Annex 4 - Background document Frisian Front and Central Oyster Grounds

Background document to the proposed Joint Recommendation for Conservation measures under the Common Fisheries Policy

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These institutes provided the scientific information on natural features, activities in the areas, economic value of the areas and the expected effects of the conservation measures. This information has been incorporated in chapters 2 and 4 of the site specific Background Documents and chapters 3, 6 and 7 of the General Background Document.

Contents

Summary

This document contains the site-specific background information to the proposed Joint Recommendation under Art. 11 and 18 of Regulation (EU) 1380/2013) on the Common Fisheries Policy to implement conservation measures on the Frisian Front and Central Oyster Grounds necessary to comply with Union Environmental legislation, such as the Habitat Directive, Birds Directive or Marine Strategy Framework Directive. The current Joint Recommendation contains a request to the European Commission to regulate fisheries in parts of these areas to protect the seabed ecosystem habitat. The Frisian Front and the Central Oyster Grounds mark the transition from the relatively shallow southern North Sea to the deeper northern parts. Consequently, water current velocity decreases and sedimentation takes place, resulting in a silt-rich seabed. Two main seawater currents meet, creating a front; this Frisian Front is nutrient-rich. Benthos is characterised by high biodiversity and biomass. Several rare and long-lived species are found in the area. The Frisian Front qualifies for the Birds Directive (guillemot), but the seabed of Frisian Front and Central Oyster Grounds does not qualify for the Habitats Directive. However, the proposed measures in the Joint Recommendation are drafted to provide special protection measures under article 13.4 of the Marine Strategy Framework Directive, contributing to good environmental status regarding descriptors D1, D4 and D6. Since fishing with bottom contacting towed gear is considered to be the main human activity adversely affecting the contribution for achieving good environmental status, the conservation measures consist of prohibiting the use of all bottom contacting towed gear from designated areas within the Frisian Front and Central Oyster Grounds. Stakeholders have been consulted on the designed management areas. Preconditions are optimizing ecological value and at the same time minimizing the economic impact on the fisheries sector. To this end, proposed designs have been subject to a societal cost-benefit analysis. In 2020, the Dutch government and stakeholders agreed on additional conservation measures for the Frisian Front and Central Oyster Grounds. These additional conservation measures build on conservation measures laid down in Commission Delegated Regulation (EU) 2023/340 of 8 December 2022 amending Delegated Regulation (EU) 2017/118 as regards conservation measures. The additional measures consist of an expansion of the closed area for bottom contacting fishing activities in both areas and inclusion of a no fisheries zone on the Frisian Front. This will lead to a total area of circa 2063 km^2 exempted from bottom contacting fishing activities on the Central Oyster Grounds and a total area of circa 2016 km^2 exempted from bottom contacting fishing activities on the Frisian Front. The complete surface area covered by the proposed management areas now totals circa 4080 km^2.

1 Introduction

This document contains the site-specific background information to the proposed Joint Recommendation[1] under Art. 11 and 18 of Regulation (EU) 1380/2013) on the Common Fisheries Policy to implement conservation measures on the Frisian Front and Central Oyster Grounds necessary to comply with Union Environmental legislation, such as the Habitat Directive, Birds Directive or Marine Strategy Framework Directive. The Joint Recommendation contains a request and a proposal to the European Commission to implement conservations measures in these areas to ensure a key contribution to the Good Environmental Status (GES) of the North Sea under the Marine Strategy Framework Directive (MSFD) (Directive 2008/56/EC).

This chapter provides the introduction of this site-specific Background Document (BD). Chapter 2 elaborates on the site description including its natural features, fishing activities, and other human activities. Chapter 3 describes the rationale for conservation. The conservation objectives are explained, the policy considerations are described and the translation into conservation measures is discussed. Chapter 4 describes the expected effects of the conservation measures on natural features, fishing and other human activities. Finally chapter 5 elaborates on the discussions in the Scheveningen Group and NSAC regarding the proposed conservation measures for the Frisian Front and Central Oyster Grounds. In Chapter 6, the conclusion leading to the current Joint Recommendation is summarized.

The content of this site-specific BD is established in accordance with the requirements as requested by the European Commission (2018).

This site specific Background Document needs to be read in conjunction with the Joint Recommendation and General Background Document.

[1] This document refers to the (current) Joint Recommendation. With this reference the proposed Joint Recommendation for conservation measures is meant.

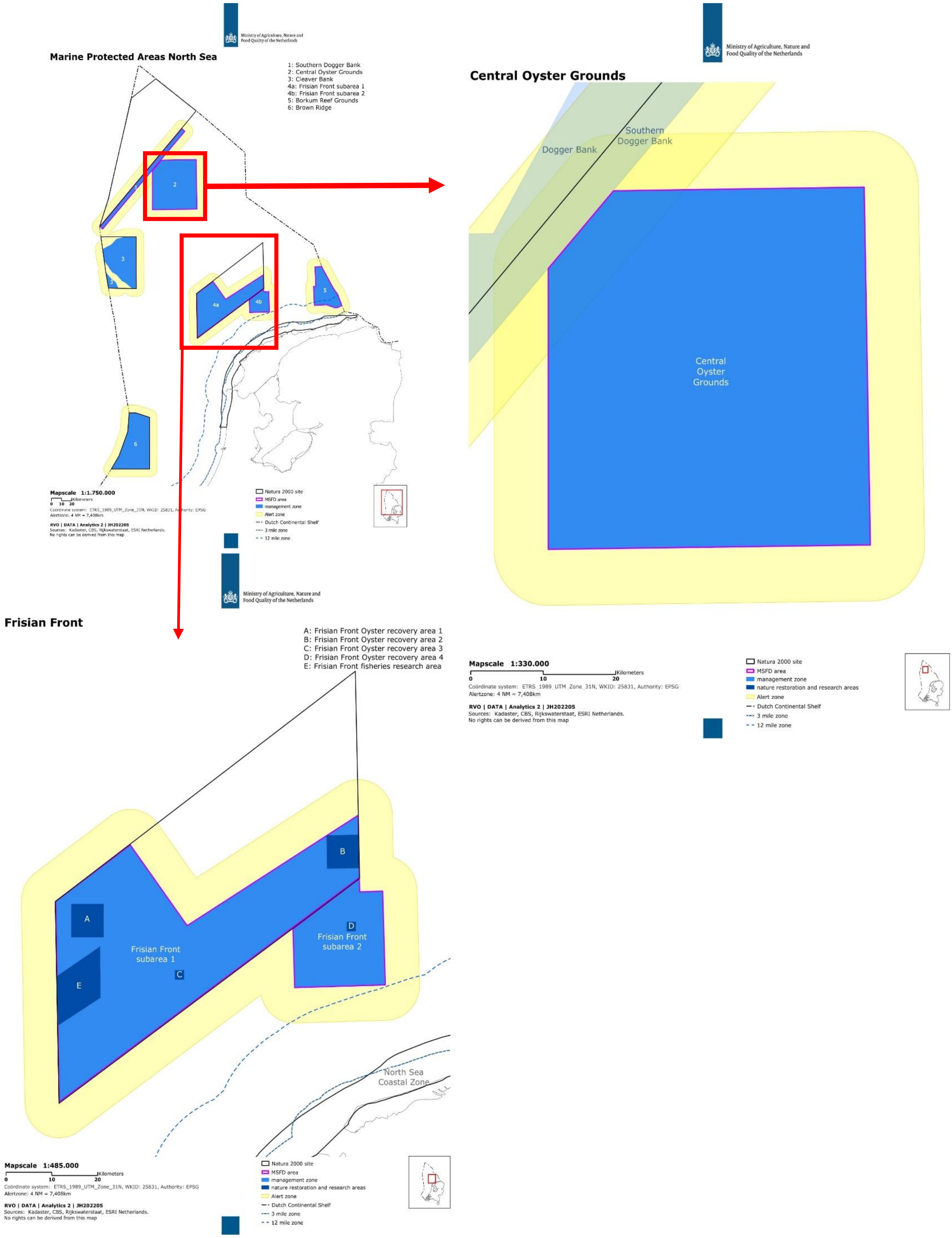


Figure 1. North Sea protected areas with detailed maps of the Frisian Front (bottom left) and Central Oyster Grounds (top right).

2 Site description

2.1 Legal status

Protection of the seabed ecosystem in the areas of the Frisian Front subareas 1 and 2 and Central Oyster Grounds is offered on the basis of article 13.4 of the MSFD.

The Frisian Front and Central Oyster Grounds do not qualify for the Habitats Directive, because although their silty seabeds are ecologically valuable, these habitats are not included in the list of natural habitat types in Annex I of the Directive. Only two types of habitat types categorized in Annex 1 of the Habitat Directive occur naturally on the Dutch part of the continental shelf (DCS). These are Habitat type 1110 (H1110) Sandbanks which are slightly covered by sea water all the time and H1170 Reefs (of open sea).

Nevertheless, the Dutch Marine Strategy provides additional protection to the seabed ecosystem in the areas of the Frisian Front and Central Oyster Grounds due to a unique combination of ecosystem elements, on the basis of article 13.4 of the MSFD. The proposed conservation measure areas are an addition to Natura 2000 areas on the Dutch part of the North Sea in order to contribute to a coherent and representative network of marine protected areas.

The MSFD is implemented in art. 4.6 and 4.16 of the Water Decree under the Dutch Water Act. Nature 2000 areas and MFSD area protection are part of the Dutch Policy Document on the North Sea 2022-2027 (IenW, 2022a) and Marine Strategy for the Dutch part of the North Sea 2022-2027, Part 3 Programme of Measures MSFD (IenW, 2022b, Table 1). These documents are part of the Dutch Water Plan under article 4.1 paragraph 3b of the Dutch Water Act.

In addition, part of the Frisian Front was classified as Special Protection Area (SPA) under the Bird Directive (BD) 2009/147/EC in June 2016 (De Staatssecretaris van Economische Zaken (2016), with Natura 2000 site code NL2016166. The surface area is 2882 km^2 (288200.00 ha). It protects 1 species: Guillemot (*Uria aalge*, Natura 2000 species code A199). The standard data form was last updated in December 2018. However, the current Joint Recommendation is only applicable to MSFD Frisian Front subarea 1 and 2.

Table 1: Overview of environmental targets under the Dutch Marine Strategy (IenW & LNV, 2018) to which conservation measures in the Frisian Front subarea 1 and 2 and the Central Oyster Grounds will contribute.

Good Environmental Status	Environmental target	Contribution Frisian Front 1, 2 and Central Oyster Grounds
D6 Habitats		
Overarching: improvement in the size, condition and global distribution of populations of the community of benthos species.	D6T1: 10-15% of the area of the Netherlands' part of the North Sea is not notably disrupted by human activities. D6T2: improvement in the quality of the assessed areas and habitats. D6T4: further development and testing of regional assessment methods (OSPAR and ICES) which can be used in the future for assessing benthic and pelagic habitats. D6T5: return and recovery of biogenic reefs including flat oyster beds.	D6T1: installing a no fisheries zone in subarea 1 and prohibit bottom contacting towed gear in subarea 2 and the Central Oyster Grounds will contribute to reaching 10-15 %. D6T2: Prohibiting all forms of bottom contacting towed gear in the areas improves the quality of the habitat type sand banks. D6T4: MONS will contribute to developing the regional assessment methods and bridge knowledge gaps that are present (see 4.1 for expected natural features). D6T5: Protecting the sandy seabed and facilitating reintroduction of the European flat oyster will contribute to the return of biogene reefs in the area.

Physical disturbance of the seabed – D1 (biological diversity), D6 (sea-floor integrity)		
Overarching: physical disruption of the seabed due to human activities is restricted to ensure that the scale, condition and global distribution of populations of the community of characteristic benthos species increases, and targets for specific habitats are achieved.	D6T1: 10-15% of the surface of the Netherlands' part of the North Sea is not notably disrupted by human activities. D6T3: no rise in the physical disturbance due to fishing activities over time on the total seabed of the EEZ and on the habitats described in the framework of the MSFD.	D6T1: protection of the Frisian Front subarea 1 and 2 and Central Oyster Grounds will help reaching 10-15% D6T3: fishery measures in the areas will contribute to this target.
D1 Species/marine mammals and birds		
D1C2: For every functional group there will be 75% of the populations above the threshold value of 1992 (OSPAR-assessment value). D1C2: Population of seabirds have to contribute to national targets set according to the Birds Directive.	D1T1: Contribute to further development and assessment of bird populations and identifying important pressures on regional level (OSPAR).	D1T1: monitoring the effects of the measures, will help contribute to effects and recovery rates of bird populations. Thus indicating what pressures are
D1 Species/fish community		
D1C2 – Commercial fish populations (D3C1 and D3C2) D1C2 – Rise in the proportion of vulnerable species of fish in the fish community (OSPAR).	D3T1/T2: Management of all commercial fish stocks complies to FsMSY and spawning stock biomass is above MSY Btrigger.	D3T1/T2: Reducing the fisheries impact in the area contribute to recovery of fish stocks in and around the Frisian Front and Central Oyster Grounds.

2.2 Natural features

The Frisian Front is located in the Dutch Exclusive Economic Zone (EEZ), about 50 km northwest of the Wadden Islands (Figure 1). The area is comparable in size to the Dutch part of the Wadden Sea (Fey-Hofstede and Witbaard, 2013). The Central Oyster Grounds are located about 100 km northwest of the Dutch Wadden Islands, in between the Dogger Bank and the Frisian Front (Figure 1). Note that for the Central Oyster Grounds, only the proposed management area is shown and not the entire Central Oyster Grounds. In contrast to the Frisian Front, which is designated under the BD, the Central Oyster Grounds has no official status (Table 2). The entire Central Oyster Grounds area is slightly larger than the Frisian Front, more than 3400 km^2 (Fey-Hofstede and Witbaard, 2013). The areas are of high biodiversity value, mainly for their benthic biodiversity (Bos et al. (2011); Table 2).

Table 2: Schematic overview of the main biodiversity characteristics for the Central Oyster Grounds and Frisian Front derived by Bos et al. (2011). The shaded cells represent the components of the ecosystem that are located within Natura 200 areas (SACs or SPAs). Habitat in the last row refers to the definition of habitats in Bos et al. (2011) (i.e. combination of abiotic characteristics) (Bos et al., 2011).

Characteristic	Central Oyster Grounds	Frisian Front
Natura 2000 (+Natura 2000 habitat types)	- (qualifies as OSPAR area)	SPA
Macrobenthos	Many old growing species Many big growing species High species richness	Many big growing species High species richness
Megabenthos	High density Many rare species High species richness	High density High biomass Many rare species High species richness
Fish	No specific values reported	No specific values reported
Birds	High bird values (Aug-Sept)	High bird values (Aug-Sept)
Mammals	No specific values	No specific values
Habitat	Rare habitat	Rare habitat

Physical features

The Frisian Front and the Central Oyster Grounds are naturally low dynamic areas with fine sediment (Rijnsdorp, 2015 and Rijnsdorp et al., 2015). They mark the transition from sandy seabed into the deeper, silt-rich part of the Dutch continental shelf (DCS), going from south to north, Especially the depth gradient at the Frisian Front accommodates a variety of seabed habitats, resulting in a high benthos biodiversity (Figure 2).

The following physical phenomena concur in the Frisian Front area:

- Two main seawater currents, one from the British coast and the second, nutrient-rich flow from the Channel and the southern North Sea, meet and mix, forming a hydrographic front.
- Increasing sea water depth causes a decreasing water flow rate, thereby causing silt and organic material to settle on the sea floor. In fact, the flow rates are the lowest on the DCS.
- Transport of nutrient-rich bottom water to the surface induces a high primary production (algae growth). Benthic fauna profits from dead algae sinking to the bottom.

The concurrence of the physical phenomena makes the Frisian Front unique in the North Sea. Globally there are only a couple of sites that are slightly similar: close to Newfoundland and in the Sea of Japan.

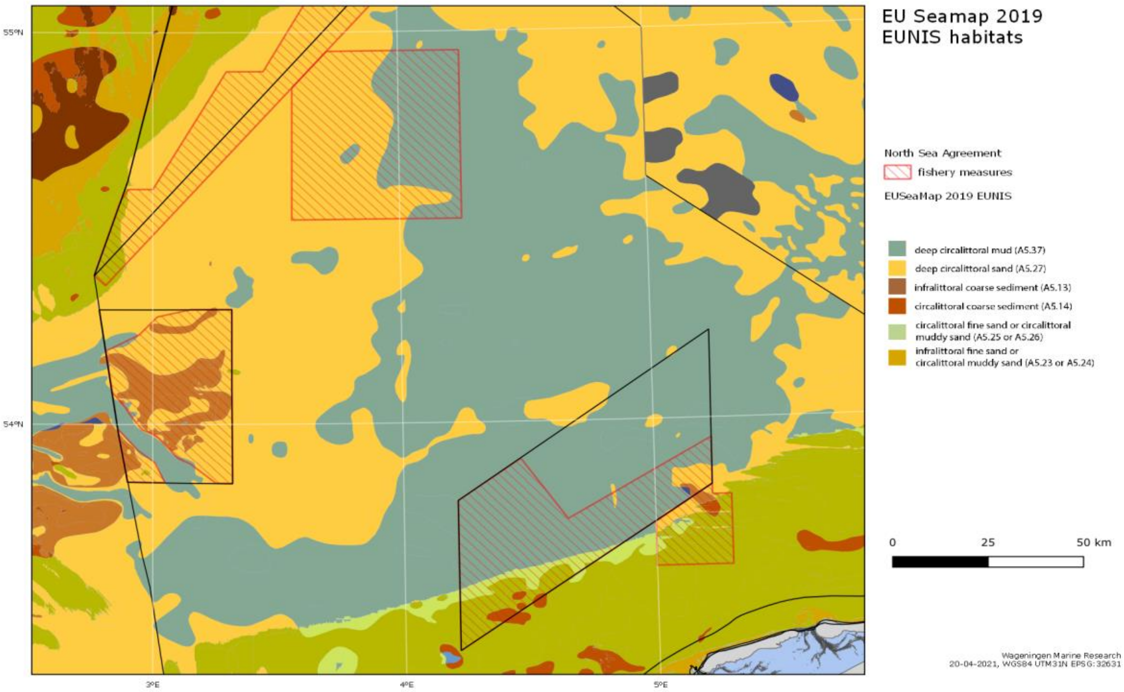


Figure 2. Habitat distribution at the DCS. The proposed protected areas, including the Frisian Front and Central Oyster Grounds have been indicated. (Source: EMODnet).

The North Sea water masses are organised in a generally strong anti-clockwise circulating tidal motion, responsible for the transport of water and material. Living and non-living material in the southern part of the North Sea is transported northwards with residual tidal currents, eventually being accumulated in the Skagerrak (the depositional area of the North Sea) and some in the Oyster Grounds and German Bight (Le Guitton et al., 2017). While most of the North Sea lacks any considerable carbon burial, the Oyster Grounds is one of the areas of increased carbon burial (De Borger et al., 2021).

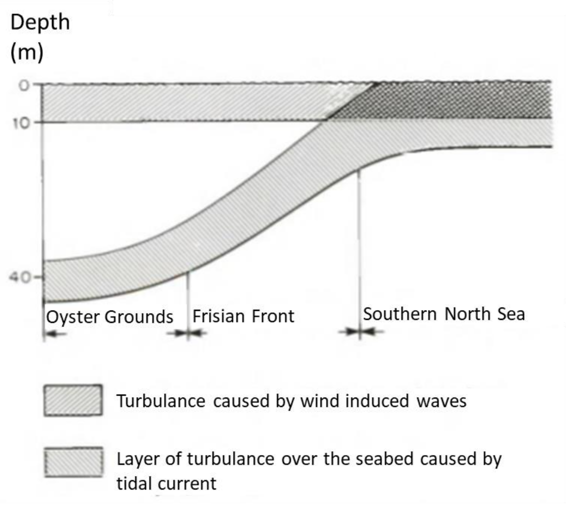


Figure 3. Schematic representation of turbulence caused by tidal currents and by wind waves over the Oyster Grounds and Frisian Front areas (translated from (de Gee and Ridderinkhof, 1991)).

The majority of the southern North Sea is well-mixed year round due to its shallow depth and strong tidal currents opposing summer stratification, whereas the northern and central regions stratify throughout summer (Große et al. (2017); Greenwood et al. (2010) and references therein). Water depth at the Central Oyster Grounds is high enough to sustain a water layer that is not affected by turbulence (Figure 3). At the Central Oyster Grounds the water column is stratified in the summer, leading to limited exchange of the water in the bottom mixed layer (Greenwood et al., 2010). Under thermally stratified conditions the dissolved oxygen concentration in the bottom water decreases. At the Central Oyster Grounds decreasing oxygen was driven by increasing temperature and biomass input, the latter which is driven by production during the spring bloom (Greenwood et al., 2010).

Field measurements and modelling showed rapid mineralization of fresh organic matter in the sediments of a region of the North Sea including the Central Oyster Grounds . The Central Oyster Grounds lies in a zone of fast nutrient recycling, where fresh organic material is recycled to nutrients that are available to the water column within weeks, or a few months after deposition and thus resulting in an overall low nutrient build-up (De Borger et al., 2021).

Benthic fauna

The Central Oyster Grounds and the Frisian Front megabenthos show the highest biodiversity values on the DCS (Figure 4). A regional benthic fauna assessment of the Southern North Sea (van Loon et al., 2018) shows that benthic species abundance and -richness in the Frisian Front and Oyster Grounds are relatively high compared to the coastal zone and the offshore region in general, especially for the Oyster Grounds (Table 3). Consequently, the Margalef diversity (i.e. a species diversity index) is also relatively high. However, species diversity is highest in the Dogger Bank.

In the Dutch North Sea, the seldom observed priapulid worm (*Priapulus caudatus*) is mostly found at the silt bottoms of the Oyster Grounds and the Frisian Front (Moorsel et al., 2017).

Table 3: Reference values of different regions of the Dutch North Sea (van Loon et al., 2018)

	Coastal Zone	Dogger Bank	Oyster Grounds	Frisian Front	Offshore
Habitat	Sand	Sand	Mud	Sand	Sand
Median depth (m)	12.2	32.9	47.8	36.9	29.5
Total number of samples	403	139	448	364	536
Average total abundance	147	174	165	156	76
Average species richness	14	32	28	25	15
Average Margalef diversity	2.84	6.03	5.53	4.95	3.41

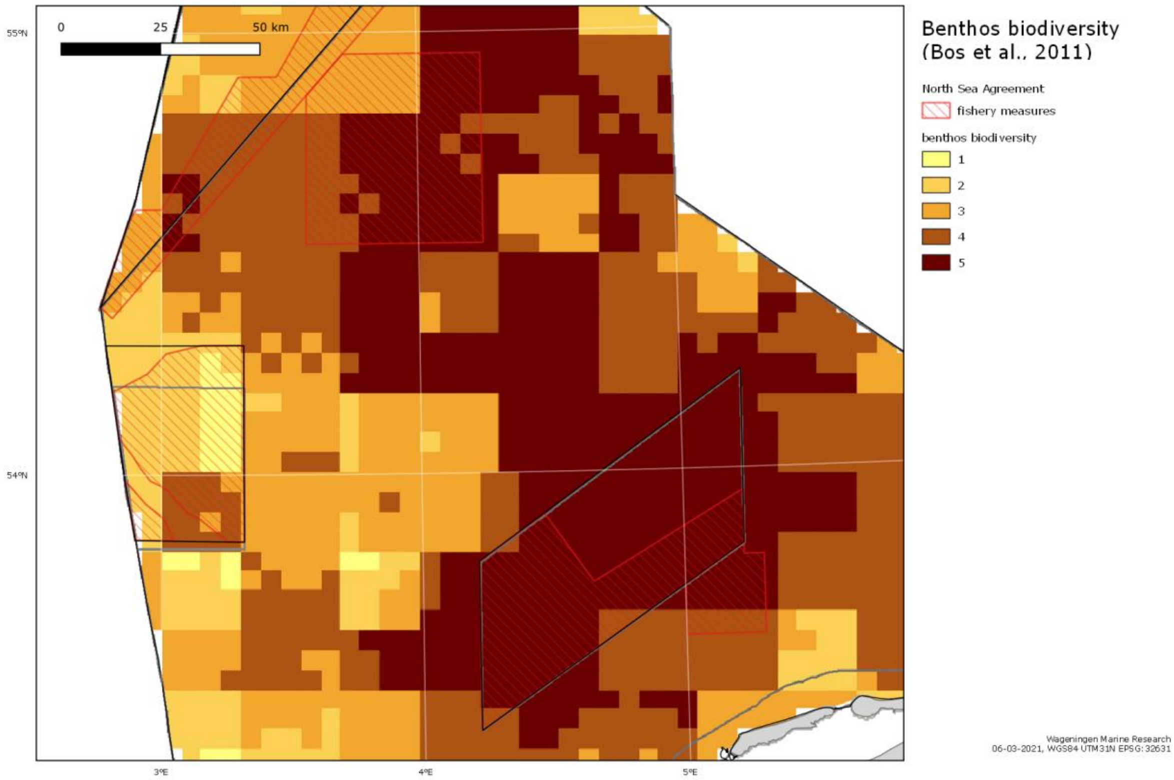


Figure 4. Total macro- and megabenthos at Frisian Front and Central Oyster Grounds. The proposed protected areas have been indicated (Source: Bos, 2011).

The sea floor and the related benthos communities (for some examples see Figure 5) are an essential link in the marine ecosystem and food webs. Species that live in or on the sea floor are important for the exchange of nutrients and oxygen and the formation of bottom structures. Burrowing animals locally rummage the soil (bioturbation). Natural sediment deposition processes and bioturbation determine structure and solidity of the bottom.

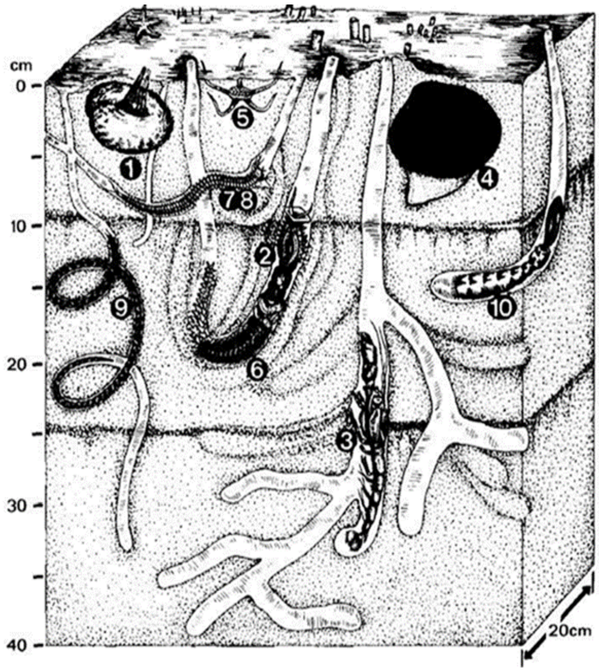


Figure 5. Artist impression of a cross section of the seabed and habitat species on Frisian Front and Central Oyster Grounds (Source: IenM, 2012, taken from De Wilde et al., 1984)). 1. Sea potato – *Echinocardium cordatum*; 2. Parchment worm – *Chaetopteris variopedatus*; 3. Burrowing mud shrimp – *Callianassa subterrana*; 4. Ocean quahog – *Arctica islandica*; 5. Brittle star – *Amphiura filiformis*; 6. Scale-worm - *Gattyana cirrosa*; 7. *Glycera unicornis*; 8. Ragworm spp. – *Nereis spp.*; 9. *Notomastus latericeus*; 10. Spoon worm - *Echiurus echiurus.*

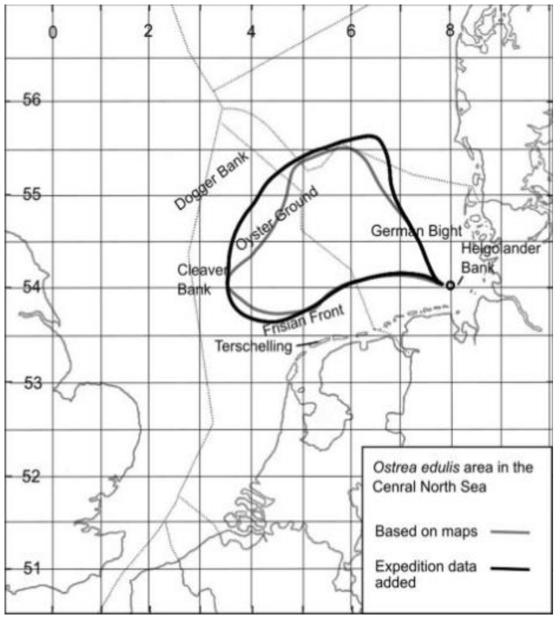


Figure 6. Delineation of area with oyster beds within the central North Sea, as derived from historical texts and maps (line a) and after inclusion of historical ship-based research survey data (line b) (Bennema et al., 2020).

For example: parchment worms create fibrous channels protruding a couple of centimetres above the bottom. Channels dug by the burrowing mud shrimp result in deposition of manganese and iron, reinforcing the channels and thus stabilizing the open sea floor structure (Jongbloed, 2013).

Flat oysters

Until the late 19th century, extensive beds of flat oyster (*Ostrea edulis)* populated the Central North Sea (Figure 6), which have vanished after intensive fisheries (Bennema et al., 2020). These beds provided key ecosystem services, allowing the existence of a hard substrate benthic community rich in species (Bennema et al. (2020) and references therein). The flat oysters in the North Sea were found on stable, silt-rich sand, including the Frisian Front and Central Oyster Grounds.

Status benthic habitat quality

In the Netherlands, the benthic habitat quality status is evaluated by use of the Benthic Indicator Species Index (BISI) (Wijnhoven and Bos, 2017; Wijnhoven, 2018), which is specifically designed for areas of special ecological value and used for MSFD status reporting (IenW & LNV, 2018.

The BISI indicates that the quality of benthos in both the Frisian Front and the Central Oyster Grounds is under the GES and declining (Ministerie van Infrastructuur en Waterstaat and Ministerie van Landbouw Natuur en Voedselkwaliteit, 2018). The trend towards a decline is first visible on the Frisian Front. The quality assessment in 2015 confirms that this quality decline is continuing and accelerating (Wijnhoven, 2018). In particular, bottom contacting activities seem to play a role. It is therefore expected that, for the time being, the GES will not be achieved (Ministerie van Infrastructuur en Waterstaat and Ministerie van Landbouw Natuur en Voedselkwaliteit, 2018).

Distribution within the sites of the different variables is shown in Figure 7.

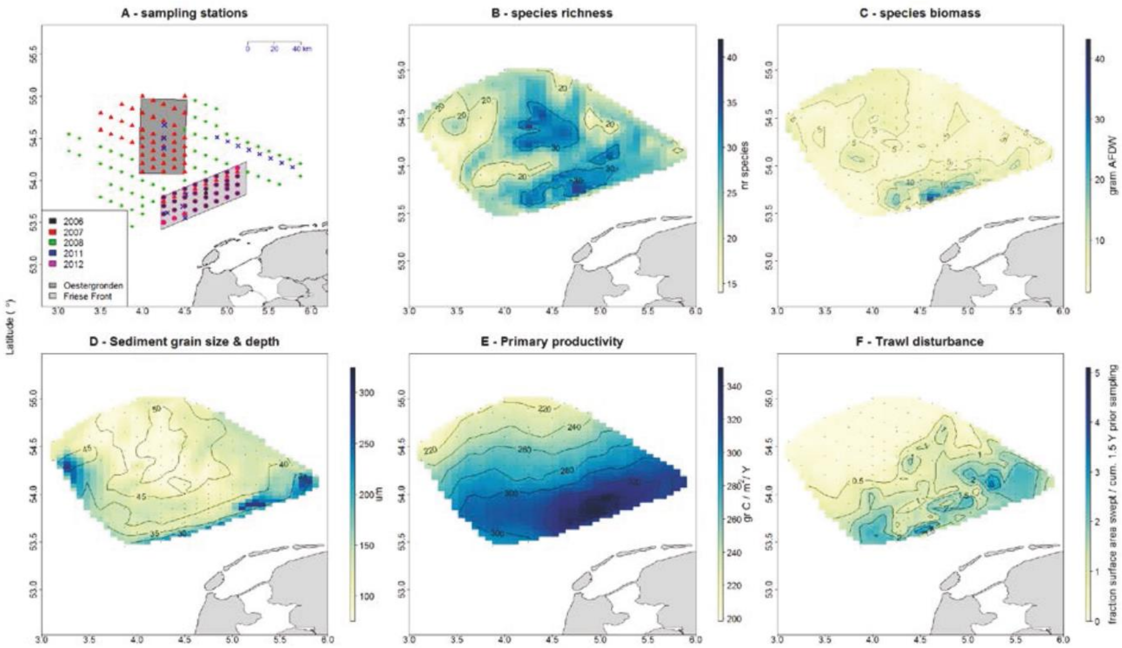


Figure 7. Maps of the macrozoobenthos stations (Panel A) and the variables studied (Panels B – F). The sampling took place between 2006 and 2012 at the Dutch EEZ (A, with the shaded areas indicating the Frisian Front and Central Oyster Grounds). Panels B – F are made by means of point interpolation of the mean over all years per station for species richness (B, color scale; number of species), species biomass (C, color scale; grams AFDW / sampling), sediment grain size with depth contours (in meters) (D, color scale µm), primary production (E, color scale; gr C / m2 / y), and fishing intensity (F, color scale; fraction of area fished in a period of 1.5 years before sampling) (van Kooten et al., 2015).

2.2.1 Depth contours

Frisian Front

The Frisian Front[2] is situated in the Dutch EEZ, above the West Frisian Islands, 75 km from the city of Den Helder. It is a transition area between the shallow sandy grounds of the southern North Sea and the deeper muddy seabed of the Central Oyster Grounds. Over a relatively short distance, the sea floor drops 10 to 15 m, from approximately 25 until 40 m below sea level (Figure 8).

Central Oyster Grounds

The Central Oyster Grounds is the name for the deeper area in the North Sea and lies north of the Frisian Front (Jager et al., 2018). Water depth is 40-50 m (Figure 8), with maximum depths at the eastern side (Greenwood et al., 2010). It is bordered by the shallower bathymetry of Dogger Bank, German Bight and Southern Bight (Greenwood et al., 2010). The proposed closure 'Central Oyster Grounds' is part of this deeper area and is uniformly 40 m deep.

The deep water habitats of offshore circalittoral sand and offshore circalittoral mixed sediment are not protected under the Habitats Directive. Between May and October, the phenomenon of stratification occurs: a layer of warm sea water (up to 20°C) floats on a colder one (12°C) without mixing. Only in autumn, strong winds cause the layers to mix again.

[2] The content of this paragraph is taken from Lindeboom, 2015, unless otherwise mentioned.

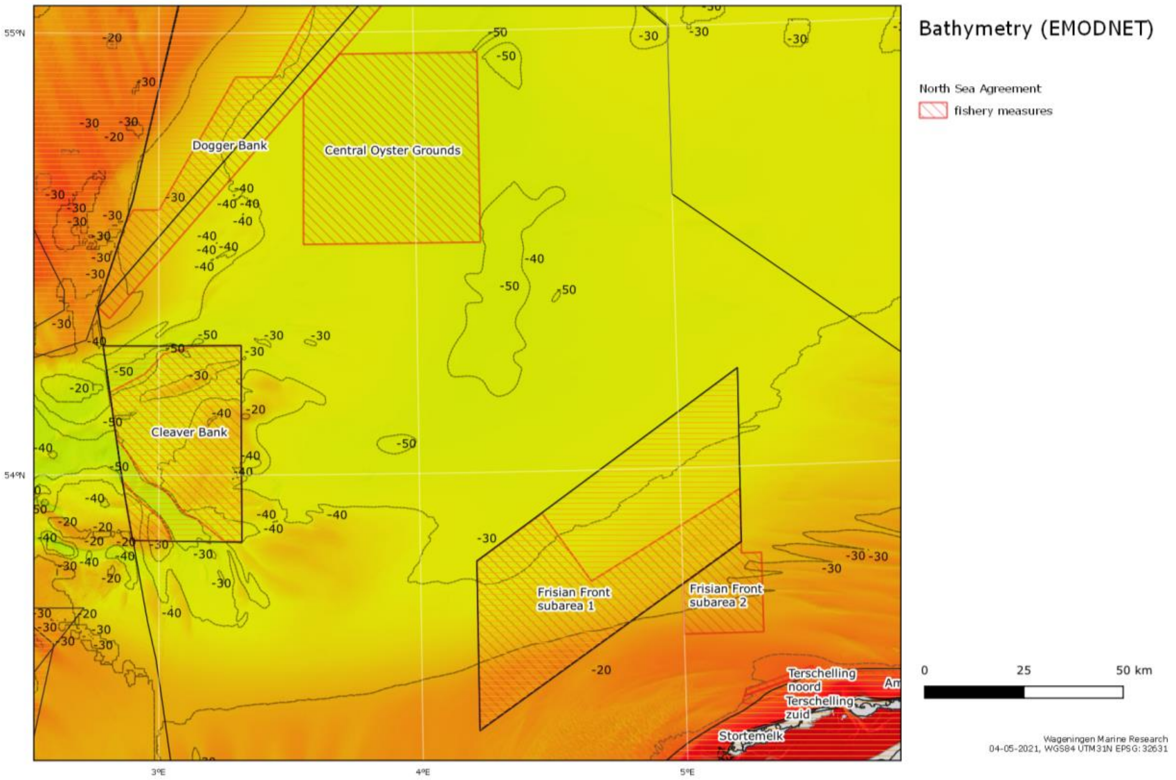


Figure 8. Bathymetry and depth contours of the Central Oyster Grounds and the Frisian Front (Source: EMODNET).

2.2.2 Sediment type

Frisian Front

The physical phenomena (see above) result in a large variety of sediment types, each with a specific fauna, parallel to the depth contour lines (Figure 8). The sediments range from sand in the south, via the hydrographic front to the silt-rich northern part. In the core area of the Frisian Front (100 x 15 km), the bottom consists of 15-20% silt.

Central Oyster Grounds

Going north from the Frisian Front, one enters the relatively low-dynamic sedimentation area of the Central Oyster Grounds and stratification in summer (Jongbloed, 2013). Sediment silt contents are lower in the Oyster Grounds than in the frontal area of the Frisian Front (5- 8%, versus 15-20%) (Jager et al., 2018).

2.2.3 Benthic communities

Frisian Front

The large variety of sediment types (see above) each have a specific fauna, parallel to the depth contour lines. Due to the nutrient-rich silt bed and the different depth gradients, a high diversity of benthic fauna occurs. There is a marked zonation of benthic species from south to north, not only in macrofauna but as well in for example foraminifers and in the epibenthic fauna (Duineveld and Moodley, 1991). The sediments with fine sand in the south, with tidal currents and wave action too strong to allow organic matter to settle, have high densities of suspension feeders such as bean-like fabula (*Tellina fabula)* (Duineveld and Moodley, 1991). Slightly to the north, in a narrow zone of unstable sediment, the *Tellina fabula* community that characterizes the sandy North Sea disappears and high densities occur of the bivalve *Nucula turgida*, the commen heart urchin (*Echinocardium cordatum)* and the sand mason worm (*Lanice conchilega)*. The subsequent very silty area with high content of organic carbon is characterized by large numbers of the crumbling star *Amphiura filiformis* and of the bivalves *Mysella bidentata* and *Abra alba* (Duineveld and Moodley, 1991).

The wide variety of sediment types each with their specific fauna on a relatively limited surface with a steep gradient in environmental circumstances make the area special, even on a global scale. The area is characterized by high biodiversity and biomass and a high production of seabed fauna. The relatively short distance between the different fauna communities allows interaction between them. The front with its gradients forms a palette of valuable circumstances in which many species can find their potential niche.

On the Frisian Front, there are many large growing macrobenthic species. Together with the Central Oyster Grounds, the Frisian Front megabenthos shows the highest biodiversity values on the DCS. Also, richness of megabenthic species is high and the area contains high densities and biomasses of megabenthos, and many rare megabenthic species (Bos, 2011), such as the ocean quahog (*Arctica islandica*). The area contains relatively rare habitat types.

Neumann et al. (2017) investigated the spatial distribution of epibenthic communities in the south-eastern North Sea. The community of Frisian Front was found to be linked to muddy sediments (Neumann et al., 2017). Mean fauna abundance was highest at the Frisian Front with high densities of characteristic species such as the serpent's table brittle star (*Ophiura albida)*, the flying crab (*Liocarcinus holsatus)* and the common tower shell (*Turritella communis)* (Neumann et al., 2017). Besides the mud content of the sediments, abiotic variables determining the Frisian Front community distribution were fishing effort and high annual mean temperature. Fishing and natural factors on the Frisian Front both affect benthic communities in a similar way and are spatially correlated in the south-eastern North Sea, making it difficult to disentangle the relative impacts (Jager et al., 2018 and references therein).

Burrowing megafauna may be part of the biotope 'Sea Pen and Burrowing Megafauna Communities' (OSPAR Commission, 2010), which is included in the OSPAR list of threatened and/or declining habitats and in the monitoring prescriptions of the MSFD (Gutow et al., 2020). Gutow et al. (2020) studied this biotope in the German part of the North Sea and found the burrowing megafauna occurring on a wide range of sediments with varying mud contents. Five species of the burrowing megafauna were considered for the analysis: *Callianassa subterranea, Goneplax rhomboides, Echiurus echiurus, Upogebia deltaura* and *Upogebia stellate*. The core distribution area of the burrowing megafauna was characterized by elevated mud content and a water depth of 25–55 m (Gutow et al., 2020), corresponding to the characteristics of the Frisian Front and Central Oyster Grounds.

<u>Habitat type "Sea-pen and Burrowing Megafauna Communities"</u> (OSPAR Commission, 2010)
Plains of fine mud, at water depths ranging from 15–200 m or more, which are heavily bioturbated by burrowing megafauna; burrows and mounds may form a prominent feature of the sediment surface with conspicuous populations of sea-pens, typically *Virgularia mirabilis* and *Pennatula phosphorea*. The burrowing crustaceans present may include *Nephrops norvegicus, Calocaris macandreae* or *Callianassa subterranea*. In the deeper fjordic lochs which are protected by an entrance sill, the tall sea-pen *Funiculina quadrangularis* may also be present. The burrowing activity of megafauna creates a complex habitat, providing deep oxygen penetration. This habitat occurs extensively in sheltered basins of fjords, sea lochs, voes and in deeper offshore waters such as the North Sea and Irish Sea basins and the Bay of Biscay.

Central Oyster Grounds
The most biodiverse element of this area is the benthos. The microbenthic community in the northern part of the DCS, north of the Frisian Front, is characterized by a high species richness with a relatively high number of rare species (low frequency of occurrence), a relatively high number of old growing (>10 years) and larger growing species (>1 g AFDW, ash-free dry weight). Together with the Frisian Front, the megabenthos shows the highest biodiversity values on the DCS.

The Oyster Grounds has a different species composition compared to Frisian Front whose sediments have higher silt percentages (Neumann et al., 2017).

The Oyster Grounds benthic community is dominated by brittlestar *Amphiura filiformis* (Meyer et al., 2018). In the period 1986-2015 decreasing abundance and biomass, especially of suspension- feeding species such as *Amphiura filiformis* or *Kurtiella bidentata* was observed, which seemed to be caused by ongoing decreasing food availability due to decreasing phytoplankton primary production and phytoplankton biomass since the late 1980s (Meyer et al., 2018 and references therein). Moreover, while in the eighties *Kurtiella bidentata* and the armoured bristleworm (*Scoloplos armiger)* were found as additional characteristic species, since 2000 characteristic species were juvenile heart urchins (*Echinocardium* spp), followed by the small bivalves shiny nutclam (*Nucula nitidosa)* and *Abra nitida*, and the tube-living polychaetes *Spiophanes bombyx* and *Lagis koreni* (Meyer et al., 2018). Changes were related to decreasing phytoplankton biomass and pelagic and benthic primary production in line with increasing sea surface temperature, ongoing seabed degradation, and predation by small non-target fish species (Meyer et al., 2018).

North of the -30 m bathymetric contour, the ocean quahog is found on the Frisian Front and Central Oyster Grounds. Density is low: about 0,1 specimen per m^2. The oldest specimen of the long-lived quahog ever found in the North Sea was 167 years old (Lindeboom, 2008). The ocean quahog is on the OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR Commission, 2009a).

2.2.4 Fish communities

Frisian Front
Due to the high primary production and production of plankton caused by the hydrographic front, the area attracts fish and higher trophic levels such as sea birds and marine mammals (Didderen et al., 2019). High concentrations of fishing schools (young herring, adult sprat) have been observed in acoustic surveys of the Frisian Front (de Gee et al., 1991). Besides herring and sprat, many other fish are found in the area, including mackerel, whiting, dab and solenette (Didderen et al. (2019) and references therein). These fish species eat prey in or on the bottom or in the water column.
Due to the high nutrient richness in the area, many larval fish of different species are found in the water column (Didderen et al. (2019) and references therein). It is unknown if these larvae stay in the Frisian Front or go somewhere else to grow up. Whether the Frisian Front is an important nursery area for fish is thus unknown. The abiotic gradients of the Frisian Front are reflected in the spatial temporal distribution of both benthic and pelagic fish communities (Jager et al., 2018). Regarding fish, there are no biodiversity hotspots identified for the Frisian Front (Figure 9; Bos et al., 2011).

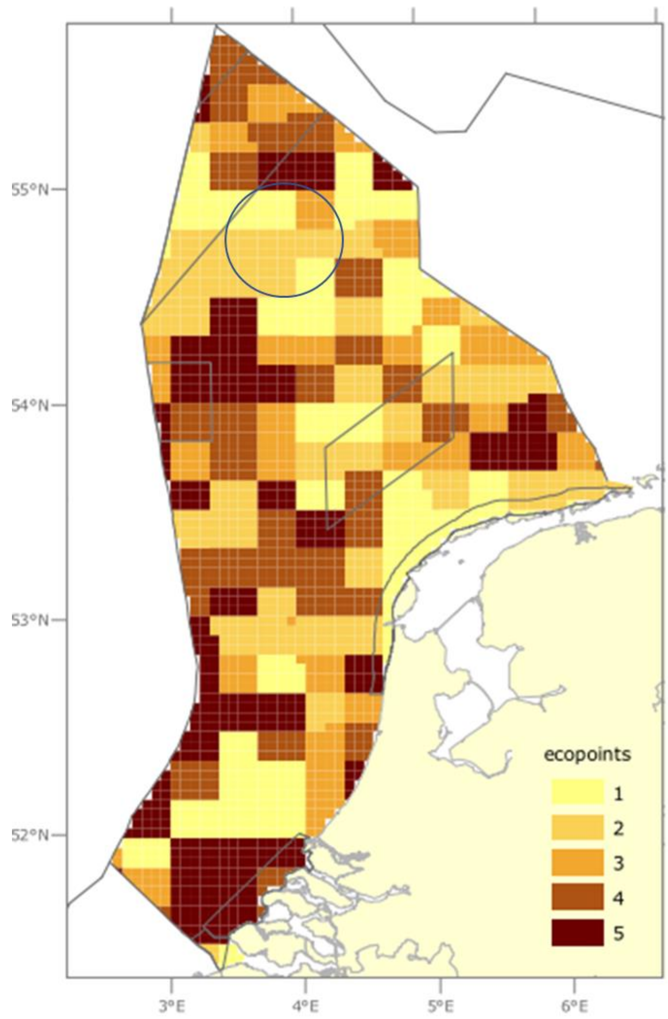


Figure 9. Hotspots of fish biodiversity on the Dutch North Sea, with darker colours indicating higher biodiversity values (Bos et al., 2011).

Central Oyster Grounds

There are no clear patterns of fish biodiversity on the Dutch North Sea (Figure 9). Some patterns emerge though: the species richness and frequency of occurrence of the larger growing species (>90 cm) appear to be higher in the deeper part of the DCS (Bos et al., 2011). For the Central Oyster Grounds, no biodiversity hotspots have been identified regarding fish (Bos et al., 2011).

2.2.5 Birds

The Frisian Front stands out as an offshore area due to its high bird values (Bos et al., 2011). Throughout the year, seabird densities at the Frisian Front are higher by a factor of circa 3 than south and north of the area (Leopold, 1991). Densities peak in summer and autumn, when large numbers of guillemots (*Uria aalge*) visit the area after the breeding season. Presence of sprat (*Sprattus sprattus*) and herring (*Clupea harengus*) attracts guillemots, mainly in August and September.

Young guillemots leave the colony before they can even fly (Leopold et al., 2011). They plunge from the steep breeding cliffs into the sea and are then guided and fed by their father. In late summer, guillemots from colonies along the British East Coast (Isle of May, Flamborough Head) swim with their young on the North Sea, towards the Dutch Continental Shelf. At the Frisian Front, they find a nutrient-rich situation (Leopold et al., 2011 and references therein). The adult birds use this period to renew their own plumage, leaving them temporarily unable to fly. The availability of sufficient food is an important condition in a period when the young have to grow and the birds are not very mobile (Leopold et al., 2011). The amount of wind largely affects the conditions at the Frisian Front; if the wind blows hard and long in summer, the front becomes unclear. If it is less windy, or strong winds occur only occasionally for short periods, then a clear front situation arises, in which the food is highly concentrated. In addition, the location of the front is probably also dependent on the wind direction. These conditions are expected to reflect in the distribution of guillemots on the Frisian Front (Leopold et al., 2011).

Due to the occurrence of large numbers of guillemots, the Frisian Front has been assigned as a Natura 2000 SPA to protect the guillemot. Moreover, the Frisian Front meets three of the seven scientific criteria for a special ecological area as mentioned in the Convention on Biological Diversity (CBD): it is unique and has a high biological production as well as diversity.

Besides the common guillemot, the Frisian Front is also important to other bird species. In summer, the area may function as a foraging area for lesser black backed gulls breeding at the Wadden Sea islands. During late summer/early autumn, great skuas migrate through the southern North Sea, and the Frisian Front is one of the areas in which high concentrations can be found (Bos et al., 2011). Great black-backed gull can regularly be encountered in late October to November (The Netherlands, 2019).

Although the Central Oyster Grounds has high bird values in August-September, the area does not stand out regarding relative importance for birds on the Dutch Continental Shelf (Bos et al., 2011). Hence, the Central Oyster Grounds is not designated under the BD.
Nevertheless, in the North Sea Agreement (2020) (NSA) an agreement was reached on research of six potential SPA's under the BD. Central Oyster Grounds is one of these areas. In 2021 a desk study was carried out to verify if the area qualifies under the BD. In case insufficient data is available to do a verification, additional field research will be carried out in 2022-2025. If the area qualifies it will be a designated area under the BD in 2025 at the latest.

2.2.6 Marine mammals

During the most recently reported marine mammal surveys (Geelhoed et al., 2020), *Harbour Porpoise Phocoena phocoena,* minke whale *Balaenoptera acutorostrata* and White-beaked Dolphin *Lagenorhynchus albirostris* were observed. The densities of harbour porpoise in the Frisian Front and Central Oyster Ground areas were in the same order of magnitude as most other areas on the Dutch Continental Shelf, ranging between 0.68-071 animals/km² (Geelhoed et al., 2020). Only at the Dogger Bank, densities were slightly lower (0.46 animals/km²).

2.3 Fishing activities

2.3.1 Impact of fishing activities

The impact on benthos caused by bottom contacting towed gear depends a.o. upon the footprint of the gear, the penetration depth of the gear into the sediment, the morphology and size of biota and their position relative to the sediment surface and frequency of disturbance (Hiddink et al., 2019). Biota and habitats differ in their degree of exposure and sensitivity to bottom trawling; the sensitivity of habitats to bottom trawling is higher in habitats with higher proportions of long-lived organisms (Hiddink et al., 2019). The sensitivity of the seabed also depends upon the natural disturbance (shear stress) and the structure of the seabed. The degree of natural disturbance decreases with water depth. The grain size of the sediment is usually a good indicator of the natural disturbance. High dynamic areas are characterized by coarse sediments, low dynamic areas by fine sediments. The Frisian Front and the Central Oyster Grounds are low dynamic areas with fine sediment and are characterized by a benthic community with a higher proportion of long-lived species (Rijnsdorp, 2015 and Rijnsdorp et al., 2015). These characteristics indicate a high sensitivity to bottom trawling. The density of ocean quahogs diminished since 1980. A probable cause is the increase of bottom trawling on the Frisian Front (Lindeboom, 2008b, referred to in Slijkerman et al., 2013).

On the Oyster Grounds, standard mortality from beam trawls were estimated at 25% (Bergman and Meesters, 2020). The authors note that this is on the higher end (95% percentile) of the range of a large number of experimental studies reported in Hiddink et al. (2017). Based on a global analysis, Hiddink et al. (2017) estimated the mean depletion of biota (i.e. benthic mortality) from a single beam trawl passage at 14%. It has been suggested that mortality rates are higher in softer sediments than in sandier sediments and higher mortality can also be anticipated in un-trawled areas when inhabited by vulnerable taxa, such as ascidians, soft corals, bivalve banks, and reef-building polychaetes (Bergman and Meesters (2020) and references therein).

A study by van der Reijden et al. (2018) provides insight in benthic habitat types that are frequently targeted by fishermen in the North Sea. Three dominant Dutch fisheries from 2008 to 2015 were studied: beam-trawlers targeting sole *Solea solea* (Beam-Sole), beam-trawlers targeting plaice *Pleuronectes platessa* (Beam-Plaice), and otter-trawlers targeting Norway lobster *Nephrops norvegicus* and demersal fish (Otter- Mix). Results showed that all three fisheries target highly specific, uncommon habitats (van der Reijden et al., 2018). Beam-Sole fishers targeted warmer, shallow, dynamic, nearshore habitats, and within these specifically the depressions between sand ridges. Beam-Plaice fishers mainly targeted the exposed, non- muddy flanks of the Dogger Bank and similar large-scale elevations (50–75 km) where especially the ridges of smaller sand banks are used. Otter trawl fisheries concentrated in areas with low bed shear stress, located in muddy, relatively deeper areas. The hotspot locations of Otter trawls are located in the Central Oyster Grounds and Frisian Front, which score high for various benthos biodiversity metrics. Observations suggest that the conditions prevailing at the hotspot locations support rich benthic communities. Moreover, the fact that there are only a few locations with these conditions in the North Sea indicates that the species depending on these conditions probably are relatively uncommon (van der Reijden et al., 2018).

The long-term effects of beam trawl (TBB) will be studied within the no fishery zone on the Frisian Front (see also section 2, section 0 and section 4.1). For this purpose an area of 100 km^2 will be designated for research, where bottom contacting fishing activities will be permitted under strict conditions (OFL, 2020).

2.3.2 Fleet activity in effort

The data sources and processing, data for fishing effort calculations and fishing gear types and groups are described in the GBD and Jongbloed et al. (2022). A data call to relevant EU Member States was sent out in autumn 2022 by Wageningen Marine Research. Wageningen Marine Research provided the R-script to collect data from the Dutch, Danish, German, Belgian, Swedish and French fleets. No UK fleet data were used, since the UK is not part of the EU anymore. The pre-processing of the data follows the approach developed in Hintzen et al. (2013). Data on the fishing activity of fleets, gear types and gear groups for each year in the period 2014 to 2021 is shown for the three areas: Frisian Front subarea 1 (Table 4, Table 5,

Table 6: Overview of fishery effort (fishing days) per year of gear groups in the proposed management zone of the Frisian Front subarea 1. All gear groups are part of the proposed fishery measures.

Gear group	2014	2015	2016	2017	2018	2019	2020	2021	Average
Beam trawl	120.8	158.1	240.4	154.3	141.5	89.3	252.7	255.2	176.5
Bottom trawl	62.5	96.5	180.3	198.5	79.8	119.3	62.8	41.5	105.1
Flyshooting seine	4.6	11.6	3.9	18.0	14.4	9.7	4.1	8.0	9.3
Anchored seine						0.5		0.3	0.1
Nets	6.1	3.3		3.6	0.7	7.2	0.2		2.6
Traps						0.6		0.1	0.1
Pelagic trawl	1.4	18.8	13.4	0.0	3.1		5.6	1.8	5.5
Total	*195.4*	*288.3*	*438.0*	*374.4*	*239.3*	*226.7*	*325.3*	*306.9*	*299.3*

and Figure 10), Frisian Front subarea 2 (Table 7,

Table 8, Table 9, Figure 11), and Central Oyster Grounds (Table 10, Table 11, Table 12, Figure 12). The observations on extent and trends in the fishing activity are described in the next sections. The tables 3, 6 and 9 plus figures 10, 11 and 12 (country) show the fishery effort of EU Member States only. This is because the article 11 procedure only applies to Member States and does not apply to third countries. For instance, UK interests are being evaluated after consensus has been reached between Member States.

Table 4: Overview of fishery effort (fishing days) per year of fleet nationality in the proposed management zone of the Frisian Front subarea 1.

Country	2014	2015	2016	2017	2018	2019	2020	2021	Average
Belgium	6	9	19	37	25	6	4	5	14
Denmark	7	26	18	1	7		9	3	9

France					5	6	0	0	1
Germany	52	49	112	73	43	58	121	99	76
Netherlands	130	204	290	263	160	157	191	199	199
Total	*195*	*288*	*438*	*374*	*239*	*227*	*325*	*307*	*299*

Table 5: Overview of fishery effort (fishing days) per year of gear types in the proposed management zone of the Frisian Front subarea 1.

Gear type	2014	2015	2016	2017	2018	2019	2020	2021	Average
TBB+	120.8	157.9	240.4	154.3	141.5	89.0	252.7	255.2	176.5
TBS*		0.2				0.3			0.1
OTB	40.7	77.6	98.7	148.8	62.4	104.1	52.3	35.2	77.5
OTT	21.9	18.9	81.6	49.8	17.4	15.2	10.5	6.2	27.7
SSC	4.6	11.6	3.9	18.0	14.4	9.7	4.1	8.0	9.3
SDN						0.5		0.3	0.1
GNS	6.1	3.3		3.2	0.7	7.2	0.2		2.6
GN				0.4					0.0
FPO						0.6		0.1	0.1
OTM	1.4	18.8	13.4	0.0	3.1		5.6	1.8	5.5
Total	*195.4*	*288.3*	*438.0*	*374.4*	*239.3*	*226.7*	*325.3*	*306.9*	*299.3*

Table 6: Overview of fishery effort (fishing days) per year of gear groups in the proposed management zone of the Frisian Front subarea 1. All gear groups are part of the proposed fishery measures.

Gear group	2014	2015	2016	2017	2018	2019	2020	2021	Average
Beam trawl	120.8	158.1	240.4	154.3	141.5	89.3	252.7	255.2	176.5
Bottom trawl	62.5	96.5	180.3	198.5	79.8	119.3	62.8	41.5	105.1
Flyshooting seine	4.6	11.6	3.9	18.0	14.4	9.7	4.1	8.0	9.3
Anchored seine						0.5		0.3	0.1
Nets	6.1	3.3		3.6	0.7	7.2	0.2		2.6
Traps						0.6		0.1	0.1
Pelagic trawl	1.4	18.8	13.4	0.0	3.1		5.6	1.8	5.5
Total	*195.4*	*288.3*	*438.0*	*374.4*	*239.3*	*226.7*	*325.3*	*306.9*	*299.3*

Table 7: Overview of fishery effort (fishing days) per year of fleet nationality in the proposed management zone of the Frisian Front subarea 2.

Country	2014	2015	2016	2017	2018	2019	2020	2021	Average
Belgium	1	0	0	0	0		0	1	0
Denmark	0	8	4	0			1	1	2
France			0	0				0	0
Germany	0	2	3	7	3	3	1	0	2
Netherlands	22	8	8	7	6	6	3	8	8
Total	*24*	*19*	*14*	*14*	*10*	*9*	*5*	*10*	*13*

*Table 8: Overview of fishery effort (fishing days) per year of gear types in the proposed management zone of the Frisian Front subarea 2. **not part of the proposed fishery measures.*

Gear type	2014	2015	2016	2017	2018	2019	2020	2021	Average
TBB+	0.8	1.3	3.8	1.8	0.7	0.7	0.7	2.1	1.5
TBS*	0.1			0.1		0.1			0.0
OTB	0.1	2.3	1.0	0.2	0.3	0.6	0.4	1.5	0.8
OTT	0.1	0.1	0.1			0.2			0.1
SSC	16.1	6.8	5.4	5.8	4.4	4.0	3.0	5.5	6.4
SDN			0.0	0.1				0.3	0.1
**GNS	6.1		1.2	6.1	4.5	3.2			2.6
**GN				0.5					0.1
**FPO	0.2								0.0
**OTM	0.1	8.5	2.8				1.1	1.2	1.7
Total	*23.5*	*19.0*	*14.4*	*14.5*	*9.9*	*8.9*	*5.1*	*10.5*	*13.2*

Table 9: Overview of fishery effort (fishing days) per year of gear groups in the proposed management zone of the Frisian Front subarea 2.

Gear group	2014	2015	2016	2017	2018	2019	2020	2021	Average
Beam trawl	0.9	1.3	3.8	1.9	0.7	0.8	0.7	2.1	1.5
Bottom trawl	0.2	2.4	1.1	0.2	0.3	0.8	0.4	1.5	0.9
Flyshooting seine	16.1	6.8	5.4	5.8	4.4	4.0	3.0	5.5	6.4
Anchored seine			0.0	0.1				0.3	0.1
**Nets	6.1		1.2	6.6	4.5	3.2			2.7
**Traps	0.2								0.0
**Pelagic trawl	0.1	8.5	2.8				1.1	1.2	1.7
Total	*23.5*	*19.0*	*14.4*	*14.5*	*9.9*	*8.9*	*5.1*	*10.5*	*13.2*

**not part of the proposed measures.

Table 10: Overview of fishery effort (fishing days) per year of fleet nationality in the proposed management zone of the Central Oyster Grounds.

Country	2014	2015	2016	2017	2018	2019	2020	2021	Average
Belgium	5	3	4	27	16	28	22	16	15
Denmark	22	78	42	19	14	10	5	17	26
France				1					0
Germany	22	29	31	59	25	60	24	26	34
Netherlands	40	33	38	82	29	109	43	37	52
Total	*89*	*142*	*114*	*188*	*85*	*207*	*94*	*96*	*127*

Table 11: Overview of fishery effort (fishing days) per year of gear types in the proposed management zone of the Central Oyster Grounds.

Gear type	2014	2015	2016	2017	2018	2019	2020	2021	Average
TBB+	9.0	4.4	16.6	10.6	1.3	25.3	1.9	0.5	8.7
TBS*		0.2						1.8	0.2
OTB	57.0	71.1	53.6	142.0	64.7	163.8	81.8	65.1	87.4
OTT	5.0	10.9	8.6	22.4	7.0	9.7	6.0	13.1	10.3
SSC			0.1		0.3				0.1
SDN		3.0	1.9						0.6
**GNS	8.9	13.9	8.6	1.7					4.1
**GN		0.5	0.3						0.1
**OTM	9.3	38.5	24.1	11.6	10.7	8.5	3.9	15.6	15.3
**PTM					0.9				0.1
Total	*89.2*	*142.4*	*113.7*	*188.2*	*85.0*	*207.3*	*93.6*	*96.1*	*126.9*

** not part of the proposed fishery measures.

Table 12: Overview of fishery effort (fishing days) per year of gear groups in the proposed management zone of the Central Oyster Grounds.

Gear group	2014	2015	2016	2017	2018	2019	2020	2021	Average
Beam trawl	9.0	4.6	16.6	10.6	1.3	25.3	1.9	2.3	8.9
Bottom trawl	62.0	82.0	62.1	164.4	71.7	173.5	87.8	78.2	97.7
Flyshooting seine			0.1		0.3				0.1
Anchored seine		3.0	1.9						0.6
**Nets	8.9	14.4	8.9	1.7					4.2
**Pelagic trawl	9.3	38.5	24.1	11.6	11.6	8.5	3.9	15.6	15.4
Total	*89.2*	*142.4*	*113.7*	*188.2*	*85.0*	*207.3*	*93.6*	*96.1*	*126.9*

**not part of the proposed fishery measures.

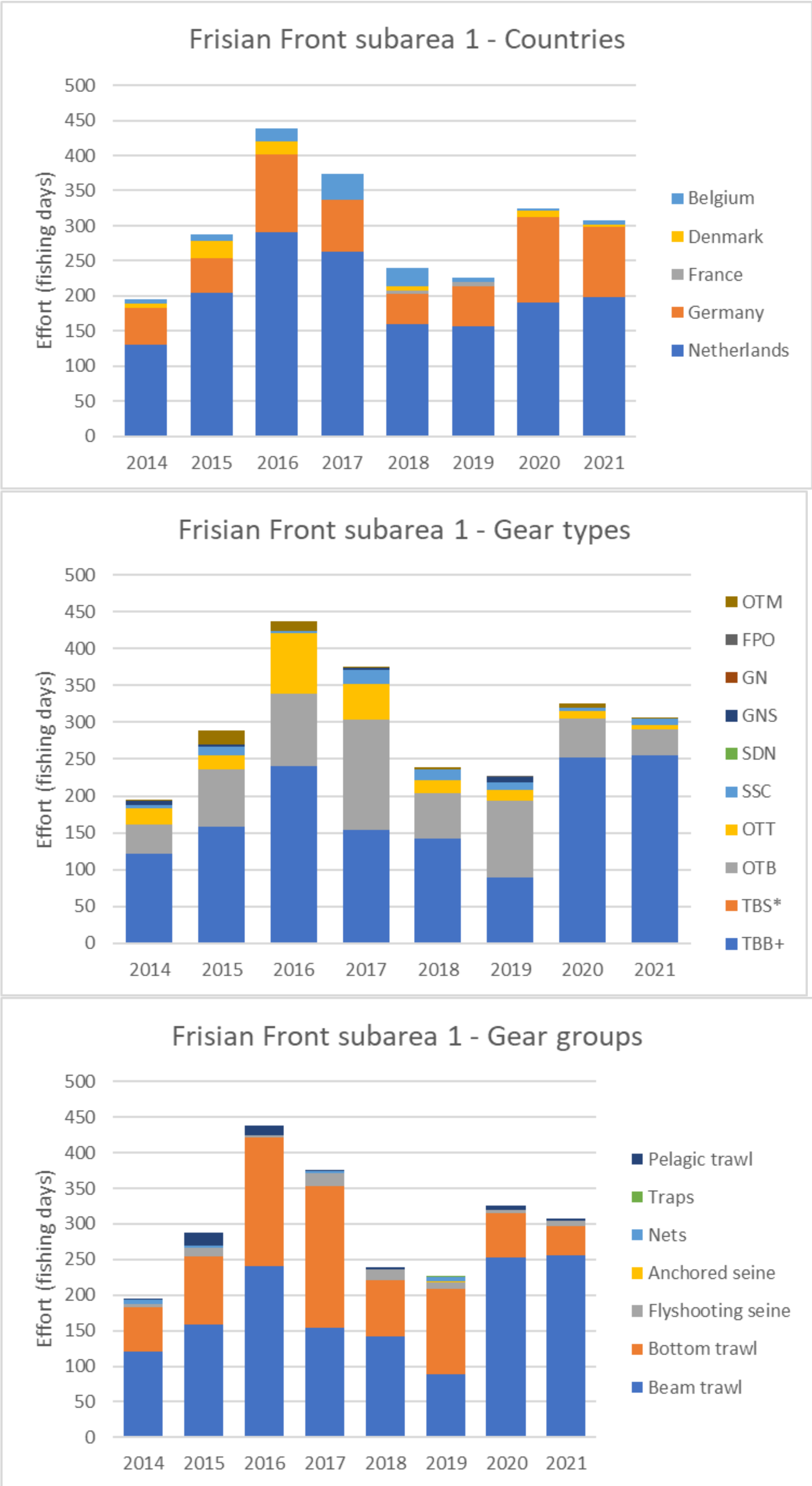
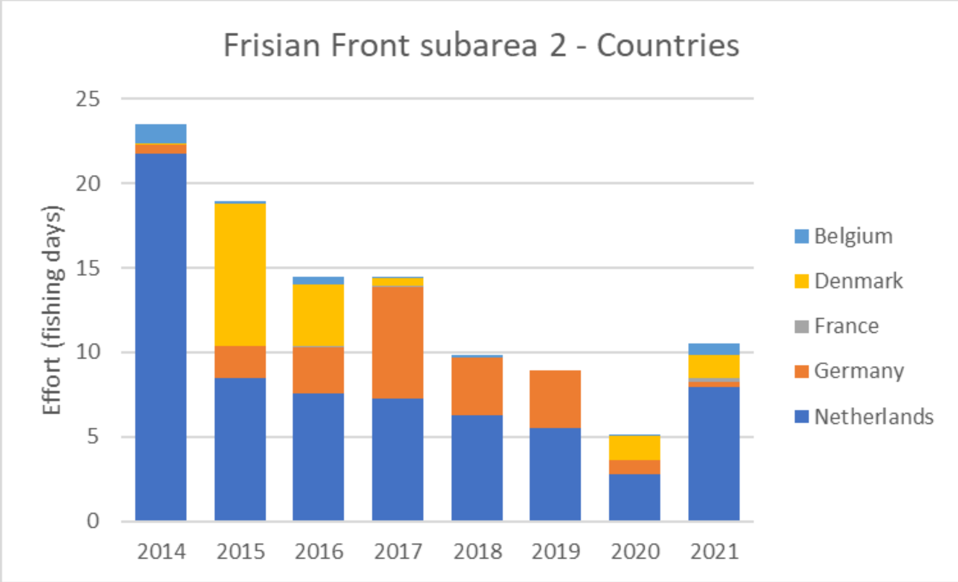
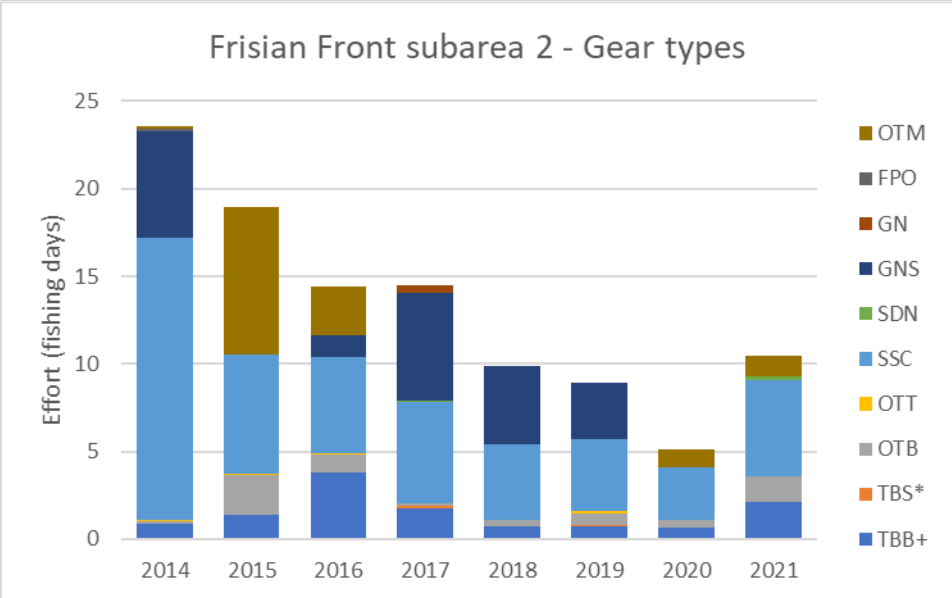


Figure 10. Fishery effort (fishing days) per year in the proposed management zones of Frisian Front subarea 1 for fleets (countries), gear types and gear groups.





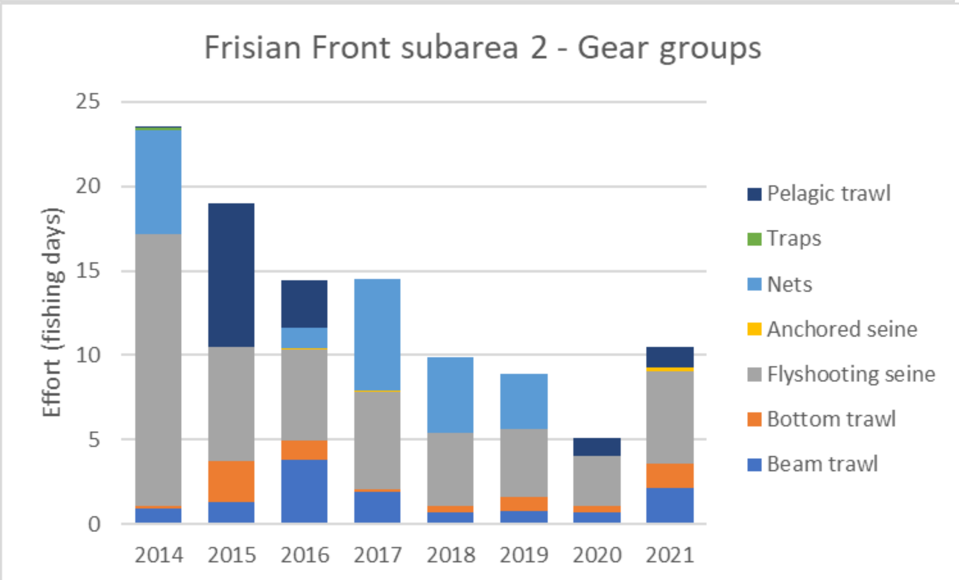


Figure 11. Fishery effort (fishing days) per year in the proposed management zone of Frisian Front subarea 2 for fleets (countries), gear types and gear groups.

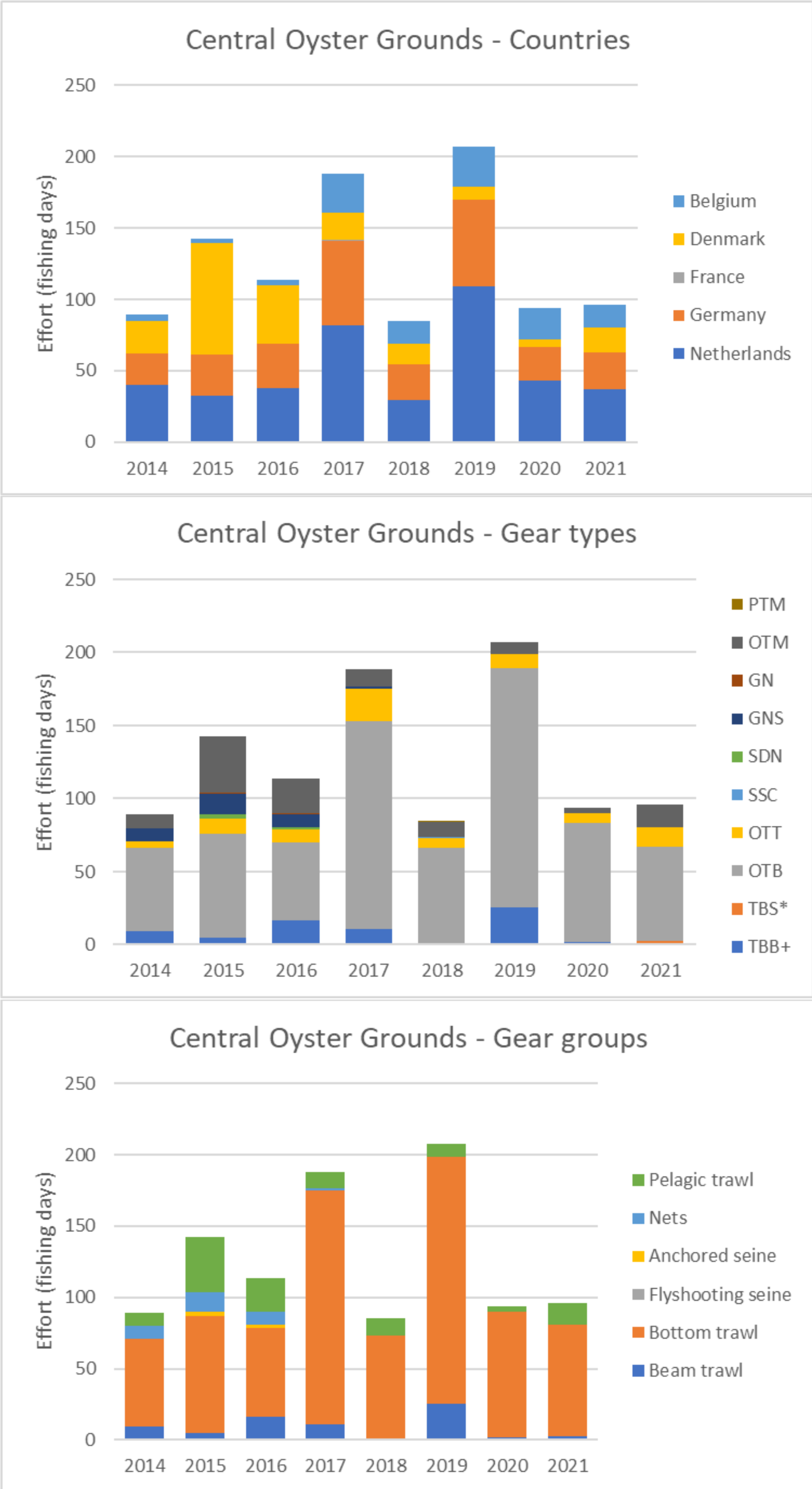


Figure 12. Fishery effort (fishing days) per year in the proposed management zone of Central Oyster Grounds for fleets (countries), gear types and gear groups.

2.3.3 Fleet activity by member state

The majority of the fishing activities on the **Frisian Front subarea 1** in the period 2014-2021 is carried out by the Dutch fleet with on average 199 fishing days per year which is 67% of total average effort of 299 fishing days per year for the fleets on the five countries considered. Next highest fishing activities are found for Germany, Belgium, Denmark and France with a share of 25%, 5%, 3% and 0,5%, respectively.

The majority of the fishing activities on the **Frisian Front subarea 2** in the period 2014-2021 is carried out by the Dutch fleet with on average 8 fishing days per year which is 64% of total effort of 13 fishing days for the five countries considered. Next highest fishing activities are found for Germany, Denmark, Belgium and France with a share of 19%, 14%, 3% and 0,4%, respectively. There was no fishing activity of the French fleet in this area.

The majority of the fishing activities on the **Central Oyster Grounds** is carried out by the Dutch fleet with on average 52 fishing days per year amounting to 41% of total effort of 127 fishing days for the fleets of the five countries considered. Next highest fishing activities are found for Germany, Denmark, Belgium and France with a share of 27%, 20%, 12% and 0.1%, respectively.

Trends over years
Over the whole 2014-2021 period there was no clear trend of increase or decrease in total fishery activity in the **Frisian Front subarea 1**. There was an irregular pattern from year to year, mainly determined by the changes in effort by the Dutch fleet. The effort of the French fleet was zero in the period 2014-2021, but some effort occurred in 2018 and 2019 with 5 and 6 fishing days, respectively.

Over the whole 2014-2021 period there was an average annual decrease in total fishery activity of 10.4% in the **Frisian Front subarea 2.** This could be mainly attributed to the decrease in the effort of the Dutch fleet. For the other countries the effort was so low and irregular that no trend could be observed.

Over the whole 2014-2021 period there was no clear trend in the total fishery activity in the **Central Oyster Grounds**. However, there was a very irregular pattern with time. For instance in 2018 the total fishery activity was 60% lower than in 2019. The effort of the Belgian fleet somewhat increased, whereas the effort of the Danish fleet decreased in the period 2014-2021. For the Dutch and German fleets no regular trend of increase or decrease was observed.

2.3.4 Gear and gear groups

During 2014-2021 the average share of the gear types in the total fishing effort in the **Frisian Front subarea 1** was with 176 fishing days per year the highest for beam trawls (TBB+) (59%), followed by bottom otter trawls (OTB) (26%), otter twin trawls (OTT) (9%), Scottish seines (SSC) (3%), otter trawls midwater (OTM) (2%) and set gillnets (anchored) (GNS) (1%) (Figure 10). The effort of the bottom-contacting gears comprised 97% of the total fishery activity in **Frisian Front subarea 1**.

The main gear type used in the **Frisian Front subarea 2** was with 6 fishing days per year SSC (48%), followed by GNS (19%), OTM (13%), TBB+ (11%), OTB (6%) and Danish seines (SDN) (0.4%) (Figure 11).
The effort of the bottom-contacting gears comprised 67% of the total fishery activity in Frisian Front subarea 2, respectively.

During 2014-2021 the average share of the gear types in the total fishing effort in the **Central Oyster Grounds** was with 87 fishing days per year the highest for OTB (69%), followed by OTM (12%), OTT (8%), TBB+ (7%), GNS (3%) (Figure 12).

The total fishing activity per km^2 was much higher in the Frisian Front subarea 1 as compared to the Frisian Front subarea 2 and Central Oyster Grounds, approximately a factor 4 and 2, respectively.

2.3.5 Seasonal variation in fishing activity

Data on the fishing activity per month of fleets, gear types and gear groups in the period 2014-2021 are shown for the Frisian Front subarea 1 (Table 13, Table 14, Table 15, Figure 13), Frisian Front subarea 2 (Table 16, Table 17, Table 18, Figure 14) and Central Oyster Grounds (Table 19, Table 20, Table 21, Figure 15).

Table 13: Overview of fishery effort (fishing days) per month of fleets nationality in the proposed management zone of the Frisian Front subarea 1. Months are numbered as follows: 1 January; 2 February; 3 March; 4 April; 5 May; 6 June; 7 July; 8 August; 9 September; 10 October; 11 November; 12 December.

Country	1	2	3	4	5	6	7	8	9	10	11	12	Average
Belgium	0.3	0.1	1.3	1.1	1.3	2.5	3.0	2.3	0.7	0.3	0.5	0.7	1.2
Denmark	0.7	0.3	0.6		0.0	0.1	1.2	3.5	0.6	0.4	0.6	0.7	0.7
France					0.1	0.0	0.8	0.5					0.1
Germany	3.7	5.0	4.3	5.6	9.5	7.8	9.7	4.9	7.6	6.2	6.5	5.3	6.3
Netherlands	8.3	9.3	12.9	13.4	33.0	31.3	31.9	15.8	15.7	11.4	8.0	8.1	16.6
Total	*13.0*	*14.8*	*19.0*	*20.1*	*43.9*	*41.7*	*46.6*	*27.1*	*24.5*	*18.2*	*15.6*	*14.8*	*24.9*

Table 14: Overview of fishery effort (fishing days) per month of gear types in the proposed management zone of the Frisian Front subarea 1.

Gear type	1	2	3	4	5	6	7	8	9	10	11	12	Average
TBB+	12.0	14.2	17.3	13.6	17.3	17.1	13.9	7.3	18.9	16.3	14.6	13.9	14.7
TBS*					0.0	0.0						0.0	0.0
OTB	0.6	0.3	1.0	4.5	15.4	15.5	23.0	11.5	3.7	1.1	0.4	0.5	6.5
OTT			0.2	1.8	5.6	5.2	8.2	5.2	1.1	0.4			2.3
SSC				0.2	5.0	2.7	0.9	0.3	0.1	0.0			0.8
SDN					0.1	0.0							0.0
GNS			0.6	0.1	0.4	1.1	0.0	0.3	0.1				0.2
GN									0.0				0.0
FPO									0.1				0.0
OTM	0.4	0.2					0.6	2.5	0.5	0.3	0.5	0.4	0.5
Total	*13.0*	*14.8*	*19.0*	*20.1*	*43.9*	*41.7*	*46.6*	*27.1*	*24.5*	*18.2*	*15.6*	*14.8*	*24.94*

Table 15: Overview of fishery effort (fishing days) per month of gear groups in the proposed management zone of the Frisian Front subarea 1.

Gear group	1	2	3	4	5	6	7	8	9	10	11	12	Average
Beam trawl	12.0	14.2	17.3	13.6	17.3	17.2	13.9	7.3	18.9	16.3	14.6	13.9	14.7
Bottom trawl	0.6	0.3	1.2	6.2	21.0	20.8	31.1	16.6	4.8	1.5	0.5	0.5	8.8
Flyshooting seine				0.2	5.0	2.7	0.9	0.3	0.1	0.0			0.8
Anchored seine					0.1	0.0							0.0
Nets			0.6	0.1	0.4	1.1	0.0	0.3	0.2				0.2
Traps									0.1				0.0
Pelagic trawl							0.6	2.5	0.5	0.3	0.5	0.4	0.5
Total	*13.0*	*14.8*	*19.0*	*20.1*	*43.9*	*41.7*	*46.6*	*27.1*	*24.5*	*18.2*	*15.6*	*14.8*	*24.9*

Table 16: Overview of fishery effort (fishing days) per month of fleets nationality in the proposed management zone of the Frisian Front subarea 2. Months are numbered as follows: 1 January; 2 February; 3 March; 4 April; 5 May; 6 June; 7 July; 8 August; 9 September; 10 October; 11 November; 12 December.

Country	1	2	3	4	5	6	7	8	9	10	11	12	Average
Belgium			0.04	0.01	0.20		0.06		0.02			0.01	0.03
Denmark							0.16	1.19	0.26	0.30	0.01		0.16
France						0.05	0.01						0.00
Germany		0.01	0.03	0.14	0.39	0.91	0.18	0.49	0.26	0.01	0.03	0.04	0.21
Netherlands	0.18	0.09	0.41	0.41	3.11	2.78	0.88	0.24	0.16	0.01	0.07	0.12	0.70
Total	*0.18*	*0.09*	*0.48*	*0.55*	*3.69*	*3.74*	*1.29*	*1.92*	*0.70*	*0.32*	*0.11*	*0.17*	*1.10*

Table 17: Overview of fishery effort (fishing days) per month of gear types in the proposed management zone of the Frisian Front subarea 2.

Gear type	1	2	3	4	5	6	7	8	9	10	11	12	Average
TBB+	0.14	0.07	0.20	0.14	0.13	0.25	0.22	0.07	0.07	0.01	0.04	0.16	0.13
TBS*	0.02											0.01	0.00
OTB	0.01	0.02		0.02	0.07	0.14	0.09	0.35	0.08	0.01	0.02		0.07
OTT			0.01	0.01	0.01	0.01	0.01						0.00
SSC				0.09	2.99	2.26	0.76	0.15	0.09		0.03		0.53
SDN						0.05	0.01						0.00
**GNS			0.25	0.28	0.50	1.03	0.09	0.23	0.26				0.22
**GN									0.06				0.00
**FPO	0.02												0.00
**OTM							0.12	1.13	0.14	0.30	0.02		0.14
Total	*0.18*	*0.09*	*0.48*	*0.55*	*3.69*	*3.74*	*1.29*	*1.92*	*0.70*	*0.32*	*0.11*	*0.17*	*1.10*

**not part of the proposed fishery measures.

Table 18: Overview of fishery effort (fishing days) per month of gear groups in the proposed management zone of the Frisian Front subarea 2.

Gear group	1	2	3	4	5	6	7	8	9	10	11	12	Average
Beam trawl	0.15	0.07	0.21	0.14	0.13	0.25	0.22	0.07	0.07	0.01	0.04	0.17	0.13
Bottom trawl	0.01	0.02	0.01	0.03	0.08	0.15	0.10	0.35	0.08	0.01	0.02		0.07
Flyshooting seine				0.09	2.99	2.26	0.76	0.15	0.09		0.03		0.53
Anchored seine						0.05	0.01						0.00
**Nets			0.25	0.28	0.50	1.03	0.09	0.23	0.32				0.22
**Traps	0.02												0.00
**Pelagic trawl							0.12	1.13	0.14	0.30	0.02		0.14
Total	*0.18*	*0.09*	*0.48*	*0.55*	*3.69*	*3.74*	*1.29*	*1.92*	*0.70*	*0.32*	*0.11*	*0.17*	*1.10*

**not part of the proposed fishery measures.

Table 19: Overview of fishery effort (fishing days) per month of fleets nationality in the proposed management zone of the Central Oyster Grounds. Months are numbered as follows: 1 January; 2 February; 3 March; 4 April; 5 May; 6 June; 7 July; 8 August; 9 September; 10 October; 11 November; 12 December.

Country	1	2	3	4	5	6	7	8	9	10	11	12	Average
Belgium	0.14	0.07	0.24	0.91	1.30	0.86	0.46	0.89	1.99	3.54	3.46	1.19	1.25
Denmark	0.52	0.17		0.04	2.21	2.38	0.75	2.06	7.90	7.53	1.08	1.27	2.16
France									0.07				0.01
Germany	0.79	1.06	0.45	2.53	0.81	0.86	0.47	2.99	4.11	7.64	7.89	4.83	2.87
Netherlands	0.75	1.28	1.37	2.92	3.27	3.73	1.87	3.00	4.12	12.22	13.12	3.86	4.29
Total	*2.20*	*2.58*	*2.06*	*6.40*	*7.58*	*7.83*	*3.55*	*8.95*	*18.19*	*30.92*	*25.55*	*11.14*	*10.58*

Table 20: Overview of fishery effort (fishing days) per month of gear types in the proposed management zone of the Central Oyster Grounds.

Gear type	1	2	3	4	5	6	7	8	9	10	11	12	Average
TBB+	0.09	0.11	0.03	0.06	0.01		0.04	0.09	0.45	3.59	3.53	0.69	0.72
TBS*											0.23	0.02	0.02
OTB	1.55	2.03	1.30	6.00	4.81	4.35	2.75	6.71	10.89	19.50	19.01	8.48	7.28
OTT	0.09	0.44	0.73	0.31	0.55	1.32	0.13	0.67	0.73	2.34	1.99	1.02	0.86
SSC								0.04		0.01			0.00
SDN					0.61								0.05
**GNS					1.52	2.16	0.44				0.02		0.34
**GN					0.07				0.03				0.01
**OTM	0.47			0.02			0.19	1.43	6.00	5.45	0.77	0.93	1.27
**PTM									0.09	0.03			0.01
Total	*2.20*	*2.58*	*2.06*	*6.40*	*7.58*	*7.83*	*3.55*	*8.95*	*18.19*	*30.92*	*25.55*	*11.14*	*10.58*

**not part of proposed fishery measures.

Table 21: Overview of fishery effort (fishing days) per month of gear groups in the proposed management zone of the Central Oyster Grounds.

Gear group	1	2	3	4	5	6	7	8	9	10	11	12	Average
Beam trawl	0.09	0.11	0.03	0.06	0.01		0.04	0.09	0.45	3.59	3.76	0.71	0.74
Bottom trawl	1.64	2.47	2.03	6.32	5.37	5.67	2.87	7.38	11.62	21.84	21.00	9.50	8.14
Flyshooting seine								0.04		0.01			0.00
Anchored seine					0.61								0.05
**Nets					1.60	2.16	0.44		0.03		0.02		0.35
**Pelagic trawl	0.47			0.02			0.19	1.43	6.09	5.47	0.77	0.93	1.28
Total	*2.20*	*2.58*	*2.06*	*6.40*	*7.58*	*7.83*	*3.55*	*8.95*	*18.19*	*30.92*	*25.55*	*11.14*	*10.58*

**not part of proposed fishery measures.

There was a clear seasonal pattern for the fishing activity on the **Frisian Front subarea 1** (Figure 13) The relative fishing activity over an average year was highest in the period May to July (42-47 fishing days per month). The effort is relatively low in the months October to April (13 to 20 fishing days per month). This seasonal pattern also applies to the effort of three of the four frequently applied fishing gear types (OTB, OTT, SSC) and the national fleets (Belgium, Germany, Netherlands).

Similarly a very high seasonal variation in fishing activity was observed for the Frisian Front subarea 2, although it should be noticed that the monthly effort is always low (between 0 and 4 fishing days) (Figure 14). During the months of May and June the fishing activity peaked with 4 fishing days due to SSC and GNS activity. In the period October to March the fishery activity is very low (varying between 0.1 and 0.6 fishing day per month).

There was a clear seasonal pattern for the fishing activity on the **Central Oyster Grounds** (Figure 15). The relative fishing activity over an average year is the highest in the period August to December (9-31 fishing days per month), with a peak in October. The effort is relatively low in the months January to July (2-8 fishing days per month). In general, this seasonal pattern also applies to the effort of the four frequently applied fishing gear types (OTB, OTM, TBB, OTT) and the effort of the Belgian, Danish, German and Dutch fleets.

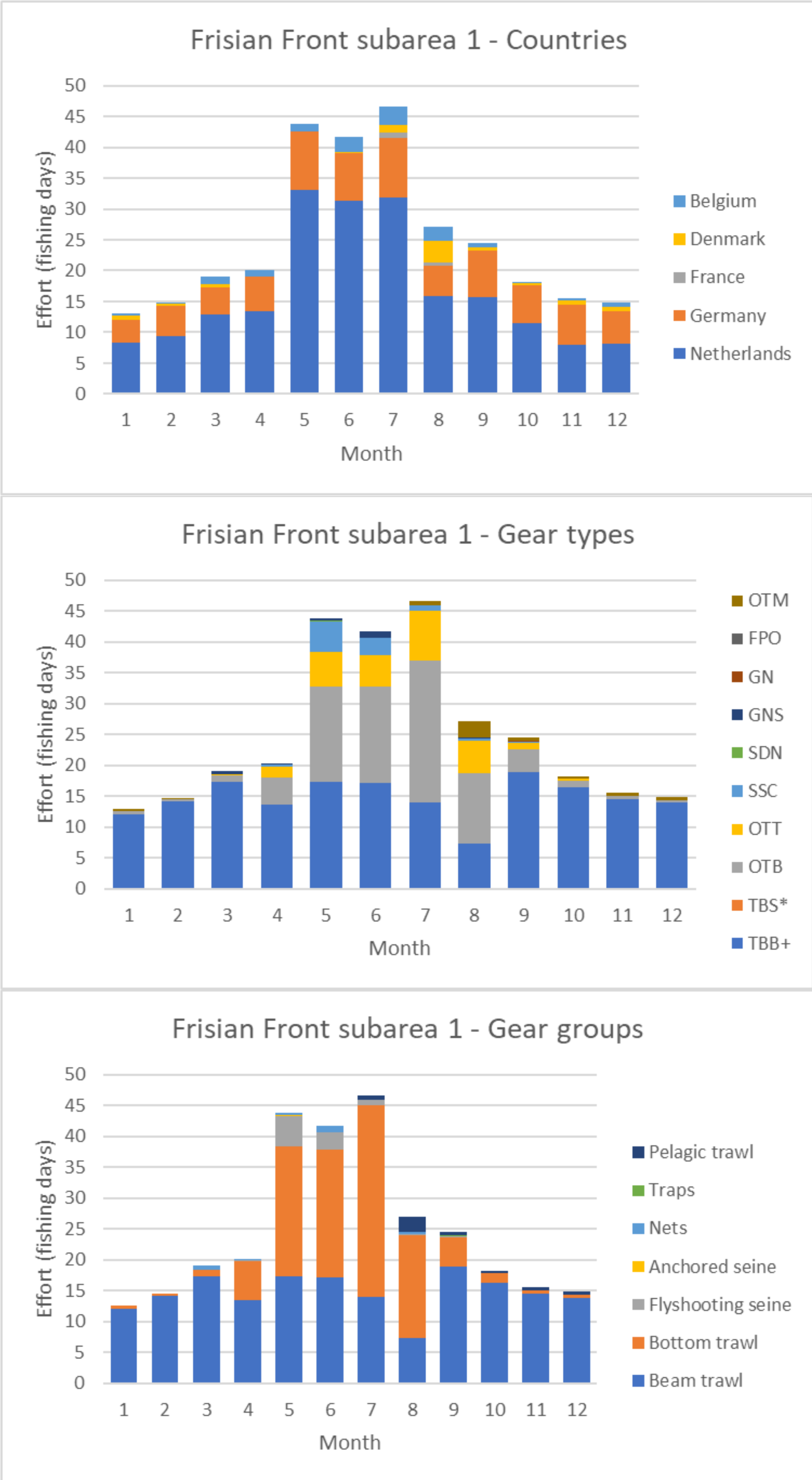


Figure 13. Fishery effort (fishing days) per month in the proposed management zone of Frisian Front subarea 1 for fleets (countries), gear types and gear groups. Months are numbered as follows: 1: January; 2: February; 3: March; 4: April; 5: May; 6: June; 7: July; 8: August; 9: September; 10: October; 11: November; 12: December.

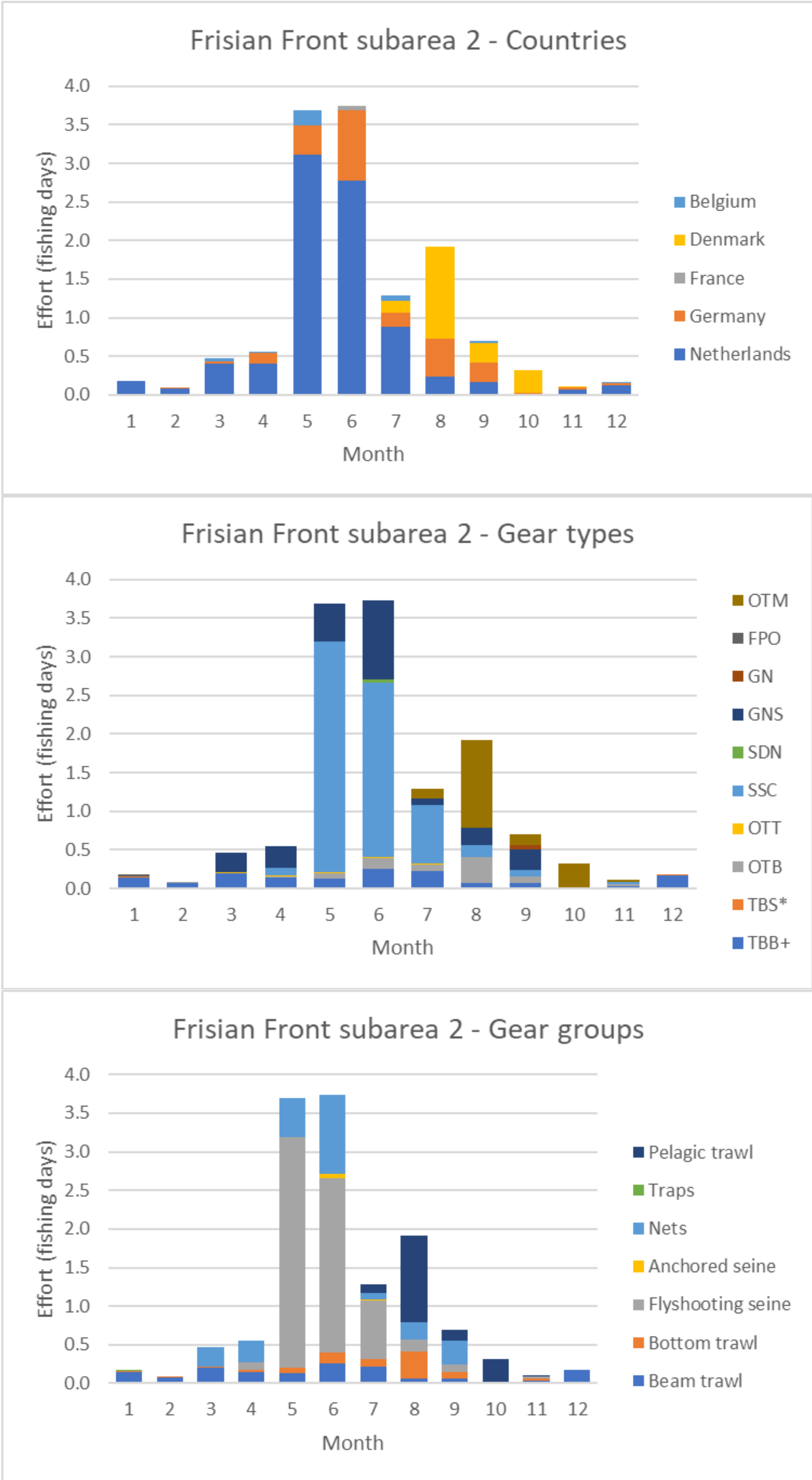


Figure 14. Fishery effort (fishing days) per month in the proposed management zone of Frisian Front subarea 2 for fleets (countries), gear types and gear groups. Months are numbered as follows: 1: January; 2: February; 3: March; 4: April; 5: May; 6: June; 7: July; 8: August; 9: September; 10: October; 11: November; 12: December.

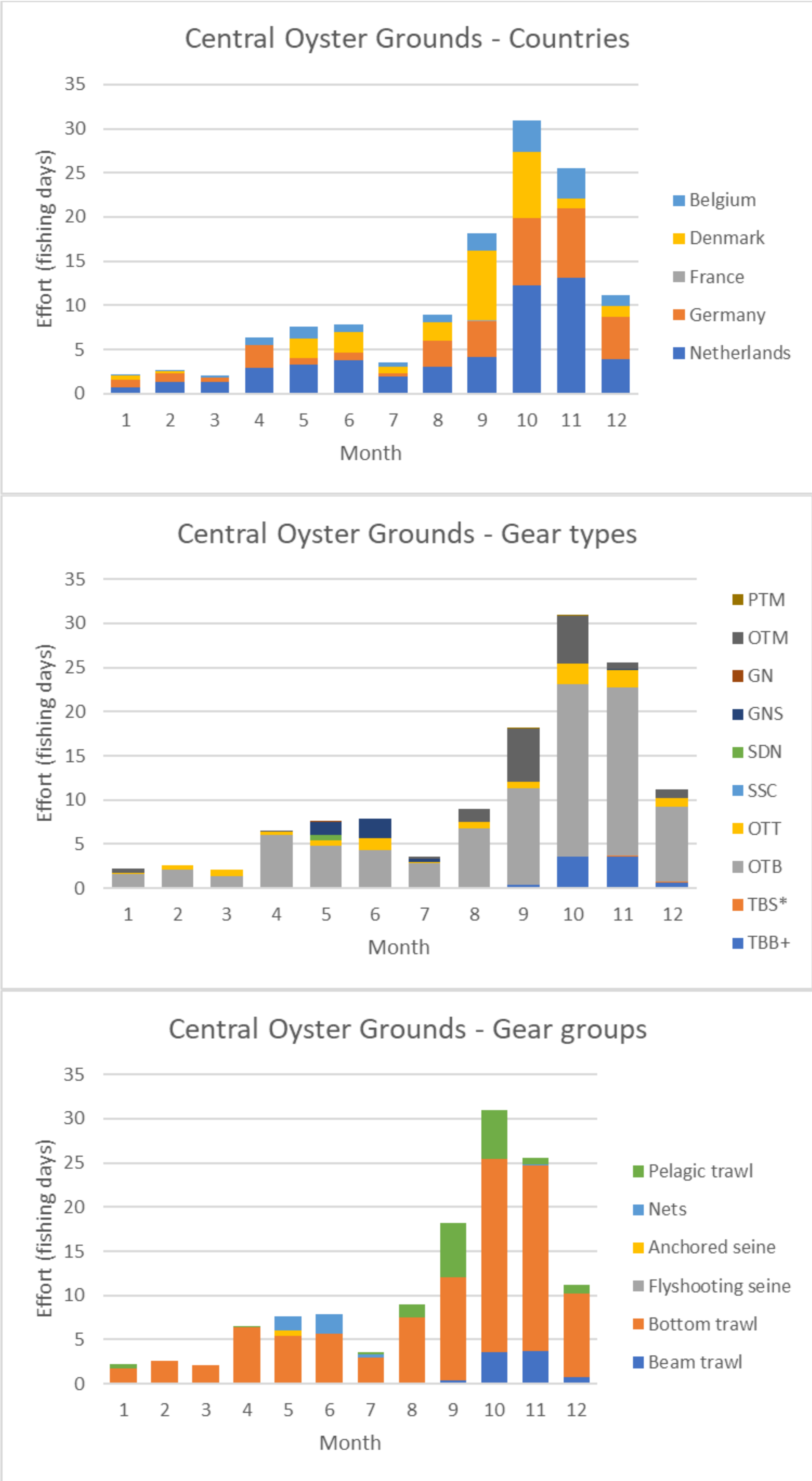


Figure 15. Fishery effort (fishing days) per month in the proposed management zone of Central Oyster Grounds for fleets (countries), gear types and gear groups. Months are numbered as follows: 1: January; 2: February; 3: March; 4: April; 5: May; 6: June; 7: July; 8: August; 9: September; 10: October; 11: November; 12: December.

2.3.6 Spatial distribution of fishing activity

Maps for the spatial distribution of the fishing activity of all gear groups combined and of the fishing activity of the various gear groups in a part of the North Sea. The Frisian Front subareas 1 and 2 and the Central Oyster Grounds and their surroundings are shown in Figure 16, Figure 17 and Figure 18.

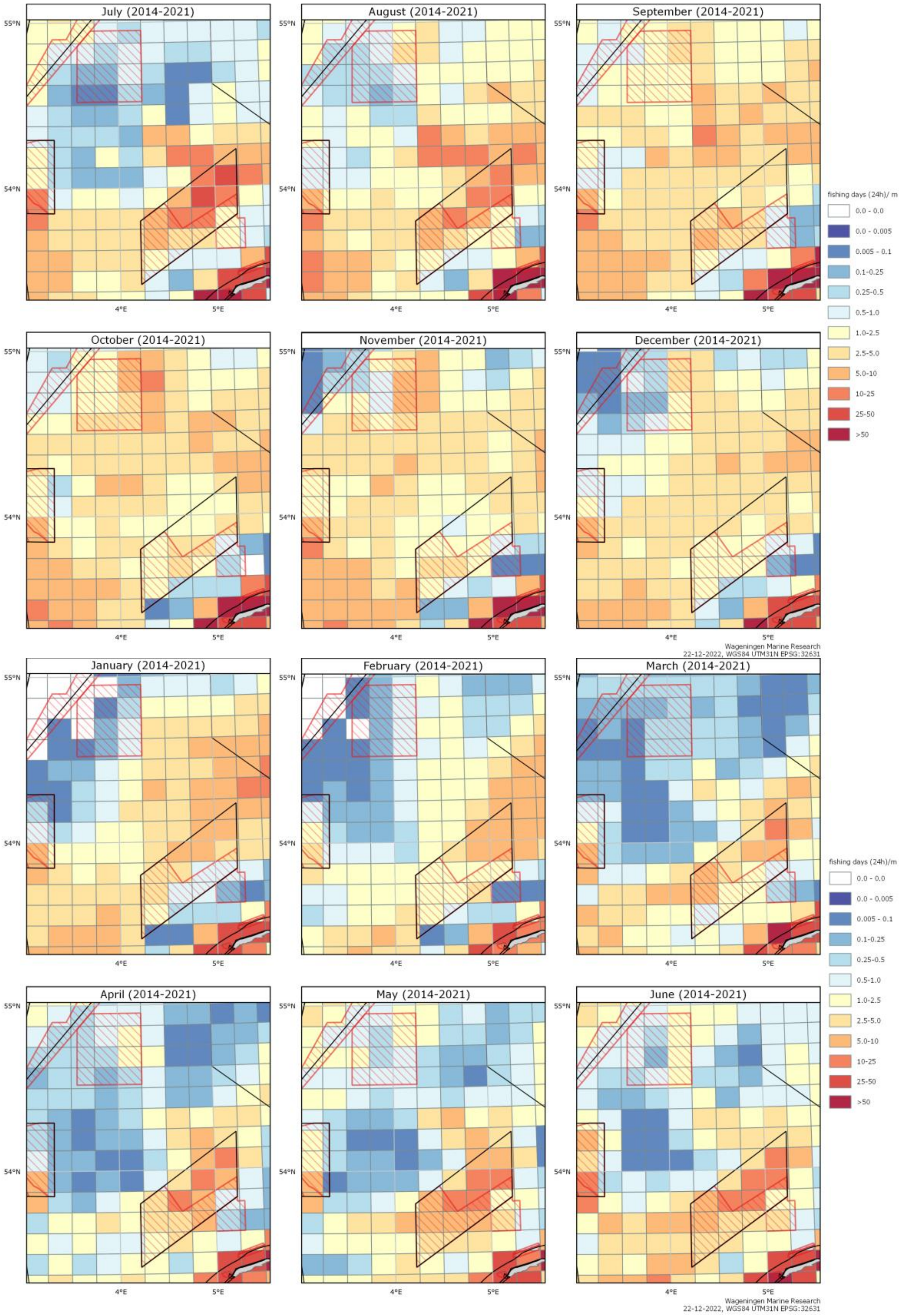


Figure 16. Frisian Front and Central Oyster Grounds: fishing effort per month, of all gears groups combined (fishing days (24 h)/month).

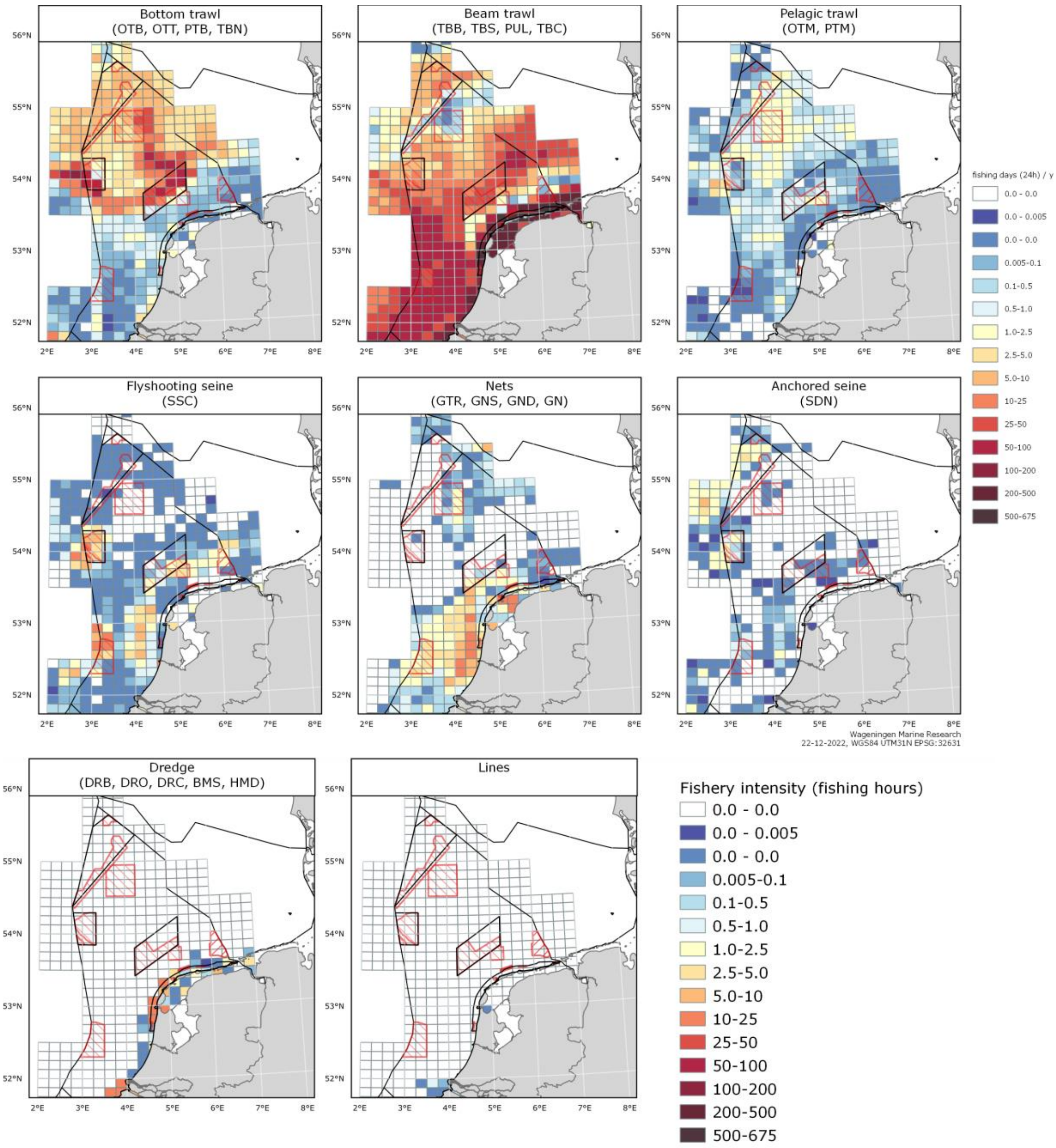


Figure 17. Fishing effort (fishing days (24 hours)/year) per gear group in the Dutch part of the North Sea.

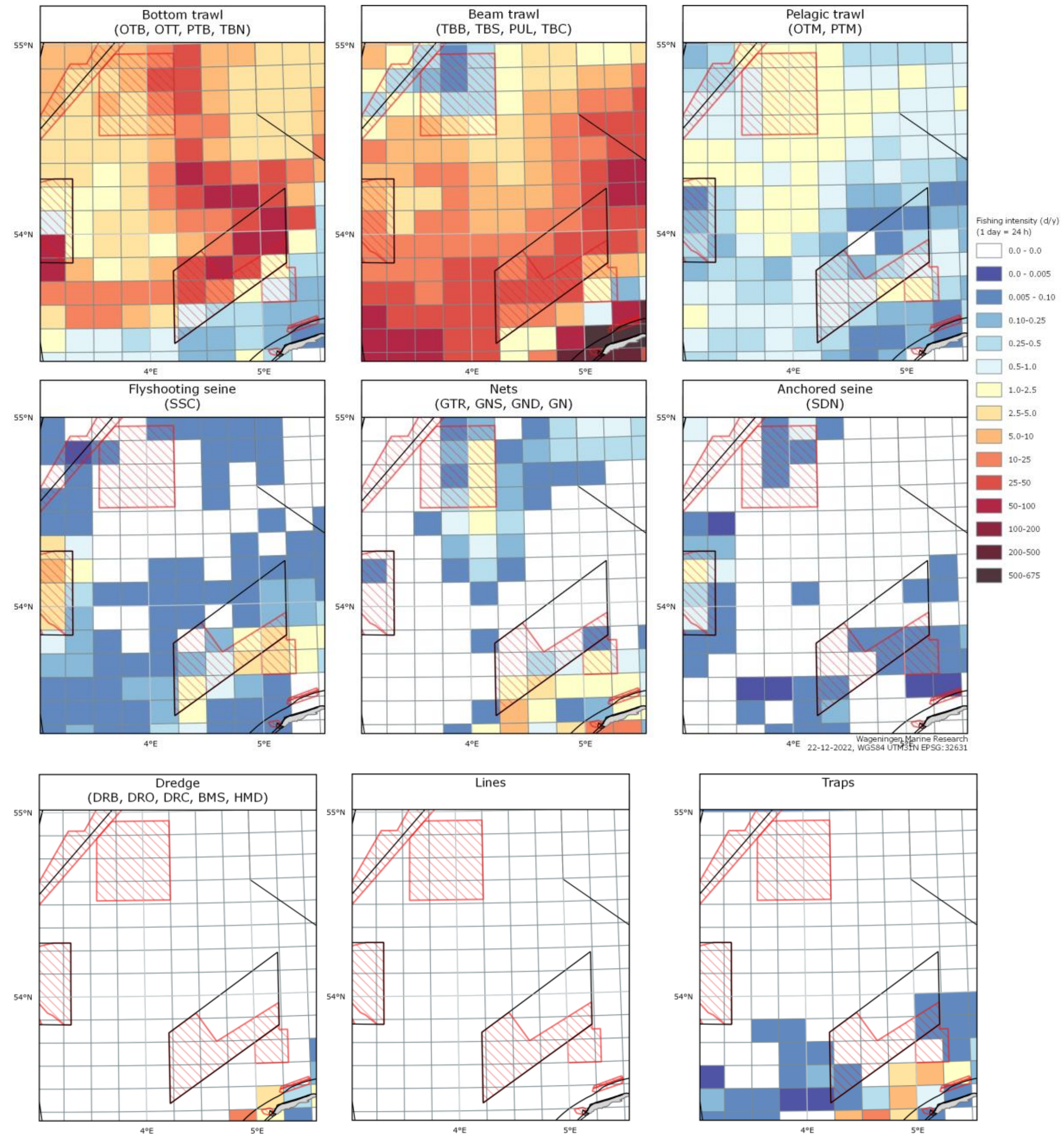


Figure 18. Frisian Front and Central Oyster Grounds: Fishing effort (fishing days (24 hours)/year) per gear group.

2.3.7 Main target species

Central Oyster Grounds

The main species caught on the Central Oyster Grounds are the European sprat (*Sprattus sprattus*; SPR) and the Atlantic herring (*Clupea harengus*; HER). Figure 19 shows the species that are caught in the Central Oyster Grounds by the Belgian, German, Danish, French, Dutch and Swedish fleets. European sprat are mostly caught in the Central Oyster Grounds by the Danish fleet with demersal trawlers or seiners and pelagic trawlers. In addition, they also catch Atlantic herring in the Central Oyster Grounds. Dutch and German beam trawlers catch European plaice (*Pleuronectes platessa*; PLE). Other species are also caught by the other fleets, but to a lesser extent.

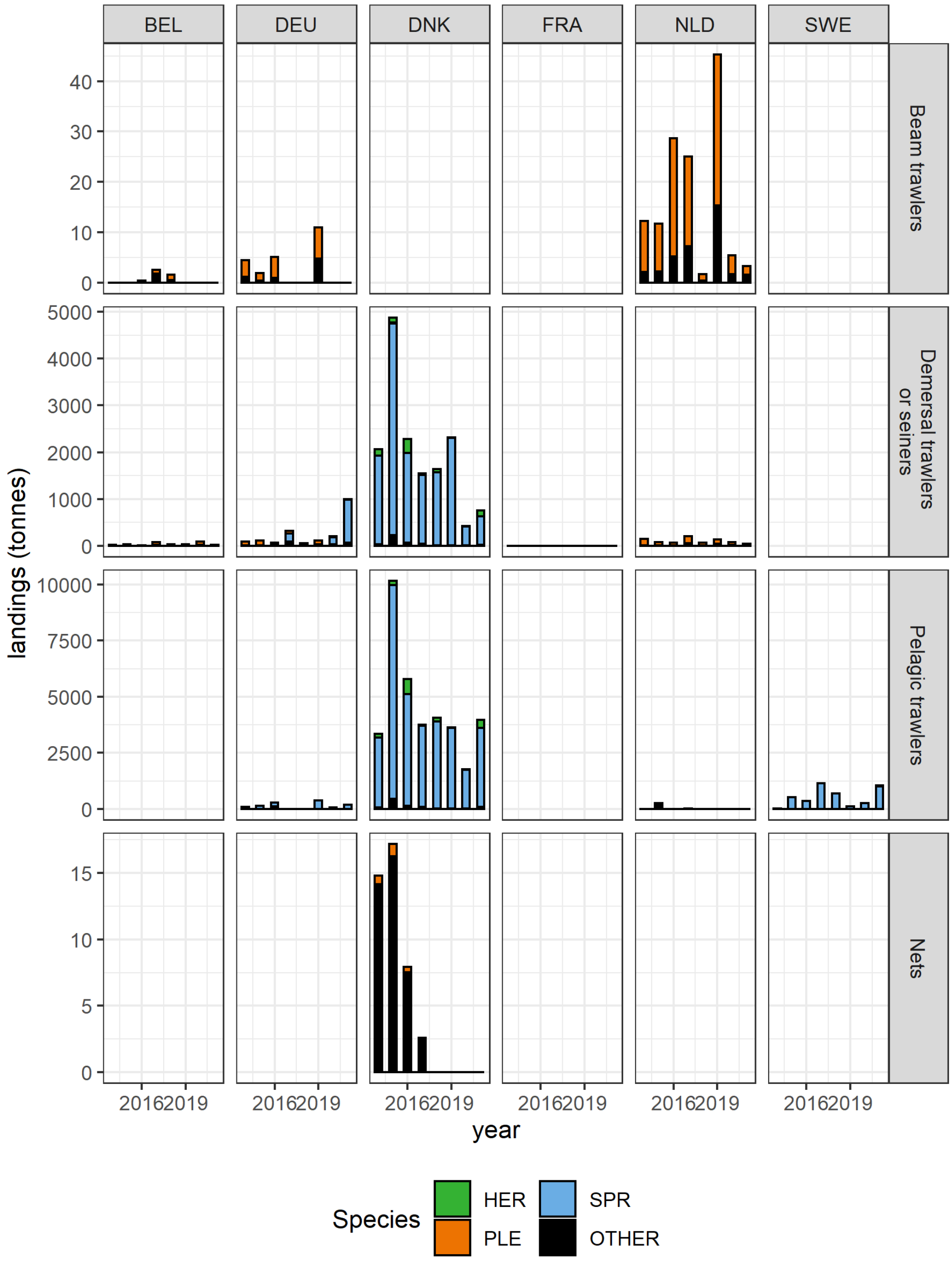


Figure 19. Historical trend by gear type of the species caught in the Central Oyster Grounds by the Belgian, German, Danish, French, Dutch and Swedish fleets (HER: Atlantic herring; PLE: European plaice; SPR: European sprat; Other: other species). Note the scale difference for the landings by gear type.
Source: Logbook data and VMS data, processed by WUR, DTUAQUA, TI, ILVO, SLU and IFREMER.

Frisian Front

The main species caught in this area are European sprat (*Sprattus sprattus*; SPR), European plaice (*Pleuronectes platessa*; PLE), Norway lobster (*Nephrops norvegicus*, NEP), common sole (*Solea solea*; SOL) and tub gurnard (*Chelidonichthys lucerna*; GUU). Figure 20 shows that most landings in **the Frisian Front subarea 1** consist of European sprat caught by the Danish fleet. European sprat are caught both by the Danish demersal trawlers or seiners and the Danish, Swedish and German pelagic trawlers. In addition, Dutch beam trawlers and Dutch demersal trawlers or seiners mainly caught European plaice, common sole, nephrops and tub gurnard in the Frisian Front subarea 1. However, the landings of the Dutch fleet were much lower compared to the landings of the Danish fleet caught in the Frisian Front subarea 1. German and Danish netters also caught common sole in limited quantities.

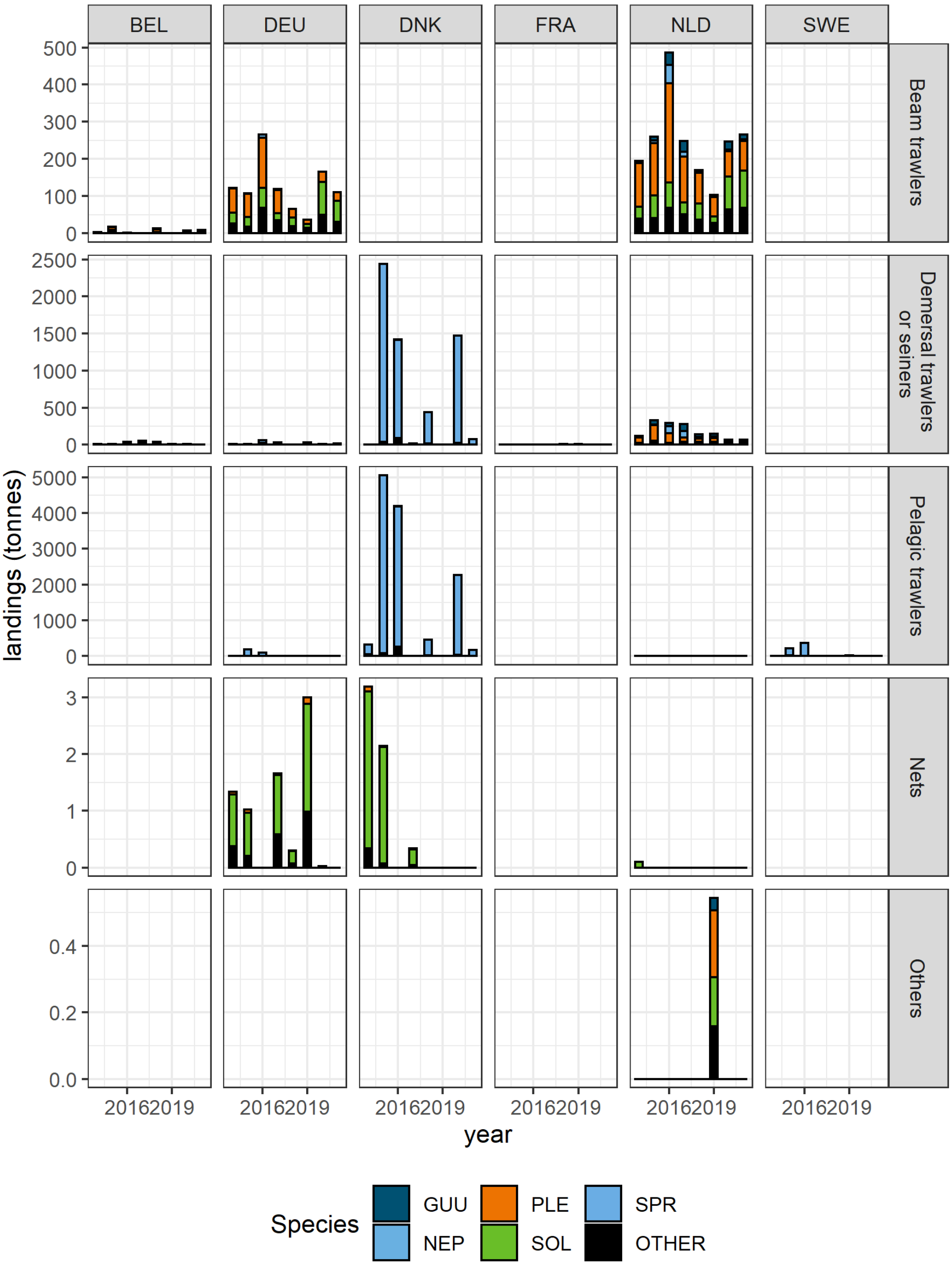


Figure 20. Historical trend of the species caught in the Frisian Front subarea 1 by the Belgian, German, Danish, French and Dutch fleet (GUU: Tub gurnard; NEP: Norway lobster; PLE: European plaice; SPR: European sprat, Other: other species).

Source: Logbook data and VMS data and data from the Annual Economic report (STECF 2022), processed by WUR, DTUAQUA, TI, ILVO, SLU and IFREMER.

The main species caught in this area are European sprat (*Sprattus sprattus*; SPR), tub gurnard (*Chelidonichthys lucerna*; GUU) and Atlantic mackerel (*Scomber scombrus*; MAC). Figure 21 shows that

European sprat are mainly caught in Frisian Front subarea 2 by the Danish fleet with demersal trawlers or seiners. However, the landings decreased significantly. In addition, Dutch demersal trawlers or seiners caught some tub gurnard in Frisian Front subarea 2. However, the landings of the Dutch fleet were much lower compared to the landings of the Danish fleet caught in Frisian Front subarea 2. Note that Figure 21 only shows the landings of the main gears. Pelagic trawls are not included in the Figure because these trawls will not be banned when this area is closed.

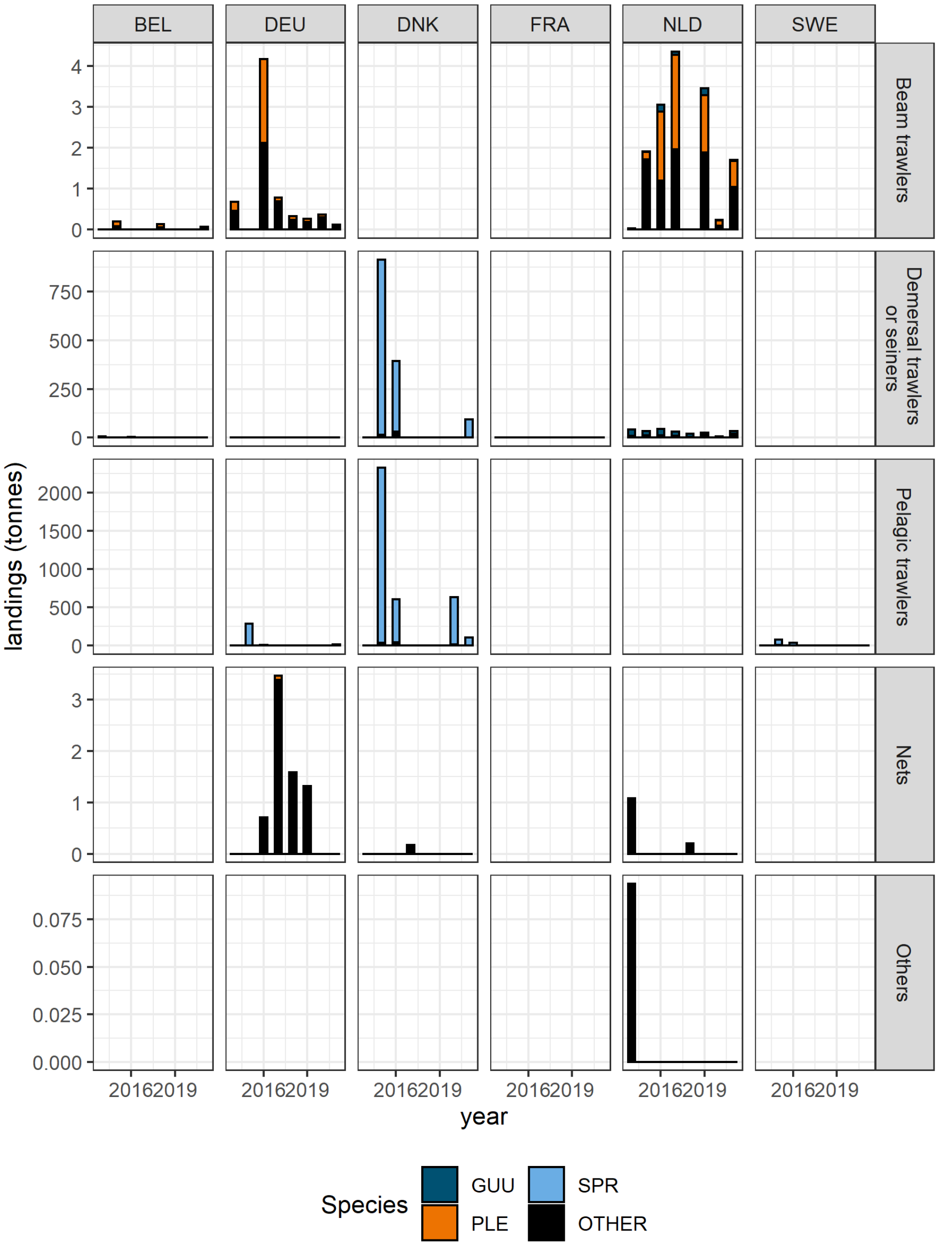


Figure 21. Historical trend by gear type of the species caught in the Frisian Front subarea 2 by the Belgian, German, Danish, French, Dutch and Swedish fleets (GUU: tub gurnard; PLE: European plaice; SPR: European sprat; Other: other species). Note the scale difference for the landings by gear type. Source: Logbook data and VMS data, processed by WUR, DTUAQUA, TI, ILVO, SLU and IFREMER

2.3.8 Economic value of the historic landings

Over the 2014-2021 period the amount of fishing activities has varied significantly from year to year in the Central Oyster Grounds and all countries were active in this area for at least one year during the period (Table 22). Total effort in the Central Oyster Grounds was between 90 and 210 fishing days (average of 159 days) and the added value varied between 1.0 and 3.5m euros (average of 1.8m euros). The Danish fleet was (by far) the most important fleet in this area in economic terms; the GVA of this fleets contributed to more than 70% of the total GVA from this area. However, the Danish activity decreased between the highest point in 20215 with 78 fishing days to its lowest in 2020 with only 5 fishing days. The German and Dutch fleet showed considerable levels of fishing activities in the area at varying levels but without showing any clear trends. The economic importance of the German and Dutch fleet was much lower than the one of the Danish fleet.

Table 22: Overview of effort, landings and values and gross value added of the fishing sector in the Central Oyster Grounds are given by country.

	Country	2014	2015	2016	2017	2018	2019	2020	2021	Average
Effort (fishing days)	BEL	5	3	4	27	16	28	22	16	15
	DEU	22	29	31	59	25	60	24	26	34
	DNK	22	78	42	19	16	10	5	18	26
	FRA				1					-
	NLD	40	33	38	82	29	109	43	37	52
	SWE	-	1	2	4	1	-	1	4	2
	Total	89	144	116	193	88	208	95	102	129
Landings (tonnes)	BEL	28	42	9	91	39	47	101	41	50
	DEU	201	250	362	319	57	501	276	1,198	396
	DNK	5,431	15,042	8,063	5,373	5,804	5,953	2,203	4,818	6,586
	FRA				1					-
	NLD	160	376	168	281	68	177	89	50	171
	SWE	33	529	360	1,152	693	293	355	1,065	560
	Total	5,854	16,239	8,962	7,217	6,661	6,972	3,025	7,172	7,763
Value (1,000 euros)	BEL	41	74	28	313	150	182	297	147	154
	DEU	174	220	335	548	202	533	179	430	328
	DNK	1,282	3,818	2,142	931	1,398	1,688	598	1,442	1,662
	FRA				4					-
	NLD	250	286	383	732	177	696	300	185	376
	SWE	7	120	114	251	152	68	89	337	142
	Total	1,754	4,518	3,002	2,779	2,079	3,167	1,463	2,541	2,663
Gross Value Added (1,000 euros)	BEL	18	40	16	171	76	85	168	84	82
	DEU	97	125	218	322	129	281	104	238	189
	DNK	922	3,165	1,762	725	1,143	1,293	500	1,202	1,339
	FRA				2					-
	NLD	134	143	228	403	93	283	149	89	190
	SWE	3	70	63	150	77	35	50	190	80
	Total	1,174	3,544	2,287	1,773	1,518	1,977	971	1,802	1,881

Source: Logbook data and VMS data and data from the Annual Economic report (STECF 2022), processed by WUR, DTUAQUA, TI, ILVO, SLU and IFREMER.

The Danish fleet mainly operated mid-water otter trawls (OTM) and bottom otter trawls (OTB) and showed decreasing effort, but stable landings and economic indicators after 2016 increasing landings and economic indicators after 2016 (*Figure 22*). The Dutch fleet in the area mainly used OTB and otter twin trawls (OTT), just as most other fleets. The economic importance for the Danish fleet, and particularly the GVA, was first decreasing (2015-2016) and then remained stable (2017-2021).

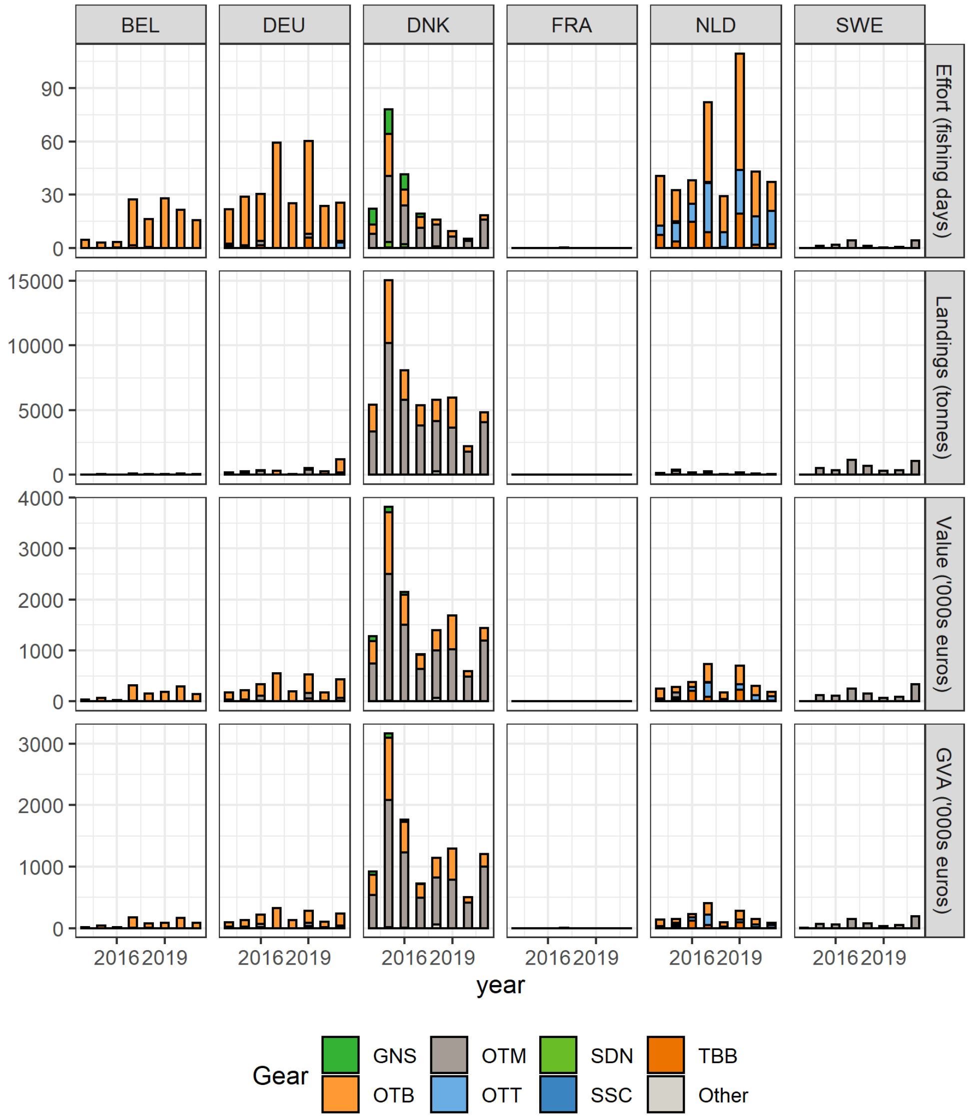


Figure 22. Historical trend of the fishing activities in the Central Oyster Ground with different gears (GNS: set gillnets (anchored); OTB: bottom otter trawls; OTM: otter trawls midwater; OTT: otter twin trawls; SDN: Danish seines; SSC: Scottish seines; TBB: beam trawls; Other: other gears) in the proposed closure of the Central Oyster Grounds for the different countries. Effort, landings, value of landings and GVA are given by country

Source: Logbook data and VMS data and data from the Annual Economic report (STECF 2022), processed by WUR, DTUAQUA, TI, ILVO, SLU and IFREMER.

Over the 2014-2021 period the amount of fishing activities has varied significantly from year to year in the Frisian Front subarea 1 and all countries were active in this area (Table 23), although France and Sweden have extremely low activity. Total effort in the Frisian Front subarea 1 was between 196 and 441 days at sea (average of 299 days) and the added value varied between 0.6 and 4m euros (average of 1.8m euro). The Dutch fleet was the most important in the area (65% of effort and 50% of GVA), followed by the German fleet (about 25% of effort and 20% of GVA). The Danish fleet was also quite important in economic terms (about 30% of GVA) despite the high interannual variability of its activity in the area.

Table 23: Overview of effort, landings and values and gross value added of the fishing sector in the Frisian Front subarea 1 are given by country. Source: Logbook data and VMS data and data from the Annual Economic report (STECF 2022), processed by WUR, DTUAQUA, TI, ILVO, SLU and IFREMER.

	Country	2014	2015	2016	2017	2018	2019	2020	2021	Average
Effort (fishing days)	BEL	6	9	19	37	25	6	4	5	14
	DEU	53	50	112	73	43	58	121	99	76
	DNK	7	26	18	1	7		9	3	9
	FRA					5	6	-	-	1
	NLD	130	204	290	263	160	157	191	199	199
	SWE		1	3			-			-
	Total	196	289	441	374	239	227	325	307	300
Landings (tonnes)	BEL	17	27	45	57	59	13	22	13	31
	DEU	136	313	426	155	71	75	175	132	185
	DNK	331	7,499	5,611	31	898		3,736	255	2,295
	FRA					7	13	-	1	3
	NLD	331	633	815	610	324	254	321	337	453
	SWE		222	382			19			78
	Total	815	8,693	7,279	853	1,359	374	4,254	738	3,046
Value (1,000 euros)	BEL	43	104	223	278	244	65	108	64	141
	DEU	473	534	1,288	597	398	369	905	764	666
	DNK	97	1,776	1,464	9	170		1,068	84	584
	FRA					32	47	-	3	10
	NLD	968	1,825	3,022	2,330	1,223	926	1,969	1,908	1,771
	SWE		54	91			-			18
	Total	1,581	4,293	6,088	3,214	2,067	1,407	4,051	2,824	3,190
Gross Value Added (1,000 euros)	BEL	19	56	136	145	127	30	61	36	76
	DEU	238	313	772	306	239	193	513	421	374
	DNK	70	1,474	1,217	7	140		894	71	484
	FRA					14	18	-	1	4
	NLD	468	907	1,848	1,279	612	384	898	870	908
	SWE		32	50			-			10
	Total	795	2,782	4,024	1,736	1,133	626	2,366	1,399	1,858

Figure 23 presents the historical trend of the fishing activities in the proposed closure area of the Frisian Front subarea 1 for the different countries with different gears per country. The Dutch and German fleets used mainly beam trawls (TBB) and to a lesser extent bottom otter trawls (OTB) in the Frisian Front subarea 1. In addition the Dutch fleet also used substantially otter twin trawls (OTT) in 2016 and 2017. The Danish fleet was active in the area with midwater otter trawls (OTM) and bottom otter trawls (OTB) and the Belgian fleet with bottom otter trawls (OTB).

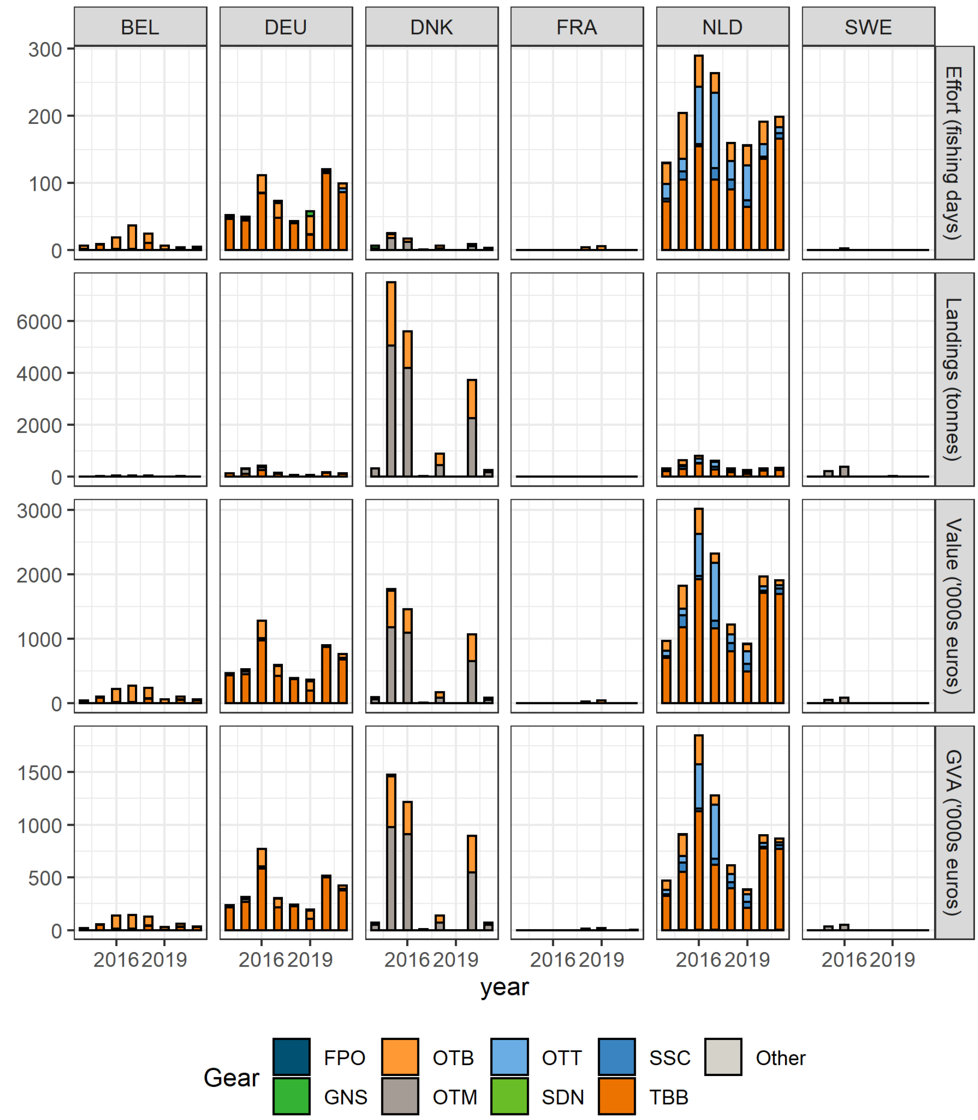


Figure 23. Historical trend of the fishing activities in the Frisian Front subarea 1 with different gears (FPO: Pots; GNS: set gillnets (anchored); HMD: Mechanised dredges; OTB: bottom otter trawls; OTM: otter trawls midwater; OTT: otter twin trawls; SDN: Danish anchored seines; SSC: Scottish seines; TBB: beam trawls; TBS: shrimp trawls, Other: other gears) in the proposed closure of the Frisian Front subarea 1 for the different countries. Effort, landings, value of landings and GVA are given per country. Source: Logbook data and VMS data and data from the Annual Economic report (STECF 2022), processed by WUR, DTUAQUA, TI, ILVO, SLU and IFREMER.

Over the 2014-2021 period the amount of fishing activities has varied significantly from year to year in the Frisian Front subarea 2 and all countries were represented in this area although Belgium, France and Sweden have extremely low activity (Table 24). Total effort in the Frisian Front subarea 2 was between 5 and 24 days at sea (average of 13 days) and the added value varied between 36 and 725 thousand euros (average of 200 thousand euros). The overall time trend in this area was driven by the activities of the Danish fleet, which was dominant in 2015, 2016 and 2020, and almost absent in the other years contributing to about 70% of the total GVA of the area over the period. The Dutch fleet was on average the most active in the area (on average 60% of the effort).

Table 24: Overview of effort, landings and values and gross value added of the fishing sector in the Frisian Front subarea 2 are given by country. Source: Logbook data and VMS data and data from the Annual Economic report (STECF 2022), processed by WUR, DTUAQUA, TI, ILVO, SLU and IFREMER.

	Country	2014	2015	2016	2017	2018	2019	2020	2021	Average
Effort (fishing days)	BEL	1	0	0	0	0	0	0	1	0
	DEU	1	2	3	7	3	3	1	0	3
	DNK	0	8	4	0			1	1	2
	FRA			0	0				0	0
	NLD	22	8	8	7	6	6	3	8	8
	SWE		0	0						0
	Total	24	19	15	14	10	9	5	10	13
Landings (tonnes)	BEL	7	0	5	0	3	0	2	1	2
	DEU	6	287	15	4	2	2	3	16	42
	DNK	4	3,239	999	0			636	199	635
	FRA			0	0				0	0
	NLD	58	47	54	43	20	31	8	37	37
	SWE		81	49						16
	Total	75	3,655	1,122	47	25	32	648	254	732
Value (1,000 euros)	BEL	9	2	11	0	19	1	5	3	6
	DEU	19	67	29	34	17	13	6	8	24
	DNK	1	742	266	2			178	65	157
	FRA			1	0				1	0
	NLD	122	102	103	113	35	69	19	74	80
	SWE		20	9						4
	Total	152	933	418	149	70	83	208	152	271
Gross Value Added (1,000 euros)	BEL	4	1	6	0	10	0	3	2	3
	DEU	11	40	18	18	10	6	3	4	14
	DNK	1	621	222	1			149	54	131
	FRA			0	0				0	0
	NLD	61	52	60	67	17	30	9	34	41
	SWE		12	5						2
	Total	77	725	312	87	37	36	163	95	192

Source: Logbook data and VMS data and data from the Annual Economic report (STECF 2022), processed by WUR, DTUAQUA, TI, ILVO, SLU and IFREMER.

Figure 24 presents the historical trend of the fishing activities in the proposed closure area of the Frisian Front subarea 2 for the different countries with different gears per country. The Dutch fleet is mainly active with Scottish seines (SSC) in the Frisian Front subarea 2. The German fleets used gillnets (GNS) between 2016 and 2019. The Danish fleet is active in the area with midwater otter trawls (OTM) and bottom otter trawls (OTB).

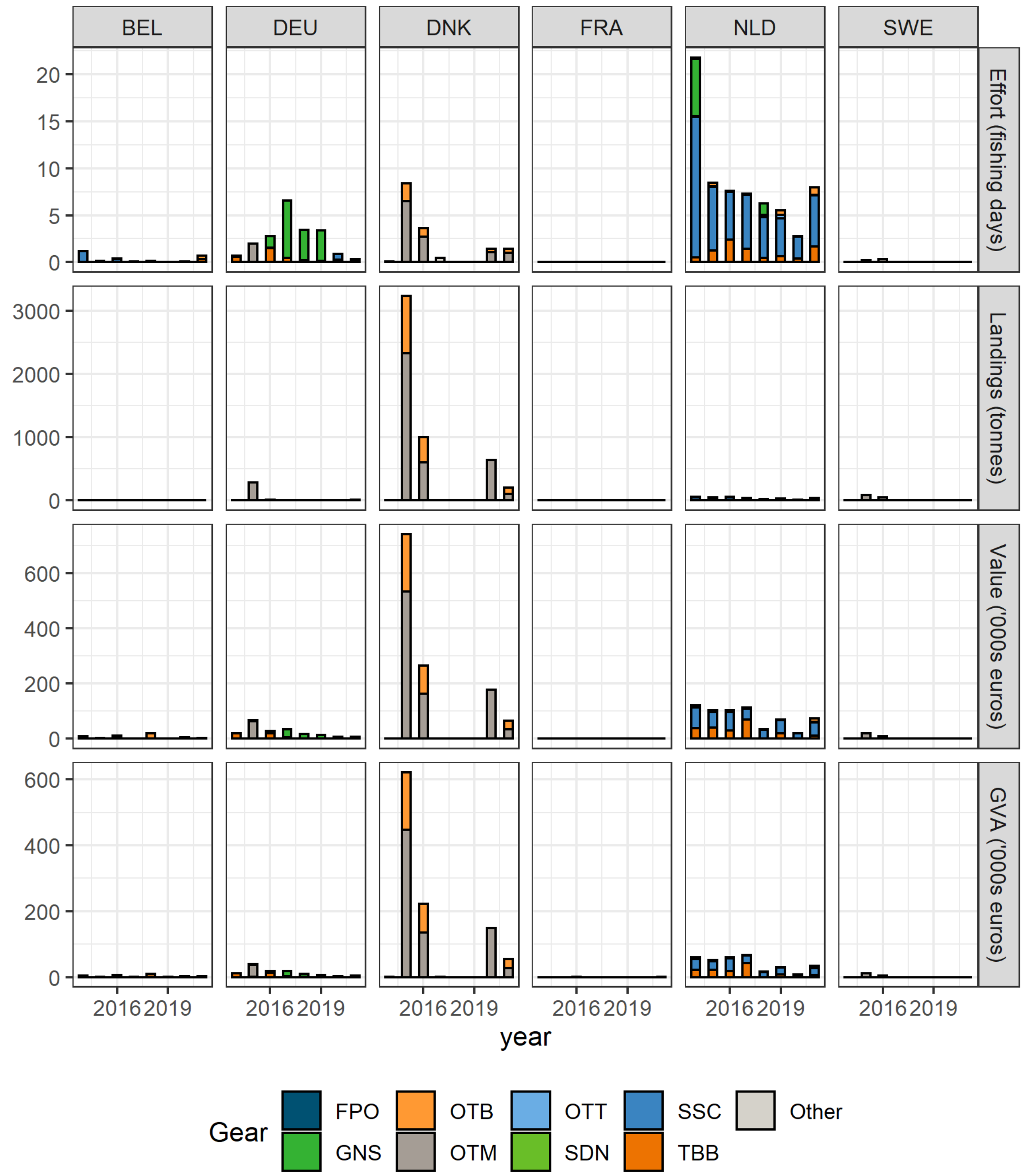


Figure 24. Historical trend of the fishing activities in the Frisian Front subarea 2 with different gears (GNS: set gillnets (anchored); OTB: bottom otter trawls; OTM: mid-water otter trawlsr; OTT: otter twin trawls; SDN: Danish anchored seines; SSC: Scottish seines; TBB: beam trawls; TBS: shrimp trawls, Other: other gears) in the proposed closure of the Frisian Front subarea 2 for the different countries. Effort, landings, value of landings and GVA are given per country. Source: Logbook data and VMS data and data from the Annual Economic report (STECF, 2022), processed by WUR, DTUAQUA, TI, ILVO, SLU and IFREMER.

2.3.10 Individual dependency of Dutch fishermen

Figure 25 shows that the number of Dutch vessels actively fishing on the Central Oyster Grounds varied over the study period between 14 and 37 vessels without a clear trend. The revenue dependency on the Central Oyster Grounds was lower than 10% for all vessels except 2014, 2017 and 2019 when one to two vessels concentrated more of their activity on the Central Oyster Grounds.

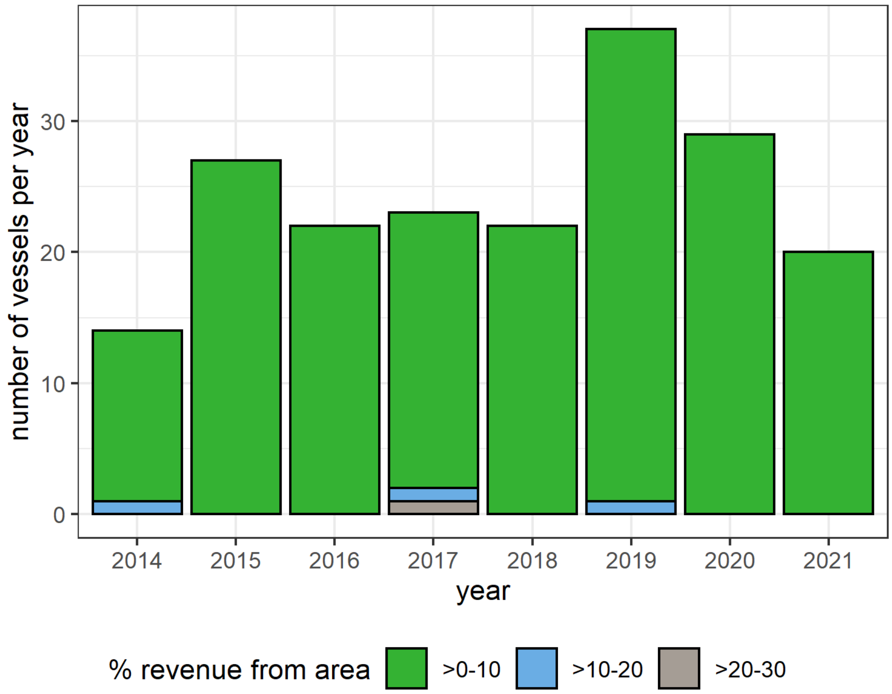


Figure 25. The number of Dutch vessels per year and the revenue dependency.

Over the 2014-2021 period, the majority of the vessels with fishing activities on the Central Oyster Grounds had a moderate dependency on the area (less than 10% of their revenue, Figure 26) and they came mainly from Urk (13 vessels) followed by Holland (8 vessels). Only one vessel came from Zeeland and another one from the North of the Netherlands. Most of the vessels that had a higher revenue dependency came from Urk.

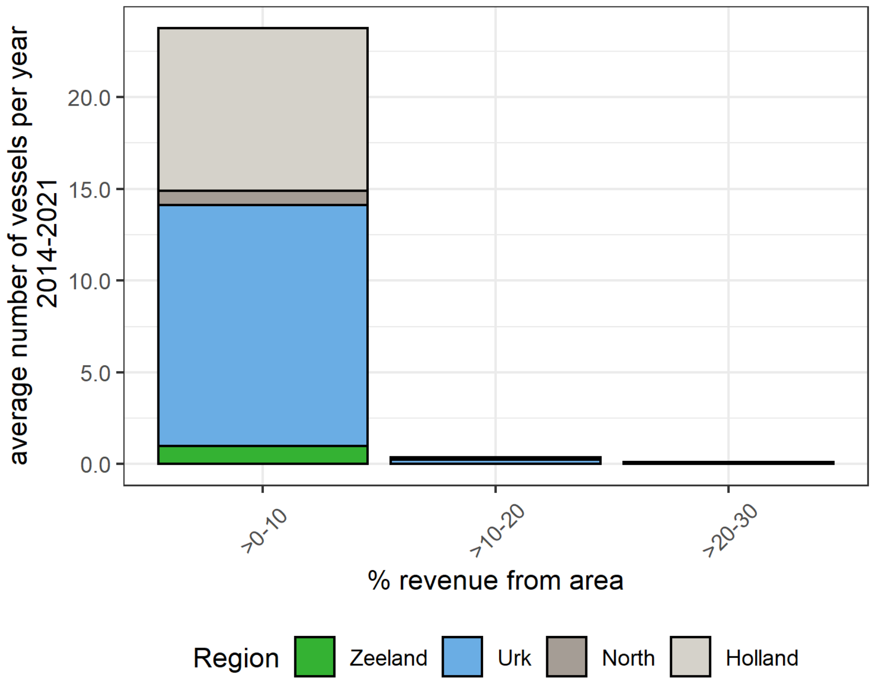


Figure 26. The average number of vessels per region and the revenue dependency.

The Majority of the fishing revenue from the Central Oyster Grounds, about 190 thousand euros per year, was obtained with bottom otter trawls (OTB) (Figure 27). The second most important gear was otter twin trawls (OTT) with an average annual revenue of about 100 thousand euros, followed by beam trawls fishing for flatfish (TBB) with a revenue of about 60 thousand euros. About a third of the revenue from the Central Oyster Grounds of the OTB and of the OTT came from vessels with an annual dependency higher than 10% (up to 30%).

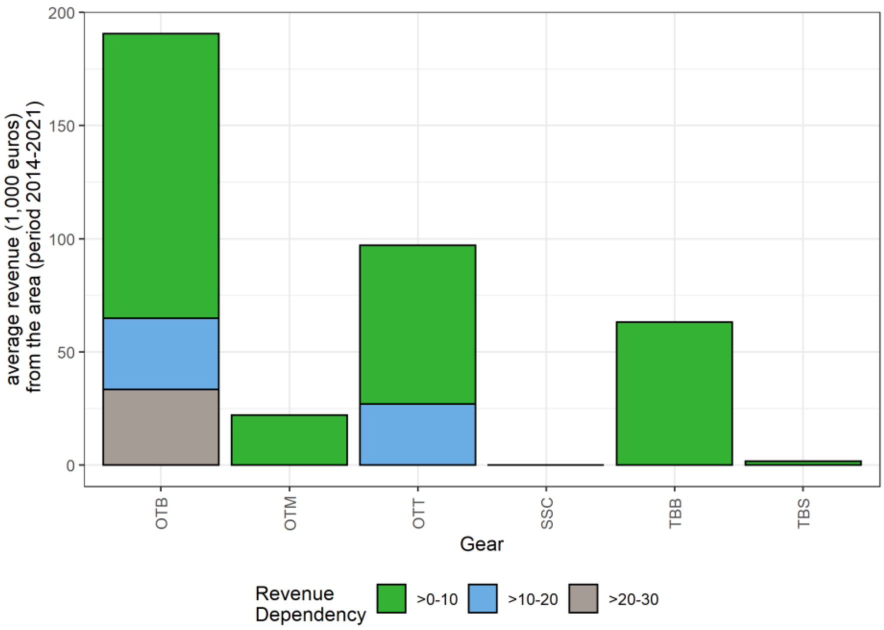


Figure 27. Total of the average revenues (x 1,000 euros) of the vessels with different dependencies on the area per gear type in the Central Oyster Grounds.

Figure 28 shows that the number of Dutch vessels actively fishing on the Frisian Front subarea 1 increased over the study period from 50 to 75 vessels. The revenue dependency on the Frisian Front subarea 1 was lower than 10% for most vessels but every year, a couple of vessels (up to ten in 2017) obtained more than 10% of their revenue on the Frisian Front subarea 1, up to 40% in 2016 and 2017.

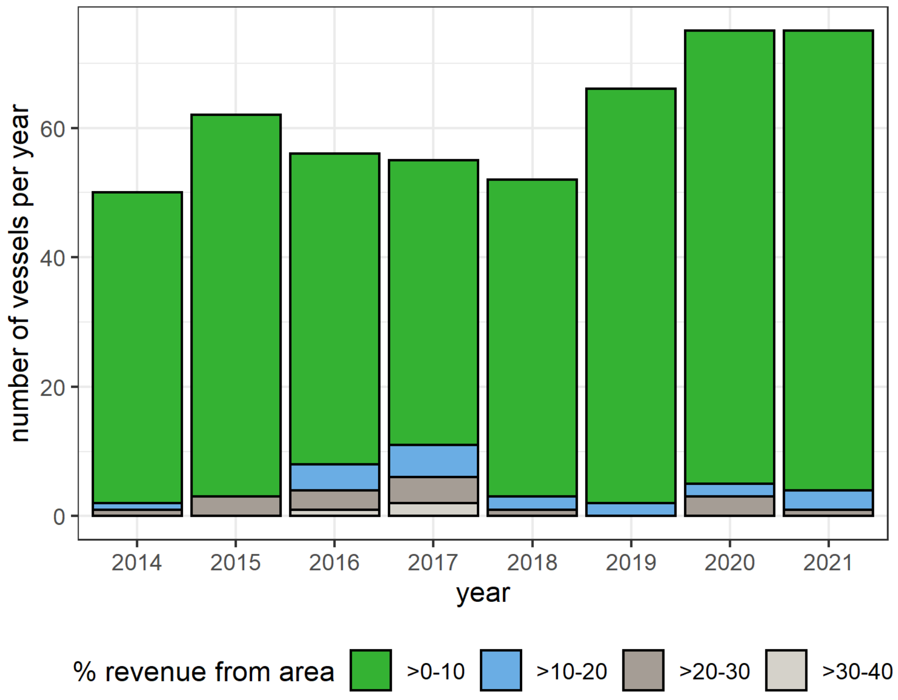


Figure 28. The number of Dutch vessels per year and the revenue dependency.

Over the 2014-2021 period, the majority of the vessels with fishing activities on the Frisian Front subarea 1 had a low dependency on the area (less than 10% of their revenue) and they came mainly from Urk (about 25 vessels) or Holland (about 21 vessels, see Figure 29). About three vessels came from Zeeland and about six from the North of the Netherlands. Most of the vessels that had a higher revenue dependency came from Urk and the others from Holland.

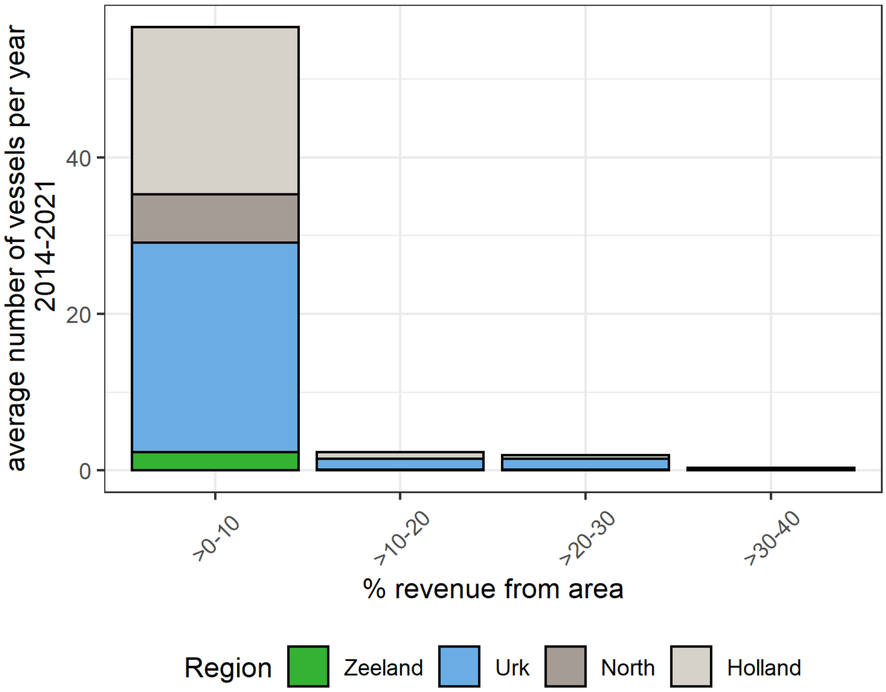


Figure 29. The average number of vessels per region and the revenue dependency.

The majority of the fishing revenue from the Frisian Front subarea 1, about 1.2m euros per year was obtained with beam trawls targeting flatfish (TBB) (Figure 30). The second most important gear was the otter twin trawls (OTT) with a revenue of about 300 thousand euros per year and then the bottom otter trawls (OTB) with an annual revenue of about 200 thousand euros. About half of the shrimp trawlers, otter twin trawlers and bottom otter trawlers revenue came from vessels with an annual dependency higher than 10%, and about a third from a dependency higher than 20%. The Scottish seiners amounted to an annual revenue of more than 100 thousand euros, mainly caught by vessels with a dependency lower than 10%.

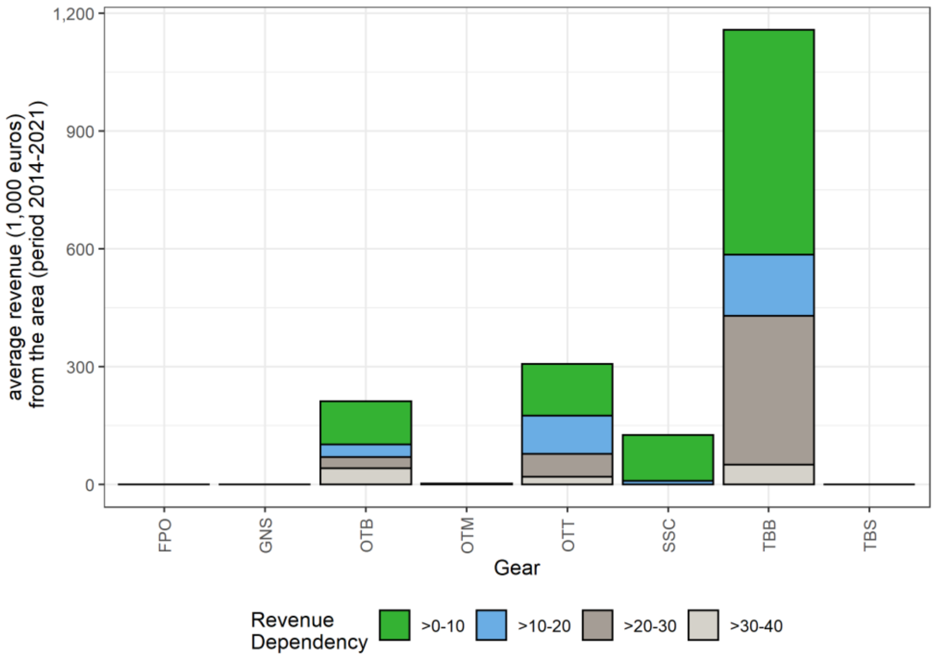


Figure 30. Total of the average revenues (x 1,000 euros) of the vessels with different dependencies on the area per gear type.

Figure 31 shows that the number of Dutch vessels actively fishing on the Frisian Front subarea 2 varied from year to year over the study period between 8 and 19 vessels. The revenue dependency on the Frisian Front subarea 2 was lower than 10% for all vessels except one vessel[3] in 2018 that obtained up to 60% of their revenue on the Frisian Front subarea 2.

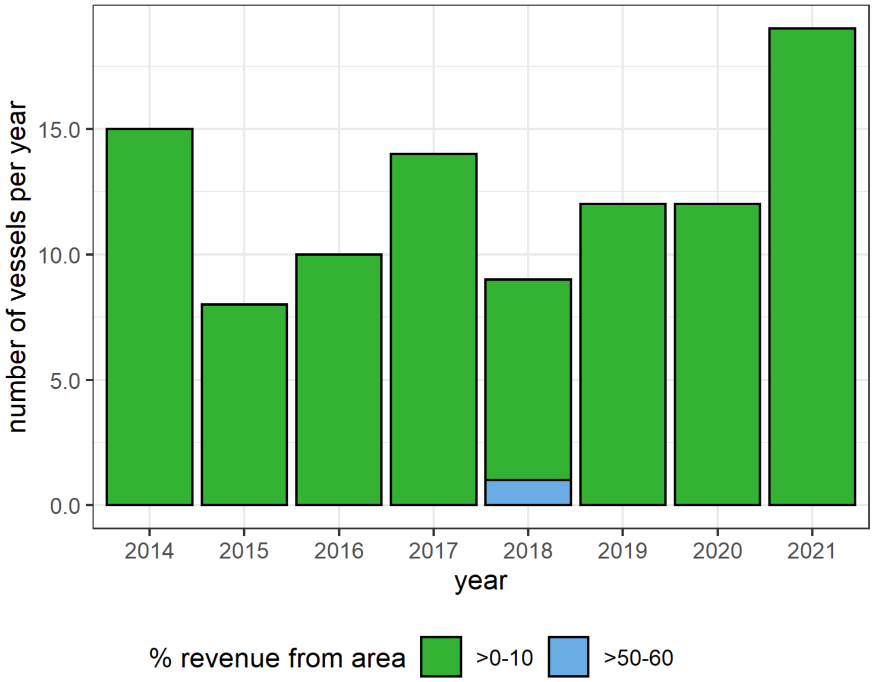


Figure 31. The number of Dutch vessels per year and the revenue dependency.

Over the 2014-2021 period, the majority of the vessels with fishing activities on the Frisian Front subarea 2 had a low dependency on the area (less than 10% of their revenue) and they came mainly from Urk (about 9 vessels per year, see Figure 32). About one vessel came from the North of the Netherlands per year and two from Holland. The vessel with the higher revenue dependency came from the North of the Netherlands.

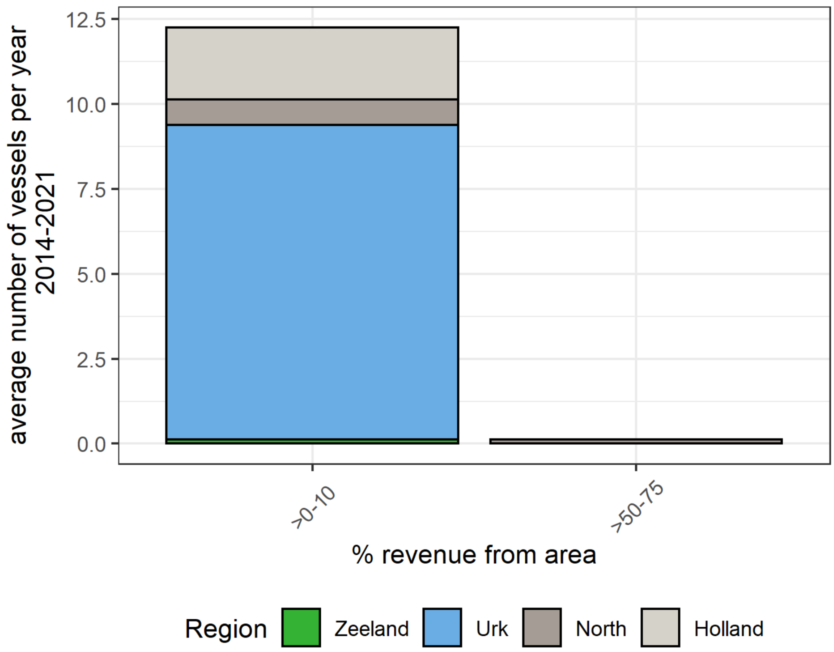


Figure 32. The average number of Dutch vessels per region and the revenue dependency.

[3] That vessel fished most of its revenue in the Frisian Front subarea 2, although the vessel was hardly active that year and the total annual revenue was low, about 3,300 euros for the year.

The majority of the fishing revenue from the Frisian Front subarea 2, about 60 thousand euros per year, was obtained with Scottish seines (SSC) (Figure 33). The second most important gear was the beam trawls fishing for flatfish (TBB) with a revenue of about 10 thousand euros. Most of the revenue came from vessels with an annual dependency lower than 10%.

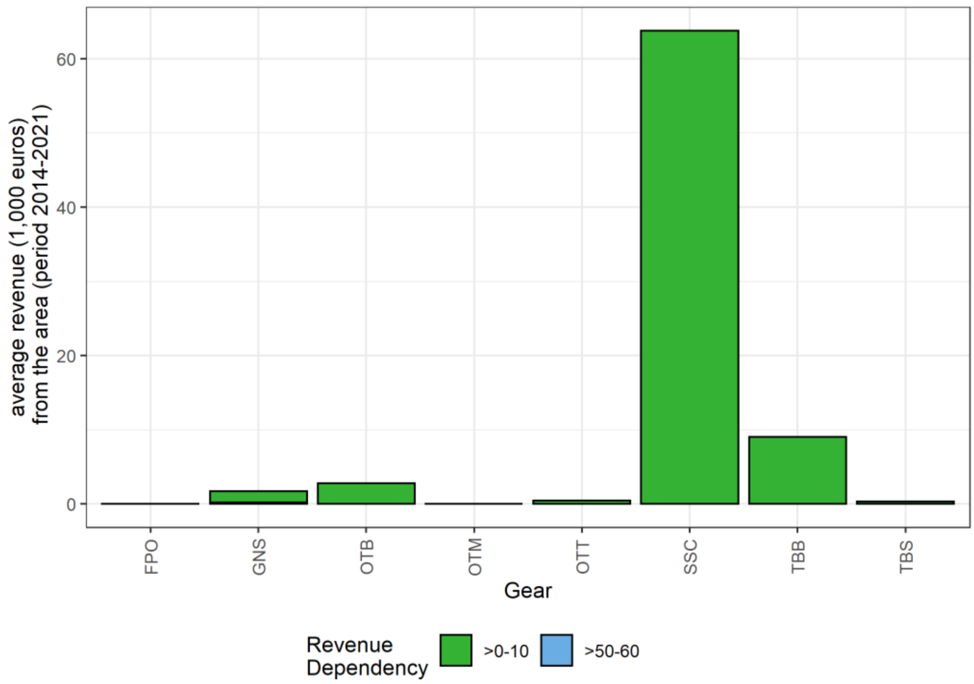


Figure 33. Total of the average revenues (x 1,000 euros) of the vessels with different dependencies on the area per gear type.

2.4 Other human activities

This paragraph provides an overview of predominant human activities on the Frisian Front and Central Oyster Grounds (Table 25). Information on the (spatial distribution of) activities is taken from the Noordzeeloket[4], a website of the Dutch Government that provides governmental information on the North Sea (e.g. management, policy, functions and use). Activities present on one or both sites (Table 25) are discussed in the separate sections below.

For the Frisian Front (designated Natura 2000 site under the Birds Directive), a national management plan is established in 2023[5]. The management plan is aimed at achieving the conservation objectives for the Natura 2000 area Frisian Front. It describes, among other things, the current situation and the measures that are necessary to achieve the objectives. Also the effects of current activities on the ability to achieve the conservation objectives in and adjacent to the Natura 2000 area are discussed. Activities that do not cause impact on conservation goals are exempted from permitting in the framework of the Nature Conservation act. For these activities, specific preconditions that should be met are described in the management plan.

[4] https://www.noordzeeloket.nl/en/functions-and-use/
[5] https://www.noordzeeloket.nl/beheer/gebieden/friese-front/

Table 25: Activities on the Frisian Front and Central Oyster Grounds (based on information from Noordzeeloket[6]).

Activity	Frisian Front	Central Oyster Grounds
Fishery	Presence of fisheries	Presence of fisheries
Oil and Gas	Presence of oil and/or gas platforms	No oil and/or gas activities
Cables and pipelines	Presence of cables and pipelines	Presence of cables and pipelines
Shipping	Presence of shipping lanes	No shipping lanes
Military use	Partly designated for military use	No military use
Surface mineral (sand/shell) extraction	No mineral extraction	No mineral extraction
Dredging spoil	No discharge of dredged material	No discharge of dredged material
Wind energy	Next to designated wind energy area	Not designated as wind energy area
Recreation	Not indicated for recreation area and/or recreational shipping routes	Not indicated for recreation area and/or recreational shipping routes

2.4.1 Oil/gas platforms (or exploration)

Within the boundaries of the Frisian Front, about twenty production installations are situated and another twenty in the direct vicinity (< 10 km, mainly SW of the area) (Van der Burg, 2012) (Figure 34). Next to this, movable exploration platforms (which perform test drills that take one to three months) have also been reported to be used in or near the site (The Netherlands, 2019).

The placement and removal of the platform, the placement of the pipelines, the drilling of wells and the discharge of drilling mud and cuttings have a direct effect on the habitat. By placing facilities on the seabed, part of the surface is no longer available for the original biological use and (part of) the biota present there will be destroyed. For the physical loss due to a platform for (oil and) gas extraction, a circular surface with a radius of 100 meters is used (I&W and LNV, 2018). However, when placing a platform, new (hard) substrate is introduced, on which other species can settle (Coolen, 2017). Each platform has a safety zone; no fishing, shipping or other use is allowed in a 500 m zone around the platforms. In case fisheries are excluded completely, a refugium can arise (Duineveld et al., 2007).

Continuous noise is (temporarily) caused by transportation (ships and helicopters) to- and from the drilling- and production platforms. Impulse noise is caused by seismic surveys and sometimes piling during the drilling phase (before drilling starts, a heavy metal pipe with a large diameter is driven or drilled several tens of meters into the ground at the site of the well) (Tamis et al., 2019). The main concern regarding noise pollution is the threat to marine mammals, because it can lead to physical damage, stress, disturbance of communication and / or behavioural change of individuals. This can lead among others to abandonment of the habitat or decreased reproduction. (Sub-)lethal effects of underwater noise have also been demonstrated for fish, lobster, squid and bivalves (Tamis et al., 2019 and references therein). However, in certain cases, habituation can also occur, especially with continuous sound.

Above sea level, the lighting on oil and gas installations during night-time may disturb birds within a five km radius. Optical disturbance by the silhouette of the installations may occur to a less extent. For the Frisian Front (BD area), these effects have been investigated. The degree of disturbance during day and night is assumed to be low (Tamis et al., 2011; The Netherlands, 2019). Significant negative effects on the conservation objectives are not expected, mainly because the impacted surface area is very limited (Tamis, 2011).

Van der Burg (2012) observed a decline in the number of oil pollution incidents per year in the Frisian Front over the period 1992-2010, which is consistent with the global downward trend. Also, a strong decline of the volume of oil pollution in oil-related incidents was recorded.

[6] https://www.noordzeeloket.nl/en/functions-and-use/recreatie-toerisme/

Offshore oil- and gas activities are expected to decline on the Dutch EEZ. Exhausted gas fields can be used for the storage of CO_2. The entire EEZ is designated as a search area for CO_2 storage locations Min I&M and Min EL&I, 2015).

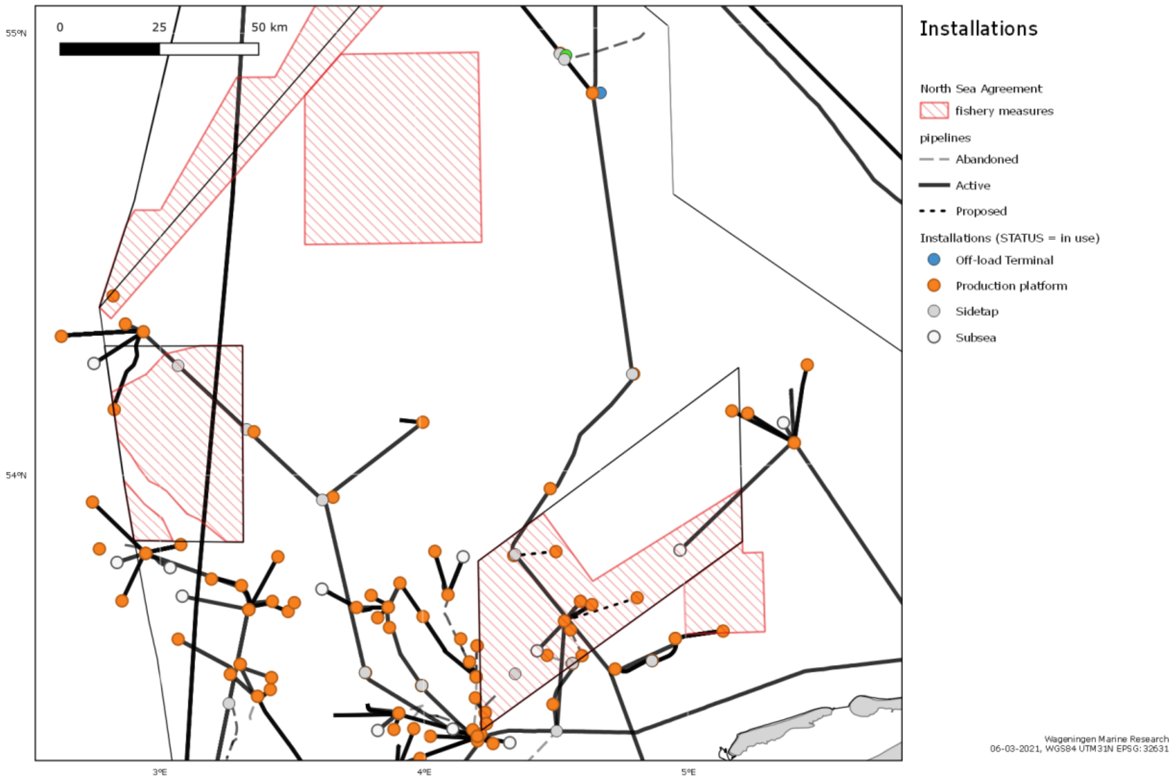


Figure 34. Installations and pipelines in the area of the Frisian Front and Central Oyster Grounds.

2.4.2 Cables and pipelines

On the Dutch Continental Self, cables stretch over about 4500 km, of which approximately half is no longer in use. The length of pipelines is an estimated 6000 km (CBS et al., 2019).

Figure 35 shows the cables and pipelines within and around the proposed closures of the Frisian Front and Central Oyster Grounds. In the Frisian Front area, several telecom cables are found, but only one is still in use. Three long distance gas pipelines cut through the area. A new subsea power cable, the NeuConnect Interconnector, will link England with Germany and is planned to transverse the Frisian Front. The route of the subsea cables and exact onshore locations will be determined by project development work that is currently underway[7]. The trajectory of this cable is thus not included in Figure 35. One active cable transverses the Central Oyster Grounds. The construction of a telecom cable between England and Denmark (Viking Link), was recently competed (2023) and travels through the Central Oyster Grounds[8].

Cables and pipelines are generally buried and thus there is no loss of surface. Rock dumping is only used at intersections, with an estimated surface area of 500 m^2 being lost (Ministerie van Infrastructuur en Waterstaat and Ministerie van Landbouw Natuur en Voedselkwaliteit, 2018). The installation causes some physical disturbance of the seafloor, for approximately 10 m at each side (Tamis et al., 2011).

Construction, inspection and maintenance of cables and pipelines obviously affect the sea floor, but the scale is very limited in terms of surface and duration.

[7] https://neuconnect-interconnector.com/what-is-neuconnect/
[8] https://www.viking-link.com/cables/offshore-work/

Figure 35. Cables and pipelines in the area of the Frisian Front and Central Oyster Grounds.

2.4.3 Shipping routes

There are no shipping lanes in the Central Oyster Grounds, whereas several deep water shipping routes cut through the Frisian Front (Figure 36). When comparing these routes with the shipping routes south of the area, the routes transecting the Frisian Front are not used very intensively (Figure 36). Spots with high shipping density are related to production platforms. The density of all ships using these routes

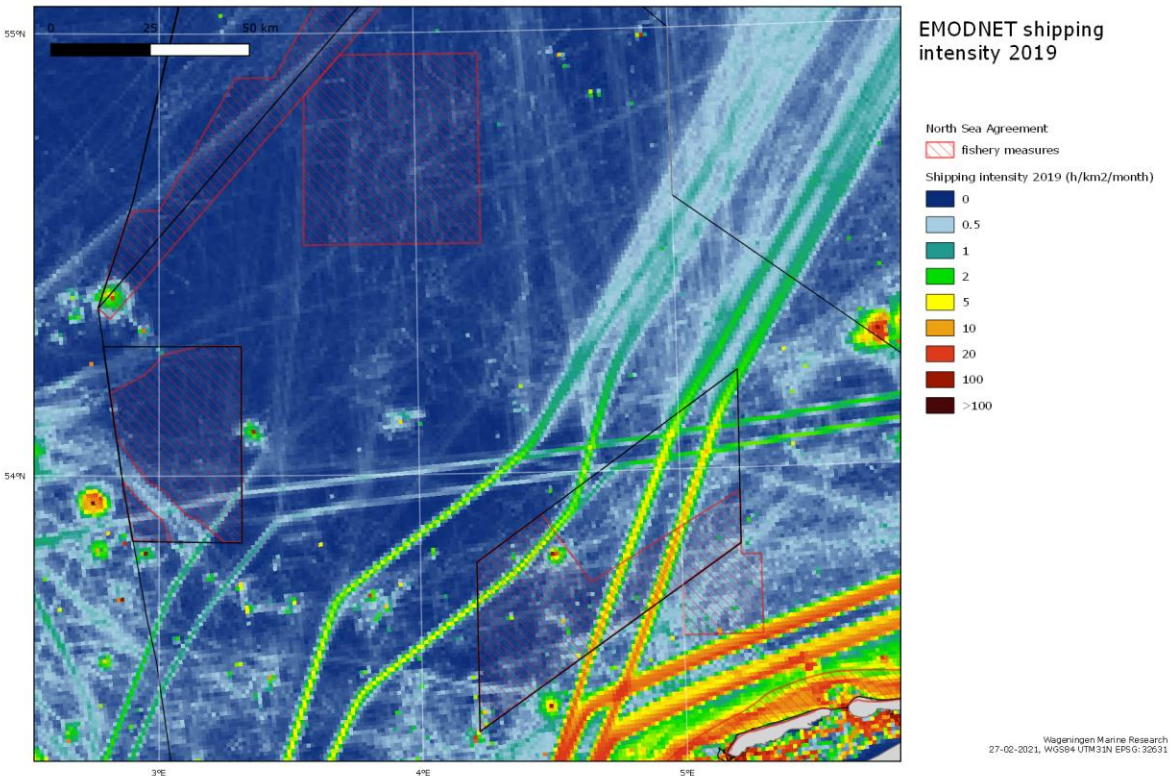


Figure 36. Shipping intensity (2019) in the area of the Frisian Front and Central Oyster Grounds.

is about three to nine ships per 1000 km^2. In addition, shipping not bound to these routes occurs on both the Frisian Front and the Central Oyster Grounds, mainly recreational ships and fishing vessels. Disregarding eventual polluting incidents, shipping has no effect on the sea floor. In the past, the use of tributyltin (TBT) as biocide in anti- fouling paint on ship hulls had serious negative effects on marine organisms, including benthos (e.g. imposex in dog whelk populations). From the 1980s, regulations developed towards a complete ban of TBT. However, TBT may remain present in the ecosystem for 30 years or so, but is not linked to present shipping.

2.4.4 Military use

More than 7% of the Dutch part of the North Sea is specifically available for military purposes[9]. This includes artillery exercises, flight exercises and exercises in mine disposal. There are also two former ammunition dumps in the North Sea, where mainly British and German ammunition was deposited after World War II. The designated area for military use has been established in the National Water Plan 2009-2015.

There are no military areas present at the Central Oyster Grounds but part of the Frisian Front is available for military flight exercises. Military activities can lead to the disruption of marine fauna due to the noise and vibrations they produce. Moreover, ammunition remnants end up in the North Sea during artillery training. Ecological research has not shown that this results in any environmental damage. Artillery training diminished by over 25% in the last ten years[10]. Military use has not been indicated as a threat to the conservation of the guillemots (*Uria aalge*) at the Frisian Front (Didderen et al., 2019).

2.4.5 Wind energy

There are no wind farms located in the Frisian Front and Central Oyster Grounds and the sites are not part of the designated area for wind energy (Figure 37). However, there are wind farms located east of the Frisian Front: the Buitengaats and Zee-Energie farms (called the Gemini Wind Park, Figure 37), located 60 km north of the Wadden Islands with a joint capacity of 600 MW[10]. The Gemini Wind Park[11] construction started in 2014 and was fully operational by 2017. An offshore wind farm may affect benthos, fish, birds, bats and marine mammals (WOZEP, 2016). Because of the large distance between the Gemini Wind Farm and the Frisian Front, impact within the Frisian Front is expected to be negligible. However, the Gemini Wind Farm lies within a designated area for wind energy which borders the Frisian Front (Figure 37). In case a wind farm will be planned close or even next to the Frisian Front, effects on fish, birds and marine mammals may occur (i.e. external impacts).

[9] https://www.noordzeeloket.nl/en/functions-and-use/militair-gebruik/
[10] https://www.noordzeeloket.nl/en/functions-and-use/offshore-wind-energy/bestaande-windparken/
[11] https://www.geminiwindpark.nl/about-gemini-wind-park.html#o1

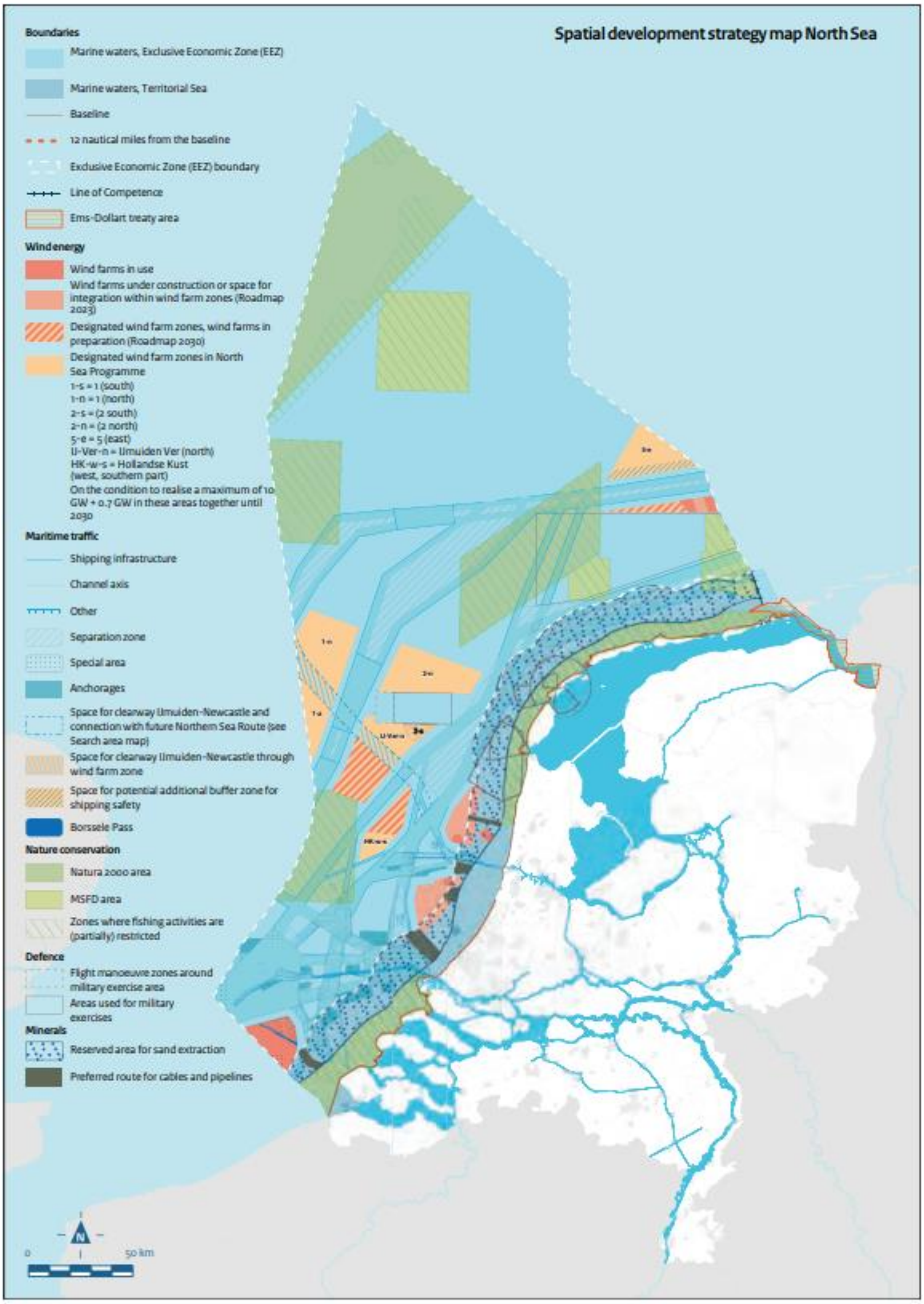


Figure 37. Spatial development strategy map of the North Sea. Source: National Water Program 2022–2027 (The Dutch Ministry of Infrastructure and Water Management et al., 2022). The red colour indicates the offshore wind farms in use.

2.4.6 Air traffic

Besides military flight exercises, no specific air traffic takes place at the Frisian Front and Central Oyster Grounds.

2.4.7 Shell/sand/gravel extraction

No shell/sand/gravel extraction takes place at the Frisian Front and Central Oyster Grounds.

2.4.8 Dredging

No dredging takes place at the Frisian Front and Central Oyster Grounds.

2.4.9 Coastal protection

No activities regarding coastal protection are undertaken at the Frisian Front and Central Oyster Grounds.

2.4.10 Recreation

No recreation takes place at the Frisian Front and Central Oyster Grounds.

2.4.11 Cumulative effect of other human activities

Cumulative effects on the conservation objective have been assessed for the common guillemot on the Frisian Front (Mastrigt et al., 2019). Significant effects cannot be excluded due to cumulation of the following: disturbance by underwater noise on birds caused by military use, shipping and research; disturbance by presence and light caused by oil and/or gas activities and military use; changes in food availability caused by commercial fishing outside the Natura 2000 area (Mastrigt et al., 2019). At this point, no further insight can be given on the cumulative effects of other human activities other than fisheries on the Frisian Front and Central Oyster Grounds. In the Dutch North Sea Programme 2022-2027 (IenW, 2022a) the Dutch government has indicated to reduce the knowledge gap on cumulative effects of human activities on the (benthic) ecosystem.

2.5 Monitoring

Once the measures to prevent seabed disruption in the proposed closed areas at Frisian Front and Central Oyster Grounds are determined, the monitoring programme will be modified and the baseline measurement will be performed. For more general information about monitoring, see the General Background Document.

Since 2014, seabird species have been monitored by airplane MWTL (Monitoring Waterstaatkundige Toestand des Lands) on the Dutch part of the North Sea with a focus on sampling in the Special Protection Areas (SPA) under the Birds Directive. In the 2022-2023 season, the Frisian Front was monitored in August, November 2022, January, February, April and June 2023 (van Bemmelen et al., 2023). The monitoring programme is adaptive and is evaluated regularly.

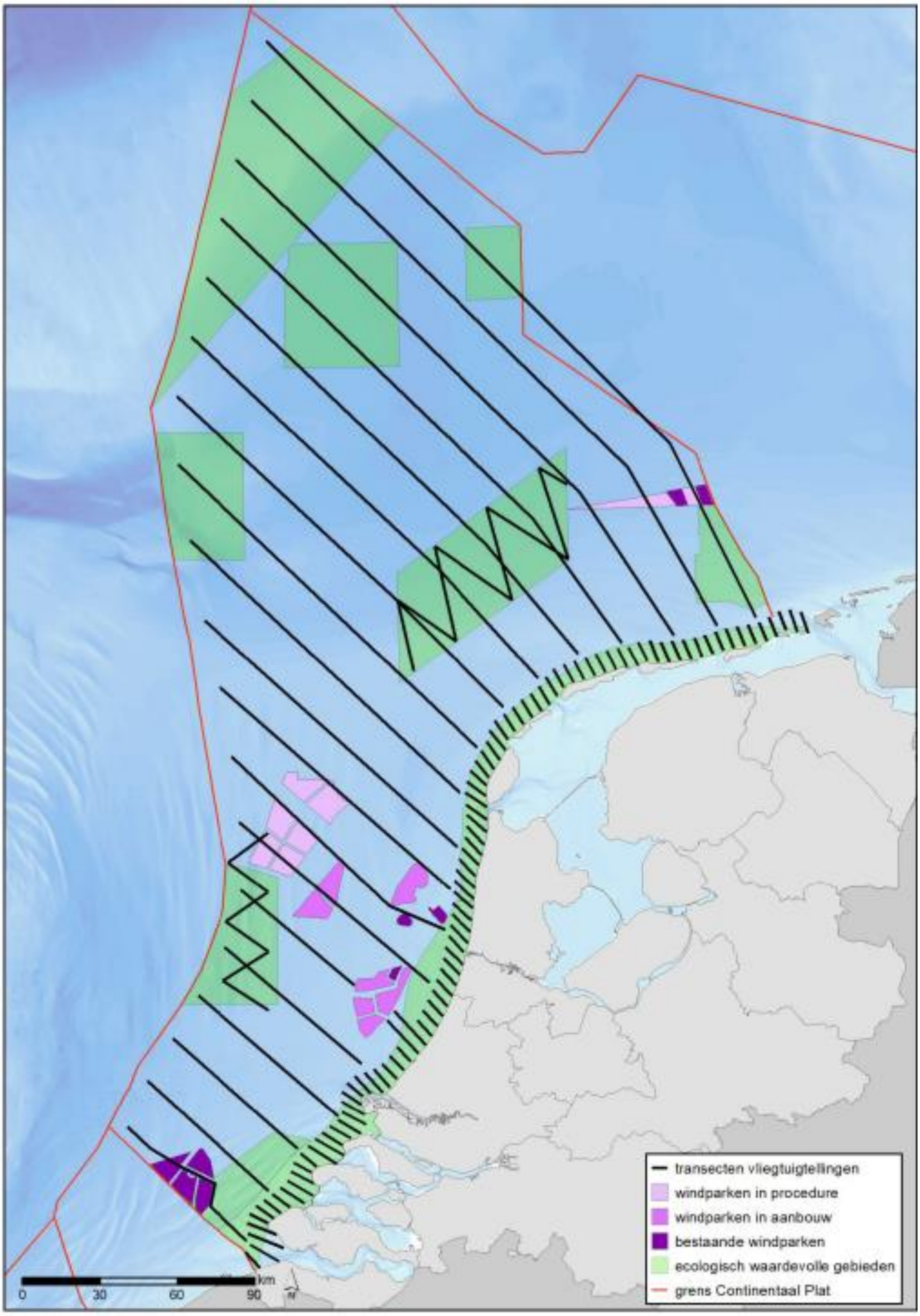


Figure 38: Spatial coverage of the Natura 2000 MSFD (MWTL) bird monitoring programme on the DSC, Brown Ridge, Frisian Front and coastal zone (van Bemmelen et al., 2023).

Benthic sampling in both areas will take place every three years with a box corer and dredge. All species found in the samples are recorded. The analysis needed for the detection of an increase in hit rate will be performed only for the indicator species. See Figure 39 for an overview of all sampling stations. For more general information about monitoring, see the General Background Document.

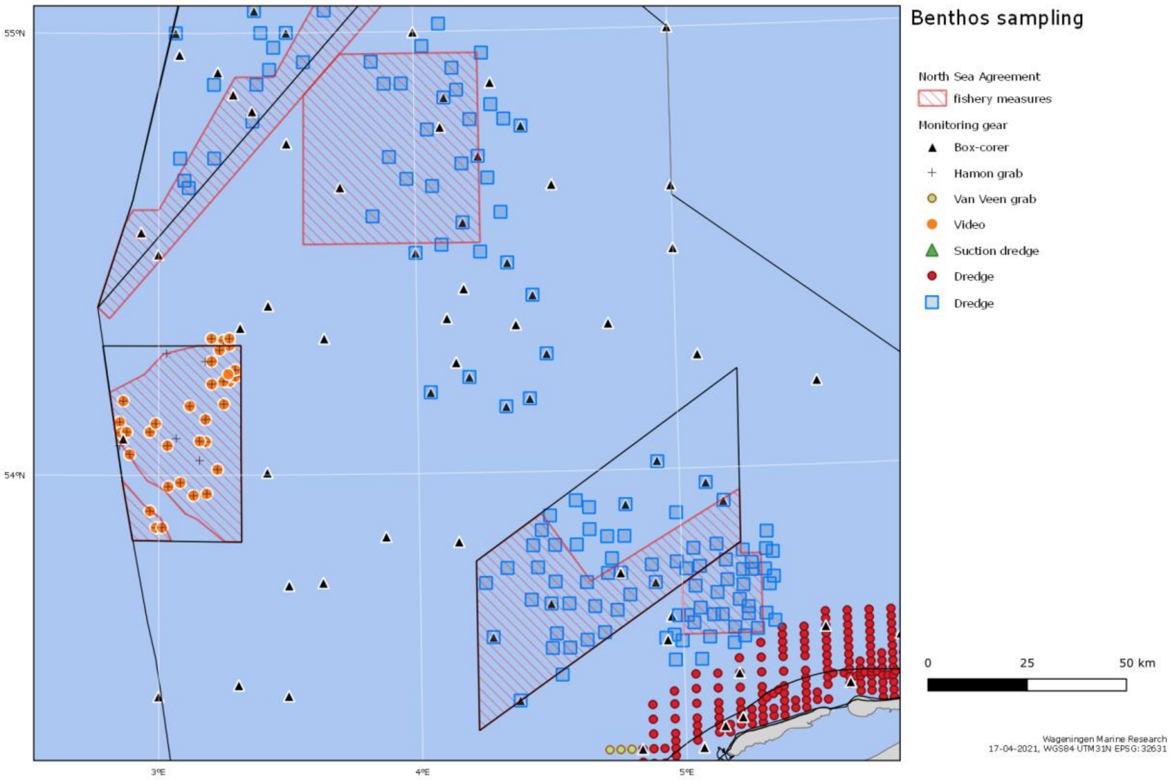


Figure 39. Overview sampling stations of the monitoring campaign at the Frisian Front and Central Oyster Grounds. Source: Marine Information and Data Centre. Selected sampling points: offshore MWTL survey 2021 and nearshore WOT shellfish survey 2018.

3 Rationale for conservation measures

3.1 Conservation objectives

The aim of the Marine Strategy Framework Directive (MSFD) is to reach a Good Environmental Status. Despite the implementation of the measures from the previous program of measures (2015), the Marine Strategy part 1 (MS1 2018-2024) concludes that Good Environmental Status has not yet been reached for the Dutch North Sea: there is a remaining task for the descriptors of biodiversity (D1), seabed integrity (D6), marine litter (D10) and underwater noise (D11). Additional measures are required to achieve Good Environmental Status.

The main descriptors for the benthic habitat are D1 (biological diversity), and D6 (sea-floor integrity). The overarching goal is to achieve good environmental status: improve the size, condition and global distribution of populations of the community of benthos species. This goal is primarily supported by two criteria, being: D6C3: improvement in the quality of the assessed areas and habitats in the Netherlands' part of the North Sea (benthic Indicator Species Index, BISI), and D6C5: the diversity of benthos demonstrates no further downward trend in the assessed areas (OSPAR assessment value). These criteria are supported by four environmental targets:

- D6T1: 10-15% of the surface of the Dutch part of the North Sea will not be notably disturbed by human activities;
- D6T2: improvement in the quality of the assessed areas and habitats;
- D6T4: further development and testing of regional assessment methods (OSPAR and ICES) which can be used in the future for assessing benthic and pelagic habitats;
- D6T5: return and recovery of biogenic reefs including flat oyster beds.

On top of that, these goals also contribute to the improvement of food webs, especially in the nutrient-rich area of the Frisian Front (D4).

The Frisian Front and Central Oyster Grounds have been designated for its benthic ecosystem, stretching from the water column to the actual bottom, in the Dutch Marine Strategy part 3 (MS 2012-2020), also called the Programme of Measures. The designation is again laid down in the Marine Strategy part 3 (Min IenW, 2022a). It is expected that the proposed conservation measures contribute to reaching the objectives as described in the MSFD and are proportionate in regards to the socio-economic impact of the proposed measure.

3.2 Policy considerations

The quality of the ecological values in the Frisian Front and the Central Oyster Grounds are considered to be declining and therefore not contributing for reaching GES (MS1 2018-2022). The recovery of substantial parts of the seabed ecosystem from a disrupted state towards a natural condition can be supported by protecting the Frisian Front and Central Oyster Grounds from activities which contribute to this disrupted state. Fishing activities with bottom contacting towed gear are considered to be the main human activity adversely affecting the seabed, and causing this disrupted state.

The ecologically most valuable areas should be, whenever possible, protected to ensure the recovery of the seabed ecosystem to stop the decline in quality. These areas should be large enough to be ecologically valuable and should contain (as many) different habitats and gradients as possible, such as in depth or silt richness. The proposed measures include one large area in the Central Oyster Grounds and two management zones which form one large area in the Frisian Front. The proposal is thus in accordance with Lindeboom et al. (2015), arguing that one large area is better than several smaller areas owing to boundary effects. In addition, during the negotiations the assumption was made that the greatest gain for nature will be achieved if at least a significant part of the most valuable areas are exempted from fisheries. This lead to the proposal of closing part of the Frisian Front for all forms of fishery. The relative ecological value of the different nature areas served as the basis (OFL, 2020).

The proposed closures in the Frisian Front include a large variety of habitat types over the depth gradient and therewith the high benthos biodiversity (Bos et al., 2011). For the Central Oyster Grounds the proposed closure includes both habitat types of the area: the deep circalittoral sand and the deep circalittoral mud (see section 2.1). The distribution of the threatened species Ocean quahog (*Arctica islandica)* (OSPAR Commission, 2009a), European flat oyster (*Ostrea edulis)* (OSPAR Commission, 2009b) and the habitat "Sea-pen and Burrowing Megafauna Communities" (OSPAR Commission, 2010) lies within the proposed closures.

The original proposed measure in the national North Sea Agreement was altered to meet the socio-economic impact of the conservation measures. The original proposal to limit all fishing activities on the Frisian Front had the same coordinates as the area which is designated as SPA under the Birds Directive. It was considered that this measure would be disproportionate to the socio-economic effects on the active fisheries. A substantial part of the area was removed as management zone. This alteration of the original proposal provides the fishing industry to continue fishing in the area of the Frisian Front were most fishing activity takes place on based on historical data (Figure 18, Figure 41). A second precondition for the implementation of the measure is that sufficient financing is made available in time, for the mitigation of the consequences for fishery and the improved sustainability of the fleet (OFL, 2020).

Subarea 1 of the Frisian Front was considered to be one of the ecologically most valuable areas which resulted in the proposed measure to limit the use of all types of fisheries in subarea 1. It is expected that this leads to less disturbance of the seabed, resulting in a positive effect on the quality of the surface water. Less disturbance of the seabed is expected to have a direct positive effect on the quality of the silt rich habitat in subarea 1 and thereby crucial to stop the decline in quality of this habitat. Limiting all fisheries in subarea 1 is therefore a conditional measure necessary to comply with the goals formulated in MS1 2018-2024 and to achieve the objective supported under Article 2, sub. 5 of the Common fisheries policy (CFP). Also, apart from the protection of the silt rich habitat, fishing activities can have an impact on the conservation of the guillemot on the Frisian Front which is also a SPA under the BD. Threat of fisheries to guillemot are bycatch that may result from beam trawl fishery, otter trawling, seine fishery, gillnet fishery and pelagic fishery (Mastrigt et al., 2019). The inclusion of a no fisheries zone is expected to support the protection of the guillemot on the Frisian Front and strengthen the proposed measures as submitted to the European Commission in July 2021.

Within the NSA, additional agreements were made on an oyster restoration project in subarea 1 of the Frisian Front in an area of 100 km^2 to support relevant targets under de MS1 2018-2022. The area for oyster restoration with a total of 100 km^2 is split up in two areas of 50 km^2 (Figure 40). This is due to a higher chance on success when making use of two different locations. Both areas for oyster restoration are chosen based on the following arguments: 1) in the past there were oysters present at both locations (Olsen, 1883), 2) research by Wageningen Marine Research and Deltares shows that both locations (area 1 and 2) are suitable for oyster restoration (van Duren et al., 2022; Kamermans et al., 2022). By introducing oysters in both locations where fishery will be prohibited, the oysters will able to flourish and enhance nature in the Frisian Front, which is in line with the objectives of the CFP. Moreover, an area of 100 km^2 is designated as a possible research area in which research on the long-term effects of fisheries with bottom-contacting fishing gear (TBB) can be carried out. This area is chosen next to the border of the Frisian Front because of enforcement reasons (Figure 40). In this area, bottom trawling is exempted from the prohibition on the Frisian Front subarea 1 under provisions. This exemption is given, because research on this topic can contribute to a better understanding of the long-term environmental impact of bottom trawling and ways to minimize this, which is also in line with the objectives of the CFP.

Both designated areas[12] are selected in consultation with relevant national stakeholders, the exact coordinates of these areas can be found in Table 26,
Table 27, and Table 28. Additionally, two small areas (C and D in Figure 1) of 4 km^2 each have been designated to accommodate pilot studies for oyster recovery (Table 29, Table 30). These pilot study

[12] These areas are proposed and waiting for confirmation by the national North Sea Consultation (in Dutch: Noordzeeoverleg).

areas are located inside areas where bottom contacting towed gear is be prohibited since 8 March 2023 (Delegated act (EU) 2023/340).

Taking all of the above into consideration led to the conservation measures of the current Joint Recommendation.

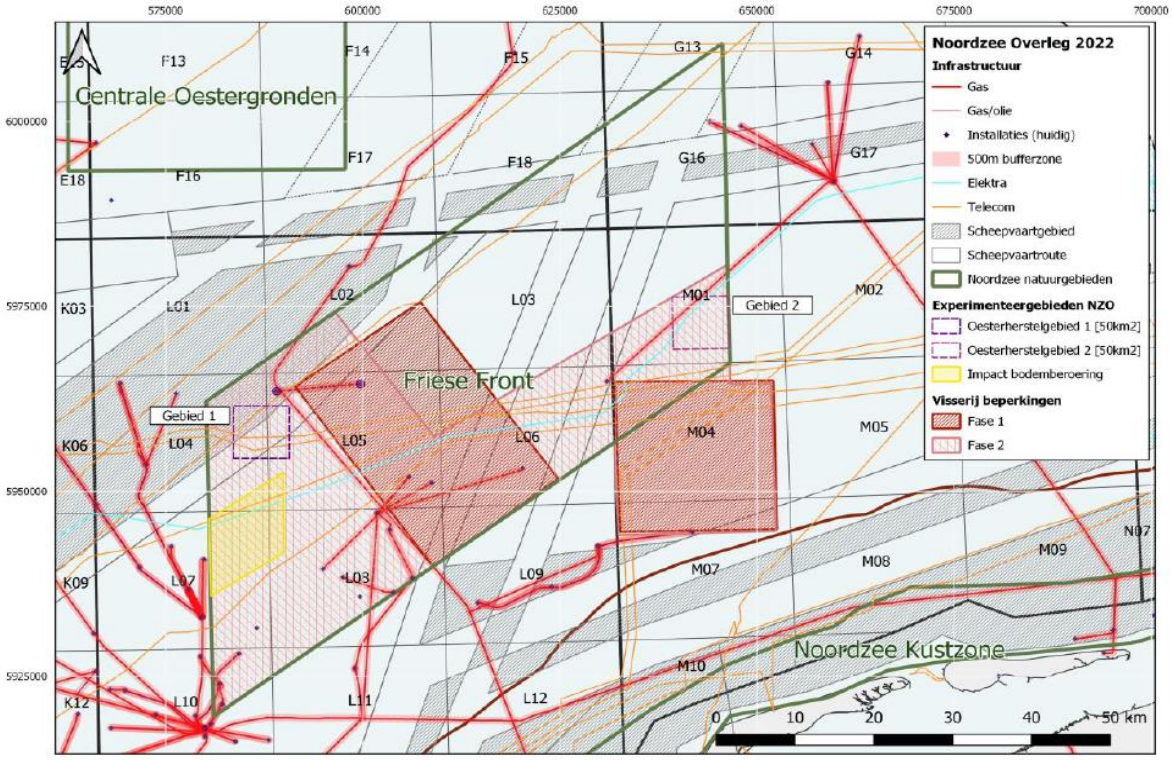


Figure 40. This figure shows two areas that are designated for oyster restoration (2x 50 km²), and one area that is designated for research on the effects of beam trawling (TBB) (1x100 km²). Inside the Frisian Front MPA there are two purple squares and one yellow rectangular. The first purple square on the west side represents oyster restoration area 1 (in Dutch: Gebied 1). The second purple square on the east side represents oyster restoration area 2 (in Dutch: Gebied 2). The yellow rectangular on the west side represents the area that is designated for research on the effects of beam trawling (TBB).

Table 26: Coordinates for area 1 that is designated for oyster restoration. The coordinate reference system used is EDM50/UTM zone 31N (EPSG:23031).

Oyster restoration area 1	50 km²
Longitude (X)	Latitude (Y)
583601,00	5954494,76
583601,00	5961557,07
590681,48	5961557,07
590681,48	5954494,76

Table 27:F Coordinates for area 2 that is designated for oyster restoration. The coordinate reference system used is EDM50/UTM zone 31N (EPSG:23031).

Oyster restoration area 2	50 km²
Longitude (X)	Latitude (Y)
639233,97	5976280,42
646313,64	5976416,62
646449,44	5969357,52
639369,76	5969221,33

Table 28: Coordinates for the area that is designated for research to the effects of beam trawling (TBB). The coordinate reference system used is EDM50/UTM zone 31N (EPSG:23031).

Research to beam trawling (TBB)	100 km²
Longitude (X)	Latitude (Y)
580473,62	5946286,76
589901,60	5952561,25

589999,13	5941735,32
580741,83	5935867,21

Table 29: Coordinates for area C that is designated for a pilot study for oyster recovery.

Area for pilot study oyster recovery (A)	4 km²
Longitude (X)	Latitude (Y)
4.606050944	53.64576974
4.606734205	53.66373944
4.636989625	53.66332959
4.636293511	53.64536016

Table 30: Coordinates for area D that is designated for a pilot study for oyster recovery.

Area for pilot study oyster recovery (B)	4 km²
Longitude (X)	Latitude (Y)
5.178656273	53.7289479
5.179585867	53.74691141
5.209890846	53.74639312
5.208948351	53.72839312

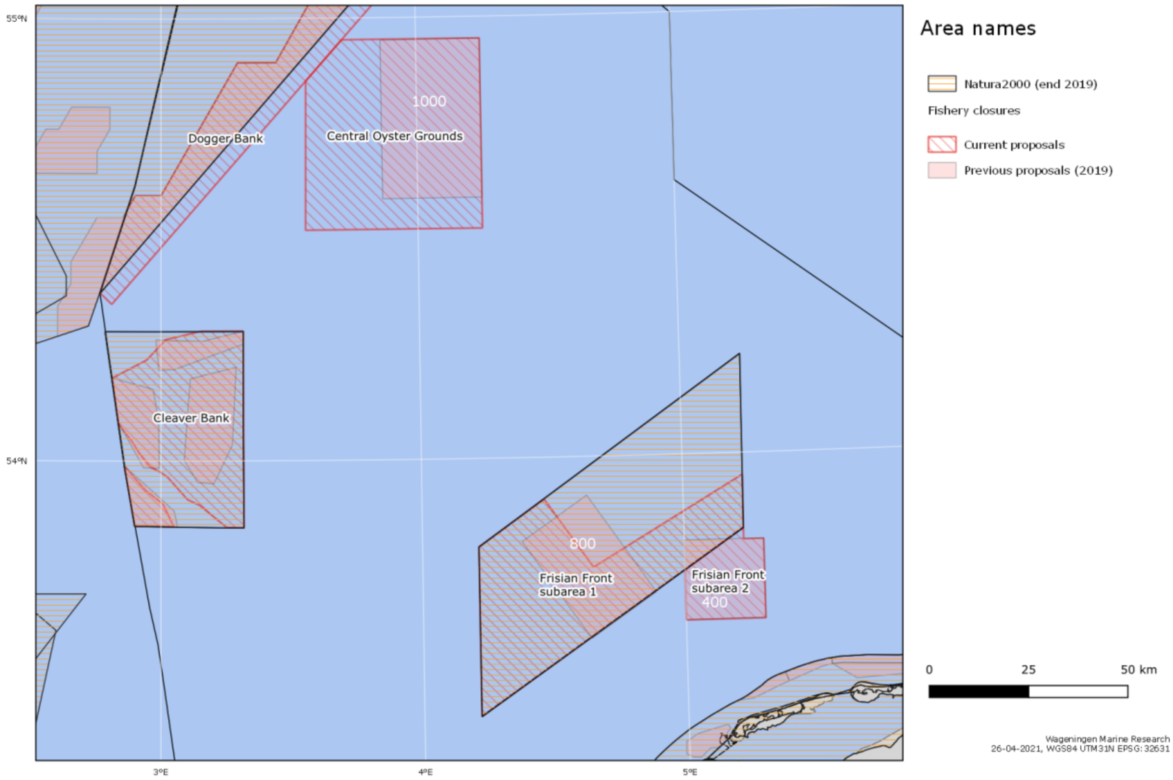


Figure 41. Fishery closures for the Frisian Front and the Central Oyster Grounds, indicating the areas proposed in 2021 (indication in map is 2019) (pink; 1000, 800 and 400 km2) and additional fisheries measures as included within the North Sea Agreement 2020 (hatched). The updated measures include closure for seabed-disturbing fishing (Central Oyster Grounds and Frisian Front Subareas 1 and 2) and a no fisheries zone (Frisian Front Subarea 1).

4 Expected effects of the conservation measures

4.1 Expected effects on the natural feature

Measures aiming at avoiding disruption of the seabed by all kinds of fisheries will not only contribute to GES for biodiversity (descriptor 1) and sea floor integrity (descriptor 6), but also to food webs (descriptor 4) and to a limited extent commercial fish species (descriptor 3):

- descriptor 1: 'Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions'.
- descriptor 6: 'Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.'
- descriptor 4: 'All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.' Food webs normally occurring in the Frisian Front and Central Oyster Grounds (i.e. in a undisturbed situation, matching the function and structure of the low-dynamic silty habitat) can develop.
- descriptor 3 (to a limited extent): 'Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.' Although fish are highly mobile and displacement of fisheries may occur, obviously fish mortality due to fisheries will decrease in the protected areas.

The Dutch Marine Strategy combined descriptors 1, 3, 4 and 6 into one integrated descriptor: 'marine ecosystem'.

An indication of the effects of long term closure of an area to fisheries is provided by research in and nearby an exclusion zone for all shipping, and thus for fisheries, around a gas production platform (Duineveld et al., 2007), see box below. In the future, more information on the effects of area closures is expected as this proposal includes designation of a research area: a specific area of 100 km^2 is designated for research into the long-term effects of beam trawl and pulse fishery. In this area, bottom contacting fishing activities will be permitted under strict conditions. The area is located within the Frisian Front, on the edge of the no fishery zone (subarea 1).

Box 1. Case study long term closure of an area to fisheries at the Frisian Front (Duineveld et al., 2007).

The effects of fishery exclusion on the composition of the macrofauna were determined by comparing the 500m circular fishery-exclusion zone around a gas production platform in the southern North Sea, just 3NM West of the Frisian Front, with nearby regularly fished areas. A gas production platform has been chosen because of the absence of oil-based mud (OBM). Platform L07A has been selected because of the silty seabed close to the Frisian Front and the fact that the presence of the platform (and thus the closure for fisheries) covers a period of over twenty years.
A Triple-D dredge was used, in addition to a standard box corer, to collect the relatively rare and larger species.
Multivariate analysis showed:

- Greater species richness, evenness, and abundance of mud shrimps (*Callianassa subterranea, Upogebia deltaura*) and fragile bivalves, long-lived (*Arctica islandica, Thracia convexa*) as well as short-lived (*Abra nitida, Cultellus pellucidus*) in the exclusion area.
- Greater densities of the brittlestar (*Amphiura filiformis*).

The observation that fisheries affect deep-living mud shrimps may point to consequences for the functioning of the benthic ecosystem other than simple loss of biodiversity.

The development of habitat and species characteristics as a result of closing Frisian Front and Central Oyster Grounds for seabed disrupting fishing techniques have been assessed in a qualitative way by expert judgement (Jongbloed, 2013). In general it is expected that seabed structure will change towards natural intrinsic conditions and an increase in natural bioturbation. A benthic community in which epifauna has a larger role can develop. It is assumed that benthos biodiversity increases, biogenic structures develop, scavengers and worms decrease, crustaceans and bivalves increase, as well as sensitive fish species, predatory fish and large specimens of certain species. On the basis of various studies, it is expected that the period over which a benthic community recovers may be in the order of 5 to 25 years. More information about monitoring recovery rate can be found in chapter six of the general background document (GBD).

Furthermore, it is assumed that the Frisian Front ecosystem will show a faster recovery of benthic fauna than Central Oyster Grounds because of an initial situation which is a result of a greater impact of fisheries and dynamism, heterogeneity and dynamics of the landscape on the Frisian Front than is the case for the Central Oyster Grounds. Frisian Front is also assumed to have a higher potential for growth of long-lived benthos (individuals and species), a higher potential for growth of biomass, a higher potential for increasing biodiversity and a higher potential for several types of big fish.

According to the MSFD status assessment, bottom contacting fishing activities seem to be a main cause for the quality of both the Frisian Front and the Central Oyster Grounds to be under the GES and declining (see also section 2.1 under 'Status') (I&W and LNV, 2018). The proposed fisheries measures are therefore expected to result in progress towards achieving GES.

Experts do not expect the return of the historical ecosystem of the Central Oyster Grounds (where oyster beds were key elements) in the foreseeable future due to the absence of hard structures. Natural oyster beds may develop again (see text box below), provided that there is hard substrate present on which oyster larvae can settle. To enable settlement and survival of native oysters, an area of 100 km^2 within the no fishery zone (subarea 1) on the Frisian Front is specifically designated for oyster recovery (Figure 40).

<u>Native oyster beds</u>

The proposed management areas include parts of the historical oyster bed area. Provided effective measures are taken, new opportunities for a natural succession towards oyster beds may arise (Bennema et al., 2020). Native oysters *Ostrea edulis* are available for restoration of oyster reefs in deeper offshore habitats, whereas invasive oysters (i.e. *Crassostrea gigas*) are restricted to a coastal (shallow) habitat (Christianen et al., 2018). These native oyster reefs not only enhance the available hard substrate in soft sediment ecosystems but also increase the species richness of associated assemblage. When native oyster reefs return to offshore habitats in the North Sea, the biodiversity and biomass of associated assemblages is expected to increase at a seascape scale, as epibenthic biogenic reefs are currently rare (Christianen et al., 2018). However, in the current state, it is questionable whether oyster settlement can survive on the Oyster Grounds because of a lack of suitable substratum and the high bioturbation levels, and also because the stocking populations for larval supply have vanished (Jager et al., 2018). A part of the no fishery zone on the Frisian Front (subarea 1) will be designated for recovery of flat oyster (OFL, 2020).

Also, the ocean quahog can spread in the northern part of the Central Oyster Grounds, potentially making a major contribution to the status of local biomass and long lived species. The ocean quahog is on the OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR Commission, 2009a) and is threatened by bottom trawling.

Possible bottlenecks for the conservation objective of guillemots under the Birds Directive (BD) on the Frisian Front are (Didderen et al., 2019): contamination with floating oil, grease or chemicals; disturbance by shipping; by-catch by fisheries (including gillnet fishing); overfishing of prey species; and wind farms. The proposed closures will reduce two of these threats: by-catch and disturbance. Overfishing of prey species might also be reduced. Knowledge gaps limit the assessment of the expected conservation benefits by the proposed closures. Several knowledge gaps have been identified for the

Frisian Front, including: population size of guillemot; bycatch of guillemot; diet of seabirds; food availability (including the relationship between biogenic reefs and food availability); and occurrence of prey species (Didderen et al., 2019).

4.2 Expected effects on fisheries

Possible effects of displacement of fishing effort for the Frisian Front and Central Oyster Grounds have been studied in the process of developing fishery closures under the MSFD (Slijkerman and Tamis, 2015) (see Box 1 and 13.1). Also see chapter 7.2 from the GBD.

4.3 Expected effects on other human activities

At this point no insight can be given in the expected effects on other human activities. In the Dutch North Sea Programme 2022-2027 the Dutch government has indicated that it will look into other activities in MSFD areas and if certain other activities should be managed as well.

5 Discussion

See Chapter 8 of the General Background Document.

6 Conclusion

See Chapter 9 of the General Background Document.

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