Assessment of the impact of gillnet fishery on conservation objectives of seabirds in the Brown Ridge

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Summary

The Brown Ridge is a candidate MPA under the Bird Directive. This means that everything must be done to achieve the conservation objectives of two bird species seasonally present in the area (common guillemot *Uria aalge* and razorbill *Alca torda*). Gillnet fishing is a potential cause of mortality of these two diving bird species because they can get entangled in the nets underwater while foraging. The current study investigated the importance of three gillnet fisheries in the area and its overlap with the habitat of the two bird species.

Gillnet fishery maps are made to depict the distribution of the (Dutch) gillnet fishing intensity for mullets and sea bass, sole and cod, from 2012 to 2014. This was derived from data on VMS, logbook, assumed net lengths and fishing duration rules. IMARES requested fishery data from Belgian, Danish, German and UK fishery institutes in order to assess the foreign gillnet fishery effort in the Brown Ridge area. Belgian gillnet fishery did not occur in the Brown Ridge and the UK did not supply data. Data sets were received for German fishery and for Danish fishery. The German and Danish gillnet fishery in the area is limited to large vessels applying VMS and targeted on sole. The German and Danish gillnet fishing intensity combined is in the same order of magnitude as the Dutch fishing intensity.

It appears that the fishing activity of gillnetters (both Dutch and foreign) is fairly limited in the Brown Ridge. Less than 1% of the overall effort of both the Dutch and the foreign fleets is carried out in the area resulting in total number of fishing days of around 50 for all gillnet fleets combined. Although the value of landings in the Brown Ridge is low relative to the total revenue from Dutch gillnetters, a few vessels are dependent on the area with up to 30% of their revenue coming from the Brown Ridge.

The impact assessment of gillnet fishery for common guillemot and razorbill is hampered by the lack of registration data for bycatch of seabirds in gillnets. The fishing impact on the bird populations was evaluated by taking several aspects into account: spatial and temporal overlap between fishery and birds, the risk for a diving bird to be caught in a gillnet and differences among gillnet types.

The spatial overlap is studied for two dimensions: surface area and water column. Both are relevant for the assessment of the potential exposure. There is a high potential spatial overlap between gillnet fishery and sea bird distribution in the Brown Ridge. Predictions about differences among sub areas within the Brown Ridge concerning the extent of overlap cannot be made. However this is not necessary because locations of fishing and birds can vary. The vertical overlap between the nets (on the seafloor) and the diving depth of the razorbill is expected to be low in the Brown Ridge, indicating low risk for bycatch of the razorbill. The common guillemot dives deeper, probably also unto the Brown Ridge seafloor with a potential chance for entanglement in the nets. The chance of seabirds, including guillemots, being caught in gillnets in case of spatial overlap is a major knowledge gap. There is a seasonal overlap between gillnet fishing and the guillemots (especially in January, March, May, October and November) at the Brown Ridge. A risk of gillnet fisheries on the Brown Ridge for bycatch of common guillemots cannot be ruled out, but there is little evidence (pro or contra) for the magnitude of the bycatch problem.

The first recommendation is to measure the actual amount of bycatch in the Brown Ridge area. Other recommendations are to derive the diet of bycaught guillemots and razorbills and to investigate the distribution and density of sandeels in the Brown Ridge area in the winter half year, because sandeels are often a very important prey for these birds. The estimation of the economic value of the gillnet fisheries contains large uncertainties and can be improved by extending VMS to small vessels and including reporting the catch below 50 kg in logbooks.

Nederlandse samenvatting

De Bruine Bank is een kandidaat beschermend marien gebied (MPA, Marine Protected Area) onder de Vogelrichtlijn (Bird Directive). Dit betekent dat alles moet worden gedaan voor het bereiken van de instandhoudingsdoelstellingen van twee vogelsoorten die in een bepaald seizoen aanwezig zijn in het gebied. Deze vogelsoorten zijn zeekoet (*Uria aalge*) en alk (*Alca torda*). Visserij met staandwant (kieuwnetten) is een mogelijke oorzaak van sterfte van deze twee duikende vogelsoorten want deze kunnen tijdens het foerageren onder water verstrikt raken in de netten. De huidige studie onderzoekt het belang van drie soorten staandwantvisserij op de Bruine Bank en de ruimtelijke en temporele overlap met het leefgebied van de twee vogelsoorten.

Verspreidingskaarten van de Nederlandse staandwantvisserij op harder en zeebaars, tong, en kabeljauw van 2012 tot 2014 zijn gemaakt. Dit is gebaseerd op gegevens van VMS, logboeken, aannames over netlengte en visserijduur regels. Visserij-instituten uit België, Denemarken, Duitsland en Verenigd Koninkrijk zijn gevraagd staandwant visserijgegevens voor het gebied in en rond de Bruine Bank ter beschikking te stellen. Belgische staandwantvisserij kwam niet voor op de Bruine Bank. Het Verenigd Koninkrijk stelde geen gegevens ter beschikking. Datasets zijn ontvangen over de Duitse en Deense visserij. De Duitse en Deense staandwantvisserij in het gebied bleek te zijn beperkt tot grote schepen met VMS en gericht op tong. De visserij-inspanning van deze Duitse en Deense visserij is gecombineerd in dezelfde orde van grootte als de Nederlandse staandwantvisserij.

De inspanning van staandwantvisserij (zowel Nederlands als buitenlands) op de Bruine Bank blijkt redelijk beperkt te zijn. Minder dan 1% van de totale inspanning van de Nederlandse en de buitenlandse (Deense en Duitse) vloten wordt uitgeoefend in dit gebied, bestaande uit een totaal aantal visdagen per jaar van ongeveer 50 voor de gecombineerde staandwantvloten. De waarde van de aanlanding van vis afkomstig van de Bruine Bank is relatief klein in vergelijking met de inkomsten van de Nederlandse staandwantvloot. Er zijn echter wel een paar schepen afhankelijk van dit gebied omdat deze maximaal 30% van de inkomsten behalen door visserij op de Bruine Bank.

De effectbeoordeling van de staandwantvisserij op de zeekoet en de alk wordt gehinderd door het ontbreken van registratiegegevens over de bijvangst van zeevogels in staande netten. De effectbeoordeling is uitgevoerd op basis van de volgende aspecten: ruimtelijke en temporele overlap tussen visserij en vogels, de bijvangstkans en verschillen tussen typen staandwant.

De ruimtelijke overlap is bestudeerd voor twee dimensie: zeeoppervlak en waterkolom (diepte). Beide zijn relevant voor de schatting van de potentiele blootstelling. Er is een grote potentiele ruimtelijke overlap te zijn tussen staandwantvisserij en de verspreiding van zeekoeten en alken op de Bruine Bank. Voorspellingen over verschillen tussen sub-gebieden binnen de Bruine Bank betreffende de mate van overlap kunnen niet worden gemaakt. Dit is ook niet zinvol omdat de locaties voor de visserij en de vogels behoorlijk kunnen variëren.

De verticale overlap tussen de netten (op de zeebodem) en de duikdiepte van de alk op de Bruine Bank is naar verwachting klein, wijzend op een klein risico voor bijvangst van de alk. De zeekoet duikt dieper, waarschijnlijk tot aan de bodem van de Bruine Bank met een potentiele kans op verstrikking in de staande netten. De kans op de bijvangst van zeevogels, inclusief zeekoeten, om bij gevangen te worden in staandwant in geval van ruimtelijke overlap is een grote kennisleemte. Er is in de periode oktober tot en met mei en dan vooral in oktober, november, januari, maart, mei een aanzienlijke temporele overlap tussen het voorkomen van staandwantvisserij en zeekoeten op de Bruine Bank. Een risico van staandwantvisserij op de Bruine Bank voor de bijvangst van de zeekoet is niet uit te sluiten, maar er is weinig bewijs (voor of tegen) voor de omvang van het bijvangst risico.

De eerste aanbeveling is de actuele omvang van de bijvangst van zeevogels in het Bruine Bank gebied te meten. Andere aanbevelingen zijn het dieet van bijgevangen zeekoeten en alken te bepalen en de verspreiding en dichtheid van zandspiering in het Bruine bank gebied in het winterhalfjaar te onderzoeken, want zandspiering is vaak een zeer belangrijke prooi van deze vogels. De schatting van de economische waarde van de staandwantvisserij bevat grote onzekerheden en kan worden verbeterd door de uitbreiding van VMS tot de kleine schepen en het rapporteren in logboeken van de vangsten kleiner dan 50 kg.

1 Introduction

The Brown Ridge (in Dutch: Bruine Bank) is a sandbank with patchy peat packets situated in the southern North Sea. The location of this area on the western edge of the Dutch EEZ is indicated in Figure 1. The area of the Brown Ridge is about 1,550 km^2 (ca. 30km x 50km). The area is used as fishing ground by the fishing fleets of The Netherlands and neighbouring countries.

Due to its importance for two bird species: common guillemot (*Uria aalge*) and razorbill (*Alca torda*), the Brown Ridge is a candidate-MPA (Natura 2000 site) under the Birds Directive (EU, 1979, 2009), thus making this a c-SPA (Special Protection Area). This means that human activities in the area should not compromise the achievement of conservation objectives of these two bird species. One human activity potentially harmful to the birds is gillnet fishing overlapping in space and time with the presence of the two species.

The Dutch Ministry of Economic Affairs (EZ) asked scientists of IMARES and LEI i) to investigate the potential effects of gillnet fisheries on common guillemots and razorbills in the area, ii) to undertake an impact assessment (a conflict analysis) and, if necessary, iii) to evaluate the mitigation options available.

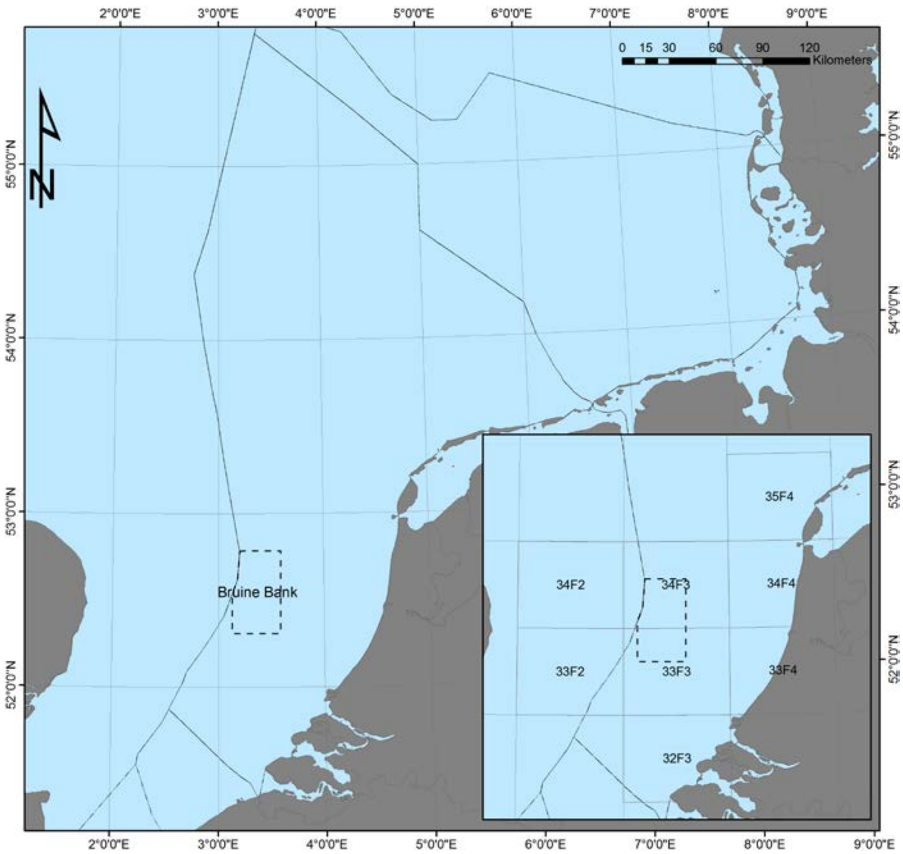


Figure 1 Location of the Brown Ridge (in Dutch: Bruine Bank) in the southern North Sea, inset showing selected ICES rectangles (from par. 2.2).

1.1 Background

The Brown Ridge is a candidate for a new Birds Directive area. Lindeboom *et al.* (2005) suggested that the Brown Ridge would be of special value for gulls and auks. Further studies by IMARES in the period 2008-2014 revealed:
The Brown Ridge qualifies for razorbill and common guillemot (>1% of the population in the North Sea) is regularly found in the area (Leopold & van der Wal, 2015). Because of this, the Brown Ridge will be designated as a Natura 2000 site. Based on the mentioned studies of IMARES, the border of the area was adjusted with respect to the one proposed by Lindeboom *et al.* (2005). This report is focussed on the Natura 2000-site Brown Ridge. This is the bordered area shown in Figure 1 and will be indicated in this report as “Brown Ridge”. Note that this area is substantially broader than the actual “Brown Ridge”, as indicated on nautical charts. Besides also “Brown Ridge area” is used in this report. This is the bordered area plus a surrounding area.

<u>Assignment</u>
The common guillemot and the razorbill are diving birds that can become entangled in gillnets. This may compromise the conservation objectives of the two species in the Brown Ridge.
The gillnet fishery in the Brown Ridge may threaten this target because studies in other areas have shown that diving birds can get caught in large numbers in gillnets (ICES, 2013; Žydelis *et al.*, 2009, 2013). Multiple factors influence the interactions between the gillnet fishery and the diving birds. Depending on the fishing location, the season, the intensity and type of gillnets on the one hand, and the density of birds, the impacts of the fishery on the bird populations on the other, will vary.

The present study aims at determining the extent of the gillnet fishery on the Brown Ridge and its surroundings and analysing its potential effects on razorbills and guillemots. The current economic value of the Dutch and foreign gillnet fisheries in the Brown Ridge is also estimated. If on the basis of the analysis, negative effects of the gillnet fishery on the bird species are demonstrated, mitigation measures are investigated as well as their economic consequences.

<u>Disclaimer</u>
While we have data on some of the factors determining the lethal interactions between the gillnet fishery and common guillemots and razorbills (e.g. fishing intensity by the Dutch fleets), part of the information needed for the analysis is still unknown. When data is unavailable, we rely on expert opinion.

Bycatch of seabirds in gillnets was also studied in the project Fisheries Measures in Protected Areas (FIMPAS) (ICES, 2010, 2011). This project aimed to introduce fisheries measures in the marine Natura 2000 sites within the Exclusive Economic Zone of the Dutch part of the North Sea by the end of 2011. The Frisian Front was one of the sites and is to be designated as a SPA under the Birds Directive. The FIMPAS project comprised an international process involving all relevant stakeholders and an agreement was reached with respect to mitigation measures for the impact of gillnet fishery on common guillemots in the Frisian Front:

- a ban on gillnetting in the Frisian Front from 1st June to 30th of November. This measure was considered to be sufficient to contribute to the achievement of the conservation objectives.
- a monitoring programme for seabird numbers and seabird bycatch will be needed in a 6 years assessment
- a VMS (Vessel Monitoring System) obligation for all vessels is required.

It should be noted that, next to the site specific ecological characteristics, there is a difference between Frisian Front and Brown Ridge in the timing of the presence of guillemots and razorbills.

2 Intensity of the gillnet fishery

In this chapter information on the geographical distribution and the intensity of the Dutch and foreign gillnet fisheries in the Brown Ridge area is presented. The method of collection and analysis of the data is described as well.

2.1 Categories for gillnet fishery

In the Dutch part of the North Sea three commercial gillnet fisheries are found. Table 1 provides an overview of the characteristics of these gillnet categories.

Table 1 Characteristics of the gillnet categories.

Cat.	Target species	Net type	Net code	Mesh width (mm stretched)	Max. net height (m)	Net length (m)
a	Mullets and Sea bass	Set gillnets (anchored)	GNS	90 - 130	2.0	50 - 2500
b	Sole	Set gillnets (anchored)	GNS	90 - 110	1.0	10000 - 25000
c	Cod	Trammel nets	GTR	> 130	2.5	50 - 5000

2.2 Data for the gillnet fishery

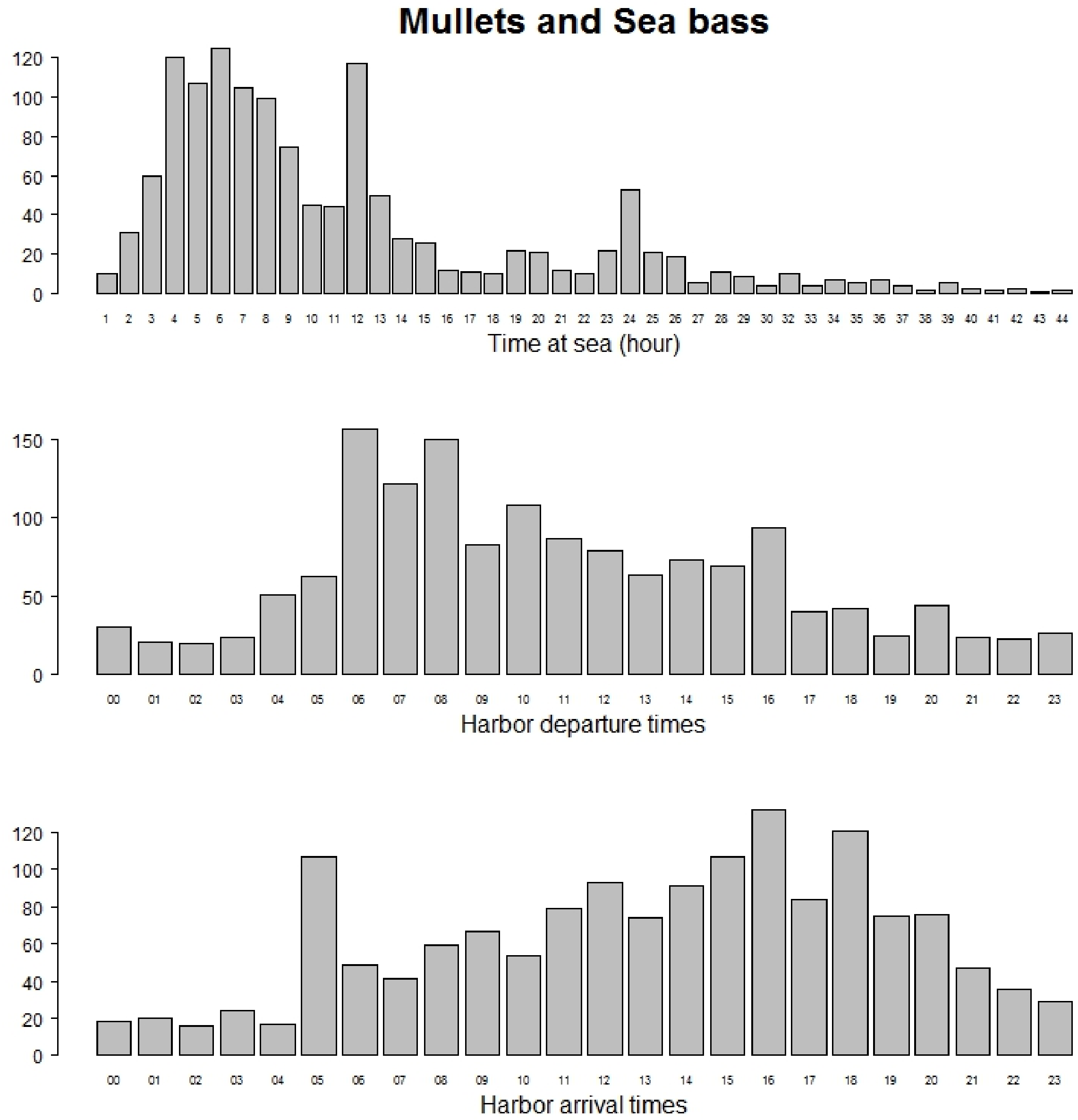
Since the 1st of January 2005 all fishing vessels longer than 15 meters are equipped with VMS (Vessel Monitoring System), while VMS was introduced on-board of vessels larger than 12 meters since the 1st of January 2012. A VMS transponder sends approximately every 2 hours a signal to a satellite providing information on the vessel's ID, position, time & date, direction and speed. Hence, VMS is a useful data source to study the distribution of the fishing fleet both in time and space. The Dutch ministry of Economic Affairs is tasked with the collection of VMS data of all (sizable) Dutch fishing vessels. VMS data of foreign vessels, even inside the EEZ, are made irregularly available for scientific purposes. All VMS positions are collected in the WGS84 coordinate reference system.

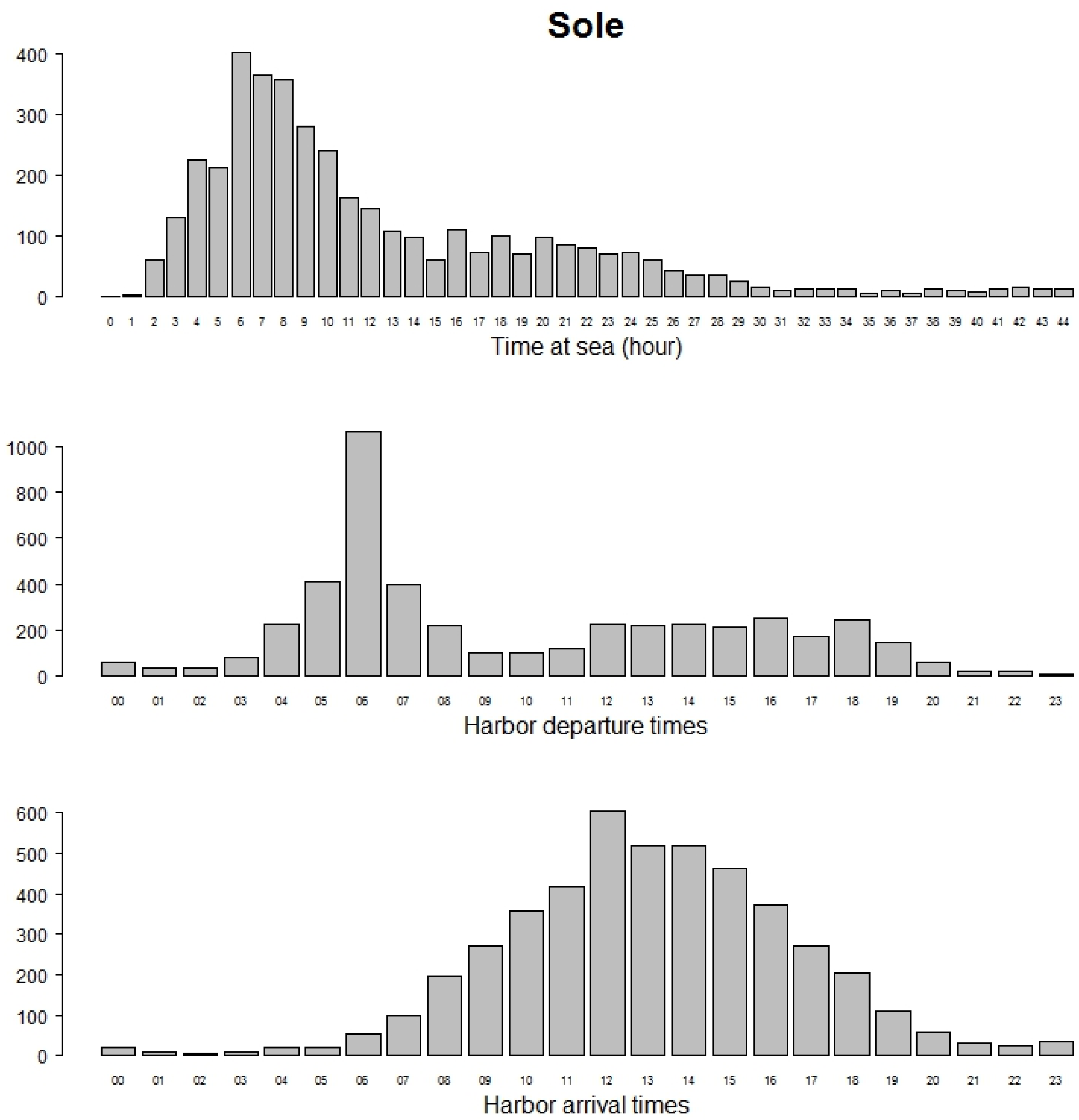
As VMS does not contain any information on the activities of the fisheries itself, e.g. regarding fishing gear, catch composition, departure harbour or vessel dimensions. For many fisheries related studies, VMS is coupled to fisheries logbooks. These logbooks report per fishing trip when fishermen leave harbour, what gear has been used to fish, the catch composition and a rough estimate of the location of the catches for each 24 hour period. Both VMS and logbook data report on the fishing vessel ID, which allows for the coupling of the two datasets and for studying fisheries distribution at smaller spatial and temporal scales. IMARES receives Logbook and VMS information of the Dutch fishing fleet from the Ministry and the information is stored in a database called "VISSTAT". A detailed description on the processing and assumptions made during the process can be found in Hintzen *et al.* (2013).

From 2012 to 2014 there were 27 unique Dutch VMS-fishing vessels using gillnets. The information from these vessels is used to quantify the spatial distribution of the fishing effort at a high resolution.
Logbook information extracted from the VISSTAT database reveal that 141 unique Dutch vessels are using gillnets as fishing gear during the period, including the VMS vessels. Records of vessels with a cumulative effort of less than 1 day at sea per year on average are omitted.
By selecting fishing trips with gear codes GNS, anchored gillnets, and GTR, trammelnets, a total of 8456 unique trips of vessels fishing in ICES rectangles 34F2, 33F2, 34F3, 33F3, 34F4, 33F4, 32F3 & 35F4 are selected from the VISSTAT database.

Net length: "Kenniskring Staandwantvisserij" provided information on the gillnet lengths used by vessels targeting mullet & seabass (category a), sole (category b), or cod (category c), supplemented with vessel specific information of 27 vessels (Jongbloed *et al.*, 2013). The average minimal number of nets of 50 m each is 240, ranging from 50 to 400. The maximal amount is on average 330, ranging from 150 to 500. The net lengths of the remaining vessels was assumed to be minimal 50, 10000 and 50 meter of categories a, b and c respectively. The maximal net lengths are 2500, 25000 and 500 meter of the 3 categories respectively.

Duration of fishing trips: The duration of fishing trips, the time period the gillnets are actually set in the water, is difficult to assess from logbook information. Often fishers leave the harbour to set the nets and collect these nets the day after. The days at sea estimated from logbook information does not reflect the actual fishing effort in these cases. The patterns of times leaving and returning to the harbours and the time period out at sea are depicted in Figure 2.


Mullets and Sea bass
Time at sea (hour)
Harbor departure times
Harbor arrival times


Sole
Time at sea (hour)
Harbor departure times
Harbor arrival times

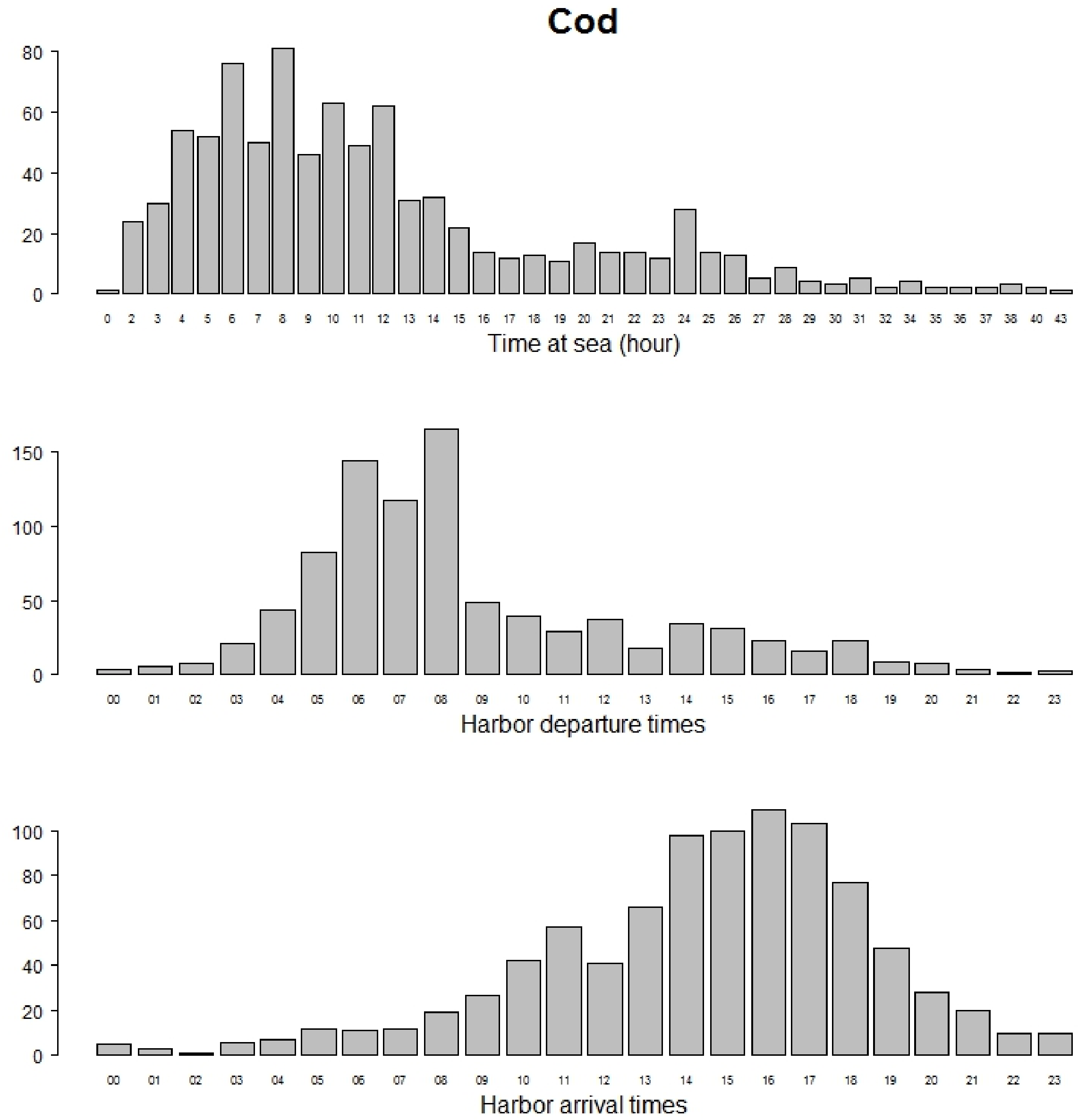


Figure 2 Number of trips and duration of time at sea (out of the harbour), departure time and arrival time of gillnetters targeting (a) Mullets and Sea bass; (b) Sole and (c) Cod.

A number of rules are formulated to estimate the net set times of fishing trips categories a, b and c (see Jongbloed *et al.* 2013 for details). The rules are summarized in Table 2.

Table 2 Formulas for estimation of net set times for gillnet fisheries.

VMS-vessels	Non-VMS vessels	
	Beach / night fishers	(multiple) Day fishers
(DTA-DTD)x20/24	(DTD2-DTD1)x20/24	(DTA-DTD)x20/24

DTA and DTD are date-times of arrival at - and departure from the harbour in the same logbook records.
DTD2 and DTD1 are date-times of departure from the harbour on two successive logbook records.

Additional conditions of the night fishery differ for the categories:

Category a) Mullets and Sea bass:
A vessel leaves the harbour in the evening after 20:00 hours to set the nets and leaves the next morning before 8:00 hours to haul the nets

Category b) Sole:
1) Vessels leaving the harbour between 3:00 and 10:00 with an additional departure from the harbour within 27 hours earlier
2) Vessels leaving the harbour between 10:00 and 22:00 with an additional departure from the harbour within 10 to 27 hours earlier

Category c) Cod:
1) Vessels leaving the harbour between 4:00 and 10:00 with an additional departure from the harbour within 27 hours earlier
2) Vessels leaving the harbour between 11:00 and 21:00 with an additional departure from the harbour within 10 to 27 hours earlier

Since gillnet set-time (days) as an effort indicator may be biased because of differences in lengths of the gillnets (km) set, km-net-days are used as an measure of gillnet fishing intensity in this study.

2.3 Results for the Dutch gillnet fishery

Based on VMS, logbook, assumed net lengths and fishing duration rules maps are made to depict the distribution of the (Dutch) gillnet fishing intensity from 2012 to 2014 (Figure 3 - Figure 5).

These maps show the fishing intensity of the 3 gillnet categories as number of km-net-days per year. Note that the scale of the intensity differs per fishing type. The maps are based on VMS data supplemented with logbook information of vessels without VMS. The spatial scale is a raster of 1/16 ICES squares (of approximately 300 km^2). In case the estimate of the fishing intensity in an ICES square is completely based on logbooks, the effort in the ICES square is proportionally divided over the 16 squares taking into account the areas covered by land. Km-net-days are calculated per fishing trip by multiplying (minimum or maximum) net lengths with fishing days. The intensities presented in the 6 maps show the (minimum and maximum) average net length used, multiplied with the average number of days fished per year of the 3 categories.

The intensity of the 3 gillnet categories in the proposed Natura 2000 site Brown Ridge is listed in Table 3. The intensity of sole fishery is the highest of the 3 categories studied. The maximum is 1600 km-net days per year per 1/16 ICES square, observed in the coastal zone between IJmuiden and Hoek van Holland. The intensity of the sole fishery in the Brown Ridge is between 554 and 823 km-net days per year. The Brown Ridge covers approximate 8 1/16 ICES squares.

Similar to the sole fishery, the highest cod fishery is observed in the coastal zone between IJmuiden and Hoek van Holland. The intensity of this category within the Brown Ridge area is limited: between 39.1 and 72.8 km-net days per year.

The intensity of mullets and sea bass fishery is overall limited compared with the other categories. The gillnet length is smaller than the average net length of sole- and cod gillnets. The intensity in the Brown Ridge is also limited compared with the coastal area and amounts to maximal 13.6 km-net days per year.

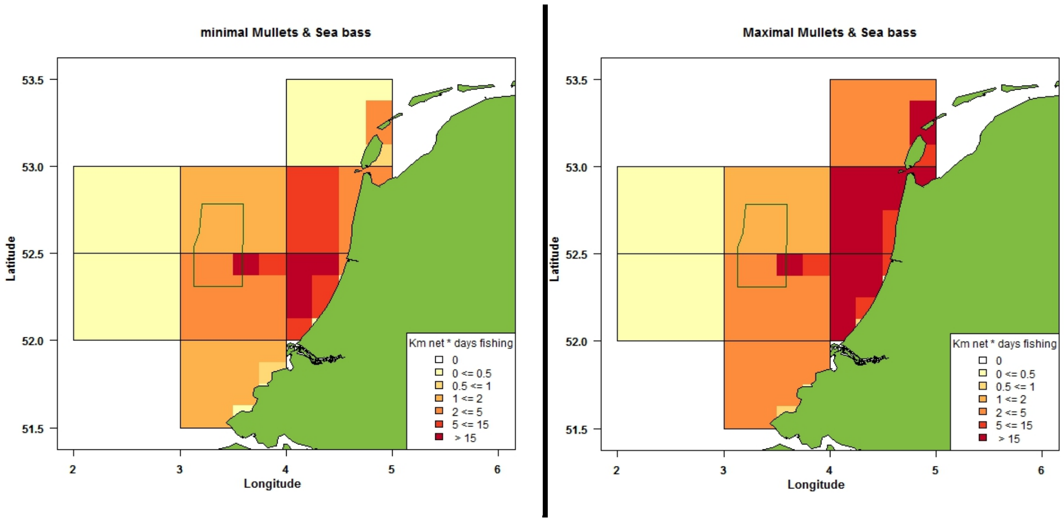


Figure 3 The intensity of gillnet fishery on Mullets and Sea bass in the Dutch coastal zone, including the Brown Ridge area, per 1/16 ICES square. Expressed in number km-net-days per year.

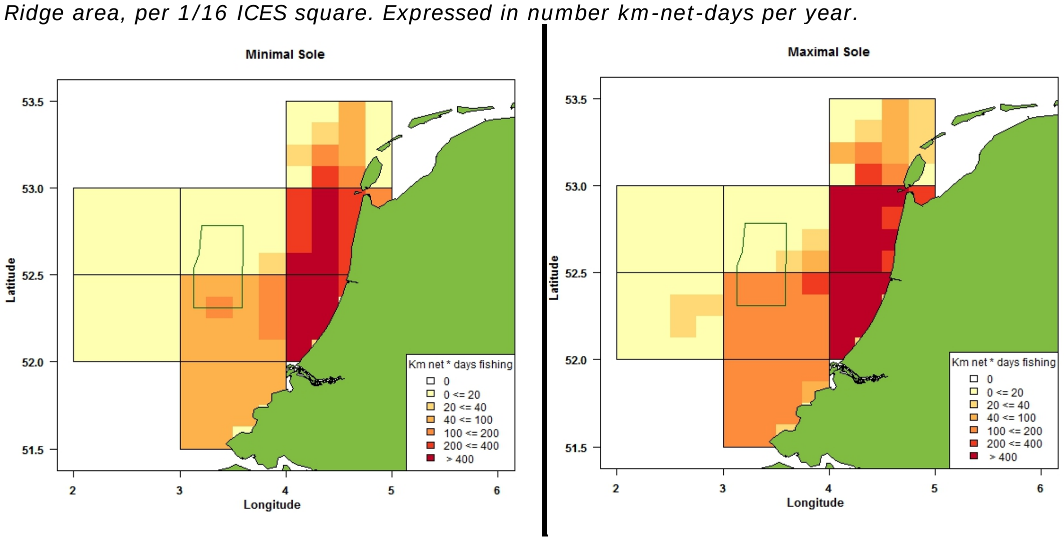


Figure 4 The intensity of gillnet fishery on sole in the Dutch coastal zone, including the Brown Ridge area, per 1/16 ICES square. Expressed in number km-net-days per year.

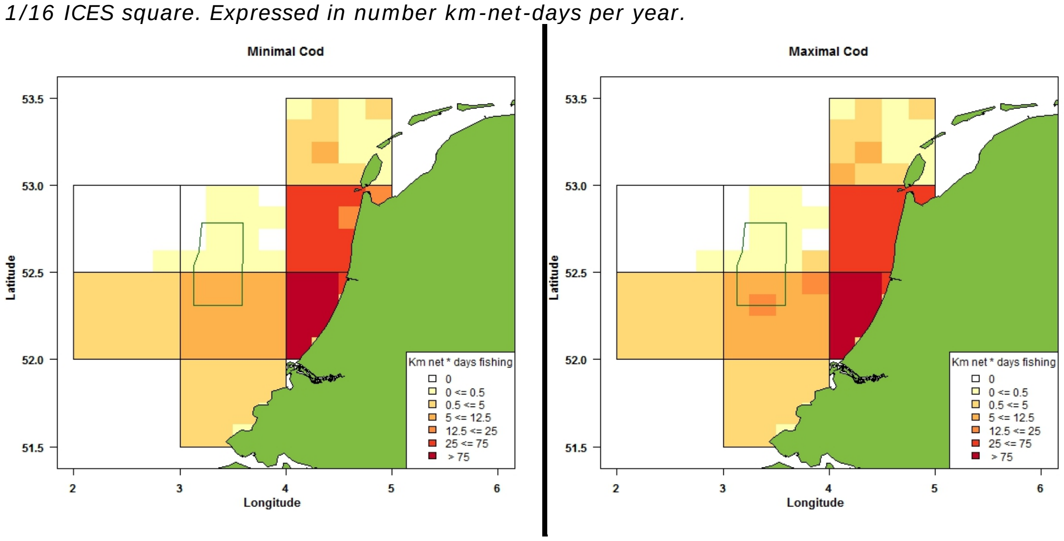


Figure 5 The intensity of gillnet fishery on cod in the Dutch coastal zone, including the Brown Ridge area, per 1/16 ICES square. Expressed in number km-net-days per year.

Table 3 Estimated fishing intensity of the Dutch gillnet fishery in the Brown Ridge in the period 2012-2014.

Fishery category	fishery-intensity (km-net-days per year)		Number fishing days per year	Number (VMS) fishing trips
	Minimum	Maximum		
Mullets and Sea bass	10.8	13.6	1.4	<1
Sole	554	823	45.4	6
Cod	39.1	72.8	7.8	8.7

During the period 2012 to 2014 the effort of the Dutch gillnet fisheries in de Brown Ridge and in a much larger area including and surrounding the Brown Ridge seems fairly constant (Table 4). It should be noted that for the Brown Ridge only the larger fishing boats, which are the boats containing VMS, could be included in the analysis. So this does not present a complete picture of the fishing effort.

Table 4 Time series for the Dutch gillnet fishery.

Year	ICES blocks 33F3 and 34F3 including Brown Ridge (logbook and VMS data)		Brown Ridge (only VMS data)	
	Number of ships	Number of fishing days	Number of ships	Number of fishing days
2012	18	128	4	15
2013	14	148	4	18
2014	14	163	5	16

2.4 Seasonal influence

The different types of gillnet fishing happen at different seasons. Based on the 2012-2014 data, the seasonality of the three gillnetting types is shown in Figure 6. Mullets and Sea bass gillnetting mainly takes place in May (60% of the total effort in the Brown Ridge was in May) while sole and cod gillnetting are predominantly distributed over longer periods (February to August for sole, and throughout the year with peaks in November and January for cod). In absolute terms sole fishing represents about 85% of the effort and cod and seabass effort remains marginal.

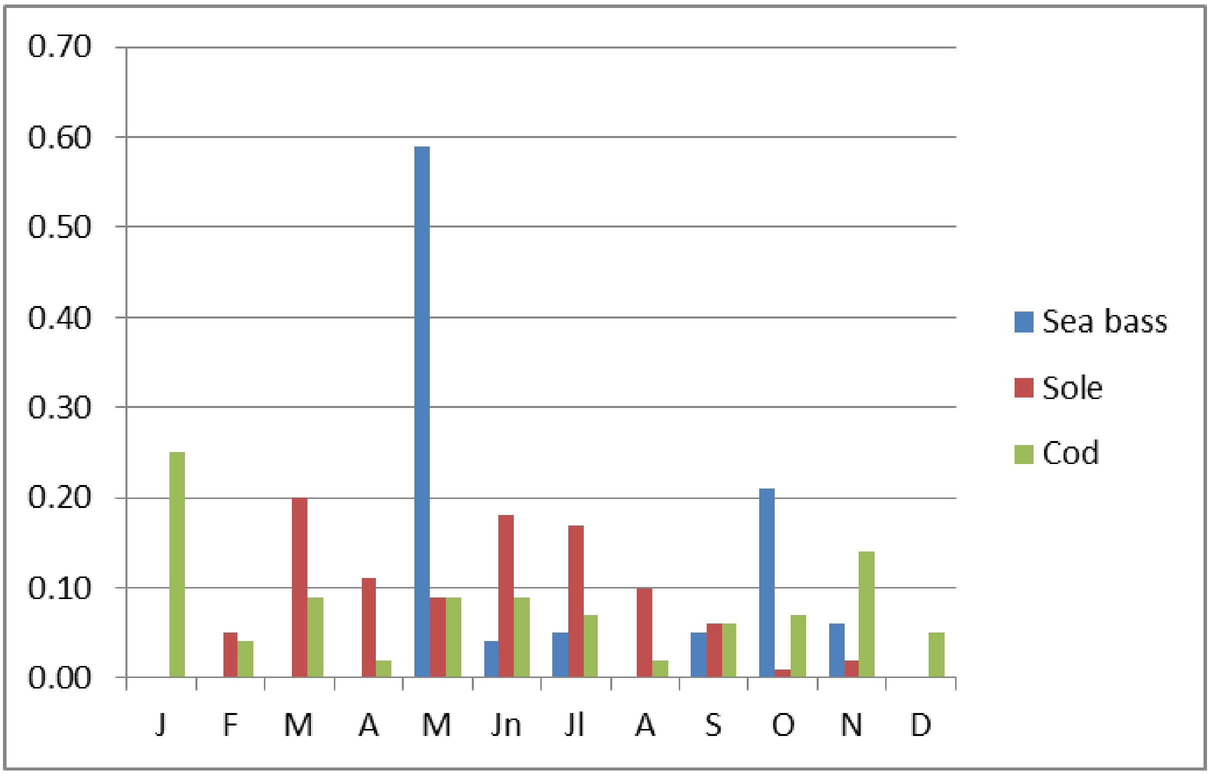


Figure 6 Relative presence of the different types of gillnet fisheries during the year on the Brown Ridge. The fishing intensity per type per month was divided by the sum of fishing intensity over the year per type. The bars add up to 1 for each type represented by colours. Please note that the absolute fishing intensity of the Sole gillnet fishery covers approximate 90% of the total in km netdays.

2.5 Results for foreign gillnet fishery

IMARES requested fishery data from Belgian, Danish, German and UK fishery institutes in order to assess the foreign gillnet fishery effort in the Brown Ridge area. IMARES was informed that Belgian gillnet fishery did not occur in the Brown Ridge area. The UK did not supply data. Data sets were sent by Rabea Diekmann for German fishery and by Francois Bastardie for Danish fishery. Therefore our analysis of the foreign gillnet fisheries was limited to the German and Danish gillnet fisheries. The characteristics of the foreign gillnet fisheries was only presented for 2014 and it was not possible to split the fishing days among vessel categories (see Table 5). In 2014 three German vessels and seven Danish vessels were active in the Brown Ridge area. The fishing effort is expressed in fishing days and VMS pings (in Table 5) and in km net days (in Table 6). The German and Danish gillnet fishery in the area is limited to sole. There are no non-VMS German – or Danish gillnet vessels active in ICES blocks 33F3-34F3.

For comparison the data for the Dutch vessels is shown as well, using the same metrics. The estimated Dutch gillnet annual fishing effort in ICES squares 33F3 and 34F3 is 146 fishing days, including 16 fishing days by VMS vessels. Four large Dutch vessels with VMS and 11 small Dutch vessels without VMS are annually active in ICES squares 33F3 and 34F3. These 4 large vessels with VMS also fish in the Brown Ridge (Table 4, Table 5). It is not known how many small non-VMS Dutch vessels fish in the Brown Ridge.

Table 5 Registration and estimated intensity of the foreign gillnet fisheries in the ICES blocks with the Brown Ridge and the Brown Ridge alone. For comparison the data for the Dutch gillnet fisheries with VMS are shown.

Nationality	Period	ICES blocks 33F3 and 34F3 including Brown Ridge			Brown Ridge	
		Number ships per year (demonstrated)	Number fishing days per year	Fishing effort (fishing days/year)	Number ships per year (demonstrated)	Number VMS pings/year
		VMS	VMS	Logbooks	VMS	VMS
Dutch	2012 – 2014	4	16	146	4	130
German	2014	3	145	145	3	295
Danish	2014	7	340	340	7	1000

Maps showing the effort of the foreign gillnet –sole- fishery on the 1/16 ICES block scale is shown in Figure 7.

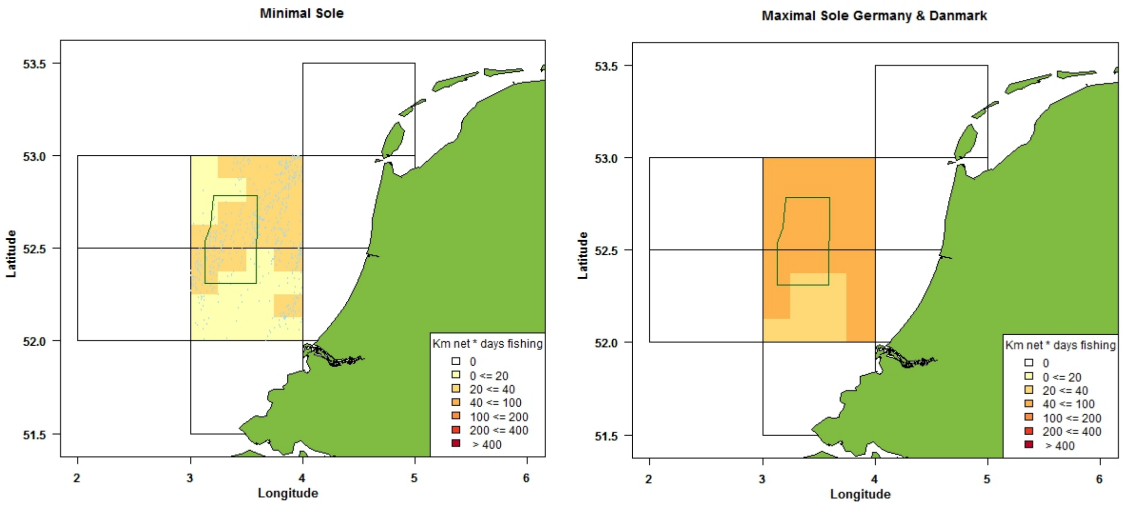


Figure 7 The intensity of the combined German and Danish gillnet fishery on sole in the Dutch coastal zone (ICES blocks 33F3 and 34F3), including the Brown Ridge, per 1/16 ICES block. Expressed in number km-net-days per year.

In case gillnet length was not available in foreign logbook records we make the same assumptions as for the Dutch gillnet lengths: 10 km as a minimum and 25 km as a maximum net length. The German and Danish effort is completely carried out by VMS vessels, while the Dutch effort is mainly applied by smaller non-VMS vessels. These smaller Dutch vessels set more/longer gillnets per (logbook) fishing days, resulting in a relative higher fishing intensity, expressed as km net days.
The minimum and maximum fishery effort, as number of km net days per year, in the Brown Ridge is listed in Table 6 and plotted in Figure 7. The fishing intensity expressed as km net days of the German and Danish gillnet fisheries is approximately 17-30% and 38-65%, respectively of the Dutch gillnet fishery effort. It can be concluded that the foreign fishing intensity (=sum of the German and Danish fishing intensity) is approximately the same as the Dutch fishing intensity.

Table 6 Comparison of the effort of Dutch and the foreign gillnet fishery in Brown Ridge on sole in the period 2012-2014. All foreign effort is estimated from VMS records. The Dutch effort is estimated from VMS records and from the contribution of small non-VMS vessels which was estimated by taking (area) proportional parts of the logbook records and the resulting km net days estimates of these vessels in ICES blocks 33F3 and 34F3.

Nationality	Fishery effort (km net days)	
	Minimum	Maximum
Dutch	576	828
German	100	250
Danish	216	541

3 Economic values of gillnet fishery

3.1 Results for the Dutch gillnet fishery

Based on logbook information and average first sale prices, the total value of the landings from the Dutch gillnet fishery is around EUR 3 million annually (Taal *et al.*, 2014). To estimate the value of landings coming from the Brown Ridge, we combined VMS data with logbooks as described in Hintzen *et al.* (2013). For vessels for which we could not couple VMS and logbooks, we used the logbook information only (at the ICES rectangle level) and we assumed a homogenous repartition of the value of landings within an ICES rectangle (i.e. the area of the Brown Ridge overlaps with 24% of ICES rectangle 34F3, so for vessels without VMS 24% of the value of the landings reported in 34F3 is allocated to the Brown Ridge).

In Figure 8, estimates of the value of the Dutch gillnet fisheries in the Brown Ridge are shown for 2012, 2013 and 2014 for fisheries targeting different species (the same method as in section 2.2 is used to determine the activity of the vessels). Based on our estimates, around EUR 45.000 is fished annually from the Brown Ridge which corresponds to about 1.5% of the value of gillnet landings for the Dutch fishery and represents a gross value added (GVA) of about EUR 20.000.

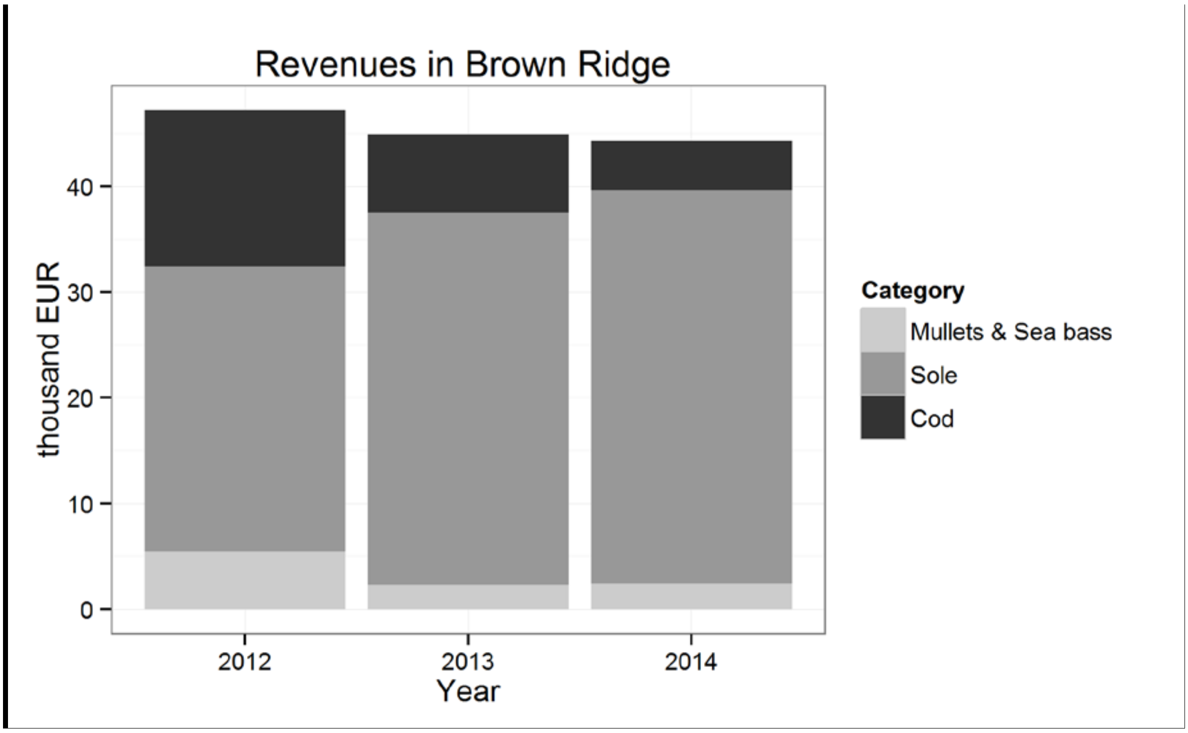


Figure 8 Value of landings in the Brown Ridge by fisheries defined by their target species (Mullets and Sea bass, Sole and Cod).

However if the total amount of revenue coming from the Brown Ridge is low for the total fleet, for a few fishers it can represent more than 10% of their revenue (up to 30% for one fisher in 2014, see Figure 9). In 2012 18 Dutch vessels fished in the Brown Ridge with gillnets, with 3 vessels fishing more than 10% of their revenue (between 11 and 20%) in this area. In 2013 and 2014 the total number of vessels fishing in the Brown Ridge fell to 14 vessels and 3 and 4 vessels with 11-20% of their revenue. In 2014 one vessel had more than 20% of its revenue coming from the Brown Ridge.

The revenues from the logbooks and average prices are most probably an underestimate of the actual revenues obtained by the gillnet fishermen. Information from questionnaires of fishermen shows that the actual revenue might be 50% higher than estimated here (Taal *et al*., 2014). This is due to the fact that not all landings have to be recorded in the logbooks and because gillnetters receive better prices than the average auction price used in estimation.

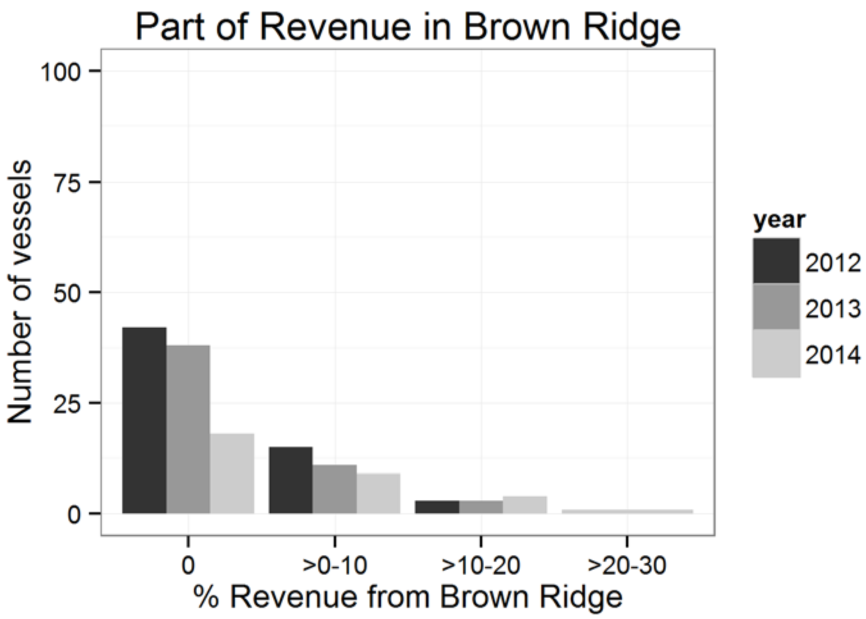


Figure 9 Number of Dutch gillnet vessels for which the revenue in the Brown Ridge is null, less than 10%, between 10 and 20% or between 20 and 30% of their total revenue in 2012, 2013 and 2014.

3.2 Results for foreign gillnet fishery

The value of landings from the Brown Ridge for foreign fleets is estimated for the German and Danish fleets. The effort and value of landings in the Southern North Sea (area IVc) are extracted from the STECF database of the Joint Research Centre (STECF, 2015). Based on the value per unit of effort (VPUE) using gillnets in the southern North Sea and on the effort in the Brown Ridge, we estimated the value of landings in the Brown Ridge for the German and Danish fleets (Table 7).

The estimated value of landings in the Brown Ridge area is 33 thousand euro for the German gillnetters (avg. 2012-2014) and 70 thousand euro for the Danish gillnetters (average 2012-2013). This should be compared to the Dutch value of landings using gillnets in area which was estimated at 45 thousand euro in average over the 2012-2014 period.
Foreign gillnet fishing in and around the Brown Ridge also only represents a small share of the total gillnet revenue of the fleets (0.25% for the German fleet).

Table 7 Overview of the total value of landings of the foreign gillnet fisheries and the estimated value of landings and effort from the Brown Ridge (averages from 2012-2014).

	Total gillnet fishery			Sub-area IV.c	Brown Ridge	
	Number of vessels (from AER)*	Value of landings (mln EUR gillnets)	Effort (fishing days gillnets)	VPUE 1000 EUR / fishing day (from AER)	Effort (from institutes)	Value of landings x 1000 EUR (calculated)
German	97	13.0	1935	3.25	10	33
Danish**	929	29.7	42279	3.25	21.6	70

* Total number of vessels of those fleet segments that have fishing with gillnets during the year.

** Danish data is not yet available for 2014, so the numbers are averages for 2012-2013

4 Density of seabirds

For the Brown Ridge two diving seabird species have been identified to be of interest both with respect to the (considered) designation as an MPA as part of Natura 2000 as well as the gillnet fisheries:

- Common guillemot, *Uria aalge*, EUring 6340
- Razorbill, *Alca torda*, Euring 6360 (Leopold & van der Wal, 2015).

Seasonal distribution maps are presented for both species in Figure 11 and Figure 12. These maps were developed by Leopold et al. (2014). The underlying data has been taken from the ESAS[1] and MWTL[2] databases for the years 1991 up to 2013 and have been processed to show a seasonal average distribution. Seasons are six two-monthly periods starting with 1= Aug-Sep, 2= Oct-Nov, 3= Dec-Jan, 4= Feb-Mar, 5= Apr-May and 6= Jun-Jul. The data from both databases was combined onto a 5 x 5 kilometer grid, considering both count and survey effort to properly combine the data into a map of seabird densities. To improve geographical cover an IDW interpolation of the raw densities was used. Further details on the methodology can be found in Leopold et al. (2014).

The legend shown in Figure 10 is a shared scale for seasonal distribution maps.

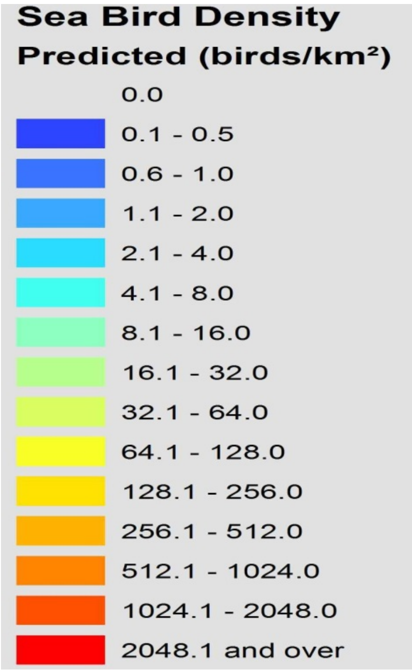


Figure 10 Shared legend of seasonal seabird density (birds/km^2) for Figure 11 and Figure 12.

[1] The European Seabirds at Sea database (ESAS) contains ship-based surveys from all borders states, and is maintained by JNCC. More information is available at the following URL: http://jncc.defra.gov.uk/page-4469

[2] The MWTL database has aerial bird survey data collected by Rijkswaterstaat, the Netherlands and covers the Dutch Continental Shelf. It is part of a wider national monitoring programme run by the Dutch authorities. Further information is available on the following website: http://www.rijksoverheid.nl/documenten-en-publicaties/rapporten/2014/04/28/mwtl-meetplan-2014-monitoring-waterstaatkundige-toestand-des-lands-milieumeetnet-rijkswateren-chemie-en-biologie.html (Dutch language only).

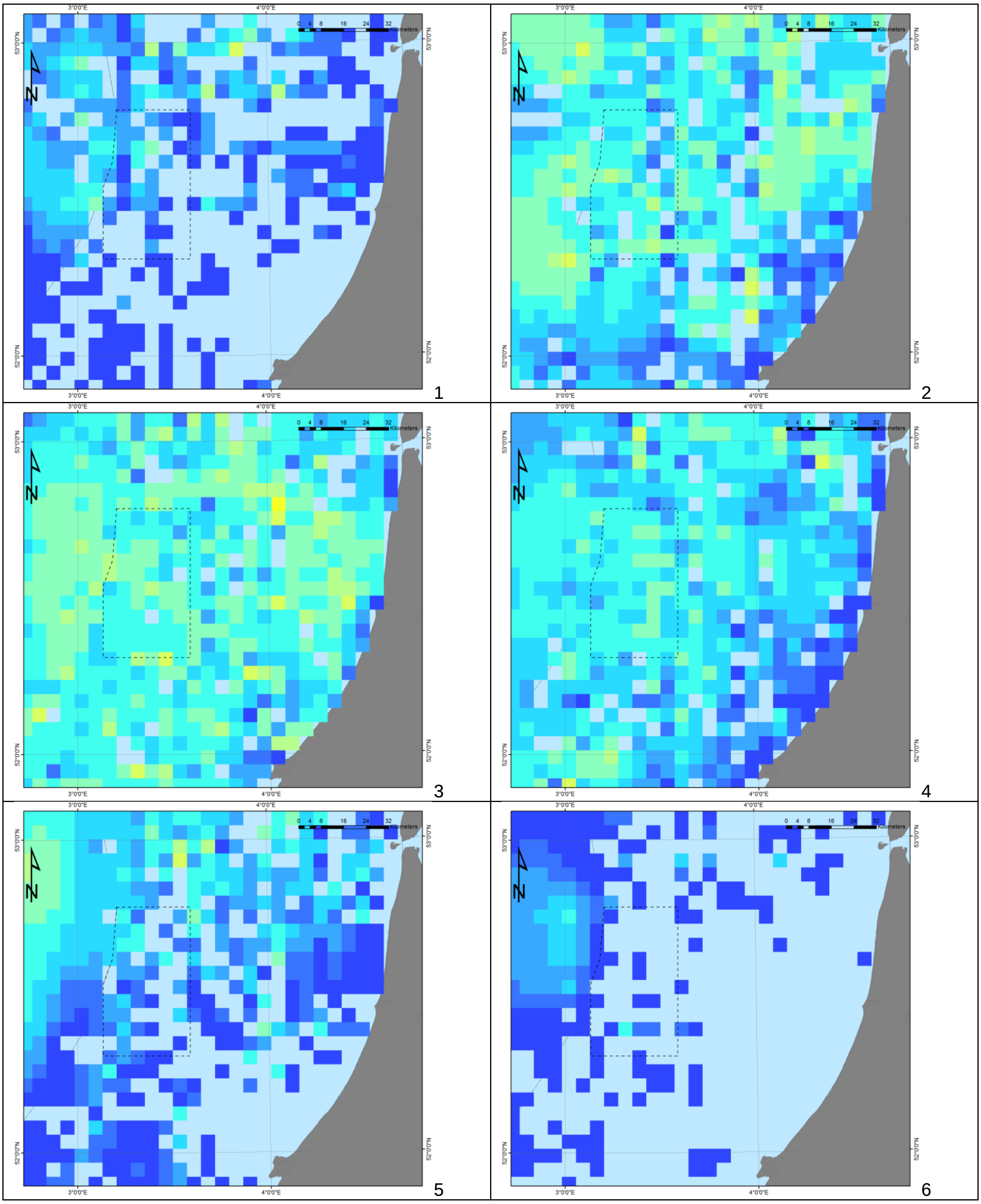


Figure 11 Seasonal distribution of Common Guillemot in and around the Brown Ridge. Seasons 1/Aug-Sept, 2/Oct-Nov, 3/Dec-Jan, 4/Feb-Mar, 5/Apr-May, 6/Jun-Jul. Legend is shown in Figure 10. Background-grey: no *data.*

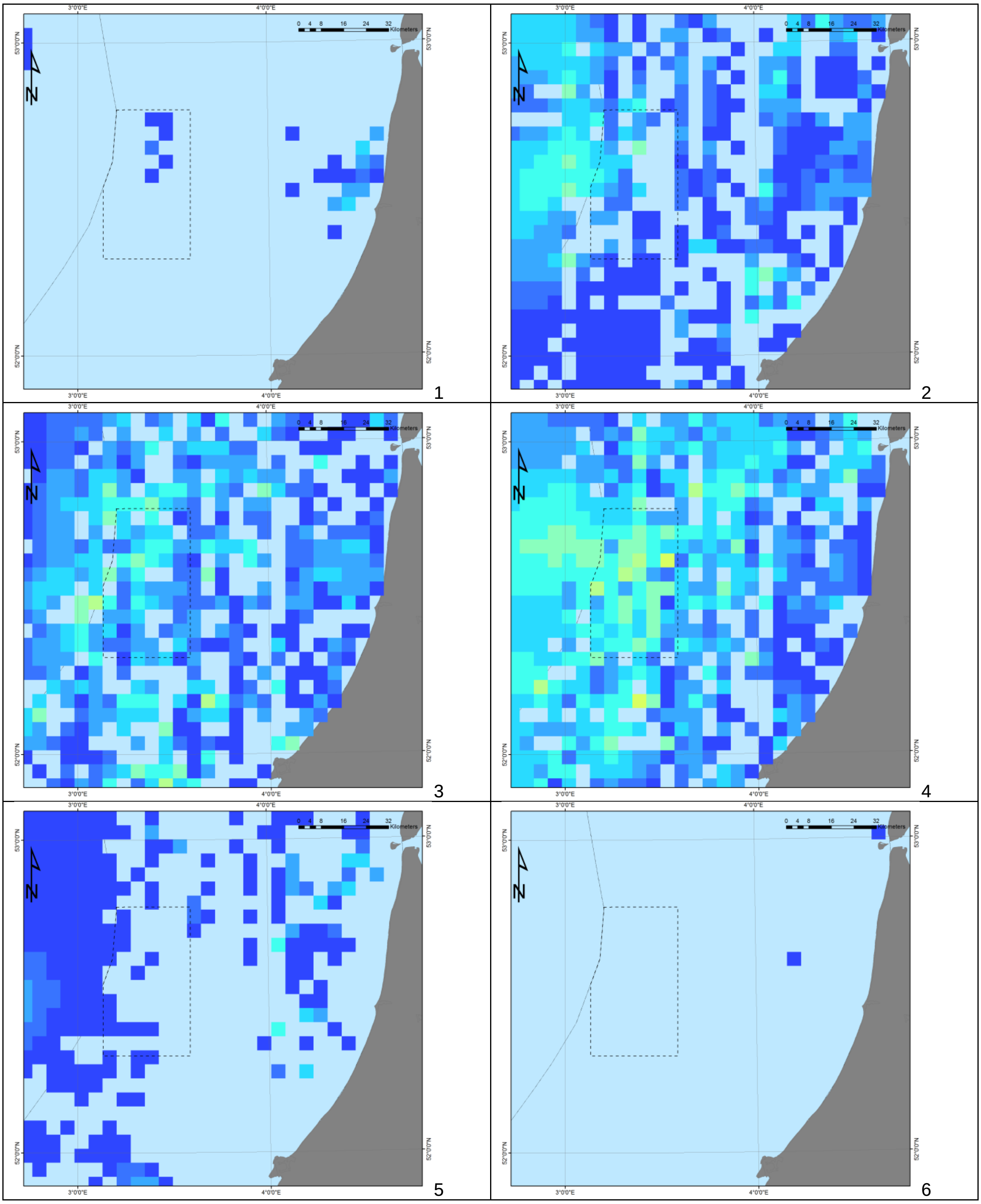


Figure 12 Seasonal distribution of Razorbill in and around the Brown Ridge. Seasons 1/Aug-Sept, 2/Oct-Nov, 3/Dec-Jan, 4/Feb-Mar, 5/Apr-May, 6/Jun-Jul. Legend is shown in Figure 10. Background-grey: no data.

In addition to the distribution maps, per season density estimates for the years 2004-2013 have been made based on counts and survey effort from both ESAS and MWTL. By multiplying these densities with the acreage of the proposed Natura 2000-site Brown Ridge, estimated numbers of birds present in the area are calculated. The results are presented in Table 8 to Table 11.

Table 8 MWTL-based number of Common Guillemot in the Brown Ridge. (- - means no survey carried out)

Season	1 / AS	2 / ON	3 / DJ	4 / FM	5 / AM	6 / JJ
2004	0.0	3582.8	2616.3	13806.6	16445.3	0.0
2005	612.1	15689.3	6520.2	5236.2	5916.9	0.0
2006	0.0	0.0	10027.0	6793.4	3260.3	0.0
2007	0.0	9556.3	7803.4	- -	237.7	862.0
2008	520.8	- -	10310.8	- -	0.0	0.0
2009	0.0	1936.7	4964.6	3022.7	264.9	215.3
2010	0.0	7264.2	- -	25332.3	0.0	174.1
2011	169.2	5338.6	7483.0	115.2	184.0	309.4
2012	681.4	1278.3	6542.2	6167.1	295.4	114.4
2013	- -	- -	18423.1	11342.8	- -	- -

Table 9 ESAS-based number of Common Guillemot in the Brown Ridge.

Season	1 / AS	2 / ON	3 / DJ	4 / FM	5 / AM	6 / JJ
2004	0.0	- -	- -	- -	- -	- -
2005	- -	- -	4348.3	- -	- -	- -
2006	- -	- -	4229.4	- -	- -	- -
2007	- -	- -	- -	- -	- -	- -
2008	0.0	- -	- -	- -	- -	- -
2009	298.0	5166.1	- -	- -	- -	- -
2010	971.6	1752.9	5892.6	1465.7	188.0	- -
2011	2777.3	4564.8	7957.3	2236.1	- -	- -
2012	- -	7156.8	8475.8	4573.5	- -	- -
2013	- -	- -	- -	- -	- -	- -

Table 10 MWTL-based number of Razorbill in the Brown Ridge.

Season	1 / AS	2 / ON	3 / DJ	4 / FM	5 / AM	6 / JJ
2004	0.0	132.7	0.0	10519.3	664.5	0.0
2005	0.0	1761.0	434.7	2327.2	0.0	0.0
2006	0.0	0.0	1432.4	2791.8	224.8	0.0
2007	0.0	1563.8	755.2	- -	0.0	0.0
2008	0.0	- -	606.5	- -	0.0	0.0
2009	0.0	113.9	730.1	1365.1	0.0	0.0
2010	0.0	1063.0	- -	17537.7	0.0	0.0
2011	0.0	136.9	1983.4	115.2	0.0	0.0
2012	0.0	1045.9	261.7	4111.4	0.0	0.0
2013	- -	- -	3225.8	2548.9	- -	- -

Table 11 ESAS-based number of Razorbill in the Brown Ridge.

Season	1 / AS	2 / ON	3 / DJ	4 / FM	5 / AM	6 / JJ
2004	0.0	- -	- -	- -	- -	- -
2005	- -	- -	734.1	- -	- -	- -
2006	- -	- -	1169.8	- -	- -	- -
2007	- -	- -	- -	- -	- -	- -
2008	0.0	- -	- -	- -	- -	- -
2009	108.4	2236.9	- -	- -	- -	- -
2010	0.0	478.1	2084.0	1818.6	0.0	- -
2011	0.0	108.0	6489.5	3354.1	- -	- -
2012	- -	0.0	1304.0	1718.7	- -	- -
2013	- -	- -	- -	- -	- -	- -

Please note that the ESAS and MWTL surveys were not conducted during the same days or even weeks, so considerable differences in encountered seabird numbers are to be expected. Also note that several dedicated, and optimally timed (with respect to guillemot and razorbill presence) ship-based surveys have been conducted that yielded substantially higher numbers (see: Van Bemmelen *et al.*, 2012; Geelhoed *et al.*, 2014; Leopold & van der Wal, 2015).

The relative presence of the common guillemot and the razorbill during the months of the year is shown in Figure 13. These data are derived from the combination of the average MWTL-based and average ESAS-based number of birds over the 10 year period 2004-3013 (Table 8-Table 11). The relative presence of common guillemot is high during 6 months (October to March). The presence of the razorbill is comparable with the common guillemot, however the period of high density is shorter, namely from December-March. During spring and summer (April-September) the presence is low, but for the common guillemot still a considerable presence is found in the months April and May.

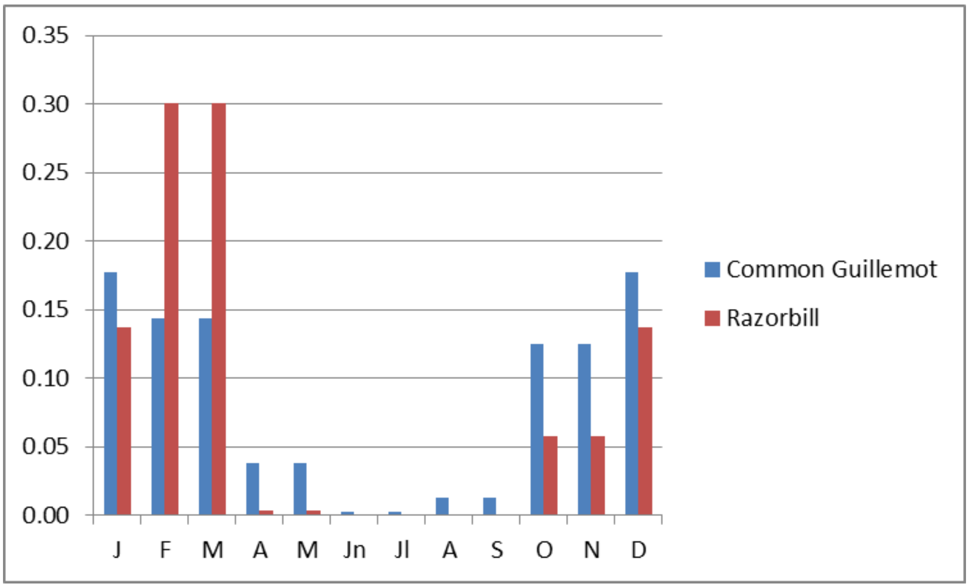


Figure 13 Relative presence during the year of protected seabirds in the Brown Ridge. For each bird species the presence per month was divided by the sum of presence over the year. The bars add up to 1 for each bird species represented by colours.

The geographical distribution and density of common guillemots and razorbills in the Brown Ridge area was counted and modelled by Van Bemmelen *et al.* (2012). Potential borders for the area were based on the numbers of birds present, both in relation to the total relevant population size and to background densities, of common guillemots and razorbills.

In February and March 2014 two surveys were carried out in the Brown Ridge area in order to map the distribution of common guillemot and razorbill as well as their potential prey fish species (Geelhoed *et al.*, 2014). The bird counts resulted in 20430 common guillemots and 13631 razorbills in February 2014 and 11337 common guillemots and 20994 razorbills in March 2014. Comparison of these data together with all older available data on bird numbers with the policy framework for Natura 2000-sites led to the conclusion that the Brown Ridge can be assigned as a Natura 2000-site under the Birds Directive. The Brown Ridge meets one of the five criteria:
b) in the area a number individuals of at least 1% of the biogeographical population of a waterbird species gathers for feeding, moulting, resting or other functions (congregatory species) (BirdLife International marine IBA criteria "Category A4-Congregations-i").

5 Bycatch of seabirds in gillnet fishery

A recent review of the bycatch of seabirds in gillnets is provided by Žydelis *et al.* (2013). They concluded that bycatch of seabird in gillnets has been reported in various regions but the risk for populations is still poorly known. The Alcidae are among the most susceptible birds to bycatch in gillnets. There are a few examples of significant impacts of gillnet mortality for local colonies of auks, namely off the Atlantic Iberian coast and islands in the Northwest Pacific. The occurrence of bycatch of seabirds is largely determined by the spatial distribution of susceptible species.

According to Žydelis *et al.* (2013) the following factors determine the chance of bycatch in gillnets:

- Bird foraging behaviour (diving for fish or benthic fauna)
- Fishing characteristics (mesh size, setting depth, time of day, period of net soaking)
- Environmental conditions (water transparency, weather conditions)
- Spatial overlap (net setting location in relation to seabird abundance).

Studies on seabird bycatch in the North Sea are relatively scarce and even absent in the eastern North Sea. Incidental gillnet bycatch are reported for other North Sea regions and sometimes include guillemots and razorbills. Local colony impacts may be possible but in the UK bycatch in gillnet fisheries was not seen as a significant threat to birds at a regional scale as indicated by the growth of auk colonies (BirdLife International, 2004).

ICES organised a Workshop to Review and Advise on Seabird Bycatch (WKBYCS, 2013). In order to define the significance of seabird bycatch the first step is an assessment of the size of the bycatch in the fisheries of interest, and the necessary and desirable metrics that contribute to this assessment are identified and reiterated from previous initiatives. WKBYCS (2013) elaborates criteria or metrics that could be used to define a seabird bycatch problem. They recommend a stepwise approach, beginning with a simple initial step. More detailed steps may be considered when earlier stages indicate a potential problem, but these steps have to be defined. Furthermore it is recommended that fishing effort should be described at least in terms of days at sea, but where feasible using more gear-specific metrics. The existing bycatch database for protected species compiled by the ICES Working Group on Bycatch of Protected Species (WGBYC) should be adequate to register and analyse bird bycatch data. The current study determines and applies fishery effort in the number of km net days for three distinguished gill net types. Both the fishing effort unity and gear-specific metrics meet the requirements of WKBYCS (2013).

6 Conservation objectives for seabirds

6.1 Natura 2000

The Brown Ridge qualifies as Special Protection Area under the Bird Directive and is intended to be assigned as a Natura 2000-site (Van Bemmelen *et al.*, 2012; Leopold & van der Wal, 2015). The intended conservation objectives are:

- Common guillemot: maintain extent and quality of the habitat to sustain maintenance of the population
- Razorbill: maintain extent and quality of the habitat to sustain maintenance of the population

6.2 Quantitative criteria for protection

In the ICES Workshop to Review and Advise on Seabird Bycatch (WKBYCS, 2013) recommendations were made to elaborate criteria for bycatch. The following approaches were mentioned:

- The Potential Biological Removal (PBR) tool would appear to be an appropriate method, although there are others, to assess the conservation consequences of bird bycatch.
- Some 'maximum allowable catch' of sea-birds, like PBR, would appear not to be acceptable from a cultural or societal point of view.
- The European Union Plan of Action (EU PoA) overall objective is to "minimise and where possible eliminate" bycatch. This objective derives directly from Article 5 of the Birds Directive (EU, 2009), which requires Member States to take measures prohibiting the "deliberate killing or capture [of birds] by any method".

We elaborated the PBR approach for the common guillemot and razorbill in the Brown Ridge. The biogeographical population level determines the 1% threshold value as well as the MCC[3]. For this study the selected values and their references are shown in Table 12. We chose the (international) North Sea as the geographic are for biographical population of both species.

Table 12 Population estimates for common guillemot and razorbill and the concomitant threshold values used for comparison with the results of this study. Note that the MCC threshold values are four times the background density values (retrieved from: Van Bemmelen et al., 2012).

Species	Estimated size biogeographical population (n)	Reference	1% threshold value (n)	Background density[1] (n/km^2)
Common guillemot	1562000	Skov *et al.* (2007)	15620	2.08
Razorbill	324000	Skov *et al.* (2007)	3240	0.43

[1] Calculated by dividing the population estimate (from Skov *et al.* (1995) for both bird species by the area of the North Sea; 750,000 km^2 – equal to the area analysed by Skov *et al.* (1995).

The PBR is derived for the North Sea (Table 13) and the Brown Ridge (Table 14).

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3 The Marine Classification Criterion (MCC) determines the density of a bird species within an important offshore bird area to be four times as high as the average density of that species in the surrounding regional sea (Skov *et al.*, 2007).

In addition we applied another criterion that is more protective than the PBR. This is the Ornis Committee criterion for bird populations which is 1% of the annual mortality.

Table 13 Number of birds for the North Sea according to the PBR and the Ornis criterion for the sea bird species.

Species	Potential Biological Removal (PBR) for North Sea #	Ornis criterion (1% of annual mortality) for North Sea	Reference
Common guillemot	26641	681	Leopold *et al.* (2014)
Razorbill	7129	249	Leopold *et al.* (2014)

Source: Leopold *et al.* (2014).

Table 14 Number of birds for the Brown Ridge according to the PBR and the Ornis criterion for the sea bird species.

Species	Potential Biological Removal (PBR) for Brown Ridge #	Ornis criterion (1% of annual mortality) for Brown Ridge #
Common guillemot	55	1.4
Razorbill	15	0.5

Area of the Brown Ridge is 0.2 % of the area of the North Sea

It should be noticed that the bycatch of one guillemot or razorbill on the Brown Ridge is already critical in case the Ornis criterion is chosen. Thus application of the Ornis criterion is comparable with application of the EU PoA's overall objective to "minimise and where possible eliminate" bycatch. In case of the PBR criterion is applied approximately 30 time more victims can be allowed before the populations of the sea birds are regarded to become threatened (Table 14).

7 Impact assessment of gillnet fishery for seabirds

In this chapter the impact assessment of gillnet fishery for common guillemot and razorbill is carried out. At first the method is described. Subsequently the different aspects playing a role in the assessment are dealt with. Finally the impact is assessed by integration of the aspects.

7.1 Method for impact assessment

The conflict analysis consists of the evaluation of the fishing impact on the seabirds (razorbills and common guillemots). Unfortunately, the bycatch of seabirds in gillnets is not recorded and no exhaustive data exist on the interaction between fishers and seabirds. To evaluate the fishing impact on the bird populations several aspects must be accounted :

- Do the fishery and birds overlap spatially?
    - In the proposed Natura 2000-site Brown Ridge (geographically)
    - In the water column (vertically)
- Do the fishery and birds overlap temporally?
- What is the risk for a diving bird to be caught in a gillnet?
- Do all gillnet types share the same risks?

7.2 Spatial overlap

The spatial overlap is studied for two dimensions: surface area and water column. Both are relevant for the assessment of the potential exposure.

<u>Surface area</u>

There is a high potential spatial overlap between gillnet fishery (see Figure 3, Figure 4, Figure 5, Figure 7) and sea bird distribution (see Figure 11, Figure 12) in the Brown Ridge. Predictions about differences among sub areas within the Brown Ridge concerning the extent of overlap cannot be made. However this is not useful because locations of fishing and birds presence can vary.

<u>Water column and diving depth</u>

The gillnet gears stand on the sea floor. The sea floor depth varies between 16 and 50 m (average 32 m). The diving depth of common guillemots and razorbills has not been investigated in the Brown Ridge or adjacent areas of comparable depth. From the literature it is known that razorbills often seem to prefer to make shallow dives (Ouwehand *et al.*, 2004; Shoji *et al.*, 2015), but they have also been found at depths of 120 m (Piatt & Nettleship, 1985) and 140 m (Jury, 1988). Guillemots can dive very deep. Common guillemots in the northwest Atlantic were recorded to dive often below 50 m with maximum depth of 152 m (Hedd *et al.*, 2009) and even 180 m (Piatt & Nettleship, 1985).

Another way to derive information on the expected diving depth of sea birds is to study the presence of important prey fish species. The winter diet of guillemots is varied and a significant portion of their prey spectrum consists of demersal fish like sandeels *(Ammodytes sp.)* as found by in the southern North Sea in winter time (Ouwehand *et al.*, 2004). Therefore the significance of sandeels in the Brown Ridge area may be high for common guillemots, because the depth is no limitation.

Razorbills, on the other hand, forage on smaller fishes (Ouwehand *et al.*, 2004). Observations at sea, in the Brown Ridge area, have indicated that razorbills do so by making shallow dives, often working together to push prey fish concentrations towards the water surface (M. Leopold, pers. comm.).

Geelhoed *et al.* (2014) investigated the densities of common guillemots and razorbills and the depth distribution of fish in the Brown Ridge area. They found very low densities of biomass of potential prey fish deeper than 13 meters. However, these low fish densities were measured in only one winter, the weather was bad and so the bird density was relatively low and it may be an underestimate of the potential conflicts. Therefore conclusions cannot be drawn from this study.

From the information described above it can be expected that razorbills mostly forage far above the bottom in the Brown Ridge area. If this would be the case (always), there would be no risk of razorbills being caught by gillnets in the Brown Ridge area. On the other hand common guillemots probably often dive to the seafloor of the Brown Ridge area in case of foraging on sandeels and other demersal fish (Leopold & Camphuysen 1992; Ouwehand *et al.*, 2004) where they are exposed to gillnets. Also in the FIMPAS project (ICES, 2011) the same interpretation was made with respect to guillemots and set gillnets in the Frisian Front.
From the literature it is known that the majority of diving birds prefer shallow waters and most seabird bycatch occurs in depths of less than 20 m (Stempniewicz, 1994 In: Žydelis *et al.*, 2013). Bellebaum *et al.* (2013) also found that the probability of bycatch decreased with increasing water depth. However, both razorbills and guillemots have been caught in bottom-set gillnets, over a large range of water depths, for both species exceeding 100 m (Piatt & Nettleship 1985), so all probably depends on the foraging strategies used by these birds, while present in the Brown Ridge area.

7.3 Temporal overlap

There is temporal overlap between fishery intensity (see Figure 6) and sea bird distribution (see Figure 13) in the Brown Ridge. Absolute values cannot be assigned to the temporal overlap. It is possible to calculate the variation among the months in the relative temporal overlap for each bird species with each of the fishery types. The results are shown in Figure 14 and Figure 15. In general the late autumn - late winter period and the month of May seem to be the seasons with the highest overlap between fishing activities and bird presence. However there are some differences in temporal overlap between the different fishery-bird combinations. For guillemot there is a high temporal overlap (chosen as values > 0.1) with sea bass fishery in October, November and May, with sole fishery in February and March, and with cod fishery in November, January, March. For razorbills there is a high temporal overlap with sea bass fishery in October, November and May, with sole fishery in February and March, and with cod fishery in January, February and March. In the period June to September there is no or negligible temporal overlap of the birds presence and gillnet fishery. This means that gillnet fisheries are no problem for these birds in this period. In the period October to May a risk of gillnet fisheries in general cannot be ruled out.

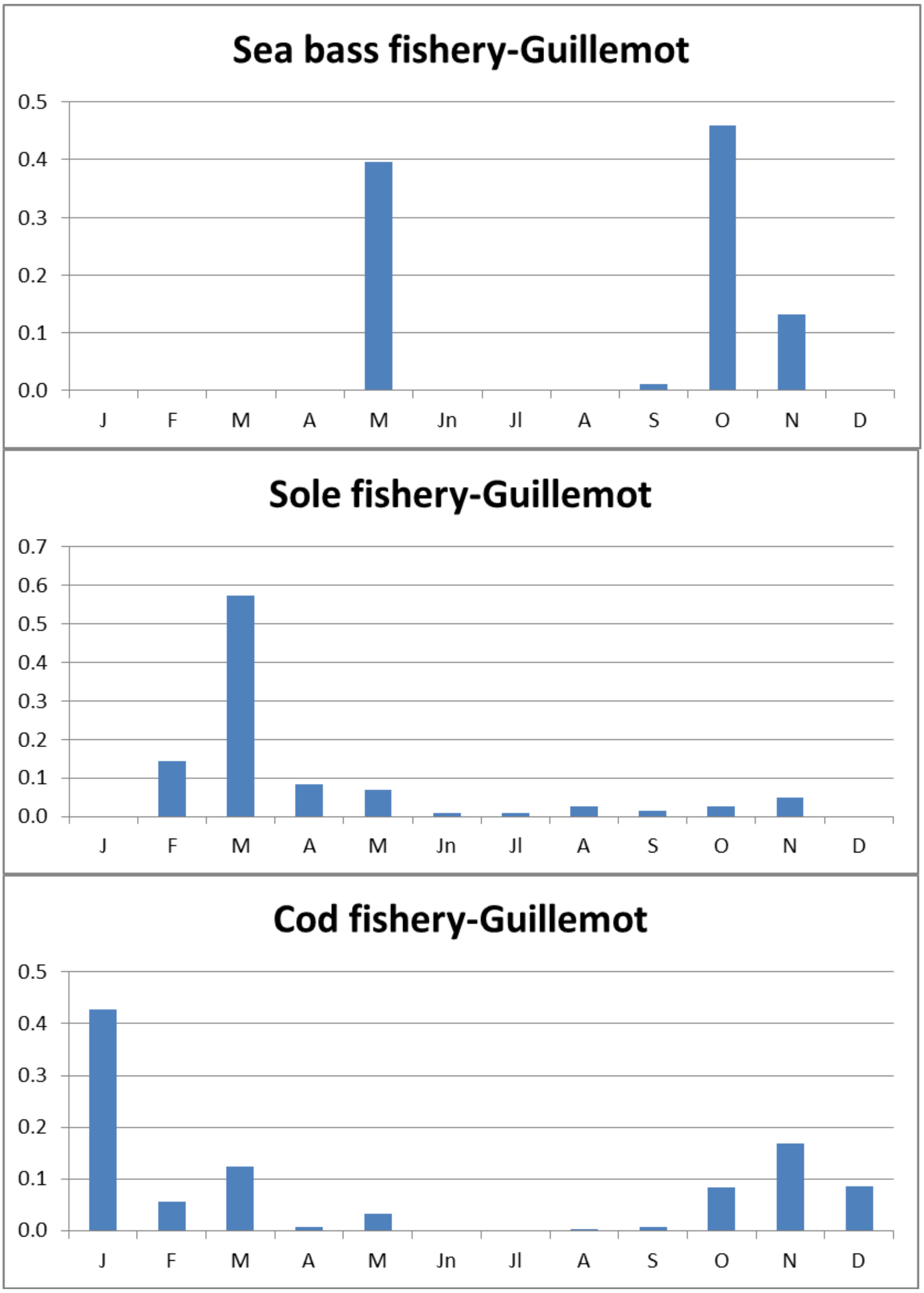

Figure 14 Relative temporal overlap of gillnet fisheries for guillemots.

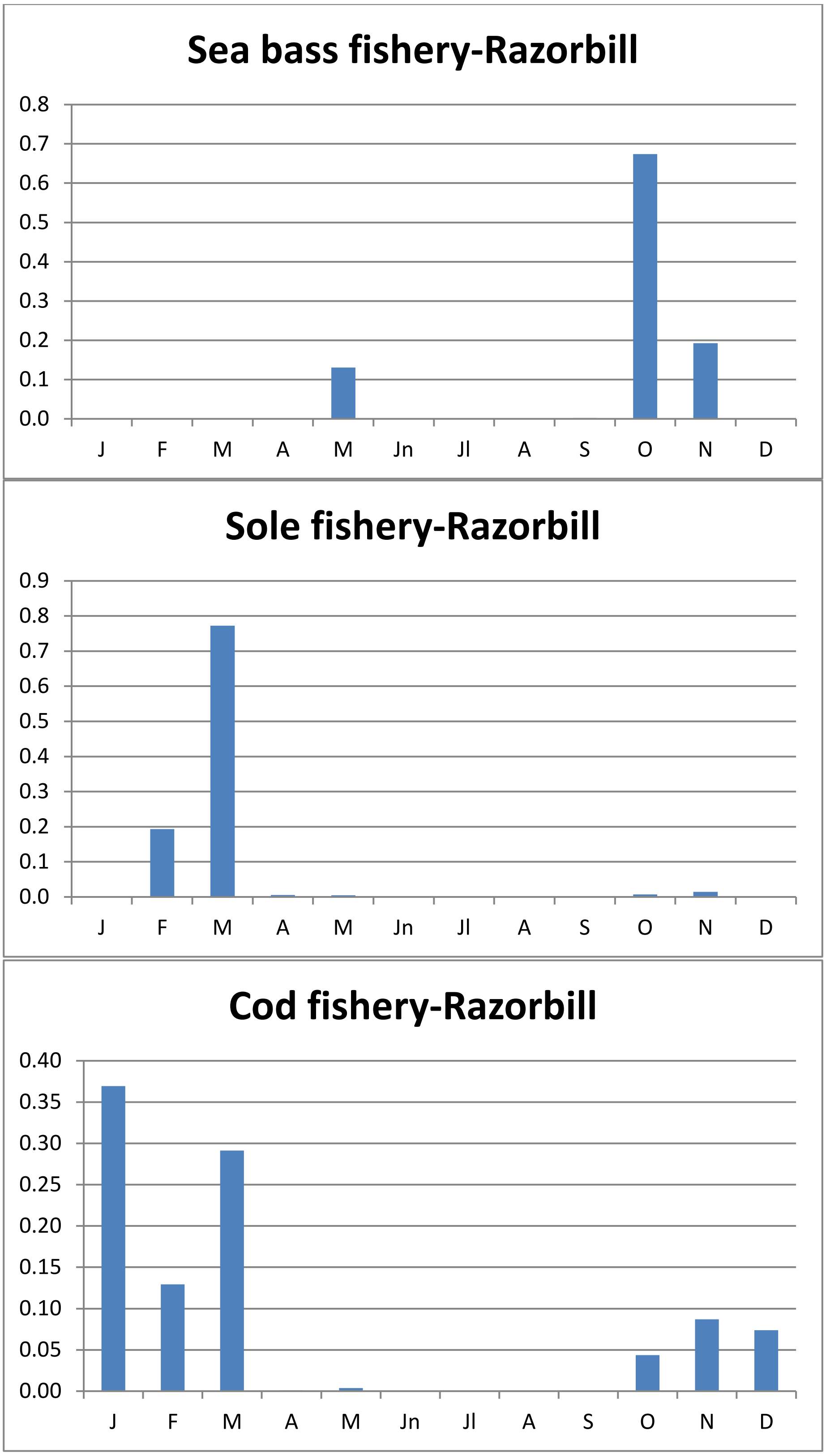

Figure 15 Relative temporal overlap of gillnet fisheries for razorbills.

7.4 Bycatch risk

It would be very helpful for the impact analysis to have quantitative data for the actual numbers of individual seabird fount entangled in gillnets in the area, over the year. The bycatch probability could then be expressed in number of mortal birds per km net length per year. However this kind of data is not available. As already described in chapter 5 many factors influencing the bycatch probability are involved making modelling bycatch probability very complicated. In addition the bycatch chance will probably differ for each combination of diving bird species and gillnet type. Therefore monitoring of bycatch seems an obvious approach.

7.5 Difference between gillnet types

In the FIMPAS projects (ICES, 2011) a literature review was carried out to reveal differences among gillnet types with respect to the risk of seabird bycatch. A basis for differences was not found. However there is a lack of knowledge on this subject (Žydelis *et al.*, 2013). Bellebaum *et al.* (2013) studied seabird bycatch in coastal set net fisheries in the eastern part of the German Baltic Sea. When accounting for season and location, differences in bycatch probability between fishing métiers were weak and disappeared when fishing effort was included in the model. In other words: any type of gillnet is likely to catch diving seabirds, if these are present at the time of fishing, and forage near the sea floor.

7.6 Integration

The impact of gillnet fishery on seabirds results from integration of the factors analyses above. The Brown Ridge is quite deep which reduces the risk significantly of sea birds being caught by gillnets standing on the sea floor (as compared to Dutch coastal waters). From the little information on diet and diving behaviour (during daylight only), razorbills would seem to be mainly shallow divers in the Brown Ridge area, which would reduce their risk of being by-caught significantly. Guillemots however dive deeper. Although the true bycatch risk is unknown, probably the risk is considerably higher than for razorbills. The months of January, March, May, October and November provide the greatest risk of encounter for the guillemot. Because the actual magnitude of the problem is unknown, monitoring the bycatch of diving seabirds should be a first step in the process and an alternative to temporal closure of the Brown Ridge.

The conclusion for the impact on common guillemots in the present study is in line with the ones from the FIMPAS project (ICES, 2010, 2011). In the FIMPAS project an impact assessment was carried out for gillnet fisheries in the Frisian Front. In the workshops a fishing gear impact matrix for the conservation objectives was composed. A high impact level was indicated for the impact of gillnets on common guillemots. High impact levels was defined as “direct disturbance, the continuity of the species is in danger”. The judgement is based on majority opinions of the stakeholders (industry, scientists, NGO’s) (ICES, 2011).

8 Draft measures

The conclusion of the impact assessment (chapter 7) was that no measures might be necessary for the razorbill, whereas measures may be necessary for the common guillemot for precautionary reasons. The bycatch of one guillemot or razorbill is already critical in case the Ornis criterion is chosen (chapter 5), which makes this criterion rather impractical in this particular situation.

It is recommended to start with monitoring the bycatch of guillemots by three gillnet fisheries in the Brown Ridge in the critical period of the year (October–May). Although the attention will be focussed on guillemots, in this monitoring other sea bird species like the razorbill among the bycatch victims should be registered as well.

In case monitoring of bycatch of common guillemots and razorbills demonstrates absence of bycatch of guillemots and razorbills it can be concluded that measures will not be necessary. In contrast substantial bycatch of these species will urge the need for effective measures. Anticipating on the outcome we can provide the general ideas existing on optional mitigation measures for bycatch (Žydelis *et al.*, 2013):

- Spatial-temporal closures
- Visual alerts (visibility of gillnet)
- Acoustic alerts (pingers)
- Restrictions on fishing depth
- Change of fishing gear

The most feasible options are spatial and temporal regulation of fishing effort and gear substitution. A ban on gillnetting in Californian waters at depths below 90 meter has nearly eliminated formerly high bycatch of common guillemots (Carretta & Chivers, 2004 In: Žydelis *et al.*, 2013). Increasing visibility of nets also seems promising but not for birds diving at night. Further research on mitigation measures is required (Žydelis *et al.*, 2013).

In FIMPAS project (ICES, 2011) an agreement was reached with respect to mitigation measures for the impact of gillnet fishery on common guillemots in the Frisian Front: a ban on gillnetting in the Frisian Front from 1ste June to 30th November. This measure was considered to be sufficient to contribute to the achievement of the conservation objectives in that particular situation, where guillemot densities are highest in a relatively short, post-breeding (summer) season. A monitoring programme for seabird numbers and seabird bycatch will be needed in a 6 years assessment a VMS obligation for all vessels is required.

The decision on a total ban on gillnet fishing from June-November was based on the precautionary principle. It should be noticed that the distribution of common guillemots differs between Frisian Front and Brown Ridge which will lead to a different period for closures for the Brown Ridge. In case this type of measure will be regarded necessary in future assessments.

In the FIMPAS projects (ICES, 2011) it was concluded that there seems to be no necessity that the management regime for gillnet fisheries in the Frisian Front should account for differences among gillnet types, based a literature review.

Bellebaum *et al.* (2013) recommended specific measures to reduce bycatch risk in the German coastal fisheries using effort reductions and replacement of set nets with alternative gear.

Specific for the present study on seabird bycatch in the Brown Ridge area it is difficult to predict the effectiveness of measures due to the absence of information on the bycatch risk without mitigation measures. It is plausible that temporal closure is a feasible and effective measure in the period when the highest density of common guillemot occurs. This is a half year period running from October to March (see Figure 13). In this period there is relatively little Mullets and Sea bass fishery except for the month October and relatively little sole fishery except for the month March (see Figure 6). On the other hand the effort of cod fishery is above its average effort in the winter half year. The absolute effort and economic value of cod fishery in the Brown Ridge is low (see Figure 8).

Still, measures like a closure of the fishery will impact that fishery and there is, as yet very little evidence (pro or contra) for the magnitude of the bycatch problem. Therefore, there would seem to be every reason to measure the actual amount of bycatch in the area.

9 Knowledge gaps

There are many important knowledge gaps in seabird bycatch in gillnet fisheries in general (Žydelis *et al.*, 2013) which hampers the impact assessment for the Brown Ridge. An example of a recently initiated study is EASME/EMFF/2015/04: “Study on mitigation measures to minimise seabird bycatch in gillnet fisheries.”

The major knowledge gap is the insight in the occurrence of bycatch of guillemots and razorbills in gillnets in North Sea areas like the Brown Ridge which are of intermediate depth. The most effective way to gain this insight is by monitoring bycatch carried out by the fishers, in combination with independent researchers.

Bycaught auks, especially in offshore locations, provide a unique opportunity for stomach content analysis. If dead birds can be made available for such studies, more can be learnt about their ecology in the Brown Ridge area.

The distribution and density of sandeels in the Brown Ridge area is poorly known, especially in the winter half year. In case sandeels are relatively abundant in the area it can be expected that guillemots are attracted to dive deep raising the risk to get entangled in gillnets. Sandeels are not specifically monitored in Dutch water and this information can be obtained from the stomach contents of dead birds.

The estimation of the economic value of the fisheries contains large uncertainties, especially the analysis of the foreign fleets. The main reason for this is the use of average catch rates and value data for the whole southern North Sea. Therefore the estimated values can only be seen as crude estimates. For Dutch data, the coverage of data for passive gears is not as good as for other fisheries. There are many small vessels in the gillnet fisheries that do not carry VMS and tend to catch lower volumes not necessarily reported in logbooks because there is no obligation to report fish volumes less than 50kg.

10 Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 124296-2012-AQ-NLD-RvA). This certificate is valid until 15 December 2015. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Fish Division has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

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Justification

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The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

Approved: Dr. M.F. Leopold
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Date: 21 December 2015