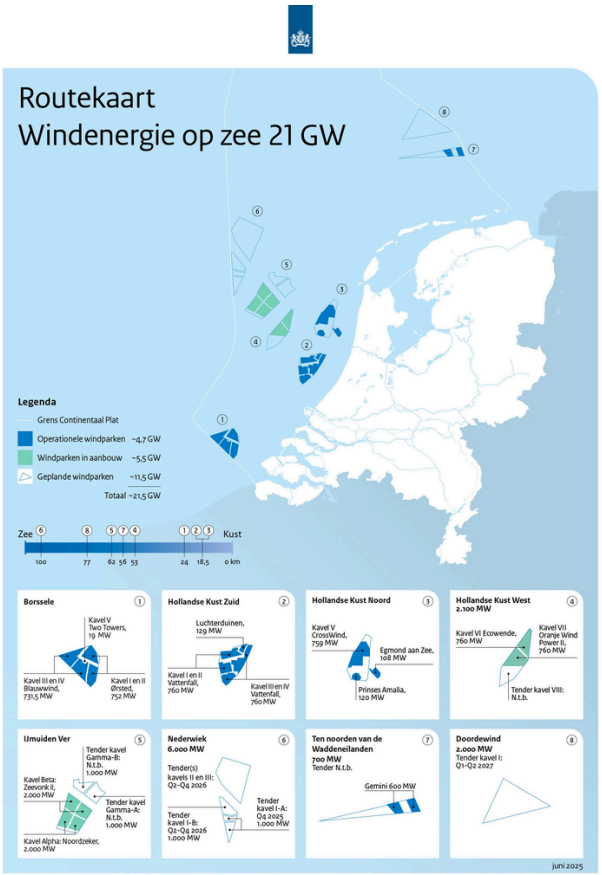

Image: RWS

For many offshore wind developers, biodiversity is now central to energy transition strategies. RWE Offshore Wind's approach focuses on a "biodiversity-positive" commitment, built on three pillars: monitoring & data transparency, negative impact reduction and positive contributions. This approach moves beyond compliance to restore habitats and protect species, embedding sustainability into every project phase.

The UK-focused Offshore Renewables Joint Industry Programme (ORJIP), consisting of many offshore wind project developers and coordinated by Carbon Trust, exemplifies this developer-driven innovation, focusing on cumulative impact assessments: a critical gap in current offshore wind planning. ORJIP is tackling this challenge by collating existing evidence and developing advanced modeling tools to understand direct impacts and displacement effects and predict long-term consequences. The programme's scope extends from birds, to fisheries, benthic communities, and marine mammals, while fostering a feedback loop with specialist advisors and regulators to ensure lessons from one project inform the next. This approach doesn't just mitigate risks; it transforms challenges into opportunities for smarter siting and innovative mitigation strategies, such as adjusting turbine layouts to reduce bird collision risks or optimising installation strategies to reduce noise impacts on marine mammals. In addition, the techniques from the ORJIP programme are also able to be generalised beyond the UK waters and species.

At the forefront of innovative environmental monitoring for offshore wind is RWE's SeaMe project. The project, located at Kaskasi offshore wind farm in Germany, aims to revolutionise marine environmental monitoring through innovative, non-invasive and low-emission technologies. Aiming for a holistic ecosystem-based monitoring approach, an integrated monitoring system was developed that combines the simultaneous collection of data on species and physical parameters and the integration of the data to understand interactions between them.

lAdvanced monitoring is also very important for the offshore wind sector's ambition of 'biodiversity positivity', for example combining long-term, high-resolution geophysical, visual and eDNA monitoring of novel nature-inclusive design technologies (e.g., the RESP scour pad pilot to measure their efficiency.

Image: RWE

Rigorous monitoring & data collection standards are needed across regions & sea basin levels to facilitate data comparability

Standardised, high-quality data collection: Robust, cross-regional monitoring standards and long-term data management are essential to ensure comparability, scalability, and reliability - enabling consistent insights across sea basins and reducing noise in biodiversity assessments.

Innovation and cross-sector collaboration: Advancing new research methods and fostering cross-border, cross-sector data sharing (e.g., on offshore wind's downstream effects) maximises data utilisation, drives standardisation, and ensures transparency in how data is measured and reused.

Integrated, purpose-driven data systems: Combining datasets through standardised portals and collaborative platforms transforms fragmented information into a cohesive, ecosystem-level understanding - making the whole greater than the sum of its parts for informed decision-making.

Advancing marine monitoring through innovations

Methodological excellence in eDNA for biodiversity assessments

Environmental DNA (eDNA) is transforming how we detect and monitor marine species, offering a scalable, non-invasive, and highly efficient alternative to traditional survey methods. By analysing genetic traces left by organisms in water, eDNA delivers a robust, data-rich approach to biodiversity assessment. Applied Genomics has refined this into three critical steps: collection, sequencing, and bioinformatic analysis, with a focus on replicable, high-resolution surveys and sufficient sample volume to accurately capture species richness.

Many eDNA technologies were developed in freshwater environments and are poorly adapted to the hydrologically complex conditions of offshore waters. Applied Genomics addresses this directly through high-volume filtration, tidal-cycle programming (continuous 24-hour sampling), and autonomous operations, delivering a comprehensive, high-fidelity picture of marine biodiversity. Results from a 12-year weekly monitoring programme resulted in nearly 500 samples analysed with zero failures, this programme showed a return-on-investment of 7:1 for data volume, and 5:1 for cost savings, compared to conventional catch-and-count monitoring approaches. The result is a scalable, future-proof framework for marine ecological surveys.

A key area of ongoing development across the eDNA field is reference database coverage. For well-documented species, reference sequences are readily available, enabling reliable detection. As research expands into less-explored environments, Applied Genomics works proactively to address gaps in reference data, and crucially, once new reference sequences are established, historical eDNA datasets can be reanalysed retrospectively, uncovering previously undetected species and continuously improving the value of existing datasets over time.

Combining remote asset inspections with environmental monitoring

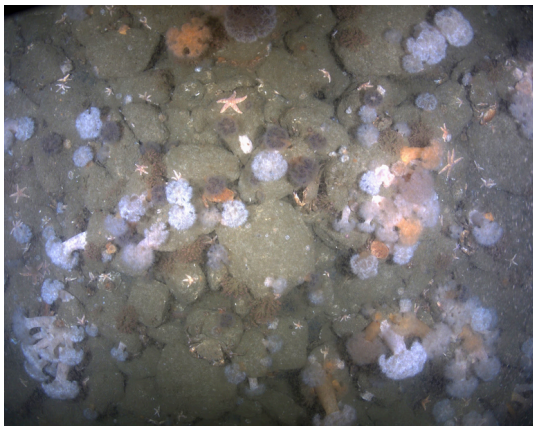

Image: Fugro

The BeWild project takes marine monitoring a step further by combining environmental surveys with asset inspections - all conducted remotely. Using uncrewed surface vessels (USVs) and remotely operated vehicles (ROVs) deployed via umbilical cords, BeWild enables real-time, high-definition monitoring of offshore infrastructure, such as monopile scour protection, while simultaneously collecting biodiversity data. This integrated approach is designed to be cost-effective and operationally efficient, with surveys controlled remotely from Aberdeen and a focus on machine learning-enhanced eDNA sampling.

Since its launch in 2023, BeWild has undergone sea trials at CrossWind (2025–2026) and is currently testing its technology at the Hollandse Kust West Wind Park, where ROVs collect HD video and eDNA samples from three monopiles. The goal? To build baseline datasets, refine remote surveying techniques, and develop biodiversity "nodes" that provide continuous, complementary species detection. By merging asset monitoring with ecological surveys, BeWild is pioneering a new standard for offshore operations – one that reduces costs, minimises human risk, and maximises data utility for both industry and conservation.

Remote surveys using USVs and ROVs revolutionise marine monitoring by making real-time and baseline data collection more cost-effective and precise, eliminating the need for expensive dedicated expeditions. While real-time insights are valuable, the priority is high-quality baseline monitoring - capturing pre-construction ecological conditions - through automated, accurate sampling during routine operations. Scaling this up requires integrating multiple techniques (eDNA, HD imaging, acoustics) into standard workflows, ensuring consistent, reliable data that supports both immediate decisions and long-term biodiversity tracking.

The path forward

Developers are funding enormous volumes of marine monitoring data, but too often, this data remains underused, poorly harmonised, and rarely synthesised at a regional scale. The high cost in data collection in combination with data transparency issues remain critical bottlenecks. Regulatory pressures are increasing in Europe due to the amount and plurality of stakeholders, due to which processes take longer. For this, transparency and harmonisation efforts are key. To take the next steps, data transparency should be mandated - this should be a two-way push from both industry collaboration across institutions, and a supported regulatory framework from the policy side. Only then can we turn raw data into regional strategies that benefit biodiversity, developers, and regulators alike.

Image: Applied Genomics

More focus should be put on real-time environmental monitoring to inform adaptive management? Its value depends on the species and the ecological context.

Gathering extended, seasonal real-time data is critical for birds due to their migratory characteristics, and real-time data are essential for active management strategies such as turbine curtailments. On the other hand, for benthic communities, real-time data are less urgent because the speed of change is slower. However, the bigger challenge isn't just the frequency of data collection but how surveys are designed and interpreted. Current environmental monitoring often lacks adaptive management in the roll-out of the surveys themselves, which would allow corrections for intrinsic errors and update assumptions. Managing these challenges ultimately leads to better data collection, which results in a more in-depth understanding of the environment. The focus should shift to flexible approaches - where data collection evolves alongside new insights. For instance, allocating 10% of efforts to trial studies and 90% to follow-up refinements could foster innovation, allowing researchers to redesign campaigns based on preliminary findings rather than adhering to static methodologies.

Image: Fugro

Challenges for adaptive management also result from policy constraints, as permits are issued and turbine designs are finalised well in advance, which limits flexibility. For the North Sea, bringing key stakeholders together is essential to achieve adaptive management that works at sea-basin scale. This can take shape in the forms of integrating data collection, analysis, and assessment into a continuous feedback loop that accounts for missing data, changing conditions, and long-term planning.

Collaborative, iterative, long-term monitoring that integrates data collection, analysis, and reassessment, while balancing cost, coverage, and flexibility is needed to inform smarter, more responsive management.

Thank you!

Thank you to the active contributions from all participants. A special thank you to all of our speakers for sharing their insights & experience with us during DMEC Deep Dive: Environmental Monitoring. Should you have any questions to the speakers, please reach out to us so that we can forward you to the right contact.

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About us

As a non-profit accelerator and knowledge centre, DMEC supports the development of sustainable offshore renewable energy solutions, including the innovation of offshore system integration, storage and nature+.

In our quarterly Deep Dives, we share knowledge & ideas and explore topics related to offshore renewable energy. Do you want to be invited? Please sign up for our Community **here**.

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For more information about our Nature+ expertises please refer to our **website** or contact

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