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DRAFT Dogger Bank Special Area of Conservation (SAC) MMO Fisheries Assessment 2020

Contents

1. Summary

Table 1 shows a summary of the outcomes of the current assessment regarding the impact of fishing gears on protected features.

Table 1: Dogger Bank SAC fisheries assessment summary

Features	Activity/gear	Part A outcome	Part B outcome	Part C outcome: In combination assessment
H1110 Sandbanks which are slightly covered by sea water all the time	Beam trawl (pulse/wing)	Not likely to have a significant effect	N/A	N/A
	Mussels, clams, oyster dredges			
	Pump scoop dredges (cockles, clams)			
	Suction dredges (cockles)			
	Jigging/trolling			
	Hand working (access from vessel)			
	Handlines (rod/gurdy)			
	Longlines (demersal)			
	Longlines (pelagic)			
	Pots/creels (crustacea/gastropods)			
	Cuttle pots			
	Fish traps			
	Drift nets (pelagic)			
	Drift nets (demersal)			
	Crab tiling			
	Digging with forks			
	Purse seine			
	Mid-water trawl (single) (pelagic)			
	Mid-water trawl (pair) (pelagic)			
	Gill nets	Likely to have a significant effect	Will not result in adverse effect on site integrity	Will not result in adverse effect on site integrity
	Trammel nets			
	Entangling nets			
	Beam trawl (whitefish)		May result in	May result in adverse
	Beam trawl (shrimp)			

	Heavy otter trawl		adverse effect on site integrity	effect on site integrity
	Multi-rig trawls			
	Light otter trawl			
	Pair trawl			
	Anchor seine			
	Scottish/fly seine			
	Mid-water trawl (single) (semi pelagic)			
	Mid-water trawl (pair) (semi pelagic)			
	Scallop dredges			

2. Introduction

Table 2 shows the name and legal status of the site. Located in the Southern North Sea approximately 150 km north east of the Humber Estuary, Dogger Bank Special Area of Conservation (SAC) lies entirely outside the 12 nautical mile limit sharing its eastern boundary with the UK's economic exclusion zone (EEZ). The site covers an area of approximately 12,331 km^2 [1].

Table 2: Site details

Name of site	Legal status
Dogger Bank	Special Area of Conservation (SAC)

Dogger Bank SAC is an offshore marine protected area (MPA) designated to protect the Annex I sandbank feature - sandbanks which are slightly covered by sea water all the time (H1110)[2] (Figure 1) which covers the expanse of the designated area. The Dogger Bank is the largest single continuous expanse of shallow sandbank in UK waters and is a cross-border sandbank extending into German and Dutch waters where it is similarly protected as Dogger Bank SAC and Doggersbank SAC respectively (Figure 1). The southern area of the sandbank is covered by water seldom deeper than 20 m and extends within the SAC in UK waters down to 35 – 40 m deep. Its location in open sea exposes the bank to substantial wave energy and prevents the colonisation of the sand by vegetation on the shallower parts of the bank. The sediments range from fine sands containing many shell fragments on top of the bank to muddy sands at greater depths. In contrast to other UK sandbanks formed by hydrological, tidal processes, Dogger Bank was formed by geological, glacial processes prior to being submerged through sea level rise (Diesing et al.,

[1] https://hub.jncc.gov.uk/assets/26659f8d-271e-403d-8a6b-300defcabcb1

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31992L0043&from=EN

2009). As a result, Dogger Bank is representative of a different sub-type of the typical offshore Annex I sandbank feature (Eigaard et al 2016) compared to other sandbank sites designated in the region (e.g. North Norfolk Sandbanks and Saturn Reef, Inner Dowsing, Race Bank and North Ridge SAC and Haisborough, Hammond and Winterton SAC). Given that it comprises more than 70% of the UK Annex I sandbank resource, it is particularly important in terms of its contribution as part of an ecologically coherent network of MPAs (JNCC 2013). Due to the difference in its formation, unlike other UK sandbanks, Dogger Bank contains substantial areas of coarser sediments (including pebbles) and unique benthic communities associated with these sediments. Communities are dominated by the soft coral – dead man's fingers (*Alcyonium digitatum*), the bryozoan sea chervil (*Alcyonidium diaphanum)* and serpulid worms[1].

The sandbank supports commercially and ecologically important fish species including flat fish and sandeels as well as invertebrate communities characterised by infauna such as polychaete worms, amphipods and small clams, and epifauna such as hermit crabs, starfish and brittlestars.

The sandeels provide an important food source for a number of species including sea birds and marine mammals. As a result, the Dogger Bank region is also an important location for the Habitats and Species Directive Annex II listed species Harbour porpoise (*Phocoena phocoena*) with approximately 52% of the Dogger Bank SAC overlapping with the Southern North Sea SAC which has been designated to protect them (Figure 1). Two other Annex II listed species, grey seal (*Halichoerus grypus*) and common seal (*Phoca vitulina*) are also known to visit the bank and are therefore included as non-qualifying features of the site along with Harbour porpoise[1].

All countries with sites designated for the protection of Dogger Bank agreed in 2011 that its conservation status was 'unfavourable' (NSRAC 2011). This was based on a long history of demersal fishing activity on the Dogger Bank and comparison of the benthic communities present in association with similar undisturbed habitats suggesting that Dogger Bank has an excess of opportunistic species and a depleted community of long-lived species.

Table 3 shows the features for which Dogger Bank SAC has been designated and the associated conservation objective.

Table 3: Designated features and general management approach

Feature	Sub-features	High level conservation objective
Sandbanks which are slightly covered by sea water all the time (H1110)	Subtidal sand	Subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the Favourable Conservation Status of its qualifying features, by maintaining or restoring: • the extent and distribution of qualifying natural habitats • the structure and function (including typical species) of qualifying habitats • the supporting processes on which qualifying natural habitats rely
	Subtidal coarse sediment	
	Subtidal mixed sediments	
	Subtidal mud	

More information regarding the conservation objectives for the protected features of the Dogger Bank SAC is available in the site's conservation advice package (Table 5).

2.1 Sub features of Dogger Bank 'sandbanks which are slightly covered by sea water all the time'

2.1.1 Subtidal sand

Subtidal (or sublittoral as per EUNIS habitat classification[3]) sand forms the predominant component of the Dogger Bank sandbank and is typified by species commonly associated with fine/medium sands with little mud content including the white catworm (*Nephtys cirrosa)* and amphipods such as *Bathyporeia sp.* The large expanses of subtidal sand in the Dogger Bank SAC result in mobile epifaunal assemblages largely similar to other North Sea sandbanks including the presence of: common hermit crabs (*Pagurus bernhardus*)*,* common starfish *(Asterias rubens),* flatfish species such as plaice (*Pleuronectes platessa*), sole (*Solea solea*) and yellow sole (*Buglossidium luteum*), sandeels (*Ammodytes spp*), swimmer crabs (*Liocarcinus* spp.), and gobies (*Pomatoschistus* spp.) (Diesing et al., 2009, Eigaard et al., 2016).

[3] https://www.eea.europa.eu/data-and-maps/data/eunis-habitat-classification

2.1.2 Subtidal coarse sediment

Among UK sandbanks, the presence of elongate patches of subtidal coarse sediments (comprising cobbles and pebbles) is unique to the Dogger Bank sandbank. While these features are common on storm dominated continental shelves, shallow sandbanks in the North Sea region tend to be composed of finer more mobile sands such as those of the sandbanks of North Norfolk Sandbanks and Saturn Reef SAC (Diesing et al., 2009).

The coarser sediments found at Dogger Bank SAC result in the presence of distinct communities due to the greater availability of micro-niches in these habitats. Certain infaunal species dominate including the polychaetes *Glycera lapidum* and *Notomastus* spp. and while epifauna is largely similar to nearby sandbanks (see above) the presence of coarse sediments allows for an abundance of additional species not routinely found in sandbank habitats, such as the burrowing sea urchin (*Echinocardium cordatum)*, masked crabs (*Corystes cassivelaunus*), and attached species including the dead man's fingers soft coral (*Alcyonium digitatum*) and the bryozoan sea chervil (*Alcyonidium diaphanum)* (Diesing et al., 2009).

2.1.3 Subtidal mixed sediments

Subtidal mixed sediments are found in three small, isolated patches within the Dogger Bank sandbank (Figure 2) totalling an area of less than 7 km^2. These habitats incorporate a range of sediments including heterogeneous muddy gravelly sands and also mosaics of cobbles and pebbles embedded in or lying upon sand, gravel or mud. The habitats may support a wide range of infauna and epibiota including polychaetes, bivalves, echinoderms, anemones, hydroids and bryozoans[4]. Recent ground truthing surveys identified subtidal mixed sediments in the site via particle size analysis (PSA) but infaunal analysis of these samples revealed communities more closely associated with those occurring in the subtidal coarse and sand habitats (Diesing et al., 2009, Eigaard et al., 2016).

2.1.4 Subtidal mud

Subtidal mud habitats are often dominated by polychaetes and echinoderms, in particular brittlestars such as *Amphiura* spp. and seapens such as *Virgularia mirabilis*. Through particle size analysis (PSA), recent habitat surveys have identified subtidal mud in a few scattered, deeper locations within Dogger Bank SAC (Eigaard et al., 2016, Eggleton et al., 2016). JNCC did not consider these areas to be sufficiently expansive to be included in the habitat map for the site hence its absence in Figure 2.

[4] https://eunis.eea.europa.eu/habitats/2503

Figure 1: Dogger Bank SAC Location overview

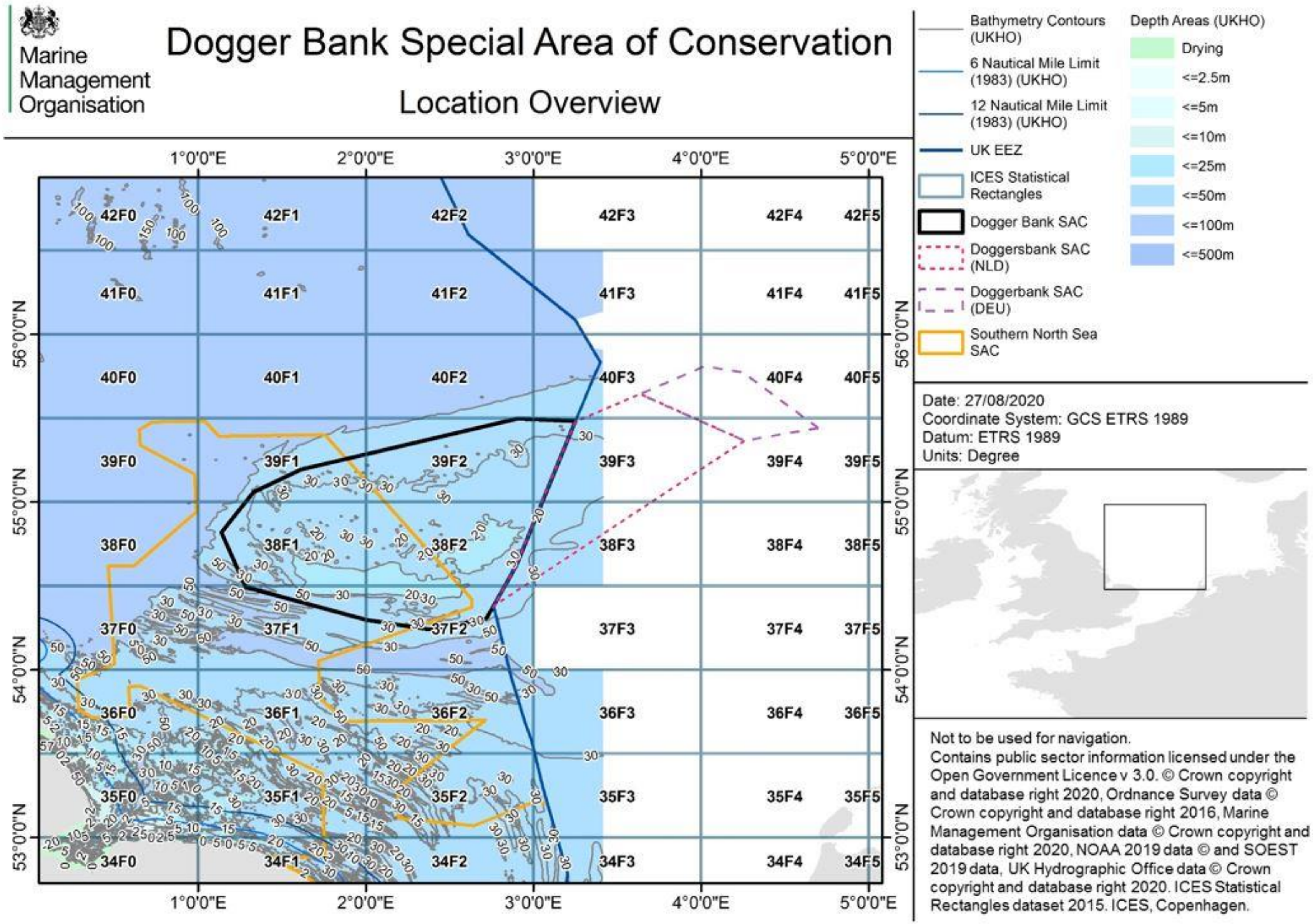
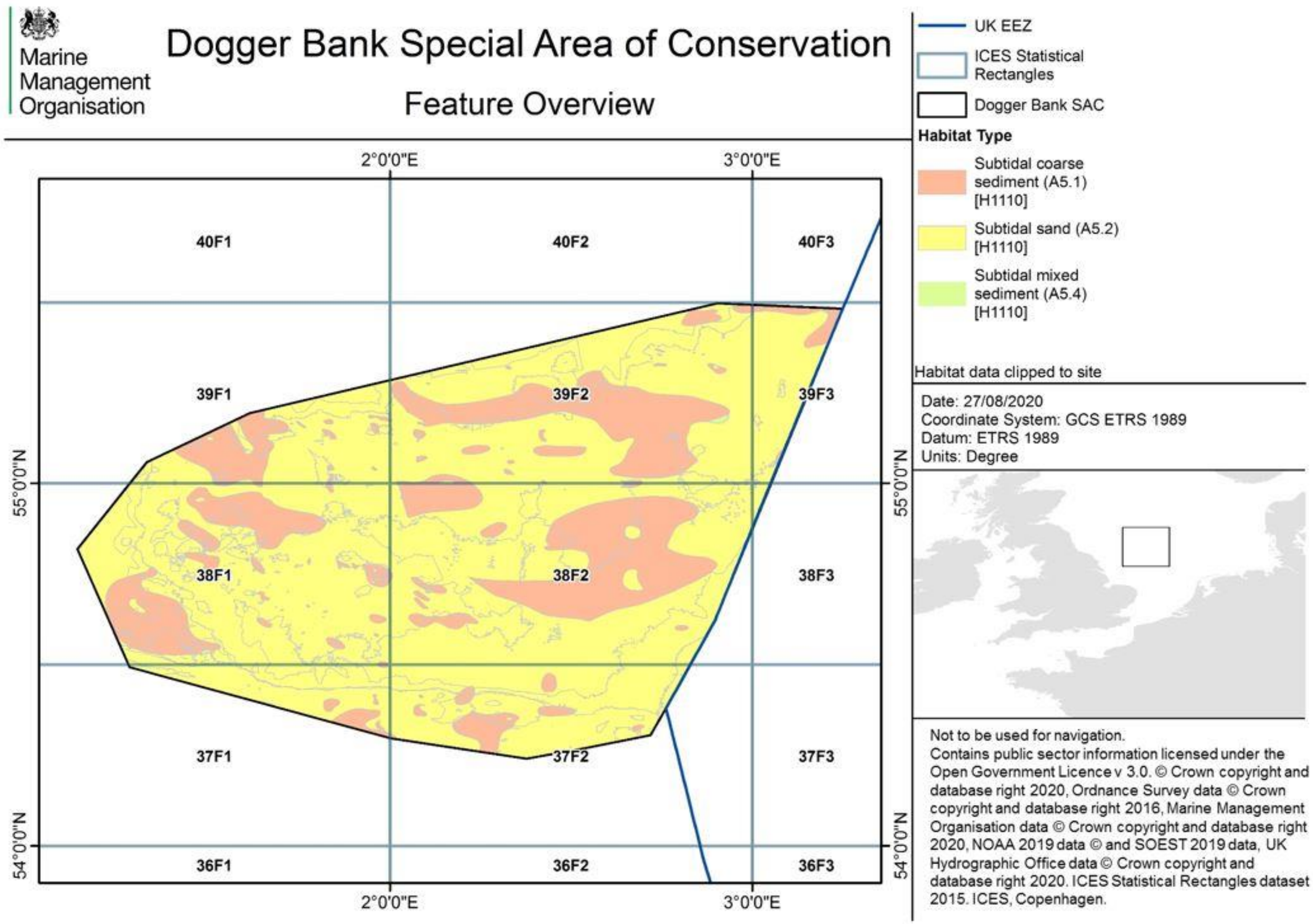


Figure 2: Dogger Bank 'sandbanks that are slightly covered by seawater all the time'



2.2 Scope of this assessment – fishing activities assessed

The geographic scope of this assessment covers the whole of the Dogger Bank SAC (Figure 2). All commercial fishing gears will be included for assessment (Table 4).

Table 4: Fishing activities covered by this assessment

Gear type		Gear Code	SNCB aggregated gear method
Towed (demersal)	Beam trawl (whitefish)	TBB	Demersal trawl
	Beam trawl (shrimp)		
	Beam trawl (pulse/wing)		
	Heavy otter trawl	OTB	
	Multi-rig trawls	TX	
	Light otter trawl	OTB	
	Pair trawl	PTB	
	Anchor seine	SDN	Demersal seines
	Scottish/fly seine	SSC	
Towed (pelagic)	Mid-water trawl (single)	TM	Pelagic fishing
	Mid-water trawl (pair)	PTM	
	Industrial trawls	TM	
Dredges (towed)	Scallops	DRB	Dredges
	Mussels, clams, oysters	DRB / HMD	Dredges / Hydraulic dredges
	Pump scoop (cockles, clams)	HMP / HMD	Hydraulic dredges
Dredges (other)	Suction (cockles)	HMD	
	Tractor	CGD	Shore-based activities
Intertidal handwork	Hand working (access from vessel)	LHP	
	Hand work (access from land)	DRH	
Static - pots/traps	Pots/creels (crustacea/gastropods)	FPO	Traps
	Cuttle pots		
	Fish traps		
Static - fixed nets	Gill nets	GNS	Anchored nets/lines
	Trammels	GTR	
	Entangling	GN	
Passive - nets	Drift nets (pelagic)	GND	Pelagic fishing
	Drift nets (demersal)		Anchored nets/lines
Lines	Longlines (demersal)	LLS	
	Longlines (pelagic)	LLD	Pelagic fishing
	Handlines (rod/gurdy)	LHP	
	Jigging/trolling	LHP / LTL	
Seine nets and other	Purse seine	PS	
	Beach seines/ring nets	SB	Shore-based activities

	Shrimp push-nets	-	
	Fyke and stakenets	FYK / GNF	Anchored nets/lines
Miscellaneous	Commercial diving	-	Diving
	Bait dragging	-	Shore-based activities
	Crab tiling	-	
Bait collection	Digging wth forks	-	

Commercial sea fishing has the potential to vary in nature and intensity over time. This assessment considers a particular range of recent and likely future activity based on activity levels and type as identified in section 4.1.

To ensure the achievement of the conservation objectives of the site is not hindered should future activity occur outside of this range, activity will be monitored at this site, and this assessment will be reviewed should certain limits be triggered. See section 8 for more information on ongoing monitoring and control at this site.

3. Part A Assessment

Table 5 shows the Joint Nature Conservation Committee (JNCC) conservation advice package used to inform this assessment.

Table 5: Advice package used for assessment

Feature	Sub features	Package	Link
H1110 Sandbanks which are slightly covered by sea water all the time	Subtidal sand	Dogger Bank MPA conservation advice	https://jncc.gov.uk/our-work/dogger-bank-mpa
	Subtidal coarse sediment		
	Subtidal mixed sediments		
	Subtidal mud		

Part A of this assessment was carried out in a manner that is consistent with the likely significant effect (LSE) test required by article 6(3) of the Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (Habitats Directive)[5].

For each fishing activity, a series of questions were asked[6]:

[5] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31992L0043&from=EN
[6] The test for likely significant effect under article 6(3) of the Habitats Directive is not required for activities which are directly connected to or necessary to the management of the site. Fishing activities are not considered to be directly connected to or necessary to the management of the site unless otherwise indicated.

1. Does the activity take place, or is it likely to take place in the future?
2. What are the potential pressures exerted by the activity on the feature?
3. Are the effects/impacts of the pressures likely to be significant?

For each activity assessed in Part A, there were two possible outcomes for each identified pressure-feature interaction:

1. The pressure-feature interactions were not included for assessment in Part B:
   a. If the feature is not exposed to the pressure, and is not likely to be in the future; or
   b. If the effect/impact of the pressure is not likely to be significant.

2. The pressure-feature interactions were included for assessment in Part B:
   a. If the feature is exposed to the pressure, or is likely to be in the future; and
   b. If the potential scale or magnitude of any effect is likely to be significant; or
   c. If it is not possible to determine whether the magnitude of any effect is likely to be significant.

Consideration of exposure to or effect of a pressure on a protected feature of the SAC includes consideration of exposure to or effect of that pressure on any ecological or geomorphological process on which the conservation of the protected feature is wholly or in part dependent.

3.1 High risk interactions

To fast track management for particularly sensitive features where there is already sufficient evidence to support the interaction of certain gears as not being compatible with the conservation objectives of an MPA, the MMO has identified “high risk” gear-feature interactions. For this purpose, and in accordance with JNCC advice, the MMO has made use of the Southern North Sea fisheries management options paper (JNCC 2015) which, while not including Dogger Bank SAC, considered management options for SACs in the region which are similarly designated for the H1110 sandbank feature. No high risk gear-feature interactions have been identified that are relevant to Dogger Bank SAC and therefore all gears will be assessed in this assessment.

3.2 Activities not taking place

Table 6 shows activities which are excluded from further assessment as they do not take place and are not likely to take place in the future.

Table 6: Activities not taking place and not likely to take place in the future

<table>
<tr><th>Feature</th><th>Gear type</th><th>Justification</th></tr>
<tr><td rowspan="26">H1110 Sandbanks which are slightly covered by sea water all the time</td><td>Beam trawl (pulse/wing)</td><td>VMS data does not differentiate between pulse wing and standard beam trawls but this gear is believed to be occurring in Dogger Bank SAC. However, both the UK[7] and the EU[8] have committed to banning the practice. This method will therefore not be included in this assessment.</td></tr>
<tr><td>Mussel, clam, oyster dredges</td><td rowspan="15">These gears do not appear in the VMS data for Dogger Bank SAC and expert opinion from MMO marine officers states these gears are not used in the site.</td></tr>
<tr><td>Pump scoop dredges (cockles, clams)</td></tr>
<tr><td>Suction dredges (cockles)</td></tr>
<tr><td>Jigging/trolling</td></tr>
<tr><td>Hand working (access from vessel)</td></tr>
<tr><td>Handlines (rod/gurdy)</td></tr>
<tr><td>Longlines (demersal)</td></tr>
<tr><td>Longlines (pelagic)</td></tr>
<tr><td>Pots/creels (crustacea/gastropods)</td></tr>
<tr><td>Cuttle pots</td></tr>
<tr><td>Fish traps</td></tr>
<tr><td>Trammel nets</td></tr>
<tr><td>Entangling nets</td></tr>
<tr><td>Drift nets (pelagic)</td></tr>
<tr><td>Drift nets (demersal)</td></tr>
<tr><td>Crab tiling</td><td rowspan="7">Dogger Bank is approximately 100 km offshore and so not subject to shore based activities.</td></tr>
<tr><td>Digging with forks</td></tr>
<tr><td>Hand work (access from land)</td></tr>
<tr><td>Tractor dredges</td></tr>
<tr><td>Beach seines/ring nets</td></tr>
<tr><td>Shrimp push-nets</td></tr>
<tr><td>Fyke and stakenets</td></tr>
<tr><td>Commercial diving</td><td>The site is not suitable for commercial dive fishing due to distance offshore, the strong tidal currents and waves.</td></tr>
<tr><td>Bait dragging</td><td>Bait dragging does not take place in the UK outside of Poole Harbour.</td></tr>
</table>

[7] https://www.legislation.gov.uk/ukdsi/2019/9780111181171
[8] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R1241

3.3 Potential pressures exerted by the activities on the feature

For the remaining activities, (anchored nets, demersal trawls, purse seines, demersal seines, dredging and pelagic fishing) potential pressures were identified using the JNCC conservation advice identified in Table 5 and the associated advice on operations tables. Table 7 shows the pressures identified. Truly pelagic fishing gears, i.e. those with no contact with the seabed (purse seines and mid water trawls) have no associated pressures considered relevant to the sandbank feature and have not been included. However, semi-pelagic towed gears are likely to interact with the seabed and have potential pressures on sandbank features. There is not a specific aggregated method category for semi-pelagic towed gears however in accordance with previous draft Joint Recommendations for fisheries management at Dogger Bank SAC[9], these gears have been categorised as bottom otter board trawls and included in the demersal trawls aggregated method gear group.

Table 7: Potential pressures for all features of the site. Red = potential pressure. Grey = pressure not relevant to feature.

Potential pressures	**Anchored Nets/Lines, Demersal Trawls, Demersal Seines**				**Dredges**			
	Subtidal coarse	**Subtidal sand**	**Subtidal mixed sediments**	**Subtidal mud**	**Subtidal coarse**	**Subtidal sand**	**Subtidal mixed sediments**	**Subtidal mud**
Abrasion/disturbance of the substrate on the surface of the seabed								
Changes in suspended solids (water clarity)								
Deoxygenation								
Hydrocarbon & PAH* contamination								
Introduction or spread of non-indigenous species								
Litter								
Nutrient Enrichment								
Organic enrichment								
Penetration and/or disturbance of the substrate below the surface of the seabed								
Physical change (to another seabed type)								
Removal of non-target species								
Removal of target species								
Smothering and siltation rate changes								

[9] https://fiskeristyrelsen.dk/media/8992/20160531_dogger_bank_background_document_final.pdf

Synthetic compound contamination								
Transition elements & organo-metal contamination								
Introduction of microbial pathogens								

3.4 Significance of effects/impacts

To determine whether each pressure is likely to have a significant effect on the site's features, the sensitivity assessments and risk profiling of pressures from the advice on operations section of the JNCC conservation advice package and Pressure Activity Database (PAD)[10] were used.

Table 8 identifies the pressures from particular gears which are likely to have a significant effect on each sub-feature. Where a pressure from a particular gear is identified as not being likely to significantly effect a sub-feature, justification is provided. Based on the JNCC assessment, it was concluded that all sediment features should be treated as having similar sensitivities to the identified pressures and have therefore been considered together.

To ensure the effects of fishing activities in-combination with other activities (including other fishing activities) are fully assessed, the pressures from fishing activities which are not likely to cause a significant effect but which do interact with the feature are considered in the in-combination aspect of the assessment (Part C, section 5).

[10] https://jncc.gov.uk/our-work/marine-activities-and-pressures-evidence/#jncc-pressures-activities-database

Table 8: Summary of pressures from specific activities to be taken to Part B for all sediment features

Potential pressures	Anchored Nets/Lines	Demersal Trawls			Demersal Seines			Dredges
	Gill nets	Otter Bottom Trawls	Otter Twin Trawls	Beam Trawls	Danish/ Anchor Seine	Scottish Seine	Scottish Pair Seines	Shellfish dredges
Abrasion/disturbance of the substrate on the surface of the seabed	LSE - from gear and associated lines or anchors.							
Changes in suspended solids (water clarity)	No LSE – Pressure not applied by gear type.	LSE - through contact and movement of the gear with and over the seabed.						
Deoxygenation	No LSE – the sediment features are not deemed sensitive to this pressure at the benchmark. Dogger Bank is exposed to substantial wave energy making the accumulation of discards and associated hypoxia or any deoxygenation resulting from ballast water unlikely.							
Hydrocarbon & PAH* contamination	No LSE – the sediment features are not deemed sensitive to this pressure at the benchmark. Deliberate releases are already prohibited. Accidental discharges from fishing vessels leading to significant releases are extremely rare.							
Introduction of microbial pathogens	No LSE – Pressure not applied by gear type.							No LSE – likelihood of shellfish fisheries transmitting disease is low due to strong wave exposure.

Introduction or spread of non-indigenous species	No LSE – The significant vector for the introduction of non-indigenous species is ballast water. Given the exposed nature of the site and the majority of fishing vessels being under 45 m and therefore using solid ballast[11] the sediment features are deemed to be at low risk from this pressure.		
Litter	No LSE – The exposure of the site to substantial wave energy make it unlikely that lost gear will persist at the site for long enough to cause a significant impact to the sediment features.		
Nutrient Enrichment	No LSE – Pressure not applied by gear type.	No LSE – the sediment features are is not deemed sensitive to this pressure at the benchmark.	
Organic enrichment	No LSE – While some of the sediments present at Dogger Bank can be sensitive to this pressure it is deemed to be a low risk to the features and Dogger Bank SAC is subject to strong wave exposure and therefore discards are unlikely to accumulate.		
Penetration and/or disturbance of the substrate below the surface of the seabed	LSE - through contact of the gear with the seabed.		
Physical change (to another seabed type)	No LSE – Pressure not applied by gear type.	No LSE – While the sediments can be sensitive to this pressure it is deemed to be a low risk to the features.	
Removal of non-target species	LSE - this pressure may result through bycatch from fishing gear.		
Removal of target species	LSE - this pressure may result through	LSE – Pressure not considered relevant to gear types in JNCC conservation advice on operations. However, as there are overlapping target species between gears, for	LSE - this pressure may result through targeted fishing over the feature.

[11] www.legislation.gov.uk/eudr/2002/35/pdfs/eudr_20020035_adopted_en.pdf

	targeted fishing over the feature.	consistency and to be precautionary, this pressure has been considered LSE for the purposes of this assessment.	
Smothering and Siltation rate changes	No LSE – Pressure not applied by gear type.	LSE - this pressure may result from physical disturbance and hydrodynamic action caused by the gear.	
Synthetic compound contamination	No – LSE Features not sensitive at the benchmark and pressure considered to be a low risk to the subtidal coarse sediment feature.		
Transition elements & organo-metal contamination	No – LSE Features not sensitive at the benchmark and pressure considered to be a low risk to the subtidal coarse sediment feature.		

4. Part B Assessment

Part B of this assessment was carried out in a manner that is consistent with the appropriate assessment required by article 6(3) of the Habitats Directive.

Table 9 shows the fishing activities and pressures identified in Part A which have been included for assessment in Part B. Pressures with similar potential impacts to a particular feature were grouped to save repetition during this assessment.

Table 9: Fishing activities and pressures included for Part B assessment

<table>
<tr><th>Feature</th><th>SNCB aggregated gear method</th><th>Fishing gear type</th><th>Pressures</th></tr>
<tr><td rowspan="7">Sandbanks which are slightly covered by seawater all the time</td><td>Anchored Nets/Lines</td><td>Gill nets</td><td rowspan="4">• Abrasion/disturbance of the substrate on the surface of the seabed
• Penetration and/or disturbance of the substrate below the surface of the seabed
• Removal of target species
• Removal of non-target species</td></tr>
<tr><td>Demersal Trawls</td><td>Otter Twin Trawlers
Beam Trawls</td></tr>
<tr><td>Demersal Seines</td><td>Danish/ Anchor Seine
Scottish Seine
Scottish Pair Seines</td></tr>
<tr><td>Dredges</td><td>Shellfish dredging</td></tr>
<tr><td>Demersal Trawls</td><td>Otter Twin Trawlers
Beam Trawls</td><td rowspan="3">• Changes in suspended solids (water clarity)
• Smothering and siltation rate changes</td></tr>
<tr><td>Demersal Seines</td><td>Danish/ Anchor Seine
Scottish Seine
Scottish Pair Seines</td></tr>
<tr><td>Dredges</td><td>Shellfish dredging</td></tr>
</table>

The important targets for favourable condition were identified within JNCC's conservation advice supplementary advice tables. 'Important' in this context means only those targets relating to attributes that will most efficiently and directly help to define condition. These attributes should be clearly capable of identifying a change in condition.

Table 10 shows which targets were identified as important. The impacts of pressures on features were assessed against these targets to determine whether the activities causing the pressures are compatible with the site’s conservation objectives.

Table 10: Relevant favourable condition targets for identified pressures for all sediment features

Attribute	**Target**	**Relevant pressures**
Extent and distribution	**Restore objective:** The feature extent within the site must be conserved to the full known distribution (sandbank feature calculated to be 12,331 km^2) based on: - large-scale topography - sediment composition - biological assemblages	Relevant to: • Abrasion/disturbance of the substrate on the surface of the seabed. • Penetration and/or disturbance of the substrate below the surface of the seabed. • Removal of non-target species. • Removal of target species • Smothering and siltation rate changes. • Changes in suspended solids (water clarity).
Structure and function	**Restore objective:** • Physical structure (finer scale topography and sediment composition and distribution) to be restored. • Biological structure (characteristic communities) to be restored. • Function to be restored	Relevant to: • Abrasion/disturbance of the substrate on the surface of the seabed. • Penetration and/or disturbance of the substrate below the surface of the seabed. • Removal of non-target species. • Removal of target species • Smothering and siltation rate changes. • Changes in suspended solids (water clarity).
Supporting processes	**Maintain objective:** • Hydrodynamic regime to be maintained.	Relevant to: • Smothering and siltation rate changes.

	• Water and sediment quality to be maintained.	• Changes in suspended solids (water clarity).

4.1 Fishing Activity Descriptions

4.1.1 Existing management

Fishing vessels from numerous European countries are active in the Dogger Bank SAC but UK, Belgian, German, Danish, and Dutch vessels are most prevalent.

There are a large number of technical measures[12] in operation within the Dogger Bank SAC for stock management and conservation. However, these measures are not designed to achieve the conservation objectives of the site (though they may contribute to the achievement of favourable condition and the impacts from ongoing fishing activities still need to be assessed and managed where appropriate.

At time of writing, Dogger Bank SAC is subject to a temporary closure for scallop dredges. From Sunday 12 July to Sunday 11 October 2020 there is a suspension of scallop dredging in ICES rectangles 39F1, 39F2, 39F3, 38F1, 38F2, 38F3, 37F1 and 37F2. This was implemented to allow data gathering on the shellfish stock in response to concerns over an increase in scalloping in the area. The four UK Fisheries Administrations have also sought views and evidence on the impact of the potential implementation of a temporary closure of the king scallop (*Pectens maximus*) fishery in the Dogger Bank area including in the Special Area of Conservation (SAC)[13].

4.1.2. Evidence Sources

To determine the levels of fishing activity, the following evidence sources were used:

- VMS data
- fisheries landings data (logbooks and sales records)
- expert opinion from MMO marine officers
- MMO and Royal Navy sightings

MMO fisheries assessments generally include spatial footprint analysis (Pr-values) of fishing activities. The spatial footprint analysis considers the interaction of VMS fishing activity data with habitat data. Unfortunately, the MMO was unable to

[12] https://ec.europa.eu/fisheries/cfp/fishing_rules/technical_measures_en
[13] https://www.gov.uk/government/consultations/call-for-evidence-dogger-bank-king-scallop-stock-closure-in-ices-rectangles-39f1-39f2-39f3-38f1-38f2-38f3-37f1-and-37f2#:~:text=The%20Marine%20Management%20Organisation%20put,in%20the%20Dogger%20Bank%20area.

complete this analysis for the current assessment but will endeavour to provide the results at a later date in association with any management proposal impact assessments that are produced for Dogger Bank SAC. Given there is just one feature designated for the entirety of the site, all demersal gear VMS data within Dogger Bank SAC will be interacting with the feature. While the spatial footprint analysis would provide an insight into the area of the feature impacted and add weight to conclusions drawn regarding management, the analysis has no bearing on the sensitivity of the features to fishing pressures and therefore the absence of the spatial footprint analysis is not considered to have a bearing on the conclusions made regarding the necessity of management but may help in determining the most appropriate management option.

Table 11 summarises the description, strengths and limitations of some of the evidence sources used. For more information about the evidence sources used, please see Annex 1.

Table 11: Summary of generic confidence associated with fishing activity evidence

Evidence source	Confidence	Description, strengths and limitation
VMS data	High / Moderate	• Confidence in VMS is high for describing activity relating to larger vessels (>12m). but it does not describe activity of smaller vessels. • There are assumptions in the processing that speeds greater than 0 and less than 6 knots is "fishing speed". • VMS records the location, date, time, speed and course of the vessel. Fishing gear information has to be linked to the VMS data itself by either matching its logbook information where possible, using the fleet register which may not be up to date or through local marine officer knowledge of the said vessel. • VMS data logs vessel movement and thus can act as a good proxy for mobile gear effort. However, it is more challenging to link VMS data to static gear effort (i.e. amount of gear, soak time etc). • Null gear codes may be present in the data which may underrepresent fishing fleet. • Non-UK VMS is of lower resolution, presented to just 3 decimal degrees.
Landings Data	High	• Annual data collated and reported to ICES statistical rectangles. • Resolution too low to directly infer landings for MPAs.
Expert judgement	Low / Moderate	• Reliability/accuracy depends on the area, and the local knowledge of MMO staff.

Sightings data	High	• Taken from Royal Navy and MMO patrols and targets inspection. • Covers all vessels, not limiting to size class. • Does not account for patrolling/inspection effort.

4.1.3. Dogger Bank fishing fleet

Fishing activity throughout the site is mostly bottom towed gear, with the main gear types being bottom otter trawls and beam trawls. Danish seines are also commonly used by both EU member state and UK vessels. Fixed gill net and mid water otter trawling is conducted almost exclusively by Danish vessels. Due to the distance from shore the Dogger Bank fishing fleet is entirely made up of larger vessels greater than 12 m in length with VMS. Additionally, UK VMS data is assigned landings data via analysis of logbooks. Confidence in the assessment of the Dogger Bank fleet is therefore high.

Up until recently there has been little to no evidence of scallop dredging occurring within the Dogger Bank SAC however during the spring of 2020 a lucrative scallop stock was discovered (MMO marine officer, *pers. comm.,* high confidence) and there has been a rapid increase in scallop dredging activity by UK vessels exploiting this stock.

In order to bridge the gaps in available data, expert opinion from MMO coastal officers has been incorporated into this assessment. The following sections describe the gear types used within the site according to expert opinion.

4.1.3.1. Aggregated Method: Anchored nets/lines

The Danish fleet appear to be the only nation using anchored nets in the Dogger Bank SAC. The vast majority of these vessels use gillnets (Savina, 2018) and target Dover sole (STECF FDI landings data 2012-2016). The nets can have anything in the region of 90-448 tiers with each tier ranging from 47 – 72 m in length (Savina, 2018). Fishing activity from these vessels is consistent through quarters 1-3, reducing in quarter 4. Other fishing gears associated with anchored nets/lines are not believed to occur in the site (Table 6).

4.1.3.2 Aggregated Method: Demersal Trawls

Demersal trawling in Dogger Bank is conducted predominantly by UK, Dutch, Danish German and Belgian vessels respectively. The main target species for the UK fleet is plaice whereas EU member state vessels tend to land large quantities of plaice, sandeels and herring the latter of which is most likely derived from semi-pelagic gears, which, as detailed previously are considered demersal trawls for the purpose of this assessment.

Demersal trawls in use consist of otter bottom trawls, beam trawls and otter twin trawls. With otter bottom trawls being the most common for all nations other than the Dutch who favour the use of beam trawls in the site.

4.1.3.3 Aggregated Method: Demersal Seines

A number of seining fishing activities occur within Dogger Bank including Danish or anchor Seines, purse seines, pair seines and Scottish seines. However Danish seines are the most common with Danish vessels using this technique most frequently, targeting sandeels.

4.1.3.4 Aggregated Method: Dredges

The 2014-2018 VMS and landings data available suggests scallop dredging does not occur in Dogger Bank SAC. However in spring of 2020 a lucrative stock of scallops was discovered in the Western portion of the site. This was initially exploited by English vessels but soon escalated to include vessels pertaining to the larger Scottish scallop fleet. In June, landings of scallops from the Dogger Bank area saw a tenfold increase compared to previous months (MMO marine officer, *pers. comm.,* high confidence). Initial unpublished landings data for June 2020 reveal these scallops account for 54% of all scallops landed by UK vessels. As noted previously, at the time of writing this assessment scallop dredging was prohibited in the area between 12 July and the 11 October 2020 in response to this activity and to allow analysis of this shellfish stock.

4.1.4. VMS & Landings Data

VMS and landings data have been included from 2014 to the most up to date information available in order to provide at least five years of data for analysis. Currently, VMS data is available up to and including 2018, landings data is available up to 2016 for (non-UK) EU member state vessels and to 2018 for UK vessels (Table 12-18).

Charts showing patterns of VMS reports at Dogger Bank are displayed in Figure 3-12.

Landings derived from Dogger Bank SAC have been calculated and estimated by combining a number of data sources and using various methods (see Annex 1 for details). The landings data support the conclusions drawn elsewhere that Dogger Bank is an important area for UK and EU member state demersal trawling and seining but unlike VMS data, suggests it is not a common fishing ground for gillnetting. VMS data shows considerable activity from gillnetting vessels in all years analysed (Figure 3-12), yet landings data reveals just one ton estimated to have been landed by EU member state vessels between 2014 and 2016 in Dogger Bank SAC (Table 12) and just 9 tons by these vessels across all eight ICES rectangles with which Dogger Bank SAC intersects (Table 13). As noted previously, according to VMS data, the EU member state vessels that are conducting gillnetting in Dogger Bank SAC are all of Danish origin. This activity can be attributed to seven vessels.

The Fisheries and Agriculture Organisation (FAO) of the United Nations holds vessel information[14] for three of these vessels and their primary gear type appears to switch regularly between set gillnets and Danish seines (and for one of the vessels, midwater and bottom otter trawls also). These three vessels account for 75% of the Danish gill net VMS fishing records between 2014 and 2018. Due to the lack of recorded landings derived from drift and fixed gillnets, it is assumed that the EU member state VMS gillnetting records are more likely to have been demersal trawls/seine activity. The estimated landings from EU member states has been updated to account for this (Table 16 and 17).

Estimates of demersal gear landings from Dogger Bank SAC reveal UK vessels were responsible for approximately 14% of landings by weight between 2014 and 2016 (Table 17), of which, over 12 metre vessels (i.e. those with VMS) were responsible for 100% (Table 15). This is in accordance with expert advice from MMO marine officers who advised that there is no fishing activity in the site from smaller vessels due to the distance from the shore (see section 4.1.3). In 2016, UK vessels were responsible for 46% of landings, however this appears to be due to a considerable reduction in the landings derived from EU member state vessels (Table 12, Table 13,Table 16 and Table 17), specifically the Danish fleet. UK landings remained comparable to previous years (Table 14, Table 15 and Table 17).

EU member state landings from Dogger Bank SAC have been estimated using the proportion of VMS records inside the site compared with the ICES rectangle in which they fall (Table 12). VMS records of midwater otter trawls (OTM) and midwater pair trawls (PTM) have been considered demersal trawling for these purpose as it is considered the most appropriate STECF gear category of those available and given the shallow nature of Dogger Bank, these gears are often considered semi-pelagic and may come into contact with the seabed.

Similarly, EU member state landings for the rectangle are almost exclusively (>99%) from vessels over 10 m in length (Table 17). The landings attributed to pots/traps within the ICES rectangles (Table 12 and Table 13) are not considered to have been derived from Dogger Bank SAC as all evidence suggests this gear type is not occurring in the site.

[14] https://www.fao.org/fishery/collection/fvf/en

Including the set gill net VMS records in the demersal trawl/seine landings group results in an average 17% increase in landings assumed to have derived from Dogger Bank SAC by EU member state vessels between 2014 and 2016. When again compared with UK landings, this resulted in a slight decrease in the percentage of landings obtained by UK vessels from within Dogger Bank SAC (Table 17).

The landings estimated to have derived from Dogger Bank SAC have remained relatively stable for most gears with the exception of UK beam trawls and EU member state demersal trawls / seines. UK beam trawl landings saw a considerable drop in 2016 which continued through 2017 and 2018 (Table 14 and Table 15). EU member state demersal trawl / seine landings decreased considerably in 2016 (Table 12, Table 13. Table 16 and Table 17). Both of these reductions in landings appear to correlate with reduced VMS fishing activity from UK beam trawlers and EU member state demersal trawl/seine vessels, specifically bottom otter trawls, purse seines and midwater otter trawls (Table 18). With regard to EU demersal trawl/seine landings, we do not have data past 2016 to determine whether the drop in 2016 was sustained. However, as this reduction appears to correlate with VMS activity and the VMS activity increased back to pre-2016 levels in 2017-2018, it can be assumed that landings similarly returned to the pre-2016 levels.

Figure 3: 2014 VMS Fishing Activity by gear type in Dogger Bank SAC

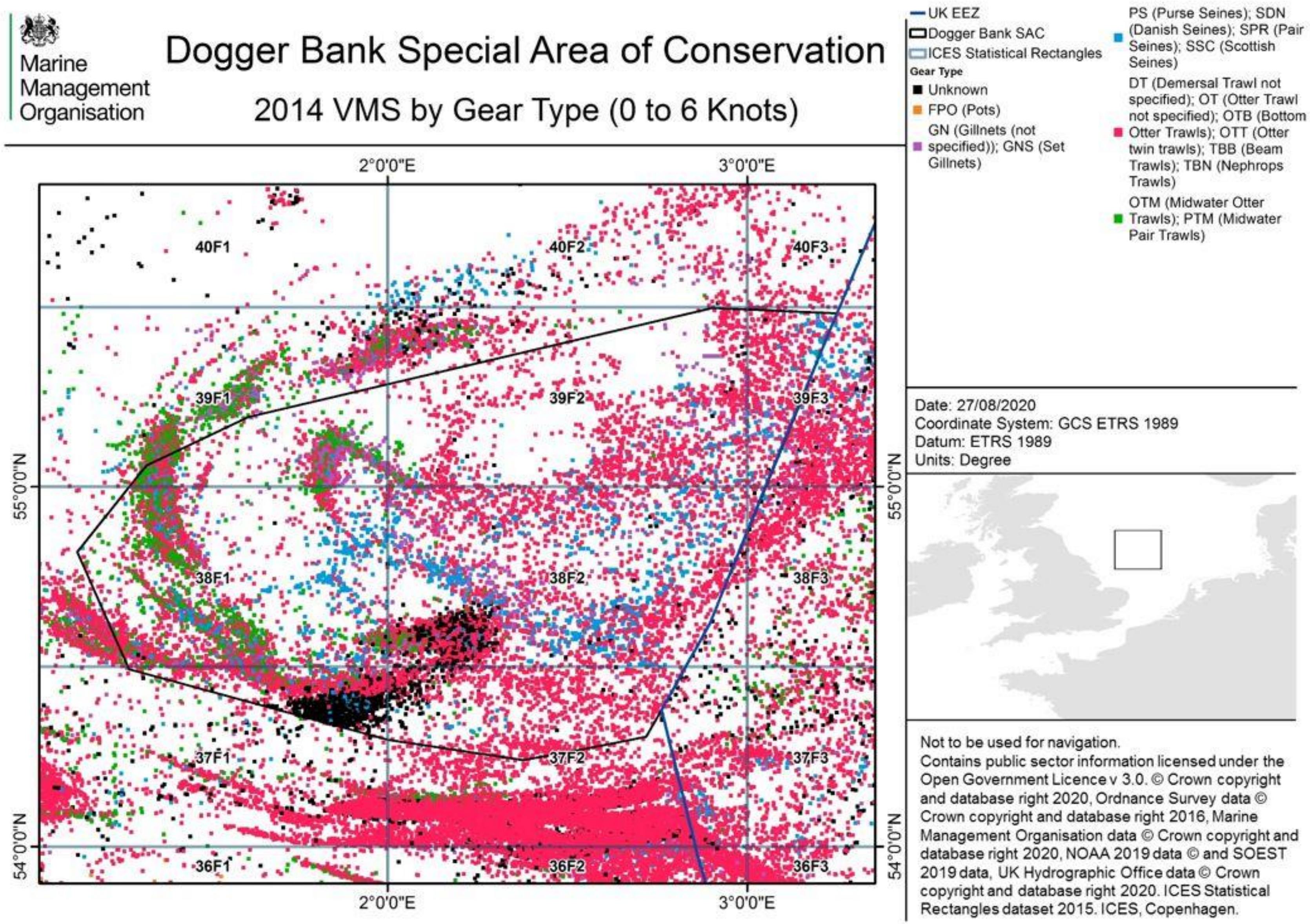


Figure 4: 2015 VMS Fishing Activity by gear type in Dogger Bank SAC

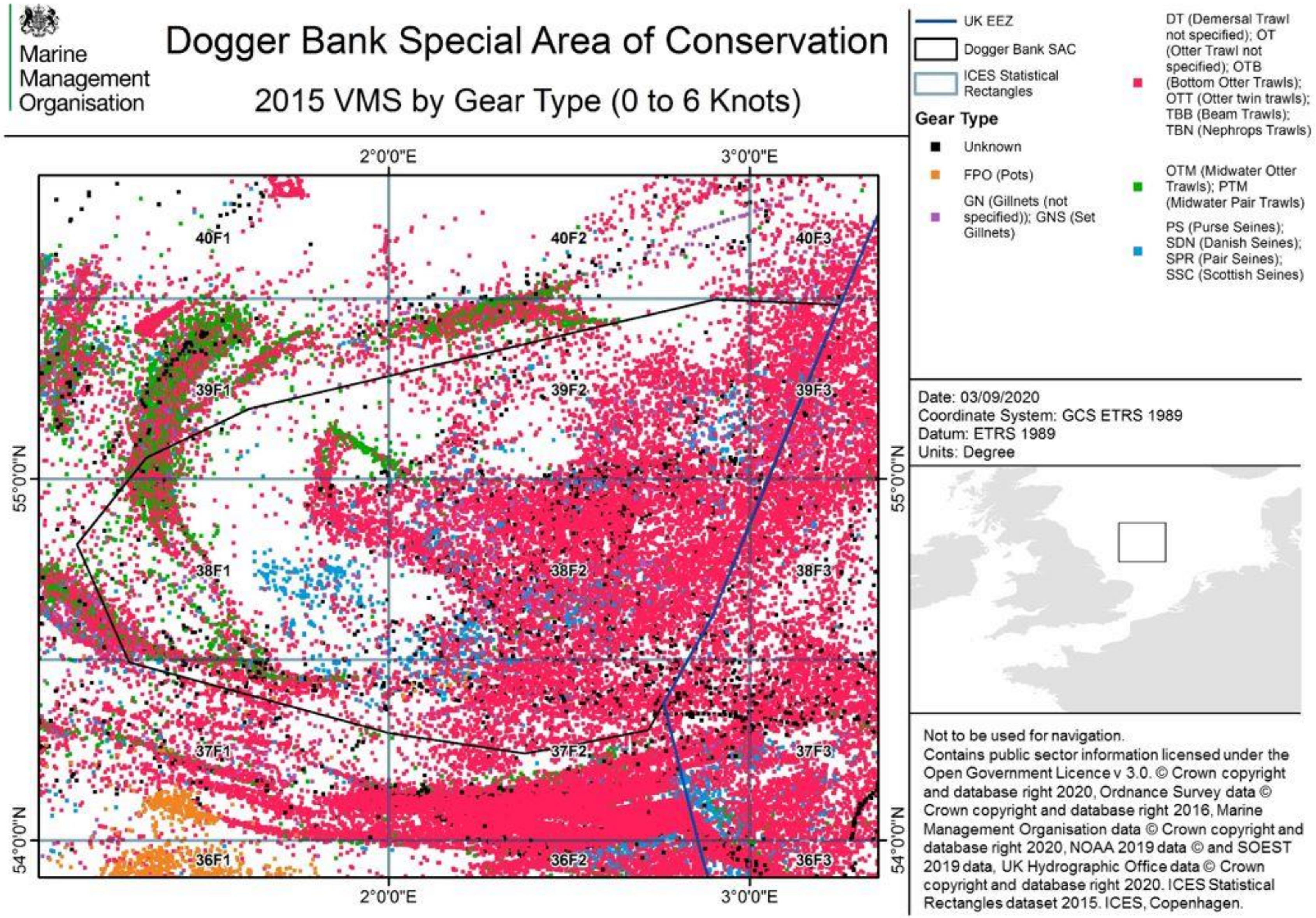


Figure 5: 2016 VMS Fishing Activity by gear type in Dogger Bank SAC

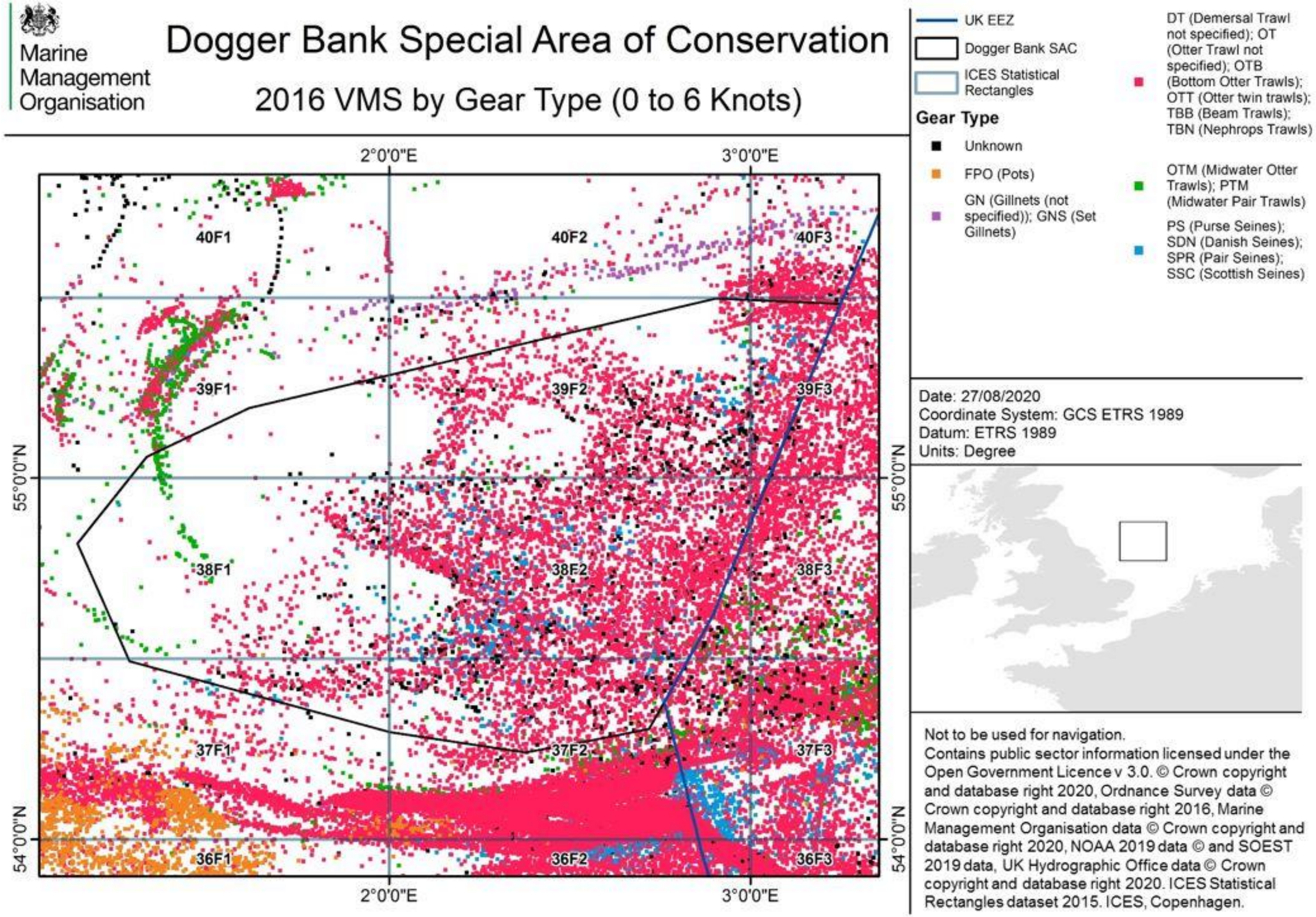


Figure 6: 2017 VMS Fishing Activity by gear type in Dogger Bank SAC

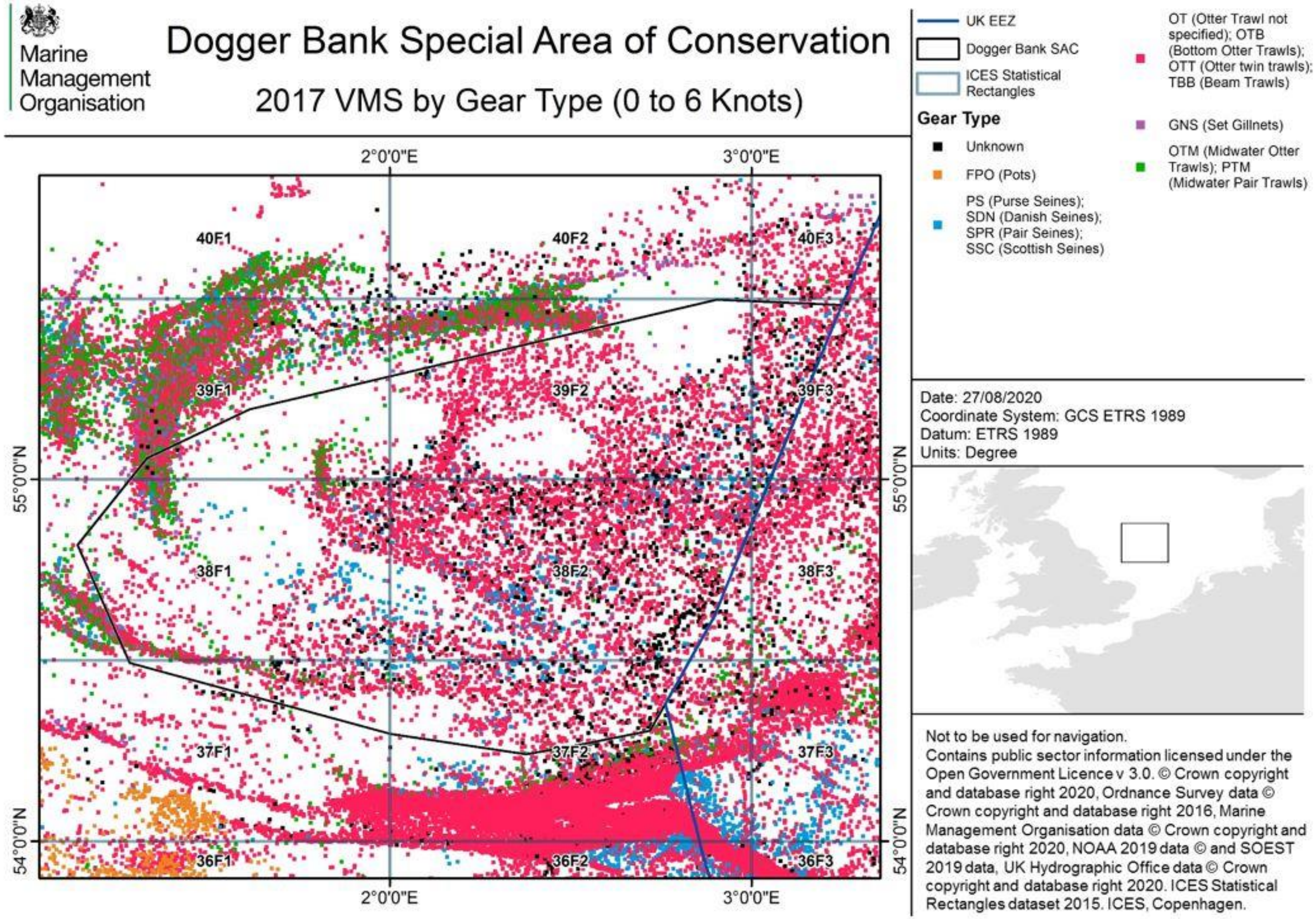


Figure 7: 2018 VMS Fishing Activity by gear type in Dogger Bank SAC

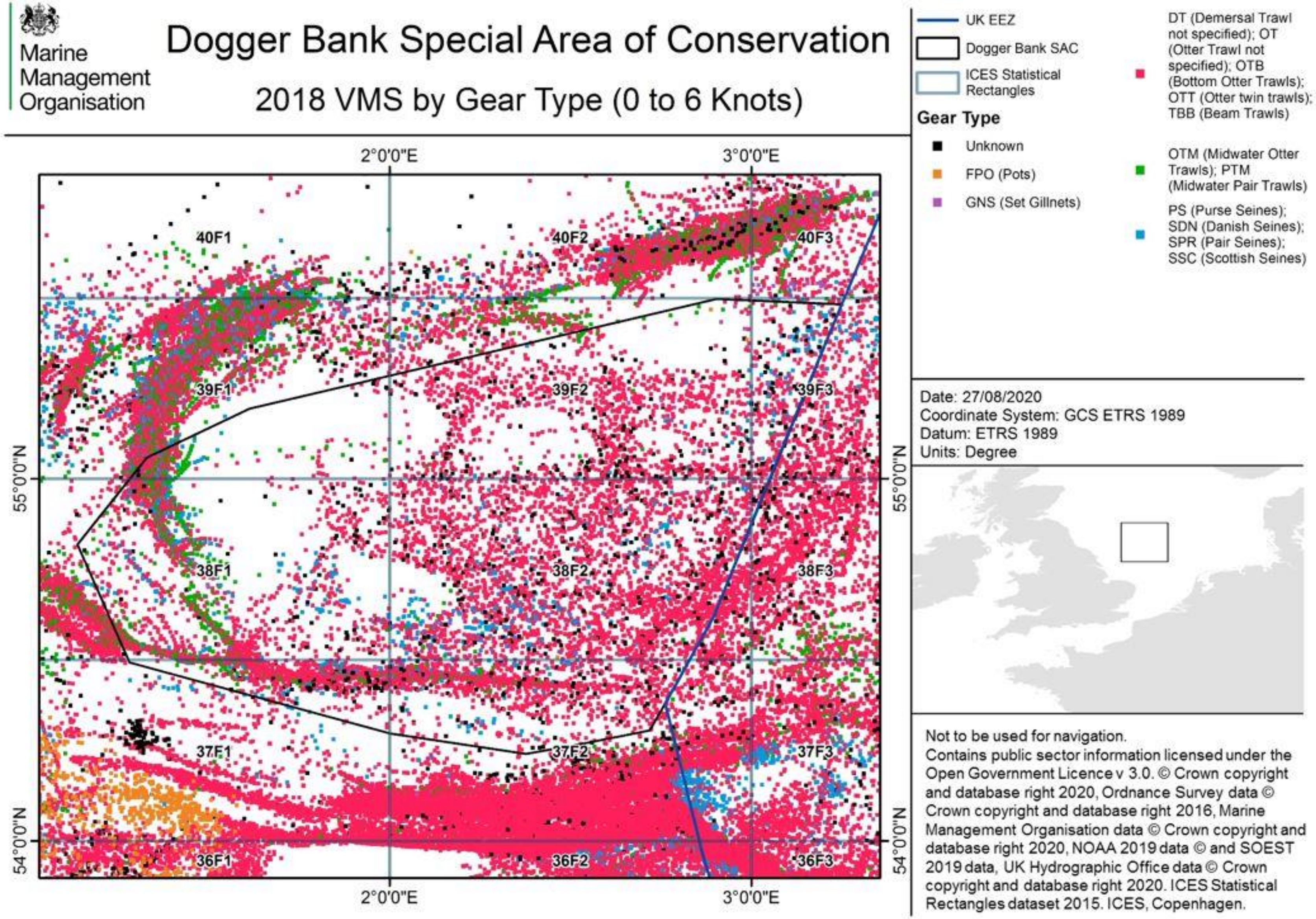


Figure 8: 2014 VMS Fishing Activity by Nationality in Dogger Bank SAC

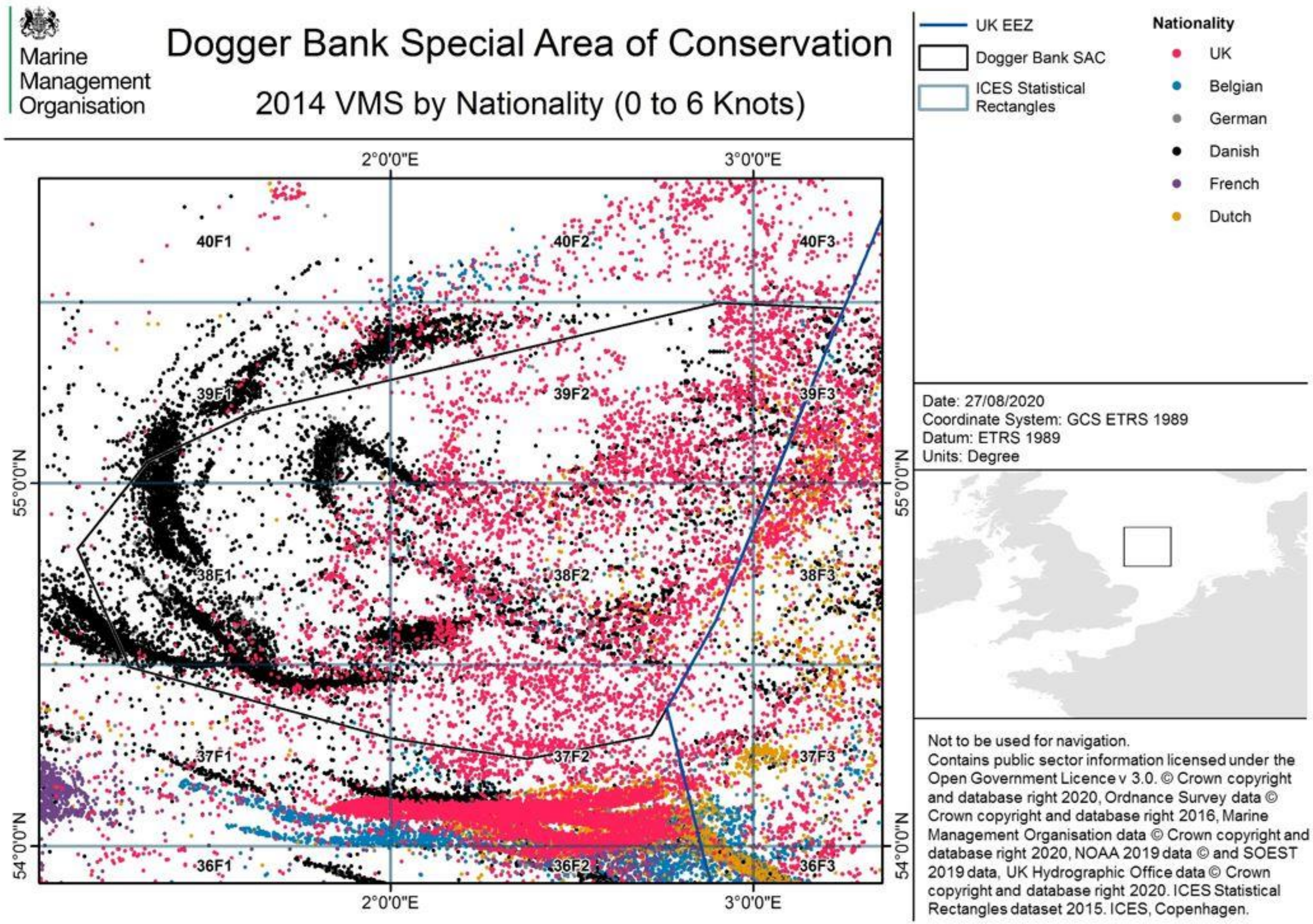


Figure 9: 2015 VMS Fishing Activity by Nationality in Dogger Bank SAC

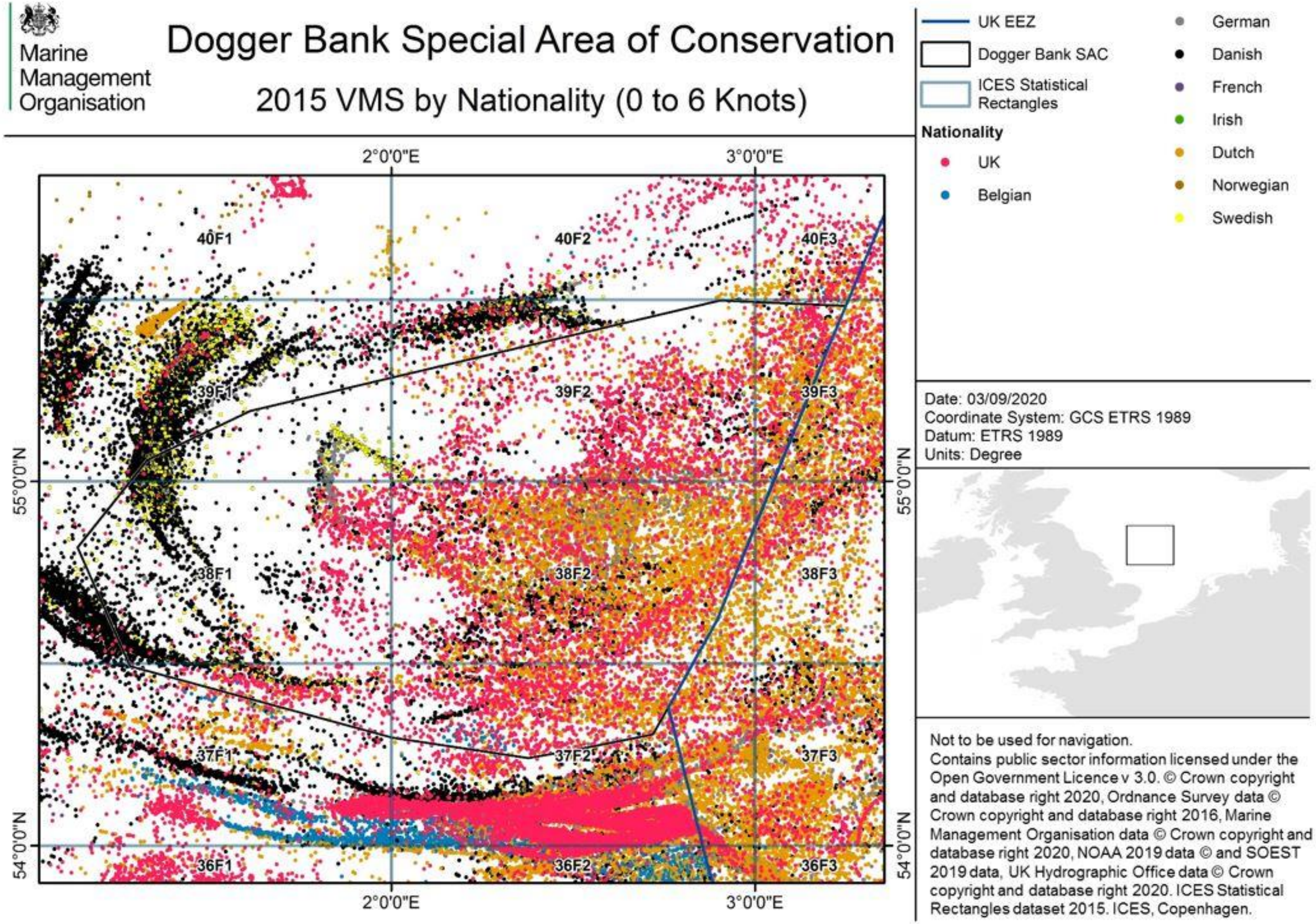


Figure 10: 2016 VMS Fishing Activity by Nationality in Dogger Bank SAC

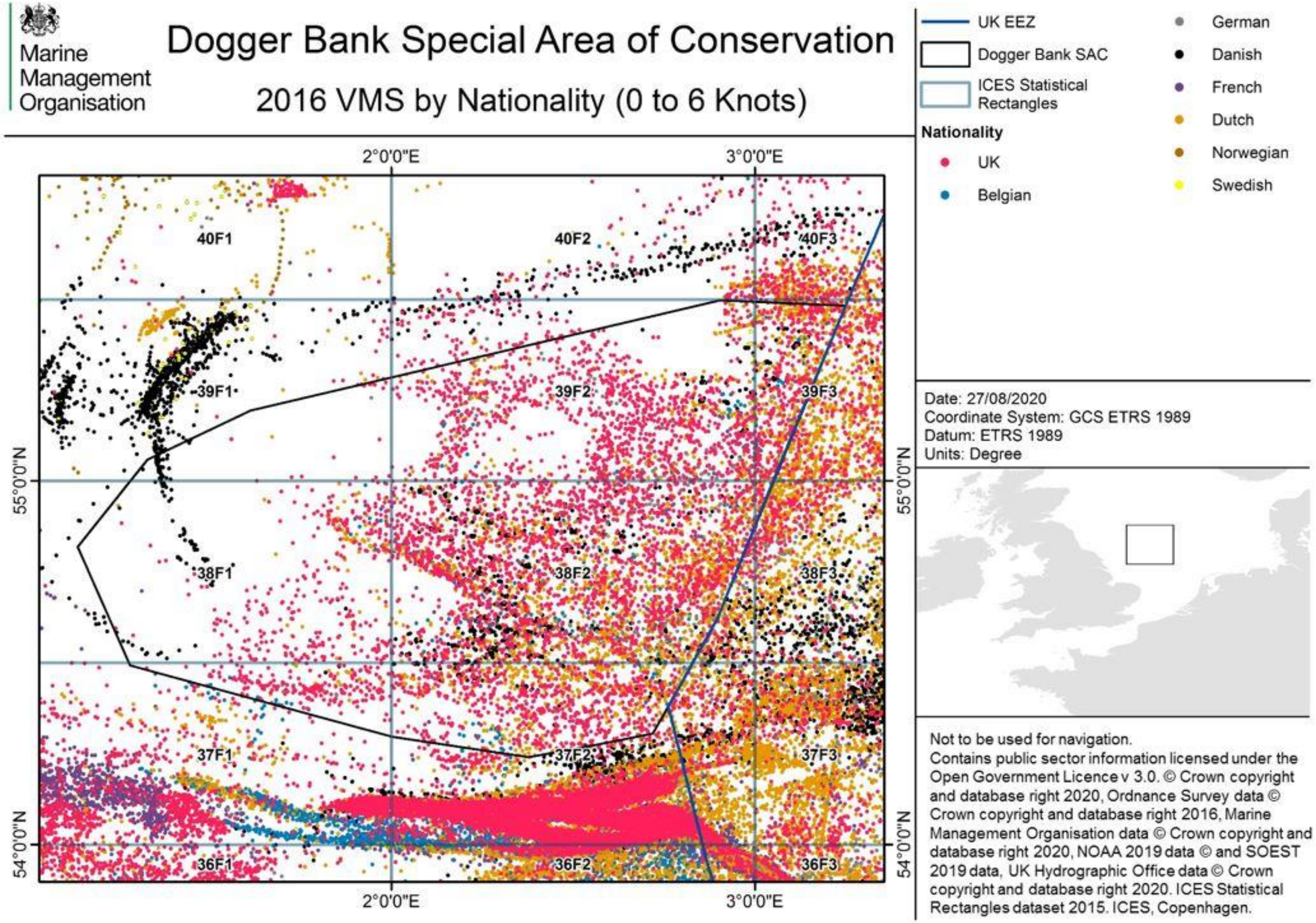


Figure 11: 2017 VMS Fishing Activity by Nationality in Dogger Bank SAC

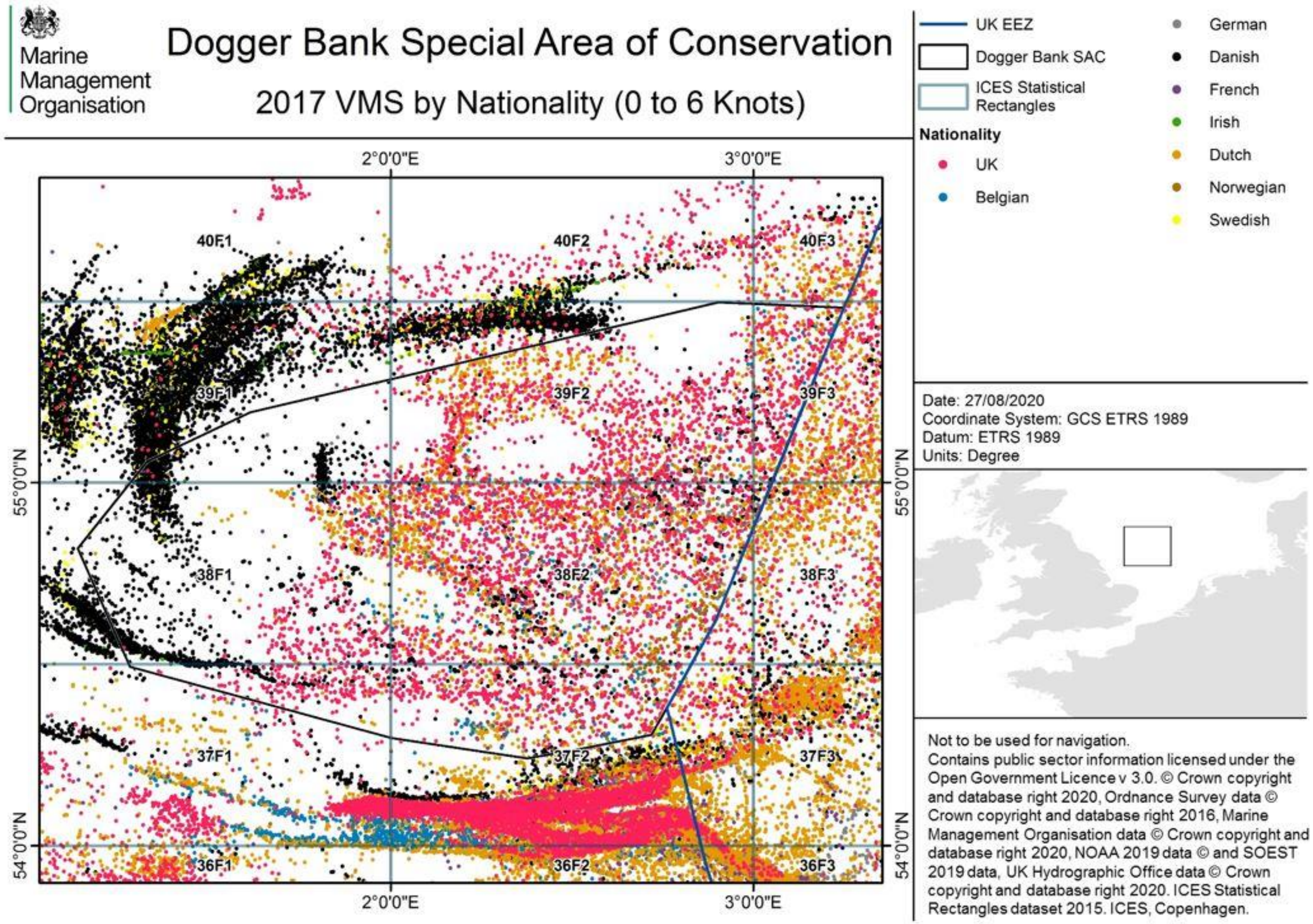


Figure 12: 2018 VMS Fishing Activity by Nationality in Dogger Bank SAC

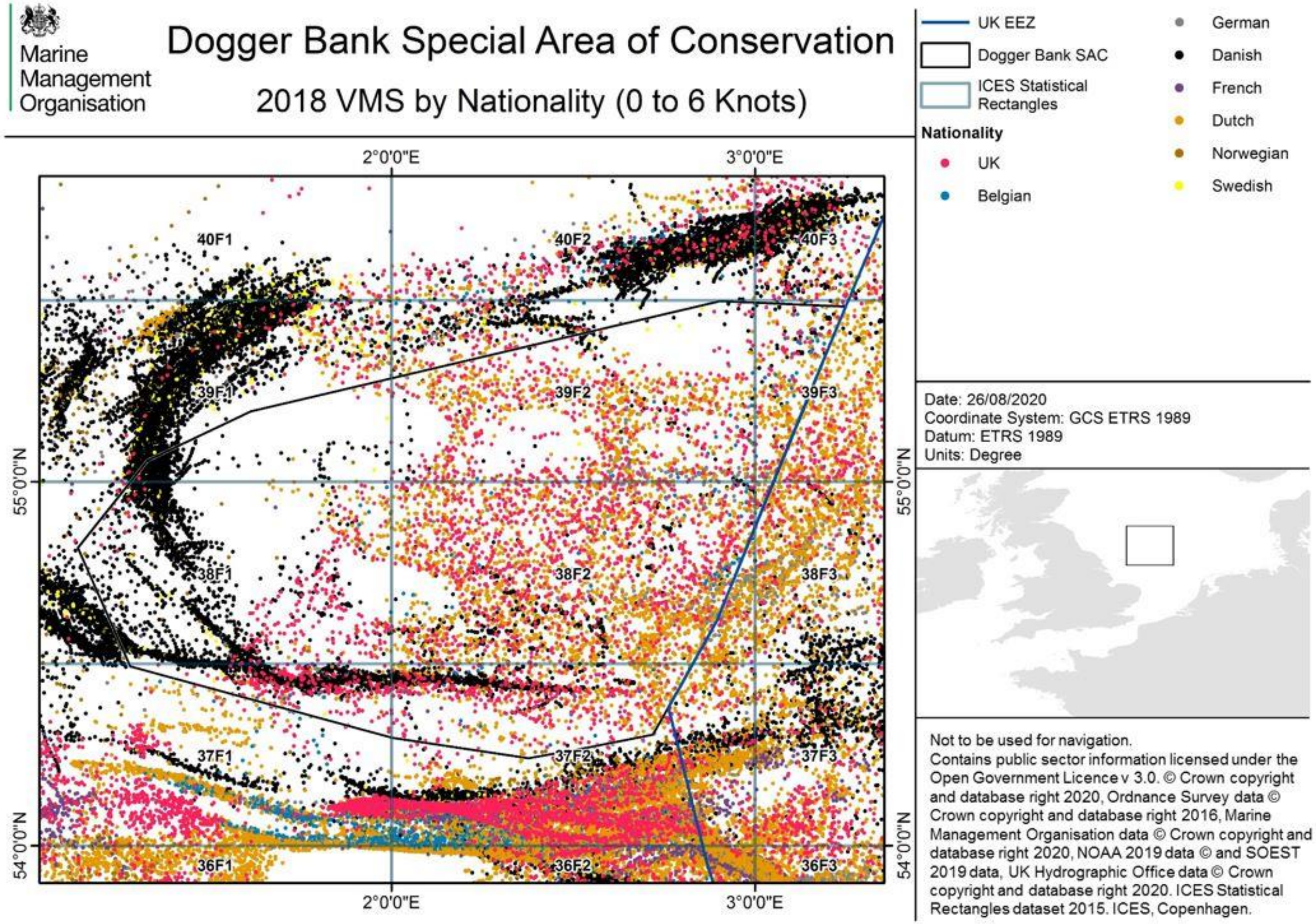


Table 12: 2014-2016 STECF landings from EU member state vessels in Dogger Bank SAC estimated from VMS data.

Year	Landings by gear (t)			
	Beam trawl	Demersal trawl/seine	Drift and fixed nets	Total landings (t)
2014	229	23,781	1	24,010
2015	1,944	18,705	0	20,649
2016	465	1,815	0	2,281
2014-2016	2,638	44,301	1	46,940

Table 13: 2014-2016 STECF landings from EU member state vessels in ICES rectangles: 39F1, 39F2, 39F3, 38F1, 38F2, 38F3, 37F1, 37F2.

Year	Vessel Size (m)	Landings by gear (t)					Total landings (t)
		Beam trawl	Demersal trawl/seine	Drift and fixed nets	Pots and traps	Unknown	
2014	All	1,744	63,488	3	-	2	65,237
	10 - 15	0.2	-	-	-	-	0.2
	15 - 24	1,743	63,378	3	-	2	65,127
	24 - 40	-	110	-	-	-	110
2015	All	5,006	116,911	-	11	-	121,928
	10 - 15	-	12	-	-	-	12
	15 - 24	5,006	116,899	-	11	-	121,916
2016	All	2,642	30,174	-	-	-	32,816
	10 - 15	-	-	-	-	-	-
	15 - 24	2,642	30,174	-	-	-	32,816
2014-2016	All	16,341	415,969	9	11	2,559	434,889
	10 - 15	0.2	11.8	0.5	0.03	-	12.6
	15 - 24	16,341	415,847	8	11	2,559	434,766
	24 - 40	-	110	-	-	-	110

Table 14: Dogger Bank SAC 2014-2018 demersal gear landings from UK vessels (derived from UK VMS)

Year	Species group	Landings by gear (t)						Total landings (t)
		GN	OTB	OTT	SDN	SSC	TBB	
2014	All	0.2	878	122	211	67	1,099	2,377
	Crustacea	0.0004	2	0.1	-	0.01	5	7
	Mollusc	-	0.3	0.004	-	0.03	8	8
	Demersal fish	0.2	876	122	211	67	1,086	2,361
2015	All	-	1,717	117	117	-	1,627	3,578
	Crustacea	-	2	0.2	-	-	12	15
	Mollusc	-	1	-	-	-	8	9
	Demersal fish	-	1,713	117	117	-	1,607	3,553
2016	All	-	2,182	313	-	-	588	3,083
	Crustacea	-	9	2	-	-	4	15
	Mollusc	-	1	0.2	-	-	3	4
	Demersal fish	-	2,171	311	-	-	581	3,063
2017	All	-	2,087	377	-	-	232	2,696
	Crustacea	-	8	3	-	-	3	15
	Mollusc	-	2	0.4	-	-	2	4
	Demersal fish	-	2,076	373	-	-	227	2,676
2018	All	-	984	199	-	-	63	1,246
	Crustacea	-	6	2	-	-	1	9
	Mollusc	-	0.4	0.1	-	-	1	1
	Demersal fish	-	978	196	-	-	61	1,235
2014-2018	All	0.2	7,848	1,128	327	67	3,609	12,980
	Crustacea	0.0004	27	7	-	0.01	26	60
	Mollusc	-	5	1	-	0.03	21	27
	Demersal fish	0.2	7,814	1,119	327	67	3,562	12,889

Table 15: 2014-2018 landings from UK Vessels in ICES rectangles: 39F1, 39F2, 39F3, 38F1, 38F2, 38F3, 37F1, 37F2.

Year	Vessel Size (m)	Landings by gear (t)										Total landings (t)
		DRB	FPO	GN	OTB	OTT	PTB	SDN	SSC	TBB	TBN	
2014	>12	0.1	16	2	2,207	362	-	225	154	2,559	125	5,650
	<12	-	-	-	-	-	-	-	-	-	-	-
2015	>12	-	121	0.3	3,292	300	34	143	-	2,787	189	6,866
	<12	-	-	-	-	-	-	-	-	-	-	-
2016	>12	-	363	3	3,570	581	-	-	0.1	1,815	153	6,486
	<12	-	-	-	-	-	-	-	-	-	-	-
2017	>12	-	167	-	4,775	686	-	-	-	952	109	6,689
	<12	-	-	-	-	-	-	-	-	-	-	-
2018	>12	-	222	-	2,051	350	-	-	-	439	0.03	3,063
	<12	-	-	-	-	-	-	-	-	-	-	-
2014 -2018	>12	0.1	888	6	15,894	2,279	34	368	154	8,553	577	28,753
	<12	-	-	-	-	-	-	-	-	-	-	-

Table 16: 2014-2016 STECF original and updated demersal trawl/seine landings from EU member state vessels in Dogger Bank SAC estimated from VMS data. (GNS VMS records reassigned to SDN and grouped with demersal trawls/seine landings)

Year	EU Member state Demersal trawl/seine landings		
	Original (t)	Updated (t)	% increase
2014	23,781	26,264	10%
2015	18,705	22,318	19%
2016	1,815	3,084	70%
2014-2016	44,301	51,666	17%

Table 17: Updated 2014-2016 Dogger Bank SAC UK – EU landings comparisons

Year	Landings											
	Beam trawl			Demersal trawl/seine			Drift and fixed nets			Total landings (t)		
	UK (t)	EU (t)	UK (%)	UK (t)	EU (t)	UK (%)	UK (t)	EU (t)	UK (%)	UK (t)	EU (t)	UK (%)
2014	1,099	229	83	1,278	26,264	5	0.2	0	100	2,377	26,493	8
2015	1,627	1,944	46	1,951	22,318	8	0	0	-	3,578	24,262	13
2016	588	465	56	2,495	3,084	45	0	0	-	3,083	3,549	46
2014-2016	3,314	2,638	56	5,724	51,666	10	0.2	0	100	9,038	54,304	14

Table 18: Dogger Bank SAC UK and EU VMS fishing records 2014-2018

Gear	UK / EU	Year(s)					
		2014	2015	2016	2017	2018	2014 - 2018
GN / GNS	**UK**	5	1	2	0	0	8
	EU	2,044	1,325	70	219	91	3,749
OTB	**UK**	2,465	3,287	3,082	2,981	1,929	13,744
	EU	5,851	3,158	875	3,638	4,770	18,292
OTT	**UK**	125	169	340	448	333	1,415
	EU	1	52	17	522	1,091	1,683
OTM	**UK**	0	1	0	0	0	1
	EU	2,357	1,302	137	565	1,218	5,579
PS	**UK**	0	0	0	0	0	0
	EU	590	107	2	110	507	1,316
PTM	**UK**	1	1	0	0	0	2
	EU	0	56	5	0	0	61
SDN	**UK**	989	475	0	0	0	1,464
	EU	2,083	2,158	1,179	1,355	774	7,549
SPR	**UK**	0	0	0	0	0	0
	EU	0	3	0	30	46	79
SSC	**UK**	38	45	0	0	0	83
	EU	86	71	285	228	114	784
TBB	**UK**	1,542	1,983	938	98	80	4,641
	EU	50	6,302	1,623	2,049	1,058	11,082

4.1.5 MMO and Royal Navy Sightings

Sightings data from Dogger Bank SAC reveals a similar picture to that concluded by other data sources with the majority of vessels observed fishing in the site between 2014 and 2018 being demersal trawlers and seining vessels.

4.1.6 Summary

Dogger Bank SAC is an important area for both UK registered and EU member state fishing vessels using demersal gears. With the exception of UK beam trawling and a reduced EU fleet in 2016, UK and EU landings and fishing intensity have remained relatively consistent over the last five years.

Fishing activity in and around Dogger Bank SAC is almost exclusively conducted by larger vessels over 12 m in length, which are better able to travel the considerable distance to Dogger Bank from mainland Europe.

Analysis of landings data contradicts that of VMS data with regard to set gill net activity. Few landings have been recorded by EU member state vessels for the ICES rectangles that intersect Dogger Bank SAC despite considerable activity apparently recorded by VMS data. This anomaly has been attributed to inaccurate/outdated gear information within the VMS data. The set gill net fishing activity recorded in the VMS data is more likely to be demersal trawl/seine activities.

Set or anchored gill nets will still be considered in this assessment as there is some, albeit limited, UK gill net activity occurring in Dogger Bank SAC and we cannot be certain our assumptions regarding the EU gill net activities are correct, nor that the activity will not occur/increase in the future.

It is clear there is an interaction between the fishing activity occurring and the protected Annex I sandbank feature of the Dogger Bank SAC. The sections below begin to explore the pressure that each fishing type exerts on the Dogger Bank sandbank feature.

For pressures where potential impacts to features are of a similar nature, those pressures have been consolidated to avoid repetition during this stage of the assessment. For each subsequent pressure, new information regarding the potential effects of that pressure could have on the feature has been discussed.

4.2 Abrasion/disturbance of the substrate on the surface of the seabed AND Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion

These pressures are relevant to anchored nets/lines, demersal trawls, demersal seines and dredges in Dogger Bank SAC. The impacts of these pressures have been assessed for the ‘sandbanks which are slightly covered by sea water all the time’ feature.

4.2.1 Impact of anchored nets/lines

Gill nets have been identified as gear types which may have an impact via surface and sub-surface abrasion and penetration on the sandbank feature. Surface and sub-surface abrasion and penetration from gill nets may be possible through associated lines and anchors. This is particularly apparent during hauling of gear or the movement of gear along the seabed when subject to strong tides, currents or storm activity. However, interaction of lines and anchors associated with nets with the seabed is likely to be minimal. Evidence suggests that static gears have a relatively low impact on benthic communities in comparison to towed gears, as a result of the small footprint of the seabed affected (Roberts et al., 2010). In accordance with this, Hall et al. (2008) concluded that assuming they are set correctly, demersal static gears are not considered to have a significant impact on subtidal sand features. Anchored nets/lines are unlikely to impact the extent and distribution or structure and function of the sandbank feature.

As noted previously, VMS and landings data are contradictory with regard to anchored netting activity within Dogger Bank SAC and is likely not occurring with any considerable regularity. The low levels of gillnetting activity, combined with the minimal impacts predicted to be caused via surface abrasion and sub-surface penetration, suggest that this activity is not currently a cause of concern for the protected features of Dogger Bank SAC.

With regards to the discussion above and the assessed activity levels, the **MMO concludes that impacts of abrasion or penetration from anchored nets/lines on the sandbank feature are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity.**

4.2.2 Impact of demersal trawls

Bottom otter trawls, otter twin trawls and beam trawls have been identified as gear types which may have an impact via surface and sub-surface abrasion and penetration on the sandbank feature.

The trawl doors and associated ground gear of otter trawls can penetrate into sediments. Furrows and berms are created through physical impact of trawl doors on the sediment, thus creating irregular features on the seabed (Løkkeborg, 2005). Trawl doors may cause furrows of up to 35 cm deep depending on the door weight and the hardness of the sediment (Løkkeborg, 2005; Eigaard et al., 2016). Otter trawling has been shown to create berms and furrows on sandy substrates, with repetitive trawling causing increased surface relief or roughness (Schwinghamer et al., 1998). Trawl doors can penetrate up to 10 cm into sand, gravel and mixed substrates, with associated chains penetrating up to 8 cm (Eigaard et al., 2016; Humborstad et al., 2014). Particle size analysis of Dogger Bank sediment samples in 2014 reveal that the sandbank feature is made up of sediments and pebbles no greater than 2.5 cm in diameter (Eggleton et al., 2016). Otter trawls have been shown to create visible paths and furrows on substrates dominated by pebbles less than 6.5 cm in diameter (Freese et al., 1999) as occurring in Dogger Bank SAC. Eigaard et al. (2016 a,b) estimated that the subsurface ratio (proportion of the gear footprint where gear components penetrate the seafloor by 2 cm) for otter trawls ranges from 0.078 to 0.304, depending on target species. Otter trawls are unlikely to significantly impact the large scale topography or sediment composition of the sandbank feature, however, impacts to the biological structure are likely and are discussed below.

The chains of a beam trawl cover the whole width of the gear and are designed to penetrate the upper few centimetres of the sediment, ranging from a few centimetres to at least 8 cm (Løkkeborg, 2005). Beam trawls have been described to cause a flattening of bottom features such as ripples and irregular topography (Thrush et al., 1995; Kaiser et al., 1996). Beam trawl shoes and tickler chains penetrate up to 10 cm into sandy, coarse and mixed sediments (Eigaard et al., 2016). Side scan observations have indicated that beam trawling creates clear marks in fine and medium sand habitats, with sea bed roughness decreasing and hardness increasing directly after the trawls (Løkkeborg, 2005; Fonteyne, 2000). Tickler chains may also turn, displace and even remove larger pebbles and boulders in areas with mixed sediments (Eigaard et al., 2016; JNCC, *pers. comm.*). Despite this, seabed characteristics of sandy substrates have been shown to return to their original levels in 15 hours following beam trawling (Løkkeborg, 2005). Eigaard et al. (2016 a,b) estimated that the subsurface ratio (proportion of the gear footprint where gear components penetrate the seafloor by 2 cm) for beam trawls ranges from 0.522 to 1.000, depending on target species. As above, beam trawls are unlikely to significantly impact the large scale topography or sediment composition of the sandbank feature, however, impacts to the biological structure are likely and are discussed below.

Surface and sub-surface abrasion and penetration by demersal trawls may impact the biological communities found in the sandbank feature of Dogger Bank SAC. Demersal trawls may have physical impacts on infaunal species such as the bristleworm - *Spiophanes bombyx*, the bivalve - *Tellina fibula*, the polychaete - *Magelona filiformis* and amphipods - *Bathyporeia* spp which are typically found in the sandy sediments of the site, causing direct mortality of these species (Eggleton et al., 2016). Similarly, epifauna are likely to be adversely impacted. This includes potential impacts to the endobenthic bivalves, *Mactra stultorum, Donax vittatus, Arctica islandica* and *Ensis* species, as well as the masked crab - *Corystes cassivelaunus*, sea potato - *Echinocardium cordatum* and more common species belonging to the groups Asteroidea, Cnidaria, Bryozoa and Paguridae (Eggleton et al., 2016; Van Moorsel, 2011). Fragile species such as the soft coral - dead man's fingers (*Alcyonium digitatum*) are particularly vulnerable as they are highly sensitive to removal and displacement (Jager et al., 2018). This species is permanently attached to the substratum and once displaced does not have the ability to re-establish its attachment (Jager et al., 2018). Over time, there has been an indication that longer-lived species such as the bivalves, *Spisula subtruncata* and *Mactra stultorum,* have now been replaced by more opportunistic, short-lived bivalve feeders such as *Spiophanes bombyx*, *Amphiura filiformis* and *Phoronids* on Dogger Bank (Kröncke, 2011). This change, as well as reduction in fish species such as the thornback ray may be attributed to the use of bottom towed gear (Jak et al., 2009). The impacts of demersal trawling activity at the levels indicated in this assessment are not compatible with the restore extent and distribution and structure and function targets for the site with regards to the biological communities.

VMS data shows that very high levels of demersal trawling take place throughout Dogger Bank SAC with a focus on the middle and eastern sections. This is indicative of intense trawling activity and therefore the impacts, described above, are likely to occur throughout the site.

With regards to the discussion above and the assessed activity levels, the **MMO concludes that impacts of abrasion or penetration from demersal trawls on the sandbank feature are not compatible with the conservation objectives of the site and may result in an adverse effect on site integrity.**

4.2.3 Impact of demersal seines

Danish/anchor seines, Scottish seines and Scottish pair seines have been identified as gear types which may have an impact via surface and sub-surface abrasion and penetration on the sandbank feature. Purse seines are a pelagic gear and so are not assessed in this section as they are unlikely to make contact with the seabed.

Demersal seine hauls can impact the seabed either via contact of the seine rope or ground gear, with the largest impact by area coming from the seine rope when they are pulled together in the first phase of fishing operation (Eigaard et al., 2016; Rijnsdorp, 2013). Scottish seines are expected to have a larger impact than Danish seines due to their weight, thicker ropes and larger area footprint (Eigaard et al., 2016). The surface footprint of Scottish seines (1.6 km^2) and Danish seine (1.0 km^2), defined as the surface area covered during one hour of fishing, is relatively high compared to the otter trawl (0.3 – 1.2 km^2) and beam trawl (0.2 km^2) (Eigaard et al., 2016; Rijnsdorp, 2015). The sub-surface footprint of Scottish seines (0.1 km^2) is estimated to be lower than the sub-surface footprint of otter trawls used for Nephrops (0.3 km^2) or beam trawl fisheries (0.2 km^2) (Eigaard et al., 2016; Rijnsdorp, 2015). The physical structure of the feature is unlikely to be impacted and therefore this activity is compatible with the structure and function target for the site.

Given the absence of otter boards and lighter groundgear, seines tend to be considered as less damaging to seabed habitats via abrasion and penetration compared to other demersal gear types. Eigaard et al. (2016 a,b) estimated that the subsurface ratio to be 0.000 for Danish seines and 0.050 for Scottish seines. In comparison, predicted sub-surface ratios for otter trawls ranged from 0.078 to 0.304 and from 0.522 to 1.000 for beam trawls, depending on target species (Eigaard et al., 2016 a,b). These predictions are in line with the conclusions of MBIEG (2020) which suggest that demersal seines alone may not have a significant impact on benthic communities via surface abrasion and subsurface penetration. Where sessile or attached epifauna are absent this is compatible with the restore extent and distribution and structure and function targets of the site in relation to biological communities. However, impacts of abrasion and penetration through removal of non-target species may exist and are assessed in section 4.4.3.

VMS data indicates that UK vessels only use Scottish seines within the site. Non-UK vessels mostly use Danish seines in addition to Scottish seines. VMS charts indicates that demersal seining within the site occurs at a much lower level than demersal trawling, with activity occurring sporadically throughout the site.

With regards to the discussion above and the assessed activity levels, the **MMO concludes that impacts of surface abrasion on the sandbank feature from demersal seines alone are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity.**

4.2.4 Impact of dredges

Shellfish dredges have been identified as gear types which may have an impact via surface and sub-surface abrasion and penetration on the sandbank feature.

The ground gear of dredges used for catching molluscs is mostly homogenous across the entire width of the dredge, with the exception of scallop dredges that have teeth protruding into the sediment (Eigaard et al., 2016). Scallop dredges therefore produce a more uneven sediment furrow (Eigaard et al., 2016; O'Neill et al., 2013). Scallop dredging can cause a flattening of irregular bottom topography by eliminating natural features such as ripples, bioturbation mounds and faunal tubes (Løkkeborg, 2005). The ground gear of dredges can penetrate up to 15 cm into sandy substrates

(Eigaard et al., 2016). A study by Lambert et al. (2015) and Murray et al. (2015) demonstrated how tracks from scallop dredges persisted for up to ten months in coarse sediment, whereas dredge tracks were not found to be visible in sand. This impact on the physical structure of the sandbank is not compatible with the restore structure and function target for the site.

The epifauna and infaunal assemblages of both stable and dynamic fine sands are known to be susceptible to direct physical disturbance from dredges which penetrate and disturb the sediment (Roberts et al., 2010). A meta-analysis by Kaiser et al. (2006) indicated that both deposit- and suspension-feeders were consistently vulnerable to scallop dredging across gravel, sand and mud habitats. Slow-growing species, such as soft corals took much longer to recover (up to 8 yr) from scallop dredging than biota with shorter life-spans such as polychaetes (<1 yr) (Kaiser et al., 2006). Therefore surface and sub-surface abrasion and penetration by demersal dredges may impact the biological communities found in the sandbank feature of Dogger Bank SAC. As described for demersal trawls in section 4.2.2, dredges may adversely impact infauna and epifauna found on the sandbank feature through direct physical impacts. This impact is not compatible with the restore extent and distribution and structure and function targets for the site with regards to the biological communities.

VMS and landings data show that scallop dredging has not occurred within the site between 2014 and 2018. However, recent, unpublished VMS data from 2020 indicates that there has been a considerable rise in dredging for king scallops (*Pecten maximus)* in the site. If activity continues impacts from dredges may become a concern to the site's protected features.

With regards to the discussion above and the assessed activity levels, the **MMO concludes that impacts of abrasion or penetration from dredges on the sandbank feature are not compatible with the conservation objectives of the site and may result in an adverse effect on site integrity.**

4.2.5 Pressure conclusion

Given the evidence above, surface abrasion and sub-surface penetration caused by anchored nets/lines or demersal seines alone within Dogger Bank SAC is unlikely to hinder the restoration of the extent and distribution as well as structure and function of the sandbank feature. The **MMO conclude that anchored nets/lines or demersal seines alone are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity via this pressure.**

There is a risk that surface abrasion and sub-surface penetration caused by demersal trawls and dredges may not help the achievement of favourable condition targets. Use of these gear types may impact the physical and biological structure of the sandbank feature via direct physical impacts from gear interacting with the seabed and species. This may impact the extent and distribution regarding large scale topography, sediment composition and biological assemblages. The **MMO conclude that demersal trawls or dredges alone are not compatible with the conservation objectives of the site and may result in an adverse effect on site integrity via this pressure.**

Table 19: Pressure conclusion for abrasion/disturbance of the substrate on the surface of the seabed AND penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion based on assessed activity levels

Pressure	Feature	Favourable condition target	SNCB aggregated gear method	Compatible with the conservation objectives?
Abrasion/disturbance of the substrate on the surface of the seabed And Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion	Sandbanks which are slightly covered by seawater all the time	**Restore extent and distribution:** The feature extent within the site must be conserved to the full known distribution (sandbank feature calculated to be 12,331km^2) based on: - large-scale topography - sediment composition - biological assemblages	Anchored nets/lines	Yes
			Demersal trawls	No
			Demersal seines	Yes
			Dredges	No
		Restore structure and function: • Physical structure (finer scale topography and sediment composition and distribution) to be restored. • Biological structure (key and influential	Anchored nets/lines	Yes
			Demersal trawls	No
			Demersal seines	Yes

		species and characteristic communities) to be restored.	Dredges	No

4.3 Changes in suspended solids (water clarity) AND smothering and siltation rate changes

These pressures are relevant to demersal trawls, demersal seines and dredges in Dogger Bank SAC. The impacts of these pressures have been assessed for the ‘sandbanks which are slightly covered by sea water all the time’ feature.

The impacts of demersal trawls, demersal seines and dredges have been grouped in this section due to the similarity in impacts caused by towed gear. Compatibility with conservation objectives and favourable condition targets has been considered for all gear types.

4.3.1 Impact of demersal trawls, demersal seines and dredges

When towed gear interacts with the seabed and ambient water, regions of high velocity, high bed shear stress and possibly a fluidised bed are produced (O’Neill and Summerbell, 2011). This may contribute to entrainment of sediment around and behind the gear which is then dispersed in a cloud, creating a suspension with a vertical profile that depends on the turbulence and the particle settling velocities (O’Neill and Summerbell, 2011). The sediment then gradually settles as turbulence reduces. Suspension and settlement of sediments varies between gear types used and type of substrate.

Experiments using otter trawls on sand demonstrated that sediments can be suspended up to 80 cm above the seabed (O’Neill and Summerbell, 2011). Otter trawl components can cause a sediment concentration increase behind the gear of up to 429 μl/l (O’Neill and Summerbell, 2011). Per metre towed, an estimated 41.3 kg m^{-1} of sediment has been shown to be suspended by all otter trawl components (ground gear and trawl doors) in sandy substrates (O’Neill and Summerbell, 2011). Linders et al. (2018) concluded that sand is typically transported 10 to 100 m when in suspension. With regards to dredging, scallop dredges have been shown to entrain sandy sediments up to 30 m behind the gear (O’Neill et al., 2008). A study on sandy sediment grounds in Scotland demonstrated that the turbulent wake of scallop dredges entrains up to the equivalent of a 1 mm layer of sediment per unit of swept width (O’Neill et al., 2013).

Mobilisation of sediment can cause the release of nutrients, benthic infaunal mortality and the resuspension of phytoplankton cysts and copepod eggs (O'Neill and Summerbell, 2011). Increased turbidity and redistribution of sediments may be a risk to organisms that are vulnerable to increased levels of sediment particles in the water column and creates the potential for impacts via smothering (Linders et al., 2018; Gubbay and Knapman, 1999). Changes in suspended sediment in the water column may have a range of biological effects on different species within the habitat; affecting the ability to feed or breathe[15]. A prolonged increase in suspended particulates for instance can have a number of implications, such as affecting fish health, clogging filtering organs of suspension feeding animals and affecting seabed sedimentation rates (Elliot et al., 1998).

Many of the species found within the sandbank feature of Dogger Bank SAC are sedentary filter or suspension feeders such as bivalves which may be at risk from smothering caused by resuspension of sediment (Tillin and Tyler-Walters, 2014). However, evidence suggests that there is relatively low suspended sediment concentrations within the site of the order of 2 mg/l with a maximum of 10 mg/l (Doerffer and Fisher, 1994; Eleveld et al., 2004). Furthermore, the location of the site means that it is exposed to substantial wave energy which means the dispersion of sediment plumes created by towed demersal gears will be high. This is compatible with favourable condition targets requiring maintenance of the hydrodynamic regime, water and sediment quality.

Tillin and Tyler-Walters (2014) concluded that both the resistance and resilience of erect, large, longer-lived epifaunal species with some flexibility was high to this pressure. For soft-bodied or flexible epifaunal species, Tillin and Tyler-Walters (2014) noted that increased turbidity could be beneficial for these species under certain conditions, and only up to a level that wasn't considered too high. Therefore impacts on the biological communities of the sandbank feature from this pressure is likely to be minimal. This is compatible with favourable condition targets for the extent and distribution and structure and function of the sandbank feature in relation to biological communities.

VMS data shows that there are high levels of activity for demersal towed gears throughout the site between 2014 and 2018. However, given the discussion above, there is no evidence to suggest that this pressure is adversely affecting the features of Dogger Bank SAC. This pressure will be considered in combination with other plans and projects in Part C.

With regards to the discussion above and the assessed activity levels, the **MMO**

[15] JNCC Supplementary Advice of Conservation Objectives for Dogger Bank Special Area of Conservation https://data.jncc.gov.uk/data/26659f8d-271e-403d-8a6b-300defcabcb1/DoggerBank-3-SACO-v1.0.pdf

concludes that impacts from changes in suspended solids (water clarity) AND smothering and siltation rate changes by demersal trawls, demersal seines and dredges on the sandbank feature are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity.

4.3.2 Pressure conclusion

Given the evidence above, impacts from changes in suspended solids, smothering and siltation caused by demersal trawls, demersal seines and dredges alone within Dogger Bank SAC are unlikely to hinder the restoration of the extent and distribution or structure and function of the sandbank feature. This pressure is also unlikely to hinder the maintenance of the hydrodynamic regime or water quality in the site. The **MMO conclude that demersal trawls, demersal seines and dredges are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity via this pressure.**

Table 20: Pressure conclusion for changes in suspended solids (water clarity) AND smothering and siltation rate changes based on assessed activity levels

Pressure	Feature	Favourable condition target	SNCB aggregated gear method	Compatible with the conservation objectives?
Changes in suspended solids (water clarity) AND Smothering and siltation rate changes	Sandbanks which are slightly covered by seawater all the time	**Restore extent and distribution:** The feature extent within the site must be conserved to the full known distribution (sandbank feature calculated to be 12,331km^2) based on: - large-scale topography - sediment composition - biological assemblages	Demersal trawls	Yes
			Demersal seines	Yes
			Dredges	Yes

		Restore structure and function: • Physical structure (finer scale topography and sediment composition and distribution) to be restored. • Biological structure (key and influential species and characteristic communities) to be restored.	Demersal trawls	Yes
			Demersal seines	Yes
			Dredges	Yes
		• **Maintain** hydrodynamic regime • **Maintain** water and sediment quality to be maintained.	Demersal trawls	Yes
			Demersal seines	Yes
			Dredges	Yes

4.4 Removal of non-target species

These pressures are relevant to anchored nets/lines, demersal trawls, demersal seines and dredges in Dogger Bank SAC. The impacts of these pressures have been assessed for the ‘sandbanks which are slightly covered by sea water all the time’ feature.

4.4.1 Impact of anchored nets/lines

Fixed nets such as gill nets have the potential to entangle non-target species. Species that are likely to become entangled include diving seabirds, seals and cetaceans (Gislason, 1994) and erect, branching benthic species such as pink sea fans (*Eunicella verrucosa*) (Eno *et al*, 2013). Characteristic communities within the subtidal sandbank feature of Dogger Bank include infauna and epifauna such as bivalves, polychaetes, echinoids, soft corals and bryozoans. The majority of these are unlikely to be removed by gill nets. An exception may be the dead man’s finger soft coral, a species unique to Dogger Bank SAC in terms of North Sea sandbanks. Standing up to 250 mm tall (Picton et al., 2016), it is theoretically possible these soft corals may be removed by the drift or hauling of anchored gill nets. However, there is little empirical evidence to support this and recent surveys in the site (Diesing et., 2009) observed the species in abundance on the coarse sediment areas of the sandbank feature, suggesting current gillnetting activities are not negatively impacting the species. Anchored net/line activity is therefore compatible with the favourable condition target to restore extent and distribution and structure and function with regards to the biological communities.

As noted previously, VMS and landings data are contradictory with regard to anchored netting activity within Dogger Bank SAC and it is likely not occurring with any considerable regularity. The low levels of gillnetting activity, combined with the minimal impacts predicted to be caused via the removal of non-target species, suggest that this activity is not currently a cause of concern for the protected features of Dogger Bank SAC.

With regards to the discussion above and the assessed activity levels, the **MMO concludes that impacts from removal of non-target species by anchored nets/lines on the sandbank feature are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity.**

4.4.2 Impacts of demersal trawls

Demersal trawls interact directly with the seabed and penetrate into the sediment which means that species occupying this area may be removed by passing trawls.

Mortality of non-target species caught by demersal gear such as beam trawls varies. One study found that mortality ranges from 0% for hermit crab, whelks and starfish to 100% for shells such as *Arctica islandica* (Gislason, 1994). De Groot and Lindeboom (1994) found that high mortalities occurred for undersized fish discarded, 50% or less for most crabs and molluscs and very little mortality (<10%) for starfish. Overall findings indicated a decrease of 0-85% from initial numbers for different mollusc species (solid-shelled or very small species (De Groot & Lindeboom, 1994). *Arctica islandica* is a long lived, slow growing and late maturing species found within the sandbank feature of Dogger Bank SAC; these life history characteristics make their populations particularly susceptible to overfishing and their recovery from population declines, as seen in the North sea (OSPAR 2009), particularly slow. This has led to their listing as an OSPAR threatened or declining species. It is likely that their removal by trawls has and will have adverse effects on the structure of benthic communities.

Fisheries generated mortality results in a reduced abundance of long-lived benthic species and increased abundance of short-lived species, a change which has been observed in Dogger Bank SAC (Gislason, 1994; Kröncke, 2011). Jennings (1998) noted that within heavily fished areas, the removal of large epibenthic organisms can lead to long-term reductions in structural complexity and declines in the abundance of fishes associated with the epibenthic community. It can therefore be concluded that commercial beam trawling may affect the structure and composition of the benthic community in the North Sea (De Groot & Lindeboom, 1994). This impact is therefore not compatible with the favourable condition target to restore extent and distribution and structure and function of the sandbank feature.

VMS data shows that very high levels of demersal trawling take place throughout Dogger Bank SAC with a focus on the middle and eastern sections. This is indicative of intense trawling activity and therefore the impacts, described above, are likely to occur throughout the site.

With regards to the discussion above and the assessed activity levels, the **MMO concludes that impacts from removal of non-target species by demersal trawls on the sandbank feature are not compatible with the conservation objectives of the site and may result in an adverse effect on site integrity.**

4.4.3 Impacts of demersal seines

When the ropes of a seine net are closed up in order to herd demersal fish, there is the potential for removal of epifauna.

Biotopes containing attached or sessile epifauna are considered sensitive to abrasion due to the removal of these non target species (MIEG 2020). Observations in the North Sea show that seining caught 19 of the Dogger Bank typical species across the anthozoa, crustacea, echinoderm, mollusca and fish groups (van der Reijden et al. 2014; Verkempynck & van der Reijden, 2015 cited in Waardenburg, 2017). All fish species excluding *Raja clavata* were target species and all other species were bycatch. Bycatch included long-lived species: *Alcyonium digitatum* (10-28 years), *Arctica islandica* (100+ years), *Pagurus bernhardus* (6-10 years), *Buccinum undatum* (11-20 years) and *Neptunea antiqua* (21-100 years) (van der Reijden et al. 2014; Verkempynck & van der Reijden, 2015 cited in Waardenburg, 2017). The occurrence in bycatch as well as the sensitivity of *Arctica islandica* and *Buccinum undatum* to seining is also shown in further studies from the North Sea (Verschueren, 2015; Wijnhoven et al., 2013; Rijnsdorp et al., 2015). Long-lived species have life history traits such as slow growth, late maturity and low fecundity. This results in slow recovery rates and high vulnerability to fishing disturbance. As a result, demersal seining may affect the structure and function of the benthic community. This impact would not be compatible with the favourable condition target of the site to restore extent and distribution and structure and function of the sandbank feature.

The studies above indicate that a number of species found within Dogger Bank SAC are vulnerable to removal by seining. VMS data indicates that demersal seining within the site occurs at a much lower level than demersal trawling, however, the risk to long-lived species even at a low level could be significant.

With regards to the discussion above and the assessed activity levels, the **MMO concludes that impacts from removal of non-target species by demersal seines on the sandbank feature are not compatible with the conservation objectives of the site and may result in an adverse effect on site integrity.**

4.4.4 Impacts of dredges

Scallop dredges are the only form of dredge determined to be used within Dogger Bank SAC.

Dredges can cause large amounts of bycatch for a range of non-commercially targeted species, the majority of which is discarded damaged, dying or dead (Howarth and Stewart, 2014). Hinz et al. (2012) found that for every scallop captured by a Newhaven dredge, four individuals of bycatch were also caught. An assessment of the 10 most common bycatch species in the Irish Sea scallop fishery found that approximately 20 to 30 % of individuals suffered fatal damage after dredge capture (Shephard et al. 2009). Another study in the Irish Sea also demonstrated how benthic communities are significantly altered by scallop dredging by comparing a previously fished closed area to a fished area over 6 years (Bradshaw et al., 2001).

Hinz et al. (2012) studied the environmental impact of different types of queen scallop fishing gears, including dredges. Results showed that traditional scallop dredges contained larger amounts of non-target species such as invertebrates than other gear types such as otter trawls (Hinz et al., 2012). For example, clear negative effects were found for the brittlestar, *Ophiura ophiura* (Hinz et al., 2012). Species such as brittlestars, as well as other benthic invertebrates, are known to be key members of the sandbank feature of Dogger Bank SAC.

Given the proven impact of scallop dredges on benthic communities, it is likely that continued scallop dredging within Dogger Bank SAC will hinder the site’s favourable condition targets to restore extent of biological assemblages and biological structure of the sandbank.

VMS and landings data shows that scallop dredging has not occurred within the site between 2014 and 2018. However, recent, unpublished VMS data from 2020 indicates that there has been a considerable rise in dredging for king scallops (*Pecten maximus*) in the site. If activity continues, impacts from dredges will become a concern for the site’s protected features.

With regards to the discussion above and the assessed activity levels, the **MMO concludes that impacts from removal of non-target species by dredges on the sandbank feature are not compatible with the conservation objectives of the site and may result in an adverse effect on site integrity.**

4.4.5 Pressure conclusion

Given the evidence above, removal of non-target species caused by anchored nets/lines alone within Dogger Bank SAC is unlikely to hinder the restoration of the extent and distribution as well as structure and function of the sandbank feature. The **MMO conclude that anchored nets/lines alone are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity via this pressure.**

There is a risk that removal of non-target species caused by demersal trawls, demersal seines and dredges may not help the achievement of favourable condition targets. Use of these gear types may impact the physical and biological structure of the sandbank feature via direct removal of characteristic species. This may impact the extent and distribution regarding biological assemblages. The **MMO conclude that demersal trawls, demersal seines or dredges alone are not compatible with the conservation objectives of the site and may result in an adverse effect on site integrity via this pressure.**

Table 21: Pressure conclusion for removal of non-target species based on assessed activity levels

Pressure	**Feature**	**Favourable condition target**	**SNCB aggregated gear method**	**Compatible with the conservation objectives?**
Removal of non-target species	Sandbanks which are slightly covered by seawater all the time	**Restore extent and distribution:** The feature extent within the site must be conserved to the full known distribution (sandbank feature calculated to be 12,331km^2) based on: - large-scale topography - sediment composition	Anchored nets/lines	Yes
			Demersal trawls	No (biological assemblages)
			Demersal seines	No (biological assemblages)

		- biological assemblages	Dredges	No (biological assemblages)
		Restore structure and function: • Physical structure (finer scale topography and sediment composition and distribution) to be restored. • Biological structure (key and influential species and characteristic communities) to be restored.	Anchored nets/lines	Yes
			Demersal trawls	No
			Demersal seines	No
			Dredges	No

4.5 Removal of target species

These pressures are relevant to anchored nets/lines, demersal trawls, seines and dredges in Dogger Bank SAC. The impacts of these pressures have been assessed for the ‘sandbanks which are slightly covered by sea water all the time’ feature.

4.5.1 Impacts of anchored nets/lines

Landings data indicates that minimal gillnetting activity occurs in Dogger Bank SAC but what activity is/may be occurring mostly targets sole (*Solea solea*). The sandbank feature of Dogger Bank SAC provides spawning and nursery grounds for sole which migrate to the area (Ellis, 2012).

Landings derived from UK VMS indicate that gill nets landed 0.2 tonnes between 2014 and 2018 which comprised mostly demersal fish. Non-UK landings determined from STECF data between 2014 and 2016 indicated no landings from gill nets within Dogger Bank SAC.

ICES advice in 2019 details how spawning-stock biomass for sole has increased in subarea 4 of the North Sea since 2007 and has been estimated above the maximum sustainable yield (MSY) $B_{trigger}$ since 2012 (ICES, 2019a). MSY $B_{trigger}$ is an indicator where if biomass levels decrease below this level, fishing should be reduced to below MSY levels and additional measures may be needed under the MSY precautionary approach (ICES, 2019a). Recruitment of sole was also estimated to be the highest since 1988 (ICES, 2019a). Considering this, it is unlikely that gill nets within Dogger Bank SAC are creating a potential risk to sole stocks in the area. The biological assemblages and structure of the sandbank feature is unlikely to be significantly impacted via this pressure. This indicates that anchored net/line activity is compatible with the favourable condition targets for the site.

Due to the low levels of gillnetting activity believed to be occurring in Dogger Bank SAC, combined with the status of target species in the area, suggests that this pressure is not occurring at a level of concern within Dogger Bank SAC.

Considering the low levels of gillnetting activity and status of sole stocks, the **MMO concludes that impacts from removal of target species by anchored nets/lines on the sandbank feature are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity.**

4.5.2 Impacts of demersal trawls and seines

UK vessels make use of demersal trawls to target plaice, whereas EU member states, specifically Dutch, Danish, German and Belgian vessels, target plaice, sandeels and, via semi-pelagic trawls, herring.

The main target species of the Danish demersal seine fleet is sandeels and therefore the impact of their removal will be considered alongside that of sandeel removal via demersal trawls.

Landings derived from UK VMS reveal that between 2014 and 2018 UK vessels removed approximately 12,000 tonnes of plaice via demersal trawls from Dogger Bank SAC. Between 2014 and 2016 Dutch, Danish, German and Belgian demersal trawl and seine vessels removed approximately 15,700 tonnes of plaice from the eight ICES rectangles which intersect Dogger Bank SAC (STECF FDI landings data 2014-2016). An estimate based purely on the proportional area of Dogger Bank SAC to the eight ICES rectangles equates this to approximately 6,500 tonnes of plaice removed from Dogger Bank SAC.

ICES advice in 2019 details how spawning-stock biomass for plaice has markedly increased in subarea 4 of the North Sea since 2008 and has been estimated well above the maximum sustainable yield (MSY) $B_{trigger}$ since 1999 (ICES, 2019b).

Recruitment of plaice was estimated to be the second highest since 1957 (ICES, 2019b). Considering this, it is unlikely that demersal trawls within Dogger Bank SAC are creating a potential risk to plaice stocks in the area.

Between 2014 and 2016, approximately 137,000 tonnes of sandeels were removed by Dutch, Danish, German and Belgian demersal trawl/seine vessels from the eight ICES rectangles which intersect Dogger Bank SAC (STECF FDI landings data 2014-2016). Approximately 79% of these landings came from just two of the eight ICES rectangles intersecting Dogger Bank SAC: 39F1 (~75,000 tonnes) and 38F1 (~33,000 tonnes). Approximately 53% of these two rectangles (79% and 26% per rectangle respectively) falls within Dogger Bank SAC. Using a proportional area based estimate as above, this equates to approximately 45,700 tonnes removed from the Dogger Bank SAC area of these two ICES rectangles alone. The total estimated figure for sandeel landings from Dogger Bank SAC is approximately 55,200 tonnes.

ICES advice in 2019 details how spawning-stock biomass for sandeels was below B_{lim} (biomass limit reference point) and B_{pa} (precautionary biomass level) and therefore MSY $B_{escapement}$ (biomass reference point) (ICES, 2019c). The biomass reference point ensures there are adequate escaping/surviving fish left to spawn and that there is 95% probability of the stock being above $B_{lim.}$ Stocks with spawning stock biomass below B_{lim} level are considered to suffer from impaired recruitment (recruit overfished) and hence may not be able to sustain a fishery. Stocks with spawning stock biomass below B_{pa} level are at risk (around 5-10%) of being below the Biomass limit reference point (Blim) (Lart, 2019).

Recruitment of sandeels in 2018 was slightly above the geometric mean of the time series (1983 – 2019) following the lowest historical recruitment in 2017 (ICES, 2019c). Considering this, and assuming landings of sandeels have remained at similar levels since 2014-2016, it is likely that demersal trawl and seine activity within Dogger Bank SAC are creating a potential risk to sandeel stocks in the area.

Within the Dogger Bank SAC intersecting ICES rectangles, approximately 5,800 tonnes of herring was landed by Dutch, Danish, German and Belgian vessels. The demersal trawl/seine gear category was the only category to document herring landings from these nations in the ICES rectangles (STECF FDI landings data 2014-2016). This suggests semi pelagic landings are included in this category. A proportional area based estimate of landings derived from Dogger Bank SAC suggests approximately 1,200 tonnes of herring were removed from Dogger Bank SAC.

ICES advice in 2019 details how spawning-stock biomass for herring has fluctuated considerably between 1998 and 2018 but was above MSY $B_{trigger}$ for all years (ICES, 2019d). However, recruitment has been relatively low since 2002 with very low recruitment in 2015 and 2017 (ICES, 2019d).

Considering the above and the relatively small quantities of herring estimated to have been landed from Dogger Bank SAC, it is unlikely that semi pelagic trawls within the site are creating a potential risk to herring stocks in the area.

The biological assemblages and structure of the sandbank feature is unlikely to be significantly impacted via this pressure where it concerns plaice and herring. However, given the poor status of the sandeel stock in the North Sea and the large quantities of sandeel estimated to be being removed from Dogger Bank SAC, the biological assemblages and structure of the sandbank feature is likely to be significantly impacted via this pressure where it concerns sandeels. This indicates that demersal trawling activity and demersal seining activity is not compatible with the favourable condition targets for the site. Therefore the **MMO concludes that impacts from removal of target species by demersal trawls and demersal seines on the sandbank feature are not compatible with the conservation objectives of the site and may result in an adverse effect on site integrity.**

4.5.3 Impacts of dredges

Scallop dredging is the only form of dredging recorded in the site. Non-UK vessels target both king and queen scallops and UK vessels target king scallops.

Recent data indicates a significant increase in UK vessel landings of king scallop from the Dogger Bank area which includes the SAC. 948 tonnes of king scallops were landed from four of the eight ICES rectangles that intersect Dogger Bank SAC from the start of the year up until 29th June 2020, compared to an average of 1 tonne per year between 2015 and 2019. The full spatial extent of the scallop stock is unknown, however, it is likely that this increase in activity will have a considerable impact on the stock.

Reductions in population density and removal of larger scallops, capable of producing more eggs, may result in reduced fertilisation success and recruitment (Cappel et al., 2018). Additionally, where scallops are damaged by dredges and not captured or captured and discarded, they can show reduced growth and reproductive rates and be highly susceptible to predation (Cappel et al., 2018). Details on the spawning stock, population density and age-structure for scallops in this area are currently unknown and therefore there is the potential for increased dredging activity to be having a detrimental impact on stocks. This would not be compatible with the favourable condition targets of the site with regards to restoring the structure and function of biological communities.

VMS and landings data show that scallop dredging has not occurred within the site between 2014 and 2018. However, as detailed above, recent unpublished VMS from 2020 provides evidence that there has been a significant rise in dredging for king scallops in the site. If activity continues to increase and continues annually, impacts from dredges may become of a level of concern to the site's protected features.

Considering this significant increase in activity, the **MMO concludes that impacts from removal of target species by dredges on the sandbank feature are not compatible with the conservation objectives of the site and may result in an adverse effect on site integrity.**

4.5.4 Pressure conclusion

Given the evidence above, removal of target species by anchored nets/lines alone within Dogger Bank SAC is unlikely to hinder the restoration of the extent and distribution as well as structure and function of the sandbank feature. The **MMO conclude that anchored nets/lines alone are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity via this pressure.**

In order for Dogger Bank sandbank to achieve favourable status and to avoid adverse effects on site integrity, the 'typical species' associated with the Annex 1 habitat must also be maintained at, or restored to, favourable conservation status (ClientEarth and MCS, 2013; Rees et al., 2013). Sandeels are considered a 'typical species' associated with the sandbank feature. The stock assessment of sand eels (ICES 2019c) suggests this species is in unfavourable status in the North Sea. The removal of sandeels by demersal trawls in Dogger Bank SAC is therefore likely to impact the physical and biological structure of the sandbank feature via direct removal of sandeels. The **MMO conclude that demersal trawls alone are not compatible with the conservation objectives of the site and the removal of sandeels may result in an adverse effect on site integrity via this pressure.**

There is a risk that removal of target species by dredges may not help the achievement of favourable condition targets. This is due to a recent increase in scalloping activity within the site. Continuation of or an increase in this activity may impact the physical and biological structure of the sandbank feature via direct removal of scallops. This may also impact the extent and distribution regarding biological assemblages. The **MMO conclude that dredges alone are not compatible with the conservation objectives of the site and may result in an adverse effect on site integrity via this pressure.**

Table 22: Pressure conclusion for removal of target species based on assessed activity levels

Pressure	Feature	Favourable condition target	SNCB aggregated gear method	Compatible with the

				conservation objectives?
Removal of target species	Sandbanks which are slightly covered by seawater all the time	**Restore extent and distribution:** The feature extent within the site must be conserved to the full known distribution (sandbank feature calculated to be 12,331km^2) based on: - large-scale topography - sediment composition - biological assemblages	Anchored nets/lines	Yes
			Dredges	No
			Demersal seines	No
			Demersal trawls	No
		Restore structure and function: • Physical structure (finer scale topography and sediment composition and distribution) to be restored. • Biological structure (key and influential	Anchored nets/lines	Yes

		species and characteristic communities) to be restored.	Dredges	No
			Demersal seines	No
			Demersal trawls	No

4.6. Part B conclusion

The assessment of fishing pressures on the sandbank feature of Dogger Bank SAC has revealed that an adverse effect on site integrity cannot be ruled out where demersal trawl, demersal seine and dredging activities occur. As such **the MMO conclude that management measures are required to restrict these activities within Dogger Bank SAC**. Section 7 contains further details of these measures.

With the introduction of the aforementioned management measures, **the MMO conclude that the remaining fishing activities (anchored nets and lines), when considered in isolation, are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity of Dogger Bank SAC**.

5. Part C assessment

5.1 In combination assessment

This section assesses the effects of activities considered as compatible with the conservation objectives of Dogger Bank SAC in combination with other relevant activities taking place which includes the following**:**

- fishing activity/pressure combinations which were excluded in Part A of this assessment as having no likely significant effect (see Table 8);
- fishing interactions assessed in Part B but not resulting in adverse effect;
- plans and projects.

The MMO SPIRIT (SPatial InfoRmatIon Toolkit) system was used to check relevant activities that occur within, or adjacent to, the assessed site where there could be a pathway for disturbance. To determine plans and projects to be included in this part of the assessment, a distance of 5 km was selected as suitable to capture any potential source receptor pathways which could impact the site in combination with effects of the fishing activities assessed. A 5 km buffer was therefore applied to the site boundary to identify relevant plans and projects.

Demersal trawls, seines and dredges have been identified in Part B as requiring management to avoid adverse effects to site integrity and will therefore not be considered in Part C. Anchored nets/lines are the only other fishing activity occurring within 5 km of Dogger Bank SAC therefore there is no current requirement to assess in combination impacts of fishing activities, only in combination effects of anchored nets/lines with other project/plans.

5.2 Pressures exerted by fishing and plans or projects

In accordance with the methodology detailed above, the SPIRIT system identified military surface/firing danger areas, offshore windfarm construction, disposal sites, pipelines and submarine cables as potential plans or projects occurring within 5 km of Dogger Bank (Table 23).

No recreational activities were identified and no additional fishing activities to those already assessed in Part B occur within 5 km of the Dogger Bank SAC.

Table 23: Other fishing activities and plans and projects considered in combination with anchored nets and traps in Dogger Bank SAC

Relevant activity	Description
Submarine cables	Numerous telecommunication cables run through the site and across the sandbank and there is the potential for the laying of further cables in conjunction with the Dogger Bank offshore windfarm soon to be constructed.
Military surface/firing danger areas	The Ministry of Defence make use of an area West of Dogger Bank for firing practice. The area of activity is outside of Dogger Bank SAC but within 5 km
Offshore windfarm construction	Three offshore windfarms have been licensed for construction within Dogger Bank SAC.
Disposal sites	Three disposal sites for use in the construction of the Dogger Bank offshore windfarms occur within the Dogger Bank SAC

Offshore windfarm operation and maintenance	With the construction phase completed (estimated 2023 – 2025) the three offshore wind farms will move into the operation phase and require general maintenance
Pipelines	Numerous pipelines run through the site and across the sandbank feature

To identify the specific pressures that the activities exert on the Dogger Bank SAC sandbank feature, the MMO has used JNCC's PAD[10] and the AoO section of JNCC's Dogger Bank SAC conservation advice package (Table 5).

Use of JNCC's AoO and PAD required the identified activities to be matched to the appropriate categories and activities. Table 24 and Table 25 show how the activities were matched.

Table 24: Categories from the PAD that have been used to inform pressures information for disposal sites.

Name of plan/project	PAD category	PAD activity
Disposal sites	Extraction (and disposal) of non-living resources	Dredge and spoil disposal
Military surface/firing danger areas	Sea surface military activity	Defence and national security

Table 25: Categories from the AoO that have been used to inform pressures information for identified fishing and non-fishing activities.

Name of plan/project	AoO category	AoO activity
Submarine cables	Cables	Power cable: laying burial and protection
		Power cable: operation and maintenance
		Telecommunication cable: operation and maintenance
Offshore windfarm construction	Renewable energy	Offshore wind: during construction
Offshore windfarm operation and maintenance	Renewable energy	Offshore wind: operation and maintenance

Pipelines	Oil, gas and carbon capture storage	Pipelines

A list of pressures has been collated from the AoO and/or PAD for the above activities. It is only those pressures that are relevant to both anchored nets/lines and the project or plans, that have been discussed below (Table 26). Pressures from plans or projects that are not associated with the fishing activities are not within the scope of this assessment.

All pressure-feature interactions from fishing other than those identified as “Not Relevant” (the evidence base suggests that there is no interaction of concern between the pressure and the feature OR the activity and the feature could not interact) have been considered.

From these considerations, Table 26 details the pressures exerted by military firing activity; power cables: laying, burial and protection and operation and maintenance; telecommunication cables: operation and maintenance; offshore wind: during construction and operation and maintenance; disposal sites; pipelines and anchored net/line fishing activities. Pressures highlighted green have been screened out as not requiring further consideration in this assessment as they are not exerted by the anchored net/line fishing activities occurring within Dogger Bank SAC.

Table 26 also indicates pressures which are exerted by each activity (Y – pressure exerted, N – pressure not exerted).

Table 26: Pressures exerted by anchored net/line fishing and non-fishing activities occurring in Dogger Bank SAC. Non fishing pressures similarly exerted by anchored nets/lines require further assessment and are highlighted in red.

Pressure	Exerted by Telecommunication cable: operation & maintenance	Exerted by Power cable: operation & maintenance	Exerted by Power cable: laying, burial and protection	Exerted by Offshore wind: during construction	Exerted by Offshore wind: Operation & maintenance	Exerted by Sea surface military activity	Exerted by Dredge and soil disposal	Exerted by Pipelines	Exerted by anchored nets/lines
Abrasion/disturbance of the substrate on the surface of the seabed	Y	Y	Y	Y	Y	Y	Y	Y	Y
Changes in suspended solids (water clarity)	Y	Y	Y	Y	Y	Y	Y	N	N
Deoxygenation	N	Y	Y	N	N	Y	Y	Y	Y
Electromagnetic changes	N	Y	N	N	N	N	N	N	N
Habitat structure changes - removal of substratum (extraction)	N	N	Y	Y	Y	Y	N	Y	N
Hydrocarbon & PAH contamination. Includes those priority substances listed in Annex II of Directive 2008/105/EC.	Y	Y	Y	Y	Y	Y	Y	Y	Y
Introduction of other substances (solid, liquid or gas)	N	N	N	Y	Y	Y	Y	Y	N
Introduction or spread of invasive non-	Y	Y	Y	Y	Y	Y	Y	Y	Y

indigenous species (INIS)									
Litter	Y	Y	Y	Y	Y	Y	N	Y	Y
Nutrient enrichment	N	Y	Y	N	N	Y	Y	Y	N
Organic enrichment	N	N	N	N	N	N	N	N	Y
Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion	Y	Y	Y	Y	Y	Y	N	Y	Y
Physical change (to another seabed type)	Y	Y	Y	Y	Y	N	Y	Y	N
Physical change (to another sediment type)	N	N	N	N	N	N	Y	N	N
Radionuclide contamination	N	N	N	N	N	N	Y	N	N
Removal of non-target species	N	N	N	N	N	N	N	N	Y
Removal of target species	N	N	N	N	N	N	N	N	Y
Siltation rate changes (high), including smothering (depth of vertical sediment overburden)	N	N	Y	Y	Y	N	Y	N	N
Siltation rate changes (low), including smothering (depth of vertical sediment overburden)	Y	Y	Y	Y	Y	Y	Y	Y	N
Synthetic compound contamination (incl.	Y	Y	Y	Y	Y	Y	Y	Y	Y

pesticides, antifoulants, pharmaceuticals). Includes those priority substances listed in Annex II of Directive 2008/105/EC.									
Temperature changes - local	N	Y	N	N	N	N	N	N	N
Transition elements & organo-metal (e.g. TBT) contamination. Includes those priority substances listed in Annex II of Directive 2008/105/EC.	Y	Y	Y	Y	Y	Y	Y	Y	Y
Vibration	Y	Y	Y	Y	Y	N	N	Y	N
Water flow (tidal current) changes, including sediment transport considerations	Y	Y	Y	Y	Y	N	N	Y	N
Wave exposure changes - local	N	N	N	N	N	Y	N	N	N

5.2.1 Abrasion/disturbance of the substrate on the surface of the seabed AND Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion

Abrasion/disturbance of the substrate is relevant to all plans, projects and anchored nets/line fishing activities however the Dogger Bank SAC sandbank feature is not considered sensitive to the pressure associated with sea surface military activity as it is derived from propellers and ship movements causing scour around berth pockets and channel margins which does not occur the site.

Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion is relevant to all plans, projects and anchored net/line fishing activities with the exception of dredge and soil disposal. As above, the Dogger Bank SAC sandbank feature is not considered sensitive to the pressure associated with sea surface military activity.

As discussed in section 4.2.1, anchored nets/lines have minimal interaction with the seabed. Gillnets will only interact with the seabed where anchors have been used to secure the net. As gillnets are not towed over the seabed abrasion and penetration of substrate only occurs in the small distances the nets/anchors drift or drag through currents and/or wave action. Gillnetting activity levels over the five years studied is very low.

Throughout operation and maintenance, telecommunication and power cables may need to be reburied or uncovered for repair. Abrasion and physical disturbance will occur from this activity. Usually free-swimming burial machines are deployed to rebury exposed sections of cable (BERR, 2008). Disturbance may also occur through anchoring of vessels which may cause abrasion via deployment, subsequent dragging and locking in of the anchor, as well as scour of the anchor chain whilst in use and upon recovery. The anchors of large ships may penetrate the seabed up to depths of approximately 1 metre (Luger & Harkes, 2013). There are two disused BT telecommunications cables running through the site, connecting the UK to Denmark and Germany respectively. These cables are disused and therefore the cable will require no maintenance. There is an active Ta Ta North Europe telecommunications cable connecting England to the Netherlands. There are also 2 active Tampnet telecommunications cables connecting England to the Draupner oil platform. The frequency of maintenance to existing cables will be low. Additionally, this is a licensable activity, if there was a positive determination on applications for maintenance, licence conditions would be put in place to mitigate against any significant impacts to the features of the site. Therefore it is unlikely that operation and maintenance of existing submarine cables will have a significant in combination impact with fishing and other activities via this pressure.

Pipelines are predicted to cause abrasion and penetration disturbance to a maximum of 100 m either side of the pipelines. Beyond this, disturbance may be caused through maintenance of the pipeline when anchors are used to secure vessels. There are multiple pipelines which intersect the site, with a total length of 457.7 km. These are mostly towards the southern boundary. As discussed above for submarine cables, given that these pipelines are already in place, there are no potential in combination impacts through installation. Maintenance of pipelines is a licensable activity, therefore licence conditions would be put in place to mitigate against any significant impacts to the features of the site. Consequently, it is unlikely that pipelines will have a significant in combination impact with fishing and other activities via this pressure.

The laying, burial and protection of power cables will also lead to seabed abrasion and sub-surface penetration. Ploughing, trenching, rock placement and anchor placement will result in these pressures. The footprint of the seabed disturbed by cable installation machinery could be 5-10 m wide per cable trench for ploughing and trenching (Aecome Intertek, 2011; Nemo Link, 2013). Cables laid at the surface may cause abrasion where there is high wave activity, evidence suggests in shallow waters less than 20 m, marks from cables ranged from 6-45 cm in width (Carter et al., 2009). Alternatively, cables may instead be buried at depths of 1 to 2 metres (Aecom Intertek, 2011; Nemo Link, 2013). As described above, anchors of vessels associated with cable installation will also cause disturbance. Existing cables within the site were granted licences between 2002 and 2015. Given that these cables are already in place, there are no potential in combination impacts through laying, burial and protection via this pressure.

Four offshore windfarm sites have been consented inside Dogger Bank SAC. These are Dogger Bank A, Dogger Bank B, Dogger Bank C and Sofia. Two disposal sites have been licensed in Dogger Bank SAC for use during construction of the windfarms and there is the potential for laying of further cables to service the windfarms.

Abrasion and penetration, from installation of cables via the pathways described above, is likely to have an in combination effect with fishing activities. Furthermore, during construction of windfarms, installation of turbine foundations and associated infrastructure will lead to penetration and abrasion via placement of infrastructure, scour protection and use of jack up barges or other installation vessels (Polet & Depestle, 2010). Turbine foundations penetrate into the seabed with typical pile diameters being between 4 and 5 m in the OSPAR area (OSPAR, 2008a). Anchoring of vessels used in windfarm installation may also cause abrasion and penetration as described above in relation to cable maintenance. Similar impacts will occur throughout operation and maintenance of the windfarm via the use of jack up legs or anchors for associated vessels (DECC, 2011; ABPmer, 2011). It is estimated that an 11.5 tonne anchor penetrates up to 0.88 m in soft sediment when dropped and dragged for 87 m (Luger and Harkes, 2013).

Construction of these windfarms is estimated to start from 2022 and the two consented disposal sites will be used to dispose of spoil generated from installation of foundations and seabed preparation (Forewind, 2014b). This is estimated to be the top 0.75 cm of the sediment (Forewind, 2014b). The deposition of spoil may cause disturbance via abrasion and will be most severe when coarser sediment is disposed of on finer substrates. The material proposed to be disposed of in construction of the windfarms will be identical to the existing seabed material and so impacts are likely to be minimal (Forewind, 2014b).

Leased areas for these windfarms are located over the subtidal sand bank feature of the SAC where fishing activities occur. However, the pressures associated with the construction, operation and maintenance of the windfarm in combination with fishing activities has previously been assessed and, subject to agreed deemed marine license (DML) conditions and mitigation being implemented, the pressures were not considered to result in an adverse effect on the integrity of the site in view of its conservation objectives. Equally, the construction, operation and maintenance of the proposed windfarm was not deemed to impact upon the trajectory of habitat recovery, regardless of any future management measures that may be adopted[16].

The MMO conclude that abrasion/disturbance and penetration pressures associated with anchored nets/lines, in combination with the plans/projects/activities occurring in the site are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity.

5.2.2 Deoxygenation

This pressure is relevant to anchored net/line fishing activities, pipelines, power cable: laying, burial, protection and operation and maintenance, sea surface military activity and disposal sites.

The main pathway of deoxygenation from fishing is through discards and the release of deoxygenated ballast water. Dogger Bank SAC is exposed to substantial wave energy and the majority of fishing vessels active in the site are under 45 metres in length and therefore have solid ballast[17]. As a result, the accumulation of discards and associated hypoxia or any deoxygenation resulting from fishing vessel ballast water is unlikely.

For other plans and projects the main source of deoxygenation is associated with sediment mobilisation and increase of suspended sediments.

Modern equipment and techniques reduce the re-suspension of sediment during cable burial, repair and removal, however, increases in suspended sediment may occur (OSPAR, 2012). The magnitude of this depends on the silt fraction, the equipment used and background levels (OSPAR, 2012). With regards to impacts caused during maintenance of cables, the frequency of this activity will be low. Furthermore, this is a licensable activity and so licence conditions would be put in place to mitigate against any significant impacts to the features of the site. Therefore it is unlikely that operation and maintenance of existing submarine cables will have a considerable in combination impact with fishing and other activities via these pressures.

The construction of the Dogger Bank offshore windfarms may contribute to this pressure. The use of dredging to prepare the seabed for windfarm foundations may cause localised and temporary increases in suspended solids within the water column (Forewind, 2013; ABPmer,

[16] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010051/EN010051-002090-Habitats%20Regulations%20Assessment.pdf
[17] www.gov.uk/government/uploads/system/uploads/attachment_data/file/441098/MGN_501_Combined.pdf

2011). This will only occur in the initial construction phase and therefore this activity will not have continued in combination impacts with fishing activities. During operation of windfarms, scour will occur around the base of the foundations due to hydrological changes, leading to the liberation of sediment and formation of sediment plumes. Once the foundations have been scoured to their equilibrium depth, there will be an absence of sediment for further scouring (Forewind, 2013). Therefore impacts from this activity are likely to be short-lived. The Habitats Regulation Assessment carried out for Dogger Bank Teesside A & B offshore windfarms, found that the effects during construction would be temporary, short-term and negligible in magnitude (DECC, 2015). It was concluded that the worst case impact would mean the site would remain within its current natural environmental range (DECC, 2015). The dragging of anchors used in maintenance and repair activities for windfarms may cause increased suspended sediment (The Green Blue, 2009). This impact is likely to be localised and temporary and maintenance activities will be infrequent (The Green Blue, 2009). Therefore it is unlikely that construction, operation and maintenance of wind farms will have a considerable long term impact via these pressures.

The disposal sites associated with the Dogger Bank windfarms may change the redox conditions in the former surface layer considerably and anoxic conditions (oxygen deficiency and sulphide production) may develop shortly after disposal (OSPAR, 2008b). The release of organic rich sediments during disposal can result in the localised removal of oxygen from the surrounding water, substances which consume oxygen, nutrients and harmful materials, bonded to the sediments, can be released into the water relatively easily and thus reduce its oxygen content or cause an increase in the concentration of nutrients or harmful materials (OSPAR, 2009b) OSPAR, 2008b). Following the initial placement of dredged material at a disposal site, there is the potential for some localised reduction in dissolved oxygen concentrations in the water column. However given the dynamic nature of Dogger Bank SAC, the water column is likely to be rapidly re-oxygenated, making any changes localised and very short-lived (OSPAR, 2008b).

There are multiple pipelines within Dogger Bank SAC, with the majority being located towards the southern boundary. Seabed currents and the type of sediment will affect the accumulation and scouring of sediment around pipelines. As described for foundations of windfarms, once pipelines have been scoured to their equilibrium depth, there will be an absence of sediment for further scouring therefore limiting resuspension and ultimately deoxygenation.

The surface military activities are not thought to result in the disturbance of the sediment at Dogger Bank SAC and therefore the main pathway for deoxgenation is not present.

While a number of plans and project contribute to this pressure in combination with anchored nets/lines the impacts are likely to be minimal, short lived and temporary in nature. **As such the MMO consider that the combined pressure from anchored nets/lines and other plans/projects are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity**.

5.2.3 Hydrocarbon & PAH contamination

This section is also relevant to transition elements & organo-metal (e.g. TBT) contamination. The primary route of chemicals of concern is via vessel oil and fuel and therefore covered by hydrocarbon and PAH contamination. Synthetic compound contamination is not considered further as these compounds are likely to originate from terrestrial sources.

These pressures are relevant to all plans, projects and anchored net/line fishing activities however the Dogger Bank SAC sandbank feature is only considered sensitive to the pressure associated with pipelines, sea surface military activity, disposal sites and fishing activities.

Polycyclic aromatic hydrocarbons (PAH) in vessel oil and fuel are of environmental concern when released into the water. Fishing vessels of all gear types may contribute to this pressure in combination with military vessels. However, deliberate releases of oil or oil/water mixture from ships are prohibited within the North West European Waters Special Area, established by the International Maritime Organisation (IMO) under MARPOL Annex I in 1999[18]. This area includes all waters around the UK and its approaches. While Navy vessels are exempt from MARPOL, they are expected to act in a manner consistent with MARPOL in so far as is reasonable and practicable[19]. Accidental discharges may occur, however significant releases are extremely rare. Releases of significant amounts of oil are typically from large shipping vessels and tankers. Sea surface military vessels are therefore unlikely to contribute considerably to the minor, existing impact from fishing vessels via this pressure.

Hydrocarbon and PAH contamination may occur through antifouling compounds like copper wash and TBT from ship coatings. However, fishing and MOD vessels comply with IMO standards for hull coatings and so are unlikely to contribute via this pathway.

Pipelines may be a source of hydrocarbon and PAH contamination. Additionally, cuttings from drilling operations and old cutting piles may contain organic-phase drilling fluids which may be disturbed during decommissioning of the pipelines (BEIS, 2019). Results from surveys undertaken across the SAC indicate that there is very little contamination from either heavy or trace metals or hydrocarbons, with the majority of samples reporting levels similar to background levels (BEIS, 2019). Therefore pipelines are unlikely to contribute to the existing impact from fishing vessels via this pressure.

The disposal sites to be utilised for the construction of the Dogger Bank offshore windfarms may contribute to this pressure. However, environmental monitoring for offshore windfarm construction has shown that the seabed material due to be dredged and disposed of is not heavily contaminated and so contamination from this activity is unlikely (Forewind, 2014b).

[18] https://www.imo.org/en/OurWork/Environment/SpecialAreasUnderMARPOL/Pages/Default.aspx
[19] www.mar.ist.utl.pt/mventura/Projecto-Navios-I/IMO-Conventions%20%28copies%29/MARPOL.pdf

The MMO conclude that these pressures associated with anchored nets/lines, in combination with the plans/projects/activities occurring in the site are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity.

5.2.4 Introduction or spread of invasive non-indigenous species (INIS)

This pressures is relevant to all plans, projects and anchored net/line fishing activities.

Aquatic organisms may be transferred to new locations through biofouling which takes place on all craft, even if recently cleaned or anti-fouled (IMO, 2012). Ballast water of vessels may also be a vector for transferral (OSPAR, 2009a). Military vessels, and vessels associated with installation, operation or maintenance of submarine cables, offshore windfarms and pipelines may therefore transport organisms.

With regards to submarine cables, offshore wind farms and pipelines, the artificial structures themselves may encourage the spread of INIS. It has been demonstrated that new artificial substrata offers opportunities for INIS to enter an area, or if already present, allows them to expand their population size and hence strengthen their strategic position (Kerckhof et al., 2011). This is particularly important for the obligate intertidal hard substrata species, for which offshore habitat is rare to non-existing (Kerckhof et al., 2011). Despite this, the Environmental Statement prepared for Dogger Bank Teesside A and B found that no INIS were identified as present in the area during the site-specific surveys (Forewind, 2014a). Furthermore, this report refers to the post construction monitoring report for the Barrow offshore wind farm which demonstrated no evidence of INIS on or around the monopiles (Forewind, 2014a).

For fishing vessels, ballast water is the principal vector for invasive non-indigenous species. VMS data shows that the majority of fishing vessels visiting the site are smaller than 45 m in length which means they use solid ballast. Additionally, for vessels using ballast water, the International Convention for the Control and Management of Ships' Ballast Water and Sediments[20] requires them to manage ballast water and sediments to a certain standard to prevent the spread of organisms. This means that the contribution of fishing activities to this pressure is minimal. Therefore, in combination effects with other activities are unlikely to mean that fishing will have a significant impact via this pressure.

Disposal sites for windfarm construction will not introduce INIS as spoil will be sourced from within the site.

The MMO conclude that this pressure associated with anchored nets/lines, in combination with the plans/projects/activities occurring in the site are compatible with

[20] https://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Control-and-Management-of-Ships'-Ballast-Water-and-Sediments-(BWM).aspx

the conservation objectives of the site and will not result in an adverse effect on site integrity.

5.2.5 Litter

This pressures is relevant to anchored net/line fishing activities and all plans/ projects with the exception of disposal sites.

For installation, operation and maintenance of submarine cables, offshore wind farms, military activities and pipelines, this pressure is relevant to the vessels associated with the activity. Vessels may release litter accidentally, due to inappropriate storage, or deliberately (Potts & Hasting, 2011; Lozano & Mouat, 2009). Litter may include pallets, strapping bands and drums or materials related to the construction of infrastructure. Similarly, military vessels may also contribute to marine litter via accidental or deliberate releases.

Litter released by fishing vessels may include galley waste, fish boxes, floats/buoys, nets, ropes, weights and microplastic particles resulting from disintegration of plastic gear (Lozano & Mouat, 2009). These may cause damage to benthic habitats through abrasion or ghost fishing.

All vessels, bar those attaining to the Navy, adhere to MARPOL requirements which prohibit the discharge of plastics. While exempt, Navy vessels are expected to act in a manner consistent with MARPOL so far as is reasonable and practicable[21] and therefore releases of litter is likely to be minimal from all vessels.

The exposure of this site means that any marine litter that does occur, is unlikely to persist in the same location long enough to cause damage to the sand bank feature, for example via abrasion. Therefore it is unlikely that this pressure will be significant when considered in combination with non-fishing activities.

The MMO conclude that this pressure associated with anchored nets/lines, in combination with the plans/projects/activities occurring in the site are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity.

5.3 Part C conclusion (fishing in combination with relevant activities)

MMO concludes, taking into account the introduction of management measures for demersal trawls, seines and dredges outlined in section 6, that fishing activities in combination with other relevant activities will not adversely affect the site integrity of Dogger Bank SAC nor achievement of its conservation objectives.

[21] http://www.mar.ist.utl.pt/mventura/Projecto-Navios-I/IMO-Conventions%20%28copies%29/MARPOL.pdf

6. Assessment result

6.1 Fishing alone

The MMO consider that there is a pathway for impact from bottom towed gear (demersal trawls, demersal seines and dredging) activities and the impacts alone are not compatible with the conservation objectives of the site and may result in an adverse effect on site integrity of Dogger Bank SAC.

The MMO consider that there is not a pathway for impact from anchored nets/lines, and therefore anchored nets/lines are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity of Dogger Bank SAC.

6.2 In combination

As with the assessment of fishing alone, this section assumes that management for bottom towed gear will be introduced. When the pressures from anchored nets/lines were combined and considered alongside pressures from the potential non-fishing activities taking place, none were identified which likely result in a negative impact on the designated features. Therefore the MMO concludes that anchored nets/lines assessed, in-combination with other known activities, are compatible with the conservation objectives of the site and will not result in an adverse effect on site integrity of Dogger Bank SAC.

7. Management options

Option 1: No fisheries restrictions. Introduce a monitoring and control plan within the site.

Option 2: Reduce/limit pressures. Due to the potential impacts of demersal and semi pelagic trawls, demersal seines and dredges on the features of the site, management will be introduced to reduce the risk of the conservation objectives not being achieved. This may be through a zoned management approach and/or limiting the activity/intensity of these gear types.

Option 3: Remove/avoid pressures (whole site prohibition). Demersal and semi pelagic trawls, demersal seines and dredges will be prohibited in all areas of the site.

At this time, the MMO does not believe that management option 1 is sufficient to protect Dogger Bank SAC due to the unfavourable status of the site and the likely adverse effects to site integrity from fishing with gears that are towed over the seabed.

The introduction of any management measures will be subject to a separate process, including appropriate levels of consultation.

Dogger Bank SAC lies within the East Marine Plan Area. The East Marine Plan[22] was adopted in 2014. Management decisions will be compliant and made in accordance with relevant policies. Consideration of policies will be detailed in the Regulatory Triage Assessment which will accompany the proposed management.

8. Review of this assessment

MMO will review this assessment every five years or earlier if significant new information is received.

Such information could include:

- updated conservation advice;
- updated advice on the condition of the feature;
- considerable change in activity levels.

To coordinate the collection and analysis of information regarding activity levels, and to ensure that any required management is implemented in a timely manner, a monitoring and control plan will be implemented for this site. This plan will be developed in line with the MMO Monitoring and Control Plan framework.

Monitoring of activity levels will occur through a combination of surface surveillance and ongoing monitoring of VMS and landings data. Should activity levels increase considerably or in a manner that could affect the site features, this will trigger further investigation into the level and distribution of the activity, including consultation with JNCC regarding current site condition. Any subsequent evidence gathered will be used to assess the need for further management measures.

Monitoring will be recorded through annual MPA reporting. Dogger Bank SAC is categorised as Tier 2 which means an individual report is produced by the MMO's Marine Conservation Team for this site annually between June and August. The report includes VMS data for fishing activity over the reporting period and a 5-year period as well as information on inspected/observed activities, intelligence and non-compliant activity (if applicable). Coastal questionnaires are completed by local MMO officers regarding any changes in activity within the site. This will act as an early warning system for potential negative impacts on the site. If the report determines that a change in fishing activity is a risk to the conservation objectives of the site, an assessment of the site will be triggered regardless of whether a review is due. An increase in

[22] https://www.gov.uk/government/collections/east-marine-plans

activity above that identified in this assessment, will initiate discussion with JNCC following the annual MPA report.

Possible management measures include an MMO emergency byelaw, which can be implemented immediately for up to 12 months, or a (non-emergency) MMO byelaw which would be subject to public consultation before implementation.

An overview of the monitoring and control process is illustrated in Annex 3.

9. Conclusion

MMO have had regard to best available evidence and through consultation with relevant advisors and the public, conclude that, provided that appropriate management measures for the fishing activities identified above are implemented, all remaining fishing activities are compatible with the conservation objectives of this marine protected area.

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Annex 1 - MMO methodology

The need for assessment

In 2012, the Department for Environment, Food and Rural Affairs (Defra) announced a revised approach to the management of commercial fisheries in European marine sites (EMS)[23]. The objective of this revised approach is to ensure that all existing and potential commercial fishing activities are managed in accordance with the provisions of Article 6 of the Habitats Directive[24]. The revised approach was extended to include management of commercial fisheries in marine conservation zones (MCZ) in 2014[25].

This approach was being implemented using an evidence based, risk-prioritised, and phased basis. Risk prioritisation is informed by using a matrix of the generic sensitivity of the sub-features of EMS to a suite of fishing activities. These activity/sub-feature interactions have been categorised according to specific definitions, as red, amber, green or blue[26].

Activity/sub-feature interactions identified within the matrix as amber required a site-level assessment to determine whether management of activity is required to conserve site features. Activity/sub-feature interactions identified within the matrix as green also require a site level assessment if there are "in combination effects" with other plans or projects.

Site-level assessments are carried out in a manner consistent with the requirements of Article 6(3) of the Habitats Directive for EMS and the requirements of section 126 of the Marine and Coastal Access Act 2009 for MCZ. For EMS the assessments will determine whether, in light of the sites conservation objectives, fishing activities are having an adverse effect on the integrity of the site. For MCZ the assessments will determine whether there is a significant risk of fishing activities hindering the conservation objectives of the site.

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[23] www.gov.uk/government/publications/revised-approach-to-the-management-of-commercial-fisheries-in-european-marine-sites-overarching-policy-and-delivery

[24] Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora

[25] The MMO responsibilities in relation to management of MCZs are laid out in Sections 125 to 133 of the Marine and Coastal Access Act 2009

[26]Managing Fisheries in MPAs matrix: www.gov.uk/government/publications/fisheries-in-european-marine-sites-matrix

Assessment process

The fisheries assessments have three stages:

Part A: A coarse assessment using generic sensitivity information to identify which fishing activities can be discounted from further assessment (Part B) as they are not taking place or not a significant concern.

Part B: An in-depth analysis to assess the effects of remaining pressures on the features of the site

Part C: An in-combination assessment between all fishing and non-fishing activities occurring.

Sources of evidence

Evidence used in the assessments falls into two broad categories:

1. Fishing activity information. This includes patterns, intensity, and trends of fishing activities and types of gear used.
2. Ecological information, in particular the location, condition and sensitivity of designated features.

Fishing activity information

VMS data

VMS data are derived from positional information reported by UK and Other Member States (OMS) vessels carrying the EU mandated vessel monitoring system (VMS). Since 2015 all commercial fishing vessels of 12 metres and over in length have been required to report their position, course and speed at regular intervals using VMS. Prior to 2015 this requirement applied to commercial fishing vessels of 15 metres and over.

VMS data were analysed in ArcGIS. VMS reports not associated with fishing activity were removed. These included reports with speeds greater than 6 knots (indicating non-fishing) and reports from vessels known to be performing guard ship duties for marine developments.

For UK vessels gear type and landings were assigned to VMS data by matching each report to gear types recorded in relevant landings declarations, logbooks and the Community Fishing Fleet Register.

For OMS vessels only gear types are assigned to the VMS data as individual vessel landings are not available.

Landings data

Landings data are recorded at International Council for the Exploration of the Sea (ICES) statistical rectangle[27] level through landings declarations and logbooks.

In areas where a high proportion of landings came from vessels with VMS, landings data from vessels with VMS were linked to VMS-derived location reports to provide spatial estimates of where landings were derived from within an ICES rectangle (see VMS data above).

For vessels that do not require VMS (<12 m in length) or OMS vessels where landings are not assigned to VMS reports (see VMS data above), landings from within specified areas (e.g. MPA's or area of feature) are estimated using the proportion of VMS reports (for VMS vessels) or the relative size of the MPA/Feature area compared to the sea area of the containing ICES rectangle(s).

Landings data are analysed to determine quantities of landings by gear group and vessel size group.

Vessel Sightings data

Sighting information is recorded into the Monitoring Control and Surveillance System (MCSS). It is collected by various bodies such as MMO coastal staff, IFCAs, Navy patrols and other relevant agencies and contains the following:

1. Date and time of sighting
2. Reporting body
3. Vessel name, ID, gear type
4. Approximate location of vessel
5. Approximate speed of vessel
6. Whether the vessel is: Laid/tied up, steaming or fishing.

MMO expert opinion on fishing activity

MMO marine officers provided information on fishing activity within MPAs. Information included number and size of vessels fishing, target species, type and amount of fishing gear used and seasonal trends in activity. Confidence levels were provided alongside expert opinion and estimates were provided where exact numbers were not known.

Fishing Industry Information

Where possible and achievable, information from the fishing industry regarding current fishing locations, intensity and gear types has been used to build the evidence base for the assessment.

[27] ICES statistical rectangles are part of a widely used grid system for North Eastern Atlantic waters. For more information see: www.ices.dk/marine-data/maps/Pages/ICES-statistical-rectangles.aspx

Ecological information

The fisheries assessments use the conservation advice packages produced by Natural England and the Joint Nature Conservation Council. These provide information on the features of the site, their area and conditions. The packages also contain advice on operations and supplementary advice documents which allow the assessment of which pressure/gear combinations a feature may be sensitive too.

For some assessments, further ecological information has also been provided by Natural England. This information is available in the relevant assessments.

Sensitivity and vulnerability

The following definitions of sensitivity and vulnerability are used in MMO assessments.

Sensitivity is defined as:

a measure of tolerance (or intolerance) to changes in environmental conditions.[28]

Vulnerability is defined as: ***a combination of the sensitivity of a feature to a particular pressure/activity, and its exposure to that pressure***

[28] Tilin *et al* 2010, Roberts *et al* 2010

Annex 2 - Assumptions used to calculate spatial footprint (Pr-values)

1. Pr-value background

1.1. Introduction

The MMO are required to assess the impacts of all fisheries on designated features and habitats within marine protected areas (MPAs) in English waters.
The application of a “footprint” approach has been promoted by previous authors (such as Jennings *et al.*, 2012[29]) as a method to quantify fishing pressure within an area of interest (AOI) such as a ‘fishing impact equation’ where:

$$Fishing\ footprint\ (Pr) = \frac{Fishing\ effort\ within\ AOI * Area\ fished\ by\ indiviual\ vessel\ in\ 1\ day}{Total\ area\ of\ MPA/feature}$$

Generating a “fishing footprint value” (Pr) aims to define the level of pressure for a single average day of effort for a reference vessel or fisher (land-based) within a fleet, taking into account the gear used. This value could be multiplied by the number of vessels or fishers to give the total pressure for a particular gear over a specific time period e.g. a calendar year.

This aims to inform assessments concerning the level of impact that is acceptable for maintaining integrity of the site or feature. This approach can also be used to help define the spatial extent of the fisheries activities (in relation to feature size) or simply identify where interactions exist with features (which may in itself signify adverse effect and warrant management measures). The equation can also be used to model “worst case” scenarios to help define upper limits of potential impact, which can be refined to more realistic levels with local expert judgement.

However the factors involved in calculating the area of interaction and level of impact can be complex depending on the range of vessels, fishing effort and gear types used in the area, temporal or spatial patterns of activity within the fishery, the frequency of impacts and resilience of the habitats concerned, and any cumulative impacts of different types of gear. The incorporation of these factors will need to be considered when calculating the equation, along with the availability and robustness of data to provide such information for current and future assessments.

In order to calculate the fishing pressure effectively for each gear, a clear understanding of the three parameters that define the fishing pressure must be obtained.

1.1.1. Fishing effort

In order to calculate fishing effort there are two specific variables that must be defined for each gear type:

- **Effort** (the number of effort units for a particular gear type) and
- **Area of interaction** (the area of contact from a unit of gear)

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[29] Jennings, S., Lee, J., Hiddink, J.G., 2012. Assessing fishery footprints and the trade-offs between landings value, habitat sensitivity, and fishing impacts to inform marine spatial planning and an ecosystem approach. ICES J. Mar. Sci. 69, 1053–1063. doi:10.1093/icesjms/fss050

A source of effort data is vessel monitoring system (VMS) data as this represents high quality independent data that can be linked to logbook data for UK vessels to verify and merge catch and effort datasets. Area of interaction is defined as the actual impact of the individual gear type based on the proportion of gear in contact with the bottom and this information can be sourced from scientific literature and/or interviews (see section 3.1 for further details).

1.1.2. Area of interest

The area of interest (AOI) could be defined as the MPA itself or designated features within a specific MPA. Data sources on the distribution and extent of designated features could be obtained from statutory nature conservation bodies (SNCBs) such as Natural England and the Joint Nature Conservation Committee (JNCC).

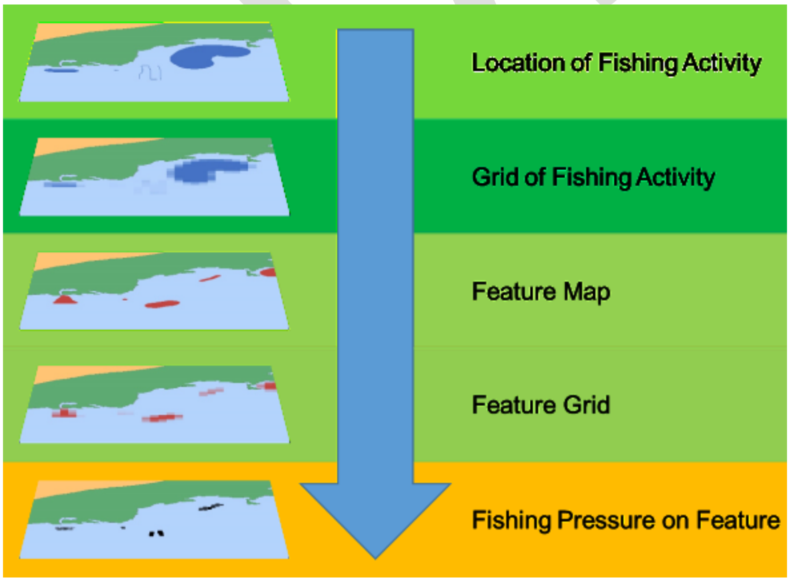
1.2. Developing the equation further

In order to determine the level of impact of fishing activity on designated features, the sensitivity of the feature should be incorporated into the proposed fisheries footprint calculation to help determine the extent to which the interaction is likely to cause an adverse effect. The sensitivity of the feature may be influenced by the time of recovery of a feature, the level of natural disturbance, cumulative impacts etc. This was identified through the fisheries European Marine Site (EMS) matrix and further scientific literature reviews.

Fishing effort also varies in terms of both the spatial and temporal distribution, potentially leading to clustering and non-uniform distribution of fishing effort across a single feature. Therefore gaining an understanding of intensity of fishing on a feature would be useful in identifying potential cumulative impacts.

To incorporate clumping or non-uniform distribution of fishing effort a geospatial system was developed (Figure 13).

Figure 13: An example of input layers and stages for geospatial calculations



Spatial and temporal data was obtained in the form of VMS data to map fishing activity (effort). Area of interaction with the seabed from different gears was calculated using scientific literature and interviews with informed individuals. Feature maps of designated features within MPAs were obtained from SNCBs. From this the following can be calculated for the different gear types:

- Single VMS report gear footprint (m^2): This calculates the gear fishing footprint equivalent to a single VMS report across a cell area ($0.2025km^2$) over a 2hr time frame.
- Total VMS report area (km^2): This calculates the sum of unique cell areas ($0.2025km^2$) where VMS reports occur.
- Total gear footprint (km^2): This is the total area impacted by fishing gear. This is calculated by multiplying the total number of VMS reports by cell area ($0.2025km^2$) and the single VMS report gear footprint.
- Pr-value: Total extent of AOI impacted by gear (as a ratio). This is calculated by dividing total gear footprint by the AOI.
- Pr-value percentage (%): Percentage of AOI impacted by gear.

2. Analysis

2.1. Single VMS report gear footprint

The types of gear currently included in the gear calculators which calculates the single VMS report gear footprint are described in Table 27.

Table 27: A description of gear and the gear code used

IFISH Code	Gear	Brief Description
DRB	Boat dredges	Two types; one that is dragged along sea bed, another that is like a benthic scoop that penetrates the sea bottom. Targets mussels, clams, scallops, crab etc.
FPO	Pots	Cages/baskets made from various materials and come in various sizes. Mainly set on the bottom, sometimes designed for mid-water use. Pots target fish, crustaceans and cephalopods.
GN/GNS	Gillnets (not specified) /Set gillnets (anchored)	A gillnet is a wall of netting that hangs in the water column. Set gillnets are anchored in the sea bed and held down by the heavy rope line. They can be either vertical (with a float line) or flat (without a float line). Targets coastal species.
HMD	Mechanized dredges	Hydraulic dredges dig and wash out mussels from the sea bed. It is considered a harvesting machine when the same gear collects the mussels and hauls them on board.
OTB	Otter trawls - bottom	Dragged along bottom and has an extended top panel to stop fish escaping upwards. Targets bottom and demersal species.
OTT	Otter twin trawls	Two identical trawls fixed together to increase the fishing area. Two otter boards to hold mouths open, one at each far

		end. The connection between the two trawls is a rope which joins the connection between the two pulling. Usually targets shrimp.
TBB	Beam trawls	Mouth of trawl is permanently held open by a beam with guides/skids attached. This disturbs bottom fish which rise up and get caught.
TBN	Nephrops trawls	Adapted to be selective for Nephrops with mall holed mesh. Some have devices to allow the inevitable larger by-catch to escape.

Each gear type has a gear calculator which calculates the gear fishing footprint for a cell area over a 2 hour time frame. A cell is 450m by 450m (20250m^2) or 0.2025km^2, 2 hours was chosen as it is the maximum time allowed between VMS reports. This is calculated as 0.083 or one twelfth of a day.

The calculation is as follows for trawls or dredge gears:

$$Single\ VMS\ report\ = \frac{\text{Total width of gear (m)} * \text{Total length hauled per day (m)}}{\text{Area of cell size } (20250m^2)} * \text{2hr period (0.083)}$$

The calculation is as follows for nets & lines, pots & traps, hand-gathering or single position gears:

$$Single\ VMS\ report\ = \frac{\text{Area of impact from one unit of gear } (m^2) * \text{No.of operations in one day}}{\text{Area of cell size } (20250m^2)} * \text{2hr period (0.083)}$$

This gives an estimate of the area (in m^2) impacted by gear from a single VMS report based on the different fishing gears (Table 28). However this does assume the same size gear and amount of operations/hauls occurs for each gear type regardless of other variables (e.g. boat length, engine power, bylaws in place etc). See section 3.1 for assumptions made about the gear calculations.

Table 28: Estimate of different gears fishing footprint across a cell area for a two hour period.

Gear	Single VMS report gear fishing footprint over cell area (m^2)
TBB	1.336195
OTT	0.559954
DRB	0.437237
OTB	0.282455
OT	0.282455
HMD	0.057756
TBN	0.034159
GNS	0.001787
GN	0.001787
FPO	0.000004

2.2. Pr-value model

The Pr-value model requires several datasets as inputs including:

- Annual UK VMS data for >12m vessels
- Annual Non-UK VMS data >12m vessels
- Single VMS report gear footprint calculations
- MPA sites and designated feature data

Assumptions about the datasets are included in Section 3.

The pr-value model has the following steps:

1. The UK and non-UK VMS data is clipped to the area of interest (MPA site or designated feature within site)
2. VMS reports which are denoted as 'fishing' are chosen (vessels travelling between >0 and <6 knots)
3. VMS reports from the same vessels which are less than 2 hours apart (7080 seconds exactly, see Section 3.4 for explanation) are excluded
4. The processed VMS data (VMS reports= fishing & ≥ 2 hours) is joined to the gear calculations data
5. A grid is created across the area of interest, with cell sizes of 450m by 450m
6. The grid and processed VMS data are joined together.
7. Gear not included in the current gear calculators is excluded.
8. The cell area is calculated as 0.2025km^2 for each cell.
9. Total gear footprint is calculated by multiplying single VMS report gear footprint by the cell area (0.2025km^2). This is then multiplied by the number of VMS reports per gear type.
10. The VMS report area and total gear footprint is summed by gear type
11. A summary table is created which includes:

- AOI field (km^2)
- AOI name (text)
- Total VMS report area (km^2): Sum of unique cell areas (0.2025km^2) where VMS reports occur.
- Total gear footprint (km^2): Total area impacted by fishing gear.
  $\text{Total no. of fishing VMS reports} * \text{cell area } (0.2025) * \text{single VMS report gear footprint}$
- Pr-value: Total extent of AOI impacted by gear. $\frac{Total\ gear\ footprint}{AOI}$
- Pr-value percentage (%): Percentage of AOI impacted by gear. $\frac{Total\ gear\ footprint}{AOI} * 100$

3. Pr-value Assumptions

3.1. Gear Calculators

A cell is 450m by 450m or 0.2025 km^2. Two hours was chosen as it is the maximum time allowed between VMS reports. These were chosen so that a beam trawler (the largest swept area) will have covered the whole cell in 2hrs.

Current gear calculations are based on the following defaults:

Boat dredges (DRB):

- Based on one vessel with two tow bars each carrying eight dredges of 75cm.Trawl wheels/skids not added as no data on size could be found. Data from:

https://www.researchgate.net/publication/269629387_Review_of_habitat_dependent_impacts_of_mobile_and_static_fishing_gears_that_interact_with_the_sea_bed.

- No information on number of hauls and length found. Assumption made that a 12 hour shift is undertaken with 6 hauls. Haul speed assumed to be similar to other bottom towed gear.

Pots (FPO):

- Data taken from Annexes to: "Feasibility study on applying a spatial footprint approach to quantifying fishing pressure".
- Based on a pot 500cm by 700m and hauling 30 pots per day.

Gillnets/ Set Gillnets (GN/GNS):

- Based on a vessel shooting 10 tiers each 132m. Each tier has 2 anchors at 2 x 0.5m. Foot rope 3m wide drag. Info derived from seafish report on a workshop on the physical effects of fishing activities on Dogger Bank and Annexes to: Feasibility study on applying a spatial footprint approach to quantifying fishing pressure.
- 5.5 nets hauled per day. Info derived from seafish report on a workshop on the physical effects of fishing activities on Dogger Bank and MMO coastal.

Mechanised dredges (HMD):

- Based on 1 cage with a total width of 74". Data from http://spo.nmfs.noaa.gov/mfr444/mfr4441.pdf
- Haul duration 10.12 hours. Data from http://www.seafish.org/media/Publications/SR348.pdf
- Haul speed 4 knots. Data from http://www.seafish.org/media/Publications/SR348.pdf

Otter trawls/ Otter trawls – bottom (OT/OTB):

- Based on a vessel with one 12m trawl with two 1.2m x 0.65m otter boards and with 60 % ground rope interaction. Information derived from seafish report on a workshop on the physical effects of fishing activities on Dogger Bank.
- Haul duration 4 hours, from an MMO officer.
- Haul speed 4 knots, from an MMO officer.

Otter twin trawls (OTT):

- Based on a vessel with two 12m trawls with two 1.2m x 0.65m otter boards and with 60 % ground rope interaction and 1 clump of 0.6m. Information derived from seafish report on a workshop on the physical effects of fishing activities on Dogger Bank and Annexes to: Feasibility study on applying a spatial footprint approach to quantifying fishing pressure.
- Haul duration 4 hours, from an MMO officer.
- Haul speed 4 knots, from an MMO officer.

Beam trawls (TBB):

- Based on a vessel with two 12m trawls, four 720mm shoes and 2 tickler chains with 60% interaction with the sea bed. Information derived from seafish report on a workshop on the physical effects of fishing activities on Dogger Bank and Annexes to: Feasibility study on applying a spatial footprint approach to quantifying fishing pressure.
- Haul duration 4 hours. Information derived from seafish report on a workshop on the physical effects of fishing activities on Dogger Bank and MMO coastal.

- Haul speed 4 knots. Information derived from seafish report on a workshop on the physical effects of fishing activities on Dogger Bank and MMO coastal.

Nephrops trawls (TBN):

- Based on a vessel with two 3.5m beam trawls, 4 x 0.2 feet and 60% ground rope interaction. Information derived from Annexes to: Feasibility study on applying a spatial footprint approach to quantifying fishing pressure.
- Haul duration 2 hours. Information derived from Annexes to: Feasibility study on applying a spatial footprint approach to quantifying fishing pressure.
- Haul speed 1.5 knots. Information derived from Annexes to: Feasibility study on applying a spatial footprint approach to quantifying fishing pressure.

3.2. VMS data assumptions

It has been assumed that:

- Non-UK VMS data is accurate although only presented to 3 decimal degrees for latitude and longitude.
- UK data is complete or null gear codes are processed and corrected.
- ‘Fishing’ VMS reports are vessels travelling between 0-6kts.
- VMS data is only available for >12m vessels.

3.3. MPA sites and designated features assumptions

It has been assumed that:

- The data used for the outline of the MPAs is accurate, although there may be very minor inaccuracies due to differences in projection.
- Designated features areas are up to date and complete.

3.4. Pr-value assumptions

It has been assumed that:

- The model does not have false fishing VMS reports such as vessels moving between 0-6kts but not fishing.
- VMS reports from the same vessels which are less than 2 hours apart (7080 seconds to allow for a grace period) are duplicated and therefore are removed.
- All gear is included in the gear calculators to be used in the model. Gear not included in the gear calculators are removed.

Annex 3 - Monitoring and Control Process

Figure 14: Monitoring and control process