Offshore Wind Farm Site Location/Effort Displacement: 2022 Update

Bibliography

Hope Shinn, Librarian, MPF-ZAI, Inc. on assignment at NOAA Central Library

NCRL subject guide 2022-06
doi: 10.25923/gt4j-3v52

June 2022

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Office of Oceanic and Atmospheric Research
NOAA Central Library – Silver Spring, Maryland

Table of Contents

Background & Scope

This bibliography is a representative sample of relevant peer-reviewed, academic, and grey literature on offshore wind farm site location and its impact on marine species and the fishing community. This document is meant to be an update to the bibliography completed in 2021 and also includes some relevant articles from fishing trade publications. The majority of references are from 2021 and 2022. Please find all references listed alphabetically.

Sources Reviewed

Along with a web search for relevant grey literature, the following databases were used to identify sources: ProQuest's Aquatic Science and Fisheries Abstracts, Dimensions, Lens.org, Clarivate Analytics' Web of Science: Science Citation Index Expanded, Wiley Online Library, ProQuest's Earth-Atmospheric & Aquatic Science Database, Science Direct, and Google Scholar via Publish or Perish. Only English language materials were considered.

References

Abramic, A., García Mendoza, A., & Haroun, R. (2021). Introducing offshore wind energy in the sea space: Canary Islands case study developed under Maritime Spatial Planning principles. *Renewable and Sustainable Energy Reviews,* 145, 111119. https://doi.org/10.1016/j.rser.2021.111119

In this study, we define a novel methodological approach for introducing Offshore Wind Energy (OWE) facilities into sea space, determining the most suitable locations with regard to the five clusters: oceanographic potential; environmental sensibility; restrictions related to marine conservation; Land–Sea interactions; and avoiding potential conflict with current maritime and coastal activities. The methodology was tested along 1.583 km of the Canary Islands coastline and across more than 50 000 km2 of related offshore areas. We have identified marine areas that have significant wind&depth potential, minimal impact on the marine environment, compatibility with marine conservation and conflict avoidance with operative economic maritime and coastal sectors (such as coastal tourism, fisheries, aquaculture, maritime transport, etc.). Suitability maps were developed with Decision Support System INDIMAR, a novel tool that analyses the OWE facilities' relationship with each cluster parameter, introducing weights calculated by an Analytical Hierarchy Process. OWE development needs to find a balance of all five clusters reflecting on Ecosystem-Based Management components that should be mirrored in the Maritime Spatial Planning (MSP) strategy, including options with tradeoffs among sectorial growth, conflict prevention and environmental protection & conservation.

American Saltwater Guides Association. (2021). *Offshore wind development policy platform.* Retrieved from https://saltwaterguidesassociation.com/wp-content/uploads/2021/05/ASGA-Wind-Policy-Platform_May-2021.pdf

The American Saltwater Guides Association (ASGA) represents the interests of fishing guides, fishing-related small businesses, and conservation-minded recreational anglers who believe in "better business through conservation" and who value long-term stock abundance and ecosystem health. We recognize the challenges presented by human-induced climate change and the threats it poses both to society and the marine environment. The U.S. east coast is particularly vulnerable to such impacts, which include warming waters, sea level rise, ocean acidification, and shifts in the distribution and productivity of commercially and recreationally valuable marine species. Approximately half of exploited, forage, and protected marine species in the region will be negatively affected by these changing conditions over the next several decades, underscoring the need to mitigate underlying causes.

Bacchiocchi, E., Sant, I., & Bates, A. (2022). Energy justice and the co-opting of indigenous narratives in U.S. offshore wind development. *Renewable Energy Focus,* 41, 133-142. https://doi.org/10.1016/j.ref.2022.02.008

The possibility of substantial offshore wind energy development in the United States (U.S.) is rapidly advancing. Several offshore wind projects have been proposed proximate to federally-recognized tribal territory. Historically marginalized, indigenous communities have for centuries experienced injustices during the expansion of the U.S. energy system. Few studies have systematically examined the

responses of indigenous communities to offshore wind, and little is known about the ways that indigenous concerns are leveraged by non-members to advance a position advocating for or against offshore development. In this study, we examine the discourses that surround indigenous communities through legally mandated decision-making processes for two proposed offshore wind projects in the northeast U.S. We show that narratives surrounding indigenous stakeholders in the offshore wind scoping process can be thematically identified as: 1. religious, cultural, and spiritual value, 2. land and identity, and 3. process and procedures. However, the concerns and perspectives of indigenous communities are mostly brought forth by non-group members, and were found to be leveraged or diminished by non-indigenous individuals pushing anti- or pro-offshore wind sentiment. This reveals the finding that indigenous concerns are being co-opted or sidelined through formal and legal decision-making processes in the U.S. The results indicate that the formal consultation process failed to meet standards of energy justice by inadvertently giving outsize voice to lesser impacted communities. Therefore, our study cautions that energy justice is not achieved solely through "inclusive" processes and decision-makers should be diligent in considering the multi-faceted aspects of justice.

Bastardie, F., Brown, E. J., Andonegi, E., Arthur, R., Beukhof, E., Depestele, J., . . . Reid, D. (2021). A Review Characterizing 25 Ecosystem Challenges to Be Addressed by an Ecosystem Approach to Fisheries Management in Europe. *Frontiers in Marine Science,* 7, 629186. https://doi.org/10.3389/fmars.2020.629186

The impacts of fisheries on ocean resources are no longer considered in isolation but should account for broader ecosystem effects. However, ongoing ecosystem-wide changes added to the inherent dynamics of marine ecosystems, create challenges for fisheries and fisheries management by affecting our ability to ensure future fishing opportunities and sustainable use of the seas. By reviewing a corpus of fisheries science literature, we contribute to informing policymakers with considerations of the various threats to fisheries and the marine ecosystems that support them. We identify and describe 25 ecosystem challenges and 5 prominent families of management options to address them. We capture the challenges within three broad categories: i) fishing impacts on the marine environments and future fishing opportunities, ii) effects of environmental conditions on fish and fishing opportunities, and iii) effects of socioeconomics, fisheries management and institutional set-up on fisheries. Our review shows that, while most EU fisheries are facing a similar array of challenges, some of them are specific to regions or individual fisheries. We reflect this in selected regional cases to exemplify the challenges along with fishery-specific cases, among the dramatic Baltic cod situation facing an array of cumulative pressures, moving ecosystem interactions that rely on the North Sea forage fish facing climate change, fishing interactions in a fluctuating mixed fishery in the Celtic Sea, bycatch and habitat degradation in the Bay of Biscay, undercapacity and lack of knowledge on some features of the EU Outermost Regions. We conclude by recognizing knowledge gaps regarding the direction of causality, nonlinear responses and confounding effects. All of the challenges we identify may guide further data collection and research coordination to improve our understanding and to monitor real changes, both of which are required to inform an Ecosystem Approach to Fisheries Management (EAFM). An European EAFM could build upon an array of management measures currently tailored for fisheries management only, including promoting funding interdisciplinary research and ecosystem monitoring. Such integrative management should reduce uncertainties in environmental, social and economic trends, and lower the risk for disruptive events or ecosystem effects with far-reaching consequences, including a shift toward less productive marine ecosystems.

Bessette, D., & Crawford, J. (2022). All's fair in love and WAR: The conduct of wind acceptance research (WAR) in the United States and Canada. *Energy Research & Social Science,* 88, 102514. https://doi.org/10.1016/j.erss.2022.102514

The number of studies examining social acceptance of wind energy in the United States and Canada has increased considerably since the 1980s. Here we conduct a methodological review of wind acceptance research (WAR) literature in response to four articles published in this journal. These include a recent synthesis of WAR by Rand and Hoen in 2017 recommending better incorporation of results into development practices and comparability of case studies; a 2020 investigation by Walsh and colleagues into potential research fatigue in unconventional oil and gas development research, and finally calls by Sovacool and others in 2014 and 2018 to increase the theoretical depth and reflection in energy social science. Using a systematic review of 114 WAR articles and an online survey of 41 corresponding authors, we investigate the location of WAR study sites, the success of different WAR designs and incentives, the disciplines and theories dominating WAR, and finally dissemination practices. Our results show that, outside national surveys, WAR is geographically concentrated in regions distant from the highest installed capacity and focus on projects that are novel, controversial, or unique to a specific region. We find little support for research fatigue. Additionally, most WAR lacks an underlying theory. We conclude by recommending greater qualitative analysis of study site selection criteria and greater integration of existing WAR theories and WAR with solar acceptance research. Finally, we urge scholars to ensure and communicate a clear purpose, value and financial benefit to WAR participants and meaningfully consider the broader community contexts examined.

Brandt, D. (2021). *A Current Look at Marine Renewable Energy in Oregon: Oregon MRE and the Role of Public Perception and Participation in Oregon's MRE Future*: Oregon State University. Retrieved from https://ir.library.oregonstate.edu/concern/graduate_projects/2227mx291

To meet growing energy demands and climate change goals, the use of renewable energy is increasingly becoming a policy priority globally, nationally, and at the state levels. In Oregon, the use of marine renewable energy and offshore wind remains part of this discussion but has yet to result in operational installations. Social science research on renewable energy looks at how public perceptions, place attachment, and public participation play a role in the success of projects pointing to the role of early public engagement and participation and understanding of local attachments to the place as part of public views and attitudes towards renewable energy projects. Looking more closely at these areas in Oregon along with an understanding of current MRE policy, will perhaps offer insights into an aspect of offshore renewable energy feasibility in Oregon. Looking at recent survey data, interviews with stakeholder organizations, and existing policy indicate that participation and place attachment are important elements of current Oregon marine renewable energy considerations. In a survey on wave energy perceptions, Oregon respondents indicated strong coastal attachment regardless of ideology, age, or distance to coast, and even though the majority of respondents visited the coast on a monthly or less basis. Oregon's policy framework for offshore renewable energy is fully formed but remains largely untested as only one pilot and one research wave facility have received approval. While federal and state entities share jurisdiction on MRE approvals, Oregon plays a leading role in determining the fate of projects off its coast. Interviews and documents indicated a proactively formed precautionary policy towards MRE which consulted the large number of MRE and ocean stakeholders. While the MRE application and approval process requires public engagement and comment periods, interviews indicated that consideration of local inputs prior to the approval process was desired to ensure an

equitable distribution of benefits and to have concerns fully considered. Results indicate early and meaningful engagement of stakeholder views will be crucial for MRE projects in the future.

Brannstrom, C., Leite, N. S., Lavoie, A., & Gorayeb, A. (2022). What explains the community acceptance of wind energy? Exploring benefits, consultation, and livelihoods in coastal Brazil. *Energy Research & Social Science,* 83, 102344. https://doi.org/10.1016/j.erss.2021.102344

In the Global South, qualitative research has identified injustices arising from exclusionary community consultation, wide information gaps between host communities and decision makers, and high reliance among residents on land- and sea-based resources that may compete with renewable power infrastructure. Here we analyze results of a face-to-face survey applied in three communities hosting wind farms in Ceará state, northeastern Brazil. Results from three regression models for two dependent variables ("support wind farm" and "support more wind farms") are reported. The comparative case study shows wide variation in support for wind farms among host communities with Benefits as a consistently significant independent variable, followed by Consultation and Environment variables. High support was observed in a community where a flawed consultation and construction process may have been partly overcome by mitigation funds that paid for new houses in one sub-community. Lowest support was found in a community with contested land tenure and a polemic consultation process, but the Benefits variable predicted increased odds of supporting a proposed wind farm. Support for wind farms was highest in a community where the wind investors negotiated royalties with landholders. The findings suggest that perceived or real economic benefits generated support for wind farms, especially when those benefits strengthened livelihoods and land-tenure security of host communities where livelihoods depended on fishing and farming and few employment opportunities exist. The varying consultation processes indicate that need for wind investors and state officials to improve community consultations.

Brink, T. t., Dalton, T., & Livermore, J. (2021). Integrating Social and Ecological Research on the Impacts of Offshore Wind Farms in North America. In *Researching People and the Sea* (pp. 239-258) https://doi.org/10.1007/978-3-030-59601-9_11

This chapter discusses lessons learned from a socio-ecological study on the impacts of the first offshore wind farm in North America. The authors reflect on the combination of ecological data from demersal fish trawl and lobster surveys and qualitative social science data from interviews with commercial and recreational fishermen. They encountered several challenges in integrating the different research strands, arising from the temporal and spatial ranges of data, mismatch in focal fish species, and research framing. Despite these challenges, an integrated approach led to more comprehensive capture of impacts and guidance on how to design better biological studies. Early stage collaboration during research design, aligned goals, and comprehensive planning are all key to more integrated data collection and analysis within interdisciplinary studies of marine and fisheries domains.

Carey, D. A., Wilber, D. H., Read, L. B., Guarinello, M. L., Griffin, M., & Sabo, S. (2020). Effects of the Block Island Wind Farm on Coastal Resources: Lessons Learned. *Oceanography,* 33(4), 70-81. https://doi.org/10.5670/oceanog.2020.407

The Block Island Wind Farm, the first offshore wind farm in the United States, attracted intense interest and speculation about the effects of construction and operation on valuable coastal resources. Four studies designed to address the questions raised were conducted over seven years as a requirement of the lease agreement between the State of Rhode Island and the developer, Deepwater Wind Block Island. The objectives of the studies were to separate the effects of construction and operation on hard bottom habitats, demersal fish, lobster and crabs, and recreational boating from regional changes in conditions. Study elements included: early engagement with stakeholders (fishermen and boaters), adaptive monitoring based on data and stakeholder feedback, cooperative research with commercial fishermen, use of methods consistent with regional surveys, stratified random sampling within a before-after-control-impact (BACI) design, power analysis (when possible) to determine sample size, and multiple metrics to evaluate fish and fisheries resources. This combination of studies and analytical approaches evaluated multiple mechanisms by which potential effects could be detected. Lessons learned included practical guidance, for example, for collaborating with stakeholders and regional scientists to address concerns through adaptive monitoring, quantifying uncertainty associated with BACI contrasts, and evaluating the duration of a seasonal lobster survey. Applying these lessons can improve monitoring at proposed larger-scale offshore wind projects in the United States.

Chung, H.-S. (2021). Taiwan's Offshore Wind Energy Policy: From Policy Dilemma to Sustainable Development. *Sustainability,* 13(18), 10465. https://doi.org/10.3390/su131810465

Taiwan's offshore wind energy policy (OWE policy) is a response to sustainable development goals. Offshore wind energy has become one of the fastest growing renewable energies on Taiwan's coastline, with the government's full support for the promotion and implementation of the OWE policy. With the operation of Taiwan's first wind farm in 2021, increasing controversies are specifically concerned with the distribution of social, economic, and environmental burdens and benefits resulting from the OWE policy. More offshore wind farms are forthcoming by 2025. However, little attention has been paid to policy dilemmas for many aspects relevant to sustainable development. Therefore, this paper conducts a policy analysis to construct policy-relevant information of the OWE policy and identifies policy dilemmas in relation to concerns about sustainable development. This paper presents policy recommendations on the design and decision-making processes for facilitating the smooth promotion and implementation of Taiwan's OWE policy and future renewable energy policies.

Copping, A. E., Hemery, L. G., Viehman, H., Seitz, A. C., Staines, G. J., & Hasselman, D. J. (2021). Are fish in danger? A review of environmental effects of marine renewable energy on fishes. *Biological Conservation,* 262, 109297. https://doi.org/10.1016/j.biocon.2021.109297

Many fish species are threatened worldwide by overfishing, contamination, coastal development, climate change, and other anthropogenic activities. Marine renewable energy (MRE) is under development as a sustainable alternative to carbon-based energy sources. Regulators and stakeholders worry that MRE devices will add another threat to fish populations already under pressure. This paper reviews the current knowledge of potential effects of MRE development on fish. These may include

collision with devices that may lead to injury or death; underwater noise generated by MRE devices that may affect fish behavior and health; electromagnetic fields from power cables and other electrical infrastructure that may lead sensitive fish species to approach or avoid them; changes in critical fish habitat, including nursery, feeding, and spawning grounds; shoaling of fish around MRE devices; and displacement of fish populations or communities around arrays of multiple MRE devices. Field- and laboratory-based studies that have examined fish presence, avoidance, and evasion around MRE devices suggest that collisions are rare. Progress is being made on data collection and modeling tools to estimate fish encounter rates with MRE devices, the consequences of collisions, and population-level ecological risks. Similarly, studies exposing fish to turbine-generated noise and electromagnetic fields demonstrate little effect on fish behavior; in fact, MRE device noise falls below reported hearing thresholds. Inquiries into the effects of MRE devices on fish are ongoing, and research is needed to ensure the health of fish populations while facilitating the sustainable development of renewable energy sources.

Dalton, T., Weir, M. J., Calianos, A., D'Aversa, N., & Livermore, J. (2020). Recreational boaters' preferences for boating trips associated with offshore wind farms in US waters. *Marine Policy,* 122, 104216. https://doi.org/10.1016/j.marpol.2020.104216

This study used a stated preference approach to assess potential impacts of offshore wind farms on recreational boaters in and around Rhode Island (US) waters. To develop the stated preference survey, seven focus groups were conducted with recreational boaters in Rhode Island (RI) in 2017. A combined mail and on-line choice experiment survey was administered in the spring and summer 2018 to 2500 owners of US Coast Guard-documented recreational vessels with a hailing port in Rhode Island. The survey instrument elicited recreational boaters' preferences for particular attributes of a recreational boating trip (location, proximity to a wind farm, amount of nearby boating activity, main activity during trip, trip costs). Data were analyzed using the mixed logit model to understand how changes in individual attributes affect the acceptability of a boating trip. Findings indicate that the value of a recreational boating experience is considerably reduced in areas with offshore wind farms. Findings from this study provide valuable insights into the potential impacts of the growing offshore wind industry on one group of marine resource users and potential management strategies for addressing these impacts in the US.

Dépalle, M., Sanchirico, J. N., Thébaud, O., O'Farrell, S., Haynie, A. C., & Perruso, L. (2021). Scale-dependency in discrete choice models: A fishery application. *Journal of Environmental Economics and Management,* 105, 102388. https://doi.org/10.1016/j.jeem.2020.102388

Modeling the spatial behavior of fishers is critical in assessing fishery management policies and has been dominated by discrete choice models (DCM). Motivated by the widespread availability of micro-data on fishing vessel locations, this paper examines the complexity associated with the choice of the spatial scale in a DCM of fishing locations. Our empirical approach estimates the standard DCM at varying spatial resolutions using both simulated data and vessel monitoring system data from the Gulf of Mexico longline fishery. We assess model performance using goodness-of-fit, predictive capacity, parameter estimates, and the assessment of the fishery response to a hypothetical marine protected area. Results show that, even when the specification of the decision-making process is correct, models can be

structurally biased because of the aggregation of spatial scale that neglects the value of many fishing locations. The extent of such biases can only be detected by considering various spatial aggregation levels.

Elrick-Barr, C. E., Zimmerhackel, J. S., Hill, G., Clifton, J., Ackermann, F., Burton, M., & Harvey, E. S. (2022). Man-made structures in the marine environment: A review of stakeholders' social and economic values and perceptions. *Environmental Science & Policy,* 129, 12-18. https://doi.org/10.1016/j.envsci.2021.12.006

Man-made marine structures (MMS) are commonly used to describe any artificial structure in the marine environment, encompassing oil and gas infrastructure and pipelines, artificial reefs, jetties, piers and shipwrecks. MMS are increasingly proposed to address issues facing marine planners, including augmenting fish stocks through the creation of artificial reefs and the repurposing of redundant offshore oil and gas infrastructure ('rigs to reefs'). Marine spatial planning is a highly contested process, characterised by multiple stakeholders with often divergent priorities due to competing objectives and values. Understanding stakeholder perspectives in relation to MMS is therefore critical in formulating appropriate policies. This review presents the first systematic and comprehensive integration of information from academic journals and 'grey' literature relating to social and economic values and perceptions of MMS. The review identifies that, despite advocacy for research on social and economic values of MMS, there are significant gaps in knowledge, in particular relating to comparative assessments of stakeholder values across different types of MMS. Priority areas for future research are highlighted.

Félix-Silva, A. V., Olivera, M. M. S. d., & Bezerra, L. L. d. S. (2020). Cartography of the struggle and resistance of an artisanal fishing community. *Saúde debate,* 44(spe2), 303-315. https://doi.org/10.1590/0103-11042020E221I

The peoples of the sea are threatened by the production of capitalistic colonial subjectivity which, through the state of exception device, has the power to make the ways of living in community in the water territories die. In this cartography, the objective was to analyze processes of subjectivation, struggle and resistance of artisanal fisherwomen and fishermen in a community in the face of wind farms in the Coastal Plain of Piauí, located in the Northeast of Brazil. It is a way of doing research-intervention, in which observant participation was used for data production, arranging reunions, meetings, and public hearings with the research participants, in addition to the use of cartographic journals for the recording of reports and writing of themselves. The discussion and analysis of the results show the sovereignty of capital, impacting the social determination of health by affecting environmental, subjective and social ecologies; struggle and resistance as political dimensions of life and health as a power of life; coexistence of death policies and community life force lines; subjectivation processes that sometimes express subjections, sometimes express singularities when collectively managing the desire to resist policies imposed by the state of exception device.

Gao, A. M.-Z., Huang, C.-H., Lin, J.-C., & Su, W.-N. (2021). Review of recent offshore wind power strategy in Taiwan: Onshore wind power comparison. *Energy Strategy Reviews,* 38, 100747. https://doi.org/10.1016/j.esr.2021.100747

Since 2016, Taiwan has pursued an agenda of energy transition and a nuclear-free homeland by 2025, with an increase in renewable energy from 5% in 2016 to 20% in 2025. Furthermore, Taiwan has significantly accelerated its offshore wind power (WP) targets since (i.e., 5.7 GW by 2025) from two 4-MW turbines in mid-2016. The Taiwanese government set the highest feed-in tariff worldwide to attract the attention of large global renewable developers. The criterion for a high feed-in tariff is a local content requirement. If successful, Taiwan would become the third largest offshore WP country in terms of installation capacity and would have achieved this the fastest, despite the current low industry capability for both onshore and offshore WP. This study provides updated information on offshore WP policy development in Taiwan, focusing on the world's first offshore WP selection and local content requirement regime in 2018. Moreover, this study compares the evolution of research development, demonstration, and commercialisation of onshore and offshore WP, identifying the lessons and challenges in realising such an ambitious plan.

García, P., Sanabria, J. G., & Ruiz, J. A. C. (2021). Marine renewable energy and maritime spatial planning in Spain: Main challenges and recommendations. *Marine Policy,* 127, 104444. https://doi.org/10.1016/j.marpol.2021.104444

Preliminary studies demonstrate the availability of significant renewable energy potential in Spanish waters. Its use could contribute to achieving the recently updated national objectives for the generation of clean energy in the future National Energy and Climate Plan 2021–2030. Despite the different initiatives that were unsuccessfully proposed at the end of the 2000s, the current implementation of blue energy is practically zero in Spain due to the characteristics of the marine space, which limits the technical and economic viability of the projects. There are other factors, such as a complex regulatory framework, inadequate administrative processes, limited availability of information as well as social rejection of this type of facility. Like other Member States of the European Union, Spain is currently developing a process of maritime spatial planning (MSP) that should be concluded, according to RD 363/2017, with the approval of a maritime spatial plan (POEM) for each of the five existing marine demarcations. This planning will have consequences for the uses and activities of the marine environment, including marine renewable energies. It also provides an opportunity to address existing non-technical barriers and promote the deployment of blue energy facilities. This investigation studies the MSP landscape in Spain from a holistic perspective and analyzes the repercussions of future POEMs in the offshore wind sector and other marine renewable energies. It concludes by proposing a set of recommendations, based on previous experiences in other regions, aimed at facilitating the integration of clean energy policies in the future uses of this marine space.

Gilek, M., Armoskaite, A., Gee, K., Saunders, F., Tafon, R. V., & Zaucha, J. (2021). In search of social sustainability in marine spatial planning: A review of scientific literature published 2005–2020. *Ocean & Coastal Management,* 208, 105618. https://doi.org/10.1016/j.ocecoaman.2021.105618

A number of commentators have argued that up until now marine/maritime spatial planning (MSP) research and practice have been dominated by blue economy and environmental concerns and have tended to neglect what might be regarded as social sustainability concerns. To gain more insight into the character and extent of such a gap, as well as how to address it, this article examines how social sustainability has been addressed in peer reviewed scientific articles on MSP between 2005 and 2020. Using search terms such as participation, democracy, social inclusion, social cohesion, equity we systematically identify and review 310 scientific articles that address diverse social sustainability concerns within MSP and marine governance. The review showed that very few papers systematically conceptualised or developed a coherent framework for engaging with social sustainability. Instead, they mostly addressed particular social concerns including participation and engagement, equity and social justice, socio-cultural values and preferences. Marine management and planning efficiency, as well as related instrumental framings of the merits of participation were the key arguments for including these dimensions of social sustainability in MSP. In terms of how to better include social sustainability in MSP, most attention was given to social-cultural mapping and ways to improve social inclusion/participation while also redressing exclusion and maldistribution of outcomes in MSP practice. We conclude that there is a need to deepen and diversify MSP inquiry with respect to social sustainability. In particular, scholars would do well to delve deeper and more broadly in social science literature to find inspiration on ways to understand and elucidate social issues. Here, the enormous body of relevant work on justice, power, critical institutionalism, political ecology and terrestrial planning literatures has hardly been tapped. It is also evident from this review that there is a need for both the academic and practice-based communities to more comprehensively address how the multidimensions of social sustainability interact with each other, as well as with economic and environmental aspects of marine planning and governance. Based on these observations, we highlight a set of suggestions on how to develop MSP research and practice on social sustainability. Most importantly, we argue that more in-depth co-production, linking scholars, practitioners and society actors, is needed.

Glasson, J., Durning, B., Welch, K., & Olorundami, T. (2022). The local socio-economic impacts of offshore wind farms. *Environmental Impact Assessment Review,* 95, 106783. https://doi.org/10.1016/j.eiar.2022.106783

The offshore wind farm (OWF) industry is of growing importance, particularly in Europe. However, the local socio-economic impacts of OWF projects have received little attention compared with biophysical impacts. Yet, they have the potential to be significant for the regeneration of declining coastal communities. Drawing on findings from academic and industry literature, from a review of ESs (Environmental Statements) for OWFs and from particular case studies, it highlights some of the differential coverage of social and economic impacts, and the differences between predicted and actual impacts, by stage in project life. For example, the ES predictions substantially overestimate local offshore construction stage economic impacts, but underestimate other elements of the OWF lifecycle, including onshore construction, and especially the 20–25 years of the operation and management stage. The Aberdeen (Scotland) case study shows the importance of the engagement strategy of the developer. The case study of the major Hornsea projects, off the coast of Yorkshire (England), also highlights the

positive and cumulative impacts of scale and hub status, where a programme of large OWFs can have important local impacts. The research identifies some factors leading to the identified outcomes, including the changing size and location of OWF projects, the relevant legislative and regulatory context behind the decision-making processes for OWF projects, and the responses and relationships of stakeholders involved in the process. The key role of monitoring impacts is an underpinning issue and a requirement for the more effective assessment of impacts.

Gómez, S., & Maynou, F. (2021). Balancing ecology, economy and culture in fisheries policy: Participatory research in the Western Mediterranean demersal fisheries management plan. *Journal of Environmental Management,* 291, 112728. https://doi.org/10.1016/j.jenvman.2021.112728

Fishing communities in the Mediterranean Sea face challenges in dealing with Common Fisheries Policy (CFP) ecosystem-based management measures aimed at reducing fishing effort and implementing partial closures of fisheries. The Participatory Action Research method is used here as a "pilot experience" to gather reactions from fishers, scientists and fisheries managers to the Western Mediterranean Multi-Annual Demersal Fisheries Plan (WM MAP) by identifying needs and concerns, but also alternatives to maintain the viability of the fishery. The data gathering process consisted on a structured questionnaire administered during a workshop to 40 stakeholders involved in Spanish fisheries in the Mediterranean, followed by an open discussion session. The results show that fishers disagree with the new regulations, which they perceive as yet another layer of restrictive regulations for an industry that faces major challenges and currently has low profitability, whereas scientists tended to agree more with the WM MAP than the administration or the fishers. Nevertheless, all stakeholders agree that the values of the cultural heritage of fisheries and the exploration of alternative marketing systems should balance the productivity-based approach to fisheries policies followed so far, that have shown signs of failure. According to stakeholder perceptions, this would improve the economic and social viability of fisheries, as well as highlight the value of fishing activity and its social prestige. Integrating the value of cultural heritage and post-production processes into the CFP would improve stakeholder involvement in fisheries policies. Through participatory research methods the ecosystem-based management approach could be embedded in a community-based approach, integrating its social actors in a proactive attitude and considering fisheries as a human activity socially and culturally rooted in the environment, which would enhance the effective implementation of fisheries policies.

Guinan, J., McKeon, C., O'Keeffe, E., Monteys, X., Sacchetti, F., Coughlan, M., & Aonghusa, C. N. (2021). INFOMAR data supports offshore energy development and marine spatial planning in the Irish offshore via the EMODnet Geology portal. *Quarterly Journal of Engineering Geology and Hydrogeology,* 54(1). https://doi.org/10.1144/qjegh2020-033

The characterization of the seafloor is a fundamental first step in informing resource management, marine spatial planning, conservation, fisheries, industry and research. Integrated Mapping for the Sustainable Development of Ireland's Marine Resource (INFOMAR), Ireland's national seabed mapping programme, delivers freely available, high-resolution seabed imagery derived from multibeam echosounder data in the Irish Exclusive Economic Zone. The European Union established the European Marine Observation and Data Network (EMODnet) Geology data portal, which provides harmonized

broad-scale seabed substrate information for all European seas and confidence assessments of the information that underpins the geological interpretations. A multi-scale product has been produced using INFOMAR's high-resolution seabed substrate information at the 1:50 000 scale. As part of the Supporting Implementation of Maritime Spatial Planning in the Celtic Seas project, the EMODnet Geology seabed substrate data portal assisted in addressing the challenges associated with the implementation of the European Union's Marine Spatial Planning Directive. The seabed substrate data in the EMODnet Geology data portal were identified as a valuable tool for guiding the selection of sites for offshore wind farms in the Irish Sea and their subsequent characterization. This paper outlines the approach to delivering a multi-scale seabed substrate dataset for the Irish offshore and its applicability to marine spatial planning and the development of offshore energy resources. Thematic collection: This article is part of the Mapping the Geology and Topography of the European Seas (EMODnet) collection available at:

Hélène, B., Marjolaine, F., Christelle, L. G., & Le Floc'h, P. (2022). Vulnerability and spatial competition: The case of fisheries and offshore wind projects. *Ecological Economics,* 197, 107454. https://doi.org/10.1016/j.ecolecon.2022.107454

Professional fishing activities are subject to spatial pressures. The cohabitation between a traditional fishing activity and development of the offshore wind energy industry raises questions about space sharing and rules of use. This paper proposes to adapt the vulnerability methodology developed to deal with global threats of climate change to this example of local, non-climatic change using the case study of a floating wind turbine project between Groix and Belle-Île (France). To understand and compare the potential impact of the different artisanal fishing activities, the method aims to conceptualize vulnerability with the identification of social, economic, and environmental key pressures and address them in a composite index. Although the smallest fishing units appear to be the most vulnerable, this effect is associated with a high sensitivity to the area near the coast. This research also highlights the importance of transparency and clarity during the construction of the composite index to avoid misinterpretation. This case study supports the relevance of applying the vulnerability method on a local scale to facilitate dialogue between stakeholders and reduce negotiation costs.

Hernandez, C. O. M., Shadman, M., Amiri, M. M., Silva, C., Estefen, S. F., & La Rovere, E. (2021). Environmental impacts of offshore wind installation, operation and maintenance, and decommissioning activities: A case study of Brazil. *Renewable and Sustainable Energy Reviews,* 144, 110994. https://doi.org/10.1016/j.rser.2021.110994

The objective of the paper is to perform a review of the environmental impacts of the installation, operation and maintenance (O&M), and decommissioning of offshore wind technologies. At first, a comprehensive review is presented on offshore wind technologies and techniques related to the installation, O&M, and decommissioning stages. Then a thorough review of environmental issues using the main available studies in the literature associated with the activities of each stage is performed. The review employs an activity–stressor–receptor–impact framework in which the possible positive or negative impacts of an environmental stressor on a specific receptor are identified for each activity, such as pile driving, cabling, blade rotation, etc. Additionally, a case study of Brazil addresses regions with biological resources, marine protected areas, and offshore wind hotspots considering atmospheric

reanalysis along the coastline. Moreover, the presence of the offshore oil and gas (O&G) industry is discussed as an important influence on the development of offshore wind projects in Brazil.

Hintzen, N. T., Aarts, G., Poos, J. J., Van der Reijden, K. J., & Rijnsdorp, A. D. (2021). Quantifying habitat preference of bottom trawling gear. *ICES Journal of Marine Science,* 78(1), 172-184. https://doi.org/10.1093/icesjms/fsaa207

Continental shelves around the world are subject to intensive bottom trawling. Demersal fish assemblages inhabiting these shelves account for one-fourth of landed wild marine species. Increasing spatial claims for nature protection and wind farm energy suppresses, however, the area available to fisheries. In this marine spatial planning discussion, it is essential to understand what defines suitable fishing grounds for bottom trawlers. We developed a statistical methodology to study the habitat preference of a fishery, accounting for spatial correlation naturally present in fisheries data using high-resolution location data of fishing vessels and environmental variables. We focused on two types of beam trawls to target sole using mechanical or electrical stimulation. Although results indicated only subtle differences in habitat preference between the two gear types, a clear difference in spatial distribution of the two gears was predicted. We argue that this change is driven by both changes in habitat preference as well as a change in target species distribution. We discuss modelling of fisheries' habitat preference in light of marine spatial planning and as support in benthic impact assessments.

Hintzen, N. T., Beukhof, E., Brunel, T., Eweg, A., Hamon, K. G., de Koning, S., . . . Steins, N. A. (2021). *Exploring potential ecological impacts of different scenarios for spatial closures and fleet decommissioning for Dutch North Sea demersal fisheries.* Wageningen Marine Research report C029/21 Wageningen Marine Research, https://doi.org/10.18174/544217

The Dutch government aims to expand renewable energy production and areas for nature conservation in the North Sea. These developments are part of its commitment to the Paris Agreement, implemented in Dutch legislation through the Climate Law ('Klimaatwet', 2019), and the Dutch North Sea Agreement (NZA) involving the main economic users affected by offshore wind farm development and nature conservation organisations (OFL, 2020). As sea space is limited, developing offshore wind farms and establishing (additional) marine protected areas will cause displacement of the Dutch fishing fleet. Displacement will possibly result in higher fishing pressure in those areas that remain accessible for fishers. In this study, we assess the potential ecological impact of different spatial closure scenarios. Our study area is the North Sea (ICES division 4.a-c) and the eastern English Channel (ICES division 7.d) between 49 and 60°N latitude. We compare situations in which part of the fleet is decommissioned (with the catch of the decommissioned vessels either exploited or not exploited by the remaining fleet) and situations in which no decommissioning takes place. All scenarios are compared to a Status Quo scenario, i.e., the current situation with regard to closed areas, catch level and fleet size.

Hooper, T., Ashley, M., & Austen, M. (2018). Capturing benefits: Opportunities for the co-location of offshore energy and fisheries. In *Offshore Energy and Marine Spatial Planning.* K. L. Yates & C. J. A. Bradshaw (Eds.), (pp. 189-213) Retrieved from https://www.routledge.com/Offshore-Energy-and-Marine-Spatial-Planning/Yates-Bradshaw/p/book/9780367508500

Book description: The generation of offshore energy is a rapidly growing sector, competing for space in an already busy seascape. This book brings together the ecological, economic, and social implications of the spatial conflict this growth entails. Covering all energy-generation types (wind, wave, tidal, oil, and gas), it explores the direct and indirect impacts the growth of offshore energy generation has on both the marine environment and the existing uses of marine space.

Chapters explore main issues associated with offshore energy, such as the displacement of existing activities and the negative impacts it can have on marine species and ecosystems. Chapters also discuss how the growth of offshore energy generation presents new opportunities for collaboration and co-location with other sectors, for example, the co-location of wild-capture fisheries and wind farms.

The book integrates these issues and opportunities, and demonstrates the importance of holistic marine spatial planning for optimising the location of offshore energy-generation sites. It highlights the importance of stakeholder engagement in these planning processes and the role of integrated governance, with illustrative case studies from the United States, United Kingdom, northern Europe, and the Mediterranean. It also discusses trade-off analysis and decision theory and provides a range of tools and best practices to inform future planning processes.

Hutchison, L. (2022). Fissues in the Windustry: Mitigating Fishing Industry Concerns While Promoting Offshore Wind. *Journal of Environmental Law & Litigation,* 37, 285-318. Retrieved from https://scholarsbank.uoregon.edu/xmlui/handle/1794/27117

Offshore wind development is the next great frontier for energy production in the United States. The technical potential for offshore wind is more than 2,000 gigawatts, double the nation's current electricity use and far greater than the potential for wind energy produced on land. Despite this enormous potential, the United States has no commercial-scale offshore wind farms and only two active offshore wind farms at this time, off the coasts of Rhode Island and Virginia. Many concerns accompany the development of offshore wind, including a lack of scientific studies on the effects offshore wind farms have on the fishing industry. The fishing industry has been successfully fighting back on the development of offshore wind farms.To ensure the success of President Biden's ambitious offshore wind development plan, the Bureau of Ocean Energy Management (BOEM)and state and local governments must adequately consider the fishing industry. This Article explains the piecemeal approach of the many laws that control the development of offshore wind farms and how those laws work together.

Kallis, G., Stephanides, P., Bailey, E., Devine-Wright, P., Chalvatzis, K., & Bailey, I. (2021). The challenges of engaging island communities: Lessons on renewable energy from a review of 17 case studies. *Energy Research & Social Science,* 81, 102257. https://doi.org/10.1016/j.erss.2021.102257

Islands have attracted growing attention as sites of renewable energy generation, both for generating commercial low-carbon energy and to improve local energy conditions. However, significant challenges

exist in achieving fair distribution in the benefits and costs of developments located on or around islands and in engaging local communities on proposals for installations. A broad literature exists on the merits of different community engagement techniques but important gaps remain in understandings of the particular challenges of engaging with island communities on energy issues. Based on a thematic literature review, this article examines general principles and considerations for community engagement on energy developments, features of islands that can affect community engagement, and how past engagement processes have sought to encourage community participation, gain trust, and manage conflicts over developments. The review indicates that island communities appeared to be particularly concerned with ensuring that engagement processes give adequate priority to securing local benefits and incorporate credible mechanisms for managing intra-community conflicts. The article concludes by arguing that islands provide important arenas for testing not just new energy technologies but also ways to improve the integration of justice principles into community engagement on energy issues.

Korda, R., Gray, T., & Stead, S. M. (2021). Perceptions of Vulnerability in the English SSF. In *Resilience in the English Small-Scale Fishery: Small Fry but Big Issue.* R. Korda, T. Gray, & S. M. Stead (Eds.), (pp. 67-87). Cham: Springer International Publishing https://doi.org/10.1007/978-3-030-54245-0_4

This chapter turns to the perceptions of vulnerability expressed by English SSF respondents in interviews and focus group discussions conducted during 2015 and 2016. We can divide these perceptions intro two categories: external threats and internal obstacles (Islam 2011). External threats are perceived to come from outside the fleet; internal obstacles are perceived to exist within the fleet itself. These perceptions provide a unique record of experiences that are informative, sometimes deeply moving and occasionally amusing. Many of the external threats facing the English fleet chime with those reported in Chap. 1to impact SSFs across the globe, such as reduced access to resources because of ocean grabbing (played out through a reduced quota allowance, or being displaced as a consequence of industrial vessel activities, marine industry and the instigation of a conservation focused network of MPAs); environmental degradation (including overfishing); reduced product value as a consequence of operating within an increasingly globalised market; and top-down managerial arrangements in combination with the heightened influence of other stakeholder groups. The internal obstacles include a general lack of social solidarity preventing grassroots unity, which erodes SSF's political strength.

Laskowicz, T. (2021). The Perception of Polish Business Stakeholders of the Local Economic Impact of Maritime Spatial Planning Promoting the Development of Offshore Wind Energy. *Sustainability,* 13(12), 6755. https://doi.org/10.3390/su13126755

The recently adopted maritime spatial plan for Polish sea waters promotes offshore wind farm (OWF) development. The study's identification of the local municipalities affected by offshore development was based on the plan's provisions. Through the analysis of the plan and literature findings, both positive and negative impacts of future OWF development were identified and examined. Such an analysis seems to be a precondition for the more active engagement of local stakeholders in the debate on the ways in which to best utilize the new opportunities created by the plan and cope with the threats resulting from maritime spatial planning (MSP). The key impacts recognized by the local business stakeholders have been related to landscape pollution and fishing limitations. Stakeholders less

frequently have noticed positive impacts of MSP such as development of a new form of tourism. Up to this point, small municipalities have not undertaken sufficient action, and there is a lack of communication between developers, marine planners and coastal communities. Planners have not assessed the impact of their plan on local economic development. The proposed remedies cover standard actions related to communication, education and dialogue, but in addition to that, a consolidated action of local municipalities on how to capitalize on OWF development has been proposed. The first step proposed is preparation of a joint strategy by coastal municipalities addressing this issue.

Letschert, J., Stollberg, N., Rambo, H., Kempf, A., Berkenhagen, J., & Stelzenmüller, V. (2021). The uncertain future of the Norway lobster fisheries in the North Sea calls for new management strategies. *ICES Journal of Marine Science,* 78(10), 3639-3649. https://doi.org/10.1093/icesjms/fsab204

Nephrops (Nephrops norvegicus) is an economically valuable target species in the North Sea. Although individual Nephrops populations are scattered, the crustacean is managed regionally by the European Union (EU). The spatial competition for fisheries in the North Sea is growing especially due to expanding offshore wind farms (OWF) and newly implemented marine protected areas (MPA). Moreover, the Brexit affects the availability of EU fishing quotas and adds to the overall uncertainty EU fishers face. We compare landings and catches to scientifically advised quantities and perform an overlap analysis of fishing grounds with current and future OWFs and MPAs. Furthermore, we explore the German Nephrops fleet using high-resolution spatial fishing effort and catch data. Our results confirm earlier studies showing that Nephrops stocks have been fished above scientific advice. Present OWFs and MPAs marginally overlap with Nephrops fishing grounds, whereas German fishing grounds are covered up to 45% in future scenarios. Co-use strategies with OWFs could mitigate the loss of fishing opportunities. Decreased cod quotas due to Brexit and worse stock conditions, lowers Germany's capability to swap Nephrops quotas with the UK. We support the call for a new management strategy of individual Nephrops populations and the promotion of selective fishing gears.

Lloret, J., Turiel, A., Solé, J., Berdalet, E., Sabatés, A., Olivares, A., . . . Sardá, R. (2022). Unravelling the ecological impacts of large-scale offshore wind farms in the Mediterranean Sea. *Science of The Total Environment,* 824, 153803. https://doi.org/10.1016/j.scitotenv.2022.153803

The need for alternative energy systems like offshore wind power to move towards the Green Deal objectives is undeniable. However, it is also increasingly clear that biodiversity loss and climate change are interconnected issues that must be tackled in unison. In this paper we highlight that offshore wind farms (OWF) in the Mediterranean Sea (MS) pose serious environmental risks to the seabed and the biodiversity of many areas due to the particular ecological and socioeconomic characteristics and vulnerability of this semi-enclosed sea. The MS hosts a high diversity of species and habitats, many of which are threatened. Furthermore, valuable species, habitats, and seascapes for citizens' health and well-being coexist with compounding effects of other economic activities (cruises, maritime transport, tourism activities, fisheries and aquaculture) in a busy space on a narrower continental shelf than in other European seas. 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.

Luhtala, H., Erkkilä-Välimäki, A., Eliasen, S. Q., & Tolvanen, H. (2021). Business sector involvement in maritime spatial planning – Experiences from the Baltic Sea region. *Marine Policy,* 123, 104301. https://doi.org/10.1016/j.marpol.2020.104301

In the European Union, Maritime Spatial Planning (MSP) has been regarded as a means of promoting the sustainable growth of the blue economy. Consequently, where the planning outcomes affect the business operations in marine areas, commercial and industry stakeholders should have an important role in the planning process. However, the business perspective in MSP has gained little attention in stakeholder involvement literature. The aim of this study is to elaborate on the business sector's interest and involvement in MSP in the Baltic Sea region. The findings are based on the first-hand experiences of MSP authorities and experts. Furthermore, perspectives from two sea-use sectors, maritime transport and marine tourism, have been investigated using online questionnaires to discover their views. The study focuses on the questions of who to involve and what are the driving forces promoting business sector involvement. Even though MSP is a form of broad-scale planning, the results indicate that all spatial and organisational scales from local to international and from small enterprises to umbrella organisations should be considered when designing approach to business stakeholder participation. The planning authorities need to consider what are the benefits and challenges of involving different types of business stakeholders. Planners often rely on organisations that represent business stakeholders and individual companies. It is resource effective to interact with representatives as they are considered to have a wide and general knowledge of the respective sector's interests. However, in some cases it is beneficial to also integrate individual companies, especially in local or regional contexts.

MacNab, S., & Nimmo, F. (2021). *Awel y Môr Offshore Wind Farm Commercial Fisheries Baseline Report.* Poseidon Aquatic Resources Management Ltd., Retrieved from https://www.awjmarine.co.uk/wp-content/uploads/2021/09/4.8.1_AyM_PEIR_Volume4_Annex8.1_CommercialFisheriesBaseline_vFinal.pdf

This document has been prepared by Poseidon Aquatic Resource Management Ltd (Poseidon) to support the Environmental Impact Assessment (EIA) of the Awel y Môr Offshore Wind Farm (hereafter referred to as Awel y Môr or AyM). The information on commercial fisheries activity presented in this document is intended to inform the Environmental Impact Assessment (EIA) for Awel y Môr by providing a detailed understanding of the commercial fisheries baseline, against which the potential impacts of Awel y Môr can be assessed. An overview of the information presented in this Technical Report is provided in Volume 2, Chapter 8: Commercial Fisheries of the Preliminary Environmental Information

Report (PEIR). This document describes commercial fisheries activity, defined as fishing activity legally undertaken where the catch is sold for taxable profit. A description of charter angling activity, defined as fishing for marine species where the purpose is recreation and not sale or trade, is provided in Volume 2, Chapter 12: Other Marine Users and Activities and Appendix 12.1: Charter Angling Baseline Report. The ecology of the fish and shellfish species targeted by commercial fishing activity is described in Volume 2, Chapter 6: Fish and Shellfish Ecology.

Meeks, K. R. (2021). Offshore Wind Power: California Fishing Industry Voices Its Concerns. *Fishermen's News*. Retrieved from https://fishermensnews.com/article/offshore-wind-power-california-fishing-industry-voices-its-concerns/

No abstract available.

Mid-Atlantic Fishery Management Council. (2021). *Mid-Atlantic Fishery Management Council Wind Energy Policy*. Retrieved from https://www.mafmc.org/northeast-offshore-wind

This document summarizes the Mid-Atlantic Fishery Management Council's (Council's) policies regarding offshore wind energy development. This document complements the Council's general policies on non-fishing activities and projects and the preamble to all Council fish habitat policies. The Council will review and consider revisions to this document on a periodic basis. The Council will consider the responses to and impacts of Council comments when conducting these reviews.

Monti, D. (2018). Can Offshore Wind and Fishing Coexist? Retrieved from https://conservefish.org/2018/08/21/can-offshore-wind-and-fishing-coexist/

This is an update on offshore wind farms in the northeast and what some in the fishing community are saying about the relationship between fishing and offshore wind.

Moore, K. (2020, February 11, 2020). Recreational anglers wade into offshore wind. *National Fisherman*. Retrieved from https://www.nationalfisherman.com/mid-atlantic/recreational-anglers-wade-into-offshore-wind

The prospect of dozens, perhaps hundreds of massive offshore wind energy turbines dotting East Coast waters has commercial fishermen alarmed and engaged.

The recreational fishing community has its share of skeptics too, worried about the effects of construction and new seafloor cables carrying megawatts of energy to shore.

One group, Anglers for Offshore Wind Power, is working on the premise that offshore wind development could be good for their fisheries and the environment — if they, like organized commercial fishermen, can get a seat at the table with federal energy planners and wind companies.

Navarro, M., Hailu, A., Langlois, T., Ryan, K. L., Burton, M., & Kragt, M. E. (2022). Combining spatial ecology and economics to incorporate recreational fishing into marine spatial planning. *ICES Journal of Marine Science,* 79(1), 147-157. https://doi.org/10.1093/icesjms/fsab249

Many researchers have pointed to coastal environments and their use for energy production, aquaculture, and conservation as key to solving profound challenges facing humanity. Navigating this transition in ocean space necessitates tools to quantify impacts on displaced marine users, including recreational fishers. In this study, we present a novel method combining spatial ecological models of recreational catch with fine-scale random utility models of site choice to predict the impacts of site closures on recreational fishing experiences (fisher welfare). We demonstrate our approach by modelling data from over 10 000 fishing trips to fine-scale sites across 1500 km of coastline in the south-west of Australia and simulating the effects of no-take marine reserves recently implemented in the Australian Marine Parks. The results show how the combination of random utility modelling with spatial ecological methods provides a powerful tool for investigating recreational fisheries as joint social-ecological systems and incorporating recreational fishing into marine spatial planning.

Nogues, Q., Araignous, E., Bourdaud, P., Halouani, G., Raoux, A., Foucher, É., . . . Niquil, N. (2022). Spatialized ecological network analysis for ecosystem-based management: effects of climate change, marine renewable energy, and fishing on ecosystem functioning in the Bay of Seine. *ICES Journal of Marine Science,* 79(4), 1098-1112. https://doi.org/10.1093/icesjms/fsac026

Integrative and spatialized tools for studying the effects of a wide variety of ecosystem drivers are needed to implement ecosystem-based management and marine spatial planning. We developed a tool for analyzing the direct and indirect effects of anthropic activities on the structure and functioning of coastal and marine ecosystems. Using innovative modelling techniques, we ran a spatially explicit model to carry out an ecological network analysis (ENA) of the effects of climate change (CC), of an offshore wind farm (OWF) and of multiple fishing scenarios on the Bay of Seine (eastern part of the English Channel) ecosystem. ENA indices described the effects of those different drivers in a holistic and spatial way. The spatial analysis of ecosystem properties revealed local and global patterns of modifications attributed to CC, while the OWF resulted in localized changes in the ecosystem. This ability of ENA indicators to detect human-induced changes in ecosystem functioning at various spatial scales allows for a more integrative view of the effects of human activities on ecosystems. ENA indices could be used to link both local and global ecosystem changes, for a more cross-scale approach to ecosystem management.

Obane, H., Nagai, Y., & Asano, K. (2021). Assessing the potential areas for developing offshore wind energy in Japanese territorial waters considering national zoning and possible social conflicts. *Marine Policy,* 129, 104514. https://doi.org/10.1016/j.marpol.2021.104514

This study identified areas suitable for offshore wind energy development in Japan based on a low probability of conflicts with stakeholders, such as fishery groups, shipping agents, and residents (minor conflict areas). Using geographic information systems, this study uses a two-stage approach. The first stage reviews Japanese zoning rules and excludes non-conforming areas with rules. The second stage examines case studies of stakeholder conflicts to identify minor conflict areas using three parameters, i.e., distance from the shore, shipping density, and existence of fishery rights, by considering local

concerns regarding the seascape and conflicts resulting from shipping routes and fishery rights. Although previous studies have assessed massive offshore wind energy potential areas (> 140,000 km2) with various approaches, the areas that conform to the zoning rules (53,665 km2) and minor conflicts areas (7,213 km2 or 2% of Japanese territorial waters) are significantly limited. Furthermore, this study revealed that concerns regarding the seascape are a key issue inhibiting the expansion of bottom-fixed offshore wind turbines in Japan. Thus, the approach, which considers both zoning rules and stakeholder conflicts, can reduce the risk of offshore wind energy potential overestimation. For offshore wind energy capacity targets, relevant authorities should carefully examine both the zoning rules and stakeholders.

Oh, H.-T., Chung, Y., Jeon, G., & Shim, J. (2021). Review of the marine environmental impact assessment reports regarding offshore wind farm. *Fisheries and Aquatic Sciences,* 24(11), 341-350. https://doi.org/10.47853/FAS.2021.e33

The energy production of offshore wind farms plays an important role in expanding renewable energy. However, the development of offshore wind farms faces many challenges due to its incompatibility with marine environments and its social acceptability among the local community. In this study, we reviewed the marine environmental impact assessment status of offshore wind farm development projects for 2012–2019 in South Korea. A total of nine projects were selected for this study, all of which experienced considerable conflict with local fisheries resources. To appropriately respond to the underlying challenges faced by offshore wind farm development and in order to better support decision-making for future impact assessment, our findings identified: i) a need for adequate preliminary investigation and technical examination of fisheries resources; ii) a need to assess and estimate the impact of underwater noise, vibration, and electromagnetic waves on fisheries resources during wind farm construction and operation; and iii) a need for a bottom-up approach that allows for communication with local stakeholders and policy-makers to guarantee the local acceptability of the development.

Park, S., Yun, S.-j., & Cho, K. (2022). Text Analysis of Social Dialogue on the Offshore Wind Energy Projects: Implications to Renewable Energy Acceptance and Collective Planning. *SSRN Preprints*. https://doi.org/10.2139/ssrn.4035249

Local opposition to a renewable energy project shows competition among various ideas and values in the energy transition process. Offshore wind farms (OWFs), one of the most promising renewable energy sources, are still not free from conflicts. This study aims to enrich our understanding of what residents want before the siting of an OWF and reconfigure the local conflict from collaborative planning. To this end, we used the methodology of citizen participation and analyzed the results. In one of Korea's OWFs with siting conflicts, we hosted social dialogue programs in which local opinion leaders participated and discussed the issues related to the OWF project. Post-text analysis and factor analysis allowed us to identify the three most important factors for residents about the siting of an OWF: resident participation in the siting process, consideration of damage to fisheries, and sufficient information for judgment. Fishers emphasized the consideration of damage to fisheries, while environmental groups stressed sufficient judgment evidence, but all actors regarded citizen participation in the siting process as necessary. The findings of the social dialogue can be interpreted in specific local contexts to indicate that many aspects of the socio-technical system should be changed to enhance social acceptance of renewable energy. Furthermore, the practice of social dialogue can be

used as an effective transition strategy to overcome the confrontation through the co-production of knowledge and an agenda with the public.

Pfeiffer, O., Nock, D., & Baker, E. (2021). Wind energy's bycatch: Offshore wind deployment impacts on hydropower operation and migratory fish. *Renewable & Sustainable Energy Reviews,* 143. https://doi.org/10.1016/j.rser.2021.110885

Hydropower plays a key role in maintaining grid reliability, but there is uncertainty regarding the ecological implications of using hydropower to balance variability from high penetration of intermittent renewable resources, such as solar and wind. Hydropower can offer advantages at the macro-ecological level (e.g., reduced greenhouse gas emissions), however it may have significant environmental impact on a local level (e.g., increased risk to fish species during migration and breeding periods). Using the New England region as a case study, we use an electricity model to estimate how hydropower operation changes as offshore wind capacity increases at a system level. We then tie alterations in hydropower energy production to local impacts on riverine ecosystems and the lifecycle of migratory fish. We find that increasing offshore wind capacity from 1600 to 10,000 MW more than doubles the average hourly hydropower ramping need and the associated river flowrate during April. This increased flowrate aligns with the migration timing of the lone endangered fish species on the Connecticut River, the shortnose sturgeon. Alternatively, the majority of months in which hydropower operation is most strongly impacted by the addition of offshore wind capacity do not coincide with key fish lifecycle events. Other sustainability benefits, including reduced air pollution and water consumption, can be achieved through deployments of offshore wind. Our results suggest that in order to balance global (i.e., CO2 mitigation) and local (i. e., fish migration) environmental issues, a portfolio of solutions is needed to address grid integration of renewables.

Prevost, L. (2019, November 4, 2019). In Rhode Island, offshore wind farm emerging as popular fishing spot. *Energy News Network*. Retrieved from https://energynews.us/2019/11/04/in-rhode-island-offshore-wind-farm-emerging-as-popular-fishing-spot/

A survey finds many recreational anglers think the Block Island Wind Farm improved fishing by acting as an artificial reef.

Qu, Y. (2021). *Impacts of offshore wind energy on seafood sectors : a macroeconomic perspective of the energy-food nexus.* (Ph.D.), University of Exeter, Exeter, UK. Retrieved from https://ethos.bl.uk/OrderDetails.do?uin=uk.bl.ethos.831947

The rapid expansion of offshore wind farms (OWFs) in response to increasingly ambitious renewable energy and climate targets in the UK has led to growing concerns about conflicts and synergies with existing fishing activities. The complex relationship between energy and food in the marine environment needs to be explicitly evaluated from an energy-food nexus perspective. On one hand, developing OWFs has potential to reduce GHG emissions and increase energy security through diversifying energy supply and providing domestically produced electricity. On the other hand, the expansion of OWFs could have

fish supply implications through impacts on seafood production. There are indirect linkages between OWFs and fishing activities through limited economic production factors, influenced heavily by market forces, and direct linkages through physical and environmental interactions, driven mostly by policies and management practices and affected by ecosystem dynamics. These complex linkages could lead to both negative and positive impacts of OWFs on seafood production and consequently availability and affordability of food supply from the marine environment. Through indirect economic linkages OWFs can affect the demand, supply and prices of the production factors such as labour and capital needed by the seafood production sectors. In terms of direct physical and environmental linkages, the exclusion of fishing activities from OWF areas could result in a decrease in fish landings while reduced fishing activities and artificial reef effect provided by OWF structures could have positive impacts on preservation of fish stocks. To quantitatively evaluate this marine energy-food nexus from a macroeconomic perspective, a static computable general equilibrium (CGE) model is developed, using Scotland as a case study. A particular focus is on the disaggregation of (i) the electricity and seafood sectors to explicitly reflect their economic interconnectedness in order to better model the impacts on availability of food and energy security; (ii) the household groups with different income levels to concentrate on the affordability of energy and food and the distributional effects on welfare. To better emphasise the physical and environmental linkages, two additional modules are created in the model. The innovative marine resource allocation module simulates the spatial conflicts between OWFs and fishing activities while integrating the natural capital and ecosystem services approach further extends the modelling framework to analyse feedbacks between economy and environment. There are therefore three versions of the CGE model, each with a different focus and structure. The first one uses the basic structure of the CGE model to assess the near-term, indirect impact of decreasing cost of OWFs through economic linkages. The results suggest that high cost under subsidy and low cost of OWFs would have positive impacts on energy security and limited negative impacts on seafood production sectors. In particular, the falling cost of electricity from OWFs would have a small positive impact on the economy overall and benefit lower income households, contributing to the reduction in fuel poverty. The second application includes marine resource as an additional production factor and creates a novel marine resource allocation module within the model to better capture the physical interactions between expanding OWFs and fishing activities. The model shows that massive expansion of OWFs results in increasing energy security but significant negative impacts on seafood supply as marine resource is taken away from fisheries by expanding OWFs. The third application integrates natural capital, represented by fish stock, into the CGE model to evaluate the environmental impacts of OWFs considering ecosystem dynamics and feedbacks. Expanding OWFs would reduce fishing output and thus preserve fish stock. However, the artificial reef effect of OWFs would increase the fish stock, eventually benefiting fishing output. The combination of these two opposing impacts suggests that the artificial reef effect is sufficient to mitigate the negative impacts of expansion of OWFs as long as fishermen could get access to the fish stocks close to OWFs. Overall, the model results demonstrate that expanding OWFs would enhance energy security but also bring negative impacts on fish supply. Therefore, there is a need for integrated management of food and energy in the marine environment. To minimise conflicts and maximise synergies from the nexus perspective, co-locating OWFs and fishing activities through marine spatial planning could be a possible solution. The modelling framework is also applicable to other marine renewable energies to assess their potential impacts on energy security and seafood supply, and on the wider economy.

Qu, Y., Hooper, T., Swales, J. K., Papathanasopoulou, E., Austen, M. C., & Yan, X. (2021). Energy-food nexus in the marine environment: A macroeconomic analysis on offshore wind energy and seafood production in Scotland. *Energy Policy,* 149, 112027. https://doi.org/10.1016/j.enpol.2020.112027

The rapid development of offshore wind farms (OWFs) has stimulated debate about its overall socioeconomic impacts. Expanding the scale of OWFs increases the availability and affordability of electricity but could displace existing fishing activities and reduce food supply. To evaluate these impacts from a macroeconomic perspective, a computable general equilibrium (CGE) model is developed, using Scotland as a case study. A particular focus is placed on the disaggregated electricity and seafood sectors, their interconnectedness from an energy-food nexus perspective, and the distributional effects across household groups. This paper explores, from macroeconomic perspective, the trade-offs in the energy-food nexus between expanding OWFs and the seafood sectors, together with the impacts on food and energy security. The results suggest that, through economic linkages, increasing the number of OWFs would have a negative, but limited, effect on seafood production sectors. However, the falling cost of electricity from OWFs would have a positive impact on the economy overall and benefit lower income households, contributing to a reduction in fuel poverty. The model results raise the awareness of nexus linkages between OWFs and seafood production and are applicable to policies involving the development of other offshore renewables.

Roach, M., Revill, A., & Johnson, M. J. (2022). Co-existence in practice: a collaborative study of the effects of the Westermost Rough offshore wind development on the size distribution and catch rates of a commercially important lobster (*Homarus gammarus*) population. *ICES Journal of Marine Science,* 79(4), 1175–1186. https://doi.org/10.1093/icesjms/fsac040

The global expansion of offshore windfarms (OWF), whilst seen as a tool to combat climate change, can often be of concern to fishing communities already challenged by spatial restrictions. Static gear fisheries, due to their strong fidelity to specific sites, can be particularly affected by spatial conflict with OWF. Here we investigate, using four sampling efforts over a six-year period, the effects of the development of the Westermost Rough OWF (UK) on a commercially important European Lobster (Homarus gammarus) population. A collaborative study was developed and conducted by the local fishery and the developer. A baseline potting survey was conducted ∼ every 4 days over the summer months of 2013 (pre-construction) and post-construction surveys were conducted in 2015, 2017, and 2019. Size, catch, and landings per unit of effort (CPUE & LPUE) of all lobsters were recorded and compared between sites and between years. Size structure and catch rates differed between years, however differences were not observed in comparisons of the windfarm and export cable to their associated control sites within each year, although there were compounding factors associated with the proximity of the control sites to the treatment sites. There was a short-term increase in size and catch rates of lobsters associated with the construction phase of the windfarm site, but this was not observed during the subsequent operational phase surveys. Although the impacts of windfarms on fisheries will vary on a case-by-case basis, this study has implications for the expansion of offshore wind developments on other static gear crustacean fisheries.

Russell, A., Bingaman, S., & Garcia, H.-M. (2021). Threading a moving needle: The spatial dimensions characterizing US offshore wind policy drivers. *Energy Policy,* 157, 112516. https://doi.org/10.1016/j.enpol.2021.112516

The Atlantic Coast of the United States represents one of the most promising development environments for offshore wind installation in the world due to the convergence of several geographic factors. These include, but are not limited to, population size and density, electricity prices, ocean depth, wind speed, and the dynamics of the region's current energy infrastructures. However, these have not been sufficient to kickstart a mass movement to offshore energy generation despite two decades of affirmative discussions and some entrepreneurial starts. Planned projects now total over 6 GW. Presently, market variables and institutional controls have become more hospitable for development though undertested except in small pilot projects. Socio-cultural concerns including interaction with the fishers, coastal tourism and real estate, Native American Tribes, and environmental and aesthetic factors have been studied, but applicable information remains limited to reliance on comparisons with European offshore wind research, hypothetical analyses, and attention to small pilot projects. This gap as well as a fundamentally differentiated patchwork of state and local stages means that the current research direction will need to be extended through the development of the first utility-scale projects with attention to new case studies as well as new perspectives, framings, and questions. This report outlines important physical and social policy factors of offshore wind development and then explores several case studies.

Schupp, M. F., Kafas, A., Buck, B. H., Krause, G., Onyango, V., Stelzenmuller, V., . . . Scott, B. E. (2021). Fishing within offshore wind farms in the North Sea: Stakeholder perspectives for multi-use from Scotland and Germany. *Journal of Environmental Management,* 279. https://doi.org/10.1016/j.jenvman.2020.111762

Offshore wind power generation requires large areas of sea to accommodate its activities, with increasing claims for exclusive access. As a result, pressure is placed on other established maritime uses, such as commercial fisheries. The latter sector has often been taking a back seat in the thrust to move energy production offshore, thus leading to disagreements and conflicts among the different stakeholder groups. In recognition of the latter, there has been a growing international interest in exploring the combination of multiple maritime activities in the same area (multi-use; MU), including the re-instatement of fishing activities within, or in close proximity to, offshore wind farms (OWFs). We summarise local stakeholder perspectives from two sub-national case studies (East coast of Scotland and Germany's North Sea EEZ) to scope the feasibility of combining multiple uses of the sea, such as offshore wind farms and commercial fisheries. We combined a desk-based review with 15 semi-structured qualitative interviews with key knowledge holders from both industries, regulators, and academia to aggregate key results. Drivers, barriers and resulting effects (positive and negative) for potential multi-use of fisheries and OWFs are listed and ranked (57 factors in total). Factors are of economic, social, policy, legal, and technical nature. To date, in both case study areas, the offshore wind industry has shown little interest in multi-use solutions, unless clear added value is demonstrated and no risks to their operations are involved. In contrast, the commercial fishing sector is proactive towards multi-use projects and acts as a driving force for MU developments. We provide a range of management recommendations, based on stakeholder input, to support progress towards robust decision making in relation to multi-use solutions, including required policy and regulatory framework improvements, good practice guidance, empirical studies, capacity building of stakeholders and improvements of the

consultation process. Our findings represent a comprehensive depiction of the current state and key stakeholder aspirations for multi-use solutions combining fisheries and OWFs. We believe that the pathways towards robust decision making in relation to multi-use solutions suggested here are transferable to other international locations.

Serpetti, N., Benjamins, S., Brain, S., Collu, M., Harvey, B. J., Heymans, J. J., . . . Wilson, B. (2021). Modeling Small Scale Impacts of Multi-Purpose Platforms: An Ecosystem Approach. *Frontiers in Marine Science,* 8. https://doi.org/10.3389/fmars.2021.694013

Aquaculture and marine renewable energy are two expanding sectors of the Blue Economy in Europe. Assessing the long-term environmental impacts in terms of eutrophication and noise is a priority for both the EU Water Framework Directive and the Marine Strategy Framework Directive, and cumulative impacts will be important for the Maritime Spatial Planning under the Integrated Maritime Policy. With the constant expansion of aquaculture production, it is expected that farms might be established further offshore in more remote areas, as high-energy conditions offer an opportunity to generate more power locally using Marine Renewable Energy (MRE) devices. A proposed solution is the co-location of MRE devices and aquaculture systems using Multi-Purpose Platforms (MPPs) comprising offshore wind turbines (OWTs) that will provide energy for farm operations as well as potentially shelter the farm. Disentangling the impacts, conflicts and synergies of MPP elements on the surrounding marine ecosystem is challenging. 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.

Smythe, T., Bidwell, D., & Tyler, G. (2021). Optimistic with reservations: The impacts of the United States' first offshore wind farm on the recreational fishing experience. *Marine Policy,* 127, 104440. https://doi.org/10.1016/j.marpol.2021.104440

The expansion of offshore wind farms (OWF) has given rise to increased concerns about potential use conflicts with ocean and coastal users and attempts to mitigate these conflicts through marine spatial planning. Whereas scholars and managers often focus on the impacts of OWF on commercial fishing, members of the public also raise concerns about impacts on recreational fishing. Despite these concerns, relatively few empirical studies have been conducted to assess the impact of OWFs on

recreational anglers. This study fills this gap. We conducted a mixed-methods study, comprising interviews and a survey, to assess the impacts of the United States' first OWF on recreational anglers' experiences. Interview findings revealed anglers' enjoyment of the OWF as an enhanced fishing location, due to catch and non-related aspects of the experience. Anglers also reported concerns about increased crowding around the OWF and raised concerns about potential fishing access restrictions around this and future projects. Survey data confirms that anglers, particularly those who fished at the wind farm, believe the wind farm has benefitted fishing. Respondents also value the wind farm as symbolic of progress towards green energy. Overall, results suggest that wind farms do not necessarily conflict with angling; to the contrary, our research shows that this OWF is viewed as an enhanced fishing destination. Results underscore the importance of understanding angler behavior and experiences in managing conflicts with OWF and other ocean uses. Recommendations include conducting social science research to enhance understanding of ocean users, managing issues like crowding and access, and considering the benefits of nearshore OWFs for anglers and other stakeholders.

Smythe, T., Smith, H., Moore, A., Bidwell, D., & McCann, J. (2018). *Analysis of the Effects of the Block Island Wind Farm (BIWF) on Rhode Island Recreation and Tourism Activities*.OCS Study BOEM (2018-068). US Department of the Interior, Bureau of Ocean Energy Management Retrieved from https://espis.boem.gov/final%20reports/BOEM_2018-068.pdf

Although impacts to tourism from offshore wind energy development are widely cited as a concern by communities and policy makers, little work has sought to define what constitutes tourism and recreation impacts or provided empirical evidence of impacts from operating projects. It has been suggested that tourists and recreationalists may change their behavior in selecting destinations due to the visibility of offshore wind structures. This study was designed to collect and review empirical data from the Block Island Wind Farm (BIWF) in order to provide a methodology for developing indicators to track effects of the first U.S. offshore wind farm, which consists of five turbines located within three miles off the coast of Block Island, Rhode Island.

Solman, H., Smits, M., van Vliet, B., & Bush, S. R. (2021). Co-production in the wind energy sector: A systematic literature review of public engagement beyond invited stakeholder participation. *Energy Research & Social Science,* 72, 101876. https://doi.org/10.1016/j.erss.2020.101876

Public concerns surrounding landscape conservation, noise pollution and impacts on bird populations are commonly incorporated into the planning phase of wind energy projects. However, public involvement tends to be highly localized and procedural, aimed at informing local stakeholders and gaining their acceptance for implementation. At the same time, other ways of engaging the public have emerged that move beyond invited stakeholder participation to facilitate the co-production of wind energy technologies and the landscapes in which they are placed. This paper systematically reviews the academic literature with the aim of identifying and characterizing these modes of co-production. A total of 230 papers published between 2009 and 2019 that report on public engagement with wind energy were included in our review. From this sample, we characterise public engagement into three modes of co-production: (1) local co-production, in spatially proximate wind energy projects; (2) collective co-production, performed through collaboration among different actors in the wind energy sector, joined ownership or consumption of wind energy; and (3) virtual co-production, mediated through information

technology. These different modes of co-production cover a broad spectrum of ways in which local and non-local publics engage in decisions about where, when, how and by whom wind energy projects are designed, developed and managed over time. Combined, they can offer guidance for future research on how the wind energy sector can further support a transition to sustainable and inclusive energy systems.

Spijkers, J., Merrie, A., Wabnitz, C. C. C., Osborne, M., Mobjörk, M., Bodin, Ö., . . . Morrison, T. H. (2021). Exploring the future of fishery conflict through narrative scenarios. *One Earth,* 4(3), 386-396. https://doi.org/10.1016/j.oneear.2021.02.004

Summary Recent studies suggest that the pervasive impacts on global fishery resources caused by stressors such as overfishing and climate change could dramatically increase the likelihood of fishery conflict. However, existing projections do not consider wider economic, social, or political trends when assessing the likelihood of, and influences on, future conflict trajectories. In this paper, we build four future fishery conflict scenarios by considering multiple fishery conflict drivers derived from an expert workshop, a longitudinal database of international fishery conflict, secondary data on conflict driver trends, and regional expert reviews. The scenarios take place between the years 2030 and 2060 in the North-East Atlantic (“scramble for the Atlantic”), the East China Sea (“the remodeled empire”), the coast of West Africa (“oceanic decolonization”), and the Arctic (“polar renaissance”). The scenarios explore the implications of ongoing trends in conflict-prone regions of the world and function as accessible, science-based communication tools that can help foster anticipatory governance capacity in the pursuit of future ocean security.

Steins, N. A., Veraart, J. A., Klostermann, J. E. M., & Poelman, M. (2021). Combining offshore wind farms, nature conservation and seafood: Lessons from a Dutch community of practice. *Marine Policy,* 126, 104371. https://doi.org/10.1016/j.marpol.2020.104371

Large-scale development of offshore wind farms implies an increase in marine resource use conflicts. Managing potential impacts on marine ecosystems and on resource access for traditional and prospective users is key. Multi-use scenarios are a solution but are often approached as a 'design question' that can be settled through Marine Spatial Planning. In practice, regulatory, technical and socio-economic factors often hinder multi-use. Overcoming such barriers requires active collaboration between all stakeholders, yet meaningful participation in MSP processes often is a challenge. This paper explores the role of Communities of Practice as a participatory tool for developing multi-use. The Netherlands set up a ‘Community of Practice North Sea’ to stimulate the development of multi-use pilots by bringing interested parties together, sharing experiences and learning from each other in a context of existing and developing spatial and social claims. This development is part of the government's strategy aimed at finding a balance between offshore wind energy development, nature conservation and seafood production. The paper shows that by (partly) decoupling policy from practice and creating a positive learning environment, Communities of Practice have potential as a participatory tool for encouraging cooperation between stakeholders in an informal setting and facilitating a transition towards multi-use of marine resources. The paper proposes ten guidelines for using Communities of Practices as an action-oriented tool for salient multi-use practices.

Stelzenmüller, V., Gimpel, A., Haslob, H., Letschert, J., Berkenhagen, J., & Brüning, S. (2021). Sustainable co-location solutions for offshore wind farms and fisheries need to account for socio-ecological trade-offs. *Science of The Total Environment,* 776, 145918. https://doi.org/10.1016/j.scitotenv.2021.145918

The spatial expansion of offshore wind farms (OWFs) is key for the transition to a carbon free energy sector. In the North Sea, the sprawl of OWFs is regulated by marine spatial planning (MSP) and results in an increasing loss of space for other sectors such as fisheries. Understanding fisheries benefits of OWFs and mitigating the loss of fishing grounds is key for co-location solutions in MSP. For the German exclusive economic zone (EEZ) of the North Sea we conducted a novel socio-ecological assessment of fisheries benefits which combines exploring potential spill-over from an OWF with an experimental brown crab (Cancer pagurus) pot fishery and an economic viability analysis of such a fishery. We arrayed a total of 205 baited pots along transects from an OWF located near the island of Helgoland. After a soaking time of 24 h we retrieved the pots and measured the carapace width (mm), weight (g), and sex of each individual crab. To conclude on cumulative spill-over potentials from all OWFs in the German EEZ and drivers of passive gear fisheries we analysed vessel monitoring system (VMS)-data and computed random forest regressions. Local spill-over mechanisms occurred up to distances of 300 to 500 m to the nearest turbines and revealed an increasing attraction of pot fishing activities to particular OWFs. This corresponds to the observation of constantly increasing fishing effort targeting brown crab likely due to both a growing international demand and stable resource populations at suitable habitats, including OWFs. Our break-even scenarios showed that beam trawlers have the capacities to conduct during summer an opportunistic but economically viable pot fishery. We argue that particularly in the North Sea, where space becomes limited, integrated assessments of the wider environmental and socio-economic effects of planning are crucial for a sustainable co-location of OWFs and fisheries.

Stelzenmüller, V., Letschert, J., Gimpel, A., Kraan, C., Probst, W. N., Degraer, S., & Döring, R. (2022). From plate to plug: The impact of offshore renewables on European fisheries and the role of marine spatial planning. *Renewable and Sustainable Energy Reviews,* 158, 112108. https://doi.org/10.1016/j.rser.2022.112108

Offshore renewables (OR), such as offshore wind farms, are a key pillar to address increasing energy demands and the global transition to a carbon-free power sector. The transition to ever more occupied marine spaces, often facilitated by marine spatial planning (MSP), increases the conflict potential with free ranging marine sectors such as fisheries. Here, we quantified for the first time the direct impact of current and future OR development on fisheries across European seas. We defined direct impact as the average annual fishing effort (h) overlapping with OR planning sites and applied an ensemble approach by deploying and harmonising various fisheries data to optimise spatial coverage for the European seas. The North Sea region will remain the centre of OR development for a long time, but a substantial increase of conflict potential between these sectors will also occur in other European sea basins after 2025. Across all sea basins, fishing fleets deploying bottom contacting gears targeting flatfish and crustaceans are and will be affected the most by the already constructed and planned OR. Our results provide a solid basis towards an understanding of the socio-economic effects of OR development on European fisheries. We argue that European MSP processes need to adopt common strategies to produce standardised and harmonised socio-economic data to understand implications of OR on free-ranging marine activities such as fisheries.

Tafon, R., Glavovic, B., Saunders, F., & Gilek, M. (2021). Oceans of Conflict: Pathways to an Ocean Sustainability PACT. *Planning Practice & Research,* 37(2), 213-230. https://doi.org/10.1080/02697459.2021.1918880

Festering ocean conflict thwarts efforts to realize the Agenda 2030 Sustainable Development Goals. This paper explores transformations of ocean conflict into situated sustainability pathways that privilege human needs, justice and equity. We first outline the promise and limits of prevailing ocean/coastal governance practices, with a focus on marine spatial planning (MSP), which by framing conflict in shallow terms as use incompatibility, supports resolution strategies that privilege neoliberal technocratic-managerial and post-political models of consensual negotiation, thereby obscuring the structural inequalities, maldistributions and misrecognitions that drive deep-seated conflicts. Next, the distinctive features of the marine realm and ocean conflict are explained. Third, we outline the root causes, drivers and scale of conflict, with reference to history, climate, culture, governance, institutions and prevailing international socio-political conditions. Fourth, we reflect on the nature of conflict, exploring implications for shallow and deeper approaches of handling conflicts. Fifth, we highlight the implications of knowledge co-production for understanding and transforming conflict in pursuit of justice. Then, in response to the orthodoxies of MSP and prevailing conflict resolution strategies, we elaborate an alternative approach – Pragmatic Agonistic co-produced Conflict Transformation (PACT) for sustainability – sketching out key elements of a praxis that seeks to transform destructive interaction patterns of conflict into co-produced, constructive, scalable and 'institutionalizable' yet contestable and provisional sustainability knowledge-action.

Tyler, G., Bidwell, D., Smythe, T., & Trandafir, S. (2021). Preferences for community benefits for offshore wind development projects: A case study of the Outer Banks of North Carolina, U.S. *Journal of Environmental Policy & Planning,* 24(1), 39-55. https://doi.org/10.1080/1523908x.2021.1940896

As offshore wind energy development gains a foothold, the possibility of conflict between local communities and developers may become increasingly common. Coastal communities within the viewshed or hosting transmission cables may fear several impacts but few benefits. Community benefits, provided through the wind farm developer, may help garner local support in communities in close proximity to a wind farm project. This research focused on the first offshore wind energy lease off the coastline of North Carolina, U.S. This study utilized semi-structured interviews to understand how key informants think of a proposed offshore wind farm in the context of community benefits. Findings reveal that key informants are skeptical of direct benefits like local employment, though optimistic about indirect, regional benefits, like economic development. The majority of key informants were interested in a community fund that would be administered by the local government or a trusted local organization. This study provides an initial assessment of perspectives on community benefits in the context of offshore wind development and makes recommendations on how to incorporate community benefits into the offshore wind development process. Furthermore, we emphasize the importance of additional research into this topic.

van der Reijden, K. J., Govers, L. L., Koop, L., Damveld, J. H., Herman, P. M. J., Mestdagh, S., . . . Olff, H. (2021). Beyond connecting the dots : A multi-scale, multi-resolution approach to marine habitat mapping. *Ecological Indicators,* 128, 107849. https://doi.org/10.1016/j.ecolind.2021.107849

Conflicts of interests between economic and nature conservation stakeholders are increasingly common in coastal seas, inducing a growing need for evidence-based marine spatial planning. This requires accurate, high-resolution habitat maps showing the spatial distribution of benthic assemblages and enabling intersections of habitats and anthropogenic activities. However, such detailed maps are often not available because relevant biological data are scarce or poorly integrated. Instead, physiotope maps, solely based on abiotic variables, are now often used in marine spatial planning. Here, we investigated how pointwise, relatively sparse biological data can be integrated with gridded, high-resolution environmental data into informative habitat maps, using the intensively used southern North Sea as a case-study. We first conducted hierarchical clustering to identify discrete biological assemblages for three faunal groups: demersal fish, epifauna, and endobenthos. Using Random Forest models with high-resolution abiotic predictors, we then interpolated the distribution of these assemblages to high resolution grids. Finally, we quantified different anthropogenic pressures for each habitat. Habitat maps comprised a different number of habitats between faunal groups (6, 13, and 10 for demersal fish, epifauna, and endobenthos respectively) but showed similar spatial patterns for each group. Several of these 'fauna-inclusive' habitats resembled physiotopes, but substantial differences were also observed, especially when few (6; demersal fish) or most (13; epifauna) physiotopes were delineated. Demersal fishing and offshore wind farms (OWFs) were clearly associated with specific habitats, resulting in unequal anthropogenic pressure between different habitats. Natura-2000 areas were not specifically associated with demersal fishing, but OWFs were situated mostly inside these protected areas. We thus conclude that habitat maps derived from biological datasets that cover relevant faunal groups should be included more in ecology-inclusive marine spatial planning, instead of only using physiotope maps based on abiotic variables. This allows better balancing of nature conservation and socio-economic interests in continental shelf seas.

Virtanen, E. A., Lappalainen, J., Nurmi, M., Viitasalo, M., Tikanmäki, M., Heinonen, J., . . . Moilanen, A. (2022). Balancing profitability of energy production, societal impacts and biodiversity in offshore wind farm design. *Renewable and Sustainable Energy Reviews,* 158, 112087. https://doi.org/10.1016/j.rser.2022.112087

The global demand for renewable energy is on the rise. Expansion of onshore wind energy is in many parts of the world limited by societal acceptance, and also ecological impacts are a concern. Here, pragmatic methods are developed for the integration of high-dimensional spatial data in offshore wind energy planning. Over 150 spatial data layers are created, which either oppose or support offshore wind energy development, and represent ecological, societal, and economic factors. The method is tested in Finland, where interest in developing offshore wind energy is growing. Analyses were done using a spatial prioritization approach, originally developed for the prioritization of high-dimensional ecological data, and rarely used in planning offshore wind energy. When all criteria are integrated, it is possible to find a balanced solution where offshore wind farms cause little disturbance to biodiversity and society, while at the same time yielding high profitability for wind energy production. Earlier proposed areas for offshore wind farms were also evaluated. They were generally well suited for wind power, with the exception of a couple of areas with comparatively high environmental impacts. As an outcome, new areas well suited for large scale wind power deployment were recognized, where construction costs

would be moderate and disturbance to biodiversity, marine industries and people limited. A novel tradeoff visualization method was also developed for the conflicts and synergies of offshore energy deployment, which could ease the dialogue between different stakeholders in a spatial planning context. Overall, this study provides a generic and transparent approach for well-informed analysis of offshore wind energy development potential when conflict resolution between biodiversity, societal factors and economic profits is needed. The proposed approach is replicable elsewhere in the world. It is also structurally suitable for the planning of impact avoidance and conflict resolution in the context of other forms of construction or resource extraction.

Wilber, D. H., Brown, L., Griffin, M., DeCelles, G. R., & Carey, D. A. (2022). Demersal fish and invertebrate catches relative to construction and operation of North America's first offshore wind farm. *ICES Journal of Marine Science,* 79(4), 1274–1288. https://doi.org/10.1093/icesjms/fsac051

Effects of offshore wind farm (OSW) development in the US on fishery resources have been predicted based on European experience. A seven-year study of the first US OSW documented the response of demersal fish and invertebrates to construction and operation. Local fishermen and scientists designed a monthly demersal trawl survey using a Before-After-Control-Impact (BACI) design to assess potential effects of Block Island Wind Farm (BIWF), a pilot scale 30 MW project completed in 2016. Common species did not exhibit statistically significant ($\alpha = 0.10$) BACI interactions in catch per unit effort (CPUE) due to BIWF operation. CPUE of structure-oriented species, such as black sea bass (Centropristis striata) and Atlantic cod (Gadus morhua), increased at BIWF following turbine installation. Fall and spring biomass varied synchronously between BIWF and a regional survey for several species including longfin squid (Loligo pealeii) and winter flounder (Pseudopleuronectes americanus). Spatial-temporal interaction between reference areas provided an estimate of the minimum effect sizes (approximately 40% to 63% among the fish evaluated) that may be considered ecologically significant when assessing potential OSW impacts. Results from this first North American OSW fisheries monitoring study provide valuable information for future OSW development on the northeastern US coastline.

Wilber, D. H., Brown, L., Griffin, M., DeCelles, G. R., & Carey, D. A. (2022). Offshore wind farm effects on flounder and gadid dietary habits and condition on the northeastern US coast. *Marine Ecology Progress Series,* 683, 123-138. https://doi.org/10.3354/meps13957

The first offshore wind farm in North America, Block Island Wind Farm (BIWF), was built on a pilot scale (five 6 MW turbines) approximately 5 km southeast of Block Island, Rhode Island. Potential effects of the BIWF on dietary habits were examined for fish collected in a trawl survey conducted monthly over 7 years (October 2012 to September 2019). Stomach content analysis was conducted on 3457 flounder, gadids, and black sea bass collected near BIWF and in 2 reference areas during baseline, construction, and operation time periods. Other trophic metrics such as fish condition, stomach fullness, and % empty stomachs were examined for an effect of wind farm operation. Temporal variation in trophic metrics was more common than spatial differences, with no consistent indication of an effect of wind farm operation across metrics or species. Prey accumulation curves indicated that diets were adequately characterized with sample sizes of approximately 40 stomachs for most time period by area combinations. Diet composition of hakes and flounder in all areas included a greater proportion of mysids and amphipods during the wind farm operation time period. Summer flounder and winter

flounder condition was lower during the operation time period in all areas. Inclusion of mussels and associated epifauna (mysids) in fish diets following turbine installation indicate fish forage on the colonized turbines. Although substantial changes to fish diets were not evident at BIWF, cumulative trophic effects of larger wind farms should be examined as the offshore wind industry expands on the northeastern US coastline.

Wildt, N. v. d. (2022). *Wind, Power - The Performance of the Marine Spatial Planning Framework. A Case Study about the Saare Wind Energy Project near the Coast of Saaremaa, Estonia.* (MSc), University of Groningen, Retrieved from https://frw.studenttheses.ub.rug.nl/3814/

Offshore wind competes with other marine interests. The Marine Spatial Planning (MSP) framework could foresee in guidelines to make sure these interests are fairly equally balanced. However, previous examples showed that implementation was often insufficient and inconsequent, making the performance of MSP unsure. This report presents the outcomes of a study into the performance of two key principles of MSP – participation and integration – in offshore wind developments. This study was executed by applying a case study that focused on the Saare Wind Energy (SWE) offshore wind park near Saaremaa, Estonia. Data was collected from prior documentation, interviews and an online survey. Previous studies indicated that MSP was mostly subject to the interests of the planning authorities, which returned in this study in the form of prioritising state interests and shaping the MSP process just so, although more themes and factors were taken into account in the strategical EIA and in consulting theme groups. Participation and integration in the SWE project process were more present than required by the relevant legislation, but the incorporation was similar with the MSP process, indicating an insufficient safeguard of the Estonian Maritime Spatial Plan in current offshore developments. Finally, although knowledge on the project is limited and the general stance towards offshore wind is slightly negative, the local population does not seem to organise themselves in the form of active opposition, which raises the question what cultural factors play a role in the mobilisation of opposition. This study adds to the knowledge on the implementation of the theoretic principles of MSP into a range of different cases. Meanwhile, this study focused on one particular offshore project to assess whether this limited safeguarding in the plan also materialises in the implementation phase. Furthermore, this study also contributes to knowledge of offshore wind planning in general by considering the land-sea interaction between the offshore wind farm and the population who lives from that particular sea area and its surroundings.

Xavier, T. W. d. F., Gorayeb, A., & Brannstrom, C. (2022). Participatory Methodologies and the Production of Data on Artisanal Fishing in Areas with Offshore Wind Farm Projects in Ceará, Brazil. *Sustainability in Debate,* 13(1), 14. Retrieved from https://periodicos.unb.br/index.php/sust/article/view/40625/33071

Offshore wind farms (OWF) are an essential emerging energy source. In Brazil, environmental licensing of OWFs requires an identification map of multiple preexisting uses, targeting potentially conflicting activities, such as fishing and navigation routes. The objective of the work was to evaluate the application of participatory methodologies in the construction of data on fishing activity, aiming at analyzing potential impacts of OWFs in marine territories of the state of Ceará, with a focus on artisanal fishing. A participatory map and fishing calendar were produced in Colônia Z18, Amontada,

Ceará. Data collection took place through four participatory workshops with 45 participants. The data were digitized in a GIS environment and later validated with the community. The results show complete overlap between an OWF and the local fishing activity. Thus, participatory methodologies can help in the acquisition of fishery data and the assessment of the multiple uses of marine territories.