



State of Knowledge regarding the Cumulative Impacts of Offshore Wind Farm Expansion: What are the Consequences & Solutions for achieving GES across European marine waters



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Outline



Outlook Request

Eclipse in a Nutshell

Presentation of the OWF Request

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The Policy Request Objective

Enhance the understanding of the potential impacts of Offshore Wind Farms (OWF) expansion on achieving Good Environmental Status (GES) as defined by the Marine Strategy Framework Directive (MSFD).

Specifically:

- a. Investigate the impacts of fixed-foundation wind turbines and grid connection infrastructure expansion as well as the consequences of the cumulative nature of impacts on marine ecosystems linked to each of the 11 Descriptors of GES under the MSFD.
- b. Identify and analyse knowledge gaps and mitigation strategies through literature review, expert consultation and participatory workshop.



5 functions



Answer key questions from policy and/or society by mobilising and synthesising the best available knowledge and experts



Identify current and future emerging issues of policy makers and citizens related to biodiversity and ecosystem services



Create a responsive and active network of experts and knowledge holders across Europe that get acknowledged for providing their knowledge



Improve citizens engagement in SPI activities



Link up with international SPIs such as IPBES, SBBSTTA-CBD

Ethical Infrastructure

12 measures:

- Guiding values
- Code of ethics
- Training programmes
- Declaration of conflict of interest
- Management body
- Complaint mechanism
- Transparent selection procedure
- Reinforced measures
- Legal framework
- Crisis management group
- Feedback processes
- Public consultation of all our outputs

A proven and robust process to answer policy relevant requests

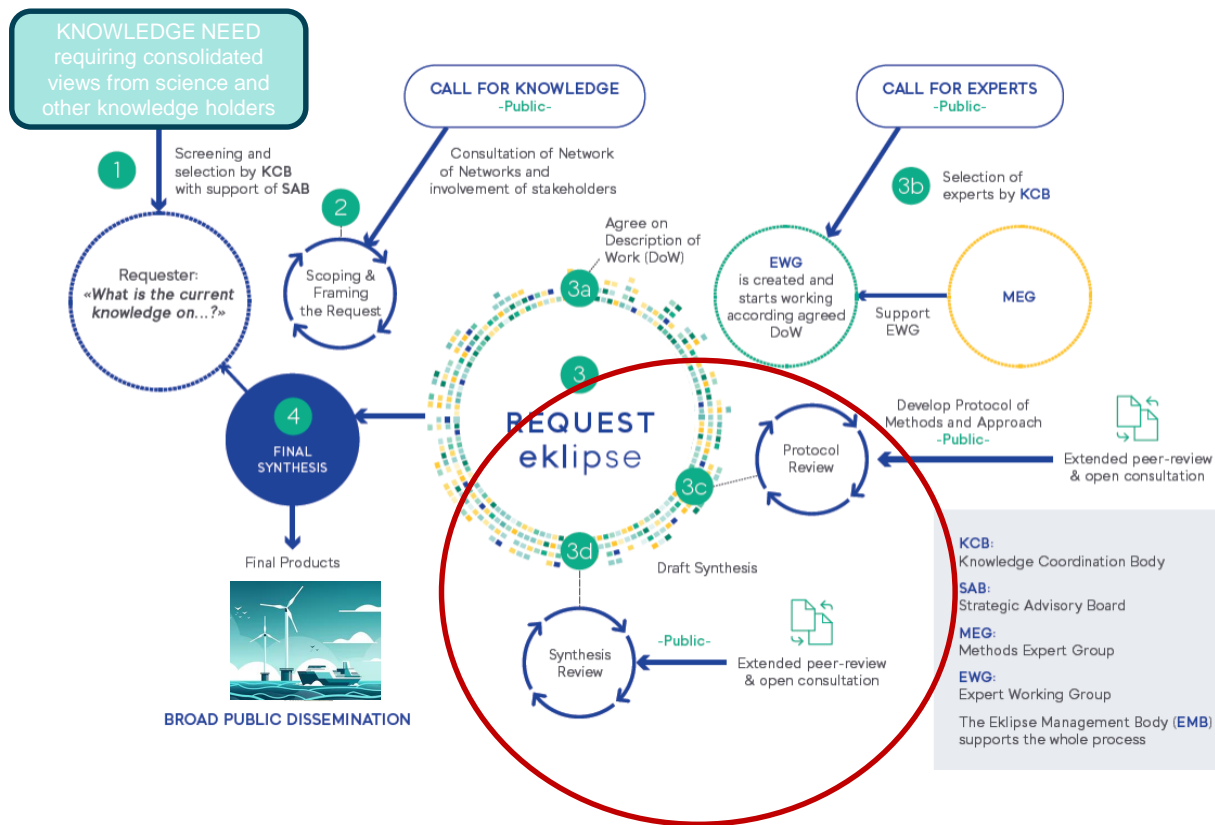
Method Experts

Advanced Governance structure

networking



Structure of the OWF Request





The OWF Methods Protocol

Two-staged methods process:



i) Scoping review (SR) to produce short science summaries (SSS)



ii) SSS used to inform online expert consultation and participatory workshop.



Stage 1. Scoping review (SR):



Provide an overview of the distribution and extent of existing evidence in relation to the objectives of the request - focus on the cumulative effects of OWF expansion on marine ecosystems

Identify current knowledge gaps → to address in expert consultation and participatory workshop(s)

1 Structured methodology

Methods protocol developed (in progress) and reviewed

2 Collate and synthesise existing research evidence

Academic and grey literature (i.e. Web of Science and Scopus)

3 Develop short scientific summaries (SSS)

11 Descriptors of GES under MSFD - starting from 3 Descriptors with TVs defined





Preliminary Results for the first MSFD Descriptors



D6. **Sea-floor integrity** is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.



D10. **Marine Litter**: Properties and quantities of marine litter do not cause harm to the coastal and marine environment.



D11. **Energy & Noise**: Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.





D6. Sea-floor integrity (1)



Number of papers across the literature databases: **265**

Number of papers screened that were retained: **64**

Geographic areas: **65% North Sea, 14% not specified, 9% Baltic Sea, 1% Northeast Atl. Sea (other than North Sea), 1% Med. Sea**

Method types: **55% empirical, 20% modelling, 14% reviews, 9% experimental, 4% unspecified**



D6. Sea-floor integrity (2)



Key results across main research themes

- **Impacts of OWF on soft bottom native ecosystems (14)**
 - positive and negative effect
 - disturbance is short-lived, effects caused by disturbance might not last and effect might disappear
- **Negative Impacts of OWF on physical characteristics of soft bottom habitats (7)**
- **'Reef effect' by introduction of hard bottom substrate (26)**
 - Increase in hard bottom substrate habitat leading to colonization by fouling communities, that seem unstable through time, and structured by local environmental conditions
- **'Reserve effect' by limiting other human activities (7), decrease in fishing ban (3)**
 - Trawling ban does not show recovery for benthic communities nor diminishing of carbon release
 - Local recovery of commercial stocks, but inconclusive results on spillover effects



D6. Sea-floor integrity (3)



OWF and cumulative impacts: are there cumulative impact studies?

- **Cumulative impacts through space and time (7)**
- **Cumulative impacts across human activities (8)**
 - Acting as vectors - facilitating introduction/dispersion of NIS
 - Trade-offs between offshore impacts and other human impacts - management needed to limit cumulative impacts
- **Cascading effects on ecosystem functionality and biogeochemical processes (14)**
 - Benthic biogeochemical cycles affected - enrichment of carbon in sediments, decreased dissolved oxygen, increase mineralization and denitrification



D6. Sea-floor integrity (4)



Knowledge gaps identified:

- No obvious link with the agreed thresholds values regarding D6
- No long-term studies beyond 10 years of monitoring or at large spatial scales
- How long the impacts last and are they irreversible?



D10. Marine litter (1)



Number of papers across the literature databases: **796**

Number of papers screened that were retained: **2**

Reasons for exclusion: **Not related to marine litter**

Geographic areas concerned: 100% **North Sea** (empirical Belgium part; review all North sea)

Type of methods for the study:

- **Empirical** (a combination of large-scale (BTS) and local-scale (EMS) surveys)
- Literature **review**



D10. Marine litter (2)



Key results across main research themes:

- OWF appears to have **only small contribution to marine litter** compared to other pressures - the studies found **to have no significant impact** .

Key recommendations across research themes covered:

- **No specific recommendations** given with regards to OWF, only for **litter from fishing**

OWF and cumulative impacts: Both papers investigate cumulative impacts and deem **fishing** by way of **discarded fishing gear** to be the overwhelming **major contributor to marine litter**. In comparison, **OWF have an insignificant impact**.



D10. Marine litter (3)



Information on a **descriptor threshold** with regards to OWF:

- **No information given.**

Knowledge gaps identified: **Theoretically, OWFs could have an impact on marine litter but studies that specifically investigate their contribution in an isolated manner are lacking.**



D11. Energy and noise (1)



Number of papers across the literature databases: **423**

Number of papers screened that were retained: **87**

Geographic areas: **92% North Sea, 16% not specified, 8% Baltic Sea , 8% North & Baltic Sea, 8% Med. Sea**

Method types: **4.8% empirical, 71.4% modelling, 9.5% reviews/ theoretical, 17.2% experimental, 4% unspecified**



D11. Energy and noise (2)



Key results across main research themes:

Change in behaviour (fish, mammals):	21.8 %
Change in distribution (fish, mammals):	21.8 %
Change in biodiversity:	2.3 %
Impact of hearing:	5.7 %
Ship noise:	11.5 %
No impact: of construction:	4.6 %
after construction:	12.5 %
On energy field:	10.3 %

Key recommendations across research themes covered:

- Noise mitigation (bubble curtain, soft start)
- Reduced energy while piling
- More data is needed



D11. Energy and noise (3)



OWF and cumulative impacts: are there cumulative impact studies?

- **Cumulative impacts through time (3)**
 - Decreases over time
 - Short term effects
- **Cumulative impacts across space (13)**
 - Multiple piling events and wind farms
 - Spatial extent
- **Cumulative impacts across sound sources (6)**
 - Deterrent devices and ship noise
 - Clearance of unexploded ordnance (UXO), seismic surveys, military exercises
- **information on the descriptor threshold (8)**

→ Refinement of the search parameter needed



D11. Energy and noise (4)



Knowledge gaps identified

- Cumulative effects of multiple wind farms need quantification
- Uncertainties
 - weighting of audiograms to assess the TTS onset
 - how multiple pulses accumulates in the ear and how silence intervals
 - how many animals are impacted negatively
 - implications for the population
- lack of updated information on the distribution of cetacean (i.e. harbor porpoises in the Baltic Sea), preventing identification of the areas of highest overlap with windfarms and other stressors.



Takeaways for Descriptor 6 on seafloor integrity

- Local impacts on physical disturbance, but less clear on soft bottom communities
- Most evidence concentrated in the North Sea and on nature-based solutions
- No clear picture on how impacts scale across time and space



Takeaways for Descriptor 10 on marine litter

- In comparison to other pressures (major one: discarded fishing gear), OWF have no significant impact.
- Studies specifically investigating the link between OWF and litter in an isolated manner are lacking.



Takeaways for Descriptor 11 on energy and noise

- Singular wind farms without sound mitigation impact cetacean in 20 km and more
- Cumulative impacts of ship noise and windfarms, multiple OWF
- uncertainties call for some level of caution in management of impulsive noise



Next Steps



- Expand the extraction to full text articles to write the short science summaries
- Expand to all MSFD descriptors
- Complement results by the participatory workshop in 2025 to confirm findings and gaps



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