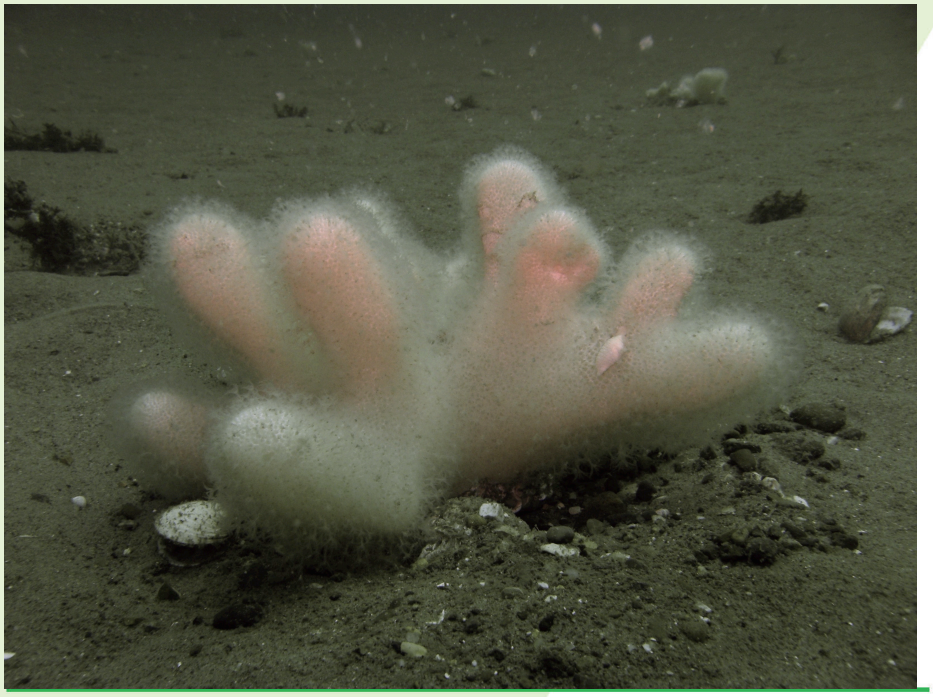
Impact of demersal seine fisheries in the Natura 2000 area Dogger Bank

A review of literature and available data



Bureau Waardenburg

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Ecologie & landschap

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Preface

The Netherlands, United Kingdom and Germany are preparing a Joint Recommendation regarding fisheries management for the protection of sandbanks in three Natura 2000 sites on the Dogger Bank. The proposed measures include the establishment of a zoning system with respect to mobile bottom contact fishing gear and a differentiation between bottom trawling and demersal seines.

WWF Netherlands commissioned Bureau Waardenburg to carry out a literature review on the ecological impact of demersal seines to the conservation goals of the Natura 2000 areas in the Dogger Bank.

Thomas Rammelt was the contact person for this project.

The authors thank everyone who has contributed to this report.

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Summary

The conservation objectives of the habitat H1110 "Sandbanks which are slightly covered by sea water all the time" in the Natura 2000 areas on the Dogger Bank are described as: "*conservation of surface area and improvement of the quality of the sandbanks*" (NL); "*restore the habitat to favourable condition*" (UK) and "*restoration of a favourable conservation status of the habitat type (1110) including its typical and threatened communities and species* (GER). The specific characteristics of sand banks (habitat type H1110), including its quality, are defined as including so-called typical species and the "*presence of long-lived benthic species*" (NL and GER; UK by implication). The conservation of the typical species will be taken as favourable when: *population dynamics on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and the natural range of the typical species is neither being reduced, nor is likely to be reduced for the foreseeable future (…)'* (article 1 sub i Habitats Directive).

Over 50 typical species are listed for the conservation objectives of the international H1110 Natura 2000 sites of the Dogger Bank, including species of anthozoa (soft coral), species of bryozoa, annelid worms, crustaceans, echinoderms, fish and molluscs.

A literature review was carried out, reviewing all available scientific information based on (1) field experiments, (2) field observations and (3) predictive studies of the impact of demersal seine fisheries on the H1110 Dogger Bank typical species. In this study the term demersal seine fisheries will be used to include Scottish seines, also known as fly-shoot fishery, and Danish seines (Figure 1). One term, fly-shoot fishery, will be used in this report for both Scottish seining and fly-shoot fishery.

There have been no targeted scientific field studies to assess the specific impact of demersal seines on the H1110 Dogger Bank typical species. However, three field observation studies are available, which measured the catching rate of commercial (target) fish species and sampled by-catch (fish and benthos) of demersal seines, either fly-shoot fisheries or Danish seining in the North Sea area. These types of fishery caught a substantial number of the H1110 Dogger Bank typical species. At least 19 of the typical H1110 species are regularly caught by fly-shoot fishery. These include several long-lived benthic species (*Alcyonium digitatum*[1], *Arctica islandica, Buccinum undatum and Neptunea antiqua*). In addition, fly-shoot and Danish seining combined caught seven species of rays (6) and shark (1) including vulnerable, near-threatened, endangered and critically endangered species according to IUCN criteria. These data suggest that sharks and rays are at risk of being caught by demersal seining in all studied regions.

[1] Common names are included in Tables 1 – 5.

Nine additional H1110 Dogger Bank typical species are considered sensitive to bottom disturbance according to the criteria of Wijnhoven *et al.* (2013): *Alcyonidium diaphanum, Lanice conchilega, Astropecten irregularis, Angulus fabula, Aporrhais pespelecani, Ensis ensis, Euspira pulchella, Gari fervensis, Mactra stultorum*. There is no evidence that suggests the specific disturbance caused by demersal seine fisheries will not impact these sensitive species and it is very likely that demersal seining will impact these species negatively. The red whelk (*Neptunea antiqua)* is similar in size and life history (large and long-lived) to common whelk (*Buccinum undatum)* and can also be indicated as sensitive to bottom disturbance (expert judgement by the authors of this report). This species is declining in the North Sea, which has been attributed to demersal trawling (de Bruijn *et al.* 2013).

The predictive study of Eigaard *et al.* (2016) concluded that (1) the subsurface and surface impact of fly-shoot fishery was similar to several types of otter trawling and that (2) the surface and subsurface footprint of fly-shoot fishery is larger than four types of otter trawling and Danish seining. The scale of this impact by fly-shoot fishery as predicted by Eigaard *et al.* (2016) on benthic species is confirmed by the observations of by-catch of 15 benthic species by fly-shoot fisheries.

These observational and predictive studies suggest that the total number of typical H1110 species sensitive to demersal seining is substantial (at least 19 and possibly 28). These numbers are much larger than the conclusion of Rijnsdorp *et al.* (2015) that only three benthic species (including two typical H1110 species) are vulnerable to fly-shoot fishery.

The results of the observational and predictive studies imply that the realisation of the conservation objectives of the Natura 2000 site Dogger Bank (improving quality or restoring to a favourable conservation status by "*increase of long-lived species*") can be considered uncertain and is possibly unlikely if demersal seining is allowed in the proposed areas closed for trawling in the Natura 2000 sites of the Dogger Bank.

Although controlled field experiments that can actually prove a significant negative impact of demersal seining on the H1110 Dogger Bank typical species are non-existent to date, the close agreement of available field observations, together with the predictions of the assessment of Eigaard *et al.* (2016) with respect to the physical impact, is at least suggestive of a negative effect. Therefore, based on the information available to date, a significant negative impact of demersal seining on the conservation objectives of the Natura 2000 sites on the Dogger Bank cannot be objectively ruled-out with certainty.

The proposed management regime, which in its current form allows for demersal seining is not scientifically justified, because the full list of H1110 Dogger Bank typical species, which form the baseline of the conservation objectives of the Natura 2000 site Dogger Bank, has not been used in previous analyses. This implies that the

conditions stated in the guidance letter of the EC (7 July 2012, cited in the Background Document Dogger Bank) are not met in full.

Based on the available knowledge to date, it cannot be concluded with certainty, that allowing demersal seine fisheries in the management zones of the Natura 2000 sites on the Dogger Bank will not have any negative impact on the conservation objectives of these sites, in keeping with Article 6 of the EU Habitats Directive (EEC 92/43). Rather, a negative impact of demersal seining on the conservation objectives is highly likely.

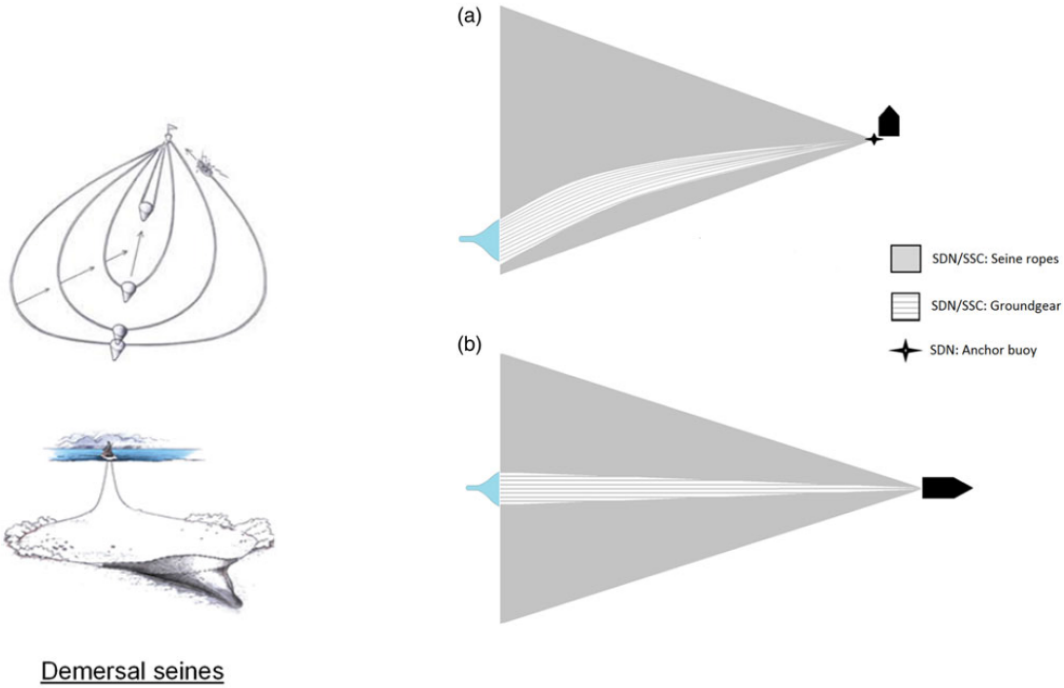

Figure 1. LEFT: *A demersal seine has long towing ropes extending from the wings of the seine, that herds the fish into the path of the seine. The boat hauls the ropes simultaneously with (Danish seining, SDN) or without (Scottish seining or fly-shoot, SSC) the use of an anchor. RIGHT: Conceptual gear footprints (total area swept) of demersal seines: (a) Danish seine and (b) Scottish seine or fly-shoot. The total surface footprint by the seine ropes is indicated in dark grey, the seine in blue and the footprint of the ground gear in light grey (From Eigaard et al. 2016).*

1 Introduction

1.1 Background

The Netherlands (27 May 2016), United Kingdom and Germany have designated or will designate Natura 2000 sites under the EU Habitats Directive (92/43 EEC) on the Dogger Bank. The overall aim is to ensure protection of habitat type H1110 on the Dogger Bank, namely "sandbanks which are slightly covered by seawater all the time". These EU Member states aim to improve the quality of the habitat (NL), restore the habitat to favourable condition (UK) and conservation and restoration of a favourable conservation status of the habitat type including its typical and threatened communities and species (GER).

According to article 1 sub e of the Habitats Directive *'the conservation status of a natural habitat means the sum of the influences acting on a natural habitat and its typical species that may effect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species within the territory (…). The conservation status of a natural habitat will be taken as 'favourable' when (…), the specific structure and functions which are necessary for its long maintenance exist and are likely to continue for the foreseeable future, and the conservation status of its typical species is favourable'*. Following article 1 sub i Habitats Directive *'the conservation status of a species* (including the typical species) *means the sum of the influences acting on the species concerned that may effect the long-term distribution and abundance of its populations'.* The conservation of the typical species will be taken as favourable when: *population dynamics on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and the natural range of the typical species is neither being reduced, nor is likely to be reduced for the foreseeable future (…)'* (article 1 sub i Habitats Directive).

To reach this aim the Member States want to decrease the human pressure on habitat type 1110 and have drafted a proposal for measures to reduce the fishing intensity. These Member States intend to submit this proposal to the Commission as a joint recommendation under articles 11 and 18 of EU Regulation (1380/2013) on the Common Fisheries Policy (CFP). The conservation objectives and H1110 typical species of the Natura 2000 sites on the Dogger Bank (in this document further referred to as "H1110 Dogger Bank typical species") are listed in the Profile Document "Permanently flooded sandbanks (H1110)" of the Netherlands (EZ, 2014) and Natura 2000 Standard Data Forms of the UK (Joint Nature Conservation Committee [JNCC], 2012, 2016) and Germany (Bundesamt für Naturschutz [BfN], 2010). The current draft Joint Recommendation for Fisheries Management Plan includes an experimental study to analyse the effects of seine fisheries on H1110 sandbanks in the German part of the Dogger Bank.

1.2 Aims

The main question to be answered in this report is:

Can it be concluded with certainty, leaving no reasonable scientific doubt, that allowing demersal seine fisheries in the management zones of the Natura 2000 sites on the Dogger Bank will not have any negative impact on the conservation objectives of these sites, in keeping with Article 6 of the EU Habitats Directive (EEC 92/43)?

1.3 Research questions

The aforementioned general question will be answered on the basis of all scientific literature and the best available data concerned.

Use of scientific information

1. Is there sufficient scientific literature available to support the conclusion that the favourable conservation status of the Natura 2000 sites is ensured in the event of a management regime, which allows demersal seine fisheries in the management zones?

2. In the literature review the question will be answered if in the Dogger Bank Background Document (version of 31 May 2016) comprehensive use has been made of available literature.

3. Was recent literature concerning the effects of demersal seines on sandbanks, habitat type H1110, left out of the Dogger Bank Background Document?

4. Were the conclusions of cited studies, which have been used in the Dogger Bank Background Document and including the desk study of Rijnsdorp *et al.* (2015), correctly reproduced?

Assessment of effects

5. Is a management regime, which allows demersal seine fisheries in the management zones of the Natura 2000 sites on the Dogger Bank, scientifically justified when considering pressures from bottom contacting fishing gear on habitat type H1110 and hence does it meet the conservation objective and status of the habitat? (See also the guidance letter of the European Commission of 7 July 2012, EC, 2012 as referred to in Dogger Bank Background Document, p. 8.)

Cumulative effects

6. Do impact assessments that support the draft proposal for the Dogger Bank, include an assessment of the cumulative effects before they are applied to the

characteristics, the specific environmental conditions and conservation objectives of the sites?

7. Have other plans and activities been included in an assessment of cumulative effects?

8. Have ‘external’ activities (that take place outside the borders of the Natura 2000 sites on the Dogger Bank), sufficiently been taken into account in the assessment of the effects inside the sites?

1.4 Overview

These questions will be answered using the following methods and information. The H1110 typical species related to the conservation objectives of the Natura 2000 sites on the Dogger Bank are first listed and analysed (Chapter 2). Subsequently, a literature search and review is carried out for three types of scientific information with respect to the impact of demersal seines: (1) field experiments, (2) field observations, (3) predictions and simulations. The results will be used to address the research questions stated in Chapter 1 (Chapter 3). The conclusions are summarized in Chapter 4.

Table 1. *Typical species of Dogger Bank habitat type H1110 with scientific name and common names in English and Dutch, species group and indication of inclusion in Dutch (NL), German (D) and British (UK) parts of the N2000 area and Background Document (BD). This selection of 50 species is characteristic for sandy substrates with low sediment dynamics and represents the complete biotic structure of the habitat type. * Analysed by Wijnhoven et al. (2015) and* ^{S} *indicated as sensitive to bottom disturbance (see section 3.2.3). IUCN conservation status vulnerable (or more threatened, see section 3.2.2 and Table 4) is indicated in red.*

H1110 typical species	English name	Dutch name	species group	NL	D	UK	BD
Aphrodita aculeata	Sea mouse	Zeemuis	annelid worm	1			
Goniada maculata			annelid worm	1			
Lanice conchilega	Sand mason worm	Schelpkokerworm	annelid worm	1		1	1
Magelona papillicornis			annelid worm	1			
Nephtys cirrosa	White catworm	zandzager	annelid worm	1		1	1
Nephtys hombergii	Catworm	zandzager	annelid worm	1			
Sigalion mathildae			annelid worm	1	1		
Spiophanes bombyx	Bee spionid	Zandkokerworm	annelid worm	1	1		1
Pennatula phosphorea	Luminescent sea pen	Zeepen	anthozoa			1	1
Alcyonium digitatum^{*S}	Dead man's fingers	Dodemansduim	anthozoan	1	1	1	
Alcyonidium diaphanum^{*S}	Sea chervil	Bruine zeevinger	bryozoa			1	1
Bathyporeia elegans	Sand digger shrimp	Knikspriet kreeftje	crustacean	1	1		1
*Bathyporeia guilliamsoniana**		Knikspriet kreeftje	crustacean	1	1		1
Corystes cassivelaunus^{*S}	Helmet crab	Helmkrab	crustacean	1		1	
Liocarcinus holsatus	Swimming crab	Gewone zwemkrab	crustacean	1		1	
Pagurus bernhardus	Common hermit crab	Gewone heremietkreeft	crustacean	1		1	
Pagurus pubescens	hermit crab	Harige heremietkreeft	crustacean		1		
Urothoe poseidonis			crustacean	1			
Acrocnida brachiata	Buried serpent star	Ingegraven slangster	echinoderm	1			1
Amphiura filiformis	Serpent star	Draadarmige slangster	echinoderm		1	1	1
Asterias rubens	Common sea star	Gewone zeester	echinoderm			1	
Astropecten irregularis^{*S}	Sand star	Kamster	echinoderm	1	1	1	
*Echinocyamus pusillus**	Green urchin	Zeeboontje	echinoderm	1	1		
Luidia sarsii			echinoderm	1			
Ophiothrix fragilis	Common brittle star	Brokkelster	echinoderm	1	1	1	1
Ophiura ophiura	serpent star	gewone slangster	echinoderm	1		1	
Psammechinus miliaris	Green sea urchin	Kleine zeeappel	echinoderm		1	1	1
Ammodytes marinus	Lesser sandeel	Noorse zandspiering	fish			1	1
Arnoglossus laterna	Scaldfish	Schurftvis	fish	1			1
Buglossidium luteum	Solenette	Dwergtong	fish	1			1
Callionymus lyra	Common dragonet	Gewone pitvis	fish	1		1	1
Echiichthys vipera	Lesser weever	Kleine pieterman	fish		1		1
Eutrigla gurnardus	Grey gurnard	Grauwe poon	fish	1		1	1
Gadus morhua	Atlantic cod	Kabeljauw	fish	1		1	1
Limanda limanda	Dab	Schar	fish	1		1	1
Merlangius merlangus	Whiting	Wijting	fish	1		1	1
Microstomus kitt	Lemon sole	Tongschar	fish	1			1
Pleuronectes platessa	Plaice	Schol	fish	1		1	1
Raja clavata	Thornback ray	Stekelrog	fish		1		1
Acanthocardia echinata^{*S}	Prickly cockle	Gedoornde hartschelp	mollusc		1		1
Angulus fabula^{*S}	Beanlike tellin	Rechtsgestreepte platschelp	mollusc	1		1	1
Aporrhais pespelecani^{*S}	Pelican foot	Pelikaansvoet	mollusc		1	1	
Arctica islandica^{*S}	Ocean quahog	Noorkromp	mollusc	1	1		1
Buccinum undatum^{*S}	Common whelk	Wulk	mollusc	1	1		1
Ensis ensis^{*S}	Sword razor shell	Kleine zwaardschede	mollusc	1	1	1	
Euspira pulchella^{*S}	Common neglace shell	Glanzende tepelhoorn	mollusc	1			1
Gari fervensis^{*S}	Faroe sunset shell	Geplooide zonneschelp	mollusc	1	1		
Kurtiella bidentata		Tweetandschelp	mollusc	1	1	1	1
Mactra stultorum^{*S}	Rayed trough shell	Grote strandschelp	mollusc				1
Neptunea antiqua^{S}	Red whelk	Gewone noordhoren	mollusc	1	1	1	

2 Materials and methods

General considerations

In the literature review the possibility of significant effects will be related to the question of whether the delivery of the conservation objectives for habitat H1110 will be jeopardized in the light of the characteristics and the specific environmental conditions of the Natura 2000 site if demersal seines (Figure 1) are allowed in the management zones of the Dogger Bank.

The literature review will analyse the effects of catch, by-catch and bottom impact of demersal seines on habitat type H1110 Dogger Bank typical species as described in the Profile Document of H1110 (EZ, 2014) and Natura 2000 Standard Data Forms of the UK (JNCC, 2012, 2016) and Germany (BfN, 2010). These H1110 typical species are listed in Table 1 with scientific name, common names in English and Dutch, species group and indication of inclusion by each Dogger Bank country and the Background Document. The effects on the seabed and associated species will include the effects on fish (target and by-catch species), benthos, shellfish and other bottom dwelling species. The study will also focus on slow-growing and long-lived species (notably shellfish species, sharks and rays) and other effects on the food web.

In this study the term demersal seine fisheries will be used to include Scottish seines, also known as fly-shoot fishery, and Danish seines (Figure 1). One term, fly-shoot fishery, will be used in this report for both Scottish seining and fly-shoot fishery. In the assessment of the effects of demersal seines, the footprint[2] per hour fishing of the demersal seines as compared to other bottom trawl gears like beam and otter trawl will also be considered.

2.1 Conservation goals of the Natura 2000 sites on the Dogger Bank

The H1110 Dogger Bank typical species, which are sensitive to demersal seines include (1) long-lived species (one soft coral species, several mollusc and fish species) and (2) epibenthic or epifauna species which live on or just in the upper two centimetres of the sediment (the same species of coral, several species of crustaceans, echinoderms, filter-feeding molluscs and fish; Kaiser 2006; Rijnsdorp *et al.* 2015; Wijnhoven *et al.* 2013).

In addition, several long-lived fish species with a vulnerable or threatened status (e.g. elasmobranchs, including sharks and rays) and reef-forming species (bio-engineers, like flat oyster, *Ostrea edulis*) are also briefly discussed. The sharks and rays were common on the Dogger Bank up to the beginning of the 20th century and oyster banks

[2] Defined by Eigaard *et al.* (2016) as the total area in km^2 swept by the seine ropes and ground gear during a fishing operation.

were present at the southern edge of the Dogger Bank in the second half of the 19th century (van Moorsel 2011), but are not included in the conservation objectives and list of H1110 Dogger Bank typical species (except for thornback ray, *Raja stellata*).

2.2 Literature and web search of fisheries impact

The scientific literature was surveyed with two search engines: Web of Science and Google Scholar. All resulting hits from the search terms were checked for relevant, peer-reviewed publications. The web was searched with a limited set of search terms. Only the first 20 hits were checked for relevant information. The following search terms were used: “demersal seine”, “demersal seining”, “Scottish seine”, “Danish seine”, “fly-shooting”, “fly-dragging”. These were used in combination with “impact”.

Relevant publications are selected if they include one of the following three methods to gather scientific information on the ecological impact of demersal seine fisheries (in decreasing order of importance):

1. *Field experiments*: The results of scientific studies, which monitor the impact of experimental or regular fishing activities before and after fishing and including a comparison with a control site without fishing. The most commonly used experimental design follows the BACI methodology. This type of experiment estimates the direct impact of the activity by comparing the ecological situation with respect to the impact on the benthic fauna before and after the activity (in this case fishing) with a control site (Before – After – Control – Impact, BACI design). Depending on the timescale used, this type of experimental study will give good evidence of the recovery potential of species impacted by the activity and if the activity has a significant effect on the conservation goals of a Natura 2000 area in the North Sea.

2. *Field observations*: Observations on catching rates of target (or commercial) species and by-catch of the focal fishing method. These scientific observations give a good indication of which species are potentially impacted, but cannot estimate the recovery potential of species impacted by the activity. Therefore, these studies have limited power to estimate if this activity has a significant negative impact on the bottom ecosystems and populations of typical species, which are part of the conservation objectives of the Natura 2000 area.

3. *Prediction and simulation*: Description of physical aspects of the fishing gear with respect to bottom impact to predict and simulate the impact of the fishing gear on benthic communities. These scientific studies facilitate the comparison of potential impact of different fishing gears, including gears which are newly designed and for which little field experience is available. Similar to the field observations, these studies cannot estimate the recovery potential of species impacted by the activity. Therefore, these studies have limited power to estimate if this activity has a significant negative impact on the benthic ecosystems and populations of typical species, which are part of the conservation objectives of the Natura 2000 area.

3 Results

3.1 Conservation goals of the Natura 2000 site Dogger Bank

The Netherlands
The conservation goals and conservation status of the (Dutch part of) Dogger Bank Natura 2000 are described in the Designation Decree Natura 2000 area Dogger Bank (Ministry of EZ, 27 May 2016).

The special protection area is designated for the following habitats and species, together with the specific conservation goals:

Habitat	**Surface area**	**quality**
H1110 Sand banks	conservation	improvement

Species	**population size**	**quality**
H1351 Harbour porpoise *P. phocoena*	conservation	conservation
H1364 Grey seal *Halichorus grypus*	conservation	conservation
H1356 Harbour seal *Phoca vituli*na	conservation	conservation

The conservation objectives for H1110 within the Natura 2000 area Dogger Bank are described as: "*conservation of surface area and improvement of the quality of the sandbanks*" (NL; EZ 2016); "to restore the habitat to favourable condition" (UK; JNCC 2012, 2016) and "restoration of a favourable conservation status of the habitat type (1110) including its typical and threatened communities and species (GER; BfN 2010).

The specific quality characteristics of H1110 are outlined below and include a list of typical species for this habitat.

Germany
General conservation objectives have been set as follows for the sandbank habitat type by which the site is defined, and for harbour porpoise and common seal as species requiring special protection:

- Maintenance and restoration of the site's specific ecological functions, biological diversity and natural hydrodynamics and morphodynamics;
- Maintenance and restoration at favourable conservation status of habitat type Code: 1110 (sandbanks which are slightly covered by sea water all the time) together with its characteristic and endangered ecological communities and species;
- Maintenance and restoration at favourable conservation status of the following Habitats Directive species and their natural habitats: Harbour porpoise and common seal.

United Kingdom

The Conservation Objectives for the Dogger Bank Sandbanks, which are slightly covered by seawater all the time, are:

Subject to natural change, restore the sandbanks to favourable condition, such that:

- The natural environmental quality is restored;
- The natural environmental processes and the extent are maintained;
- The physical structure, diversity, community structure and typical species, representative of "sandbanks which are slightly covered by seawater all the time", in the Southern North Sea are restored.

3.1.1 Description of habitat type H1110 on the Dogger Bank

The Natura 2000 areas on the Dogger Bank are designated for habitat type H1110 " Sandbanks which are slightly covered by seawater al the time". The Dogger Bank is a 100% marine area (Jak *et al.* 2009). The Dogger Bank as a whole, i.e. including the UK and the German parts, is a sandbank as defined by the Habitats Directive. The surface (in the UK part) lies 15 m below low-low water spring tide; the bank slopes away at the edges. Sand with varying silt content is found across the whole bank. The part of the bank on the Dutch Continental Shelf has higher macrozoobenthos diversity on the western side on the slopes, where important ecological values occur, predominantly between the 30 and 40 m depth contours. Fronts are encountered regularly in summer along the southern boundary of the bank; these can result in increased concentrations of fish and birds. Because of its shallow depth, its orientation and enormous size, the bank has a major effect on the processes in the North Sea. Jak *et al.* (2009) indicate that the large variability in depth and soft sediment types is characteristic of the Dutch part of the Dogger Bank and also applies to the German and UK parts. In addition it is situated on the geographical border of many northerly- and southerly-distributed species. These two aspects result in a relatively high biodiversity of benthic fauna. Generally, benthic individuals are numerous, but the overall biomass on the Dogger Bank is lower than in the Frisian Front of the North Sea coastal zone. Sandeels occur on the Dogger Bank in great numbers and are an important food source for seabirds and marine mammals.

The Designation Decree Natura 2000 area Dogger Bank (Ministry of EZ 2016) describes the conservation objectives of the Dutch Natura 2000 site on the Dogger Bank as "*conservation of surface area and improvement of the quality of sand banks*". The specific characteristics of sandbanks (habitat type H1110), including its quality, are described in The Profile Document H1110 "Permanently flooded sandbanks (H1110)" for the Dogger Bank area separately (Ministry of EZ, 2014) 'Good quality' is defined as "*presence of long-lived benthic species*". For the German part of the Dogger Bank Natura 2000 area the restoration and development objectives include "*Benthic communities should be distinguished by characteristic and in particular long-lived species. Individuals of such species should span all typical size and age classes in accordance with the natural conditions*" (BfN, 2010). For the British part the

"Conservation objectives and Advice on Operations" (JNCC, 2012) include the statement that "*Physical abrasion (for example, by mobile fishing gear) can directly damage the interest feature and its associated species. In particular, larger, fragile, sessile species are likely to be selectively removed from the community and be replaced by more mobile species, rapid colonisers and juvenile stages* [with references]". This statement implies that long-lived species are at risk in relation to mobile fishing gears and that management should be adjusted to reduce this pressure (JNCC, 2012). This can be achieved by restoring the natural dynamics of the soil and prevent soil disturbance by fishing activities.

The description of the habitat type in the Dutch part of the Dogger Bank includes 38 typical species (anthozoan or soft coral (1), annelid worms (8), molluscs (8), crustaceans (6), echinoderms (6) and fish (9) (Table 1). 12 For the German and British Natura 2000 areas in the Dogger Bank additional species are listed as typical species (including 23 infaunal species for the German N2000 area). Only the epibenthic and fish species from these lists are considered here: 1 anthozoan, 1 bryozoan, 1 crustacean, 3 echinoderms, 3 fish and 3 molluscs, Germany (BfN 2010) and the United Kingdom (Diesing *et al.* 2009). Most of these typical species are also listed in the Background Document[3] (Table 1, last column). *Mactra stultorum* is only mentioned as typical species by the Background Document and is included as well.

Evaluation of the conservation status is based on the criteria of "quality" and "future prospects". The criterion of quality is thereby based on the presence of so-called typical species and characteristics of good structure and functioning. The following principles are used:

- A good structure and functioning is determined by abiotic and biotic conditions;
- Typical species are considered an indicator (at species level) of good (ecological) structure and function. A selection of these species is listed in Table 1 with scientific and common names (below).

The conservation status of the quality of habitat type H1110 on the Dogger Bank is considered to be "unfavourable", because the number of long-lived species has declined in comparison to the reference situation in 1952-1954 (Ministry of EZ 2014) due to bottom disturbance, eutrophication and climate change. The conservation status of the quality of H1110 was assessed similarly in the German and British parts of the Natura 2000 site of Dogger Bank as has been pointed out above (Germany: BfN 2010; United Kingdom: JNCC 2012, 2016).

3.1.2 Benthic species and trends of long-lived species

Several of the species listed as H1110 Dogger Bank typical species, which are monitored in the Dutch WOT shellfish monitoring programme, were reported as

[3] Background Document to the Draft Joint Recommendation for Offshore Fisheries Management on the International Dogger Bank under the revised Common Fishery Policy. The Hague, Bonn, London, version 31 October 2016)

declining the period 1995-2010 by Wijnhoven *et al.* (2013): *Acrocnida briachiata, Corystes cassivelaunus, Iphinoe trispinosa, Mactra sultorum*. The authors of this report could not access the monitoring results of the other typical species.

The Dogger Bank is one of the few areas in the North Sea with stingrays. Historically high numbers of rays (different species) were caught in this area. Nowadays, numbers of opportunistic species have increased, whereas long-lived species such as rays (van Moorsel (2011) and some bivalves such as *Mactra stultorum* and *Spisula* species (van Moorsel, 2011) and *Neptunea antiqua* (de Bruyne et al., 2013) have decreased.

3.2 Literature search - Impact of demersal seine fisheries in the North Sea

General information about demersal seines can be found in Deerenberg *et al.* (2010), Donaldson (2010), Kuhlman & van Oostbrugge (2014), Polet & Depestele (2010), Suuronen (2012) and Walsh & Winger (2011). Technical aspects of demersal seines have been studied by Hermann (2016a,b), Madsen (2016), Noack *et a*l. (2016a,b). A schematic representation of Danish seining and fly-shoot fishery (the term Scottish seining is used in this publication) is given in Figure 1.

3.2.1 Field experiments

No peer-reviewed scientific publications were found describing the ecological impact of demersal seine fisheries on benthic ecosystems in the North Sea or nearby seas on the basis of field experiments (up to 28 November 2016).

3.2.2 Field observations

Three studies were found, which reported direct field observations of the catching rate of commercial species and by-catch by demersal seines: van der Reijden *et al.*, 2014; Verkempynck & van der Reijden (2015) reporting on fly-shoot fishery in the North Sea in 2013 including the Dogger Bank (Table 2, below), Verschueren (2015) reporting on fly-shoot fishery in the Channel (Table 3, below) and Noack *et al.* (2016a) reporting on fish species caught by Danish seining in the Kattegat, Denmark (Table 4, below). It is assumed that the areas selected for demersal seine fishery are similar in structure to allow efficient demersal seining and that the species caught are a conservative estimate of the species at risk.

Table 2. Target species and by-catch of fly-shoot fisheries (with different mesh sizes) in the North Sea, including the Dogger Bank, based on observations in 2013 (van der Reijden et al., 2014, Verkempynck & van der Reijden, 2015) with scientific name, English name and Dutch name. [TS] H1110 Dogger Bank typical species, IUCN – status "vulnerable" or more threatened in red.

Scientific name	English name	Dutch name
Fish (seine mesh size 100-119 mm)		
Amblyraja radiata	Starry ray	Sterrog
Chelidonichthys lucerna	Tub gurnard	Rode poon
Eutrigla gurnardus	Grey gurnard	Grauwe poon
Hippoglossoides platessoides	Sand dab	Lange schar
Leucoraja naevus	Cuckoo ray	Koekoeksrog
Limanda limanda [TS]	Dab	Schar
Merluccius merluccius	Hake	Heek
Microstomus kitt [TS]	Lemon sole	Tongschar
Pleuronectes platessa [TS]	Plaice	Schol
Trachurus trachurus	Scad	Horsmakreel
Fish (seine mesh size >= 120 mm)		
Amblyraja radiata	Starry ray	Sterrog
Clupea harengus	Herring	Haring
Eutrigla gurnardus [TS]	Grey gurnard	Grauwe poon
Glyptocephalus cynoglossus	Witch flounder	Witje
Hippoglossoides platessoides	Sand dab	Lange schar
Limanda limanda [TS]	Dab	Schar
Melanogrammus aeglefinus	Haddock	Schelvis
Pleuronectes platessa [TS]	Plaice	Schol
Pollachius virens	Sillock	Zwarte koolvis
Raja clavata	Thornback ray	Stekelrog
Benthos (seine mesh size 100-119 mm)		
Alloteuthis subulata	European common squid	Dwergpijlinktvis
Anthozoa	Sea anemones	Zeeanemonen
Arctica islandica [TS]	Ocean quahog	Noordkromp
Asterias rubens [TS]	Common starfish	Zeester
Buccinum undatum [TS]	Common whelk	Wulk
Cancer pagurus	Edible crab	Noordzeekrab
Ciona intestinalis	Yellow sea squirt	Doorschijnende zakpijp
Corystes cassivelaunus [TS]	Helmet crab	Helmkrab
Echinocardium cordatum	Sea-potato	Zeeklit
Neptunea antiqua [TS]	Red whelk	Gewone noordhoren
Ophiothrix fragilis [TS]	Common brittle star	Brokkelster
Psammechinus sp. [TS]	Sea urchins	Zeeappels
Benthos (seine mesh size >= 120 mm)		
Acanthocardia echinata	Prickly cockle	Gedoornde hartschelp
Alcyonium digitatum [TS]	Dead man's fingers	Dodemansduim
Anthozoa	Sea anemones	Zeeanemonen
Arctica islandica [TS]	Ocean quahog	Noordkromp
Buccinum undatum [TS]	Common whelk	Wulk
Colus gracilis	-	Slanke noordhoren
Corystes cassivelaunus [TS]	Helmet crab	Helmkrab
Hyas coarctatus	Contracted crab	Rode spinkrab
Liocarcinus holsatus [TS]	Swimming crab	Gewone zwemkrab
Nephrops norvegicus	Norway lobster	Noorse kreeft
Neptunea antiqua [TS]	Red whelk	Gewone noordhoren
Pagurus bernhardus [TS]	Common hermit crab	Gewone heremietkreeft

Table 3. *By-catch of fly-shoot fisheries in March 2013 in the Channel is given with scientific name, English name, Dutch name, individual haul number (trawl nr) and number of individuals caught per hour (Verschueren, 2015).* [TS] *H1110 Dogger Bank typical species.* # ind/hr= number of individuals caught per hour. *IUCN – status "vulnerable" or more threatened in indicated in red.*

Scientific name	English name	Dutch name	*Trawl nr*	# ind/hr
Ophiura sp.	Brittle star	Slangster	4 to 5	1,11
Pagurus bernhardus [TS]	Common hermit crab	Gewone heremietkreeft	4 to 5	1,40
Aequipecten opercularis	Queen scallop	Wijde mantel	4 to 5	1,40
Aequipecten opercularis	Queen scallop	Wijde mantel	6 to 12	0,85
Alcyonium digitatum [TS]	Dead man's fingers	Dodemansduim	6 to 12	0,95
Anseropoda placenta	Goose foot starfish	Ganzenvoetje	6 to 12	0,17
Asterias rubens [TS]	Common starfish	Gewone zeester	6 to 12	3,67
Buccinum undatum [TS]	Common whelk	Wulk	6 to 12	0,21
Echinus sp.	Sea urchin	Zee-egels	6 to 12	4,57
Enchelyopus cimbrius	Four-bearded rockling	Vierdradige meun	6 to 12	0,20
Pagurus bernhardus [TS]	Common hermit crab	Gewone heremietkreeft	6 to 12	5,78
Squalus acanthias [TS]	Spiny dogfish	Doornhaai	6 to 12	3,43
Asterias rubens [TS]	Common starfish	Gewone zeester	13 to 20	0,76

Table 4. *Vulnerable (VU), near-threatened (NT), endangered (EN) and critically endangered (CR) fish species caught by demersal seine fisheries in the Kattegat (2015-2016) in comparison with bottom trawling for Norway lobster in the same area (Noack et al. 2016a). Scientific name, English name, Dutch name, fishing method and IUCN threat category are given.* [TS] *H1110 Dogger Bank typical species.*

			# hauls		
Scientific name	**English name**	**Dutch name**	***Seine***	***Trawl***	IUCN
Amblyraja radiata	Starry ray	Sterrog	113	177	VU
Chimaera monstrosa	Rabbitfish	Gewone draakvis	37	38	NT
Gadus morhua [TS]	Atlantic cod	Kabeljauw	259	438	VU
Dipturus batis	Common skate	Vleet	2	5	CR
Hippoglossus hippoglossus	Atlantic halibut	Heilbot	29	60	EN
Raja clavata [TS]	Thornback ray	Stekelrog	1	6	NT
Squalus acanthias	Spiny dogfish	Doornhaai	24	74	VU

van der Reijden et al., (2014), Verkempynck & van der Reijden (2015)
The observations, which were carried out on board fly-shoot fishing ships in 2013 in the North Sea, show that fly shoot fishery caught 19 of the H1110 Dogger Bank typical species (Table 5). These include one anthozoan species (*Alcyonium digitatum*), three crustaceans (*Corystes cassivelaunus, Pagurus bernhardus, Liocarcinus holsatus*), four species of echinoderm (*Asterias rubens*, *Ophiotrix fragilis, Ophiura ophiura, Psammechinus miliaris*), four species of mollusc (*Acanthocardia echinata, Arctica islandica, Buccinum undatum, Neptunea antiqua*) and seven species of fish (*Eutrigla gurnardus, Gadus morhua, Limanda limanda, Merlangius merlangus, Microstomus kitt, Pleuronectes platessa, Raja clavata*). These species are either target species (six fish species, excluding *R. clavata*) or by-catch (all other species). It should be noted that the by-catch of species with seine nets smaller than 100 mm mesh size was not sampled or was confidential. At least five species that were caught are long-lived (data from MARLIN website): *Alcyonium digitatum* (10-28 years)*, Arctica islandica (100+ years), Pagurus bernhardus* (6-10 years)*, Buccinum undatum* (11-20 years)*, Neptunea antiqua* (21-100 years)*.*

Verschueren (2015)
Observations on board of a fly-shoot fishing vessel in March 2013 in the Channel show that three H1110 Dogger Bank typical species (Table 3), were caught as by-catch, including *Alcyonium digitatum* and *Buccinum undatum*, which are sensitive for bottom disturbance (Wijnhoven *et al.* 2013) and fly-shoot fishery (Rijnsdorp *et al*. 2015). It should be noted that smaller species were apparently not sampled.

Noack et al. (2016a)
The catching data for Danish seining in this study were derived from the Danish Observer Program 1997 – 2012 in the Skagerak and compared with bottom trawling. No data are available on the by-catch of benthic species. The results show that Danish seining vessels caught 46 fish species, compared to 78 species caught by bottom trawling. Seven species caught by Danish seines are classified as “vulnerable” or higher threatened IUCN conservation status (Table 4), compared to 9 threatened species caught by bottom trawling. *Gadus morhua* (“Vulnerable”) and three species of ray are caught ranging from “Vulnerable” (*Amblyraja radiata*) to “Critically Endangered” (*Dipturus batis*) and one shark species “Vulnerable”, *Squalus acanthias*.

Sharks and rays
In addition to the sharks and rays caught by Danish seining in the Skagerak, fly-shoot fisheries also caught rays in the North Sea: *Amblyraja radiata, Leucoraja naevus and Raja clavata* (Table 2), and a shark species in the Channel (Table 3, *Squalus acanthias*). These data suggest that sharks and rays are at risk of being caught by demersal seining in all studied regions.

Conclusion
In Table 5 (below) the results of the three observational studies are summarized and include all target fish species (TF) of demersal seining in general and by-catch

species (BCF) of fly-shoot fishery. A substantial number (19) of the species caught by demersal seining are H1110 typical species (TS). In addition, seven species of fish have a “Vulnerable” or more threatened IUCN conservation status. Atlantic cod and Thornback ray are both H1110 Dogger Bank typical species and have a “Vulnerable” and “Near-threatened” conservation status.

3.2.3 Predictions and simulations

Only one impact assessment is available, more specifically an impact assessment of demersal seining with respect to benthic ecosystems in the Dutch Natura 2000 areas in the North Sea (Rijnsdorp *et al.* 2015) based on gear design and dimensions (Eigaard *et al.* 2016; Rijnsdorp *et al.* 2016). The potential impact on benthic species of the Dogger Bank was also evaluated in Rijnsdorp *et al*. (2015). The latter study used the lists of benthic species on the Dogger Bank from van Moorsel (2011) and Wijnhoven *et al.* (2013). The research question of the study of Rijnsdorp *et al.* (2015) was: “What is the effect of the fly-shoot fishery on sea bed habitats and benthic ecoystems in the Natura 2000 and MSFD areas on the Dutch continental shelf?”

However, the lists of H1110 Dogger Bank typical species as published in the Profile Document (EZ, 2014), Standard Data Form (BfN, 2010) and assessment report (Diesing *et al.* 2009; Table 1) were not used. Only 13 species of the H1110 list (out of 50) were included in the impact assessment. In addition, the question of whether the fly-shoot fishery has a significant negative impact on the conservation goals of the Natura 2000 area Dogger Bank was not addressed here. The impact of the fly-shoot fishery is compared only to the impact of bottom trawling. Although the impact assessment of Rijnsdorp *et al.* (2015) provides a valuable source of knowledge for the general theme of impact by fly-shoot fishery, the study is of limited value to the specific objective for this study: “To evaluate the impact of demersal seine fishery on the Dogger Bank Natura 2000 conservation objectives”.

Eigaard *et al.* (2016) compared the physical impact or total gear footprint[4] of all types of bottom contact fishing gears and methods in the North Sea (Figure 2, below), including Danish and fly-shoot fishery (the term Scottish seining was used in this publication), Figure 1). They concluded that (1) the subsurface and surface impact of fly-shoot fishery was similar to several types of otter trawling and (2) that the total surface and subsurface footprint of fly-shoot fishery is larger than four types of otter trawling[5] and Danish seining. The total footprint, caused mainly by the contact zone of the ropes which is much wider than the seine itself (Figure 1) of fly-shoot fishery is in fact the largest of all bottom contact gear (Figure 2), but constitutes mainly surface contact.

[4] The demersal seining footprint is defined as the total area swept by the seine ropes and groundgear during a fishing operation in km^2/hour (Eigaard *et al.*, 2016).
[5] The BENTHIS métiers OT-SPF (e.g, sandeel), OT-MIX (mixed species), OT-DMF (demersal species) and OT-MIX-DMF-BEN (mixed demersal and benthic species)

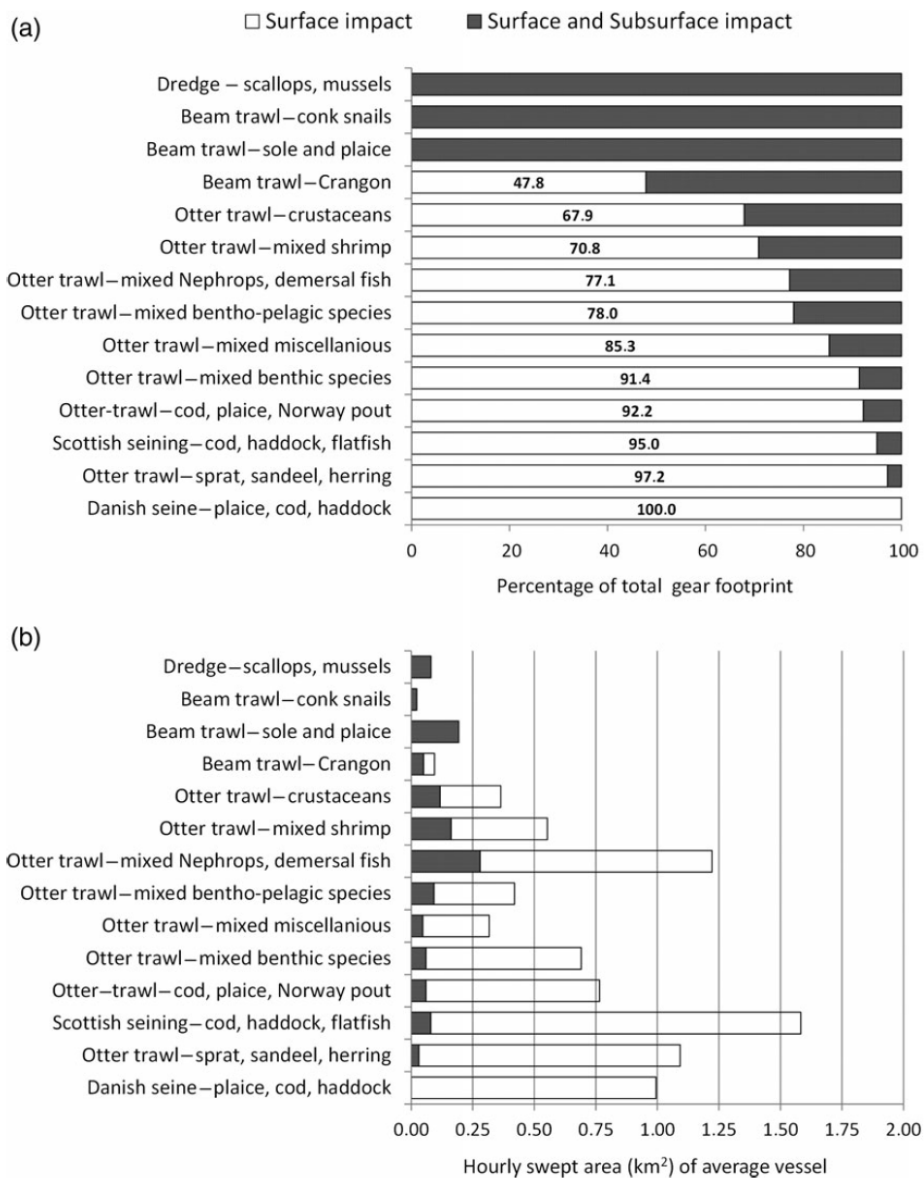

Figure 2. *Proportion of total gear footprint (the total area swept by the demersal seine ropes and ground gear during a fishing operation in km^2/hour) (a) and the area (km^2) of seabed swept in 1 hour of fishing with an average-sized vessel (b) with impact at the surface level and at both the surface and the subsurface level for the 14 BENTHIS métiers (from Eigaard et al. 2016).*

Wijnhoven *et al.* (2013) proposed a set of Marine Strategy Framework Directive benthic indicator species for the Dutch part of the North Sea. For each of the potential indicator species the sensitivity for bottom disturbance was evaluated based on literature data, including 20 of the typical species for the Dutch Dogger Bank Natura 2000 site (Table 1). Five species are by-catch of demersal seining (Tables 3-5). Nine additional H1110 Dogger Bank typical species are considered sensitive to bottom disturbance according to the criteria of Wijnhoven *et al.* (2013): *Alcyonidium diaphanum, Lanice conchilega, Astropecten irregularis, Angulus fabula, Aporrhais pespelecani, Ensis ensis, Euspira pulchella, Gari fervensis, Mactra stultorum*. There is no evidence that suggests the specific disturbance caused by demersal seine fisheries will not impact these sensitive species and it is very likely that seining will impact these species negatively.

No evidence is available yet to establish a lack of impact by demersal seines on these sensitive species. Rijnsdorp *et al.* (2015) concluded that only three benthic species, including two H1110 Dogger Bank typical species, are vulnerable to fly-shoot fisheries, according to the physical impact of gear design and dimensions (the anthozoan *Alcyonium digitatum* and the mollusc *Buccinum undatum*).

Neptunea antiqua is similar in size (or larger) and life–history (long-lived) to *Buccinum undatum* and can also be indicated as sensitive to bottom disturbance. This is confirmed by Verkempynck & van der Reijden (2015), which observed this species as by-catch of the fly-shoot fishery in the North Sea (Table 2). *Neptunea antiqua* can be added to list of typical species, which are sensitive to bottom disturbance, and brings the total to 15 species (Table 1). This species is declining in the North Sea, which has been attributed to demersal trawling (de Bruyne *et al.* 2013). Smaller by-catch species were not included in at least one of the observation studies (Verkempynck & van der Reijden, 2015).

The scale of the impact on benthic species predicted by Eigaard *et al.* (2016) is confirmed by the by-catch of benthic species as observed by Verkempynck & van der Reijden (2015; Table 2) and Verschueren (2015; Table 3).

These three observational studies in combination with the predictive studies suggest that a substantial number of typical species, which are sensitive to bottom disturbance in general, may be at risk from a negative impact of demersal seining.

3.3 Other sensitive habitats and species

For the Dogger Bank area, the benthic community is characterised by a larger proportion of long-lived and suspension feeding species both in recent and historic times. Among these groups, species occur that are estimated as being sensitive to the passage of demersal seining gear, which have not been not listed as H1110 typical species (Table 6). These include bryozoans (e.g. *Flustra foliacea*), sponges and bioengineers. In former times, horse mussels *Modiolus modiolus* formed reefs in the northern part and flat oysters (*Ostrea edulis)* in the southern part of the Dogger Bank (van Moorsel, 2013). Abiotic and biotic reefs also function as important spawning areas for elasmobranchs (sharks and rays) and other fish species.

Table 6. List of species (other than H1110 Dogger Bank typical species) and habitat functions in Dogger Bank area estimated to be sensitive to demersal seining (Source: van Moorsel, 2013; Rijnsdorp et al. 2015; Wijnhoven et al. 2013).

	Species and habitats sensitive to demersal seining gear
Bioengineers	*Modiolus modiolus* (horse mussel/ paardenmossel) (recruits)*
	Bryozoa, e.g. *Flustra foliacea* (greater horn wrack/ bladachtig hoornwier)*
	Ostrea edulis (Flat oyster/ platte oester)*
Epibenthos	*Alcyonidium digitatum* (dead men's finger/ dodemansduim)*[C]
	Buccinum undatum (whelk/ wulk) (egg capsules)[C]
	Alcyonidium diaphanum (sechervil/ bruine zeevinger)[C]
Spawning habitat	Elasmobranchs* (sharks and rays/ haaien en roggen)

* In former times abundant (Olsen, 1883)

[C] Characteristic to the area, according to Wijnhoven *et al.* (2013)

3.4 Significant effects and conservation objectives

The results of the three observational studies (Table 5) show that a substantial number (19) of the species caught by demersal seining are H1110 typical species (TS). In addition, seven species of fish have a "Vulnerable" or more threatened IUCN conservation status. Atlantic cod and Thornback ray are both H1110 Dogger Bank typical species and have a "Vulnerable" and "Near-threatened" conservation status. These totals (19 typical species and 7 species with general conservation relevance) can be considered as a conservative estimate, because the scale of the observations in these studies was rather limited. Five of the larger, sensitive benthic species are reported as by-catch of demersal seining.

Table 5. Overall list of species caught by demersal seining including H1110 Dogger Bank typical species (TS), target species of demersal seining (TF), by-catch of demersal seining (BCF), with scientific name, English name, Dutch name and species group. Threatened species are indicated in red (see text and Table 4).

TS	TF	BCF	Scientific name	English name	Dutch name	species group
1		1	*Alcyonium digitatum*	Dead man's fingers	Dodemansduim	anthozoan
		1	*Anthozoa*	Sea anemones	Zeeanemonen	anthozoan
		1	*Cancer pagurus*	Edible crab	Noordzeekrab	crustacean
1		1	*Corystes cassivelaunus*	Helmeted Crab	Helmkrab	crustacean
		1	*Hyas coarctatus*	Contracted crab	Rode spinkrab	crustacean
1		1	*Liocarcinus holsatus*	Swimming crab	Gewone zwemkrab	crustacean
		1	*Nephrops norvegicus*	Norway lobster	Noorse kreeft	crustacean
1		1	*Pagurus bernhardus*	Common hermit crab	Gewone heremietkreeft	crustacean
		1	*Anseropoda placenta*	Goose foot starfish	Ganzenvoetje	echinoderm
1		1	*Asterias rubens*	Common starfish	Gewone zeester	echinoderm
		1	*Echinocardium cordatum*	Sea-potato	Zeeklit	echinoderm
		1	*Echinus sp.*	Sea urchin	Zee-egels	echinoderm
1		1	*Ophiothrix fragilis*	Common brittle star	Brokkelster	echinoderm
1		1	*Ophiura ophiura*	serpent start	gewone slangster	echinoderm
1		1	*Psammechinus sp.*	Sea urchins	Zeeappels	echinoderm
		1	*Amblyraja radiata*	Starry ray	Sterrog	fish
	1		*Chelidonichthys lucerna*	Tub gurnard	Rode poon	fish
		1	*Chimaera monstrosa*	Rabbitfish	Gewone draakvis	fish
		1	*Clupea harengus*	Herring	Haring	fish
		1	*Dipturus batis*	*Common skate*	Vleet	fish
		1	*Enchelyopus cimbrius*	Four-bearded rockling	Vierdradige meun	fish
1	1		*Eutrigla gurnardus*	Grey gurnard	Grauwe poon	fish
1	1		*Gadus morhua*	Atlantic cod	Kabeljauw	fish
		1	*Glyptocephalus cynoglossus*	Witch flounder	Witje	fish
		1	*Hippoglossoides platessoides*	Sand dab	Lange schar	fish
		1	*Hippoglossus hippoglossus*	Atlantic halibut	Heilbot	fish
		1	*Leucoraja naevus*	Cuckoo ray	Koekoeksrog	fish
1	1		*Limanda limanda*	Dab	Schar	fish
	1		*Melanogrammus aeglefinus*	Haddock	Schelvis	fish
1	1		*Merlangius merlangus*	Whiting	Wijting	fish
		1	*Merluccius merluccius*	Hake	Heek	fish
1	1		*Microstomus kitt*	Lemon sole	Tongschar	fish
1	1		*Pleuronectes platessa*	Plaice	Schol	fish
	1		*Pollachius virens*	Sillock	Zwarte koolvis	fish
1		1	*Raja clavata*	Thornback ray	Stekelrog	fish
		1	*Squalus acanthias*	Spiny dogfish	Doornhaai	fish
	1		*Trachurus trachurus*	Scad	Horsmakreel	fish
1		1	*Acanthocardia echinata*	Prickly cockle	Gedoornde hartschelp	mollusc
		1	*Aequipecten opercularis*	Queen scallop	Wijde mantel	mollusc
		1	*Alloteuthis subulata*	European common squid	Dwergpijlinktvis	mollusc
1		1	*Arctica islandica*	Ocean quahog	Noordkromp	mollusc
1		1	*Buccinum undatum*	Common whelk	Wulk	mollusc
		1	*Colus gracilis*	-	Slanke noordhoren	mollusc
1		1	*Neptunea antiqua*	Red whelk	Gewone noordhoren	mollusc
		1	*Ciona intestinalis*	Yellow sea squirt	Doorschijnende zakpijp	sea squirt
19	10	35	total # of species			

Considering the footprint and subsurface impact of fly-shoot fisheries as predicted by Eigaard *et al.* (2016), it is possible that the nine other species listed as "sensitive to bottom disturbance" in Table 1 (based on the analysis of Wijnhoven *et al.*, 2013) and not observed as by-catch in the three observational studies are also sensitive to fly-shoot fishery (section 3.2.3). Six of the nine fish H1110 Dogger Bank typical species are reported as target species and the three other species are also likely to be caught by demersal seining. This limited dataset suggests that a demersal seining regularly catches a substantial number (up to 28) of the H1110 Dogger Bank typical species, which constitutes a substantial proportion of the typical species.

Several of these species are also long-lived (see above and Wijnhoven *et al.* 2013) and are declining (e.g. *Neptunea antiqua, Raja clavata*). Although there is a lack of controlled field experiments to prove that the negative impact of demersal seining on the H1110 Dogger Bank typical species is significant, the close agreement of the limited set of observations and the predictions of the assessment of Eigaard *et al.* (2016) with respect to the impact is at least suggestive for a negative effect of demersal seining on the conservation objectives of the Dogger Bank. Therefore, based on the information available to date, a significant negative effect of demersal seining on the conservation objectives of the Dogger Bank cannot be objectively ruled-out with certainty.

The results of the observational studies imply that the realisation of the conservation objectives of the Natura 2000 site Dogger Bank (improving quality or restoring to a favourable conservation status by "*increase of long-lived species*") can be considered uncertain and is possibly unlikely if demersal seining is allowed in the proposed areas closed for trawling in the Dutch part of the Dogger Bank.

3.5 Research questions

Use of scientific information

1. *Is there sufficient scientific literature available to support the conclusion that the favourable conservation status of the Natura 2000 sites is ensured in the event of a management regime, which allows demersal seine fisheries in the management zones?*

The answer is negative. Based on the available knowledge, it can be concluded that if demersal seine fisheries are allowed in the management zones the Dogger Bank, the risk that typical H1110 species will be negatively impacted by demersal seining and that the unfavourable conservation status will not be improved cannot be ruled out. Although no results of experimental studies of the ecological impact of demersal seine fisheries have been published, the field observations demonstrate and physical impact predictions suggest that several species listed as typical species for H1110 Dogger

Bank will be negatively impacted by demersal seining. 19 typical species are either target species (7) or by-catch (12) of fly-shoot fisheries, including at least five sensitive and long-lived species. A substantial number of the H1110 Dogger Bank typical species have been observed in demersal seining catch in observational studies and are therefore at risk.

2. *From the literature review has the Dogger Bank Background Document (version of 31 May 2016, attachment 2) made selective use of available literature?*

   The Dogger Bank Background Document made only use of the predictive study of Eigaard *et al*. (2016), which results from the BENTHIS project[6], when discussing seining impacts. The Dogger Bank Background Document did not made use of the desk study of Rijnsdorp *et al.* (2015). This report implemented the predictive study of Eigaard *et al.* to a selection of species, which occur in the Dogger Bank, based on Wijnhoven *et al.* (2013).

3. *Was recent literature concerning the effects of demersal seines on sandbanks, habitat type H1110, left out of the Dogger Bank Background Document?*

   The estimates of sensitivity for bottom disturbance of relevant benthic species by Wijnhoven *et al.* (2013) have not been included in the Background Document. The scientific observations by Verkempynck & van der Reijden (2015), Verschueren (2015 and Noack *et al.* (2016) on target species and by-catch of demersal seining have also not been used in the Background Document. In addition, the Dogger Bank Background Document does not use the full list of typical species for H1110 Dogger Bank as listed by The Netherlands (EZ, 2014) and in the Natura 2000 Standard Data Forms of the UK (Joint Nature Conservation Committee, 2016) and Germany (Bundesamt für Naturschutz, 2010), which form the base line for the conservation objectives of the habitat type H1110 in the Natura 2000 areas on the Dogger Bank.

4. *Were conclusions of research, which have been used in the Dogger Bank Background Document and including the desk study of Rijnsdorp (2015), correctly reproduced?*

   The desk study of Rijnsdorp *et al.* (2015) was not cited in the Dogger Bank Background Document. Only the report of Rijnsdorp (2015) dealing with the impact of fly-shoot fisheries in the Central Oyster Grounds and Frisian Front was cited, but not discussed in the text. Although both studies are a valuable source for the theme in general, they have less relevance for the specific impact of fly-shoot fisheries in particular and demersal seining in general, because only a few species were considered instead of the complete list of H1110 typical species of the Dogger Bank Natura 2000 areas. Eigaard *et al.* (2016) concluded that fly-shoot fishery has a similar

[6] EU project "Benthic Ecosystem Fisheries Impact Study"

impact compared to several types of otter trawling (see also Figure 2), while the Dogger Bank Background Document concluded, that: “The impacts of Scottish seines [or fly-shoot fishery] can be characterized as something between bottom trawling and Danish seining”. This interpretation is different from the data presented in Eigaard *et al.* (2016).

Assessment of effects

5. *Is a management regime, which allows demersal seine fisheries in the management zones of the Natura 2000 sites on the Dogger Bank, scientifically justified on the basis of pressures in the occurrences of habitat type H1110 and hence does it meet the conservation objectives of the habitat? (See also the guidance letter of the European Commission of 7 July 2012, EC, 2012 as referred to in Dogger Bank Background Document, p. 8.)*
   The Dogger Bank Background Document reported on the position of Germany: “Taking into account the above mentioned scientific results [Eigaard *et al.*, 2016] Germany regards it as very likely that the favourable conservation status of habitat 1110 and its typical species in the Natura 2000-site of the Dogger Bank cannot be achieved with on-going fishing activities with demersal seines.” “According to current assessments, particularly benthic epifauna,[....], would be negatively affected by the different types of demersal seines.”

   The proposed management regime, which in its current form allows for demersal seining, is not scientifically justified, because the full list of H1110 Dogger Bank typical species, which form the baseline of the conservation objectives of habitat type H1110 in the Natura 2000 sites on the Dogger Bank, has not been used in the Dogger Bank Background Document and the studies cited therein. This implies that the conditions stated in the guidance letter of the EC (7 July 2012) “ [.....]*, that each Member State makes its full contribution to meeting the conservation objectives of the area and thus fulfils its share of obligations under the [Habitat] Directive.*” and “*... and hence whether they meet the conservation objectives*” are not met in full.

Cumulative effects

6. *Do impact assessments that support the draft proposal for the Dogger Bank, include an assessment of the cumulative effects before they are applied to characteristics, the specific environmental conditions and conservation objectives of the sites?*

   No cumulative effects have been assessed.

7. *Have other plans and activities been included in an assessment of cumulative effects?*

No other plans and activities have been included in the assessment of cumulative effects.

8. *Have 'external' activities taking place outside the borders of the Natura 2000 sites on the Dogger Bank, sufficiently been taken into account in the assessment of the effects inside the sites?*

   No impact assessment has been made with respect to activities taking place outside the borders of the Natura 2000 areas on the Dogger Bank.

   Assessment of cumulative effects is usually focused on other activities than fishing (e.g. pollution, sand extraction, climate change and wind farm development). However, bottom contact fishing methods have substantial cumulative effects on marine ecosystems, which are rarely included in fishery science and management plans (Thrush *et al.* 2016).

   Predation patterns on benthic species will change if the larger individuals and species (*e.g*. apex predators) in a fish assemblage are to be removed and instead species favoured for which the predation rate was decreased. On the other hand, if the benthic ecosystem is an important spawning, recruitment or safe growth area for young fish, then any structural damage will indirectly impact the fish species depending on these habitats. Larger and long-lived species, which suffer from high fishing-related mortality, and of which simultaneously the reproduction habitats are negatively impacted by bottom-contact fishing gears, will be in particularly at risk. This double-impacted species group includes most species of elasmobranchs (see also Table 6, below). Several species were once common on the Dogger Bank (e.g. van Moorsel, 2011) and are now so rare that they were not included in the list of H1110 Dogger Bank typical species (except for *Raja clavata*) and monitoring is not feasible any more. A consequence of leaving out these rare species as a typical H1110 species is that the Dogger Bank Management Plan does not assess the impact of the management regime on the recovery potential for these rare species. The lack of recovery of several Atlantic cod populations suggests that commercial species may also suffer from these cumulative fishing effects (Thrush *et al.* 2016).

4 Conclusions

- The conservation objectives of habitat H1110 in the Natura 2000 areas on the Dogger Bank are described as: "*conservation of surface area and improvement of the quality of the sandbanks*" (NL); "*restore the habitat to favourable condition*" (UK) and "*restoration of a favourable conservation status of the habitat type (1110) including its typical and threatened communities and species* (GER; BfN, 2010). The specific characteristics of sand banks (habitat type H1110), including its quality, are defined as including the "*presence of long-lived benthic species*" (NL and GER; UK by implication).

- Over 50 Typical species are listed as indicator species for the conservation objectives of the international H1110 Dogger Bank Natura 2000 site, including species of anthozoa (soft coral), bryzoa, annelid worms, crustaceans, echinoderms, fish and molluscs.

- A literature review was carried out aimed at scientific information based on field experiments, field observations and predictive studies of the impact of demersal seine fisheries on the H1110 Dogger Bank typical species.

- No results of scientific field experiments of the impact of demersal seines, including fly-shoot fishery, on the H1110 Dogger Bank typical species of the Dogger Bank Natura 2000 area were found in the peer-reviewed scientific literature.

- Three field observation studies are available, which measured the catching rate of commercial (target) fish species and sampled by-catch (fish and benthos) of demersal seines in the North Sea (fly-shoot, Verkempynck & van der Reijden 2015); Channel (fly-shoot, Verschueren 2015) and Kattegat (Danish seines, Noack *et al.* 2016).

- Demersal seining fisheries caught a substantial number (19) of the H1110 Dogger Bank typical species. These include several long-lived benthic species (*Alcyonium digitatum, Arctica islandica, Buccinum undatum* and *Neptunea antiqua*).

- Demersal seines caught seven species of rays (6) and shark (1) including vulnerable, near-threatened, endangered and critically endangered species. These data suggest that sharks and rays are at risk of being caught by demersal seining in all studied regions.

- 14 of the H1110 typical species are sensitive for bottom disturbance according to the criteria of Wijnhoven *et al.* (2013). Five of these species are by-catch of demersal seining (Tables 3-5). Nine additional H1110 Dogger Bank typical species are considered sensitive to bottom disturbance according to the criteria of Wijnhoven *et al.* (2013): *Alcyonidium diaphanum, Lanice conchilega, Astropecten*

irregularis, Angulus fabula, Aporrhais pespelecani, Ensis ensis, Euspira pulchella, Gari fervensis, Mactra stultorum. There is no evidence that proves that this is different from the specific disturbance caused by demersal seine fisheries. *Neptunea antiqua* is similar in size (or larger) and life – history (long-lived) to *Buccinum undatum* and can also be indicated as sensitive to bottom disturbance (expert judgement by the authors of this report). This species is declining in the North Sea, which has been attributed to demersal trawling (de Bruyn *et al.,* 2013). Based on the field observations, for these 15 benthic species it cannot be concluded with certainty that they are not negatively impacted by demersal seining. This total of 15 is larger than the conclusion of Rijnsdorp *et al.* (2015) that only three benthic species (including two typical benthic species of H1110) are vulnerable for the physical impact of fly-shoot fishery.

- Eigaard *et al.* (2016) concluded that (1) the proportion of subsurface and surface impact relative to surface impact of fly-shoot fishery was similar to several types of otter trawling and that (2) the surface and subsurface footprint of fly-shoot fishery is larger than four types of otter trawling and Danish seining. The total surface footprint of fly-shoot fishery is in fact the largest of all bottom contact gear, because of the length of the ropes. The scale of this impact on benthic species is confirmed by the observations of by-catch of benthic species by fly-shoot fisheries.

- The proposed management regime, which in its current form allows for demersal seining is not scientifically justified, because the full list of H1110 Dogger Bank typical species, which form the baseline of the conservation objectives of the Natura 2000 site Dogger Bank, has not been used in previous analyses. This implies that the conditions, which are stated in the guidance letter of the EC (7 July 2012) (cited in the Background Document Dogger Bank, section 3.3.3), are not met in full.

- Although there are no controlled field experiments available that show a significant negative impact of demersal seining on the H1110 Dogger Bank typical species, the close agreement of the limited set of field observations (Noack et al. 2016, Verkempynck & van der Reijden, 2015, Verschueren 2015) and the predictions of the assessment of Eigaard *et al.* (2016) with respect to the physical impact is at least suggestive for a negative effect of demersal seining on the conservation objectives of the Dogger Bank.

- These observational and predictive studies suggest that the total number of typical H1110 species sensitive to demersal seining is substantial (at least 19 and possibly 28, including both benthic species and fish). Therefore, based on the information available to date, a significant adverse effect of demersal seining on the conservation objectives of the Dogger Bank cannot be objectively ruled-out with certainty.

- This implies that the realisation of the conservation objectives of the international Natura 2000 site Dogger Bank (by implication "*increase of long-lived species*") is considered at least uncertain and possibly unlikely if demersal seining is allowed in the proposed areas closed for trawling in the Dogger Bank.

6 Literature

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