WORKING GROUP ON OFFSHORE WIND DEVELOPMENT AND FISHERIES (WGOWDF)

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Contents

i Executive summary

The Working Group on Offshore Wind Development and Fisheries (WGOWDF) focuses on the interactions between fisheries and offshore wind energy.

WGOWDF has been working to advance coordination and scientific understanding of the interactions of offshore wind development and fisheries in 2020–2022. The terms of reference (ToRs) examined interactions across the various dimensions of fisheries - inclusive of fisheries resource species, fisheries data collections, fish habitats, and the human dimensions of fisheries. Because the effects of offshore wind energy development are pervasive; and increasing in scale, pace, and magnitude across ICES member countries, these issues also touch upon various other human pressures, marine management, ecosystem science, and survey and monitoring expert groups. As such, the group advanced connections and collaborations with many other ICES groups. International workshops, scientific publications, and symposia directly resulted from WGOWDF activities and member collaborations. These outputs have helped to advance the awareness of issues not previously identified as well as the science on methods to address offshore wind and scientific survey interactions and methods to analyse and develop evidence on fishing community and fish habitat responses to offshore wind development.

The growing and diverse membership of the group, which is composed of 54 scientists and experts from fishing industry, government, and non-government sectors and across 10 countries, reflects the importance and relevance across ICES member nations. WGOWDF concluded that there is a need to continue to fill evidence gaps on the effects of offshore wind on fisheries. The group recognizes the unique international forum that ICES and WGOWDF represents and is willing to continue to collaborate on high priority fisheries and offshore wind research.

ii Expert group information

Expert group name	Working Group on Offshore Wind Development and Fisheries (WGOWDF)
Expert group cycle	Multiannual
Year cycle started	2020
Reporting year in cycle	3/3
Chairs	Antje Gimpel, Germany
	Andrew Gill, UK
	Andrew Lipsky, USA
Meeting venue(s) and dates	27-29 April 2020, remote meeting (37 participants)
	9-11 June; 15-16 June 2021, remote meeting (30 participants)
	13-16 June 2022, remote meeting (36 participants)

1 Introduction

The global move towards offshore wind (OW) in response to increasing energy demands and security is a key pillar in the global transition to a carbon-free power sector (GWEC 2019). In 2018, the worldwide installed capacity of offshore wind, summed up to 23.1 GW with a European contribution of 79% approximately and a US contribution of 30 MW (ICES, 2021; Stelzenmüller *et al.* 2020). European OW development corresponds to over 5000 grid-connected fixed wind turbines across 12 countries. In Europe, the development of OW varies greatly among the different European sea basins (Baltic Sea, North Sea, Atlantic, Mediterranean Sea and Black Sea). Northern European countries such as the UK, Germany, Denmark, Belgium, the Netherlands, and Sweden currently have the highest numbers of installed offshore wind farms (OWFs; ICES, 2021). This development contributes significantly to reductions of greenhouse gas emissions by at least 55% by 2030 (compared to 1990); (https://ec.europa.eu/clima/policies/eu-climate-action/2030_ctp_en), a target adopted under the global Paris Agreement in 2015. The wider 2030 climate energy framework is to be implemented via national climate action plans (European Commission 2015, 2018, Europêche 2020, ICES 2021, Stelzenmüller *et al.* 2020). A large share of this (at least 32%) will be achieved by the EU Member States through renewable energy. The goal for offshore wind in Europe is for between 230 and 450 GW by 2050 to assist in the delivery of climate neutrality by 2050 (European Commission statement 2020, Stelzenmüller *et al.* 2020, ICES 2021). According to the International Energy Agency (IEA), offshore wind is set to become the main source of power generation in Europe by 2042 (made up of fixed and floating turbines and the associated power cabling).

In the United States, offshore wind development is set to expand across the Atlantic, Pacific, and Gulf of Mexico with recently announced targets of 30 GW by 2030 and 110 GW by 2050 (GWEC, 2022; Gill *et al.* 2020). As a result, the implementation of OW will speed up the race for space in the already heavily used offshore and coastal waters across the world (Halpern *et al.* 2019, Stelzenmüller *et al.* 2020). Ongoing and planned actions for OW in US waters are expected to result in increased risk of highly localized, periodic short-term or long-term, moderate to major impacts on commercial fisheries (Bureau of Ocean Energy Management, 2021). In addition, there may be major adverse impacts on fisheries scientific research and surveys that would have consequences for quota allocation and effort management measures (Bureau of Ocean Energy Management, 2021).

Some fisheries could be at risk of losing access to traditional fishing grounds due to safety requirements imposed by OWF development leading to potentially decreased landings. These implications required evidence to determine the type, level and scale of impact on the fisheries. In addition, the presence of OWFs may alter the occurrence, distribution and abundance of fisheries resource species both in the short and long term; knowledge of which is sparse (ICES, 2021). Therefore, knowledge of the impact of OWF on fisheries requires consideration of the economic and socio-cultural effects on the fishers, the ecological changes and responses to OWFs of fisheries resources species, and the ability to collect the required scientific evidence (Gill *et al.* 2020). Furthermore, current knowledge on impacts often neglect assessment of proposed large-scale future expansions of OWF (Stelzenmüller *et al.* 2020). The WGOWDF addresses these topics directly through its various and interconnected Terms of Reference.

2 Findings towards a coherent assessment of offshore wind farm effects on fisheries and fishery resource species

2.1 Consider and report on effects of habitat alteration by offshore wind development on fisheries resource species

The physical presence of offshore wind turbines, the associated hard surface scour and cable protection, and the power cabling itself represent a significant change to existing benthic, demersal and pelagic habitats. For fisheries resource species it is anticipated that these structures will cause direct responses by species, in terms of their occurrence, abundance and potential change in distribution, either through association with the OWF structures or avoidance or effects relating to changes in vertical and horizontal movement of water, sediment suspension, and water column. Furthermore, indirect changes via the food web with prey and/or predator species changes or the consequences of invasive species may occur. Any of such changes may be manifest, for example with species population level change or shifts in stock structure.

The picture is complex, leading to the WG activities breaking down the topic into consideration of the fish species (of interest) subdivided by main marine zone (pelagic, demersal and benthic) and the type of OWF related habitat (fixed, floating, scour and cables). We then applied a triage approach to identify key expected changes relevant to target fisheries species. This was followed by cause-effect pathway considerations and determination of the key factors that could lead to change that will then have consequences for the fishers when fishing for target species. This builds on an approach taken by our sister, the Working Group on Marine Benthal and Renewable Energy Developments (WGMBRED). The WGOWDF have subsequently set out a framework to consider the different elements, following a DaPSIR (Drivers, Human activities, Pressures, State change, Impact, Response) approach with a focus on the PSI parts as they relate most to the physical abiotic and biotic changes. We further broke this down into direct and indirect state changes and direct and indirect ecological impacts. This then feeds into population impacts, which will determine to a large degree the impacts on the fishers and the fishing community.

Through the annual meetings and intersessional work an outline plan and activities for drafting a paper are advanced. Also, it became evident that there is much more work to do in order to determine the priorities for evidence generation and gathering, particularly when linking the effects on fisheries species of habitat alteration and the potential consequences to the fishers. Therefore, we have proposed a continuation of the ToR and further development and focus on filling the gaps during the next iteration of the WGOWDF.

2.2 Develop and report on methodologies to assess impacts on fishery resource data collections

The use of offshore wind fixed and floating wind technologies are being advanced to achieve climate mitigation goals which will require the introduction of new energy infrastructure in marine waters. The amount of marine space needed to develop necessary transmission systems and turbine generators is substantial. In the USA, 2030 targets will require approximately 3411 turbine generators and approximately 10 000 miles of new submarine cabling over 2.37 million acres in the Northeast U.S. shelf ecosystem (BOEM, 2022a). As of September 2022, over 22.37 million acres of the U.S. northeast shelf ecosystem has been designated by the Bureau of Ocean Energy Management (BOEM) as offshore wind leases, wind energy areas, and wind planning areas (BOEM, 2022b, BOEM, 2022c). Applying similar technology requirements to the U.S. 2050 targets will require over 10 000 turbines and 33 000 miles of submarine cable. Offshore wind development at the pace, scale, and magnitude proposed across the U.S., Europe, and Asia could have profound interactions on the marine ecosystem, trust resources, and the survey enterprises need to monitor populations, stocks, and ecosystem conditions. This emerging new use requires existing regional fisheries-independent survey programs to evaluate the space-use impacts associated with this development on survey missions /operational requirements. This presents both a massive challenge and opportunity to evaluate and propose potential changes in the design, observation systems, and estimation approaches to meet existing and new scientific requirements.

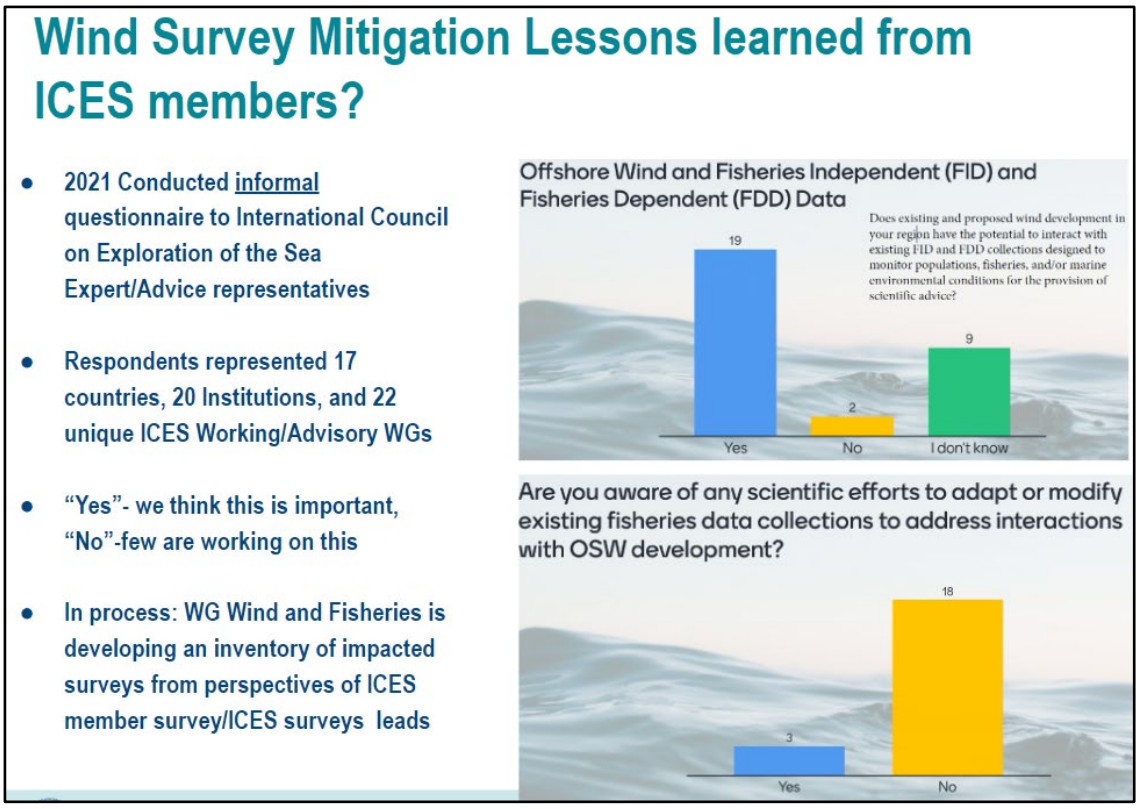

Figure 2.2.1. Summary of WGOWDF survey results highlighting the level of awareness of the issue of offshore wind on scientific data collections.

Through intersessional activities and remote meetings, the working group has been able to develop an outline and draft publication on the topic with case studies presented. This work will be completed in winter 2022. A survey instrument was distributed to ICES scientific expert

groups that focus on surveys to measure perceptions of the issue of wind development impacts on scientific data collections (Figure 2.2.1). As a follow up to the survey, ToR B working group members are conducting a follow up analysis and survey directed at all major fisheries independent surveys in the U.S. and ICES member countries where offshore wind development is planned or implemented. A number of publications authored by WGOWDF members, including in the Journal of Oceanography (REF), describe the emerging issue of wind development interactions with surveys and assessments and were informed by WGOWDF activities and collaborations. In addition, WGOWDF chair coordinated with chairs of the Workshop on Unavoidable Survey Effort Reduction 2 to contribute another milestone for WGOWDF by bringing survey expertise across ICES member countries to include the issue of offshore wind development into the next WKUSER2 Report. In October, 2022 WGOWDF members presented to WKUSER 2 in Galway, Ireland and contributed to the pending report. Finally, during the Annual Science Conference convened in Dublin, Ireland, 19 October 2022, WGOWDF members sponsored a Network Session entitled: "Methodologies to assess the impact of offshore wind development on fishery data collections." The workshop session included over 144 participants and resulted in a brief summary of findings describing emerging challenges, opportunities, and key priorities. Due to issues with COVID and the inability to meet physically, ToR B deliverables will be completed during 2022–2023 and the ToR will continue on as proposed for another three-year term

2.3 Review and report on fishing industry interactions with offshore wind development and document lessons learned including effects on the distribution of fishing operations

No common, consistent, and accepted framework for defining and quantifying socio-economic impacts of offshore wind energy on fisheries exist in Europe nor the United States. While there are distinct differences in the scale and scope of fisheries between the North American and European wind development areas, there is an opportunity to identify common issues and promote research to address these issues (ICES, 2021).

In order to develop a framework to define the socio-economic effects and impacts of OWF on fishing behaviour, fishing communities, and coastal communities; identify research gaps and lessons learnt; and generate recommendations for research to address these issues the WG led a workshop on the implications of offshore wind on fisheries. The ICES Workshop on Socio-economic Implications of Offshore Wind on Fishing Communities (WKSEIOWFC) was held on 15-17 March 2021, online. Together with 50 participants the chairs of the workshop focused on three themes relevant to the interaction between fisheries and OWF: 1) Environmental – how both ecological change and the presence of infrastructure affect fishing activities; 2) Economic – the economic implications of changes in fishing activity (at the level of individual businesses, the industry and more widely); and 3) Social/Cultural – the wider interactions between fishing, coastal communities and society, and how these might be affected (Figure 2.3.1).

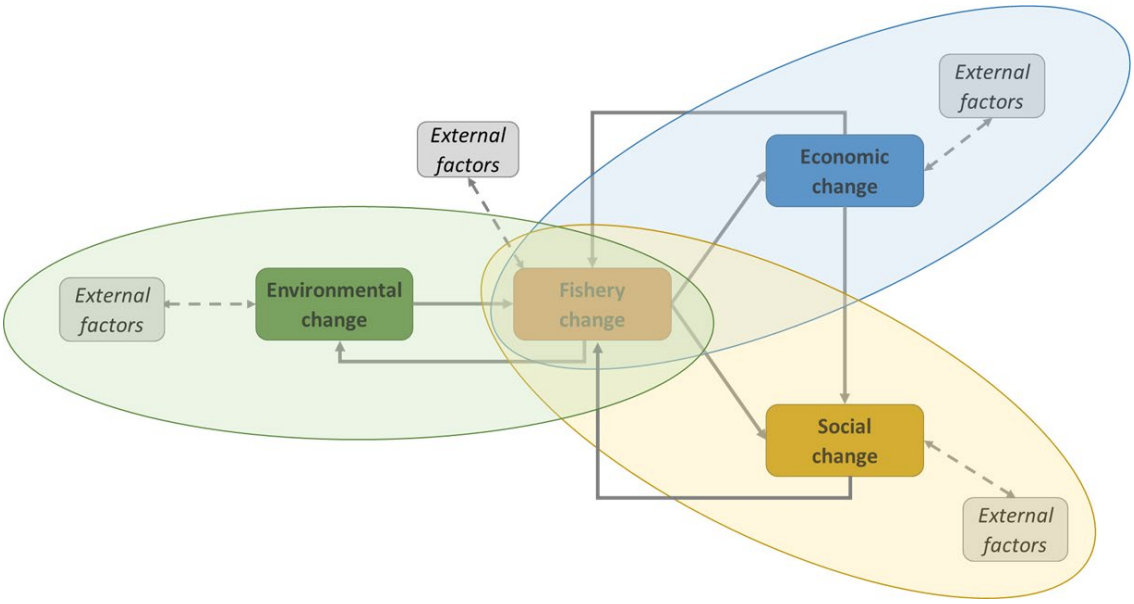

Figure 2.3.1. A conceptual representation of the interactions between environmental, fishery, economic and social/cultural changes, and how these different elements were partitioned into the three main workshop themes.

Results of the workshop fed directly into the study "Fishing industry interactions with offshore wind development on a global scale - lessons learnt" (ICES, 2021). The outcomes included a set of questions related to the three main workshop themes, a series of graphs presenting the feedback from workshop participants (synthesised following qualitative content analysis principles; see the example in Figure 2.3.2) and cause-effect maps describing for instance interrelationships between changes in fishing behaviour, OWF development, and cultural impact (see example in Figure 2.3.3). Further outcomes included a synthesis of similarities and differences between the European and US contexts, evidence and data gaps, as well as the conclusion that there is a need for a better understanding of cumulative socio-economic impacts.

Outcomes are currently synthesised in a scientific paper. Moreover, the results of this workshop will be carried further as the WGOWDF addresses its ToR A. This will include the following efforts: further analyse, review and summarise the results of mental models, identify linkages between different model dimensions, evaluate and identify metrics for measuring important factors and conditions for each of the sub-models, and identify and prioritise where there are data gaps requiring new research. This understanding can be used to foster information exchanges, collaboratively address science questions, and support decision-making. These activities are considered to have a very high priority on a global level, especially as offshore wind energy expands. Here, we foresee a strong link to other ICES working groups such as efforts towards a joint case study together with the Working Group on Economics (WGECON) and the Working Group on Social Indicators (WGSOCIAL).

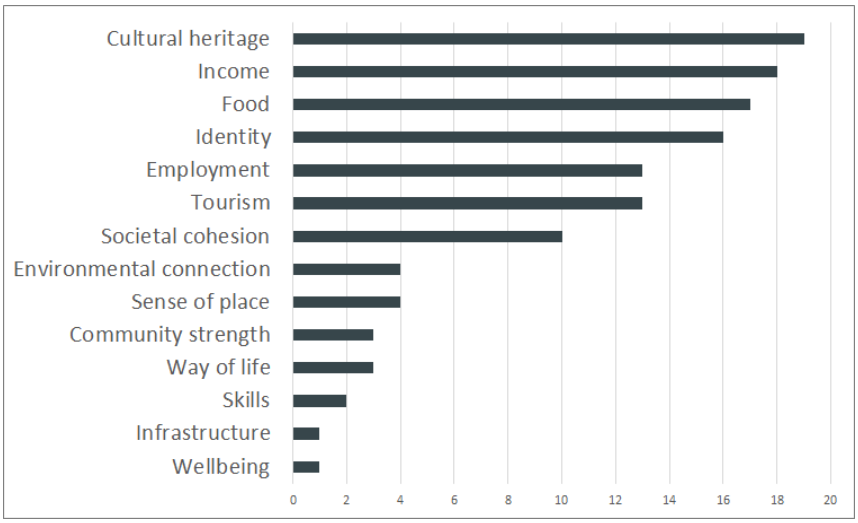

Figure 2.3.2. The number of responses in each of the main themes identified within responses to the question "In what ways is fishing important to coastal communities and wider society?"

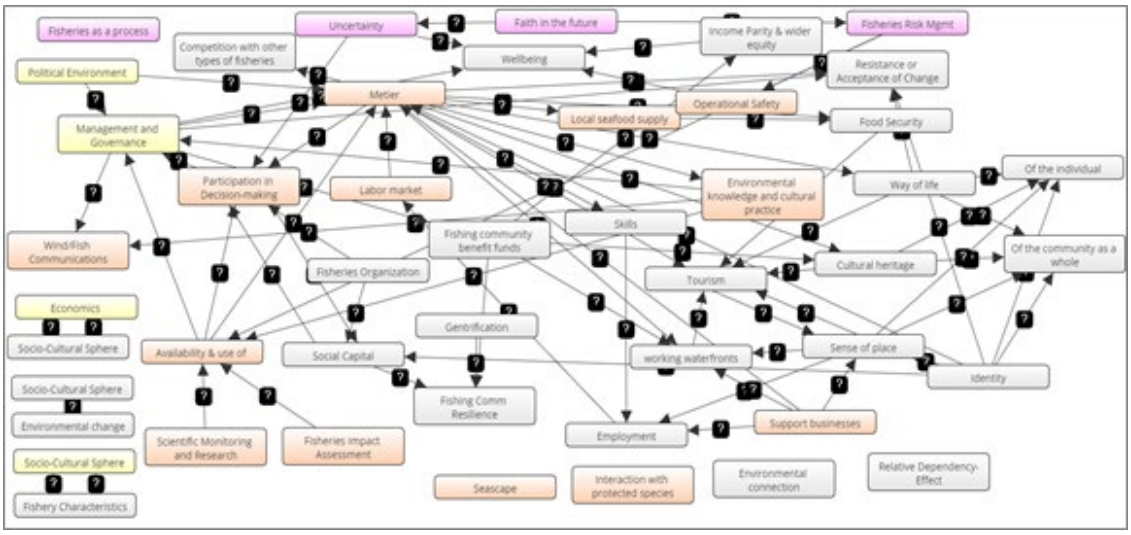

Figure 2.3.3. Example of cause effect maps describing interrelationships between changes in fishing behaviour, OWF development, and cultural impacts.

2.4 Review gaps and opportunities for cross-cutting links and communication between ICES groups in relation to renewable energy and marine ecosystems and sustainability

The focus of the WGOWDF last term of reference is on cross-cutting links and communication. We suggest that the focus should be on a communication database on fisheries and OWF interactions and the tracking /capturing where changes are happening as a result of OWF-fisheries. This includes transboundary issues, OWF with restoration and social issues (link to the Working Group for Marine Planning and Coastal Zone Management (WGMPCZM); Scallop Assessment Working Group (WGScallop)); and survey interactions with the Workshop on unavoidable survey effort reduction (WKUSER2) outputs. WGOWDF can identify existing and ongoing OWF-fisheries research (link to ToR a).

Another focus is liaison with the Working Group on Spatial Fisheries Data (WGSFD) using OWF as case study and the continuation of working together with the Working Group on Marine Benthal and Renewable Energy Developments (WGMBRED) and the Working Group on Offshore Renewable Energy (WGORE).

Other topics include assisting in future WGORE strategies/workshops and to determine if any WGs are active in relation to: i) Shifting fisheries species distributions relating to climate change? and ii) Fisheries tools adaptation - WGFTFB (Fish Technology and Fish behaviour). WGOWDF made linkages with experts from WKUSER2 and as described previously.

3 Concluding remarks

Whilst we have been pleased with the group activity and engagement using virtual means, it is evident that progress has been slower compared to the experience of previous working groups where the annual meeting was in person. This in part is inevitable because of the nature of virtual meetings, however it has been exacerbated by the time the group have been able to engage over the 5+ hour difference between group members. We have a large WG membership from the U.S. and it was important for us to ensure that all members were fully engaged on both sides of the Atlantic. The outcome is that our progress with the deliverables has been slower than we would have liked however we have had notable progress in terms of other activities of the WG. We therefore recommend that an in-person annual meeting (with hybrid option) should be aimed for the future.

The working group has initiated and developed its activities in line with the original ToRs set out three years ago at the inception of the WGOWDF. As the topic is growing in importance and appears high on the agendas of governments, research institutes, industry and individuals at the moment, the WG and its outputs will be important over the coming years. We are looking towards continuing the group through adapting and developing our existing ToRs and adding other key ToRs where the WG deems them a priority in line with the science knowledge required for the topics relevant to offshore wind and fisheries (both the fishers and the fishery resource species).

Acknowledgements

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Annex 2: WGOWDF Resolution

A **Working Group on Offshore Wind Development and Fisheries** (WGOWDF), co-chaired by Andy Lipsky, USA; Andrew Gill, UK; and Antje Gimpel, Germany, will be established and will work on ToRs and generate deliverables as listed in the Table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2020	27–29 April	by corresp/ webex		physical meeting cancelled - remote work
Year 2021	9–11 June; 15–16 June	Online meeting		
Year 2022	13–16 June	Online meeting	Final report by 15 August to SCICOM	

ToR descriptors

ToR	Description	Background	Science plan codes	Duration	Expected Deliverables
a	Review and report on fishing industry interactions with offshore wind development and document lessons learned including effects on the distribution of fishing operations	Europe has been operating offshore wind energy facilities for 20 years. North America is on the verge of large-scale development. The European experience can be used to document the effects of offshore development on fishery operations, fishing communities, and fishery economics. While there are distinct differences in the scale and scope of fisheries between the North American and European wind development areas; there is also the opportunity to identify common issues and promote research to address these issues.	2.2, 2.3, 2.7	2 years	Review paper
b	Develop and report on methodologies to assess impacts on fishery resource data collections.	Offshore wind energy development necessitates changes in fishery-independent survey operations and potentially fishery-dependent data collection. Wind energy development also transforms habitats, thus affecting the	2.2, 2.3, 2.7	3 years	Method development papers

		distribution and abundance of fish and shellfish populations. Both statistical survey design and survey techniques need to be adapted and/or developed. In addition, modeling approaches need to be developed to understand the impacts of wind development and forecast possible future conditions.			
c	Consider and report on effects of habitat alteration by offshore wind development on fisheries. This consideration should include anticipated changes to the benthic habitats, potential for invasive species, vertical and horizontal movement of water, sediment suspension, and water column changes.	Construction, operation, and decommissioning of offshore wind energy developments will affect marine habitats. These activities include seafloor and water column disturbance, ocean noise, electromagnetic signals, and habitat transformation. The various activities will be documented and methodologies for study identified. Potential effects will also be documented on the range of marine organisms with particular emphasis to species that are the target of commercial and / or recreational fisheries.	2.2, 2.3, 2.7	3 years	Review paper Recommendations of additional studies linked to other WGs
d	Review ICES expertise and identify gaps and opportunities relative to renewable energy and marine ecosystems and sustainability	The goal of WGOWDF is to complement the activities of WGMBRED and WGMRE with a focus on fisheries interactions. The development and activities of the WG will be coordinated with these other two WG. The WG will also evaluate other ICES actvities and coordinate with relevant groups.	6.6	Year 3	Report to ICES

Summary of the Work Plan

Year 1	The WG will meet and exchange ideas on ToR a, b, c. The WG will then develop a plan as to how to address ToR a, b, c in the 3 year time frame. The initial review paper will be planned and worked on during Year 1, both at the inaugral workshop and intersessionally. The WG Chairs will interact with the Chairs of WGMBRED and WGMRE to ensure activities are complementary.
Year 2	The WG will make progress on the all review papers and will plan workshops related to each of ToR a, b, and c. The first workshop will present the draft review for ToR a and work up the final paper. The ToR b and c workshops will be structured to gather the information needed for both the other papers, namely the methodologies and the effects. The WG Chairs will interact with the Chairs of WGMBRED and WGMRE to ensure activities are complementary.
Year 3	The WG will complete the ToR b and c review papers and submit for publication. The WG will also discuss next steps for the WG. The WG will complete review of ICES expertise related to renewable energy and marine ecosystems and sustainability working with WGMBRED and WGMRE. A report will be produced for ICES.

Supporting information

Priority	Offshore wind energy development continues in Europe and is beginning in earnest in North America. Sustainable fisheries are critical to global food security and renewable energy is critical to energy security and climate change mitigation. Coexistence requires an understanding of the interactions between offshore wind energy development and fishing. This understanding can be used to foster the exchange of information, collaboration in addressing science questions, and support decision-making. Consequently, these activities are considered to have a very high priority across the ICES area especially as wind energy development continues.
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants	The Group will be attended by some 30–40 members and guests..
Secretariat facilities	WebEx support for remote participating
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	There are no obvious direct linkages but developing the expertise could link to ACOM in the future.
Linkages to other committees or groups	There is potential for a very close working relationship WGMBRED and WGMRE as well as communication with WKUSER. Also the WGSFD (Spatial Fisheries Data).
Linkages to other organizations	There are linkages to fishing organizations and wind developers in the USA and similar linkages in Europe, including wider links to licencing/permitting authorities and other relevant stakeholders.