

**Monitoring the effects of the Belgian windmill parks on the epibenthos and demersal fish fauna of soft bottom sediments**

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A BACI (Before After Control Impact) design is used to evaluate two possible effects of offshore windmill parks in the Belgian part of the North Sea on soft bottom epibenthos and demersal fish, namely the effect of the presence of turbines (hard substrate) and border (fringe) effects due to changing fisheries activities at the concession borders. For the Thorntonbank wind farm (27 km offshore, 18-24 m water depth, 6 gravity based foundations), a lower number and slightly larger individuals of swimming crab *Liocarcinus holsatus* and brown shrimp *Crangon crangon* and higher autumn densities of whiting *Merlangius merlangus* inside the park were noted in 2010 compared to the reference area. VMS (Vessel Monitoring System) data showed an increased fishing intensity in the neighbourhood of the concession. The absence of the smallest size classes of sole *Solea solea* at the 'fringe' stations might indicate an increased indirect fishing mortality (discards) or changes in the local benthic community. For the Bligh Bank windmill park (40 km offshore, 18-40 m water depth, 55 monopiles), clear differences were noted at species level. For example, the green sea urchin *Psammechinus miliaris* was found at higher densities in the impact area, both on the sandbank top and in the gullies. Also, some larger flatfish individuals (plaice *Pleuronectes platessa* and turbot *Psetta maxima*) were encountered inside the concession area. The results suggest fringe, refugium and reef effects on soft bottom epibenthos and demersal fish, related to the presence of the windmill parks.

Keywords: soft bottom, epibenthos and demersal fish, windmill parks, Belgian part of the North Sea

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- Vandendriessche, S., Derweduwen, J. & Hostens, K., (2011a). Monitoring the effects of offshore windmill parks on the epifauna and demersal fish fauna of soft-bottom sediments: baseline monitoring. pp. 65-81. In Degraer, S., Brabant, R. & Rumes, B., (Eds.) (2011). Offshore wind farms in the Belgian part of the North Sea: Selected findings from the baseline and targeted monitoring. Royal Belgian Institute of Natural Sciences, Management Unit of the North Sea Mathematical Models. Marine ecosystem management unit. 157 pp. + annex.

**ABSTRACT**

This chapter reports on the condition of demersal fish, benthopelagic fish and epibenthos in the concession zones and reference zones of the Thorntonbank windmill park in the third year after the installation of the first six turbines, and on the effects of increased fishing effort just outside the Thorntonbank concessions. Due to practical issues following access restrictions in the Belwind concession area, no samples could be taken in 2010 of the Bligh Bank impact area. Hence, the data of 2010 on the Bligh Bank and Oosthinder reference zones were stored for future analyses concerning natural temporal variation in the vicinity of the Belwind windmill park.

In 2009, some alterations within the epibenthos and fish assemblages were observed in the impact area on the Thorntonbank. These included (1) higher densities of horse mackerel (*Trachurus trachurus*) in autumn 2009 and (2) lower densities of sole (*Solea solea*) in spring 2009, compared to the reference areas around the Thorntonbank. These observations, however, were not confirmed by the 2010 data. Newly observed differences between the impact area and the reference areas in 2010 included (1) generally larger individuals of the swimming crab *Liocarcinus holsatus* and the brown shrimp *Crangon crangon* at the impact station, which may reflect either increased growth due to a high food availability or increased predation pressure eliminating smaller individuals; (2) higher

autumn densities of small whiting *Merlangius merlangus* at the impact station.

The observed increase in fisheries intensity of the Belgian fleet and recreational fisheries in the area north of the concession had little effect on the level of density, biomass and diversity. However, the length-frequency distributions of sole showed an absence of the smallest size classes in both seasons of 2010, which could be the result of increased indirect fishing mortality (such as discards) or of changes in the local benthic community. Similarly, there was a striking reduction in the individuals in the size classes ranging between 21 and 26 cm for whiting *M. merlangus* in spring 2010 at the fringe stations. There were some differences between fringe stations and reference stations for small demersal fish and for epibenthos. Generally, these differences were highest in 2009 and more or less normalized by 2010.

These differences between the impact station, fringe stations and reference stations may indicate changes in predation pressure, food supply and recruitment. Further monitoring and targeted research actions are needed to confirm causal relationships between these observations and the investigated pressures.

- Vandendriessche, S., Hostens, K., Courtens, W. & Stienen, E.W.M., (2011b). Monitoring the effects of offshore wind farms: evaluating changes in fishing effort using Vessel Monitoring System data: targeted monitoring results. pp. 83-92 In Degraer, S., Brabant, R. & Rumes, B., (Eds.) (2011). Offshore wind farms in the Belgian part of the North Sea: Selected findings from the baseline and targeted monitoring. Royal Belgian Institute of Natural Sciences, Management Unit of the North Sea Mathematical Models. Marine ecosystem management unit. 157 pp. + annex.

#### **ABSTRACT**

This chapter reports on changes in fishing effort in the vicinity of the existing windmill parks at the BPNS based on Vessel Monitoring System (VMS) data. During the analysis, displacement of activities by Belgian trawlers of different size and engine power was evaluated. Additionally, we looked at possible changes in fisheries methods, and more precisely a shift towards passive fishing methods.

The results showed that the permanent closure of the existing windmill park concession areas for fisheries has not resulted in a major disruption of Belgian fisheries activities. For large segment trawlers, the observed evolution in fishing distribution and intensity was limited and could not be attributed to the establishment of the C-Power and Belwind windmill parks. For eurocutters, however, there was a shift in distribution from 2006 to 2009, with the abandonment of the western part of the Thorntonbank after 2006 and an increase of fisheries activities between the Thorntonbank and the Bank Zonder Naam in 2009. This might indicate a local increase in the availability of commercially interesting fish species. A change in fisheries methods from active (trawling) to passive (trammel netting) gears could not be observed with the currently available data.

In the current analysis, realistic maps of fishing effort and distribution could not be drafted due to the lack of VMS data on foreign vessels fishing in the windmill park area and on vessels smaller than 15m. This was partly mediated by analysing data gathered during visual surveys. However, the integration of VMS data of all vessels fishing within the study area is indispensable for future monitoring of fisheries activities of windmill parks and other closed areas.

- Vandendriessche, S., Derweduwen, J. & Hostens K., (2012). Monitoring the effects of offshore windmill parks on the epifauna and demersal fish fauna of soft-bottom sediments. Chapter 5: 55-71. In Degraer, S., Brabant, R. & Rumes, B. (Eds.) (2012). Offshore wind farms in the Belgian part of the North Sea: Heading for an understanding of environmental impacts. Royal Belgian Institute of Natural Sciences, Management Unit of the North Sea Mathematical Models, Marine ecosystem management unit. 155 pp. + annexes.

#### **ABSTRACT**

One year after the construction of 55 monopiles on the Bligh Bank, changes within the softsubstratum epibenthos and fish were observed, both on ecosystem component level and on species level. Analyses were conducted to discriminate between effects of the presence of turbines and effects as a result of changing activities in the vicinity of the wind farms (fringe effects). The results showed a decrease in total demersal fish densities and an increase in epibenthos densities within the wind farm. The changes in demersal fish may have resulted from the absence of fisheries in the area or local changes in sedimentology and infaunal communities. For commercially important flatfish, we observed higher densities (turbot, sole) and/or changes in length-frequency distribution (turbot, plaice). This may signal a refugium effect, but bearing in mind that large flatfish such as sole do not stay within a wind farm for longer periods, this effect will be limited. The increase in epibenthos probably resulted from the presence of hard substrates and their fouling communities and from the

absence of fisheries. The increase, however, was mainly seen for dominant, scavenging species such as echinoderms and hermit crabs. Signs of recovery of populations of long lived species vulnerable to trawling were not yet observed in autumn 2011 at the Bligh Bank. Some differences between fringe stations and reference stations were described but they cannot straightforwardly be linked to fringe effects resulting from changing activities in the close vicinity of the wind farm concession.

- Derweduwen, J. Vandendriessche, S., Willems T. & Hostens K., (2012). The diet of demersal and semi-pelagic fish in the Thorntonbank wind farm: tracing changes using stomach analyses data. Chapter 6: 73-84. In Degraer, S., Brabant, R. & Rumes, B. (Eds.) (2012). Offshore wind farms in the Belgian part of the North Sea: Heading for an understanding of environmental impacts. Royal Belgian Institute of Natural Sciences, Management Unit of the North Sea Mathematical Models, Marine ecosystem management unit. 155 pp. + annexes.

## **ABSTRACT**

This chapter focuses on the diet of six demersal and semi-pelagic fish species (dab, solenette, dragonet, lesser weever, whiting and horse mackerel) in the Thorntonbank wind farm and its surrounding areas. Stomach analyses were conducted to unravel changes in feeding patterns and to discriminate between effects of the presence of the turbines and effects as a result of fisheries displacement at the border of the wind farm concession area. Differences were observed between impact, fringe and reference stations. The fullness index indicated that fish had a fuller stomach close to the wind turbines and at the borders of the concession area. This might be an indication of a higher food availability around the wind turbines. The stomach content of dab revealed more amphipods and especially hard substratum species (e.g. *Phtisica marina*) in the impact area compared to the reference area. However, the most abundant hard substratum species present on the turbines (i.e. the amphipod *Jassa herdmani* and the crab *Pisidia longicornis*) were not found in any of the dab stomachs. This can probably be linked to the sampling distance (500-1500m) or to the prey preferences of dab. In general, differences in feeding patterns between sampling stations were observed. Whether these differences originated from the wind turbine presence or from changes in fisheries activities can only be unequivocally confirmed by replication within and between the wind farm(s) and by an optimisation of the sampling strategy.

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