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Global Initiative for Nature, Grids and Renewables

Biodiversity Monitoring for Offshore Wind Energy: Challenges, Opportunities and Tools

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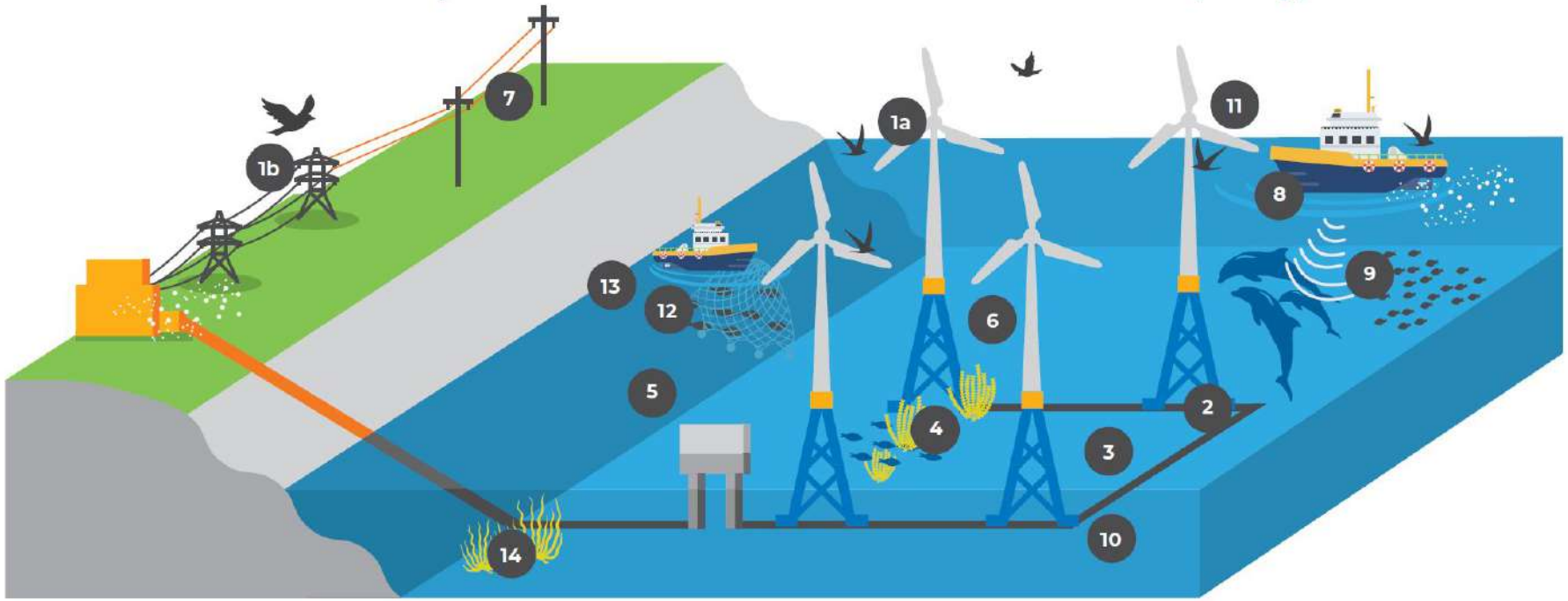
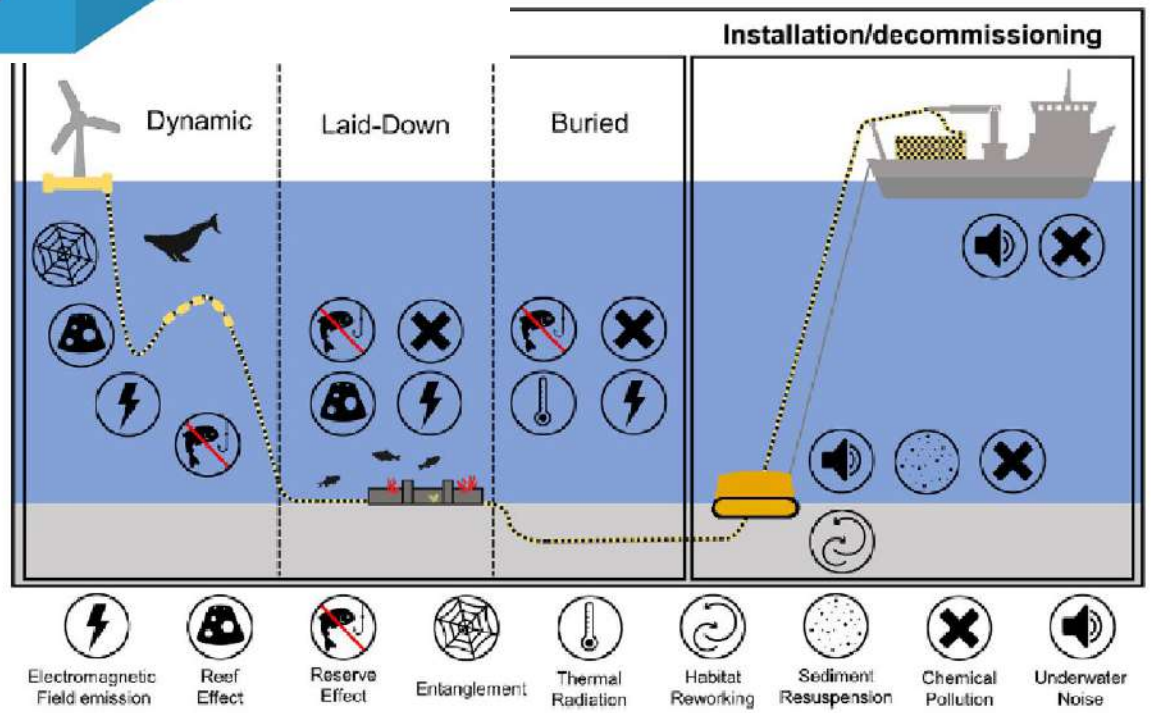


Bennun et al. 2021. Mitigating biodiversity impacts associated with solar and wind energy development. Guidelines for project developers. Gland, Switzerland: IUCN and Cambridge, UK: The Biodiversity Consultancy.



Taormina et al. 2018. *Renewable and Sustainable Energy Reviews*, 96: 380-391.

Data Needs

To facilitate data-driven maritime spatial planning and environmental mitigation measures, it is essential:

- to monitor environmental pressures and impacts (as per EIAs and SEAs)
- to monitor activities and outcomes from applying nature-inclusive designs or restoring habitats and species.

Therefore, monitoring marine fauna and flora around offshore wind farms and grids is essential during planning, operating, repowering and decommissioning

However, many actors are unclear on the best monitoring methods and struggle to acquire the biodiversity data they need.

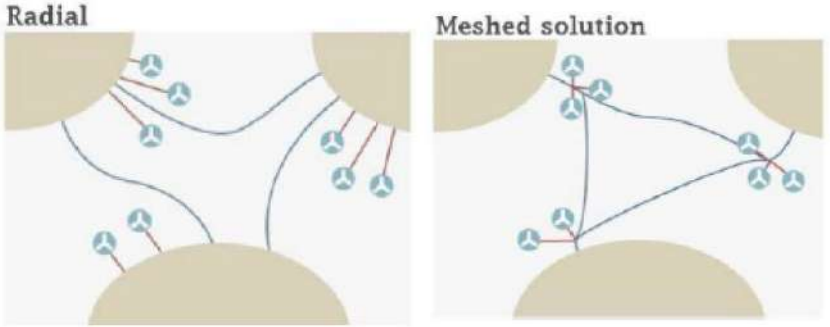
Challenges

Most marine species are small and live underwater
Ocean conditions often unfavourable to species detection (inclement weather, high seas).
Pressures on nature that need to be monitored vary:

- between taxa
  (e.g. mammals more impacted by noise, birds by collisions)
- between different stages of operation
  (e.g. habitat loss during construction; bird strikes during operation)
- between the design and type of technology used
  (e.g. bottom-fixed versus floating turbines; meshed versus radial grid connections).

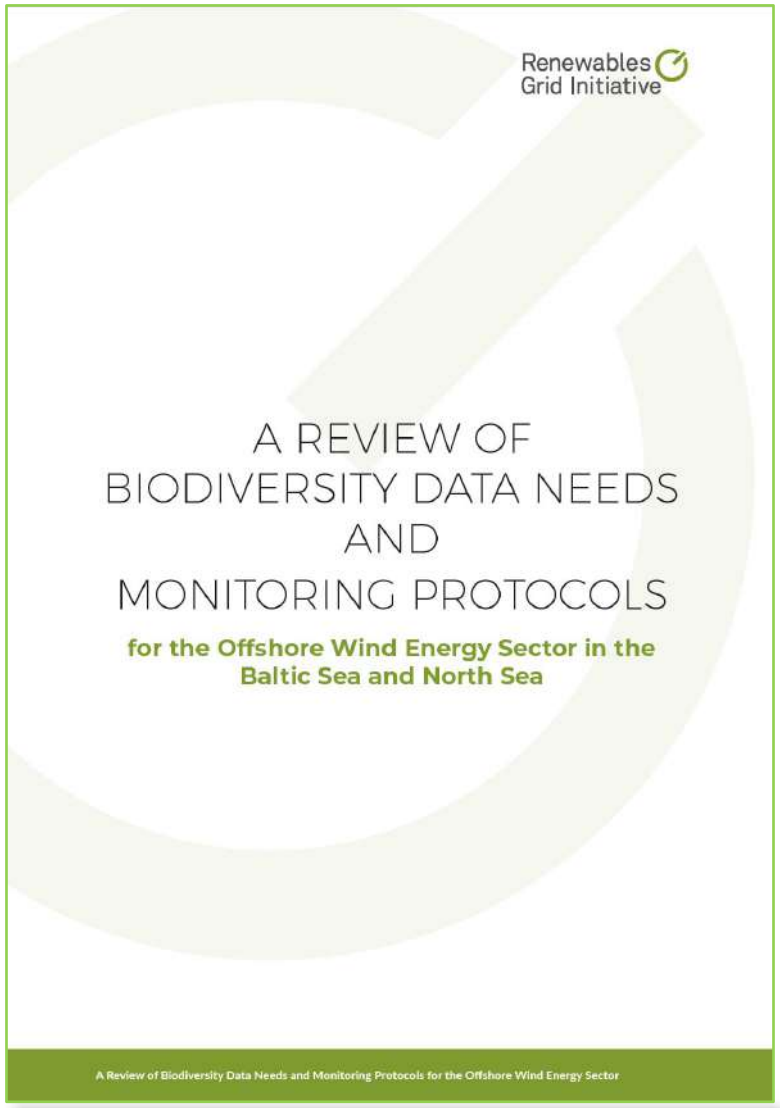
Methods used to collect data vary between sites and countries
Data are not shared adequately and lessons are not learned and shared.

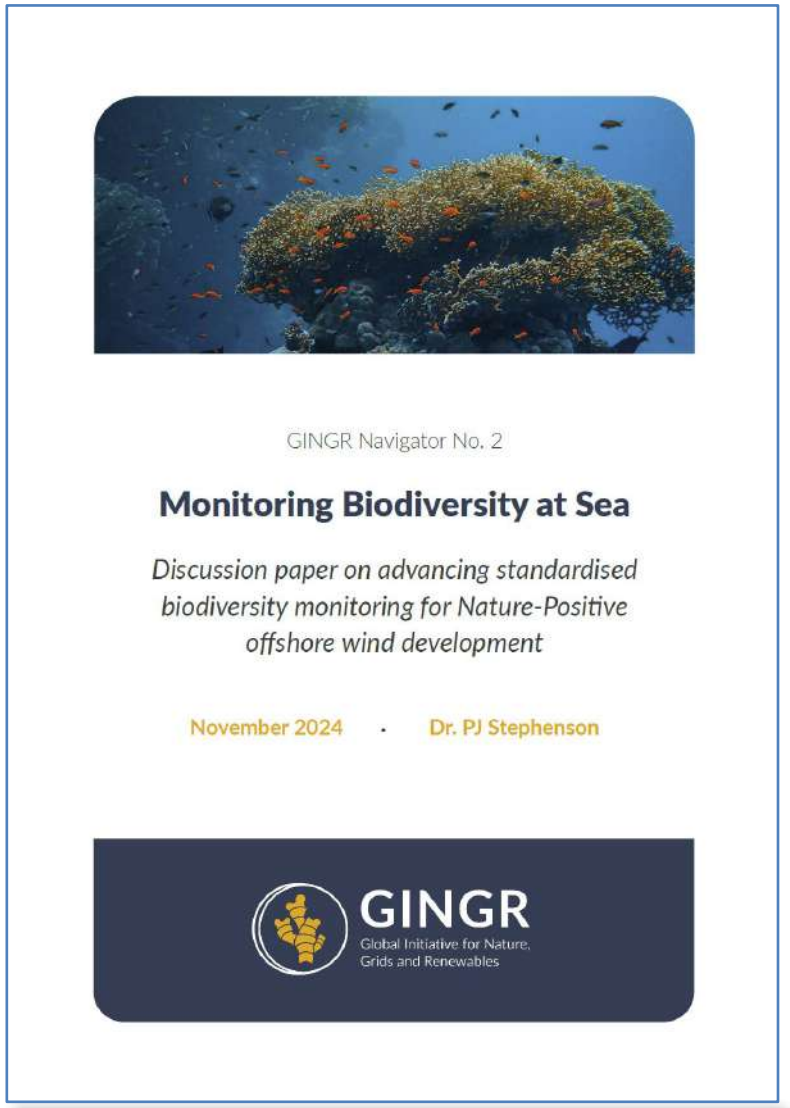
Photos © PJ Stephenson



Cole et al 2014. Report to the EC.

Addressing Monitoring Challenges





Principles for Enhancing Monitoring of Nature Around Offshore Wind Energy

Survey and monitoring will depend on environmental conditions and legal frameworks. But…

A more integrated, standardised approach across the sector would help to

- compare sites
- aggregate data
- study cumulative impacts
- facilitate results-based planning and decision-making.

Four principles should be kept in mind…

Principles for Enhancing Monitoring of Nature Around Offshore Wind Energy

Principle 1: Key stakeholders should be engaged in planning and implementing biodiversity monitoring

Principle 2: Monitoring methods should be based on the indicators being measured and the questions being asked

NOT the technology people want to use!

Methods should be chosen due to:

- relevance to the indicators, species and habitats
- available budget and capacity
- national or regional standards, policies or legal requirements.

Principles for Enhancing Monitoring of Nature Around Offshore Wind Energy

Principle 3: Invest in and build capacity where it is most needed

Principle 4: Data should be shared and made freely and openly accessible to others.

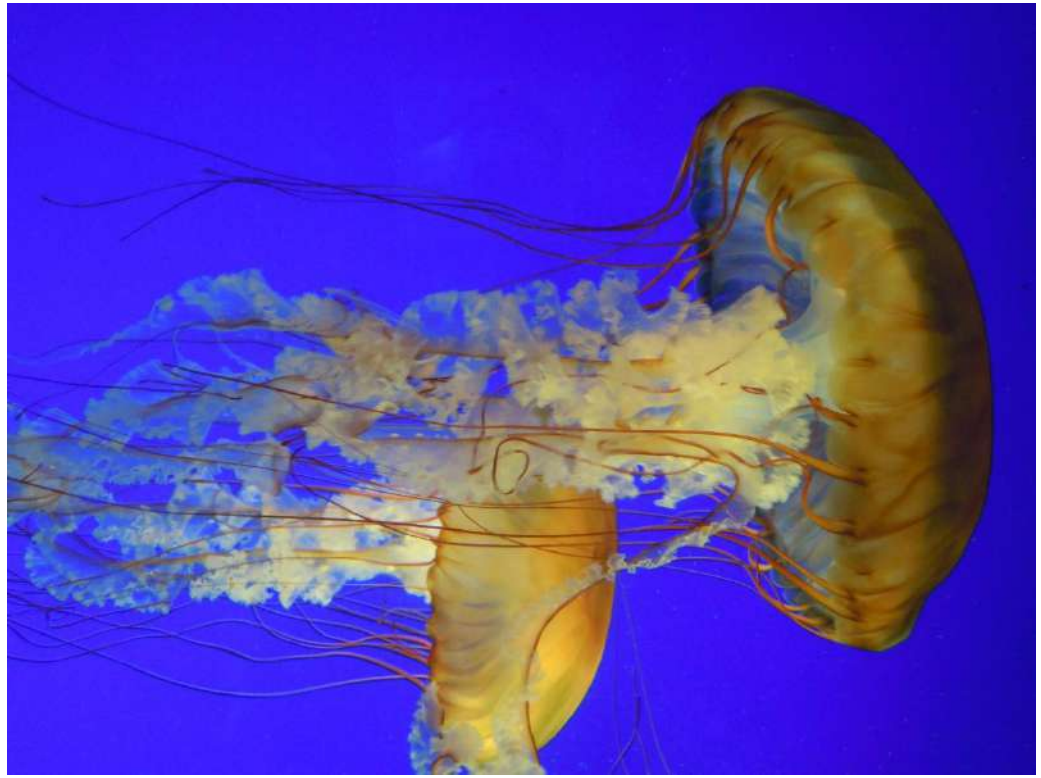
Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Step 1: Define the scope and the spatial and temporal scales for the monitoring strategy.

Scope devised around the key questions, such as:

- Which marine species and habitats occur in the area before and after construction?
- Are there any seabird or seal colonies in the area that might be foraging or breeding at the site?
- Is the site used by migratory birds and when?
- Are there any protected areas present that need to be safeguarded?
- How severe are the threats to marine life? For example, what is the level of noise? What is the distribution and abundance of invasive alien species?
- Does the distribution and abundance of species change as a result of the wind farm?
- Are mitigation measures and Nature-Positive actions impacting the fauna and flora?



Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Step 1: Define the scope and the spatial and temporal scales for the monitoring strategy.

Monitoring scope may be:

- thematic (e.g., focused on certain pressures or Nature Positive responses),
- taxonomic (e.g., fish, marine mammals)
- geographic (e.g., a given wind farm, national waters, a sea basin)
- or a combination of the three.

Spatial scale:

- tends to be the offshore wind farm and a suitable buffer zone

Temporal scale:

- National policies and standards usually suggest monthly surveys across contiguous seasons for at least 2-3 years before consent and up to 5 years after
- Some indicators are best monitored throughout the operational life of the wind farm.

Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Step 2: Identify target taxa and habitats for monitoring, to focus on those species most impacted by offshore wind development or associated Nature-Positive action

Most impacted taxa are usually birds, seals, small cetaceans and the benthic fauna and flora.




Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Step 3: Develop the key elements of a monitoring plan

Take account of national or regional strategies, policies and legal frameworks.

Contents of a monitoring plan:

- Indicators – "What"
- Methods – "How"
- Timing/Frequency – "When"
- Roles and responsibilities – "Who"
- Location – "Where"

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Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Step 3: Develop the key elements of a monitoring plan

Indicators

Indicators should measure

- biodiversity state (e.g., species abundance; habitat extent)
- pressures on biodiversity (e.g., number of invasive alien species; level of noise; level of pollution; number of bird strikes)
- activities that cause or mitigate pressures (e.g., number of incidents of shutdown-on-demand; area of mussel beds restored, painting of blades in black or red).

If the indicators used are common across different sites or monitoring strategies, it helps facilitate comparisons and data aggregation.

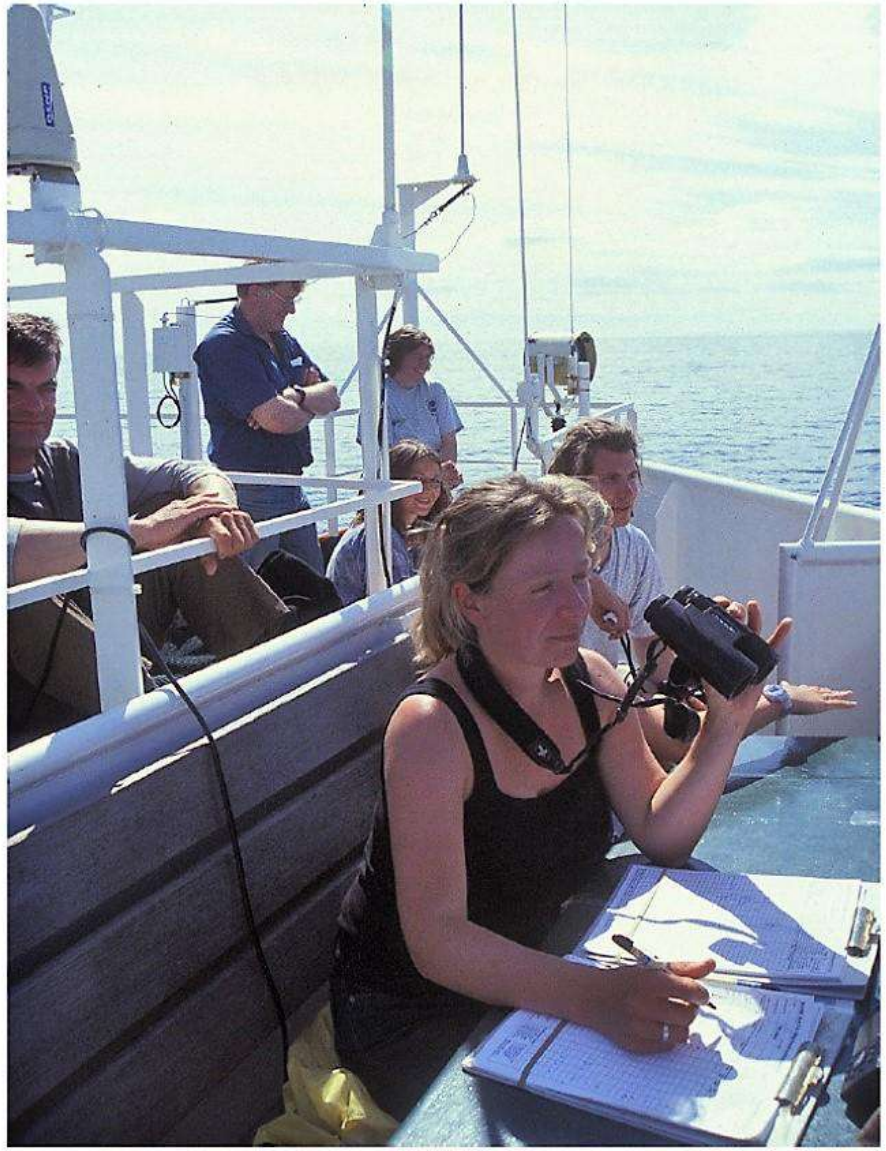
Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Step 3: Develop the key elements of a monitoring plan

Methods and data sources

Lahoz-Monfort & Magrath 2021. *BioScience*, 71: 1038-1062.

Ship-based and aerial surveys



Seabird at sea survey, Wee Bankie (E Scotland), summer 2003 (CJ Camphuysen)

Figure 1. Partenavia P-68 Observer aircraft. Note the plexiglass nose for pilot and front seat observer, and bubble windows on both sides of the aircraft in the rear passenger panels (see on open door to right).

Camphuysen et al. 2004. Royal Netherlands Institute for Sea Research.

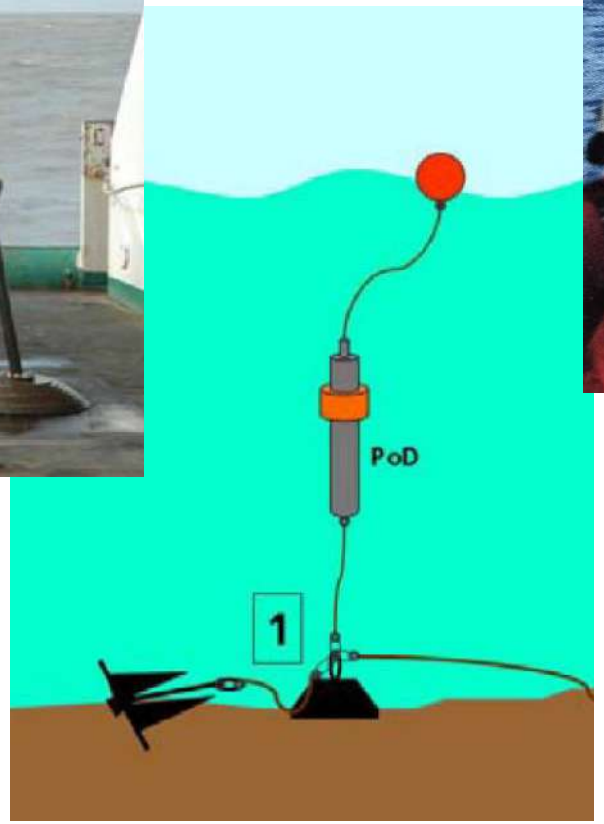
Grab sampling

Tuit & Wait 2020. Environmental Forensics, 21:3-4.

HELCOM 2015. Recommendations and Guidelines for Benthic Habitat Monitoring…

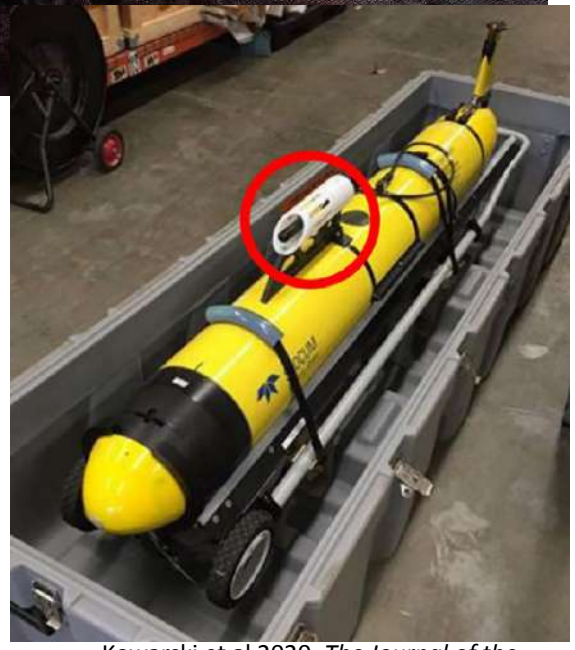
Passive acoustic monitoring

Image: J.Backers, MUMM



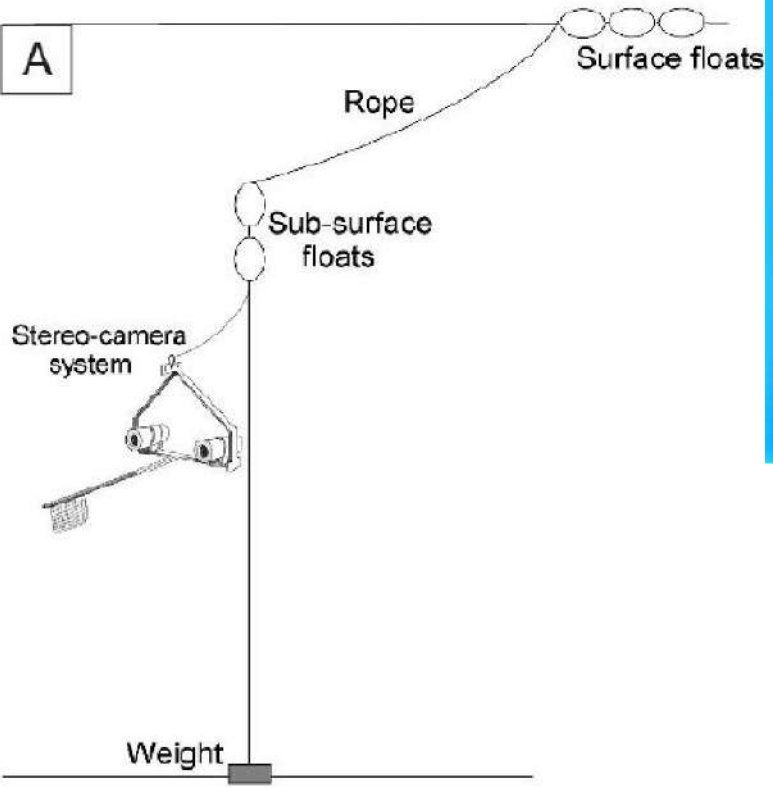
Haelters, J. (2009). *Royal Belgian Institute of Natural Sciences, Department MUMM, Brussels, Belgium*.

Perrow 2019. *Wildlife and Wind Farms, Conflicts and Solutions. Volume 4.* Pelagic, UK.



Kowarski et al 2020. *The Journal of the Acoustical Society of America*, 148: 1215-1230.

Baited Remote Underwater Videos



Photograph: Pelagic stereo-BRUV deployed in French Polynesia. Credits: Manu San Felix, National Geographic Society (2014).

Source: Bouchet et al. 2018. Marine sampling field manual for pelagic BRUVS. In *Field Manuals for Marine Sampling to Monitor Australian Waters,* National Environmental Science Programme. pp. 105-132.

Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Step 3: Develop the key elements of a monitoring plan

Methods and data sources

Monitoring methods should be

- accurate (with minimal error),
- reliable (consistently repeatable with minimal variation in results),
- cost-effective,
- feasible to use,
- appropriate (in this case, ensuring they answer specific questions and are statistically meaningful)
- precise enough to measure the change monitored and to signal any relevant thresholds identified.

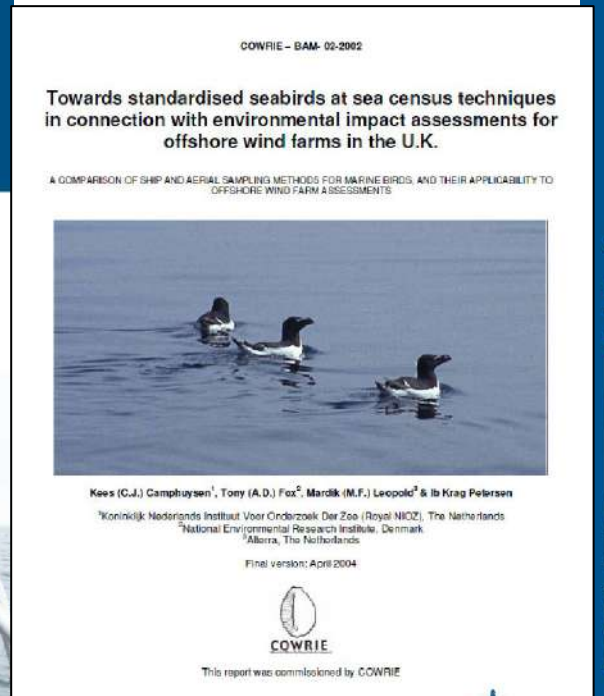
Some flexibility is needed to account for local conditions, taxa, remoteness of site, etc.

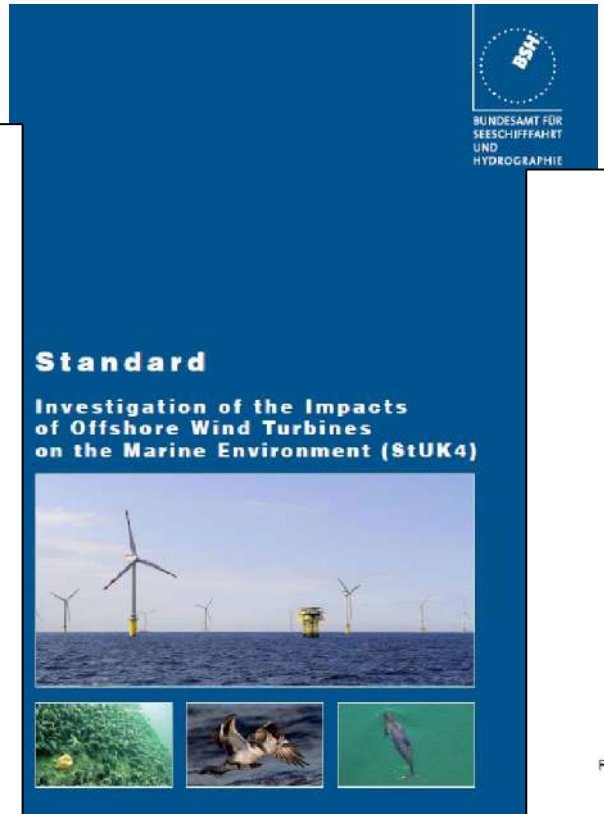
Key Steps to Develop and Implement Biodiversity Monitoring Strategies

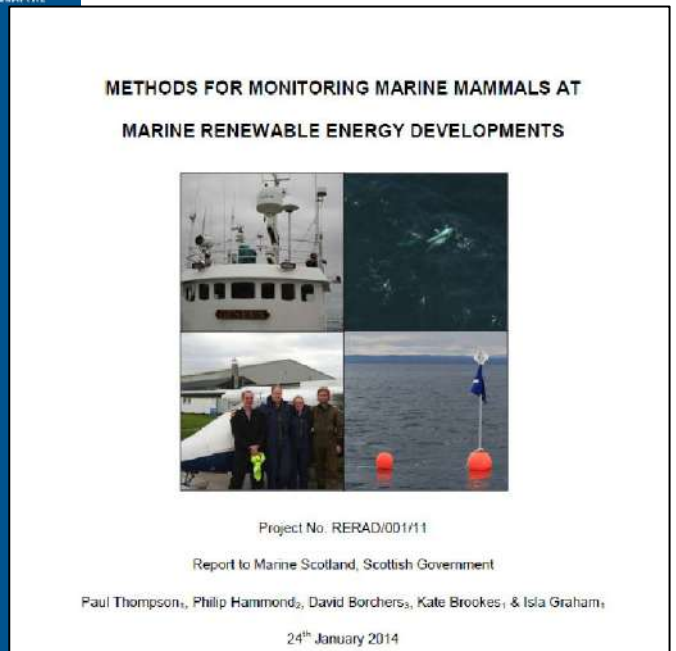
Step 3: Develop the key elements of a monitoring plan

Methods and data sources

Methods should follow standardised protocols to harmonise approaches and follow best practices for ensuring robust sampling design, statistical power and consistent replication of methods.







Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Step 3: Develop the key elements of a monitoring plan

Methods and data sources

Weigh up the pros and cons of the options available

Method	Pros	Cons
Vessel-based line transect surveys	*Data allow for estimation of absolute or relative density & abundance using distance sampling; Can collect data on age, sex, behaviour (such as foraging sites) and flight height; Well established and robust methods for assumption violations, especially for large vessels; High detection and accuracy of species identification compared to visual aerial surveys (taxa identified to species more often from the boat than in the video aerial data); Additional environmental data can be collected (e.g., water temperature, salinity, depth); *Other taxa can be monitored at the same time, especially marine mammals; e.g., PAM with towed arrays can be used at the same time;	Can be expensive (depending on spatial and temporal scale required); Restricted by weather conditions and to daylight hours; *Can cause responsive movement of animals (avoiding vessel or attracted to vessel); *Surveying speed does not allow coverage of large areas in single trip and causes temporal mismatch in different parts of survey area; Constraints on surveying nearshore in shallow water or near reefs/sandbanks; Lower detection of divers, grebes and seaducks compared to aerial surveys and poor detection of migrant species or other groups; Observers require training period and must have good species identification skills.

Stephenson, P.J. 2021. *A Review of Biodiversity Data Needs and Monitoring Protocols for the Offshore Wind Energy Sector in the Baltic Sea and North Sea.* Renewables Grid Initiative, Berlin, Germany. https://renewables-grid.eu/publications/study-offshore-biodiversity.html

Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Step 3: Develop the key elements of a monitoring plan

Methods and data sources

Cost is always a key factor

Some methods that appear to save time and money may have hidden costs.

e.g. sensors such as cameras and acoustic recording devices collect data more quickly but may be more expensive due to upfront equipment costs and the extensive data processing and analysis time and expertise required

Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Step 3: Develop the key elements of a monitoring plan

Methods and data sources

Methods most likely to be used across offshore wind farms include:

- digital aerial surveys
- passive acoustic monitoring
- underwater video surveys
- grab sampling.

Digital imagery provides a permanent and verifiable record of detections.

Software applications or artificial intelligence may be able to help with data processing or analysis.

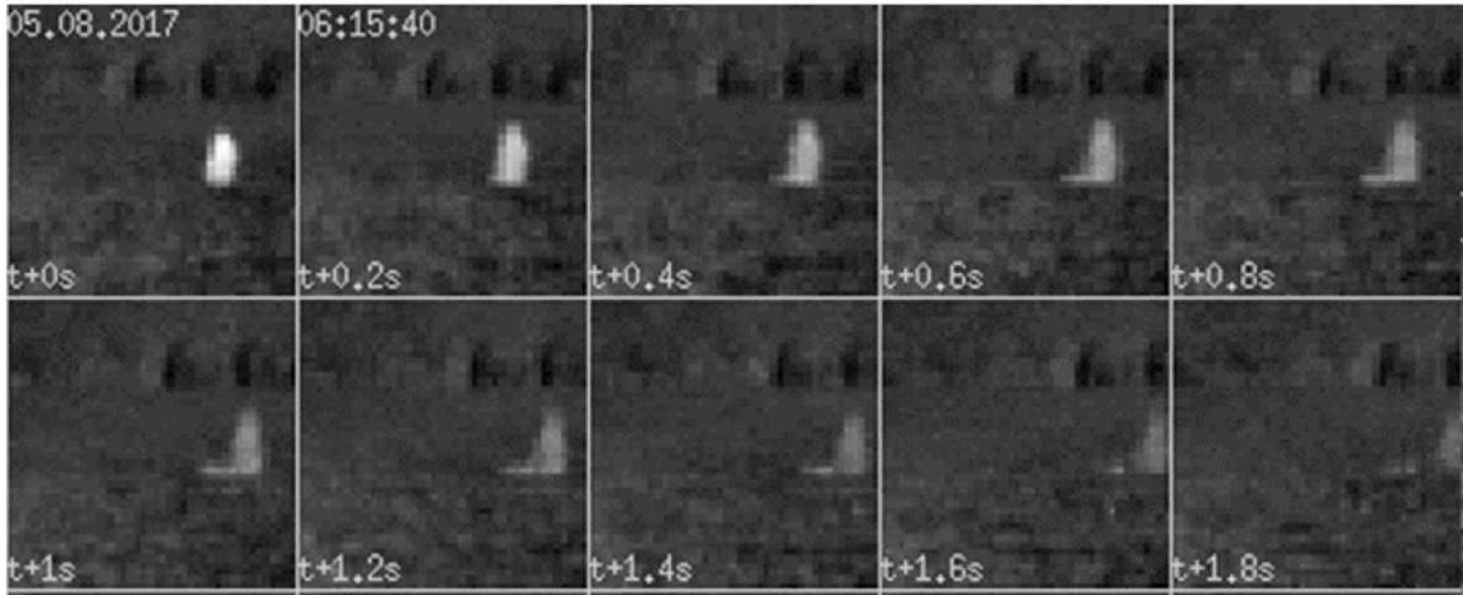
Methods are often best used together.

Combining monitoring tools

Tools used together can increase animal detection probabilities or increase the number of indicators that can be measured at one site.

e.g. Overall detection rates of cetaceans in Canada increased when 3 complementary methods were used:

- In good visibility, marine mammal observers (MMOs), infrared (IR) cameras and passive acoustic monitoring (PAM) increased detections when used together
- MMOs and PAM are likely the most effective combination during high seas and precipitation
- PAM and IR can be used in darkness.



Smith et al. 2020. *Marine Pollution Bulletin*, 154: 111026.

Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Step 3: Develop the key elements of a monitoring plan

Defining timing and frequency

Roles and responsibilities

Advantages of early collaboration

- plan for the mounting of monitoring sensors on wind turbine jackets (for weight loading calculations and construction plans)
- co-ordinate activities on site e.g. to ensure monitoring vessels or C-PODs do not obstruct construction vessels and vice versa

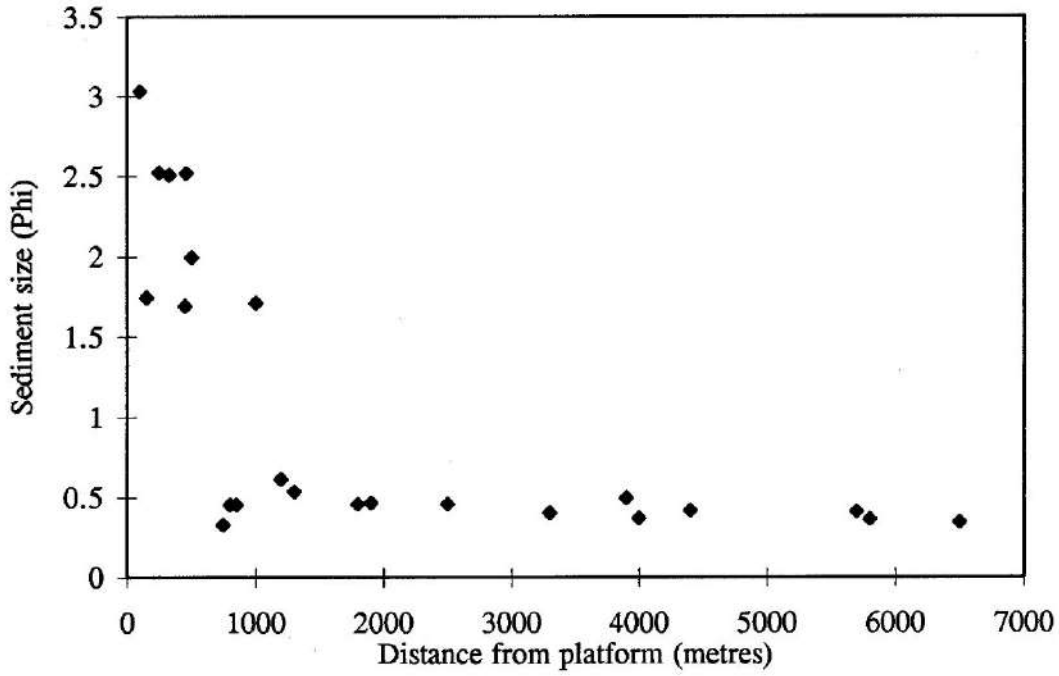
Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Step 3: Develop the key elements of a monitoring plan

Survey design considerations

One key issue is using counterfactuals to help demonstrate or infer cause and effect.

A significant before-after change that declines with distance from the wind farm or submarine power cable provides evidence that the wind farm or cable is the cause of the change.



Ellis & Schneider 1997. *Environmental Monitoring and Assessment*, *48:* 157-172.

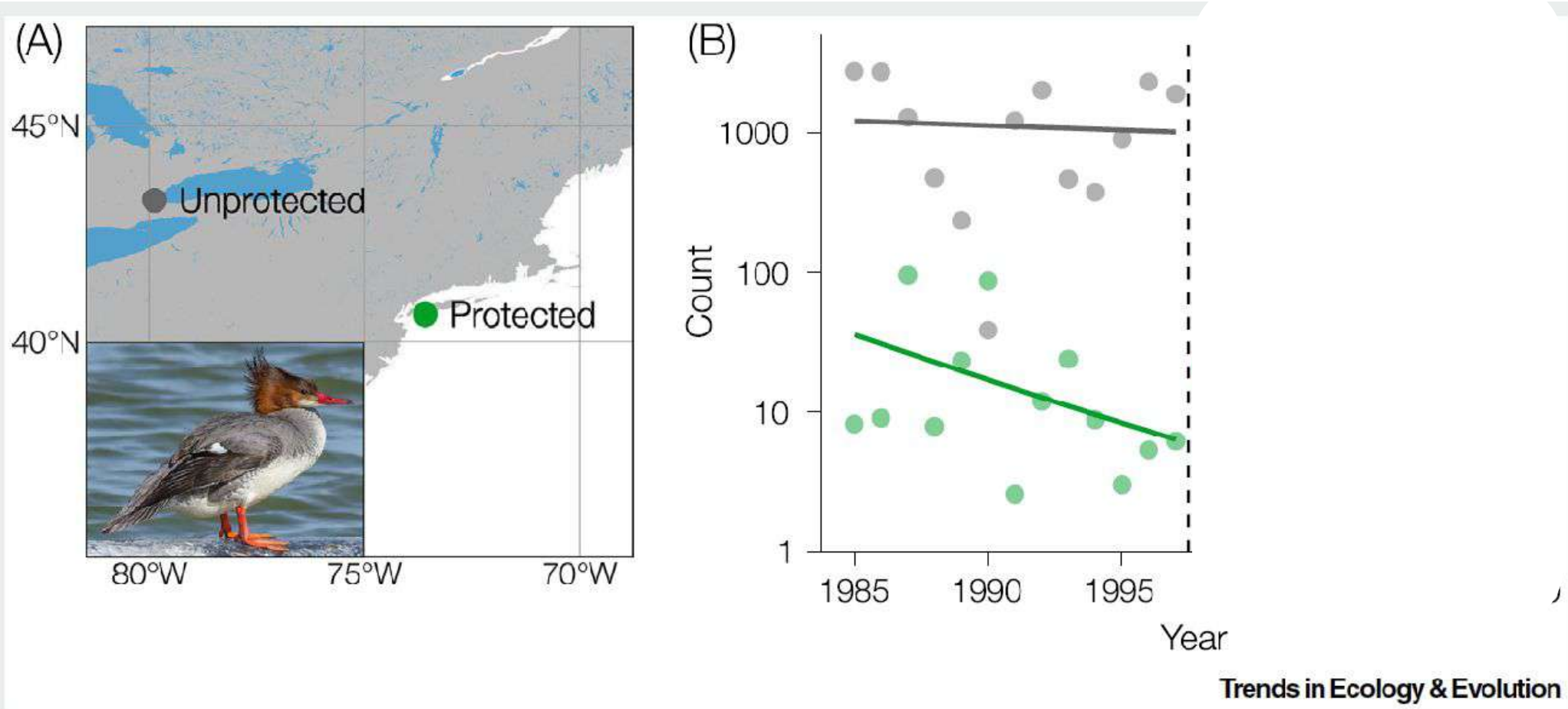


Figure I. Common Merganser (*Mergus merganser*) Case Study Site Locations and Count Data (A) Map Showing Protected (light green) and unprotected (grey) sites where merganser (*Mergus merganser*) have been monitored in the North East USA (Photo: Frank Schulenburg/Wikimedia Commons/CC BY-SA 3.0) (B) Merganser counts, with lines showing modelled trend; vertical broken line shows the year of protected area designation.

Wauchope et al 2021 *Trends in Ecology & Evolution*, 36: 193-205.

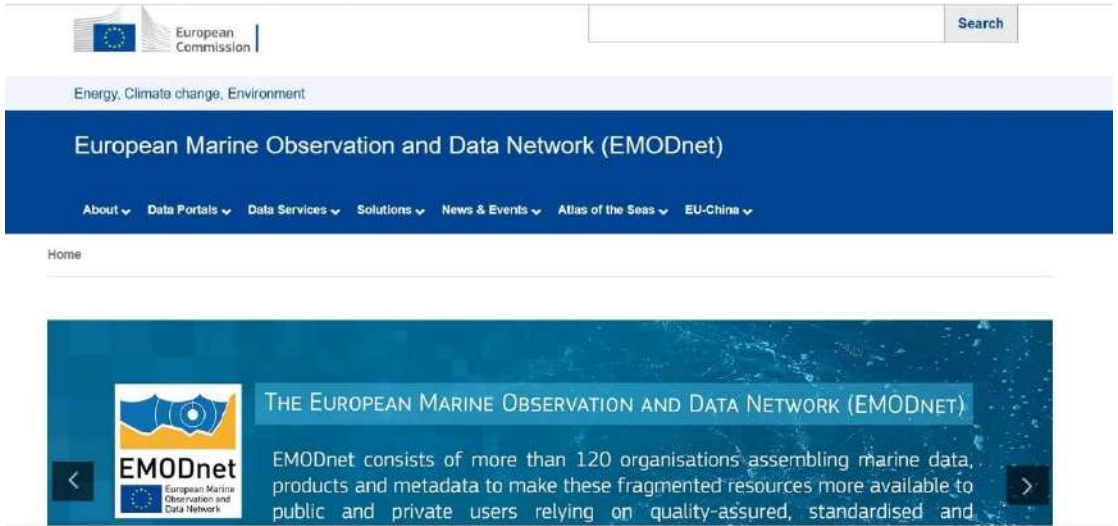
Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Step 4: Manage, share and analyse data

Produce dashboards and maps that facilitate interpretation and aid decision-making.

Where appropriate and feasible, add data to national, regional and global databases or sector –specific platforms (e.g. WREN Knowledge Base; Marine Data Exchange).

Learning and sharing lessons will help improve the impact of Nature-Positive initiatives.



Key Steps to Develop and Implement Biodiversity Monitoring Strategies

Step 5: Use data

Results should be used:

- to inform maritime spatial planning and adaptive management
- to assess and adapt the monitoring system and indicators
- to report on biodiversity disclosures.

The Way Forward

Fill Knowledge Gaps

e.g.

- Impacts on bats and turtles
- Impacts of electromagnetic fields and pollution
- Cumulative impacts
- The potential for new tools and techniques to be integrated into offshore monitoring systems.

The Way Forward

Enhance regional and sectoral collaboration on standardising monitoring protocols and data collection formats that facilitates data sharing and results-based decision-making

Ultimately, greater teamwork and enhanced partnerships will be a key factor in ensuring marine actors improve biodiversity monitoring around offshore wind developments.

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