RESEARCH ARTICLE

Assessing Fish and Motile Fauna around Offshore Windfarms Using Stereo Baited Video

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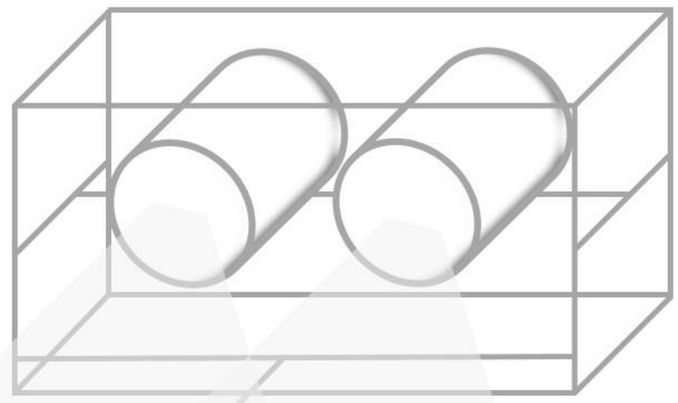
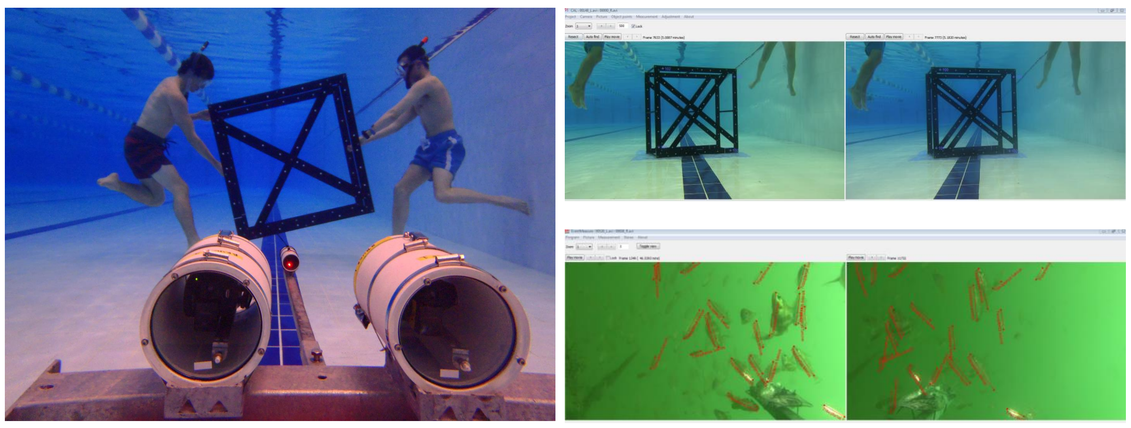


Abstract

There remains limited knowledge of how offshore windfarm developments influence fish assemblages, particularly at a local scale around the turbine structures. Considering the existing levels of anthropogenic pressures on coastal fish populations it is becoming increasingly important for developers and environmental regulators to gain a more comprehensive understanding of the factors influencing fish assemblages. Improving our ability to assess such fish populations in close proximity to structures will assist in increasing this knowledge. In the present study we provide the first trial use of Baited Remote Underwater Stereo-Video systems (stereo BRUVs) for the quantification of motile fauna in close proximity to offshore wind turbines. The study was conducted in the Irish Sea and finds the technique to be a viable means of assessing the motile fauna of such environments. The present study found a mixture of species including bottom dwellers, motile crustaceans and large predatory fish. The majority of taxa observed were found to be immature individuals with few adult individuals recorded. The most abundant species were the angular crab (*Goneplax rhomboides*) and the small-spotted catshark (*Scyliorhinus canicula*). Of note in this study was the generally low abundance and diversity of taxa recorded across all samples, we hypothesise that this reflects the generally poor state of the local fauna of the Irish Sea. The faunal assemblages sampled in close proximity to turbines were observed to alter with increasing distance from the structure, species more characteristic of hard bottom environments were in abundance at the turbines (e.g. *Homarus gammarus, Cancer pagarus, Scyliorhinus spp*.) and those further away more characteristic of soft bottoms (e.g. Norwegian Lobster). This study highlights the need for the environmental impacts of offshore renewables on motile fauna to be assessed using targeted and appropriate tools. Stereo BRUVs provide one of those tools, but like the majority of methods for sampling marine biota, they have limitations. We conclude our paper by providing a discussion of the benefits and limitations of using this BRUV technique for assessing fauna within areas close to off-shore windfarms.



BRUV systems being calibrated in the pool using fixed point targets and specialist SeaGIS software 'Event Measure and some example imagery from analysis being undertaken in UK waters to monitor fish communities around wreck sites.

Applications

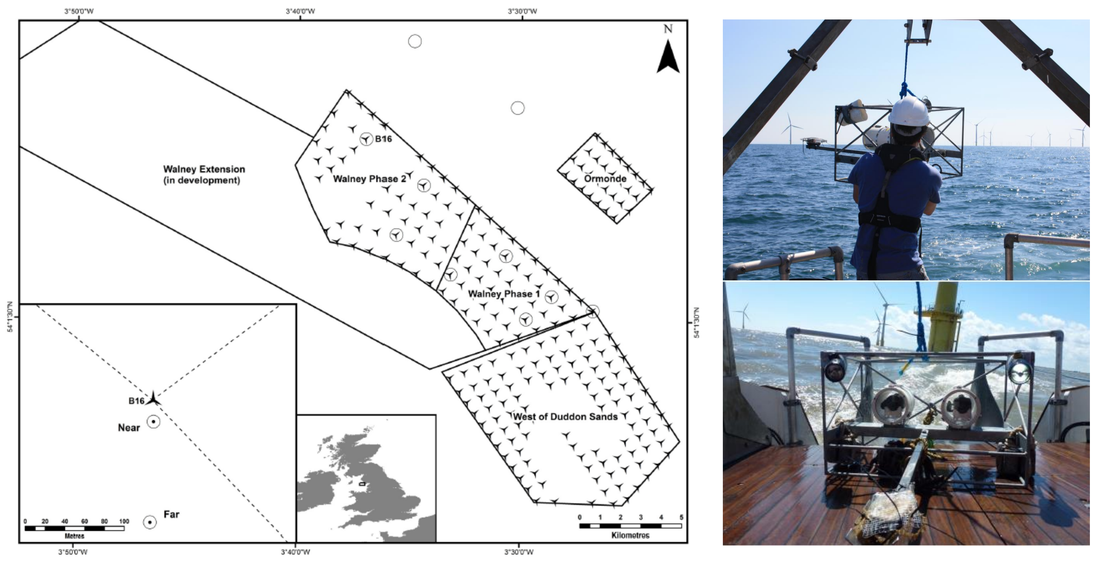
- Assessing fish assemblages at offshore windfarms
- Investigating impact of electromagnetic fields (EMF) from subsea power cables on fish assemblages
- Comparison of gill net catch vs BRUV data
- Monitoring fish assemblages around habitats sensitive to trawling (e.g. *Sabellaria spinulosa* reef, *Zostera spp.* beds)
- Monitoring species by species scavenger rates in response to bait
- Wreck fish community assessments

Case Study: Walney Offshore Windfarm

Materials and Methods

Motile fauna was sampled near and far from turbines at the Walney Offshore Windfarms (WOWF) with permission from DONG Energy, the owner of the offshore windfarm development. Each wind turbine is supported by a steel monopile foundation of up to 6.5 m diameter at the seabed and the surrounding seabed is covered by a ring of approximately 20 m of rock armour to protect against sediment scour. Species relative abundance, diversity and age structure of motile fauna was sampled within benthic habitats at locations of varying distance (100 m apart–near and far to the turbines) from eight turbine installations (at least 2 km apart from each other) within the WOWF site (sixteen samples). Sampling was also conducted at two additional reference sites (a further 4 km from the turbines) resulting in a further four samples.

Sampling used two stereo Baited Remote Underwater Video systems (stereo BRUVs) deployed during full daylight hours. The Swansea University stereo BRUV system used was a modified version of the SeaGIS equipment which is based on systems used in Australian research. The system consisted of two calibrated Canon high definition video cameras within PVC underwater housings, mounted at a fixed position on a galvanised steel frame with a 90 cm bait pole. All footage was analysed at Swansea University using the specialised SeaGIS software Event- Measure (Version 3.51) (www.seagis.com.au). This software was pre-calibrated using the SeaGIS software package Cal and cameras synchronised allowing for accurate length measurements of observed fish and motile fauna. The footage was analysed using the left hand camera for identification of both new species and species relative abundance (Nmax). The right hand camera was used in tandem with the left hand camera to produce length measurements where the maximum species Nmax was observed.



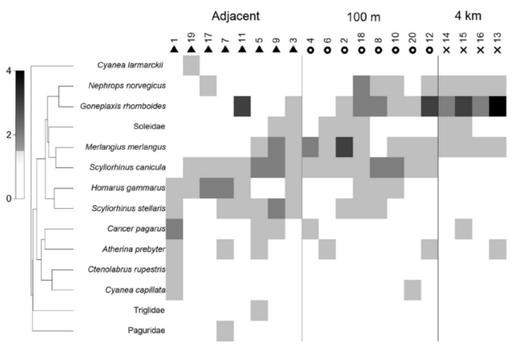
Left: Location of the Walney Offshore Windfarm (WOWF) development and the ten BRUV deployment locations. Top right: BRUV system ready for deployment within the windfarm array. Bottom right: BRUV system retrieved to deck ready for data download following close proximity deployment.

Results

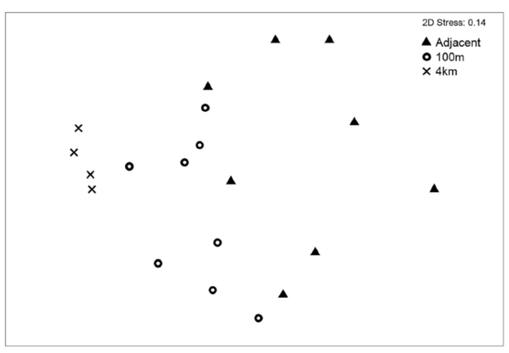
A total of 118 individuals (based on Nmax) from 14 separate taxa were identified in the 20 hours of BRUV footage collected during this study. Of the 14 taxa recorded, the majority were fish whilst 5 were mobile crustaceans. This included the commercially important European lobster (*Homarus gammarus*), Norway lobster (*Nephrops norvegicus*) and edible crab (*Cancer pagurus*). Some individuals could not be identified to species level so were recorded at family level only (e.g. *Paguridae*, *Triglidae*). Total relative abundance (Nmax) per sample ranged from 3 to 9 individuals (fish and motile invertebrates) and the number of taxa ranged from 3 to 7 in an individual sample. The average relative abundance per sample (Nmax) across all sites was 5.9 ± 0.4 SD. The most abundant taxa observed across all samples were the angular crab (*Goneplax rhomboides*) (1.3 ± 0.3), the small-spotted catshark (*Scyliorhinus canicula*) (1 ± 0.2) and the whiting (*Merlangius merlangus*) (0.9 ± 0.2).

Faunal abundance did not vary significantly with increasing distance from the turbine. The average number of taxa was slightly greater in samples taken adjacent and 100 m from the turbine installations than at the sites 4 km away, but these differences were again not significant. At the assemblage level, some significant differences were found. Pairwise analysis shows these differences in the assemblage to exist between all distance pairs. The differences were most pronounced between the samples adjacent to the turbines and those 4 km from the windfarm site demonstrated by the distinct separation of these points. The dissimilarity in the assemblages between the turbines and those 4 km from the windfarm site are driven by *Goneplaxis rhomboids*, *Scyliorhinus canicula*, *Homarus gammarus* and *Nephrops norvegicus*.

Although average number of taxa recorded per sample did not change significantly with distance, total number of taxa did change. Fourteen different taxa were observed adjacent to the turbines, 10 taxa at 100 m from the turbines and only 6 taxa were recorded 4 km away. The low number at 4 km away should be treated with caution relative to the other distances as the sampling intensity was lower at that distance. Of the 14 taxa recorded it was possible to determine length measurements of 11 taxa. The inability to determine lengths of three of the taxa was due to either individuals not being observed concurrently on both stereo cameras (gurnard and goldsinny wrasse (*Ctenolabrus rupestris*) or the individual not showing features sufficient for measurement purposes (hermit crabs, (*Paguridae*)). Most fish length ranges were relatively low in comparison to their known maximum lengths with all individuals being below the size at maturation estimates for each species. The exception to this were the *Scyliorhinidae* with most individuals being sexually mature adults.



Shade plot of 14 taxa from 20 sites sampled with BRUV systems at three different distances (adjacent, 100m and 4km) from turbines at the WOWF development with linear grey-scale intensity proportional to untransformed Nmax values.



Non-metric multidimensional scaling ordination of community Nmax data recorded using stereo BRUV systems at three different distances (adjacent, 100m and 4km) from turbines sampled at the WOWF development.

Discussion

Much discussion has focussed on the potential use of offshore windfarms for enhancing biodiversity and the areas around them for providing de facto marine reserves, but there is a dearth of data investigating such effects, particularly within the peer reviewed literature and limited examination of the methods suitable to collect such data. Where data does exist it is largely collected at a distance from the turbines using extractive methods such as beam trawling.

The present study found data to support the notion that community composition of motile fauna changed with distance from the turbines. Species more commonly associated with hard bottom environments such as *H. gammarus*, *C. pagarus* and two species of catshark (*Scyliorhinus* spp.) were in higher relative abundance in close proximity to the turbines, whilst species commonly associated to soft bottom environments (e.g. Norwegian lobster and the angular crab) were more abundant outside the windfarm. These findings can however only be considered to be of a preliminary nature and need to be considered with caution due to the limitations of the present dataset. Although these were similar species assemblages to other studies published in the academic literature, the assemblages recorded in the present study were less diverse. Whether this is a local effect or the bias associated with the methodology remains to be seen but highlights the value in utilising multiple methods in order to be able to eliminate such possible explanations. Of note in this study was the generally low abundance and diversity measured across all samples. The low abundances of individuals potentially limited the statistical power to most clearly determine the effect of the turbines and underlines the need for high numbers of replicates in order to assess these environments effectively with a BRUV system.

In conclusion, we find that stereo BRUV systems are a viable tool for assessing fish and other motile fauna in the vicinity of offshore windfarms and provide a means to elucidate differences in community composition related to the presence of the turbine structures and associated rock armour.

Citation

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