Bridging the gap between policy and knowledge on biodiversity in Europe

Document of Work (DoW)

Cumulative impacts of offshore wind farms on marine ecosystems

Requested by

European Commission's Directorate-General Environment (EC – DG ENV)

Funded by

EU Horizon Europe project " Connecting biodiversity knowledge and decision-making – BioAgora

Developed by Eklipse Scoping Group

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Contents

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General Information

Original Title: What are the cumulative impacts of offshore wind farms and their consequences for the achievement of good environmental status of marine ecosystems?

This request was put to Eklipse by the European Commission's Directorate General for Environment (EC—DG ENV) through the EU Horizon Europe project "Connecting biodiversity knowledge and decision-making"—BioAgora.

This document of work describes the results of the scoping activities as well as the background of the request and is the basis for the call for experts.

Requesters: European Commission's Directorate-General for Environment (EC – DG ENV)
Funder: EU Horizon Europe project "Connecting biodiversity knowledge and decision-making" – BioAgora
Date request received by the EC Knowledge Centre for Biodiversity[1] (KCBD): 6th of December 2023
Date request received by BioAgora: 15th of December 2023
Date request received by Eklipse: 30th of January 2024
Date of first meeting with requesters, Eklipse KCB and MEG: 9th of February 2024.
Launch of the Call for Knowledge: 06th of March 2024
Deadline Call for Knowledge: 12th April 2024
Expected deadline for deliverables: November 2024, in order to contribute to the discussions on the Greater North Sea initiative.

In order to refine the request, the following scoping activities have been carried out:

a. Call for knowledge to identify existing work on the request and
b. Discussion with initiatives/projects working on the topic of the request.

This Document of Work (DoW) describes the results of the scoping activities, the background of the request and is the basis for the call for experts. It explores the existing knowledge in this area, which the main knowledge holders are, how the request relates to existing policy processes at the EU level and identifies plausible and relevant programmes of work and methodology for answering this request.

[1] This request was originally submitted to the EC's Knowledge Centre for Biodiversity (KCBD) via its ticketing system, an online tool for policy DGs to submit knowledge requests linked to biodiversity. The BioAgora HE project is currently working with the KCBD in the development of the future Science Service for Biodiversity, the scientific pillar of the KCBD, connecting research results on biodiversity to the needs of policymaking. In this context, the request received by the KCBD was handed to BioAgora to coordinate the response

Background and context of the Call

Original request:

The request is oriented to examine the impacts of the planned expansion of wind energy production at sea, including cumulative impacts on marine ecosystems and on the achievement of good environmental status (GES).

Background:

The aim of the request is to examine the multi-level impacts of the planned expansion of wind energy production at sea, including cumulative impacts on marine ecosystems and on the achievement of good environmental status (GES). Such analysis is critically needed considering the increase in challenging targets for renewable energy sources that need to be achieved by Member States in the coming years, a large percentage of which are likely to be offshore. Existing studies on cohabitation between offshore wind energy production and nature tend to focus, in particular, on marine protected areas (MPAs) or the protection of species (e.g. birds). Existing knowledge misses an analysis relevant to all the dimensions (descriptors) of good environmental status as per the Marine Strategy Framework Directive (MSFD). Such analysis, which includes literature reviews and scenarios modeling, should look at how offshore wind energy expansion might affect the achievement of GES, considering the GES threshold values set by Member States for a number of GES criteria (such as seabed loss, impulsive noise, contaminant levels, species abundance, etc.) and the subsequent cumulative impacts. The study should empower the Commission to propose solutions, including in the context of the Member States' MSFD Programmes of Measures and the MSFD review, to make sure that offshore wind energy expansion does not impede the achievement of GES under the MSFD, considering the entire lifecycle of offshore wind power plants (including their decommissioning), whatever the type of turbine (monopiles, floating, tripods, etc.). These solutions could, for example, relate to marine spatial planning (e.g. current developments in the context of the Greater North Sea Initiative), in particular considering the cumulative impacts of other human activities on the marine environment. Identification of other solutions (for instance, technological) would also be welcome.

The planned developments of offshore wind production in order to achieve the targets set in EU and national legislation and policies are likely to be at such a large scale that they will have impacts on marine ecosystems and marine ecosystem functioning, including seabed habitat loss, disruption of migratory routes of mobiles species such as birds and cetaceans, deadly collisions with birds, disruption of feeding and breeding grounds of a number of species, underwater noise during development and maintenance, input of contaminants and litter and changes to hydrographic conditions. Almost all descriptors of good environmental status are likely to be impacted by these developments.

The main goal of the request, put forward by the DG ENV, is to identify and explore:

- Knowledge (incl. needs & synthesis, mapping & assessment, methodological guidance, facts & figures, policy briefs)
- (Web) Tools (e.g. dashboard, maps)
- Future outlook (e.g. scenarios, forecasts)
- Measuring and monitoring (e.g. models, indicators)

Specifically regarding:

a) On-the-ground actions to gain an understanding of monitoring and mitigation of short- and long-term impacts of offshore wind energy developments.

b) Knowledge (from science, policy, or societal experience) needed to better understand the cumulative impacts of offshore wind development on marine ecosystems.

c) Knowledge gap analysis concerning the following items:

i. (cumulative) impacts of offshore wind farms, strategies to mitigate impacts of offshore wind farm expansions.

ii. transformative strategies of offshore wind farm expansions (e.g. benefits for biodiversity in no-take zones around the wind farms)

iii. effectiveness of environmental impact assessments of offshore wind farm expansions.

Policy relevance and geographical scope of the request:

The final framing of the request seeks to contribute primarily to the Marine Strategy Framework Directive (and its ongoing review). It will also inform other EU legal instruments/policies such as the Maritime Spatial Planning Directive, Renewable Energy Directive, Biodiversity Strategy, Zero Pollution Action Plan, Marine Action Plan, Wind Power Action Plan, as well as regional and/or international agreements or processes, notably the Regional Sea Conventions Action Plans/activities, and other possible initiatives planned/taking place at a regional level through:

a) the negotiation or implementation of a legal act (Directive, Regulation, Decision),
b) the negotiation or implementation of a non-binding instrument (e.g., Strategies, Communications),
c) the drafting of EU action plans or legislative proposals (either at the development, negotiation, or adoption phase).

The geographical scope of the request is the European Union Marine regions and subregions as defined under the MSFD: the Baltic Sea, Black Sea, North East Atlantic (including the Greater North Sea, the Celtic Seas, the Bay of Biscay and the Iberian Coast, and Macaronesia), and the Mediterranean Sea (including the Western Mediterranean Sea, the Adriatic Sea, the Ionian Sea, the Central Mediterranean Sea, and the Aegean-Levantine Sea). So far, holistic Cumulative Effect Assessments (CEA) have been published for the North Sea, using geospatial open-source software, to assess the impacts of OWF-related pressures on selected seabed habitats, fish, seabird and mammal species. The study considered pressures specific to the three OWF development phases, spanning 1999–2050, for the entire North Sea basin.

Relevance for biodiversity

The planned developments of offshore wind production in order to achieve the targets set in EU and national legislation and policies are likely to be at such a large scale that they will have impacts on marine ecosystems and marine ecosystem functioning, including seabed habitat loss, disruption of migratory routes of mobiles species, including birds and cetaceans, deadly collisions with birds, disruption of feeding and breeding grounds of a number of species, underwater noise during development and maintenance, input of contaminants and litter and changes to hydrographical conditions. Almost all descriptors of good environmental status are likely to be impacted by these developments.

Timeline and type of deliverables

The results of the request will greatly contribute to the discussion on the Greater North Sea initiative, which will start in **November 2024.**

The desired deliverable is a technical report, which should contain:

- an analysis - based on a literature review - of the impacts, including cumulative impacts, of the planned expansion of offshore wind energy production on all types of marine ecosystems (both pelagic and benthic).
- a quantitative analysis of the scale of these impacts in relation to the achievement of good environmental status (and related thresholds), defined by the Marine Directive through eleven descriptors.
- an identification of possible solutions, including in relation to spatial planning, technological developments, and other measures.

Potential forms of participatory process/consultation and type of tools/analysis suggested by the requesters are:

- Quick consultation (e.g., dialogue with experts),
- Models, scenarios, and future outlook.

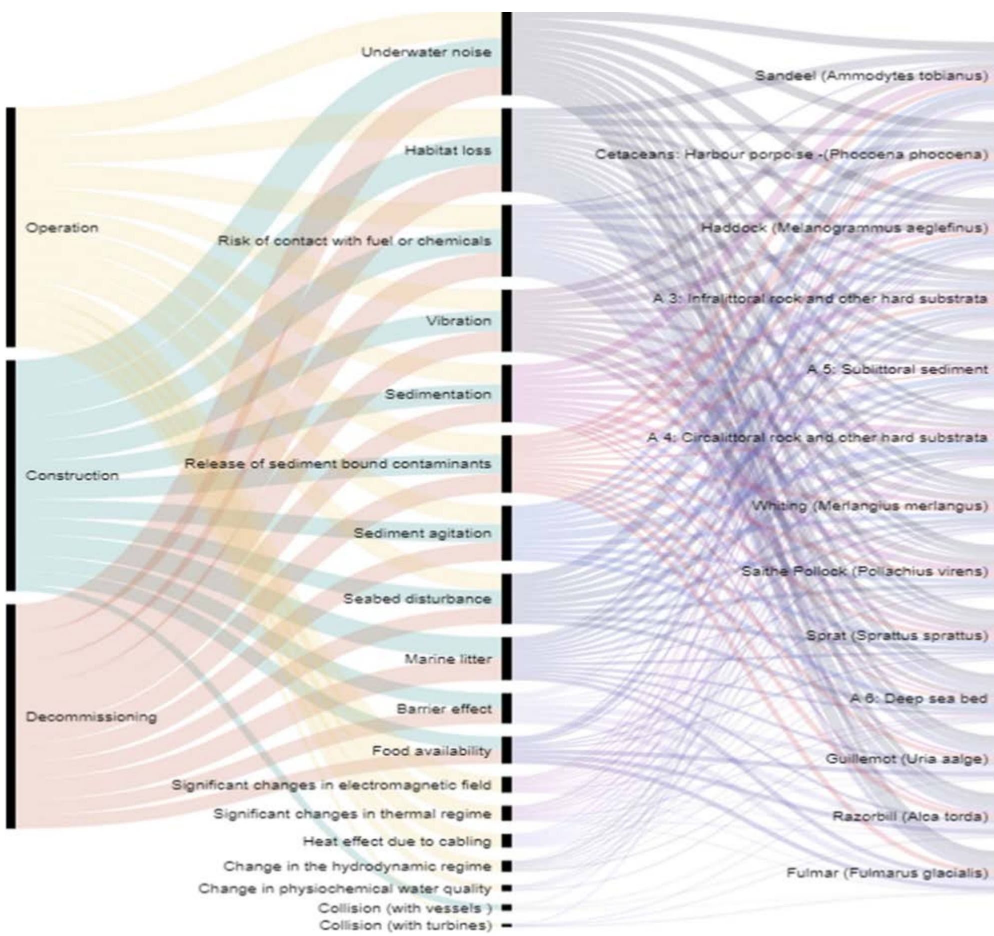
Added value of Eklipse:

The Eklipse process enables answering requests from decision-makers on a wide range of topics by synthesising available knowledge from scientists and other knowledge holders (i.e. summarising academic and grey literature). The process, in place since 2016, facilitates evidence-based decisions through a transparent, objective, and robust process. Transparency and robustness are prioritised at every step. For instance, peer review is favoured at two important stages (1. the development of the methods protocol, and 2. the production of all results deliverables) to ensure scientific quality and vigour. This is the very added value of Eklipse, which ensures the transfer of scientific knowledge to the policy arena in a meaningful way so that effective evidence-informed environmental decision-making can be undertaken with confidence.

One of the added values of Eklipse concerning this specific call will be to:

> a) link up existing initiatives, projects, and knowledge holders on offshore wind farm expansions to evaluate their impact on the GES across European marine systems, with a focus on cumulative effects and
>
> b) the identification of suitable cumulative impact indicators reflecting the GES.

Eklipse will liaise with the ICES Roadmap for Offshore Renewable Energy 2024, initiated by the European Commission, which has recognised the lack of knowledge about the potential impact of ORE on ecosystems and biodiversity and the need for more scientific evidence on cumulative effects at the sea basin level (European Commission, 2023).



Impact chain defining OWF phases-pressure-environmental components analysed in the North Sea (the strength of the link between pressures and environmental components is proportional to the sensitivity scores. The order is descending from the pressures with the highest impact and the environmental components most affected (Gusatu et al. 2021).

Refined request question

To focus on key 'research/policy gaps,' we argue that the request would be best framed by focusing wholly on cumulative impact work, as this is where the strongest pathways to impact lie. However, by broadening the question to include all impacts separately, the work may become too unwieldy and would likely struggle to fit within the time frame. The two options presented here include a focus on marine spatial planning.

- OPTION 1: How cumulative impacts can be embedded into existing marine spatial planning planning processes (Alister)

- OPTION 2: Cumulative Impacts of Offshore Wind Farm Expansions: Consequences for the GES across European marine ecosystems

Reformulated question:

approved by the requester on May 21st: "Cumulative impacts of offshore wind farm expansions: consequences & solutions for achieving GES across European marine waters"

Suggested Programme of work and methods

The MEG has undertaken an assessment of the request, conditioned by the short timescale required by the requester. To support us in identifying the best tools available, we have run the MAGICKS tool based on the characteristics of the Request (see Annexe 3). However, it is important to note that MAGICKS only assesses single methods rather than combined approaches, where the impact may be much greater.

With regards to details communicated by the Requester in terms of form: 1. "an analysis, based on literature review, of the impacts, including cumulative impacts" and 2. "a quantitative analysis of the scale of [...] impacts". We feel there is a need to undertake a Rapid Evidence Assessment to provide the foundations for an online expert consultation which could take a variety of forms (e.g. focus group/workshop/world cafe). The participatory activity could also involve the use of scenarios as discussion foci emerging from the evidence assessment, in line with the Requester's needs.

Table 1. MEG opinion(s) based on MAGICKS tool output (cf. Annexe 3 for the full MAGICKS output and options)

MAGICKS TOOL OUTPUT	**MEG insight(s)**
Expert consultation	There are various adapted techniques here (e.g focus groups, world cafe, workshops). The chosen specific method must reflect the needs of the Requester and the context of the EWG. What we can agree on is that it should be a one-off event due to time constraints.
Multiple expert consultation with Delphi	This method has certain advantages (e.g. the systematized process better ensures transparency and reproducibility) compared to regular Expert consultation, but may be less viable regarding timescale. Indeed, a Delphi requires multiple rounds of consultation and synthesis; a minimum of three rounds is advised by the MEG. We feel that the periods needed and time commitment for those involved would be too great.
Rapid evidence assessment (RAE)	Despite the MAGICKS output the MEG agrees that there is a need for a knowledge synthesis method to ensure we meet the needs of the Requester Compared to Systematic review or Meta-analysis, which both require at least 1 year, a REA would provide a quicker way (4-6 months) of equally capturing both descriptive and quantitative information to inform the participatory activities - that score highest on MAGICKS.

There are two suggested options from the MEG:

Option 1: Rapid Evidence Assessment and Expert Consultation.

This preferred option requires a two-staged methods process, with a REA undertaken in the first 4-6 months to assess the scientific literature on both impacts and policy interventions. The results of which are then used to structure an online participatory workshop.

Risks:

1. The summer vacation period may result in a period of up to 2 months where productivity is slow due to participants' and expert working groups' annual leave requirements, which likely all differ. Equally, this could have an impact on the time required to form the Expert Working Group.
2. The REA may lead to covering existing work that is underway, as revealed by the call for knowledge, but a close dialogue and exchange with existing initiatives is planned.

Opportunities (way to manage the risks):

1. June-August, in order to maximize the time and expertise on the two stages, we build an EWG with expertise in both knowledge synthesis and participatory methods together with knowledge of marine biodiversity and planning. This allows two separate working groups within the EWG to maximize their time on the different methods. recruit two expert working groups.
2. The REA process starts pre-summer (June-August) with the participatory workshop post summer (September)
3. In order to minimize the risk of duplication and to capture emerging research work in this area, which has been exposed in the call for knowledge, we recruit members of such research teams to be actively involved in the workshop event.

Option 2: Deliberative workshops using experts

This option emerged as the top-scoring single-method approach from Eklipse's MAGICKS tool. This can be planned either as a series of iterative workshops 3x3 hours over the answering request period. Alternatively, an applied policy Delphi can be used, which has the advantage of not requiring everyone to be in the same place at the same time. Here, the experts working on cumulative impacts can share their knowledge, science and practice (suggest a mixed academic/policy audience) to first identify and assess the impacts and then second, look at the design and delivery of effective policy interventions. a.

Risks:

1. The lack of objective, robust knowledge synthesis in this option may increase the risk of bias into the results of the panel, as not everyone is necessarily aware of the

work that has been done. i.e. bias is introduced due to the arbitrary selection of results as well as the panelists themselves. Results from published studies may be subconsciously prioritized, which can differ systematically from results of unpublished studies.
2. Online workshops could result in the domination of key players, thus suppressing minority voices
3. The Delphi approach requires considerably more time in reading and responding and could result in panel drop-out over successive rounds particularly over the summer.
4. Summer vacation may mean slower productivity for a duration of 2 months participants' and expert working groups' annual leave options.

Opportunities:
1. By not undertaking a knowledge synthesis, outputs are more likely to be delivered on time as only one technique is used.
2. The use of an applied policy Delphi has the advantage of enabling people to contribute when it suits them, rather than having to synchronize diaries for online workshop meetings. Given the nature of the participants (busy timetables), we need to recruit for the participatory events; this may pose a problem.

Conclusions based on Options 1 and 2:

The MEG considers that Option 1 offers the best value in terms of providing an in-depth evidence-based approach in line with the Request, which then is used to shape a one-off participatory event. Whilst this does have risks associated with the very tight timescales, we believe that a focused strategy of 'expert working group recruitment' can better meet the deadline; for example, here, the call for experts should be sent to targeted experts from the ICES 2024 Roadmap.

Logbook

The logbook describes the agenda of exchanges with the Requester and the Scoping group, which is constituted by members of the Knowledge Coordination Body (KCB), Methods group, and Eklipse Management Body (EMB), as well as the contents discussed during the meetings.

Date	Participants	Topic	Platform
30.01.2024	Scoping group meeting first meeting Eklipse KCB: Ute Jacob, Nils Bunnefeld, Aurore Maureaud, Jan-Claas Dajka Eklipse MEG: Joseph Langridge EMB: Marie Vandevalle, Candice Pouget	Topic of the request	Online
09.04.2024	Scoping group meeting with the requester Requester: Paris Vasilakopoulos (KCBD-JRC), Michail Papadoyannakis (DG Env-off-shore wind), Alice Belin (DG Env marine team), Fabio Pirotta (DG ENV marine team)	To discuss the request and clarify aspects with the requester	Online
18.04.2024	Eklipse KCB: Ute Jacob, Nils Bunnefeld, Aurore Maureaud, Eklipse MEG: Isabel Jones EMB: Karla Locher	To discuss the preliminary result of the call for knowledge	Online

02.05.2024	Eklipse KCB: Ute Jacob, Nils Bunnefeld Eklipse MEG: Joseph Langridge, Isabel Jones, Alister Scott EMB: Marie Vandevalle, Karla Locher	To discuss the suggested reformulation of the request and finalise the Document of Work (Dow)	Online
17.05.2024	Scoping group second meeting with the requester Eklipse KCB: Ute Jacob, Nils Bunnefeld, Aurore Maureaud, Jan-Claas Dajka Eklipse MEG: Joseph Langridge, Isabel Jones, Alister Scott EMB: Marie Vandevalle, Karla Locher Requester: Michail Papadoyannakis (DG Env-off-shore wind), Fabio Pirotta (DG ENV marine team)	Reformulation of the request	Online

Annexes

Annexe 1: Results Call for Knowledge

Summary

The European Commission's Directorate-General for Environment (EC – DG ENV) requests help from the Eklipse organisation to examine the multi-level impacts of the planned expansion of wind energy production at sea, including cumulative impacts on marine ecosystems and on the achievement of good environmental status (GES). This request is funded by the EU Horizon Europe project "Connecting biodiversity knowledge and decision-making" – BioAgora, which is developing the architecture and functionality of the new European "Science Service for Biodiversity".

The request is made in support of the implementation of the Marine Strategy Framework Directive and may also contribute to its ongoing review and seeks to identify and explore: (i) knowledge (incl. needs & synthesis, mapping & assessment, methodological guidance, facts & figures, policy briefs); (ii) (Web) tools (e.g. dashboard, maps); (iii) future outlook (e.g. scenarios, forecasts); (iv) measuring and monitoring (e.g. models, indicators).

The scoping phase of this project consisted of 4 meetings with and without the requester, to clarify the questions, followed by a call for knowledge. This call resulted in documented suggestions from 11 different experts. In addition, the Methods Expert Group performed an analysis of possible methods.

Call for Knowledge

While offshore wind energy has been operational in Europe for more than 20 years, new offshore wind developments are proceeding rapidly and at large-scales, a systematic literature review (based on CEE protocols) is currently underway led by CNRS and IFREMER, specifically dedicated to analyzing the effects of offshore wind energy on biodiversity. Besides this ongoing action, there are diverse knowledge resources on this topic:

Key Peer-Reviewed Literature

Galparsoro,et al (2022). Reviewing the ecological impacts of offshore wind farms. npj Ocean Sustainability, 1(1). doi:10.1038/s44183-022-00003-5;

Lloret et al (2022). Unravelling the ecological impacts of large-scale offshore wind farms in the Mediterranean Sea. Sci Total Environ, 824, 153803. doi:10.1016/j.scitotenv.2022.153803

Degraer et al. (2020). Offshore wind farm artificial reefs affect ecosystem structure and functioning: A synthesis. Oceanography, 33(4), 48-57. doi:https://doi.org/10.5670/oceanog.2020.405.

Watson et al. (2024) The global impact of offshore wind farms on ecosystem services Ocean & Coastal Management Volume 249, 1 March 2024, 107023 https://doi.org/10.1016/j.ocecoaman.2024.107023

Gusatu et al. (2022) Spatial and temporal analysis of cumulative environmental effects of offshore wind farms in the North Sea basin

Reports & Assessments

ICES. 2024. ICES Roadmap for Offshore Renewable Energy (ORE). ICES Convention, policies, and strategy. 12 pp. https://doi.org/10.17895/ices.pub.24990198

Spatial and temporal analysis of cumulative environmental effects of offshore wind farms in the North Sea basin https://www.researchgate.net/publication/351526959_Spatial_and_temporal_analysis_of_cumulative_environmental_effects_of_offshore_wind_farms_in_the_North_Sea_basin

Report on 'Mapping potential environmental impacts of offshore renewable energy' by ETC/ICM Consortium Partners Article on 'Reviewing the ecological impacts of offshore wind farms' available here: https://www.nature.com/articles/s44183-022-00003-5

The North Sea programme, which partitions the Dutch North Sea to achieve good environmental status in one of the most intensively used seas in the world (https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/)

Report on Marine Spatial Planning and ocean accounting: Synergistic tools enhancing integration in ocean governance (https://www.sciencedirect.com/science/article/abs/pii/S0308597X21005479) The

Marine Data Protocol has been designed as a framework to facilitate the exchange of marine data (https://www.informatiehuismarien.nl/uk/products/dataprotocol/)

'Spatial study North Seas 2030 – offshore wind development' for the North Sea Energy Cooperation Framework for assessing and mitigating the impacts of offshore wind energy development on marine birds (https://www.sciencedirect.com/science/article/pii/S0006320722003482) '

A framework for improving treatment of uncertainty in offshore wind assessments for protected marine birds' in the ICES journal of marine science (https://academic.oup.com/icesjms/advance-article/doi/10.1093/icesjms/fsad025/7065501)

Offshore Wind Energy and Marine Biodiversity in the North Sea: Life Cycle Impact Assessment for Benthic Communities (https://pubs.acs.org/doi/10.1021/acs.est.2c07797)

Roll out wind at sea with respect for nature - An analysis of potential risks to North Sea nature posed by the offshore wind energy transition (https://s3-eu-west-1.amazonaws.com/noordzee/app/uploads/2022/02/17080838/202202-SDN-Ecological-risks-Wind-At-Sea-DEF.pdf)

A review of biodiversity data needs and monitoring protocols for the Offshore Wind Energy Sector in the Baltic Sea and North Sea (https://offshore-coalition.eu/documents/rgi-report_pj-stephenson_october.pdf

Initiatives & Working Groups

OSPAR ICG-ORED is conducting a Pilot assessment of the cumulative impacts of offshore renewables on birds, with an anticipated final report in the first half of 2025. The overall aim of the work on offshore renewables is to support the implementation of the OSPAR North-East Atlantic Strategy (NEAES) 2030 in developing guidance on how to promote and facilitate sustainable development and scaling up of offshore renewable energy in a way that cumulative environmental impacts are minimized. To this end, an Intersessional Correspondence Group on Offshore Renewable Energy Development (ICG-ORED) was established in March 2021. As part of the initial scope of work, ICG-ORED is prioritizing the impacts of offshore renewable energy developments on birds to progress simultaneously on Operational Objective S5.04 of the NEAES 2030: "By 2025 at the latest, OSPAR will take appropriate actions to prevent or reduce pressures to enable the recovery of marine species and benthic and pelagic habitats in order to reach and maintain good environmental status as reflected in relevant OSPAR status assessments, with action by 2023 to halt the decline of marine birds." In the face of the planned large-scale development of offshore wind energy in the North-East Atlantic and the aims and scope of ICG-ORED, the group initiated the development of a framework for assessing the cumulative impacts of offshore wind energy on marine ecosystems on a regional sea scale. In line with NEAES Operational Objectives S12.04 and S5.04, this cumulative impact assessment (CIA) framework will be developed and first applied to assess the impacts of offshore wind energy on birds. These two elements constitute the focus of this request for proposals. The so-called 'bird pilots' have two main aims: first, to test and further develop the CIA framework, and second, to provide the evidence base on which to elaborate guidance on measures and actions within OSPAR with regards to preventing negative impacts on birds as a result of offshore wind energy development and operation. The assessment should consider two time frames: up to 2030 and beyond 2030. Given the large area of the North-East Atlantic to be covered and the different characteristics of each OSPAR sub-region, two case study areas are proposed: the North Sea Basin and the Celtic Sea-Bay of Biscay Area. Based on the results of the pilot studies and subsequent CIAs, ICG-ORED will assess the need for measures and identify the type of measures needed in order to develop offshore renewables in a way that minimizes cumulative impacts on the environment.

NSEC-SG2 conducted a quick scan on cumulative impacts (CIA) on a number of birds and mammals. This CIA included ORE in The North Sea and prioritized other pressures on marine ecosystems. The GES was not considered, and biodiversity was represented at a relatively crude level by species groups and habitats and more detailed bird and mammal species. On the basis of all human activities combined, benthic trawling poses the highest risk for the ecosystem components of the North Sea. The contribution of wind farms to the cumulative Impact Risk is at the moment (baseline: 2022) relatively small (~1% to the total impact risk (unweighted average for all ecosystem components)), which increases marginally over time.

For birds and mammals, the contribution of OWF to the cumulative Impact Risk is higher. The operational phase of OWF causes the highest Impact Risk for birds, ranging from 2.6% for the baseline, 4.3% for 2030 and 7.4% for 2040. For mammals highest Impact Risk is caused by the construction phase, between 3.5 and 3.7% for the baseline and the two future scenarios. Mammals, fish & cephalopods, pelagic water column, and sublittoral sediment also experience an increased future impact of OWF, but that effect is compensated by the decrease in some other human activities (fishing, oil and gas).

The Dutch Ministry of Energy (and on behalf of this Ministry conducted by Rijkswaterstaat) is conducting CIA on offshore wind farm developments in the Dutch EEZ, including biogeographic regions of affected species.

GNSBI Working Track CIA is working on an overview of CIA on a regional Sea basis for North Sea and Irish seas

The ICES Working Group on Offshore Wind Development and Fisheries (WGOWDF) focuses on the interactions between fisheries and offshore wind energy. https://www.ices.dk/community/groups/Pages/WGOWDF.aspx

The ICES Working Group on Marine Benthal and Renewable Energy Developments (WGMBRED) looks at Benthal and renewable energy-related research and cause-effect relationships and develops guidelines to aid future research. https://www.ices.dk/community/groups/Pages/wgmbred.aspx

The ICES Workshop WKWIND aims to review approaches to assess the trade-offs between offshore renewable energy developments (initial focus on offshore wind farms) and the provisions of wild harvest fish by assessing the economic, social and ecological consequences. WKWIND will provide the first steps for developing ICES best practice guidelines on how to assess trade-offs to enable sustainable marine management. https://www.ices.dk/community/groups/Pages/WKWIND.aspx

Business Involvement

The Offshore Wind Strategic Monitoring and Research Forum (OWSMRF) led by six offshore wind developers – EDF-Renewables, Equinor, Innogy, Ørsted, ScottishPower Renewables, and Vattenfall will enable government nature conservation advisors, NGOs, experts and regulators to highlight critical knowledge gaps to developers. This collaborative approach will help to identify, prioritise and develop further research and evidence. In its pilot year, the focus will be on marine birds, specifically kittiwakes.

https://jncc.gov.uk/news/owsmrf-working-together-to-understand-the-impact-of-offshore-wind-energy-on-marine-birds/

The European Marine Board had a working group on OWF, the outcomes are published, and they identified experts across Europe to join the working group: https://www.marineboard.eu/marine-renewable-energy-WG

Data Sources & Needs

A REVIEW OF BIODIVERSITY DATA NEEDS AND MONITORING PROTOCOLS for the Offshore Wind Energy Sector in the Baltic Sea and North Sea (https://offshore-coalition.eu/documents/rgi-report_pj-stephenson_october.pdf

The GES assessment dashboard of WISE (marine information system of Europe) https://water.europa.eu/marine/data-maps-and-tools/msfd-reporting-information-products/ges-assessment-dashboards

The data available on the European Marine Observation and Data Network https://emodnet.ec.europa.eu/en

Publications

- Workshop on the European Green Deal – Challenges and opportunities for EU fisheries and aquaculture: Part II: Marine biodiversity aspects: This study aims to provide an overview of the impacts, challenges and opportunities for the European Union (EU) fisheries and aquaculture sectors created by the European Green Deal (EGD) regarding marine biodiversity. The main EGD policy initiatives impacting aspects of marine biodiversity are presented. The research analyses the overall challenges, opportunities and solutions for EU fisheries and aquaculture about marine biodiversity aspects of the EGD. It also illustrates best practices and lessons learnt for implementing core objectives of the EU Biodiversity Strategy for 2030. Finally, the report provides policy recommendations to the European Parliament centred on measures for effectively implementing the EU's biodiversity framework for fisheries and aquaculture sectors. Link to the publication: https://research4committees.blog/2023/10/20/publication-workshop-on-the-european-green-deal-%e2%88%92-challenges-and-opportunities-for-eu-fisheries-and-aquaculture-part-ii-marine-biodiversity-aspects/
- Systematic literature review (ongoing), based on CEE protocols: specifically dedicated to analyzing the effects of offshore wind turbines on biodiversity.
- Galparsoro, I., Menchaca, I., Garmendia, J.M., Borja, Á., Maldonado, A.D., Iglesias, G. and Bald, J., 2022. Reviewing the ecological impacts of offshore wind farms. *npj Ocean Sustainability*, *1*(1), pp.1-8. Key conclusions/ abstract: Offshore wind energy is widely regarded as

one of the most credible sources for increasing renewable energy production towards a resilient and decarbonised energy supply. However, current expectations for the expansion of energy production from offshore wind may lead to significant environmental impacts. Assessing ecological risks to marine ecosystems from electricity production from wind is both timely and vital. It will support the adoption of management measures that minimize impacts and the environmental sustainability of the offshore wind energy sector.

Annexe 2: Rationale on parameters and results of the MAGICKS tool run on April 2024.

Below, MEG includes the full output from the MAGICKS tool, for reference.

The MAGICKS tool selection options were run as follows:

1. Purposes of question
   - Greater understanding or predictive power
   - Scenario building to analyse future events
   - Understanding changes in time and space
   - Seeking optimal management
2. Time available
   - 2-4 months
3. Resources
   - low: full-time salary for less than 4 months and/or limited specialist expertise
4. Consequences
   - medium: policy impact but this can be mitigated or adjusted

5 Controversy in the knowledge
- negligible

6 Types of Knowledge
- scientific
- technical
- opinion-based knowledge

7 Breadth
- broad: many possible research questions, responses or more than one policy area

8 Output
- quantitative data
- geographic maps
- recommendations

9 Existing knowledge
- anecdotal/local/case studies/stakeholder information
- data from surveys, monitoring, etc.
- relevant research outputs

10 Uncertainties
- yes

Prepared by Eklipse Method Expert Group members
Alister Scott, Isabel Jones and Joseph Langridge.

Annexe 3: Screening process (for more detail, check the Excel doc)

Screening of scientific papers:

Bailey, H., Brookes, K.L. and Thompson, P.M., 2014. Assessing environmental impacts of offshore wind farms: lessons learned and recommendations for the future. Aquatic biosystems, 10, pp.1-13.

Key conclusions/ abstract: Here we describe the lessons learned based on the recent literature and our experience with assessing impacts of offshore wind developments on marine mammals and seabirds, and make recommendations for future monitoring and assessment as interest in offshore wind energy grows around the world. The four key lessons learned that we discuss are: 1) Identifying the area over which biological effects may occur to inform baseline data collection and determining the connectivity between key populations and proposed wind energy sites, 2) The need to put impacts into a population level context to determine whether they are biologically significant, 3) Measuring responses to wind farm construction and operation to determine disturbance effects and avoidance responses, and 4) Learn from other industries to inform risk assessments and the effectiveness of mitigation measures.

Berkenhagen, J., Döring, R., Fock, H.O., Kloppmann, M.H., Pedersen, S.A. and Schulze, T., 2010. Decision bias in marine spatial planning of offshore wind farms: Problems of singular versus cumulative assessments of economic impacts on fisheries. *Marine policy*, *34*(3), pp.733-736.

Key conclusions/ abstract: The current approval procedure for wind farm proposals in the German EEZ only considers site specific conflict analysis between the wind farm and fisheries. Due to the relatively small spatial coverage of the sites potential opportunity losses to the fisheries are always considered as low or negligible. Cumulative effects on fisheries that will occur once all proposed wind farms are in place are not yet considered adequately. However, those cumulative effects will be quite substantial because, in particular, opportunities to catch such valuable species as flatfish will be considerably reduced.

Bergström, L., Kautsky, L., Malm, T., Rosenberg, R., Wahlberg, M., Capetillo, N.Å. and Wilhelmsson, D., 2014. Effects of offshore wind farms on marine wildlife—a generalized impact assessment. Environmental Research Letters, 9(3), p.034012.

Key conclusions/ abstract: The present study synthesizes the current state of understanding on the effects of offshore wind farms on marine wildlife, in order to identify general versus local conclusions in published studies. The results were translated into a generalized impact assessment for coastal waters in Sweden, which covers a range of salinity conditions from marine to nearly fresh waters. Hence, the conclusions are potentially applicable to marine planning situations in various aquatic ecosystems. The assessment considered impact with respect to temporal and spatial extent of the pressure,

effect within each ecosystem component, and level of certainty. It showed a high level of consensus with respect to the construction phase, indicating that potential impacts on marine life should be carefully considered in marine spatial planning. Potential impacts during the operational phase were more locally variable, and could be either negative or positive depending on biological conditions as well as prevailing management goals. There was paucity in studies on cumulative impacts and long-term effects on the food web, as well as on combined effects with other human activities, such as the fisheries. These aspects remain key open issues for a sustainable marine spatial planning.

Brabant, R., Vanermen, N., Stienen, E.W. and Degraer, S., 2015. Towards a cumulative collision risk assessment of local and migrating birds in North Sea offshore wind farms. Hydrobiologia, 756, pp.63-74.
Key conclusions/ abstract: In this paper, the number of collision victims at Belgian offshore wind farms was estimated with a (theoretical) collision risk model based on technical turbine specifications, bird-related parameters and bird density data of both local seabirds and passerine migrants. Bird density data were gathered by visual censuses and radar registrations. The outcome of the model was extrapolated to future development scenarios in the Belgian part of the North Sea and in the entire North Sea, and then further used for a preliminary assessment of the impact at population level for the species at risk. The results indicate that the cumulative impact of a realistic scenario of 10,000 turbines in the North Sea might have a significant negative effect at population level for lesser and great black-backed gull. We further show that during a single night of intense songbird migration, the number of collision victims among passerine migrants might be in the order of magnitude of several thousands in the entire North Sea. We argue that it is of great importance to further develop methods to quantify the uncertainties and to minimise the assumptions, in order to assure more reliable cumulative impact assessments.

Brignon, J.M., Lejart, M., Nexer, M., Michel, S., Quentric, A. and Thiebaud, L., 2022. A risk-based method to prioritize cumulative impacts assessment on marine biodiversity and research policy for offshore wind farms in France. Environmental Science & Policy, 128, pp.264-276.
Key conclusions/ abstract: We prioritize issues in cumulative impact assessment of offshore windfarms. Prioritization combines risk-based expert judgement and a scoring system. It is also used to identify priority research areas for the future. It was tested on two French offshore windfarm projects. Such a risk-based approach allows to manage scientific complexity and uncertainties.

Busch, M. and Garthe, S., 2018. Looking at the bigger picture: the importance of considering annual cycles in impact assessments illustrated in a migratory seabird species. *ICES Journal of Marine Science*, *75*(2), pp.690-700.

Key conclusions/ abstract: This study considers the type of information needed and the assessment tools required to implement such assessments. The developed concept is demonstrated by modelling year-round collisions of Black-legged Kittiwakes (*Rissa tridactyla*) breeding on the German North Sea island of Helgoland with constructed and planned offshore wind farms across the species distributional range, in order to assess the endangerment status of the local population.

Carpenter, J.R., Merckelbach, L., Callies, U., Clark, S., Gaslikova, L. and Baschek, B., 2016. Potential impacts of offshore wind farms on North Sea stratification. *PloS one*, *11*(8), p.e0160830.

Key conclusions/ abstract: Using a combination of idealised modelling and in situ measurements, we provide order-of-magnitude estimates of two important time scales that are key to understanding the impacts of OWFs: (i) a mixing time scale, describing how long a complete mixing of the stratification takes, and (ii) an advective time scale, quantifying for how long a water parcel is expected to undergo enhanced wind farm mixing. The results are especially sensitive to both the drag coefficient and type of foundation structure, as well as the evolution of the pycnocline under enhanced mixing conditions-both of which are not well known. With these limitations in mind, the results show that OWFs could impact the large-scale stratification, but only when they occupy extensive shelf regions. They are expected to have very little impact on large-scale stratification at the current capacity in the North Sea, but the impact could be significant in future large-scale development scenarios.

Chaji, M. and Werner, S., 2023. Economic impacts of offshore wind farms on fishing industries: Perspectives, methods, and knowledge gaps. *Marine and Coastal Fisheries*, *15*(3), p.e10237.

Key conclusions/ abstract: This work aims to provide an overview and assessment of industry perceptions, methods, results, and knowledge gaps pertaining to economic areas of concern related to interactions between OWFs and fishing industries in the region. We provide a compilation of studies focusing on industry perceptions and impacts of OWFs on the fishing industry, focusing on four key economic areas of interest: fuel expenditures; insurance costs; fishing industry revenues, income, and livelihoods; and fishing support businesses. Our findings suggest four overarching knowledge gap themes that persist across all economic areas of focus: (1) a lack of economic data or economically centered data collection efforts, (2) minimal works aiming to quantify the economic impacts of key areas of concern, (3) a lack of peer-reviewed models and methods in quantifying economic impacts, and (4) limited syntheses containing best practices or lessons learned associated with quantifying the comprehensive economic impacts posed by OWFs on fisheries. This article aims to build awareness in areas where interdisciplinary collaboration can take place as well as serve as a foundation for informing best practice guidance as it pertains to assessing economic impacts imposed by OWFs on the fishing industry.

Degraer, S., Brabant, R., Braeckman, U., Courtens, W., Annelies, D.B., Daelemans, R., Jill, D.B., Hostens, K., Bob, J.P., Kerckhof,F. and Laurent, Y., Assessing and managing the effect sphere of influence.

Key conclusions/ abstract: Observing increased densities of cod Gadus morhua at the erosion protection layer of wind turbines for example needs to be put into the wider perspective of a rapidly increasing number of offshore wind farms within the geographic distribution of the species to assess the impacts onto the population dynamics of the species. Similarly, the threat of invasive non-indigenous species present in the intertidal zone of wind turbines or the possible impact on the status of harbour porpoise Phocoena phocoena populations can only be assessed in the same cumulative perspective. With 238 km2 reserved for offshore wind farms in Belgium 344 km2 in the adjacent Dutch Borssele zone and 122 km2 in the French Dunkerque zone, cumulative ecological impacts are likely to form a major concern in the coming years. While the importance of an upscaling of locally observed effects hence is widely recognised, the key to such upscaling still is based on an understanding in depth of what happens at the wind turbine or wind farm scale. Local scale effects indeed are at the basis of possible knock-on impacts onto the wider ecosystem. Furthermore, an eventual mitigation of unwanted impacts through management measures will also most likely take place at this local scale. At-source mitigation generally is considered a better option than e.g. compensation of eventual ecological damage.

Durning, B. and Broderick, M., 2019. Development of cumulative impact assessment guidelines for offshore wind farms and evaluation of use in project making. Impact Assessment and Project Appraisal, 37(2), pp.124-138.

Key conclusions/ abstract: The sector is considered by UK Government as essential to the development of a low carbon economy and to meeting binding targets on carbon reduction and renewable energy generation. The Crown Estate, responsible for licensing development on the sea bed around the UK, has held three rounds of licensing since 2000 for wind developments. Some of the projects in the first two rounds suffered long delays due to uncertainty of project level impacts, particularly cumulative impacts. A number of key stakeholders identified a need for cumulative impact assessment (CIA) methodology to be developed that was definitive and endorsed by regulators and industry to aid unblocking barriers to delivery. This paper explores the background to the development of the guidelines and how they were 'co-created' with industry and regulators. We evaluate to what extent they have been used to shape and develop practice.

"Environmental impacts of offshore wind farms: assessment and long-term monitoring in Denmark." (2019). https://www.semanticscholar.org/paper/ENVIRONMENTAL-IMPACTS-OF-OFFSHORE-WIND-FARMS%3A-AND/51ad92cc6ac8cbdd740533d76fbbd6b30552d508

Key conclusions/ abstract: The EIA's technical specifications provide the framework which a concessionaire can navigate within by describing the main technical parts of the offshore wind project: wind turbines, layouts, foundations design, inter-array cables, installation methods, and so forth. The technical specifications are designed through a continuous and transparent dialogue with the industry, in order to reflect the actual needs of the potential bidders.

Fox, A.D., Desholm, M., Kahlert, J., Christensen, T.K. and Krag Petersen, I.B., 2006. Information needs to support environmental impact assessment of the effects of European marine offshore wind farms on birds. Ibis, 148, pp.129-144.
Key conclusions/ abstract: Using aerial survey, physical habitat loss, modification, or gain and effective habitat loss through avoidance behaviour can be measured using bird densities as a proxy measure of habitat availability. The energetic consequences of avoidance responses and habitat change should be modelled to estimate fitness costs and predict impacts at the population level. Our present ability to model collision risk remains poor due to lack of data on species-specific avoidance responses. There is therefore an urgent need to gather data on avoidance responses; energetic consequences of habitat modification and avoidance flights and demographic sensitivity of key species, most affected by OWFs. This analysis stresses the importance of common data collection protocols, sharing of information and experience, and accessibility of results at the international level to better improve our predictive abilities.

Furness, R.W., Wade, H.M. and Masden, E.A., 2013. Assessing vulnerability of marine bird populations to offshore wind farms. Journal of environmental management, 119, pp.56-66.
Key conclusions/ abstract: This paper extends an approach to assess impacts of offshore wind farms on seabirds. It separates risk in terms of collision mortality from that related to disturbance and avoidance. It identifies seabird species at greatest risk of adverse impacts from offshore wind farms. This will help to inform conservation policy (for example by indicating monitoring priorities).

Galparsoro, I., Menchaca, I., Garmendia, J.M., Borja, Á., Maldonado, A.D., Iglesias, G. and Bald, J., 2022. Reviewing the ecological impacts of offshore wind farms. npj Ocean Sustainability, 1(1), pp.1-8.
Key conclusions/ abstract: Offshore wind energy is widely regarded as one of the most credible sources for increasing renewable energy production towards a resilient and decarbonised energy supply. However, current expectations for the expansion of energy production from offshore wind may lead to significant environmental impacts. Assessing ecological risks to marine ecosystems from electricity production from wind is both timely and vital. It will support the adoption of management measures that minimize impacts and the environmental sustainability of the offshore wind energy sector.

Golbazi, M., Archer, C.L. and Alessandrini, S., 2022. Surface impacts of large offshore wind farms. *Environmental Research Letters*, *17*(6), p.064021.
Key conclusions/ abstract: Here we conduct high-resolution numerical simulations using a mesoscale model with a wind farm parameterization and compare scenarios with and without offshore wind farms equipped with these 'extreme-scale' wind turbines. Wind speed, turbulence, friction velocity, and sensible heat fluxes are slightly reduced at the surface, like with conventional wind turbines. But, while the warming found below the rotor in stable atmospheric conditions extends to the surface with conventional wind turbines, with extreme-scale ones it does not reach the surface, where instead minimal cooling is found. Overall, the surface meteorological impacts of large offshore wind farms equipped with extreme-scale turbines are statistically significant but negligible in magnitude.

Griffin, L., Rees, E. and Hughes, B., 2010. Whooper Swan migration in relation to offshore wind.
Key conclusions/ abstract: Accurate assessment of potential cumulative impacts from multiple wind farms along a flyway is a major challenge as it requires detailed information on the birds' migration routes. Where there is evidence of potential risk at one or more sites, specific research projects should be undertaken in order to support conclusions made within Environmental Impact Assessments (EIAs) for each development.

Gușatu, L.F., Menegon, S., Depellegrin, D., Zuidema, C., Faaij, A. and Yamu, C., 2021. Spatial and temporal analysis of cumulative environmental effects of offshore wind farms in the North Sea basin. *Scientific reports*, *11*(1), p.10125.
Key conclusions/ abstract: We propose a holistic Cumulative Effect Assessment methodology, applied using a geo-spatial open-source software, to assess impacts of OWF related pressures on selected seabed habitats, fish, seabird and mammal species. We take into account pressures specific to the three OWF development phases, spanning 1999-2050, for the entire North Sea basin. Our results underline 2022 as the peak year of cumulative impacts for the approved OWFs, followed by a considerable increase in potential impacts of the planned 212GWs, by 2050. The spatio-temporal analysis of the OWF environmental impacts presents the shift between highly impacted areas over the studied timeline and distinguishes between concentrated areas of high impacts (S-E of UK) and dispersed areas of high impacts (Germany). Our results can inform decision-makers and the OWF industry in a joint effort to mitigate the environmental impacts of future large OWF developments.

Haase, S., von Dorrien, C., Kaljuste, O., Plantener, N., Sepp, E., Stelzenmüller, V., Velasco, A. and Oesterwind, D., 2023. The rapid expansion of offshore wind farms challenges the reliability of ICES-coordinated fish surveys—insights from the Baltic Sea. *ICES Journal of Marine Science*, p.fsad124.

Key conclusions/ abstract: The current ban of commercial fisheries and fisheries monitoring in OWFs, in combination with an increase of OWF areas and habitat alteration within OWFs, might therefore bias the time series of scientific surveys and, thus, fisheries stock assessments. The expected increase in the overlap between OWFs and scientific fish surveys coordinated by the International Council for the Exploration of the Sea (ICES) in the Baltic Sea could result in, depending on the survey, up to 6.6–11.5% of the stations and transects being unavailable for sampling. We discuss the potential consequences for survey time series and stock assessments. Further, we aim to stimulate the discussion about the future of current standard surveys in the context of rapid expansions of OWFs, including the need for adaptations in survey design.

Hall, R., João, E. and Knapp, C.W., 2020. Environmental impacts of decommissioning: Onshore versus offshore wind farms. Environmental Impact Assessment Review, 83, p.106404.

Key conclusions/ abstract: This paper investigates how Environmental Impacts Assessments (EIA) identify, estimate and manage potential impacts of decommissioning. EIAs from 12 onshore and offshore windfarms consented between 2009 and 2014 in England and Scotland were analysed and compared. Attributes of these windfarms' Environmental Statements (ES) were scored under six categories: decommissioning in EIA stages, definitions of decommissioning, amount of analysis, depth of analysis, impacts identified, and proactive planning. Across the ESs there was a lack of analysis of potential impacts from decommissioning in their own right: not simply as a reversal of the construction process. The impacts of different end of life scenarios were not analysed in any of the ESs studied. There is evidence to suggest the presence of windfarms, especially offshore, could in some cases be environmentally beneficial for certain species. However, the ecological impact of removing offshore structures at the end of life is unknown and is currently not investigated nor predicted in EIAs.

Lindeboom, H., Degraer, S., Dannheim, J., Gill, A.B. and Wilhelmsson, D., 2015. Offshore wind park monitoring programmes, lessons learned and recommendations for the future. *Hydrobiologia*, *756*, pp.169-180.

Key conclusions/ abstract: Essentially, basic monitoring has to be rationalised at the level of the likelihood of impact detection, the meaningfulness of impact size and representativeness of the findings. Targeted monitoring is crucial and should continue to be applied to disentangle processes behind observed impacts, for instance the overarching artificial reef effect caused by wind parks. The major challenge, however, remains to achieve a reliable assessment of the cumulative impacts. A continuous international consultation and collaboration with marine scientists, managers, government officials and industry will be needed to ensure an optimisation of the future monitoring programmes.

Lloret, J., Turiel, A., Solé, J., Berdalet, E., Sabatés, A., Olivares, A., Gili, J.M., Vila-Subirós, J. and Sardá, R., 2022. Unravelling the ecological impacts of large-scale offshore wind farms in the Mediterranean Sea. *Science of the Total Environment*, *824*, p.153803.
Key conclusions/ abstract: We argue that simply importing the OWF models from the northern European seas, which are mostly based on large scale projects, to other seas like the Mediterranean is not straightforward. The risks of implementing these wind farms in the MS have not yet been well evaluated and, considering the Precautionary Principle incorporated into the Marine Strategy Framework Directive and the Maritime Spatial Planning Directive, they should not be ignored. We propose that OWF development in the MS should be excluded from high biodiversity areas containing sensitive and threatened species and habitats, particularly those situated inside or in the vicinity of Marine Protected Areas or areas with valuable seascapes. In the absence of a clearer and comprehensive EU planning of wind farms in the MS, the trade-off between the benefits (climate goals) and risks (environmental and socioeconomic impacts) of OWF could be unbalanced in favor of the risks.

Lloret, J., Wawrzynkowski, P., Dominguez-Carrió, C., Sardá, R., Molins, C., Gili, J.M., Sabatés, A., Vila-Subirós, J., Garcia, L., Solé, J. and Berdalet, E., 2023. Floating offshore wind farms in Mediterranean marine protected areas: a cautionary tale. *ICES Journal of Marine Science*, p.fsad131.
Key conclusions/ abstract: The aim of this article is to critically review the initial development of offshore wind energy inside and/or in the vicinity of Mediterranean Natura 2000 sites and other types of MPAs. In order to open up discussion of offshore wind energy policy and guide ecological research that supports holistic decisions regarding offshore wind farm (OWF) installation in the region, we (i) outline the context of Natura 2000 and other MPA policy in the Mediterranean for OWF development, (ii) summarize the potential impacts of OWF on EU-protected habitats and species, (iii) assess the interactions of OWFs, the Natura 2000 sites, and other MPAs, and (iv) propose recommendations to approach OWF development in the Mediterranean in order to safeguard the Natura 2000 sites and other MPAs

Luedeke, J., 2012, July. Is a German Harbour Porpoise much more sensitive than a British one? Comparative analyses of mandatory measures for the protection of Harbour Porposes (Phocoena phocoena) during Offshore Wind Farm ramming in Germany, Denmark and the UK. In *Proceedings of Meetings on Acoustics* (Vol. 17, No. 1). AIP Publishing.
Key conclusions/ abstract: Currently, the environmental impacts of the underwater noise on porpoises, caused by jack-hammers that are mostly used to drive the pile foundations into the seabed, are assessed differently amongst the forerunners of offshore wind energy like Denmark, Great Britain, and Germany. This paper includes an overview of the possible applied measures for avoiding damages, as well as obligatory measures and the different

thresholds of European countries. The analysis concludes by identifying a need for international standardization.

Mangi, S.C., 2013. The impact of offshore wind farms on marine ecosystems: a review taking an ecosystem services perspective. Proceedings of the IEEE, 101(4), pp.999-1009.
Key conclusions/ abstract: Using an ecosystem services approach, this paper reviews the impacts of OWFs on the ecosystem services delivered by marine environments. During the construction phase, supporting services such as reduced energy capture and nutrient cycling are changed due to the introduction of hard substrate and the reduction in soft sediment habitat at turbine bases. This may lead to changes in all other ecosystem services, both negative and positive. Quantifying these changes, however, is a challenge partly due to data limitations and a lack of clear understanding of the impacts of OWFs on the marine ecosystems. Scientific effort needs to quantitatively explore the impacts of OWFs on ecosystem functionality and the gathering of data that enables the assessment of changes to ecosystem services. Data needed to better quantify and value the impacts of OWFs on ecosystem services are suggested.

Masoumi, M., 2023. Machine learning solutions for offshore wind farms: A review of applications and impacts. Journal of Marine Science and Engineering, 11(10), p.1855.
Key conclusions/ abstract: This work specifically centers on providing a comprehensive review of the research undertaken to tackle several of these challenges using machine learning and artificial intelligence. These machine learning-based techniques have been effectively applied to structural health monitoring and maintenance, facilitating the more accurate identification of potential failures and enabling the implementation of precision maintenance strategies. Furthermore, machine learning has played a pivotal role in optimizing wind farm layouts, improving power production forecasting, and mitigating wake effects, thereby leading to heightened energy generation efficiency. Additionally, the integration of machine learning-driven control systems has showcased considerable potential for enhancing the operational strategies of offshore wind farms, thereby augmenting their overall performance and energy output. Climatic data prediction and environmental studies have also benefited from the predictive capabilities of machine learning, resulting in the optimization of power generation and the comprehensive assessment of environmental impacts. The scope of this review primarily includes published articles spanning from 2005 to March 2023.

Nene, Lefaible., Liesbet, Colson., Ulrike, Braeckman and Tom, Moens., evaluation of turbine-related impacts on macrobenthic communities within two offshore wind farms during the operational phase. Memoirs, p.47.
Key conclusions/ abstract: General trends of benthic responses included higher densities and diversity (species richness) in closer vicinity of the turbines, but effects were most pronounced at TB. Community composition differed consistently at both banks and several recurring species were responsible for between-group (far vs. very close samples)

differences during both years. Macrobenthic assemblages closer to the turbines showed similarities with communities that are associated with lower-energy environments. An in-depth community analysis was used to describe the typical within-group assemblages, but also revealed some small-scale variation in terms of densities, richness and community composition. At last, the recurrent trend of more pronounced results at TB confirm the hypothesis that impacts are site-specific (dispersive capacities, turbine-type) and can vary over different spatial scales, which highlights the importance of a targeted monitoring at the three different turbine types (gravity-based, jackets and monopiles) found in the Belgian part of the North Sea

Peschko, V., Schwemmer, H., Mercker, M., Markones, N., Borkenhagen, K. and Garthe, S., 2024. Cumulative effects of offshore wind farms on common guillemots (Uria aalge) in the southern North Sea-climate versus biodiversity? Biodiversity and Conservation, pp.1-22.
Key conclusions/ abstract: This study assessed the cumulative impacts of all operating OWFs on guillemots in the German North Sea. These estimates were applied to quantify the possible conflicts between guillemot occurrence and current German government plans to implement large-scale OWFs. If OWFs were implemented according to the current maritime spatial plan for the German Exclusive Economic zone, they would cover 13% of the German North Sea. Guillemot numbers peak during autumn, with German North Sea offshore waters hosting approximately 90,000 individuals. Guillemot density in autumn was significantly reduced within a radius of 19.5 km around operating OWFs. Applying this disturbance distance to current installation plans, about 70% of the German North Sea would be affected, and an estimated 68% of guillemots in the German North Sea would experience habitat loss. This highlights the possible threat to guillemots in the southern North Sea if the current German government plans are implemented. The current estimates are highly relevant to decisions regarding marine spatial planning and management recommendations. Such evaluations are essential for developing sustainable scenarios including reducing the human CO_2 footprint, whilst also conserving biodiversity.

Platteeuw, M., Bakker, J., van den Bosch, I., Erkman, A., Graafland, M., Lubbe, S. and Warnas, M., 2017. A framework for assessing ecological and cumulative effects (FAECE) of offshore wind farms on birds, bats and marine mammals in the southern North Sea. In Wind Energy and Wildlife Interactions: Presentations from the CWW2015 Conference (pp. 219-237). Springer International Publishing.
Key conclusions/ abstract: The application of this cumulative impacts assessment framework showed that effective mitigation measures are required to achieve this agreement without endangering protected species and habitats, in line with European Union (EU) nature and environmental legislation. Mitigation measures can be implemented through conditions on permits for offshore wind farm projects, which include restrictions on the maximum underwater noise levels during construction, the minimum capacity of

individual wind turbines, and measures to reduce bird and bat collisions and fatalities during seasons of major migration.

Rezaei, F., Contestabile, P., Vicinanza, D. and Azzellino, A., 2023. Towards understanding environmental and cumulative impacts of floating wind farms: Lessons learned from the fixed-bottom offshore wind farms. Ocean & Coastal Management, 243, p.106772.
Key conclusions/ abstract: This review focuses on the proved environmental impacts of offshore wind farms gained from post-construction environmental monitoring programs. Particularly, this study provides significant insights on: 1) the area and time span over which biological effects may occur, 2) responses to disturbance by different target organisms; 3) quantification of short/long-term effects; 4) recovery from impacts in the long term. The monitoring studies showed little or only local impacts of offshore wind farms on the marine environment, either during their construction or the operational phases. However, further research is needed to answer whether synergies of little and local impacts may determine consequences at the population level. As the number and size of offshore wind farms increase it is necessary to consider consequences at the population level as well as cumulative impacts of these activities on marine ecosystems.

Schulz-Stellenfleth, J., Emeis, S., Dörenkämper, M., Bange, J., Cañadillas, B., Neumann, T., Schneemann, J., Weber, I., Zum Berge, K., Platis, A. and Djath, B., 2022. Coastal impacts on offshore wind farms—A review focussing on the German Bight area. Meteorol. Z, 31, pp.289-315.
Key conclusions/ abstract: This paper provides an overview of coastal effects and their potential impact on the operating conditions of offshore wind farms with a focus on the German Bight. Common numerical and experimental tools to study coastal effects and developing internal boundary layers (IBL) are introduced, and a review on the current state of research is given. The German Bight is an interesting example to illustrate impacts of coastal effects on offshore wind energy, because of the large number of wind turbines with a coastal distance of 100 km or less. Phenomena related to the stability of the boundary layer, like low level jets, are discussed. Spatial variations of vertical heat fluxes in the coastal zone related to variable water depths or Wadden Sea areas are analysed. The study illustrates that due to the increasing size of offshore wind farms, horizontal wind speed gradients caused by coastal effects can lead to significant wind variations within a single farm. The study puts particular focus on the large potential provided by the combination of different measurements and modelling techniques and gives recommendations for future developments of integrated approaches including the formulation of priorities.

Schneider, J., Klüner, A. and Zielinski, O., 2023. Towards digital twins of the Oceans: the potential of machine learning for monitoring the impacts of offshore wind farms on marine environments. Sensors, 23(10), p.4581.
Key conclusions/ abstract: Here we conducted a feasibility study with the focus on monitoring these effects by utilizing different machine learning methods. A multi-source

dataset for a study site in the North Sea is created by combining satellite data, local in situ data and a hydrodynamic model. The machine learning algorithm DTWkNN, which is based on dynamic time warping and *k*-nearest neighbor, is used for multivariate time series data imputation. Subsequently, unsupervised anomaly detection is performed to identify possible inferences in the dynamic and interdepending marine environment around the offshore wind farm. The anomaly results are analyzed in terms of location, density and temporal variability, granting access to information and building a basis for explanation. Temporal detection of anomalies with COPOD is found to be a suitable method. Actionable insights are the direction and magnitude of potential effects of the wind farm on the marine environment, depending on the wind direction

Serpetti, N., Benjamins, S., Brain, S., Collu, M., Harvey, B.J., Heymans, J.J., Hughes, A.D., Risch, D., Rosinski, S., Waggitt, J.J. and Wilson, B., 2021. Modeling small scale impacts of multi-purpose platforms: an ecosystem approach. Frontiers in Marine Science, 8, p.694013.
Key conclusions/ abstract: Here we created a high-resolution spatiotemporal Ecospace model of the West of Scotland, in order to assess impacts of a simple MPP configuration on the surrounding ecosystem and how these impacts can cascade through the food web. The model evaluated the following specific ecosystem responses: (i) top-down control pathways due to distribution changes among top-predators (harbor porpoise, gadoids and seabirds) driven by attraction to the farming sites and/or repulsion/killing due to OWT operations; (ii) bottom-up control pathways due to salmon farm activity providing increasing benthic enrichment predicated by a fish farm particle dispersal model, and sediment nutrient fluxes to the water column by early diagenesis of organic matter (recycled production). Weak responses of the food-web were found for top-down changes, whilst the results showed high sensitivity to increasing changes of bottom-up drivers that cascaded through the food-web from primary producers and detritus to pelagic and benthic consumers, respectively. We assessed the sensitivity of the model to each of these impacts and the cumulative effects on the ecosystem, discuss the capabilities and limitations of the Ecospace modeling approach as a potential tool for marine spatial planning and the impact that these results could have for the Blue Economy and the EU's New Green Deal.

Slavik, K., Lemmen, C., Zhang, W., Kerimoglu, O., Klingbeil, K. and Wirtz, K.W., 2019. The large-scale impact of offshore wind farm structures on pelagic primary productivity in the southern North Sea. Hydrobiologia, 845, pp.35-53.
Key conclusions/ abstract: Our study investigates whether the accumulation of epifauna, dominated by the filter feeder *Mytilus edulis* (blue mussel), on turbine structures affects pelagic primary productivity and ecosystem functioning in the southern North Sea. We estimate the anthropogenically increased potential distribution based on the current projections of turbine locations and reported patterns of *M. edulis* settlement. This distribution is integrated through the Modular Coupling System for Shelves and Coasts to

state-of-the-art hydrodynamic and ecosystem models. Our simulations reveal non-negligible potential changes in regional annual primary productivity of up to 8% within the OWF area, and induced maximal increases of the same magnitude in daily productivity also far from the wind farms. Our setup and modular coupling are effective tools for system scale studies of other environmental changes arising from large-scale offshore wind farming such as ocean physics and distributions of pelagic top predators.

Steven, D., 2014, March. Environmental impacts of offshore wind farms in the Belgian part of the North Sea: Learning from the past to optimize future monitoring programmes. In book of abstracts.

Key conclusions/ abstract: Prior to construction, a developer needs to obtain a domain concession and an environmental permit. The latter includes a number of terms and conditions to minimise or mitigate the environmental impact of the wind farm project. This imposes a monitoring programme to assess the potential impacts on the marine environment. These assessments enable the authorities to impose mitigation measures or even halt the activities in case of extreme damage to the marine ecosystem. The monitoring programme equally allows understanding and evaluating the underlying ecological processes in support of an environment-friendly offshore wind farm policy and management. The programme started in 2005 and targets physical (hydro-geomorphology and underwater noise), biological (epifouling community on the hard substratum, macro and epibenthos of the soft substratum, fish, seabirds and marine mammals), as well as socio-economic (seascape perception and offshore renewables appreciation) aspects of the marine environment.

Vanhellemont, Q. and Ruddick, K., 2014. Turbid wakes associated with offshore wind turbines observed with Landsat 8. Remote Sensing of Environment, 145, pp.105-115.

Key conclusions/ abstract: The effects on hard and soft substrate fauna, seabirds and marine mammals are most frequently considered. Here we present Landsat-8 imagery that reveals the impact of offshore wind farms on suspended sediments. Turbid wakes of individual turbines are observed that are aligned with tidal currents. They are 30–150 m wide, and several km in length. The environmental impact of these wakes and the source of the suspended material are still unclear, but the wake size warrants further study. The underwater light field will be affected by increased suspended sediments and the turbid wakes could significantly impact sediment transport and downstream sedimentation.

van Berkel, J., Burchard, H., Christensen, A., Mortensen, L.O., Petersen, O.S. and Thomsen, F., 2020. The effects of offshore wind farms on hydrodynamics and implications for fishes. Oceanography, 33(4), pp.108-117.

Key conclusions/ abstract: We review the state of knowledge about offshore wind farm (OWF) development-related effects on hydrodynamics and their possible secondary effects on fishes derived from European studies. Theoretical, modeling, and observational studies of OWF developments are relatively advanced and identify potential impacts resulting from OWF changes to local or regional hydrodynamics through modification of (1) the wind fields, and (2) oceanographic parameters including turbulence, mixing, and vertical stratification. While limited, studies discuss local OWF (i.e., within the OWF footprint) impacts on fishes due to sediment resuspension or sedimentation, temperature change, nutrient transport, and substrate availability. These studies largely neglect possible effects further afield and generally conclude that any hydrodynamic impact of OWFs on fishes cannot be distinguished when compared to natural variability. To further understanding of the cumulative risk from extensive OWF developments requires additional research on OWF-related spillover effects on surrounding ecosystems and on natural oceanographic connectivity. The use of dynamic habitat or agent-based models coupled with refined hydrodynamic models can help quantify the scale of spatial and temporal effects of hydrodynamic cues on the movement of fishes and their habitats, which is not currently possible via conventional modeling, quantitative analysis approaches, or field-based observational studies and surveys.

Verfuss, U.K., Sparling, C.E., Arnot, C., Judd, A. and Coyle, M., 2016. Review of offshore wind farm impact monitoring and mitigation with regard to marine mammals. The effects of noise on aquatic life II, pp.1175-1182.
Key conclusions/ abstract: Monitoring and mitigation reports from 19 UK and 9 other European Union (EU) offshore wind farm (OWF) developments were reviewed, providing a synthesis of the evidence associated with the observed environmental impact on marine mammals. UK licensing conditions were largely concerned with mitigation measures reducing the risk of physical and auditory injury from pile driving. At the other EU sites, impact monitoring was conducted along with mitigation measures. Noise-mitigation measures were developed and tested in UK and German waters in German government-financed projects. We highlight some of the review's findings and lessons learned with regard to noise impact on marine mammals.

Wilson, J.C. and Elliott, M., 2009. The habitat-creation potential of offshore wind farms. Wind Energy: An International Journal for Progress and Applications in Wind Power Conversion Technology, 12(2), pp.203-212.
Key conclusions/ abstract: The present study shows that the placement of offshore wind turbines gives the potential for habitat creation, which may thus be regarded as compensation for habitat lost. Using current design criteria and construction methods, the analysis here indicates that the net amount of habitat created by the most common design of offshore wind turbine, the monopile, is up to 2.5 times the amount of area lost through the placement, thus providing a net gain even though the gained habitat may be of a different character to the one that lost. Hence, the study raises important issues for marine nature conservation managers. The study also provides suggestions for further work in order to increase the empirical evidence for the value of mitigation, compensation and habitat creation. Copyright © 2009 John Wiley & Sons, Ltd.

Screening of initiatives:

- CSA Working Group on Offshore Wind Development and Fisheries, aim: To be a world-leading marine science organization, meeting societal needs for impartial evidence on the state and sustainable use of our seas and oceans. Website: https://www.ices.dk/community/groups/Pages/WGOWDF.aspx
- Tethys, aim: The primary functions of Tethys are twofold: To facilitate the exchange of information and data on the environmental effects of marine and wind energy technologies; and To serve as a commons for marine and wind energy practitioners and therefore enhance the connectedness of the renewable energy community as a whole. Website: https://tethys.pnnl.gov/
- France Energies Marines (A), aim: institute for energy transition dedicated to offshore renewable energies. Website: https://www.france-energies-marines.org/en/
- INORE (International Network on Offshore Renewable Energy), aim: INORE is a global network of young researchers and professionals working in the field of offshore renewable energy. The organization facilitates collaboration and knowledge exchange through conferences, workshops, and research projects, including studies on environmental impacts and technological advancements. Website: https://inorean.org/about-us_new/
- BOEM (Bureau of Ocean Energy Management) Studies, aim: In the United States, BOEM conducts research and environmental assessments to evaluate the potential impacts of offshore wind energy development on marine life, habitats, and coastal communities. This includes studies on seabirds, marine mammals, fish populations, and underwater noise. Website: https://www.boem.gov/renewable-energy/offshore-renewable-activities
- Marinerg-i EU project, aim: Technical de-risking and increasing investor confidence through the development and implementation of best practices; quality metrics; standards. Leverage existing local knowledge and capabilities to accelerate the development of the Offshore Renewable Energy industry. Informing national and EU policy and investment strategies to capitalise on leadership in the Offshore Renewable Energy sector. Website: https://www.marinerg-i.eu/partners/
- Marine Collaboration Research Forum (MarCRF), aim: The Marine Collaboration Research Forum (MarCRF) is a successful cross-disciplinary initiative developed between the University of Aberdeen and Marine Scotland Science. Its priority is to work with each other as well as stakeholders and policy makers to provide the science necessary to identify research priorities, co-develop innovative research programmes and an evidence-based framework to deliver policy relevant science. Website: https://blogs.gov.scot/marine-scotland/category/marcrf/

- Office of Technology Assessment at the German Bundestag (TAB), name of the project: Impact of offshore wind farms on the environment. Website: https://www.tab-beim-bundestag.de/english/energy-and-environment_impact-of-offshore-wind-farms-on-the-environment.php
- Baltic wind EU, aim: We offer an innovative platform for news, insights, communication and professional networking. We see the need for speeding up the process of wind farm investments deployment in the Baltic Sea countries – local industry, SMEs, communities from Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Sweden. Therefore, we create an opportunity to share the voice of industry representatives, professionals, start-ups founders, analytics, journalists, academic and research centres. The structure of the BalticWind.EU is built on the basis of daily industry news reporting, enriched with expert input, extensive reports and case studies, an exclusive job board dedicated to offshore, exchange of experience and workshops platform, a database of offshore wind projects in all Baltic countries including ongoing tenders and much more. Website: https://balticwind.eu/category/top-news/
- MIROVA FOUNDATION Research Programme - FRB, aim: Synthesize existing scientific knowledge on the impact of wind energies land, marine and photovoltaic on biodiversity, as well as data evaluation solutions and good practices. Website: https://www.fondationbiodiversite.fr/la-frb-en-action/programmes-et-projets/page-en-cours-de-construction-programme-de-recherche-mirova-fondation-frb/

Annexe 4: Call for Knowledge

Bridging the gap between policy and knowledge on Biodiversity in Europe

CALL FOR KNOWLEDGE FOR INITIAL SCOPING

Eklipse - CfK 01/2024

TOPIC:

What are the cumulative impacts of offshore wind farms and their consequences for the achievement of good environmental status of marine ecosystems?

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March 2024

Responses by April 12th, 2024

1. Invitation to share knowledge for informed decision-making

Eklipse invites you to contribute to this open call with your knowledge on the impacts of planned expansion of wind energy production at sea, including cumulative impacts on marine ecosystems and the achievement of good environmental status, by answering the questions below.

Background:

The aim of the request is to examine the multi-level impacts of the planned expansion of wind energy production at sea, including cumulative impacts on marine ecosystems and on the achievement of good environmental status (GES). Such analysis is critically needed considering the increase in challenging targets for renewable energy sources that need to be achieved by Member States in the coming years, a large percentage of which are likely to be offshore. Existing studies on cohabitation between offshore wind energy production and nature tend to focus, in particular, on marine protected areas (MPAs) or the protection of species (e.g. birds). Existing knowledge misses an analysis relevant to all the dimensions (descriptors) of good environmental status as per the Marine Strategy Framework Directive (MSFD). Such analysis, which includes literature reviews and scenarios modelling, should look at how offshore wind energy expansion might affect the achievement of GES, considering the GES threshold values set by Member States for a number of GES criteria (such as seabed loss, impulsive noise, contaminant levels, species abundance, etc.) and the subsequent cumulative impacts. The study should empower the Commission to propose solutions, including in the context of the Member States' MSFD Programmes of Measures and the MSFD review, to make sure that offshore wind energy expansion does not impede the achievement of GES under the MSFD, considering the entire lifecycle of offshore wind power plants (including their decommissioning), whatever the type of turbine (monopiles, floating, tripods, etc.). These solutions could, for example, relate to marine spatial planning (e.g. current developments in the context of the Greater North Sea Initiative), in particular considering the cumulative impacts of other human activities on the marine environment. Identification of other solutions (for instance technological) would also be welcome.

The planned developments of offshore wind production in order to achieve the targets set in EU and national legislation and policies are likely to be at such a large scale that they will have impacts on marine ecosystems and marine ecosystem functioning, including seabed habitat loss, disruption of migratory routes of mobiles species, including birds and cetaceans, deadly collisions with birds, disruption of feeding and breeding grounds of a number of species, underwater noise during development and maintenance, input of contaminants and litter and changes to hydrographic conditions. Almost all descriptors of good environmental status are likely to be impacted by these developments.

Eklipse invites scientists, policymakers, practitioners and other societal actors to share their knowledge on the topics. The main aim of this Call for Knowledge is to gather all relevant knowledge to be considered during the Eklipse process. This is to avoid duplication of ongoing efforts and to ensure the outputs are jointly and timely developed. Please have a look at the following questions:

Do you know of any major or overlooked projects, papers, reports, grey literature that could support informing on known cumulative impacts of offshore wind energy development on marine ecosystems and existing mitigation strategies?

a) Could you share your experiences of on-the-ground actions aiming at understanding monitoring and mitigation of short- and long-term impacts of offshore wind energy developments?
b) Do you have any suggestions on what knowledge (from science, policy, or societal experience) is needed to better understand the cumulative impacts of offshore wind development on marine ecosystems?
c) Are you aware of any knowledge gap analysis concerning any of these items?
    i. (cumulative) impacts of offshore wind farms strategies to mitigate impacts of offshore wind farm expansions
    ii. transformative strategies of offshore wind farm expansions (e.g. benefits for biodiversity in no-take zones around the wind farms)
    iii. effectiveness of environmental impact assessments of offshore wind farm expansions.

2. How to contribute?

Please contribute your comments and knowledge/initiatives/references through the Eklipse Survey or through social media using the hashtag: #XXXX. Feel free to send us an email directly if you prefer or request a meeting with us, using emb@eklipse.eu.

We invite you to add any information that you think is relevant to this request and justify its inclusion (e.g. additional information from countries, scales, or disciplinary perspectives not covered sufficiently). We also warmly encourage you to help us disseminate broadly this call for knowledge.

Relevant information should be grouped under the following:

(1) initiatives/projects (indicating if completed, ongoing or planned),

(2) literature reviews,

(3) empirical studies/practical experiences,

(4) modelling studies, and

(5) conceptual papers.

Contributions may include:

(a) links to websites or contact details,

(b) links to open access papers,

(c) links to published and unpublished grey literature or case studies,

(d) descriptions of ongoing research projects or knowledge compilations expected to deliver results within the next year or

(e) your on-the-ground experiences in this field.

3. Objective of the call and request to be addressed by this call

The final framing of the request seeks to contribute primarily to the Marine Strategy Framework Directive (and its ongoing review). It will, however, also inform other EU legal instruments/policies such as the Maritime Spatial Planning Directive, Renewable Energy Directive, Biodiversity Strategy, Zero Pollution Action Plan, Marine Action Plan, Wind Power Action Plan, as well as regional and/or international agreements or processes, notably the Regional Sea Conventions Action Plans/activities, and other possible initiatives planned/taking place at a regional level through:

a) the negotiation or implementation of a legal act (Directive, Regulation, Decision)
b) the negotiation or implementation of a non-binding instrument (e.g., Strategies, Communications)
c) the drafting of EU action plans or legislative proposals (either at the development, negotiation, or adoption phase)

The objective of this call for knowledge is to launch an initial scoping process on the request meant to identify available assessments, existing studies and other resources.

For further details, check Eklipse's background, its functions, and its process describing how it addresses requests from policy and society.

The Eklipse Scoping Team

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Alister Scott - Eklipse MEG Co-chair, University of Northumbria, UK.

And the Eklipse Management Body.

If you have any questions, do not hesitate to get in touch with the Eklipse Management Body (https://eklipse.eu/contact/).