Field report passive fishing in offshore wind farm Borssele

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Contents

Summary

This project developed a research outline together with commercial, small-scale fishers to test fishing methods that could be suitable for fishing in offshore wind farms, including their economic viability, ecological effects, and safety requirements. This is done so that (experimental) passive fishing in wind farms can be initiated. This was done in close collaboration with the fishers in a focus group. Previous to this study, a desk study was performed to collect all the knowledge and information present concerning passive fishing in relation to offshore wind (Neitzel et al. 2023). This knowledge was used to design the field tests for this study. This research investigates further possibilities of commercial passive fishing techniques when looking at operational factors, safety, fishing gear aspects, economic feasibility and ecology. This report describes what has been done in the practical (fieldwork) part of this study and gives a first impression of the lessons learned from the field. The data collected will be further analysed and presented in the final report that will be delivered at a later stage of this project. The operations took place in Borssele I and II offshore wind farm off the Dutch coast during the period April to October 2023. During the field experiments, a total of 35 days were conducted in the Borssele I and II offshore wind farm.

The field experiments carried out in the project were as follows:

- 5 days using gill nets with YE152.
- 16 days using 4 different types of pots with YE152.
- 4 days using handlines with KG7.
- 10 days using a mechanical jigging system with MDV2.

Prior to the experiments, the operational procedures were described in a document that included a Risk Assessment Method Statement and research outline (Plan van Aanpak) for each of the fishing gears. These procedures were aligned and confirmed by the Ministry of Agriculture, Nature and Food Quality (LNV) and the Directorate-General for Public Works and Water Management (Rijkswaterstaat). The action plan was also shared with the wind farm owner of Borssele I and II, Ørsted. While the latter was not obligatory, it was helpful for coordinating activities and for safety measures during this project. Subsequently, field protocols were developed and shared with the respective skippers and crew of the involved vessels.

The weather conditions during the spring, summer and fall period of 2023 have been unfavourable. The unfavourable conditions have limited the operability of the experiments. The experienced sea states are compared to long term statistics and do show lower operability in 2023. Furthermore, a statistical comparison is made of sea states in Borssele and upcoming wind parks (HKZ, HKN, HKW). This comparison shows sea states will be worse in these upcoming wind parks.

The experiences and collected data from the field experiments are currently being processed and analyzed. The final report, as agreed with LNV, will be delivered by the end of May 2024. The final report will provide further details on the practical feasibility of fishing in a wind farm, experiences with the chosen passive fishing methods for this project, the (environmental) effects, biological insights such as bycatch and the presence of birds and marine mammals during the use of the applied methods, and the economic viability of fishing in a wind farm. In addition to the final report, it was agreed that this field report would be prepared with the key findings related to procedures and safety aspects within a wind farm.
Most of the field experiments were carried out as planned in the action plan, and there was no need for additional communication with Rijkswaterstaat, the coast guard, or the wind farm owner. However, during some field experiments, a few more or less unexpected events occurred, which were resolved during the course of the experiments. This did require extra time and effort in terms of communication, and it should be avoided in the future for fishers in their daily operations.

1 Introduction

1.1 Background

The Dutch government has established policies to enable co-use, such as passive fishing, in offshore wind farms. In this context, a guideline called "handreiking gebiedspaspoort" (area passport) has been developed for Borssele offshore wind farm. This document outlines the preferred forms of co-use in different zones within the wind energy area (see Figure 2.1.1). In addition to mariculture, sustainable energy generation and storage, and nature-enhancing projects, passive fishing has also been designated to a specific area within Borssele. However, currently, passive fishing within wind farms is only possible in experimental settings and under specific conditions. The North Sea Agreement has decided that additional regulations will need to be developed where necessary before commercial passive fishing can be allowed in offshore wind farms. The revision of regulations will be done "with a view to allocating usage rights and preventing overexploitation" (North Sea Agreement, 2020, p. 20, agreement 4.20). The Ministry of Agriculture, Nature, and Food Quality (LNV) is currently assessing the need for additional regulations to establish safe, economically viable, and sustainable fishing within wind farms. For this reason, the Ministry commissioned this research project.

While some completed and ongoing projects have explored the possibilities of (passive) fishing in wind farms, these possibilities have only been minimally investigated, and practical knowledge is currently lacking. In "Vissen voor de wind" (2016), an initial exploration was made regarding the possibilities and limitations for fishers in wind farms. The ongoing project "Win-Wind" (2019 - 2023) includes an exploration, partly in practice, of the operational aspects (safety and risk management) of navigating and working as a commercial fisher in wind farms. Prior to the present study, all knowledge concerning passive fishing in general and specifically in relation to wind farms was gathered during a desk study and published in 2023 (Neitzel et al. 2023). This study follows up on the desk study by performing the actual field tests and practical side of passive fishing in wind farms.

1.2 Research objectives

Despite previous research making significant progress in gathering knowledge about passive fishing in wind farms, there is still a lack of experience concerning fishing activities in wind farms. For example, there are still questions about the legal possibilities, safety assurance, economic viability, and ecological effects of implementing (passive) fishing in wind farms. Additionally, there has been no concrete assessment of interest from the fishing sector, specifically which fishers would want and be able to fish in wind farms in the future, using which techniques. This study therefore developed a research outline in collaboration with a focus group of commercial, small-scale fishers for fishing methods that could be suitable for fishing within wind farms. This includes their economic viability, ecological effects, and safety requirements, so that passive fishing in wind farms can be initiated. The entire project investigates further possibilities of commercial passive fishing techniques when looking at operational factors, safety, fishing gear aspects, economic feasibility and ecology. This report however describes only what has been done in the practical (fieldwork) part of this study and gives a first impression of the lessons learned from the field. The final report including all research objectives follows in 2024.

2 Practical results

2.1 Research set-up

2.1.1 Research area

The operations took place in Borssele I and II offshore wind farm off the Dutch coast, 23 km (12.42nm) away from Westkapelle during the period April to October 2023. No fishing activities were performed in the area around the wind turbines where nature inclusive design was applied (Figure 2.1.1a). The positions of the fishing gear that was used in this study are shown on the bathymetry map of Borssele II offshore wind farm (Figure 2.1.1a). Tested techniques are hand line fishing, gill nets, multi-species pots and (mechanical) jigging.

This project was carried out as 'research project commissioned by the state' and as such, permission to access to the offshore wind farm was granted based on article 2 sub 1 d of the BAS[1], instead of article 4 'experiments with passive fishing'. This meant that the conditions and restrictions under which the field experiments took place, were not bound to the limitations of article 4. For this reason, also gillnets could be tested in this project, although not mentioned in the list of gears mentioned in article 4. However, article 4 was used as a guideline when writing the action plan. The action plan was then agreed upon by Rijkswaterstaat and LNV and this action plan, together with some conditions mentioned in the letter granting access, dictated the rules to be followed in this project.

During each day at sea, different types of information were collected:

1. Operational data (vessel activity, working times, gear aspects, anchor positions, sailing time, operational and safety aspects)
2. Environmental data (weather circumstances, depths, locations)
3. Ecological data (birds and sea mammals)
4. Biological data (catch data such as length frequencies and weights of the species)
5. Economic data (ice and fuel used, distance to harbour, total marketable catch, materials used)

[1] Staatscourant 2021, 13511 | Overheid.nl > Officiële bekendmakingen (officielebekendmakingen.nl)

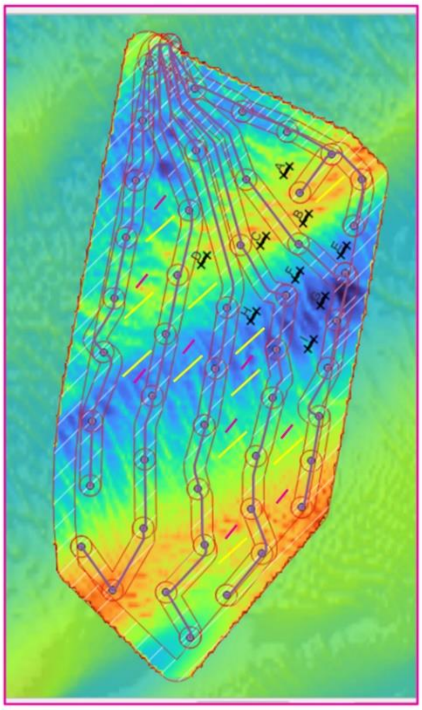


*Figure 2.1.1a (left)**:** The green area the area where no fishing activities were performed because nature inclusive design was applied.*

Figure 2.1.1b (right): Bathymetry map of Borssele II offshore wind farm showing positions of strings as used in the 2022 and present experiments (black lines), additional strings of the current experiment in pink and the positions of gill nets in yellow. Jigging and handline fishing took place in the open space outside of the maintenance zones and away from the other gears. Depth profile: dark blue: -40 m, orange: -12 m.

2.1.2 Collection of operational and environmental data

Operational and environmental data

The vessel's sailing trajectories, towards and inside the wind farm, were retrieved from the vessels AIS signal.

The following information was accurately recorded during hauling or setting:

- The GPS locations of the anchors of each string (gillnet and pots) or start/end of fishing activity (handline and jigging).
- The time of hauling or setting.
- The depth (beginning or end), as a magnitude
- Weather conditions (wind direction, wind speed, wave height).

Also, any odd observations were recorded, such as:

- Damage to markers or nets.
- Unusual conditions: visibility, blooms, indications of fish on the fishfinder or echosounder.
- Traffic in the waterway, movements of vessels.
- Safety risks or the visibility of markers.

To document the process and any peculiarities, photos and videos were taken during the trips as well.

2.1.3 Collection of ecological and biological data

Ecological data
For ecological data, an estimation of the number of birds per category (seagulls, cormorants, gannets, songbirds, others) was made. Each category is scored on 5 levels: <5, 5-10, 10-50, 50-100, or >100 birds. Also, sightings of sea mammals such as harbour porpoises and seals were recorded on each of the trips.

Biological (catch) data
For each net or pot, the catch was kept and recorded separately. For handline and jigging, the total catch of a fishing operation was recorded. Hours fished in Borssele I and II were seen as different operations and recorded separately on the hauling list.

The following biological data was recorded:
- Fish: quantities and individual lengths. Lengths were rounded 'to the cm below'.
- Weights per fish species per size category; undersized and marketable size.
- Quantities and, where possible, carapace length, and width (mm) of lobsters, velvet swimming crabs, Norway lobster, and Brown crabs.
- Quantities, lengths, and gender of elasmobranchs.
- Quantities of other species, such as benthos (starfish, hermit crabs, shellfish).

2.1.4 Collection of economic data

Immediately after the project was awarded, a description was made of the business economic fishing data to be collected and recorded. Also, the procedure and method of recording was described. Data that partly have been collected and recorded until now include:
- Investments (in order to calculate depreciation),
- fishing gear used and its deployment,
- fishing history such as the number of sea- and fishing- hours,
- costs of crew and their deployment,
- possible damage (and costs) to fishing gear on board,
- the commercial catch,
- processing of the catch and the time involved,
- preparing the catch for sale,
- selling the catch (in principle via a fish auction, but also to a private market party),
- repair of fishing gear on shore,
- consumption figures and costs of fuel/energy,
- other costs incurred to assess the profitability of the fishing activity, etc.

From the yield data (which are stated on payment slips), specifications of the fish per species are given, the quantities, prices and overall revenues etc. Depreciation of tangibles are determined and analyzes will be made based on the collected data. Estimations will be made of possible economic performance (costs and earnings) of the fishing methods used in offshore wind farm Borssele in order to give an idea of the feasibility of passive fisheries in offshore wind farms.

Chapter 3 describes more into detail which data has been collected and gives the first impressions and findings. The final report of this study which will be delivered after data analysis, will contain more information about the actual ecological, economical, and operational data.

2.2 Timing of activities

The initial timeline for this study as discussed with the focus group of fishers involved is shown in Figure 2.2.1. From the field experiences it can already be concluded that expeditions such as the field trips performed are very sensitive to winds and waves. Therefore, this planning (and therefore also the people participating) was subject to constant changes and required continuous adaptations. Dark yellow means it is anticipated peak season for that particular fishery and target species, light yellow means crew and scientists were stand-by for possible changes in schedule and for testing other gears that are less sensitive to season or species that are only available in a certain month. Throughout the project, the research team has been in close contact (on a weekly and sometimes on daily basis) with both the focus group of fishers involved and with fishers outside of the project. In that way, researchers could decide whether the planning would still match with peak seasons for particular species or if planning had to be adjusted. From communication with the fisheries sector, commercial fleet and from experiences in the field, it became clear that the 2023 season was abnormal compared to other years in terms of peak seasons of the target species. The season started at least 3 to 4 weeks later than it normally does, making the initial timeline for these field experiments suboptimal.

Figure 2.2.1 – Schedule of field activities in Borssele offshore wind farm 2023.

2.3 Procedures

2.3.1 Roles and responsibilities

Previous to the field experiments, an action plan together with a Risk Assessment Method Statement (RAMS) was delivered and agreed upon with the Ministry of Agriculture, Nature and Food Quality, Directorate-General for Public Works and Water Management (Rijkswaterstaat), the wind farm operator Ørsted and the researchers involved. This document describes all the procedures in case of emergency, contains a risk assessment and mitigation measures, describes the roles and responsibilities of personnel involved including their contact information and holds detailed information about the field experiments such as the names and numbers of the vessels involved, data collection and procedures in the field, characteristics of the fishing gears and test locations with their coordinates within the offshore wind farm. Also, previously to the field experiments, field protocols for each of the experiments / fishing techniques were delivered and aligned with the skippers and crew and also shared with the ministry and Rijkswaterstaat. Previous to the field trips, safety measures and protocols were explained to participating crew.

On each day of operation, a crew of 3 to 6 participated in the research activities in the field, consisting of:

- The skipper, in charge of manoeuvring the vessel, controlling safety and good practices onboard according to the Risk Assessment Method Statement.
- The deck crew assisting the skipper in dedicated tasks.
- The lead scientist or project leader in charge of scientific part of the expedition.
- The scientist crew doing the measurements of animals caught and registration of birds and sea mammals during hauling and deploying the gear.

In the case of 3 crew members present (for example when handline fishing), the lead scientist is also in charge of the measurements and registrations. Furthermore, a Designated Person Ashore (DPA) was informed about the field tests and acted as an extra safety measure in case of emergency.

2.4 Fishing techniques

2.4.1 Handline fishing

For this experiment a small vessel (chapter 2.4 for vessel details) was used with the crew on board fishing with handlines (rod and reel) to mainly target seabass (*Dicentrarchus labrax*) and mackerel (*Scomber scombrus*) (Figure 2.4.1). In this fishery, a line with a weighted jig or hook is sent to the bottom and baits used were artificial (lures) or natural (baitfish, pieces of fish, worms). When having a fish on the line, the line is reeled in from the boat again. This fishery can be carried out both while drifting as well as anchored on the bottom using an anchor. In this experiment, both types of fishing (drifting and anchored) were performed. Fishing while drifting was done the first two days, fishing while anchored to the bottom was done in the last two days. Anchoring was done near a wreckage present inside the offshore wind farm, taking into account 100 meters from the wreckage to prevent possible damage to the wreck by the anchor. For anchoring, Bruce anchors of 15 kgs were used. Figure 2.1.1 shows no designated areas for this technique as this technique of fishing needed a flexible approach, depending on weather circumstances and tides, but taking into account ongoing traffic, deployed objects, other fishing gears present, or other ongoing experiments. For this experiment the space between maintenance zones for both Borssele I and II (Figure 2.4.5) was used. A total of 10 fishing days were foreseen; 4 trips have been undertaken, due to unsuitable weather circumstances.

Figure 2.4.1 – Handline fishing in Borssele offshore wind farm. Photo: WMR

2.4.2 Gill nets

For this experiment, 4 gill nets were deployed from one vessel (chapter 2.5 for vessel details; Figure 2.4.2 for a photo of gill net activities). Target species of this fishery is mainly sole (*Solea solea*). Each gill net has a total length of 550 meters, from anchor to anchor. Anchoring was done according to previous experiments and was therefore suitable to use within offshore wind farms, minimizing the risk of touching cables (Rozemeijer 2021 & 2022b). The ropes from the anchors to the net were 25m on each side, leaving a total gill net length of 500 meters per net. Other vessels could cross the area where the nets are located as the nets had a height of maximum 0.5 meters from the seafloor. Figure 2.1.1 shows the positions for the possible locations of these nets within Borssele II offshore wind farm. With the distribution over depth information about areas with a lot of currents (the sandbank ridge) and little current (the valleys) were obtained and therefore catch can be compared over the two sediment types and depths. Before each trip, in consultation with lead scientist and skipper, it was decided which of the locations shown in Figure 2.1.1 would be used to actually deploy the nets, taking into account weather circumstances and tides. A total of 14 trips were foreseen. This means total number of fishing days were less, as nets have to be deployed (1 day trip), left to fish (overnight) and be picked up the next day (1 day trip). 5 days have been undertaken from which the researchers obtained biological data from 3 days (trips) mainly due to unsuitable weather circumstances.

Net specifications:

- Yellow front buoy (pick-up buoy)
- Line: 3 m rope
- North dahn (one flag)
- Line: 6 m rope
- A1 Buoy
- Buoy line 105 m (3* water depth); first 10 meters with lead line, forcing sinking.
- Bruce Anchor 15 kg;
- Line: 25 m line;
- 10 x 50m net sections, 50cm high with a 90mm mesh size
- Line: 25 m line;
- Bruce Anchor 15 kg;
- Buoy line 105 m (3* water depth); first 10 meters with lead line, forcing sinking.
- A1 Buoy
- Line: 6 m rope
- South dahn (two flags)
- Yellow front buoy (pick-up buoy)

Total length 550m.

Figure 2.4.2 – Gillnet fishing in Borssele offshore wind farm. Photo: WMR

2.4.3 Multi-species pots

For this experiment three different pot types were used: cuttlefish pots, fish pots and sole pots (Figure 2.4.3). These pots were combined in one string. Nine multi-species pot strings were (re)deployed per trip, from one vessel (chapter 2.5 for vessel details): 4 shallow strings (about 12 m) and 5 deep strings (between 30 and 35 m). The strings will each have a maximum length 210 meters from anchor to anchor. Anchoring was done according to previous experiments and was therefore suitable to use within offshore wind farms, minimizing the risk of touching cables (Rozemeijer et al. 2021 & 2022b). Per string, 5 pots were attached with a distance of 40 meters apart, making each string from first to last pot 160m long. The order of the different pot types was always the same: sole pot – cuttlefish pot with fluorescent netting – fish pot – cuttlefish pot with non-fluorescent netting – sole pot. Other vessels could cross the area where the strings were located as the pots had a height of maximum 0.5 meters from the seafloor. Figure 2.1.1 shows the positions for the locations of these strings within Borssele II offshore wind farm. The black lines are strings from previous experiments that were used in this experiment. The pink lines are new locations compared to previous years that were not used in this experiment, but were seen as extra / back-up locations. With the distribution over depth, information about areas with a lot of currents (the sandbank ridge) and little current (the valleys) was obtained and therefore catch can be compared over the two sediment types and depths. Before each trip, in consultation with lead scientist and skipper, it was decided which of the locations shown in Figure 2.1.1 were going to be used to actually deploy the strings, taking into account weather circumstances and tides. A total of 16 trips were foreseen; 17 trips have been undertaken. The additional trip was made to haul 3 strings, of which dahns became loose in a storm, from the seabed (see also Chapter 3 and Appendix 1). Strings did remain in the field during the course of the experiments and were redeployed directly after emptying the pots. Days in between deploying and hauling (soaking time) varied from 2 to 34 days, due to weather circumstances.

String specifications:

- Yellow front buoy (pick-up buoy)
- Line: 3 m rope
- North dahn (one flag)
- Line: 6 m rope
- A1 Buoy
- Buoy line 105 m (3* water depth); first 10 meters with lead line, forcing sinking.
- Bruce Anchor 15 kg;
- Line: 25 m line;
- 5 pots 40 m apart;

- Line: 25 m line;
- Bruce Anchor 15 kg;
- Buoy line 105 m (3* water depth); first 10 meters with lead line, forcing sinking.
- A1 Buoy
- Line: 6 m rope
- South dahn (two flags)
- Yellow front buoy (pick-up buoy)

Total length 210m.

Figure 2.4.3 – Pot fishing in Borssele offshore wind farm. Photo: WMR

2.4.4 (Mechanical) jigging

For this experiment 4-5 jigging machines (Figure 2.4.4) were used on the vessel (chapter 2.5 for vessel details) to fish for mackerel, horse mackerel or flying squid. With this technique, lines with many hooks are send to the bottom and are immediately reeled in again when fishing for flying squid, or make movements up and down in the case of (horse) mackerel. This movement imitates a school of small baitfish or prey that attracts the fish. Figure 2.1.1 shows no designated areas for this technique as this technique of fishing needed a flexible approach, depending on weather circumstances and tides, but taking into account ongoing traffic, objects such as buoys and wind turbines (including their maintenance zones), other fishing gears present, or other ongoing experiments. For this experiment the space between maintenance zones for both Borssele I and II (Figure 2.4.5) was used. A total of 10 fishing days / trips were foreseen; all 10 days have been undertaken.

Figure 2.4.4 – Jig fishing in Borssele offshore wind farm. Photo: WMR

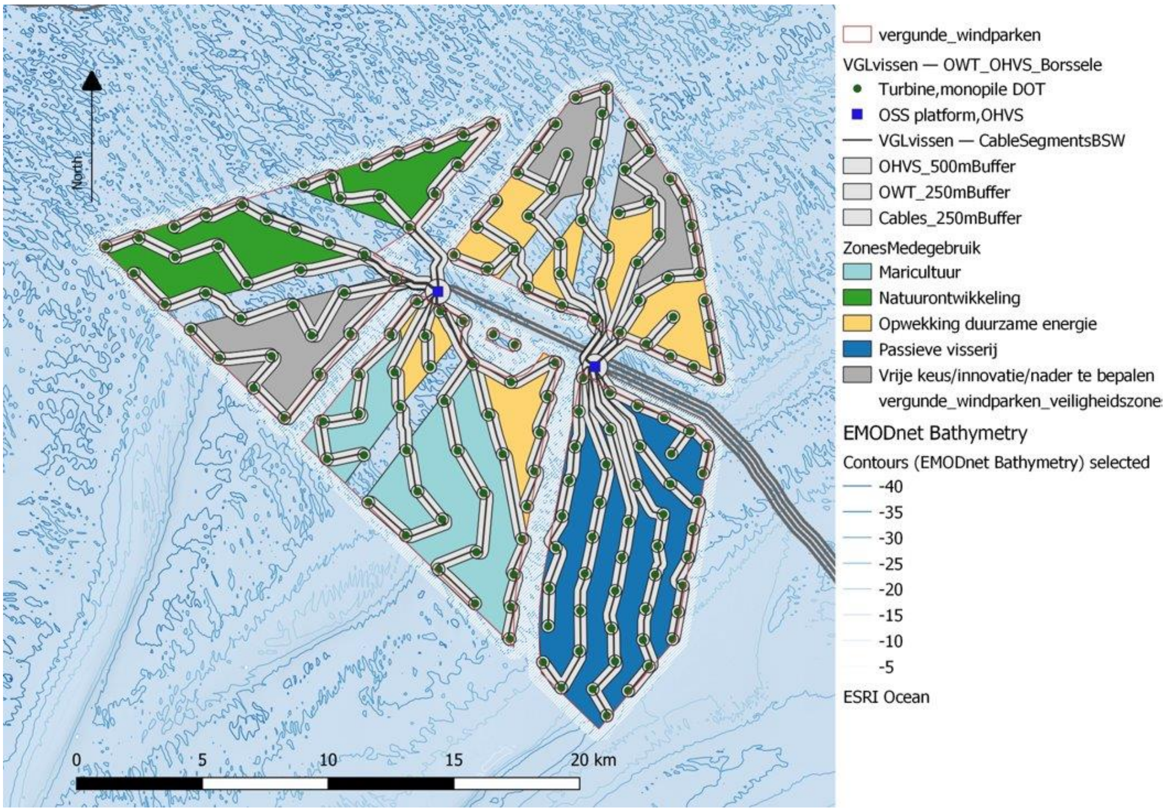


Figure 2.4.5 - Locations of Borssele I and II offshore wind farm. For the gill net and multi-species pot experiments plot II (blue area) was used. For handline and jigging experiments both plot I (grey area in the North) and II (blue area in the South) were used except for the fishery free zone, as indicated in Figure 2.1.1.

2.5 Fishing vessels

This section describes the vessels used for the experiments. All vessels comply with regulations for fishing vessels, additional regulations for fishing in Borssele wind farm zone and additional regulations for the experiments. These regulations include:

- The captain and vessel are in the possession of a fishing permit for the applied passive fishing methods.
- The maximum length over all (Loa) of the vessels is 45m
- Vessels up to 24m comply with the *Vissersvaartuigenbesluit 1989*, where applicable;
- Vessels above 24m comply with the *Vissersvaartuigenbesluit 2002*. These vessels possess a *Certificaat van deugdelijkheid*;
- The vessels have an active Automatic Identification System (AIS);
- The vessels have a VHF radio, standby at VHF16
- The vessels have an insurance for fishing in the wind farm with a minimum coverage of 500 million euros.
- Access to the wind farm is only admitted during daytime.

2.5.1 KG7 'Flying Dutchman'

The field experiments for handline fishing were done onboard KG7 'Flying Dutchman', small fishing vessel (6.50 m, Figure 2.5.1). The crew consisted of 3 persons: 1 scientific personnel (biologist or research assistant) and 2 crew members (including skipper).

The main port of departure for the experiments was Roompot Marina in the village of Kamperland, with a distance of 24 miles to the wind farm.

Operational limits of the vessel for the undertaken passive fishing activities in the Borssele II wind farm are:

- Maximum sea state (Beaufort): depending on the environmental direction[2].
- Maximum significant wave height (Hs_max) = 0.6-0.8m, depending on the wave period (Tp).

Figure 2.5.1 - KG7 'Flying Dutchman' with MMSI number 244615352. This vessel was used for handline fishing

[2] Environmental direction of wind means the direction the wind comes from

2.5.2 YE152 'Meru'

The field experiments for both gill net fishing and multi-species pots fishing were done onboard YE152 'Meru' with MMSI number 244727000, a small fishing vessel (9.95 m, Figure 2.5.2). The crew consisted of 3 to 4 persons: 1 or 2 scientific personnel (1 biologist and research assistant) and 2 crew members (including skipper).

The main port of departure for the experiments was Neeltje Jans, with a distance of 23 miles to the wind farm.

Operational limits of the vessel for the undertaken passive fishing activities in the Borssele II wind farm are:

- Maximum sea state (Beaufort): depending on the environmental direction.
- Forecasted maximum significant wave height (Hs_max) = 0.8-0.9m, depending on the wave period (Tp).
- Maximum significant wave height (Hs_max) = 1.0m, depending on the wave period (Tp).

Figure 2.5.2 - YE152 'Meru' (formerly SCH 87) with MMSI number 244727000. Equipment on the lower (stern) deck was adjusted to equipment specific for the type of fishing: gill nets or pots. This vessel was used for multi-species pots and gill net fishing.

2.5.3 MDV2 'Metanoia'

The field experiments for jigging were done onboard MDV2 'Metanoia' with MMSI number 244373000, a large fishing vessel (30.15 m, Figure 2.5.3). The crew consisted of 5 to 9 persons: 1 or 2 scientific personnel (1 biologist and 1 research assistant) and 5 to 7 crew members (including skipper).

The main port of departure for the experiments was Vlissingen, with a distance of 25 miles to the wind farm.

Operational limits of the vessel for the undertaken passive fishing activities in the Borssele II wind farm are:

- Maximum sea state (Beaufort): depending on the environmental direction.
- Maximum significant wave height (Hs_max) = 1.5m, for this project, depending on the wave period (Tp).

Figure 2.5.3 - MDV2 'Metanoia' with MMSI number 244373000. This vessel was used for jigging.

sea state.

3 Safety & operational results

3.1 Operational

3.1.1 Observations

A total of 35 field trips have been undertaken. Most field trips were undertaken as foreseen in the action plan and did not require additional communication with Rijkswaterstaat, the coast guard or the WFO. General operational observations of the field trips are listed below. During some of the field experiments unanticipated events did take place. These are described in Appendix 1.

- Prior to the start of the experiments a total of 8 phone calls for each trip were foreseen: calls to both the coast guard and wind farm operator at 4 moments during the trip: departure from port, arrival at wind farm, departure from wind farm and arrival at port. Notification of activities within the safety zone at the coast guard is mandatory for SAR operations in case of calamities. Notification to the WFO is not mandatory, but the WFO would like to be informed about activities within the wind farm and facilitates to pass these activities through to the coast guard. These phone calls were experienced as considerable administrative load by the fishers. During the first days of the experiments of this project the coast guard and wind farm operator indicated to reduce the number of calls: calls to the coast guard are not necessary, since they receive a list with vessels that will undertake activities in the wind farm through the wind farm operator; only calls to the wind farm operator upon arrival at and departure from the wind farm were required. The reduced number of 2 phone calls is workable for the fishers participating in the experiments.
- The indicative wave limit to sail out with small vessels (Lpp<12m), such as the YE152 and KG7, is Hs=<0.8-0.9m. The exact limit depends on the vessel, wind, wave period, rain fall, visibility, temperature and experience of the captain and crew. The indicative wave limit of ~1m restricts the possibilities to sail out, even in summer. Furthermore, the operability is reduced by the tide. Only on mornings without current or current from the stern sailing out is practiced. Sailing out with opposite current is not preferred, since this increases fuel consumption and increases sailing time.
- Sailing time from coast to wind farm and vice versa with a small vessel (Lpp<12m) takes approximately 3 hours, resulting in a total of 6 hours sailing time per workday. The time required to empty and replace pot strings in the wind park is approximately 3/4 hours, resulting in approximately 7 hours to replace all 9 strings. Together sailing time and working time in the wind park result in 13 hour working days. Increasing the number of strings would result in even longer working days.
- Specific unanticipated events, which have required additional communication with Rijkswaterstaat and the wind farm operator, are described in Appendix 1.

3.1.2 Sailing trajectories

The figures 3.1.1 t/m 3.1.5 reflect the sailed tracks of the fishing vessels MDV2, YE152 and KG7 in the months of April until August within wind farm Borssele. These tracks have been created using AIS data from the respective vessels and provide a geographical image of the operational activities during the experiments. Sailing tracks during the months September and October were not yet plotted at the time of writing, but will show similar patterns.

The images are high-level and do not provide much detail yet. Enhancement of the graphics will give more detail regarding the positioning of the vessels related to the safety and maintenance zones of the wind farm and the individual turbines. Such images will be produced for the final report. The vessel tracks are limited to the activities within the wind farm as arrival and departure courses are not relevant to this report.

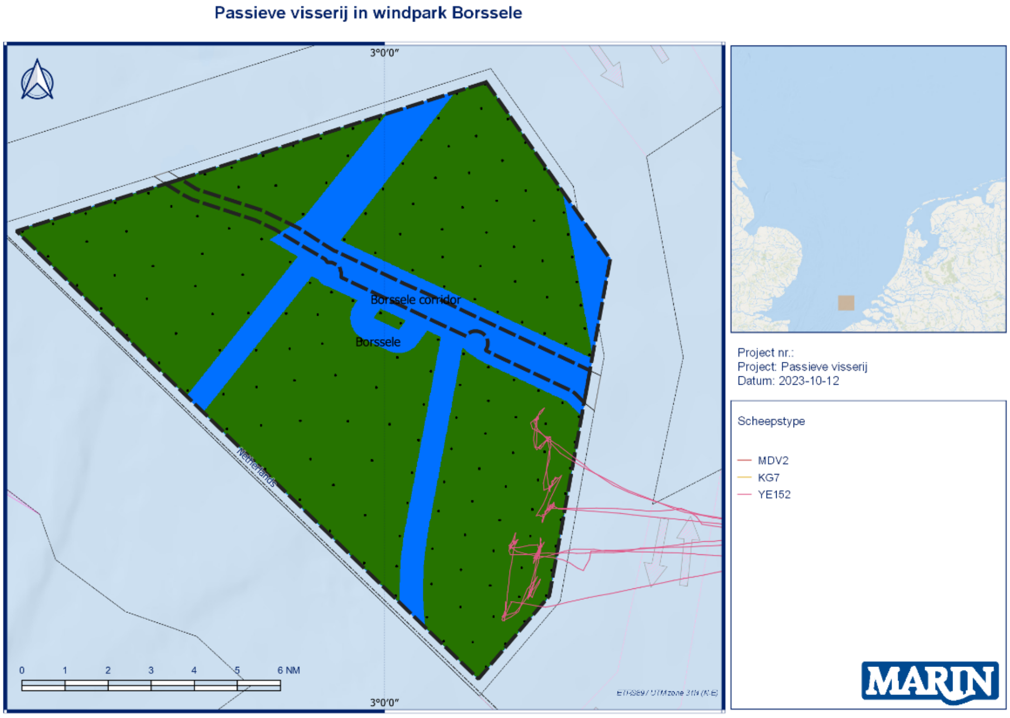


Figure 3.1.1 - Activities in April 2023.

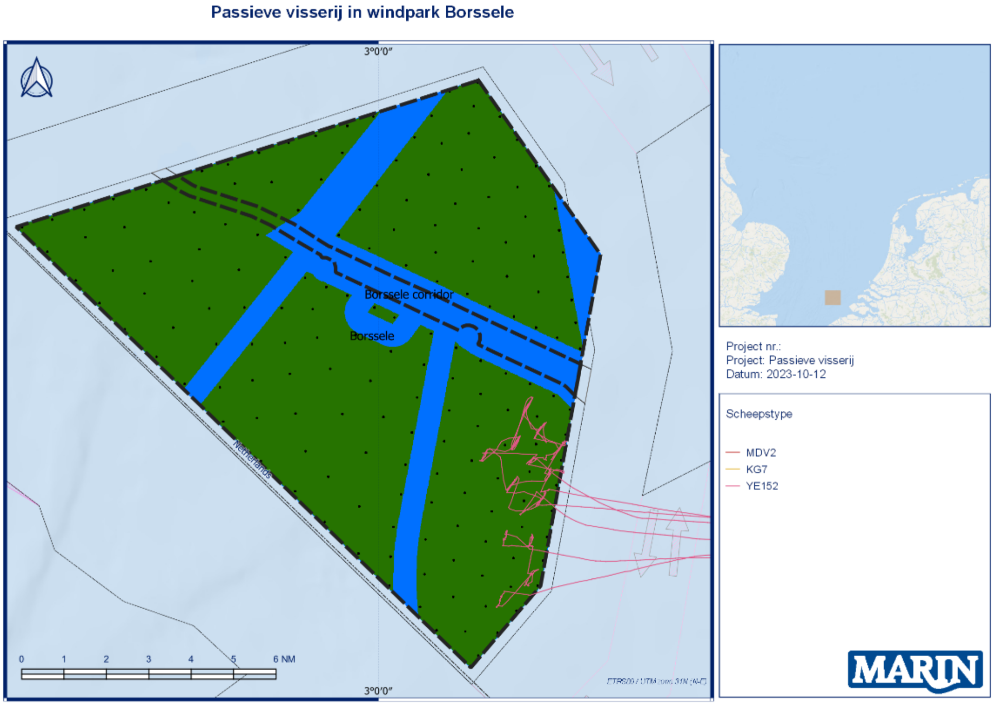


Figure 3.1.2 - Activities in May 2023.

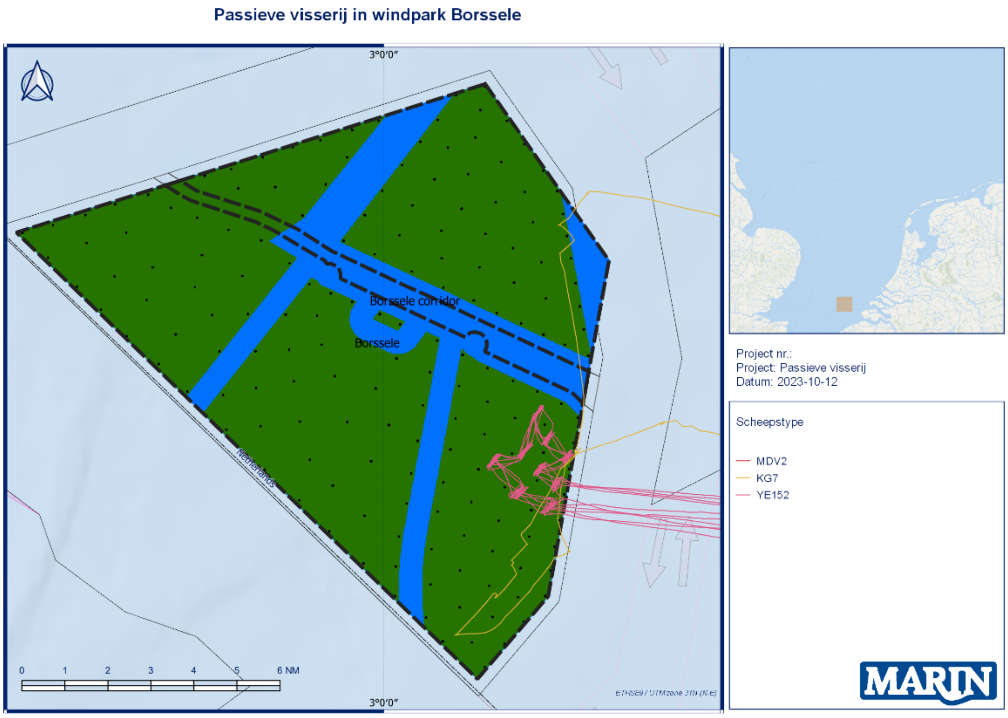


Figure 3.1.3 - Activities in June 2023.

Figure 3.1.4 - Activities in July 2023.

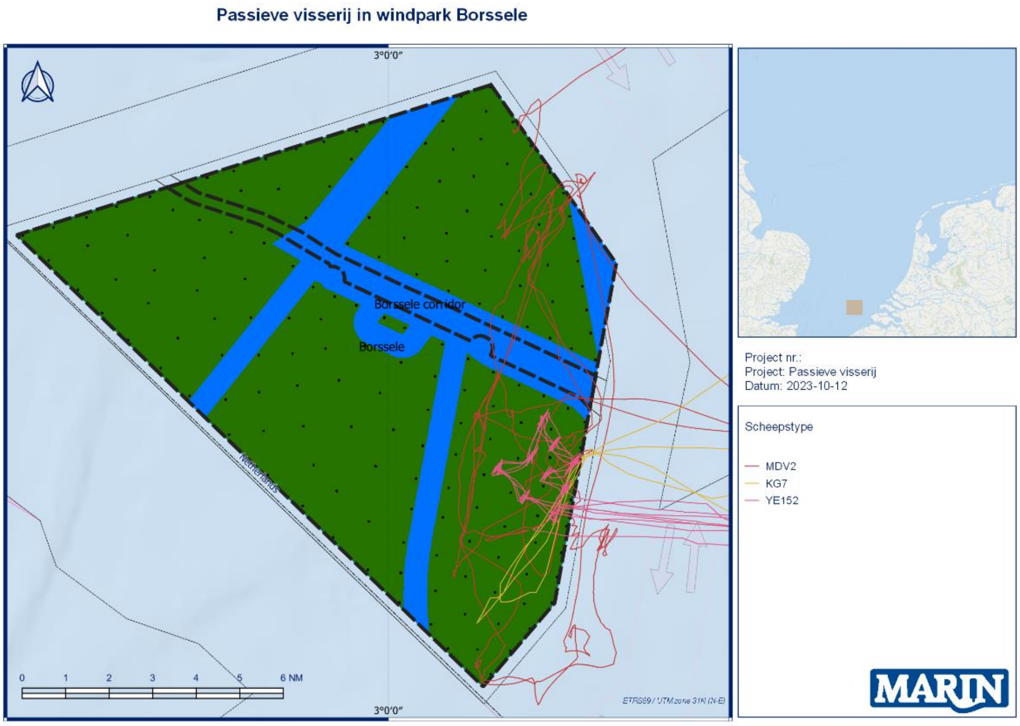


Figure 3.1.5 - Activities in August 2023.

3.2 Weather conditions

The possibility to operate safely within the wind farm, hence the feasibility of passive fishing within the wind farm from an operational point of view, does depend on vessel, captain and weather.

The present section addresses the weather conditions in Borssele II. For operations and go/ no-go decision the wave conditions are the most relevant parameter, followed the wind velocity and direction, tide and visibility. Since the wave condition is the dominant factor in the operability of the vessel, the focus of the present section is on wave conditions.

Wave conditions are obtained from the following sources (see also Appendix 2):

- “Observed” wave conditions are the conditions reported in the field reports. These are based on the weather “forecast” and personal observations of the captain within the wind farm.
- “Forecast” wave conditions are obtained prior to the voyages from available weather prediction reports, such as StormGeo and Windfinder. These sources predict the weather conditions few days ahead, based on which the decision is taken to sail out or not. The forecast wave conditions as listed on the daily field reports are adopted.
- “Measured” wave conditions in Borssele during the period of the experiments (2023) are obtained from waterinfo.rws.nl. This source provides the measured local weather conditions at station Borssele Alpha (Platform).
- “Hindcast” weather conditions are long term statistical conditions from prediction models. These weather conditions are available in the tender packages of the wind farms: for Borssele in RVO/ Deltares (2015), for HKZ in HKWFZ (2017), for HKN in HK(N)WFZ (2019), and for HKW in HK(W)WFZ (2020). The hindcast data is applied for comparison with the measured wave conditions in Borssele in 2023 and for a comparison of the wave conditions amongst wind parks Borssele, HKZ, HKN and HKW.

3.2.1 Significant wave height

A comparison of the observed and measured wave height on the days of the experiments is given in Figure 3.2.1 and Figure 3.2.2. From the wave measurements the average and maximum wave heights measured during daytime, between 6 am and 6pm, is derived.

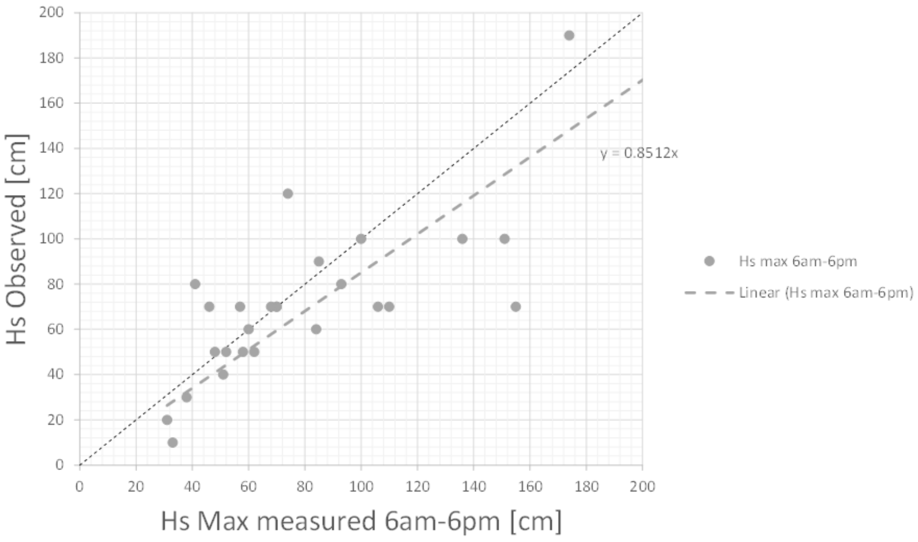


Figure 3.2.1 - Observed wave height versus measured maximum wave height during daytime on sailing days.

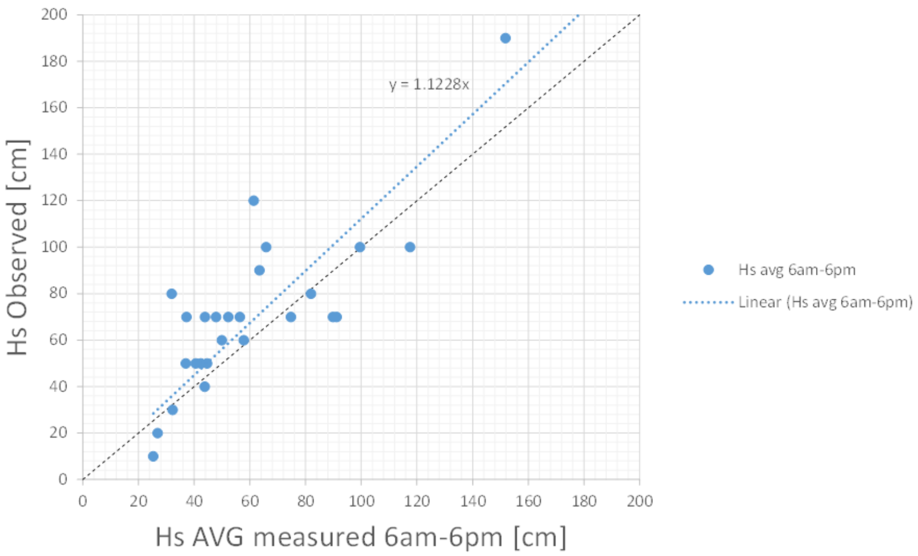


Figure 3.2.2 - Observed wave height versus measured average wave height during daytime on sailing days.

The figures show that the observed wave heights are in general in-line with the measured wave heights by the Borssele Alpha Platform. The observed wave heights are in general +10% higher than the average measured wave heights and -10% lower than the maximum measured wave heights. This is a validation of the measured wave heights by the observed wave heights and justifies the use measured wave heights.

3.2.2 Operability

The decision whether to sail out or not is taken per trip by the skipper and depends on weather conditions, including: wind force, wave height, wave period (short wind waves or longer swell waves), precipitation, visibility, temperature and experience. The wave height plays the dominant role in the decision, as it directly affects the movements of the vessel and the ability to work safely on board.

The significant wave height (Hm0) measured at Borssele Alpha Platform is shown in the figure below (3.2.3). The days on which experiments are conducted are visualized in this figure as well.

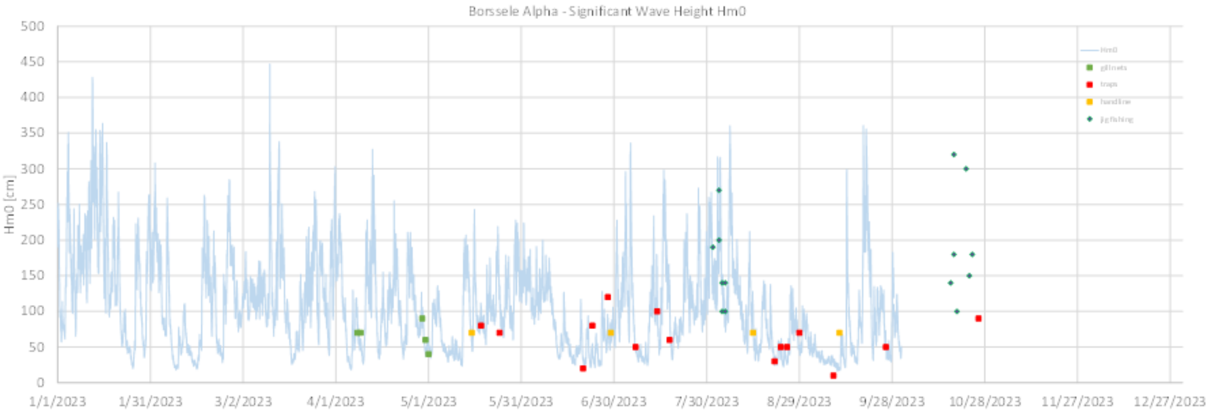


Figure 3.2.3 - Significant wave height Borssele 2023 (measured).

Indicative operational limits are:

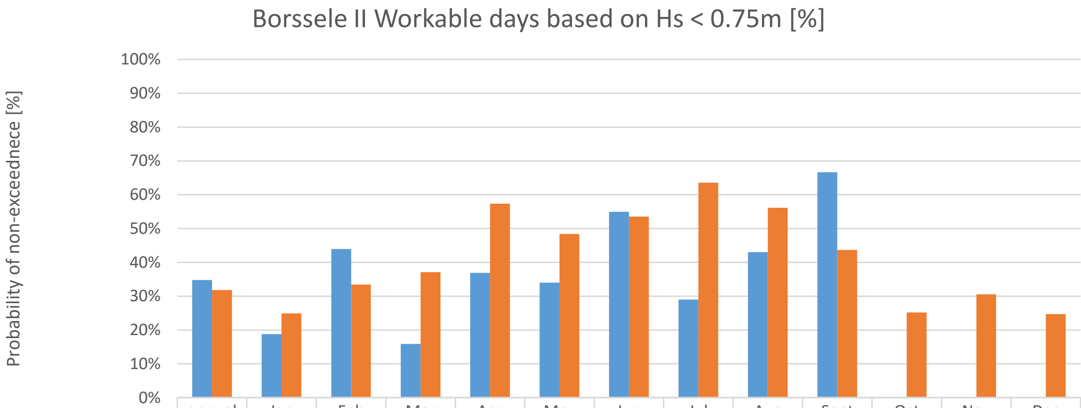
- Small vessels (Lpp=<12m), such as the YE152 Hs=<1m
- Medium sized vessels (Lpp=<~30m), such as MDV2 Hs=<1.5m in southern North Sea (short waves)

Indicative limits for decision making whether to sail out or not:

- Small vessels (Lpp=<12m): KG7 Hs<0.8m, YE152 Hs=<0.9m, WE152 Hs=<1m
- Medium sized vessels (Lpp=<~30m), such as MDV2 Hs=<1.5m in southern North Sea (short waves)

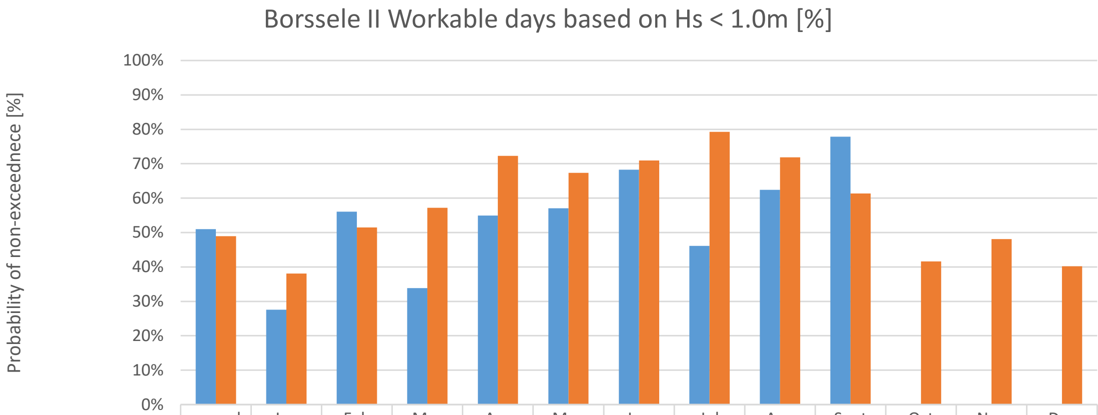
The limits mentioned above are indicative values, in accordance with the experiments. The decision whether to set sail out or not is weighed and taken per trip by the skipper and also depends on wave period, precipitation, visibility, temperature and experience.

Operational limits of Hs=<0.75m, 1.0m and 1.5m are applied to determine the workable days (in %) in Borssele during the experiments of 2023 (measured weather data) and on average (Borssele hindcast data, RVO/ Deltares (2015)). The results of this evaluation are shown in the figures 3.2.4 to 3.2.6 below on an annual and monthly basis. Comparison between the workable days of 2023 with the long-term statistics shows considerably less workable days during the spring and summer period (March till August) in 2023. This is in-line with the experience of the captain and project team that 2023 had less workable days due to bad weather compared to other years.



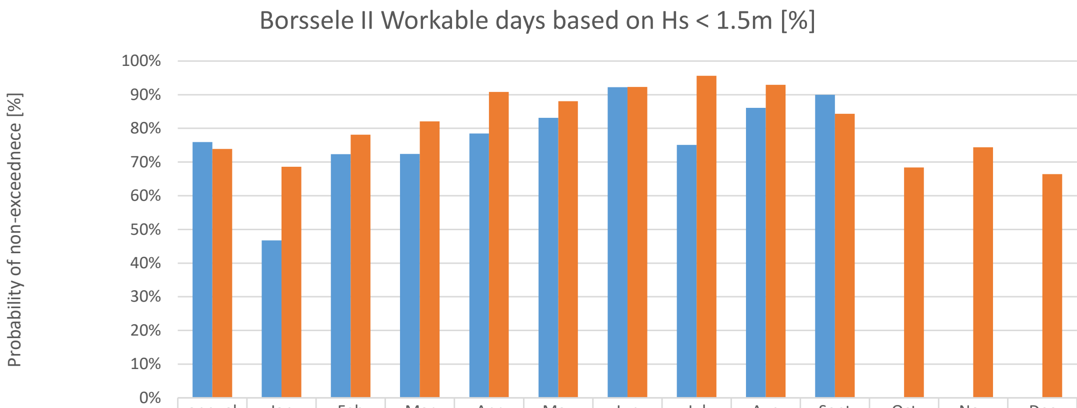
	annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Borssele 2023	35%	19%	44%	16%	37%	34%	55%	29%	43%	67%	0%	0%	0%
Borssele II Hindcast	32%	25%	33%	37%	57%	48%	54%	64%	56%	44%	25%	31%	25%

Figure 3.2.4 - Workable days based on wave height criteria Hs<0.75m in Borssele 2023 (blue) and average (blue).



	annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Borssele 2023	51%	28%	56%	34%	55%	57%	68%	46%	62%	78%	0%	0%	0%
Borssele II Hindcast	49%	38%	52%	57%	72%	67%	71%	79%	72%	61%	42%	48%	40%

Figure 3.2.5 - Workable days based on wave height criteria Hs<1.0m in Borssele 2023 (blue) and average (blue).



	annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Borssele 2023	76%	47%	72%	72%	78%	83%	92%	75%	86%	90%	0%	0%	0%
Borssele II Hindcast	74%	69%	78%	82%	91%	88%	92%	96%	93%	84%	68%	74%	66%

Figure 3.2.6 - Workable days based on wave height criteria Hs<1.5m in Borssele 2023 (blue) and average (blue).

Note the decision to sail out is made in the days prior to the fishing trip based on the weather forecast. Since the forecast is approximately +10% higher than the average measured wave height, the operational limit are even lower than the limits reported above based on the measured and hindcast weather data. A forecast wave height of 0.9m, on the basis of which a decision is made to sail, in reality results in an average wave height of 0.8m.

Furthermore, the operability is reduced by the tide. During the experiments in Borssele II in 2023 the decision to sail out was based on the wave conditions, regardless of the tide. This resulted in sailing time reduction from nominal 3 hours to approximately 2.5 hours when sailing with the side and increased sailing time to approximately 4 hours when sailing against the tide. The restriction to only be allowed to access the wind farm during daytime hampers the flexibility to select the ideal sailing times. For commercial fishing operations sailing against the tide is unfavorable because of higher fuel consumption and more working hours. Likely one only would like to sail out on mornings without current or current from the stern.

3.2.3 Distance to port and sailing time

The vessels participating in the experiments sail approximately 7 knots, resulting in approximately 3 hours of sailing time for a single trip from their main port to Borssele II. The exact sailing times can be approximately –0.5 hour less or +1 hour more due to tide and applied sailing speed.

3.3 Net and pot string positions

The positioning of the nets is described in this section. The measured positions of the nets allow to derive displacement of the nets. The displacement of the nets can be used as input for risk evaluations.

The onboard GPS location is registered at the moments of setting and hauling of the first and second anchor of each string. These positions are registered in the daily field reports.

First, from the distance between the first and second anchor at the moment of setting the length of the net or pot-string is derived (different anchors, same time). The deviation of the derived length from the actual length of the gear is a measure for the uncertainty of the anchor position registrations.
The uncertainty includes: GPS registration uncertainty, differences in the vessel position and the actual position of the anchor on the seabed, registration errors, analysis errors. Initial values are given in the present field report, these will be worked out in more detail in the end report.

Next, from the distance between the same anchor at the moment of setting and hauling (same anchor, different time) the offset of the nets during time can be derived. This can be correlated to the intermediate weather conditions to determine the effect of weather on offset. This evaluation will be worked out and reported in the end report.

For the uncertainty analysis of the anchor positions the registrations of the first 14 pot-string field trips are used, performed between May till end of August. In principle 126 anchor registrations (14 trips x 9 strings) are available for the analysis (Figure 3.3.1). These registrations are analysed as follows:

- The GPS registrations in degrees-minutes-seconds are converted to degrees.decimal.
- The distance between the first and second anchor is calculated. The actual line length between the two anchors is 210m. Calculated distances below 25m and above 1000m are rejected, based on the consideration of errors in the registrations.
- The bearing ie. earth fixed orientation, is calculated. The nets are positioned with the tide in the direction 30° N or 210° S. Calculated bearing beyond +/- 45° from this orientation are rejected, based on the consideration of errors in the registrations.

These quality checks leave 89 registrations for further analysis. The calculated distances between the first and second anchor and the bearing is presented in the tables below for the considered 14 pot-trips and all 9 strings (A to I).

Table 3.3.1 - Distance (m) between first and second anchor of each pot string calculated based on GPS registrations. Colours indicate colour scale: low=green, high=red.

	String								
Trip	A	B	C	D	E	F	G	H	I
1	498	945	468	629		394	331	578	520
2	486	417	443	669	490	369		638	475
3	554	426	455	621	446	432	392		459
4									
5	503	627	426	469	499	471	437	618	481
6	455	457	444	628	491			637	404
7	507	424	538	657	510	358	398		479
8	486	426	402	628	511	468	246	564	
9	432	384	482	618	733		455		474
10	479	420	455	478		270	373	483	316
11	150	482	455	660	628	495	461	636	
12	390	414	388	714	371	486	430		
13	434	408	439		357			625	
14	473	392	436	474	499	511	443	650	

Table 3.3.2 - Bearing (°) of each pot string calculated based on GPS registrations. Colours indicate colour scale: low=green, high=red.

	String								
Trip	A	B	C	D	E	F	G	H	I
1	210		210		0	234	206		212
2	210	217	208		214	50			223
3	29	30	34		31	230	204		17
4									
5	218		208	208	213	224	213		214
6		209	210		219	248	189		35
7	36	37	38		11	22	27	179	38
8	215	216	204		221	219	205		
9	204	214	37		196	7	34	349	33
10	211	206	208	211	181	215	211	212	32
11	226	212	212		229	222	208		
12	33	219	32		228	219	214		
13	31	27	34		26		0		
14	199	204	209	204	42	41	40		43

The derived results in the tables above show:

- Trip 4 has erroneous GPS registrations, which are rejected.
- The bearing of strings D and H is outside the expected range for most trips and therefore rejected. Furthermore, these stings show a consistent overestimate of the length, ranging from 500 till 700m. It is interesting to see that these unexpected registrations for these strings occur consistently during all trips. All registrations of strings D and H are rejected.

This quality checks leaves 72 registrations for further analysis. The calculated string lengths are presented in the distribution plot below (Figure 3.3.1). It is interesting to see the calculated strings lengths are distributed around 475m, while the actual string length is 210m.

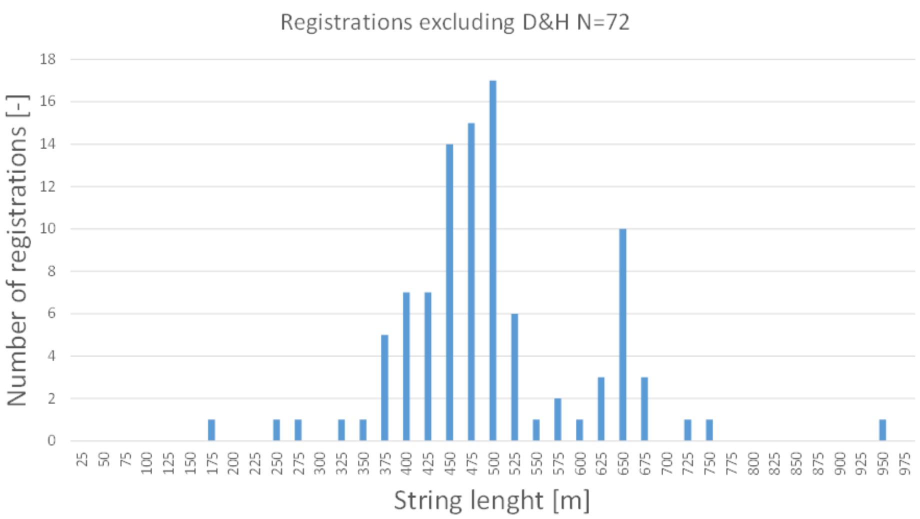


Figure 3.3.1 - Calculated string lengths between first and second anchor during setting excluding D & H.

In the final report of this study, the uncertainty of the anchor positions will be derived from these registrations and registrations of additional trips. Next the offset of the strings over time will be determined taking the uncertainty of the anchor positions into account.

3.4 Comparison with other near future wind parks

To judge the potential of passive fishing in other near future wind farms environmental conditions of Hollandse Kust Zuid (HKZ), Hollandse Kust Noord (HKN) and Hollandse Kust West (HKW) were compared to Borssele.

3.4.1 Environmental conditions and operability

Statistical hindcast environmental conditions are obtained from metocean reports RVO/Deltares (2015), HKWFZ (2017), HK(N)WFZ (2019), HK(W)WFZ (2020). Wind, wave and current rose plots copied from these reports are presented in Appendix 2. These figures show the annual frequency of occurrence of direction and amplitude. Note since these figures are copied from different metocean reports layout, scales and colormaps vary. The results presented in these figures show:

- The dominant wind direction is southwest for all four locations. In Borssele the southwest wind direction is somewhat more dominant than the HKWFZs. The most severe wind conditions come from southwest and north(north)west.
- The dominant wave directions are southwest and northwest to north for all four locations. These are also the directions of the most severe wave conditions. There is a clear strong correlation between wind speeds and wave amplitudes.
- Current direction and amplitude is similar for all four locations. The current direction follows the coast from southwest to northeast. Current velocities in general range up to 0.7 m/s (1.5 knots).

The occurrence of severe (storm) and mild (operational) conditions is hard to see from these rose plots. Therefore, the distribution of wave conditions is further addressed with focus on the operational conditions (Hs ≤ 1.5m) since these are the conditions relevant for passive fishing.

Distributions functions of the annual probability of wave height (Hm0) exceedance are derived from the four metocean reports and the Borssele 2023 measured data. These distribution functions are presented in the figure below. Note the Borssele 2023 measured data at the time of writing only ranges from 1-1-2023 till 30-09-2023, this affects the annual statistics. Workable days, below a certain operational limit, correspond to the probability of non-exceedance. The probability of non-exceedance = 100% – probability of exceedance. For example, where the figure below shows a probability of exceedance of Hs ≥ 1.5m of 25% for Borssele, this means that there are 75% days with Hs ≤ 1.5m annually in Borssele. The results presented in the figures below show:

- Annual probability of exceedance of Hs ≥ 1m in Borssele is 47%. This indicates 53% annual working days (Hs ≤ 1m).
- Annual probability of exceedance of the Hs ≥ 1m in HKZ is 51%. This indicates 49% annual working days (Hs ≤ 1m).
- Annual probability of exceedance of the Hs ≥ 1m in HKN is 55%. This indicates 45% annual working days (Hs ≤ 1m).
- Annual probability of exceedance of the Hs ≥ 1m in HKW is 60%. This indicates 40% annual working days (Hs ≤ 1m).
- The wave conditions in HKZ, HKN and HKW are more severe than in Borssele.

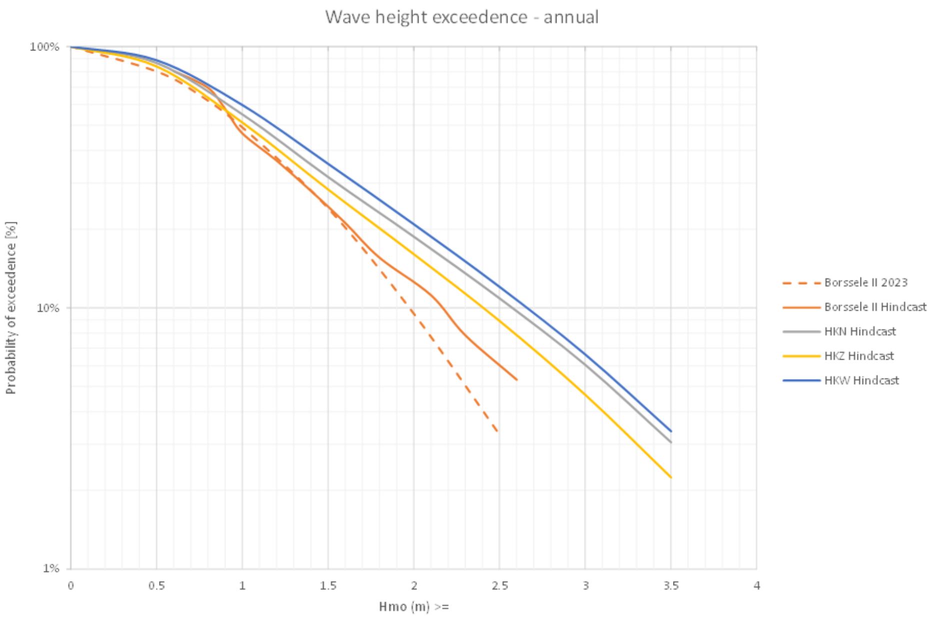
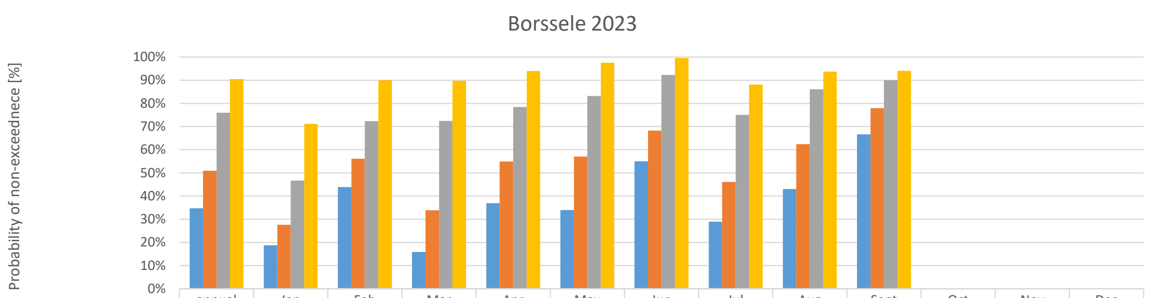


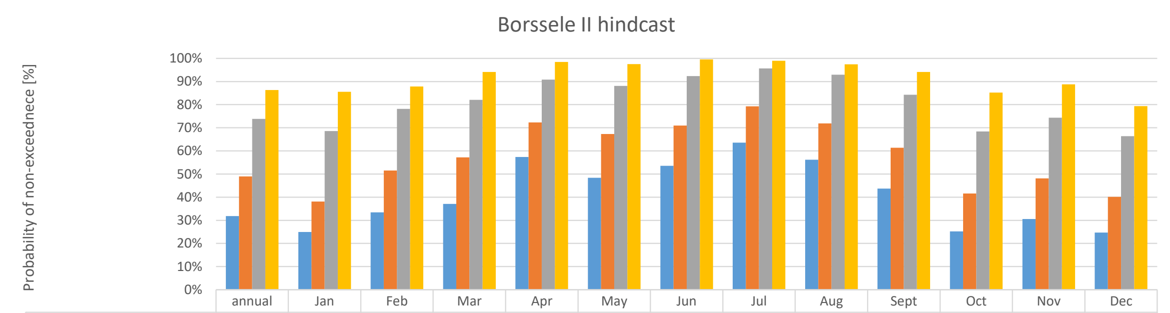
Figure 3.4.1 - Annual probability of wave height exceedance

The distributions shown in Figure 3.4.1 show the annual distribution. The monthly workable days i.e.. probability of non-exceedance in Borssele is further detailed from the 2023 observations and from the metocean report. Figure 3.4.2 and Figure 3.4.3 shown the workable days for various operational limits: Hs up to 0.5, 1.0, 1.5 and 2.0m. The figures show operability up to 100% in summer for an operable limit of Hs≤2.0m. Based on the long-term statistics the operability for a limit of Hs≤1.0m is approximately 40% in winter and up to 80% in July.



	annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Borssele 2023 Hs<0.75m	35%	19%	44%	16%	37%	34%	55%	29%	43%	67%	0%	0%	0%
Borssele 2023 Hs<1m	51%	28%	56%	34%	55%	57%	68%	46%	62%	78%	0%	0%	0%
Borssele 2023 Hs<1.5m	76%	47%	72%	72%	78%	83%	92%	75%	86%	90%	0%	0%	0%
Borssele 2023 Hs<2.0m	91%	71%	90%	90%	94%	98%	100%	88%	94%	94%	0%	0%	0%

Figure 3.4.2 - Monthly workable days in Borssele 2023 (measured; probability of non-exceedance)



	annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Borssele Hindcast Hs<0.75m	32%	25%	33%	37%	57%	48%	54%	64%	56%	44%	25%	31%	25%
Borssele Hindcast Hs<1.0m	49%	38%	52%	57%	72%	67%	71%	79%	72%	61%	42%	48%	40%
Borssele Hindcast Hs<1.5m	74%	69%	78%	82%	91%	88%	92%	96%	93%	84%	68%	74%	66%
Borssele Hindcast Hs<2.0m	86%	86%	88%	94%	98%	98%	100%	99%	97%	94%	85%	89%	79%

Figure 3.4.3 – Monthly workable days from Borssele metocean report (hindcast; probability of non-exceedance)

3.4.2 Distance to port and sailing times

Table 3.4.1 shows the locations of upcoming wind farms (coordinates are taken from wikipedia.org), the distance to suitable fishing ports and sailing time. Note these are indicative values: the from shore to the wind farm does depend on the exact area for passive fishing within these wind farms and the port of departure; the sailing time does depend on vessel speed and tide. Table 3.4.2 shows water depth in the wind farms. Comparison and projection of passive fishing activities for upcoming wind farms will be further detailed in the final report.

Table 3.4.1 - Distance from port and indicative, average sailing times

Wind park			Port of departure	Distance to wind farm [nmi]	Average sailing speed [knots]	Average sailing time [hours]
	Lat (°N)	Lon (°E)				
Borssele II	3.077777	51.668601	Neeltje Jans	23	7	3
HKZ	4.116667	52.366667	IJmuiden	33	7	4.5
			Scheveningen	21	7	3
HKN	4.251111	52.715000	IJmuiden	26	7	4
HKW	3.766667	52.683333	IJmuiden	33	7	4.5

Table 3.4.2 - Other relevant conditions

Wind park	Water depth [m]
Borssele II	14-36
HKZ	17-28
HKN	14-28
HKW	20-35

4 Conclusions

The experiences and collected data from the field experiments are currently being processed and analyzed. The final report, as agreed with LNV, will be delivered by the end of May 2024. The final report will provide further details on the practical feasibility of fishing in a wind farm, experiences with the chosen passive fishing methods for this project, the (environmental) effects, biological insights such as bycatch and the presence of birds and marine mammals during the use of the applied methods, and the economic viability of fishing in a wind farm. In addition to the final report, it was agreed that this field report would be prepared with the key findings related to procedures and safety aspects within a wind farm.

Most of the field experiments were carried out as planned in the action plan, and there was no need for additional communication with Rijkswaterstaat, the coast guard, or the wind farm owner. However, during some field experiments, a few more or less unexpected events occurred, which were resolved during the course of the experiments. This did require extra time and effort in terms of communication, and it should be avoided in the future for fishers in their daily operations.

The results of fishing with passive fishing methods in offshore wind farm Borssele, in this project, should be taken very carefully. The tests were mainly focused on safety (generally) and exploring and practicing procedures to ensure safe fishing in an offshore wind farm. The use of passive fishing gear in an offshore wind farm must generally be seen as maybe a possibility and maybe also as a temporary (seasonal) opportunity to catch fish in addition to fishing activities in other parts of the sea. Fishing in an offshore wind farm must probably be seen as part of total fishing strategy of a fisher during the year, depending on the seasons and depending on the availability of particular fish in that particular area.

5 Acknowledgement

Fieldwork requires a lot of coordination, communication and preparation between parties involved. Therefore, the authors would like to thank all persons involved that made this project successful. First of all, the fishers that designed the project together with the researchers and the fishers that were out at sea together with a highly motivated field team performing heavy duty work in all conditions imaginable, during weekends, holidays and at night if needed. Also, the authors would like to thank wind farm owner Ørsted, the Dutch Coastguard and Rijkswaterstaat for their cooperation during this project. Last, the authors would like to thank the Ministry of Agriculture, Nature and Food Quality for making this project and fieldwork financially possible and for their input and guidance throughout the process of testing the opportunities for fishing in wind farms.

6 Quality Assurance

Wageningen Marine Research utilises an ISO 9001:2015 certified quality management system. The organisation has been certified since 27 February 2001. The certification was issued by DNV.

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Justification

Report C075/23
Project Number: 4318100426

The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of Wageningen Marine Research

Approved: Wouter Suykerbuyk
Researcher

Signature:

Date: 21 november 2023

Approved: Maarten Mouissie
Management Team

Signature:

Date: 21 november 2023

Appendix 1 – Cases

A total of 35 field trips have been undertaken into Borssele II wind farm from April till October 2023 for the experimental passive fishing project 'Passive fishing in Borssele'. The activities consisted of: 5x gill net fishing with YE152 'Meru', 17x pot fishing with YE152 'Meru', 4x handline with KG7 'Flying Dutchman' and 10x jig fishing with MDV2 'Metanoia'. Prior to the experiments the anticipated operational procedures are described in the Plan van Aanpak and confirmed by LNV and Rijkswaterstaat. The Plan van Aanpak is also shared voluntarily with the WFO ie. Ørsted. Most field experiments were undertaken as foreseen in the Plan van Aanpak and did not require additional communication with Rijkswaterstaat, the coast guard or the WFO. During some of the field experiments unanticipated events did take place. These are described in the present document. The cases were resolved during the experiments but did require unanticipated additional communication. This additional communication was acceptable for the project team in light of the experiments but should be avoided for fishers in daily operations.

The intention of the present case description is to 1) create awareness for unanticipated events and 2) were possible, avoid the additional communication for future activities within the wind farm. The lessons learned from these cases could be taken into account in the framework for further passive fishing activities in wind farms.

The following unanticipated events were experienced:

1) **Discovery of unidentified moored object (03-08-2023)**
2) **Entanglement of a dahn line with Rijkswaterstaat wave buoy (24-05-2023; Pots)**
3) **Anchoring (29-06-2023; handline)**
4) **Loss of dahns and missing string I (21-08-2023; Pots)**
5) **Unidentified vessel report to the Coast Guard by Ørsted (11-09-2023; Handline)**
6) **Contact by Coast Guard about fishing activity (17-10-2023; Jigging with MDV2)**

1) **Discovery of unidentified moored object (03-08-2023)**

A moored empty red oil canister was discovered during field tests with MDV2 'Metanoia' by the project team within the wind park. This oil canister is not part of our fishing gear. The project team informed the Dutch coastguard about the unidentified object. The coastguard inspected the object and concluded it has drifted into the wind farm.

Figure A1.1: 03/08/2023 unidentified moored object

From this case follows:

- There can be unidentified objects within the wind park, not all objects within the wind farm can be associated to the experiments.
- Fishers can provide additional monitoring within the wind farm and report unidentified activities. In case of reporting feedback is appreciated.

2) **Entanglement of a dahn line with Rijkswaterstaat wave buoy (24-05-2023; Pots)**

On 23-05-2023, Ørsted reported entanglement of fishing gear with a Rijkswaterstaat wave buoy. One of the lines of string F appeared to be entangled with the wave buoy. The presence of this wave buoy was not known to the project team and was not noticed during the deployment of the gears. The line has been disconnected from the buoy. The positions of the string have been adjusted to prevent future entanglement.

Figure A1.2: 24/05/2023 line of string F entwined with Rijkswaterstaat wave buoy

3) **Anchoring (29-06-2023; handline)**

Handline fishing and jigging are usually carried out drifting. This approach was foreseen in the Plan van Aanpak. However, during the first fishing trip for handline fishing with the KG7 'Flying Dutchman' on 29-06-2023, it turned out that drift fishing in the wind farm is difficult due to the geometry/orientation of plots for passive fishing between the maintenance zones and the current direction. This is depending on the strength and direction of the tide, wave height, wind force and wind direction. The project team requested Rijkswaterstaat to allow anchoring with the same type of anchor (Bruce anchor) as used to anchor the strings, within the area for passive fishing. The proposed anchoring location is near the GO5 wreck, due to favorable catch expectations near objects. Rijkswaterstaat has agreed to this adapted approach and granted permission to anchor within the area for passive fishing, taking into account a distance of 100 meters from the wreck to prevent damage to this potential cultural heritage.

From this case follows:

- Permission for anchoring within the passive fishing zone was in this case granted by Rijkswaterstaat, with the same type of anchor as used for anchoring the strings, the so-called Bruce anchor. General permission regarding the use of anchors for future handline activities needs to be clarified.

4) **Loss of string markings (dahns and buoys)**

- **String I without markings (21-08-2023; Pots)**

The wind farm was not visited in the period between 18-07-2023 and 21-08-2023 due to bad weather and the holiday period. During this period the 9 pot strings have remained in the wind farm. Upon return on 21-08-2023, 6 dahns were found to have been thrown loose by storms in July and August (6-8Bft, Hs up to 3.5m), including both dahns of string I. As a result, this string could not be recovered. This was reported to Rijkswaterstaat and Ørsted on 22-08-2023. The project team recommended, after discussing the case with experienced fishers, dredging with light dredge anchors to recover the string without the markings. The dredge anchor is of a similar size to the Bruce anchors used to anchor the nets. Anchoring and dredges were not included in Plan Van Aanpak. Following the advice of the project team, Rijkswaterstaat granted permission to dredge up the string without markings. On 29-08-2023 the string was recovered within 2 attempts. The string was still at the installed location in the wind farm and had not been moved.

Figure A1.3: 29/08/2023 light dredge anchor used for recovery of string without markings

- **String A, B and H without markings (26-09-2023; Pots)**

The wind farm was not visited in the period between 09-09-2023 and 26-09-2023 (intended last expedition) due to bad weather. Upon return on 26-09-2023, it appeared 3 strings had lost both dahns due to the storm and continued rough weather in September (up to 6-8Bft, Hs up to 3.5m).

During the expedition on 26-09-2023 the 6 accessible strings were removed from the wind farm. The 3 strings (string A, B and H) without markings remained in the wind farm, waiting for suitable weather to dredge the strings. On 26-10-2023 the 3 remaining strings were dredged from the seabed; two strings in just one attempt, the other string in 3 attempts. The strings were still at the installed location in the wind farm and had not been moved.

From these cases follows:

- There is a substantial risk of loss of dahns during storm periods. On the one side this might be prevented by improving the connection between the dahn and line or by the use of floats, on the other side the failing connection might act as a quick release system, reducing the load on the anchor to zero and avoiding movement of the string on the seabed.
- The use of a light dredge anchor for the recovery of missing gear, within the passive fishing zone, is proven effective and does not lead to a significant risk for the wind farm and was in this case permitted.

Further considerations

In this case, the missing strings had not moved and remained at the installed location. However, it is imaginable that a string could move from the passive fishing zone and end up within the 250m maintenance zone around the in-field cables and wind turbines. It is advisable to use a risk assessment to determine how and by who the search should be conducted in such a case and how the equipment may be recovered. In order to be able to act adequately in such a case, it is advisable to carry out this evaluation prior to further rollout of passive fishing within the wind farm and to include actions in the action plan (Plan van Aanpak).

5) **Unidentified vessel report to the Coast Guard by Ørsted (11-09-2023; Handline)**

On September 11 the Ørsted MHCC reported a fishing vessel between wind turbines H03 and H04 without permission to the Coast Guard. Ørsted warns that passive fishing within the wind farm is prohibited and the fishing gear also poses a danger to fast-moving vessels that are active within the park, especially when it is dark. A photo of the vessel was taken from a wind turbine, but the name of the vessel could not be detected.

The Coast Guard confirmed the situation and did an investigation, indicating that research into passive fishing had already been announced. The Coast Guard contacted the vessel on VHF Channel 16 about their activities and it quickly became clear that the activities were known and permitted. The KG7 'Flying Dutchman' was identified on the photo taken from the wind turbine.

The next day there was contact between the Coast Guard, Ørsted and the project team, indicating that the activities had been properly reported and carried out as agreed. It seems that a mistake had been made in internal communication at Ørsted. The Coast Guard emphasized Ørsted first to verify such situations internally before reporting them to the authorities.

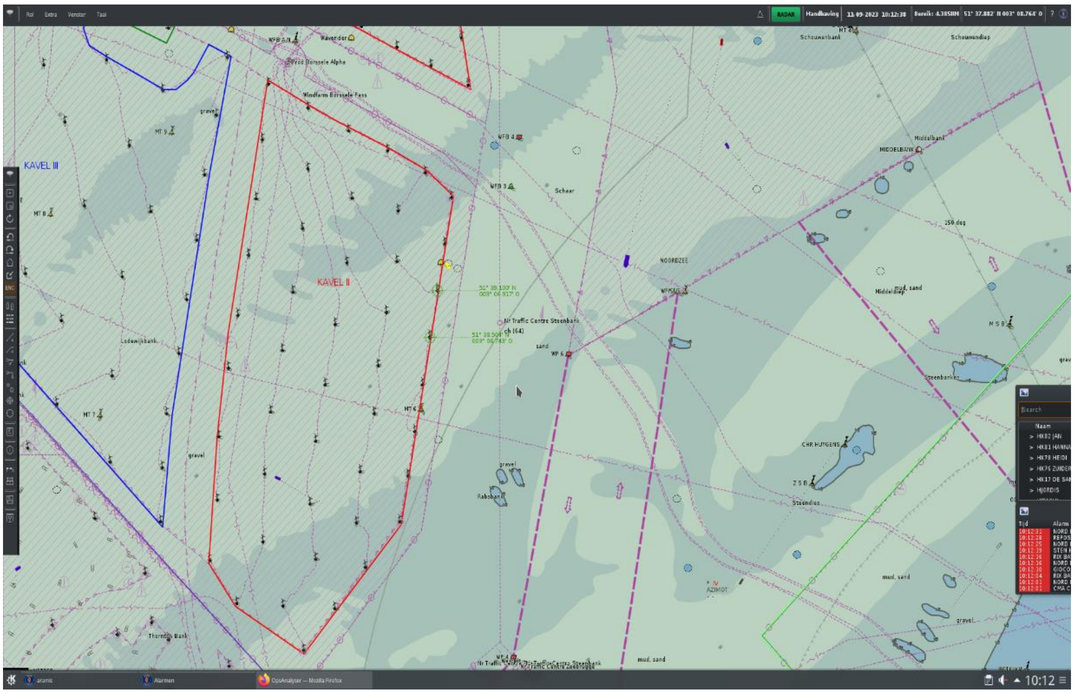


Figure A1.4: 11/09/2023 identification of the vessel

6) **Contact by Coast Guard about fishing activity (17-10-2023; Jigging)**

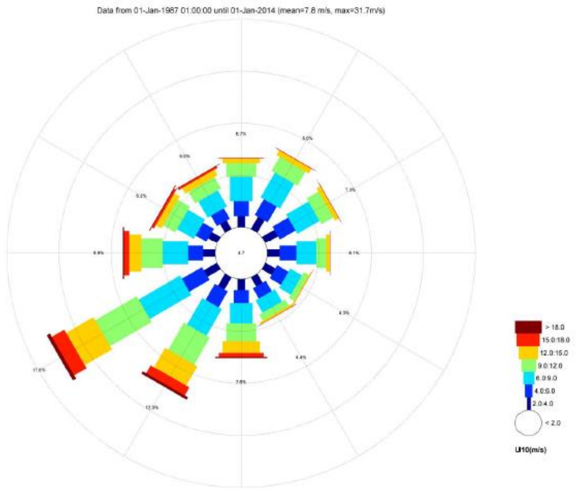
Prior to the start of the experiments a total of 8 phone calls for each trip were foreseen: calls to both the coast guard and WFO at 4 moments during the trip: departure from port, arrival at wind farm, departure from wind farm and arrival at port. Notification of activities within the safety zone at the coast guard is mandatory for SAR operations in case of calamities. Notification to the WFO is not mandatory, but the WFO would like to be informed about activities within the wind farm and facilitates to pass these activities through to the coast guard. These phone calls were experienced as considerable administrative load for the fishers. During the first days of the experiments of this project the coast guard and wind farm operator indicated to reduce the number of calls: calls to the coast guard are not necessary, since they receive a list with vessels that will undertake activities in the wind farm through the wind farm operator; only calls to the wind farm operator upon arrival at and departure from the wind farm were required. The reduced number of 2 phone calls is workable for the fishers.

On 17-10-2023 the Coast Guard contacted MDV2 'Metanoia' on VHF Channel 16 to explain their fishing activities in the wind farm. Following the initial fishing experiments, it was discussed and agreed that activities did not have to be reported by the fishing vessel to the Coast Guard. Reporting to the WFO is sufficient, the WFO informs the Coast Guard. The Coast Guard confirms again that this is agreed and the call on VHF channel 16 to MDV2 was unnecessary.

Appendix 2 – Wind, wave and current plots

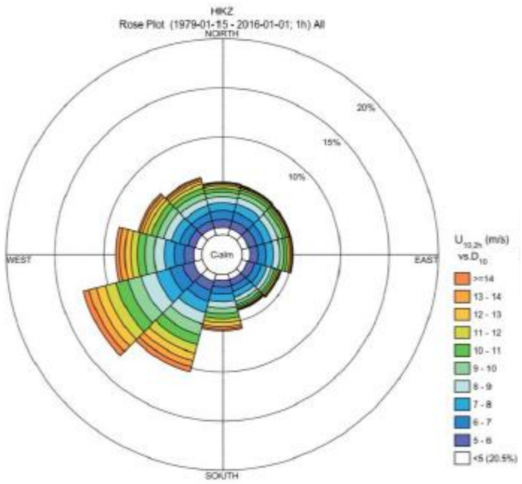
Figure A2.1 - Annual wind rose plots from metocean reports of Borssele II, HKZ, HKN and HKW.

Borssele



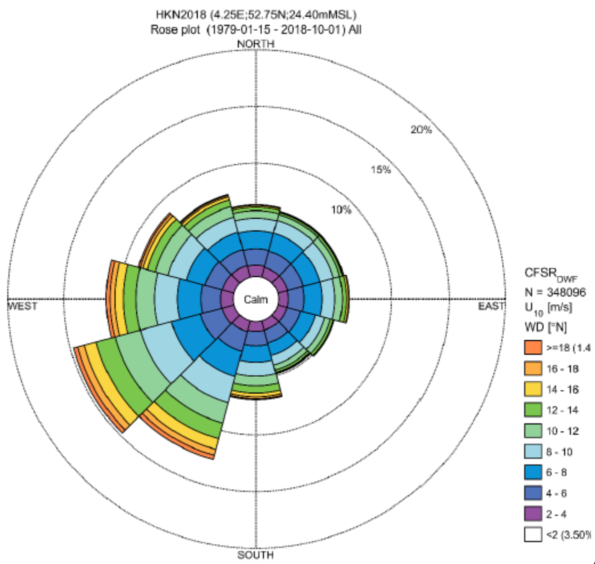
Average annual wind rose at Borssele II at 10mMSL (source: Deltares (2015), Figure 3.17)

HKZ



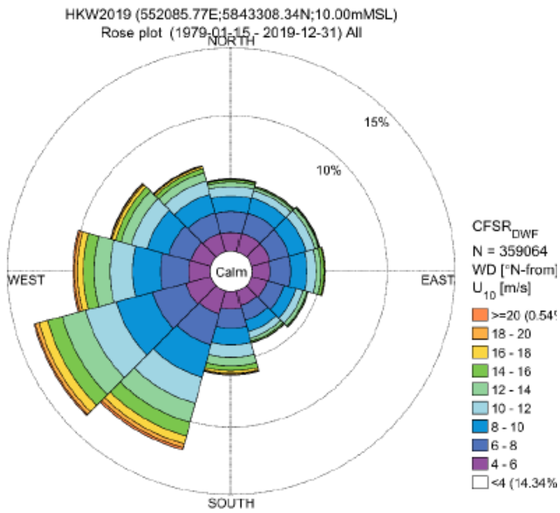
Average annual wind rose at HKZ at 10mMSL (source: Metocean Study; HKWFZ (2017), Figure 9.2)

HKN



Average annual wind rose at HKN2018 at 10mMSL (source: Metocean Study; HK(N)WFZ (2019), Figure 8.2)

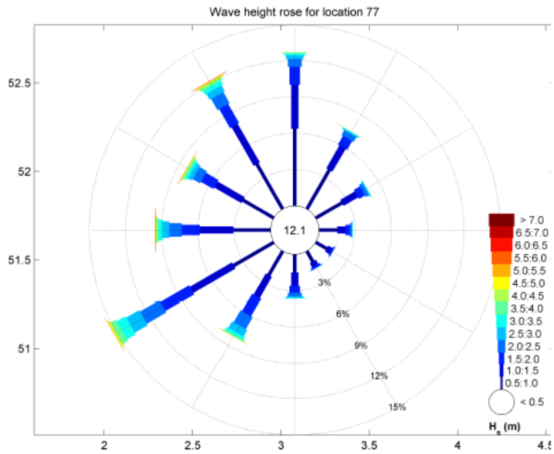
HKW



Average annual wind rose at HKW2019 at 10mMSL (source: Metocean Study; HK(W)WFZ (2020), Figure 8.2)

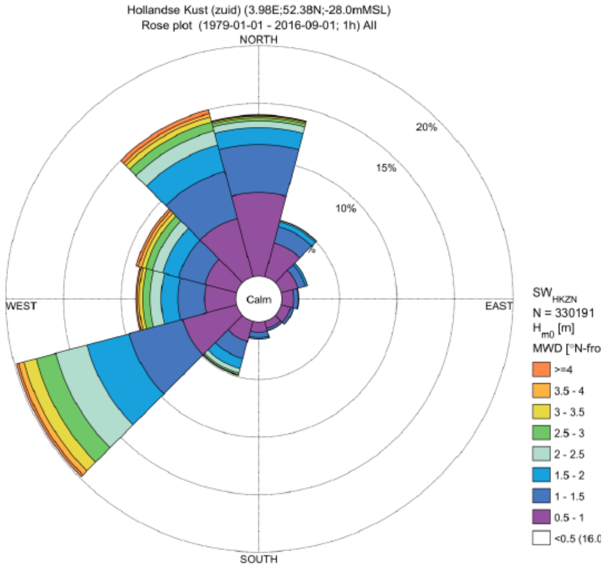
Figure A2.1 - Annual wave rose plots from metocean reports of Borssele II, HKZ, HKN and HKW.

Borssele



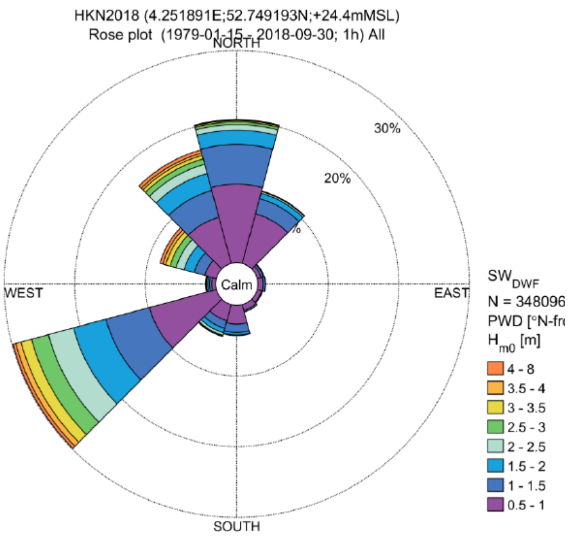
Annual wave rose at Borssele II (source: Deltares, 2015, Figure 4.5)

HKZ



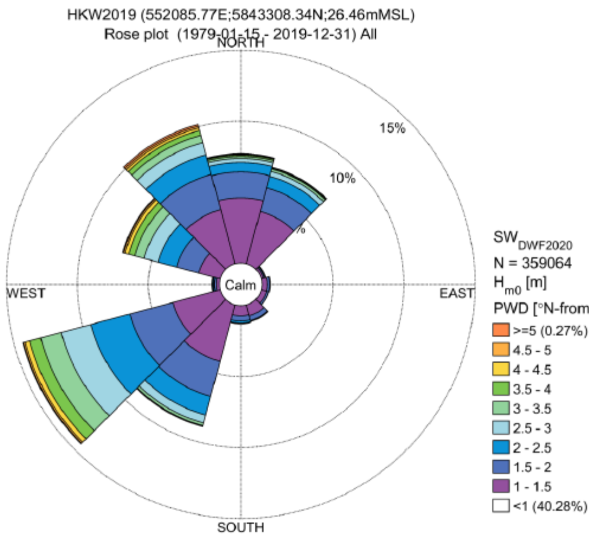
Wave rose at HKZ for the period from 1980-01-01 to 2016-09-01 (source: Metocean Study; HKWFZ (2017), Figure 9.48)

HKN



Wave rose at HKN for the period from 1979-01-15 to 2018-09-30 (source: Metocean Study; HK(N)WFZ (2019), Figure 8.54)

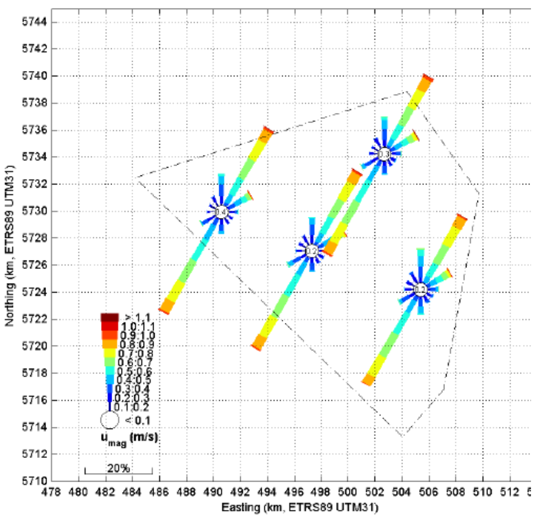
HKW



Wave rose at HKW for the period from 1979-01-15 to 2019-12-31 (source: Metocean Study; HK(W)WFZ (2020), Figure 8.50)

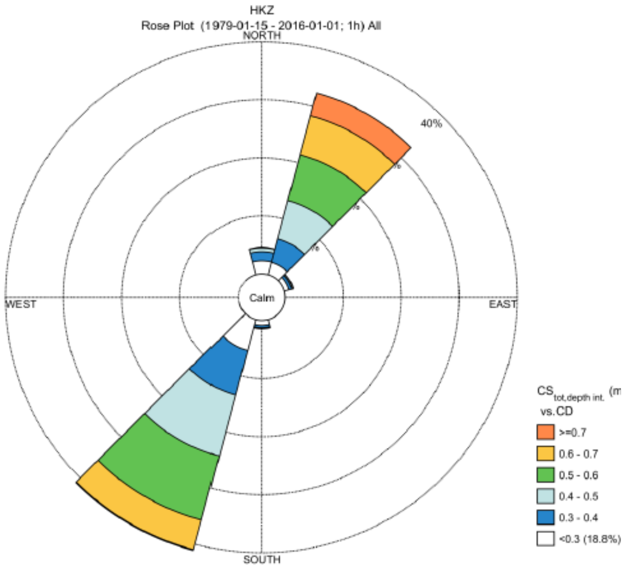
Figure A3.2 - Annual current rose plots from metocean reports of Borssele II, HKZ, HKN and HKW.

Borssele



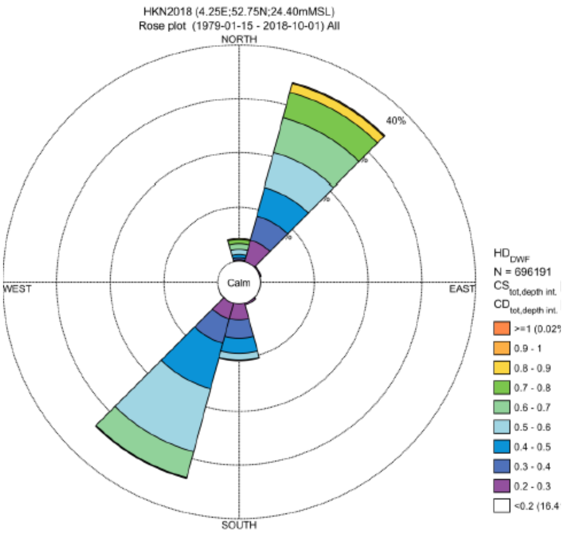
Annual current roses in the BWFZ (source: Deltares, 2015, Figure 6.2)

HKZ



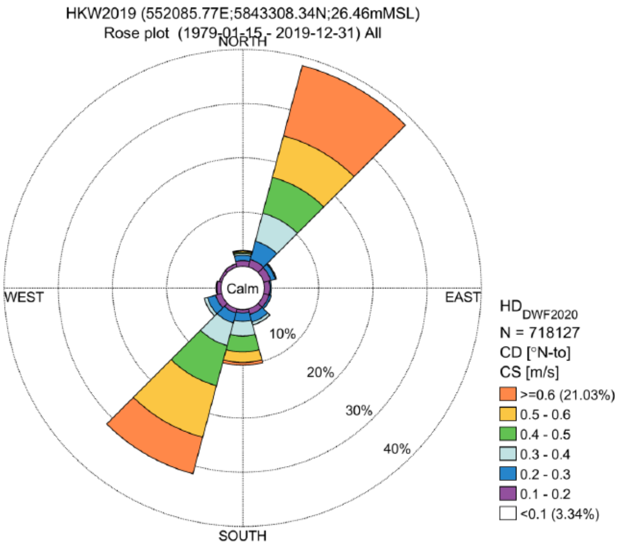
Depth-integrated current roses (going to) at HKZ: total current (source: Metocean Study; HKWFZ (2017), Figure 8.39)

HKN



Depth-integrated current roses (going to) at HKN2018: total current (source: Metocean Study; HK(N)WFZ (2019), Figure 8.41)

HKW



Depth-averaged current roses (going to) at HKW2019: total current (source: Metocean Study; HK(W)WFZ (2020), Figure 8.37)

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