Cumulative effects of offshore wind farms: loss of habitat for seabirds

Update for five seabird species until 2030.

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Inhoudsopgave

Abstract

This report updates 'A first approach to deal with cumulative effects on birds and bats of offshore wind farms and other human activities in the Southern North Sea' (Leopold *et al.* 2014) in response to the '2030 Roadmap for Offshore Wind Energy'[1]. In addition to assessing the wind farms that will be built in the period leading up to 2023, it also describes the construction schedule and locations for the offshore wind farms due for construction in the period leading up to 2030.
The assignment includes the updating of seabird density maps for a total of ten seabird species (Table 2) using the approach from the Leopold *et al.* (2014) report, supplemented with survey data that have become available for the years 2013-2017. There are concerns for the selected species about the risks of collision (with offshore wind turbines) or habitat loss, which can affect the population (possibly significantly). Five of the ten selected seabird species are considered to be at particular risk of habitat loss; these five species are discussed in this report against the background of the planned roll-out of offshore wind until 2030.

The knowledge question to be addressed relates to the habitat loss that may occur for five seabird species (divers, i.e. Red-throated and Black-throated Divers (studied in conjunction), Northern Gannet, Sandwich Tern, Common Guillemot and Razorbill) as a result of the ongoing development of offshore wind farms in the southern and central North Sea, both in a national context (the Dutch EEZ or DCS: national scenario) and an international context (international scenario). Using the Relative Displacement Score from the extended Bradbury method as elaborated in Leopold *et al*. (2014), the step is made from affected seabirds to expected additional mortality as a result of habitat loss. These modelled mortalities are compared with the reference measure Potential Biological Removal (PBR).

The reference measure used in the assessment of, among other things, habitat loss is the PBR. It calculates - on the basis of the population size of the species concerned, population status and recovery capacity - the number of victims the population can cope with on an annual basis without being endangered. To determine the PBR, this study adopted a population size based on the numbers of seabirds that can be determined using the seabird density maps (Section 3.4.1). The national scenario is linked to the population on the Dutch Continental Shelf (DCS) and the international scenario to the population in the international areas of the North Sea. The local mortality due to habitat loss caused by wind farms in the study area is therefore compared with the local populations of the seabirds concerned, in other words the numbers at sea counted in the study area.

The results are presented in the form of a comparison with maps alongside each other showing the season with maximum numbers and a season with minimum numbers (in offshore wind farms), and an approach in more detail in which the focus is on the reference years 2023 and 2030. Tables and figures are given to support this more detailed approach. For the international scenario, the figures provide a general idea of how habitat loss is developing with the ongoing construction of wind farms over the years, and of the distribution among the countries involved (Belgium, Great Britain, Denmark, Germany and the Netherlands).

The *Discussion and conclusions* chapter presents absolute numbers of victims and numbers with respect to the PBR (Table 15). At the national level, the Razorbill *(Alca* torda) is the species with the highest proportion of victims in relation to the PBR, followed by the Common Guillemot (Uria aalge). Internationally, these two species are particularly important, with divers (*Gavia* spec.) occupying third position.)

In summary: number and percentage of victims by comparison with PBR for the various seabird populations due to habitat loss Reference year 2030.

Species	Scientific name	National Number victims (2030)	National % PBR (2030)	International Number victims (2030)	International % PBR (2030)
Divers	*Gavia* spec.	2	0.4%	575	4.1%
Northern Gannet	*Morus bassanus*	22	0.7%	160	0.7%
Sandwich Tern	*Thalasseus sandvicensis*	11	0.9%	92	1.6%
Common Guillemot	*Uria aalge*	513	3.8%	16140	5.1%
Razorbill	*Alca torda*	110	23.1%	3159	26.7%

N.B. The numbers of victims and the size of the population are inextricably linked. They were established in a similar way and can therefore only be used in conjunction for a realistic estimate.

With regard to the farms that have already been built and that are still to be built on the DCS, the analysis shows that the impact on three of the five species studied in terms of potential habitat loss is relatively small. The Razorbill and the Common Guillemot suffer heavier losses (the maximum habitat loss rises to 23% of the PBR for Razorbills in 2030, and to 4% for Guillemots, whereas it is less than 1% for the other three species). Internationally, the percentages are higher, with the value being highest for the Razorbill (up to 27% of the PBR). The locations of the British farms in particular overlap with areas with quite high predicted densities of Common Guillemots and Razorbills. The divers are affected most severely by the developments in Germany.
Dutch waters remain relatively favourable areas for four of the five species analysed here because the densities of the species studied outside the DCS are significantly higher: the Northern Gannet, Common Guillemot and Razorbill in British waters, and divers in German waters. Dutch waters are relatively important for the Sandwich Tern from the international perspective. However, because this species mainly moves around within the 12-mile zone, where no wind farms are planned in the current scenarios, the impact remains small.

The concluding chapter *Recommendations and Knowledge Gaps* sets out a number of recommendations for drawing attention to knowledge gaps relating to behavioural changes in seabirds, the availability of international survey data, the refinement of OWF scenarios with decommissioning data, etc.

The annexes provide a description of how data have been worked up prior to the production of the revised seabird density maps and the survey activities, both geographically and over time for the two databases used. The survey data were discussed extensively during a project workshop (July 2018), at which the latest decisions were made about the seabird density maps. The annex with the Atlas of Seasonal Maps, International and National, includes a map for each of the five seabird species and all six seasons. An annex has been included showing the characteristics of the wind farms. The seasonal seabird numbers adopted for all OWFs have been included in two annexes (one national and one international).

1 Introduction

This report updates 'A first approach to deal with cumulative effects on birds and bats of offshore wind farms and other human activities in the Southern North Sea' (Leopold *et al.* 2014) in response to the '2030 Roadmap for Offshore Wind Energy'[1]. In addition to the wind farms that will be built until 2023, it also sets out the construction schedule and location of the offshore wind farms in the period leading up to 2030.

The assignment includes the updating of seabird density maps for a total of ten seabird species with the data used in the Leopold *et al.* (2014) report, supplemented with survey data that have become available for the years 2013-2017. There are concerns for the selected species about the risks of collision (with offshore wind turbines) or habitat loss, which can affect the population (possibly significantly). Five of the ten selected seabird species are considered to be at particular risk of collision. Bureau Waardenburg analysed and reported on these species. The other five 'species', namely divers (mostly Red-throated Diver in the study area), Northern Gannet, Sandwich Tern, Common Guillemot and Razorbill, are considered to be mainly affected by habitat loss: these species are discussed in greater detail in this report.

On the basis of the updated maps for seabirds affected by habitat loss, WMR has made an analysis of extent and severity. Two scenarios were used: a national scenario limited in spatial terms to the Dutch EEZ or DCS (Dutch Continental Shelf) and an international scenario, which extends over the southern and central North Sea (after Leopold *et al*. 2014). This area overlaps with the EEZs for Belgium, England, Scotland, Norway, Denmark, Germany and the Netherlands. The information about existing wind farms and wind farms to be built in the future used as a basis for both scenarios was supplied by Rijkswaterstaat and it includes an up-to-date estimate of the development of offshore wind farms until 2030 (see Figure 1).

[1] Letter to the Lower House of the Dutch Parliament dated 27 March 2018, 2030 Roadmap for Offshore Wind Energy, https://zoek.officielebekendmakingen.nl/kst-31710-45.html

2 Knowledge question

The knowledge question to be addressed is the calculation of habitat loss for the 2030 Roadmap and the international roadmap prior to 2030 in line with the approach adopted in the previous KEC (Leopold et al. 2014). The following bird species were considered:

- Common Guillemot
- Razorbill
- Divers (Red-throated Diver and Black-throated Diver, with Red-throated Divers in the study area accounting for the overwhelming majority; however, the two species are often merged during surveys at sea because they are difficult to distinguish from each other)
- Northern Gannet
- Sandwich Tern

The assessment area is the Dutch Continental Shelf and the southern and central North Sea for the national and international scenarios respectively. This study was based on revised seabird density maps drawn up in accordance with the methods previously developed (Leopold et al. 2014) and supplemented with new data in line with agreements about the use of databases and periods adopted during a project workshop in July 2018 (Bravo Rebolledo & Gyimesi 2018).

The results have been set out in a concise report that describes the calculations and includes supporting text. The report also contains concise recommendations relating to the international scenario.

3 Methods

The sections that follow describe the elements required for an assessment of habitat loss.

- The national (DCS) and international (southern and central North Sea) scenarios and the areas to which they relate.
- The offshore wind farms used in this study.
- The revised seabird density maps.
- The numbers of seabirds present in the offshore wind farms.
- The population size as determined and used for this study on the basis of these maps.
- The conversion factor from affected seabirds to mortality (victims) due to habitat loss (Relative Displacement Score).
- The determination of the PBR (Potential Biological Removal) based on the population size as determined in this study taking into account the current estimate of the status of the population.

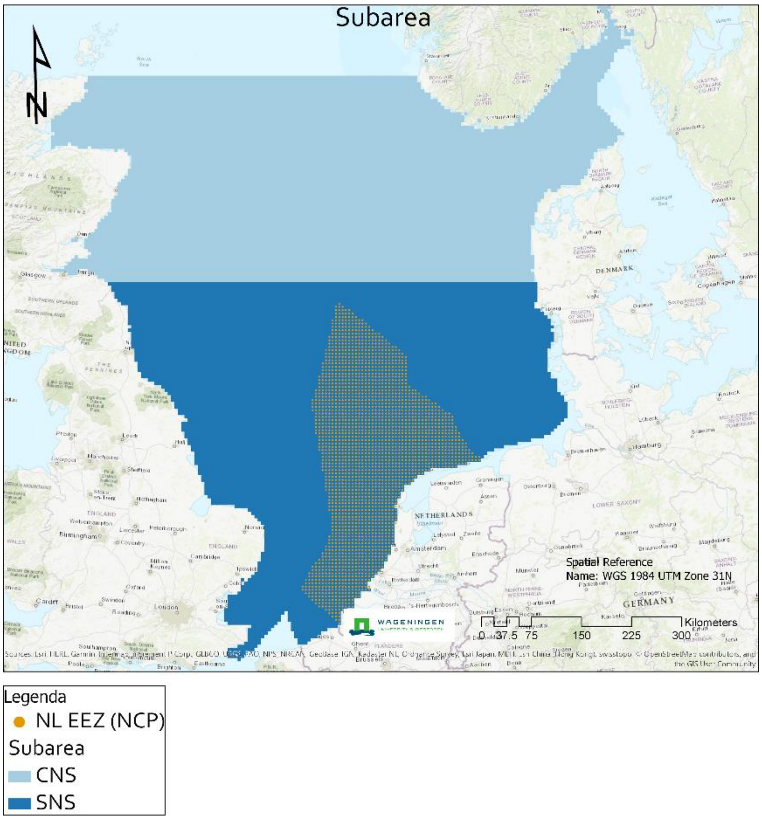
3.1 Scenarios and areas

This study (KEC 2018) elaborates two scenarios.

1) The national scenario, which is limited to the Dutch part of the North Sea, in other words the Dutch Exclusive Economic Zone (EEZ) and the Territorial Zone (TZ), which are generally referred to jointly as the Dutch Continental Shelf or DCS.
   This geographical limitation has an impact on both the offshore wind farms (Dutch farms only) and the seabird density maps.
2) The international scenario, which includes the southern and central North Sea (SNS and CNS respectively), with the DCS being an integral part of the SNS. These areas overlap with the EEZs for Belgium, England, Scotland, Norway, Denmark, Germany and the Netherlands.
   This scenario is based on both international and national offshore wind farms and seabird density maps compiled for this area.

See Figure 1 for a map of the areas listed above. Leopold *et al.* (2014) consistently show only the southern North Sea (SNS) for international maps because the OWFs assessed in that study were located in that area. The more northerly area of the central North Sea (CNS) was included in the calculations for the seabird density maps.

Figure 1 The study area. The international scenario covers the southern North Sea (SNS) + central North Sea (CNS), including the DCS (=NCP in figure 1); the national scenario covers the DCS.

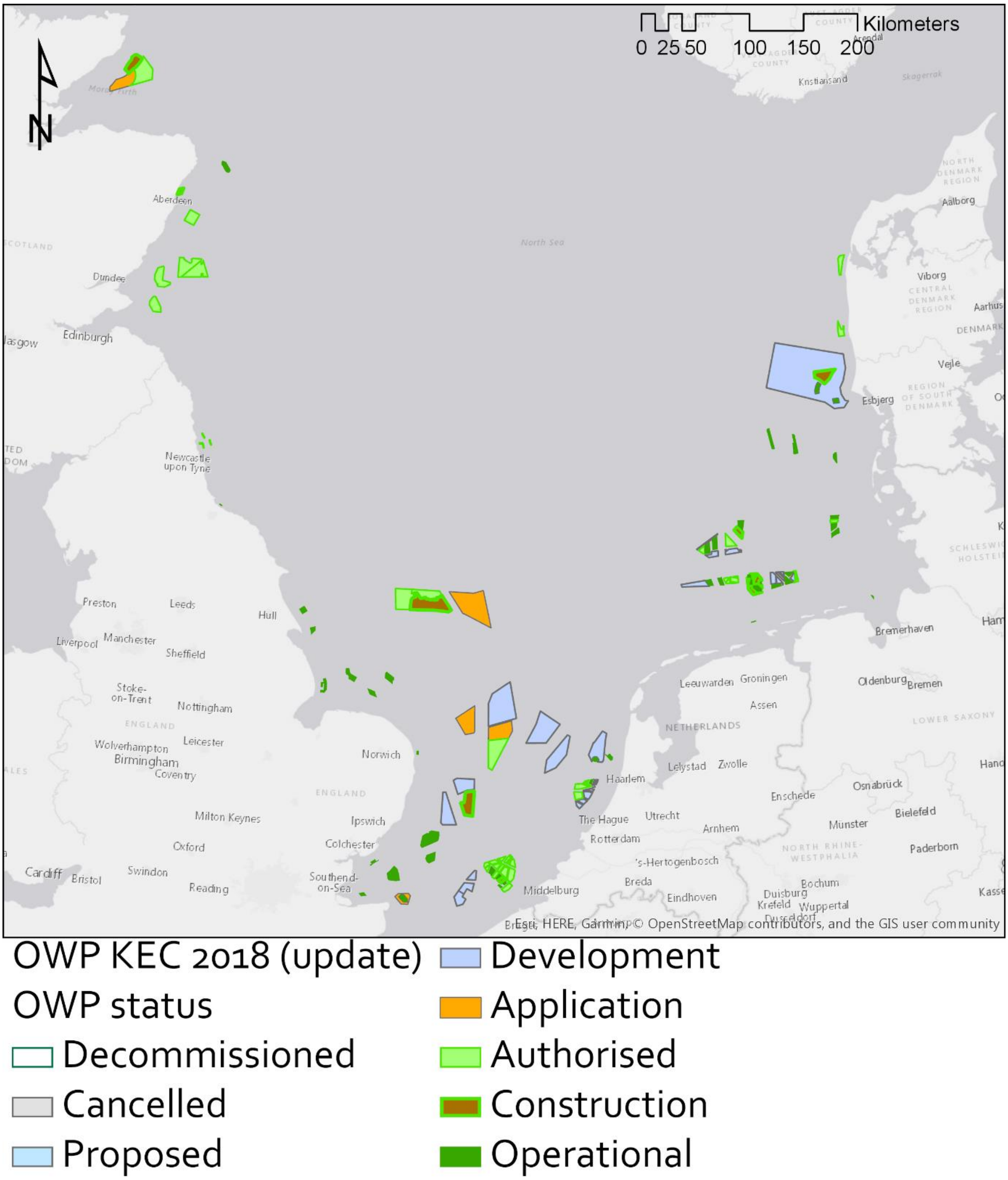


The offshore wind farms are discussed in more detail in 3.2 Wind farms.

3.2 Wind farms

The map of the offshore wind farms covered by the national and international scenarios (Figure 1) was compiled by WMR on the basis of several files supplied by Rijkswaterstaat. Information about the foreign wind farms in the files supplied by Rijkswaterstaat was provided by the governments of the countries concerned. WMR merged the files supplied into a single geographical dataset, adding some Danish OWFs in consultation with Rijkswaterstaat. For a limited number of planned German OWFs, the expected location was specified on the basis of BSH (2018).

Figure 1: Overall map of the offshore wind farms (OWP in figure 2) used for the 2018 KEC (update). Colour coding in line with status or development phase (as at summer 2018).



The basic data for the national scenario were supplied by Rijkswaterstaat before the project began (see Table 1). A table with the OWFs in the international scenario and their characteristics has been included as 0 of this report, which was also compiled by Rijkswaterstaat in collaboration with government bodies in other countries.

Table 1: Offshore wind farms for the national scenario (source: Rijkswaterstaat)

Wind farm/site	Owner	Size	Construction
OWEZ	Noordzeewind	36*3=108 MW	2007
Amalia	Eneco	60*120*10=1520 MW	2008
Luchterduinen	Eneco	43*3*129=1520 MW	2015
Gemini	Gemini	2*75*4=600 MW	2016
Borssele I/II	Orsted	2*47*8=752 MW	2020
Borssele III/IV	Blauwwind	(40+37)*9.5=731.5 MW	2020
Borssele V	Two Towers	2*9.5=19 MW	2020
Hollandse Kust (South) I/II		2*47*8=752 MW	2021
Hollandse Kust (South) III/IV		2*47*8=752 MW	2022
Hollandse Kust (North) V		95*8=760 MW	2023
Hollandse Kust (West) VI/VII		2*76*10=1520 MW	2024/2025
Ten Noorden van de Waddeneilanden I		76*10=760 MW	2026
IJmuiden Ver		400*10=4000 MW	2027-2030

3.3 Seabird density maps

In the context of the 2018 KEC study, revised density maps were produced for the purposes of determining habitat loss for five seabird species. For the purposes of a related study (Bureau Waardenburg) about collisions (birds that can be hit by the rotors of an offshore wind turbine), the density maps were revised for another five species. Table 2 shows the species for which the density maps were revised and for what reason. This report confines itself to species that may be threatened by habitat loss.

Table 2 Overview of seabird species for which revised density maps have been calculated, including why these species are at risk

EUring	Scientific name	English name	Dutch Name	Reason for risk
5690	*Stercorarius skua*$	Great Skua	Grote Jager	Collision
5910	*Larus fuscus*	Lesser Black-backed Gull	Kleine Mantelmeeuw	Collision
5920	*Larus argentatus*	Herring Gull	Zilvermeeuw	Collision
6000	*Larus marinus*	Great Black-backed Gull	Grote Mantelmeeuw	Collision
6020	*Rissa tridactyla*	Black-legged Kittiwake	Drieteenmeeuw	Collision
59*	*Gavia* spec.	Diver spec.	Duiker	Habitat loss
710	*Morus bassanus*	Northern Gannet	Jan-van-Gent	Habitat Loss + Collision
6110	*Thalasseus sandvicensis*#	Sandwich Tern	Grote Stern	Habitat loss
6340	*Uria aalge*	Common Guillemot	Zeekoet	Habitat loss
6360	*Alca torda*	Razorbill	Alk	Habitat loss

$ *Catharacta skua* (recent name change)

*EUring 20 and 30 (Red-throated and Black-throated Diver), but predominantly Red-throated Diver (>90%)

previously *Sterna sandvicensis* (recent name change)

The adopted procedure is identical to the procedure in the original KEC study (Leopold *et al.* 2014) but new survey data have been added for the years 2013 to 2017. The method for drafting the new seabird density maps was adopted at a workshop in July 2018 (Bravo Rebolledo & Gyimesi 2018). For the international maps, 1991 was maintained as the first year for the processed survey data; the year was changed to 2000 for the national maps (

Table 3). Once again, two databases were used: those of the Dutch MWTL programme (Survey Waterstaatkundige Toestand des Lands, *Survey of National Water Management Status*) and the international European Seabirds At Sea (ESAS).

Table 3 Overview of databases, periods and approaches adopted for the revision of seabird density maps

Birds	International	National
'non-gulls' • 59, Divers • 5690, Great Skua • 6110, Sandwich Tern • 6340, Common Guillemot • 6360, Razorbill	ESAS+MWTL 1991-2017	ESAS+MWTL 2000-2017
'gulls' • 710, Northern Gannet • 5910, Lesser Black-backed Gull • 5920, Herring Gull • 6000, Great Black-backed Gull • 6020, Black-legged Kittiwake	ESAS+MWTL 1991-2017 (fishy-tail and therefore spread to >10/km2 in observation, c.f. Leopold *et al.* 2014)	MWTL 2000-2017 (fishy-tail and therefore spread to >10/km2 in observation)

See 0 Working up data and workshop report (Bravo Rebolledo & Gyimesi 2018) for more details. The maps and figures in 0 Survey Effort were important during the workshop for the determination of the periods to be used (International 1991-2017 and National 2000-2017 respectively).
0 Seasonal seabird density maps per season provides a seasonal map for each of the species (from the habitat-loss group). More can be found about the seasons in Table 4.

Table 4 Seasons (periods of two months designated by two-letter codes)

Season	Code	Months
1	AS	August - September
2	ON	October - November
3	DJ	December - January
4	FM	February - March
5	AM	April/May
6	JJ	June - July

In this chapter, we provide a summary of the annual average situation for each of the species (average for six 'seasons': periods of two months each). 0 contains the seasonal maps.

Figure 2 shows the distribution of the five seabirds on the DCS and Figure 3 shows the distribution for the international areas of the North Sea. It is clear that divers and Sandwich Terns are much more coastal than Northern Gannets, Common Guillemots and Razorbills. As a result, the last three species collide with OWFs both close to the coast and far out to sea, while divers and Terns are affected only by farms that are not too far offshore.

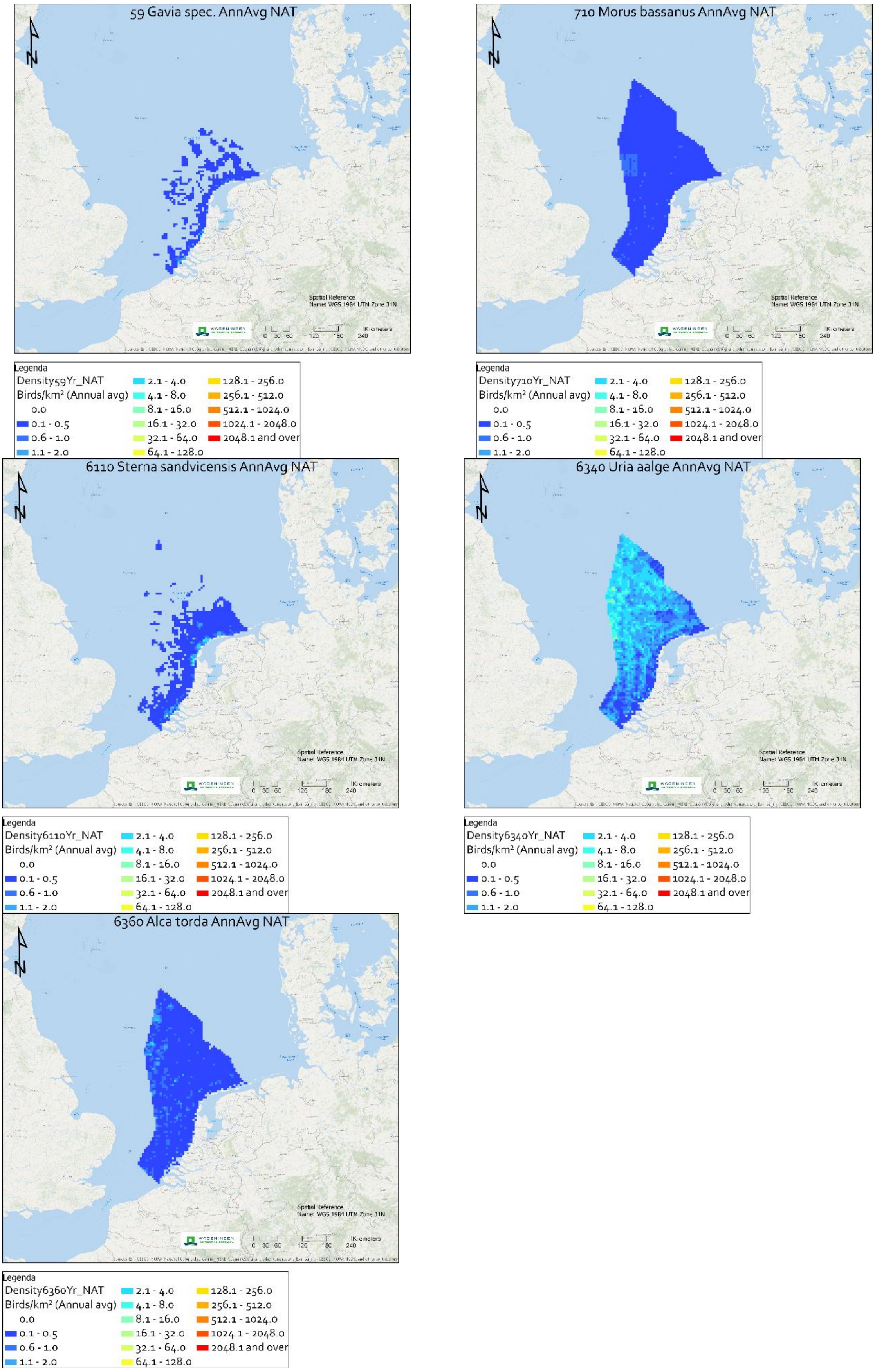


Figure 2 Average distribution of the five seabird species: divers, Northern Gannet, Sandwich Tern, Common Guillemot and Razorbill, national scenario

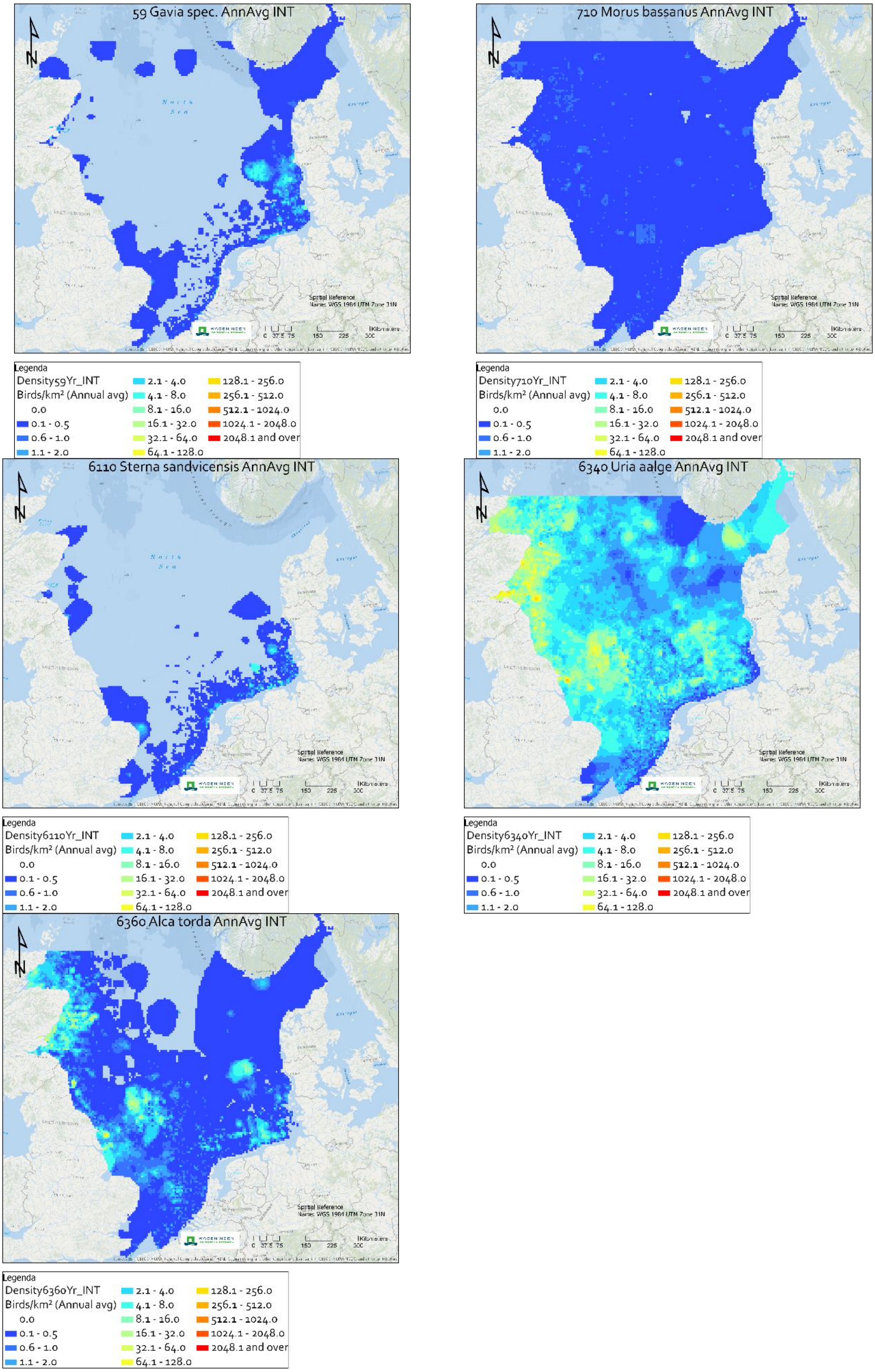


Figure 3 Average distribution of the five seabird species: divers, Northern Gannet, Sandwich Tern, Common Guillemot and Razorbill, international scenario

3.4 Determination of the numbers of affected birds

To determine the number of affected birds, it is important to determine the footprint of a wind farm. The footprint of a wind farm is determined by taking the built area plus a buffer of 500 metres (cf. Leopold *et al.* 2014). This approach is adopted because the boundaries of operational farms and farms under construction are determined by the built area. The outer wind turbines are often located close to the edge, including the corners. The habitat loss to be estimated must take into account a larger area because the seabirds already avoid wind turbines outside the built area. There are indications that the distance used (500 m avoidance) is conservative because birds also exhibit avoidance behaviour outside the actual footprint of the OWP, sometimes at distances of up to several kilometres (Dierschke *et al*. 2016)

In some cases, only search areas are known for planned wind farms (Status Development in Figure 1). These areas are generally larger or much larger than the built area that will actually be used in the future. A scaling factor has therefore been applied in these cases. This reduces the numbers of potentially affected birds to realistic numbers.
The scaling factor is the ratio between the GIS surface of the site (as shown in Figure 1) and the estimated area. This estimated area is based on the MW target for an OWF and the assumption that, on balance, the density will be 6 MW installed capacity per km2. For operational farms and farms under construction, this factor is approximately 1.

In order to determine the numbers of birds in the study area (nationally and internationally), the cells (5x5 km) that overlap with the buffered OWF areas for each of the species were determined using the GIS. This process is referred to as Spatial Join. It was performed for all species on the basis of the revised seabird distribution maps as presented in Section 3.3 (see 0 for a complete overview) and on the basis of the associated seabird density maps for both scenarios.

The detailed comparison of the years 2023 and 2030 took into account the expectation that the wind farms built earliest will have been decommissioned in about 2023. At the national level, this means two wind farms: OWEZ and the Princess Amalia Wind Farm. In the international scenario, it is assumed that OWFs of the same age or older will have been decommissioned by 2023.

3.4.1 Population size of seabirds based on density maps

One of the agreements arrived at during the project workshop (Bravo Rebolledo & Gyimesi 2018) was that the population size for each bird species as present in the study area will be used for this study and the associated study of collisions. This means determining the population, in other words how many birds taken together amount to 100%, for each of the ten seabird species.
Data for the years 2000-2017 were used for the national maps; data from 1991 to 2017 were used for the international maps (

Table 3). The results of MWTL (aircraft survey) were only used for the national calculations for the Northern Gannet (710); a combination of MWTL and ESAS was used for the other four species. The aim of this section is to establish a picture of the similarities and differences in the numbers found by comparing the annual average distribution. Table 5 shows the population size in the maps. This is the sum of the multi-year averages for all six seasons.

Table 5 Total 'populations' (sum of the six seasons) for the seabird species in the national (DCS, 2000-2017) and international (SNS+CNS, 1991-2017) scenarios

			Total 'population'	
EURING	**Scientific name**	**English name**	**National**	**International**
59	*Gavia* spec.	Divers	10186	309582
710	*Morus bassanus*	Northern Gannet	76338	507215
5690	*Stercorarius skua*	Great Skua	1633	86392
5910	*Larus fuscus*	Lesser Black-backed Gull	96588	367543
5920	*Larus argentatus*	Herring Gull	91493	473144
6000	*Larus marinus*	Great Black-backed Gull	84326	434508
6020	*Rissa tridactyla*	Black-legged Kittiwake	124176	830413
6110	*Thalasseus sandvicensis*	Sandwich Tern	38602	171457
6340	*Uria aalge*	Common Guillemot	674195	15806237
6360	*Alca torda*	Razorbill	94931	2369662

The light grey background shows 'collision species' (5690, 5910, 5920, 6000, 6020), which will not be discussed further in this report.

N.B. The 'population estimates' (Table 5) are virtual. The numbers of victims are calculated in all cases for a period of two months. To compare this bimonthly mortality with PBR, it is always compared with the 'population size' for the same two months. The 'annual mortality' is also virtual. In other words, it is the sum of the separate mortality totals for the six seasons. Division of these two virtual numbers results in a realistic estimate of the annual percentage mortality (Table 5). The time factor is therefore eliminated in the mortality/PBR comparison and it was therefore also possible to calculate mortality per day. That results in 365 separate mortality figures and the annual total must then be compared with the daily population size multiplied by 365.
The values used here belong together and they should always be considered in conjunction.

The surface area of the DCS is approximately 14% of the international range of the North Sea (as used in this study). Species such as divers, Great Skua, Common Guillemot and Razorbill are relatively scarce on the DCS (2-4% of the international population is present on the DCS). The Northern Gannet and Black-legged Kittiwake are present in moderate numbers (15% of the international population on the DCS). The Herring Gull and Great Black-backed Gull are slightly over-represented (19% of the international population). The Lesser Black-backed Gull and Sandwich Tern are relatively common on the DCS (26 and 23% of the international population respectively).

3.5 Estimated number of victims

The estimate of the number of victims, or mortality due to habitat loss (Displacement Mortality), can be made on the basis of Table 6 using the conversion factor 'Relative Displacement Risk Score' as found in Leopold *et al.* (2014) This conversion makes it possible, among other things, to compare the consequences of habitat loss at the population level with mortality due to bird collisions with wind turbines.

Table 6 Conversion factor 'Relative displacement risk score' from Table 4.31 (Leopold *et al.* 2014)

EUring	Scientific name	English Name	Relative Displacement Risk Score
59	*Gavia* spec.	Divers	0.080
710	*Morus bassanus*	Northern Gannet	0.008
6110	*Thalasseus sandvicensis*	Sandwich Tern	0.024
6340	*Uria aalge*	Common Guillemot	0.036
6360	*Alca torda*	Razorbill	0.036

The Relative Displacement Risk Score is calculated using the following formula (Leopold *et al.* 2014):

RDRS = ((i x j) / (25 * 10)

where:

i represents sensitivity to disturbance;
j represents habitat specialisation;
25 is the maximum possible score in the underlying methodology of Bradbury *et al.* (2014); and
10 implements the assumption that a maximum of 10% of the affected birds will die.

The estimated number of victims results from the multiplication of the number of birds affected (0 for the national scenario and 0 for the international scenario) by the Relative Displacement Risk Score.

3.6 Threshold value of PBR

An estimate based on Potential Biological Removal (PBR) provides a reference for the assessment of an effect (habitat loss here) in relation to the population of a species. The PBR is a calculated value based on species-specific characteristics, including maximum population growth rate and minimum population size, which aims to quantify the maximum number of victims that does not endanger the survival of the population. The factors used to calculate the PBR are summarised in Table 7.

Table 7 Factors for the PBR calculation, IUCN status, Rmax and RF (taken from Annex D-4, Leopold *et al.* 2014), population size used (INT and NAT) and PBR (INT and NAT). Bold rf values have been altered with respect to Leopold *et al.* (2014)

Euring	English and Scientific name	IUCN world status	Rmax	rf	Population size INT	=Nmin NAT	PBR INT	PBR NAT
59	Divers, *Gavia* spec.	**LC**	0.18	0.5	309582	10186	13931	458
710	Northern Gannet, *Morus bassanus*	**LC**	0.09	**1.0**	507215	76338	22825	3435
6110	Sandwich Tern, *Thalasseus sandvicensis*	**LC**	0.13	0.5	171457	38602	5572	1255
6340	Common Guillemot, *Uria aalge*	**LC**	0.08	0.5	15806237	674195	316125	13484
6360	Razorbill, *Alca torda*	**NT** *	0.1	**0.1**	2369662	94931	11848	475

*Changed to NT (Near Threatened) from LC (Least Concern) after verification with BirdLife International.

The virtual population sizes used for the PBR calculation are those presented in Table 5 of Section 3.4.1. The IUCN status of the species was checked online with BirdLife International (2018) and the status was accordingly altered for the Razorbill (*Alca torda*) to Near Threatened, as a result of which the rf for that species also changed to 0.1 (from 0.5). This is in line with the approach described in Leopold *et al.* (2014). The status of the European population was followed, where relevant, for the assessment of the IUCN status. For example, IUCN's international estimate for the Razorbill is based on an increase in North America but their trend assessment clearly indicates that the European population is declining sharply (25-50% in three generations). That is the relevant subset and rf=0.5 was maintained on that basis. The situation for the European Common Guillemot population is very similar to that of the Razorbill. However, it is less serious (on a global scale) because the Common Guillemot has a larger (circumpolar) distribution area, whereas the distribution area for the Razorbill (in the Atlantic area) is more limited. Due to population growth, the assessment for the Northern Gannet turned out to be more positive than in 2014 and an rf of 1.0 (instead of 0.5) was used.

4 Results

Sections 4.1 and 4.2 provide an overview of the results by species for the national and international scenarios respectively. Six maps were produced for each species but only the two maps representing the extremes are shown here: one of the season with the maximum densities and one of the season with minimum densities in OWF areas. The latter season is not always clear: for some species there are several seasons with, for example, 0 or 1 affected individual seabirds. In that case, a minimum season close to the maximum season has been shown (e.g. one season earlier). Thin black lines show the boundaries of the OWFs in the maps. Large differences between two maps (for example in the case of the Sandwich Tern) mean that the species in question is absent for part of the year and therefore not affected by wind farms in the North Sea during that particular season. Relatively similar minimum and maximum densities in the maps (for example in the case of the Common Guillemot) mean that the species in question is present throughout the year (on a time scale of two months).

4.1 Habitat loss, National scenario

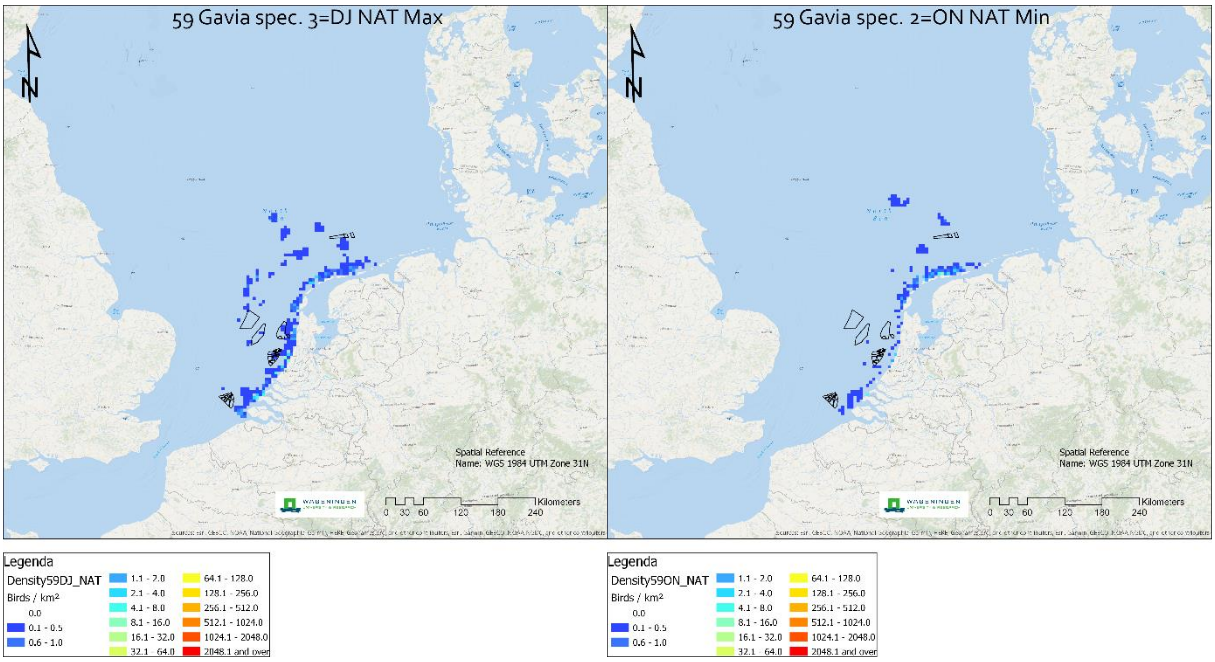
The results for the national scenario are presented here for each of the five seabird species. The maps shown are the same as the seasonal seabird density maps in 0, with the boundaries of the Dutch OWFs added. The graphs presented are based on the basic data relating to affected birds (0), to which the Relative Displacement Risk Score was subsequently applied to present the numbers of victims (mortality).

For the purposes of this study, the period for which the '2030 Roadmap for Offshore Wind Energy' was drawn up is most important, in particular the comparison of the situations in 2023 and 2030. The results are based on the assumption that the oldest OWFs in the Netherlands (OWEZ and the Princess Amalia Wind Farm) will be decommissioned before or around 2023. These two farms will therefore no longer contribute to the number of victims after 2023.

When compared with the national PBR for the birds, the level of concern for divers (Red-throated Diver) (0.4%, Figure 5) is low; the values for the Northern Gannet (Figure 7) and Sandwich Tern (Figure 9) are both higher but less than 1% of the PBR. For the Common Guillemot, the estimated number of victims in 2030 (Figure 11) is 3.8% of the PBR. The highest value is for the Razorbill: 23.1% of the PBR for 2030 (Figure 13).

4.1.1 Divers (59, *Gavia spec.*)

Figure 4 Divers, maximum (left) and minimum occurrence in offshore wind area on the DCS



Divers		
	2023	**2030**
NL	1	2
%PBR	0.3%	0.4%

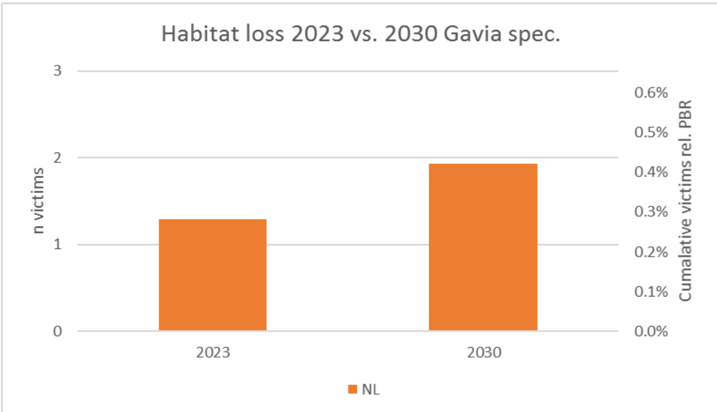
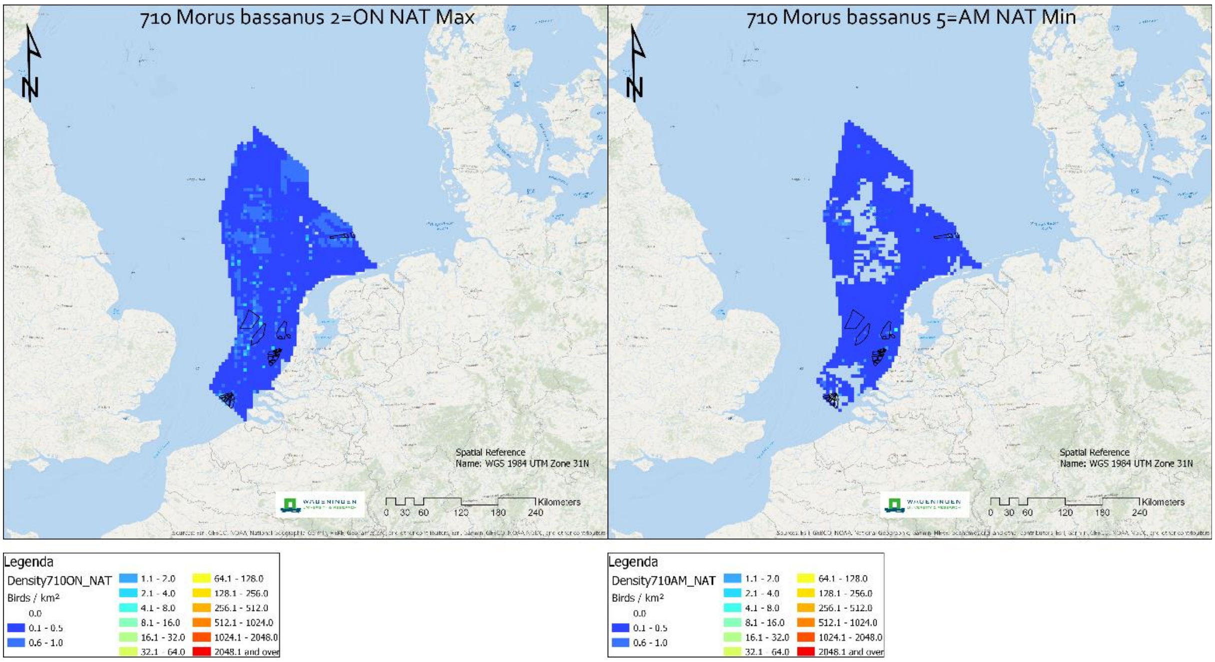


Figure 5 Overview of national habitat loss (number of victims and percentage of PBR) for divers in 2023 and 2030

The share of divers in the national Dutch population that fall victim to habitat loss in OWF footprints is, and will remain, very small: 0.4% of the PBR in 2030. The OWFs (actual and planned) are far enough offshore not to have much overlap with the current distribution of divers in the Netherlands.

4.1.2 Northern Gannet (710, *Morus bassanus)*

Figure 6 Northern Gannet, maximum (left) and minimum occurrence in offshore wind area on the DCS



Northern Gannet			
		2023	**2030**
NL		14	22
%PBR		0.4%	0.7%

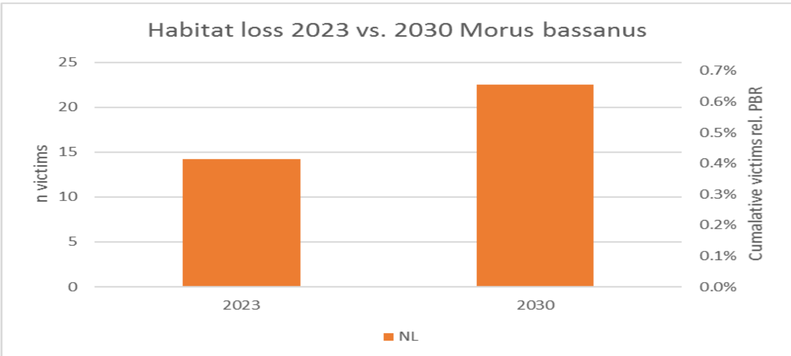
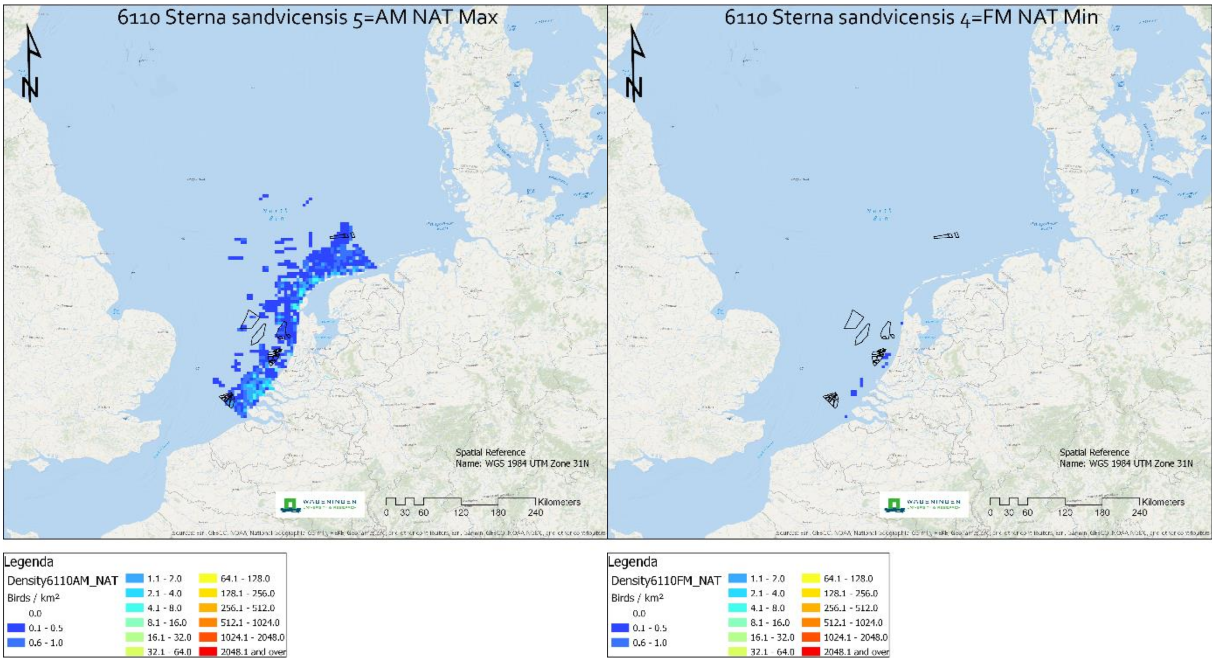


Figure 7 Overview of national habitat loss (number of victims and percentage of PBR) for Northern Gannet in 2023 and 2030

Northern Gannets are found throughout the DCS, with the result that each OWF has an effect on this species and that the cumulative effect will gradually increase to 0.7% of the PBR by 2030 if all the planned OWFs are built.

4.1.3 Sandwich Tern (6110, *Sterna sandvicensis*)

Figure 8 Sandwich Tern, maximum (left) and minimum occurrence in offshore wind area on the DCS



Sandwich Tern			
		2023	**2030**
NL		9	11
%PBR		0.7%	0.9%

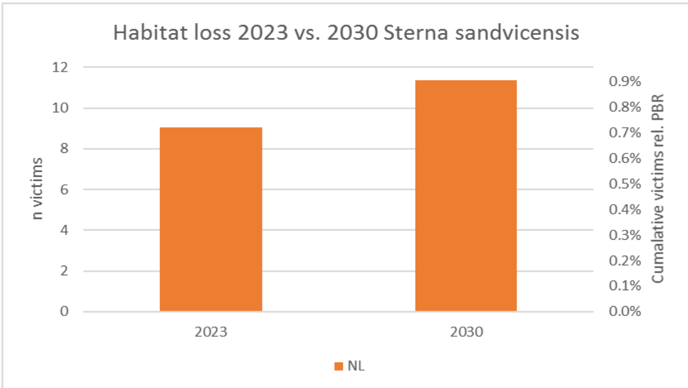
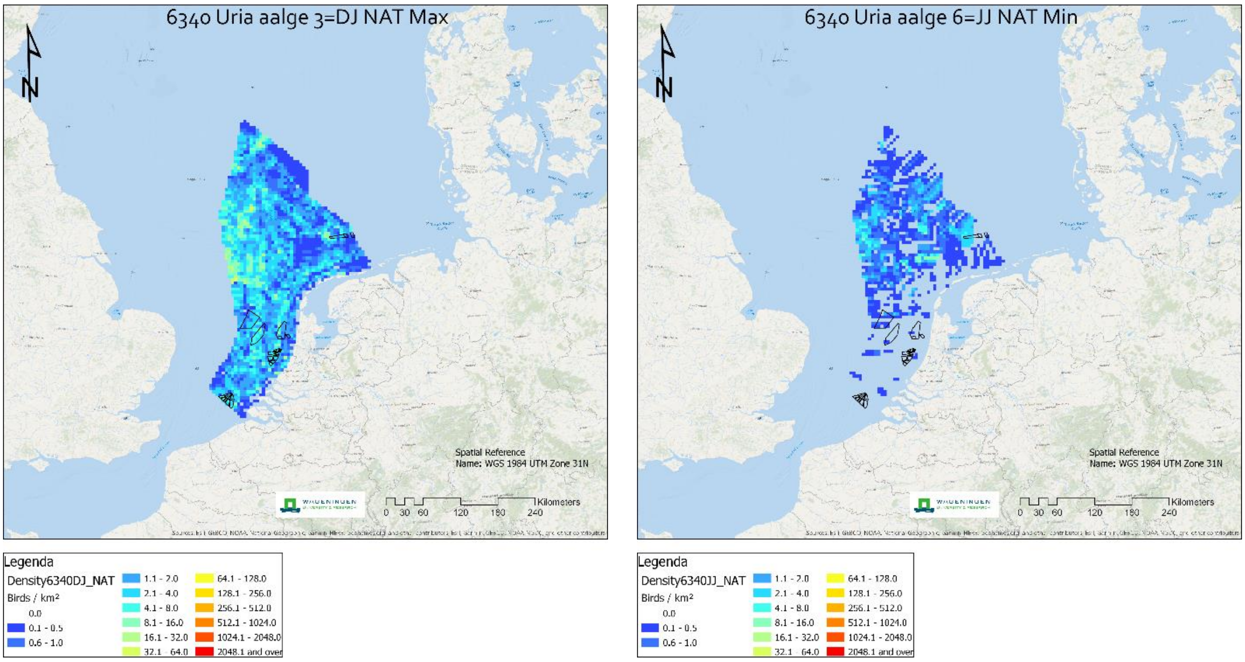


Figure 9 Overview of national habitat loss (number of victims and percentage of PBR) for Sandwich Tern in 2023 and 2030

The number of victims in relation to the PBR for Sandwich Terns in the OWF footprints is, and will remain, small: 0.9%. The OWFs (actual and planned) are far enough offshore not to have much overlap with the current distribution of Sandwich Terns in the Netherlands. This picture may be too optimistic because most of the current breeding colonies are outside the range for OWFs. This may change with the successful colonisation of new areas; the rapidly growing breeding population in De Putten (NH) is inside the range of the neighbouring OWF. It is also the case that Sandwich Terns spend the winter to the south of the Netherlands (and most of them a long way to the south) and that they are therefore not affected by wind farms in the North Sea during this season. A few birds stay in this area during the winter; the first birds return in about mid-March but they have apparently hardly been observed during the surveys at sea, if at all.

4.1.4 Common Guillemot (6340, *Uria aalge*)

Figure 10 Common Guillemot, maximum (left) and minimum occurrence in offshore wind area on the DCS



Common Guillemot			
		2023	**2030**
NL		252	513
%PBR		1.9%	3.8%

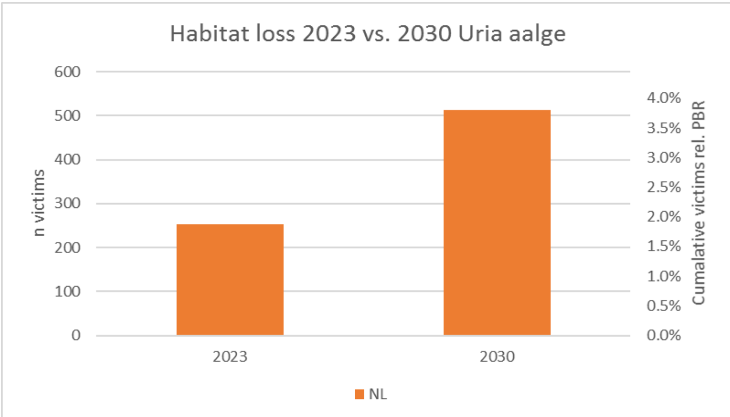
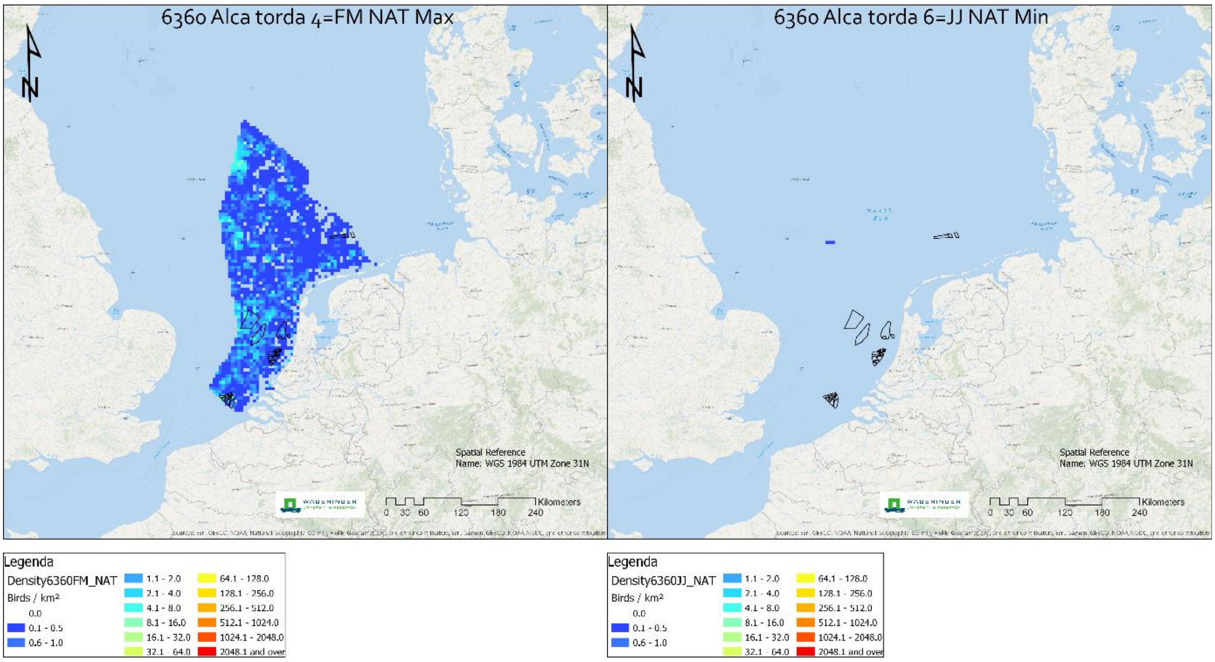


Figure 11 Overview of national habitat loss (number of victims and percentage of PBR) for Common Guillemot in 2023 and 2030

Common Guillemots are found throughout the DCS. However, there are a number of areas where this species concentrates (Frisian Front, Brown Ridge) that do not overlap with the planned OWFs. As a result, while each OWF does have an impact on this species, the cumulative effect does not increase to a major extent. If all planned OWFs are built, the effect will not exceed 3.8% of the PBR in 2030. From 2023 to 2030, the national loss of habitat will double when farms go into operation further offshore.

4.1.5 Razorbill (6360, *Alca torda*)

Figure 12 Razorbill, maximum (left) and minimum occurrence in offshore wind area on the DCS



Razorbill			
		2023	**2030**
NL		55	110
%PBR		11.6%	23.1%

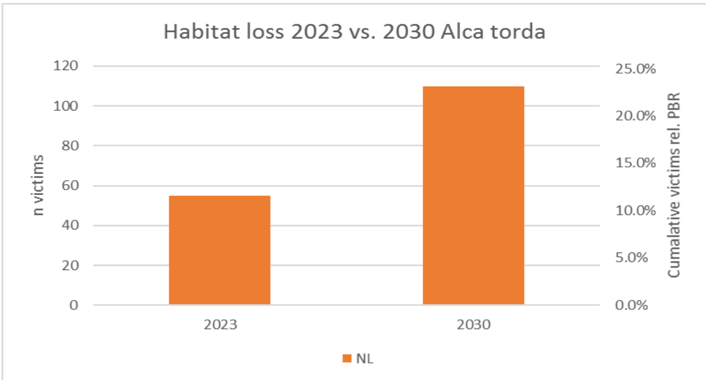


Figure 13 Overview of national habitat loss (number of victims and percentage of PBR) for Razorbill in 2023 and 2030

Razorbills are found throughout the DCS. However, there are a number of areas where this species concentrates (Frisian Front, Brown Ridge) that do not overlap a great deal with the planned OWFs. As a result, each OWF does have an impact on this species. In addition, starting in 2023, when wind farms will go into operation further offshore, the number of potential victims will increase. An effect of 23% of the PBR is expected in 2030. Habitat loss has therefore doubled in the last seven years, as in the case of the Common Guillemot. Unlike Common Guillemots, Razorbills are absent on the DCS for a longer period of time during the summer months, which means there are hardly any victims then.

4.2 Habitat loss, International scenario

The results for the international scenario are presented here for each of the five seabird species. The maps shown are the same as the seasonal maps in 0, with the boundaries of the international OWFs added. The graphs presented are based on the basic data contained in 0.
In analogy with the national scenario, it has been assumed for a limited number of foreign OWFs (Table 8) that these farms will be decommissioned before or around 2023. These are wind farms that were built earlier than the two Dutch OWFs and for which this assumption has been made in the national scenario. For the foreign OWFs, this assumption is speculative but realistic. The technical lifespan of offshore wind turbines is approximately 20 years, the age that these farms will reach about

then. As shown in the right-hand column of Table 8, these farms, which were built in the early years, occupy modest surface areas.

Table 8 Offshore wind farms for which decommissioning before or around 2023 is assumed (speculative)

OWF name	Year of construction (start)	Country	OWF surface area (GIS, km^2)
Horns Rev 1	2002	DK	19.7
Scroby Sands	2004	UK	8.8
Kentish Flats 1	2005	UK	9.9
OWEZ	2006	NL	26.1
Prinses Amalia WindPark	2007	NL	21.6

4.2.1 Divers (59, *Gavia spec.*)

Figure 14 Divers, maximum (left) and minimum occurrence in offshore wind area in the southern and central North Sea

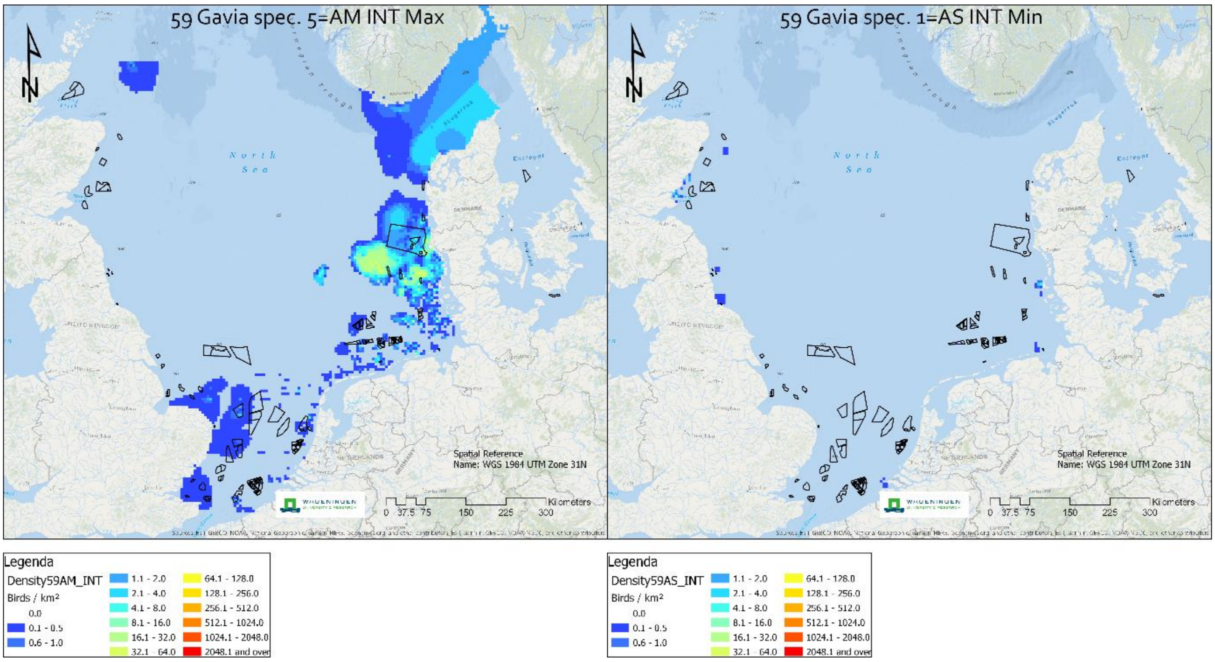


Table 9 Overview of international habitat loss (numbers of victims and PBR percentages) for divers in 2023 and 2030 by country

Gavia spec.	**2023**	**2030**
BE	13	28
UK	67	90
DK	110	155
DE	277	286
NL	11	17
Total	478	575
%PBR	3.4%	4.1%

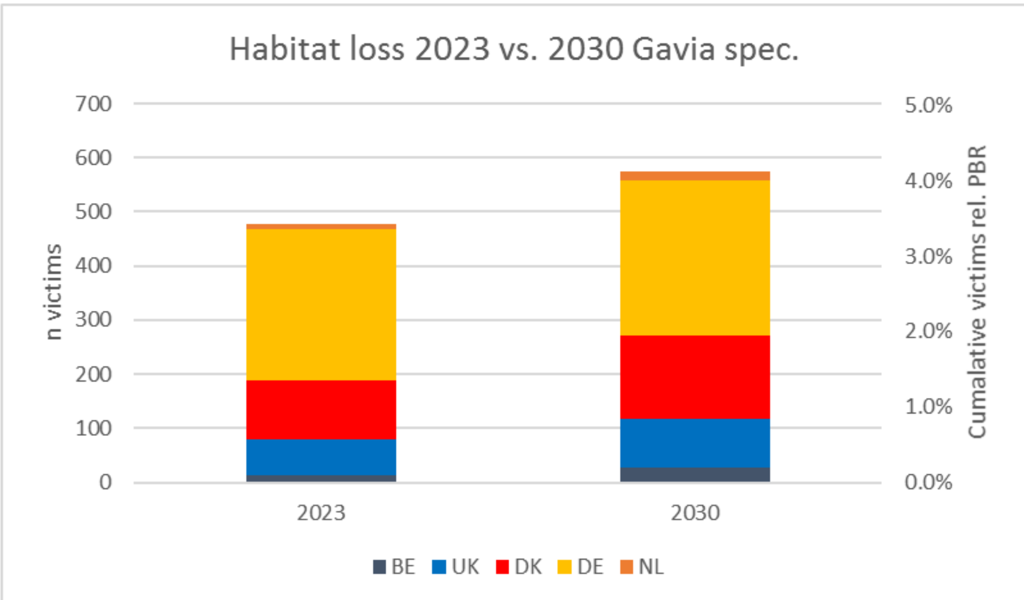


Figure 15 International habitat loss (numbers of victims and PBR percentages) for divers in 2023 and 2030 by country

The numbers of divers affected by habitat loss was broken down by country as shown in Table 9. That table also lists the percentages in relation to the reference year 2030 and in relation to PBR for the international areas of the North Sea. The ratios for the numbers in the various countries are shown in Figure 15. The German wind farms cause the highest level of habitat loss for divers (up to 50% of the total habitat loss for these birds in 2030). This is because there are very important concentration areas of Red-throated Divers in the German sector of the southern North Sea (Garthe *et al*. 2015; Mendel *et al.* 2019). N.B. The international updates to ESAS lag behind the national research effort and data analyses. For example, Germany has focused heavily on surveys of divers in the German Bight, the most important area for these birds in the North Sea (Mendel *et al.* 2019). The picture that emerges from our analysis is a good match with the results of the analyses by Mendel *et al.* (2019) but, in quantitative terms, the analysis could have been sharper if all the recent German survey data had been available to us.

The modelled mortality due to habitat loss for the species/species group increased most in Danish waters in the period 2023-2030. The estimate for 2023 is that 3.4% of the international population will suffer habitat loss due to OWFs and that this percentage will rise to 4.1% in 2030.

4.2.2 Northern Gannet (710, *Morus bassanus)*

Figure 16 Northern Gannet, maximum (left) and minimum occurrence in offshore wind area in the southern and central North Sea

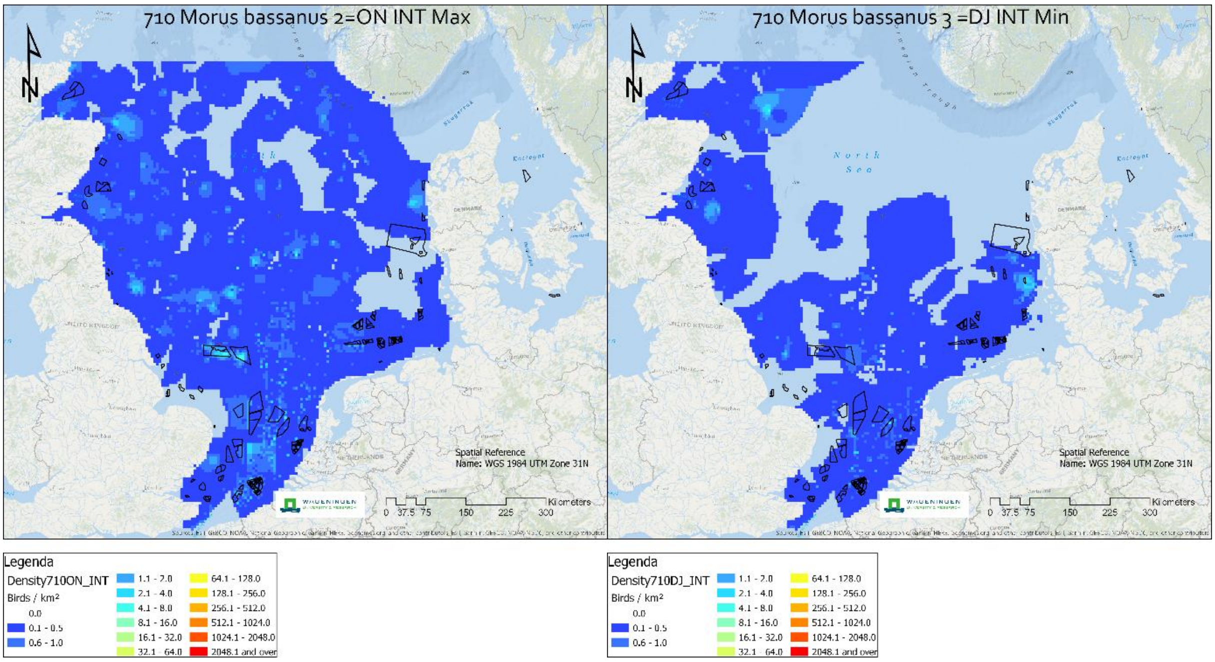


Table 10: Overview of international habitat loss (numbers of victims and PBR percentages) for Northern Gannet in 2023 and 2030 by country

Morus bassanus	2023	2030
BE	9	21
UK	37	64
DK	10	11
DE	12	18
NL	38	47
Total	107	160
%PBR	0.5%	0.7%

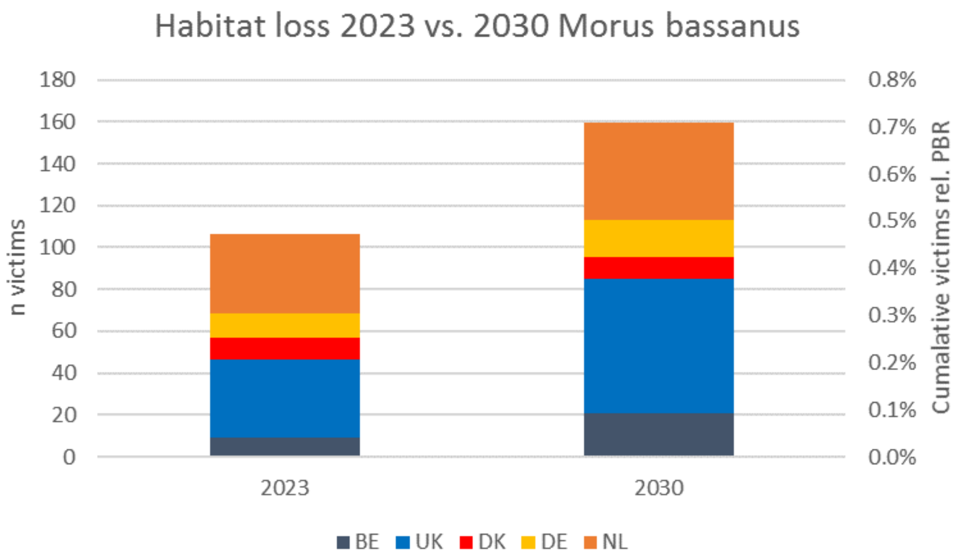


Figure 17 International habitat loss (numbers of victims and PBR percentages) for Northern Gannet in 2023 and 2030 by country

The numbers of Northern Gannet victims (per country) and percentages are shown in Table 10, with Figure 17 showing the ratio in the numbers of Northern Gannets affected by habitat loss per country. The countries where the Northern Gannet is most affected by OWFs are Great Britain and the Netherlands. The figure is 0.5% in 2023 and 0.7% in 2030 by comparison with PBR.

4.2.3 Sandwich Tern (6110, *Thalasseus sandvicensis*)

Figure 18 Sandwich Tern, maximum (left) and minimum occurrence in offshore wind area in the southern and central North Sea

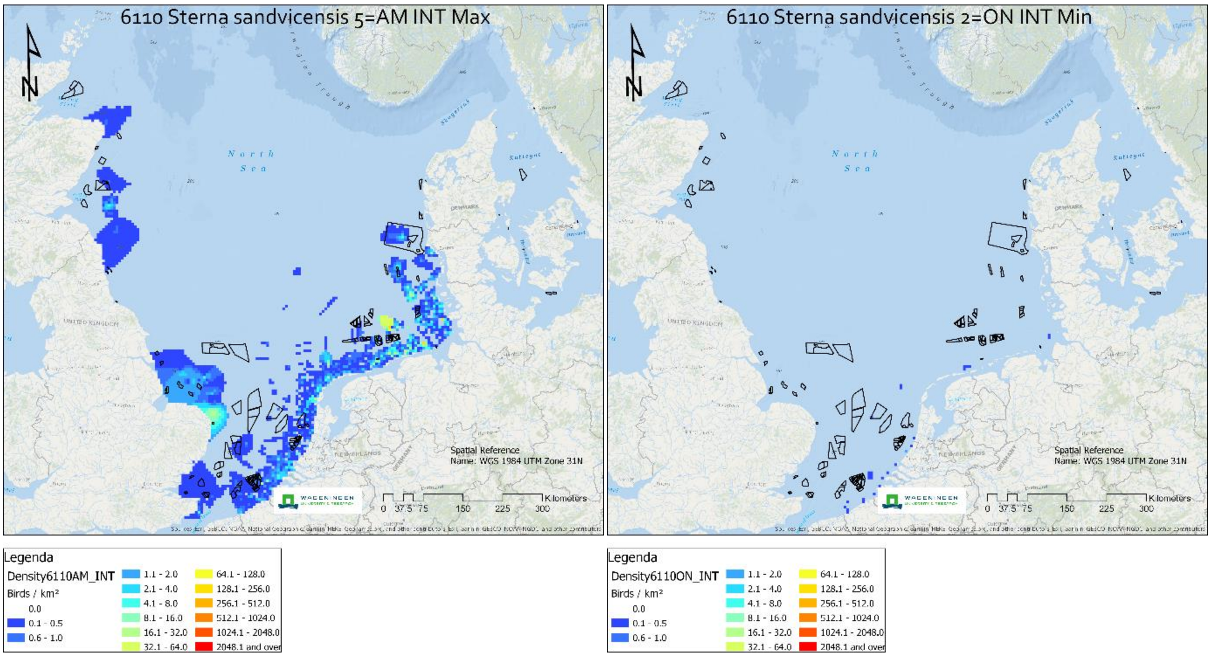


Table 11 Overview of international habitat loss (numbers of victims and PBR percentages) for the Sandwich Tern in 2023 and 2030 by country

Thalasseus sandvicensis	2023	2030
BE	7	13
UK	18	18
DK	0	1
DE	44	48
NL	11	11
Total	80	92
%PBR	1.4%	1.6%

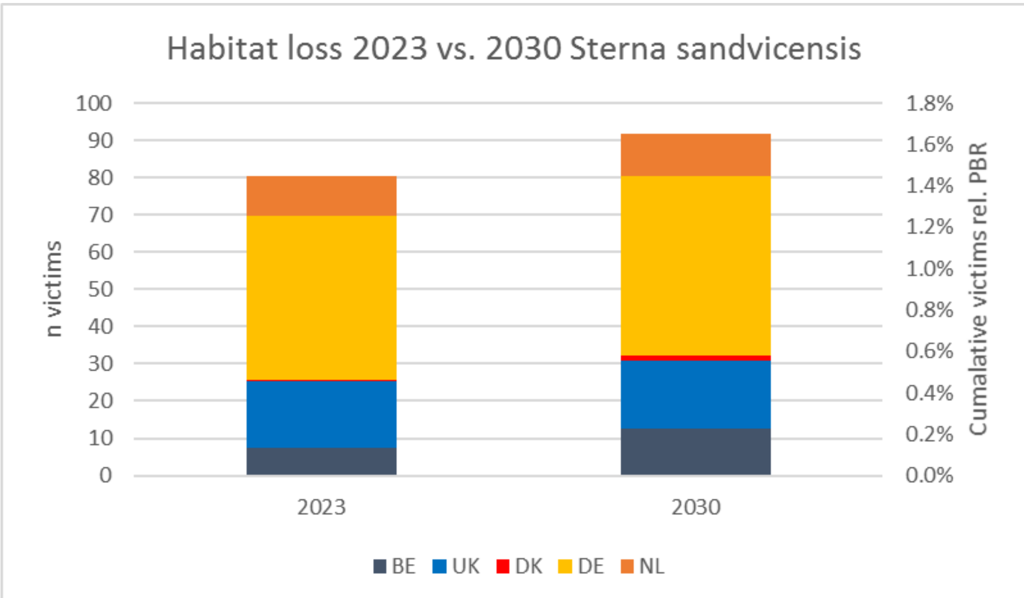


Figure 19 Overview of international habitat loss (numbers of victims and PBR percentages) for the Sandwich Tern in 2023 and 2030 by country.

The overall numbers of victims (by country) and percentages for the Sandwich Tern are shown in Table 11. Figure 19 shows the ratios between the various countries. In 2023, this will be an estimated 1.4%, with a slight increase to 1.6% of the international PBR in 2030. This slight increase is due to the fact that, from 2023 onwards, the international expansion of OWFs will primarily be located further offshore and therefore mainly outside the area used intensively by Sandwich Terns.

4.2.4 Common Guillemot (6340, *Uria aalge*)

Figure 20 Common Guillemot, maximum (left) and minimum occurrence in offshore wind area in the southern and central North Sea

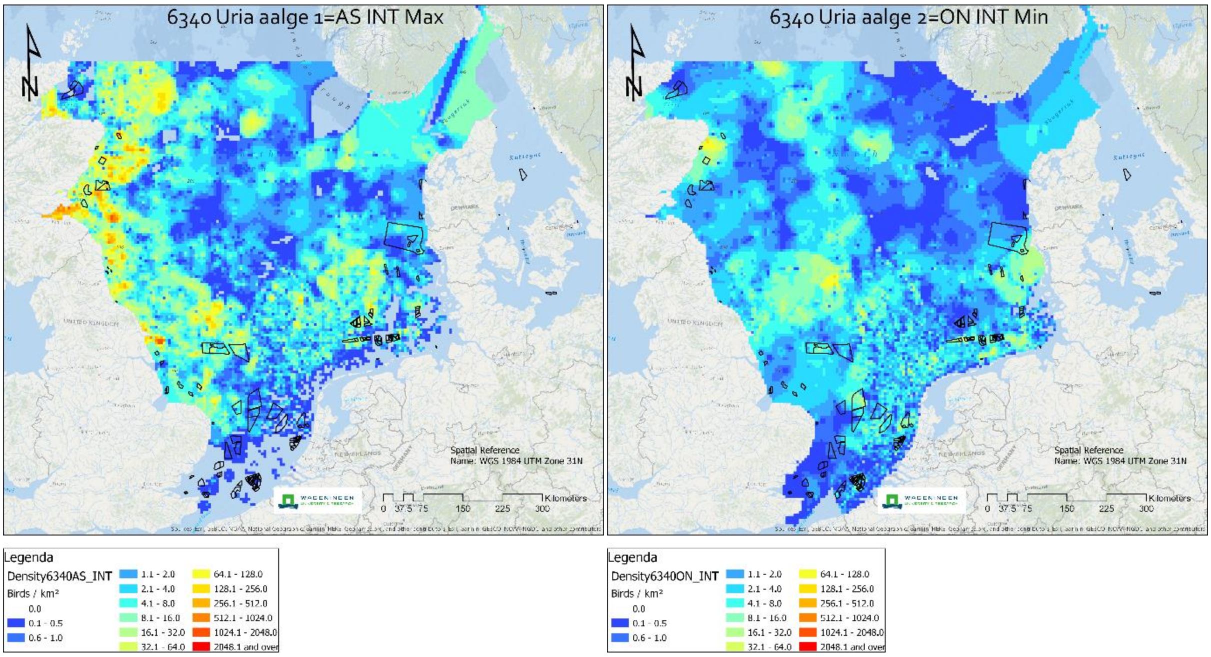


Table 12 Overview of international habitat loss (numbers of victims and PBR percentages) for Common Guillemot in 2023 and 2030 by country

Uria aalge	**2023**	**2030**
BE	214	400
UK	10131	12173
DK	118	194
DE	1407	2024
NL	693	1349
Total	12564	16140
%PBR	4.0%	5.1%

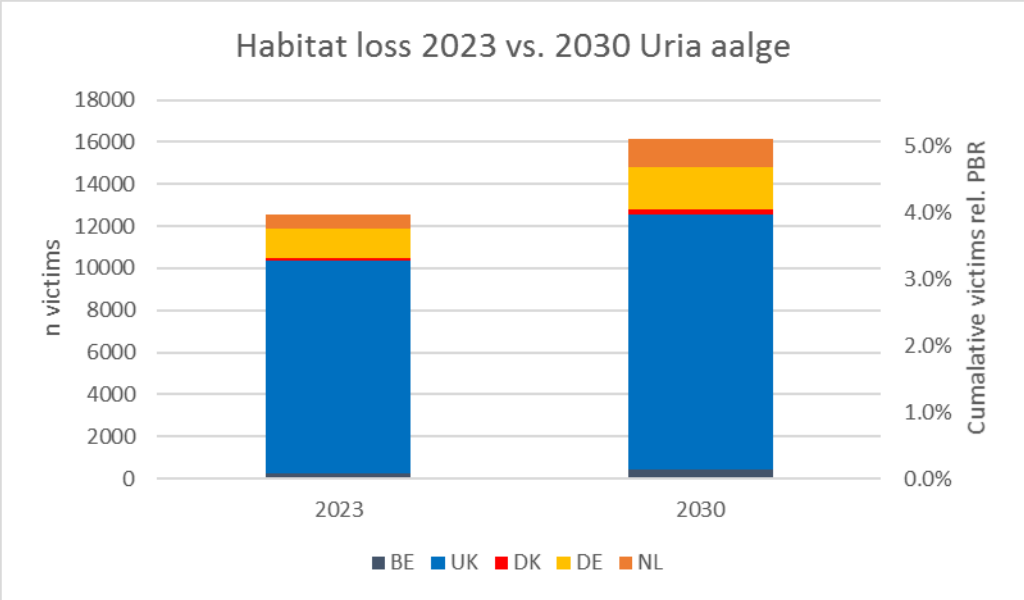


Figure 21 International habitat loss (numbers of victims and PBR percentages) for Common Guillemot in 2023 and 2030 by country

The Common Guillemot and the numbers of victims as a result of habitat loss attributable to OWFs in 2023 and 2030 can be found in Table 12. Figure 21 shows the contribution of each country. Internationally, the Common Guillemot in the North Sea is concentrated in British waters during and shortly after the breeding season, with an extension of that concentration along the Frisian Front towards Germany. In winter, the distribution is more homogeneous as far south as the southern North Sea, with the area around the Brown Ridge being important. For the time being, the Dutch OWFs (existing and planned) are mainly located south of these important concentration areas, which is why the impact of farms on the DCS remains limited. Internationally, the situation is different and the planned farms in British waters in particular will overlap with the distribution area of significant numbers of Common Guillemots.
Most Common Guillemot victims by far as a result of habitat loss are found in British waters. In 2023, the international figure will be 4.0%, rising to 5.1% of the international PBR in 2030.

4.2.5 Razorbill (6360, *Alca torda*)

Figure 22 Razorbill, maximum (left) and minimum occurrence in offshore wind area in the southern and central North Sea

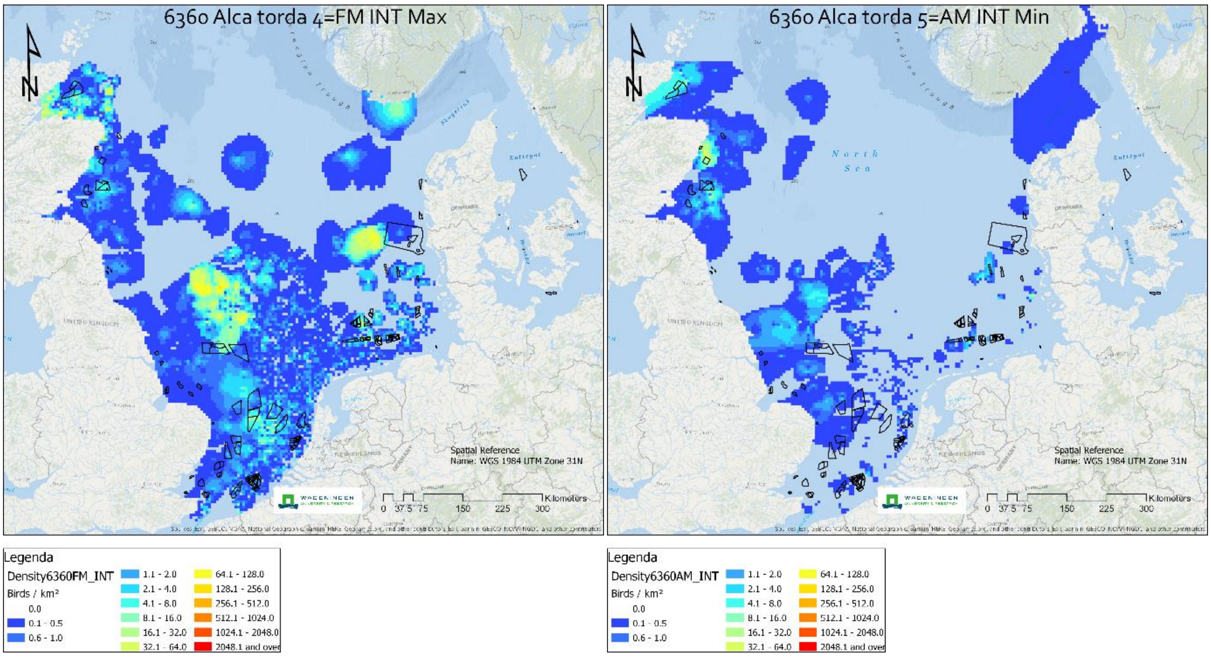


Table 13 Overview of international habitat loss (numbers of victims and PBR percentages) for Razorbills in 2023 and 2030 by country

Alca torda	**2023**	**2030**
BE	65	110
UK	1873	2190
DK	4	9
DE	298	579
NL	140	272
Total	2381	3159
%PBR	20.1%	26.7%

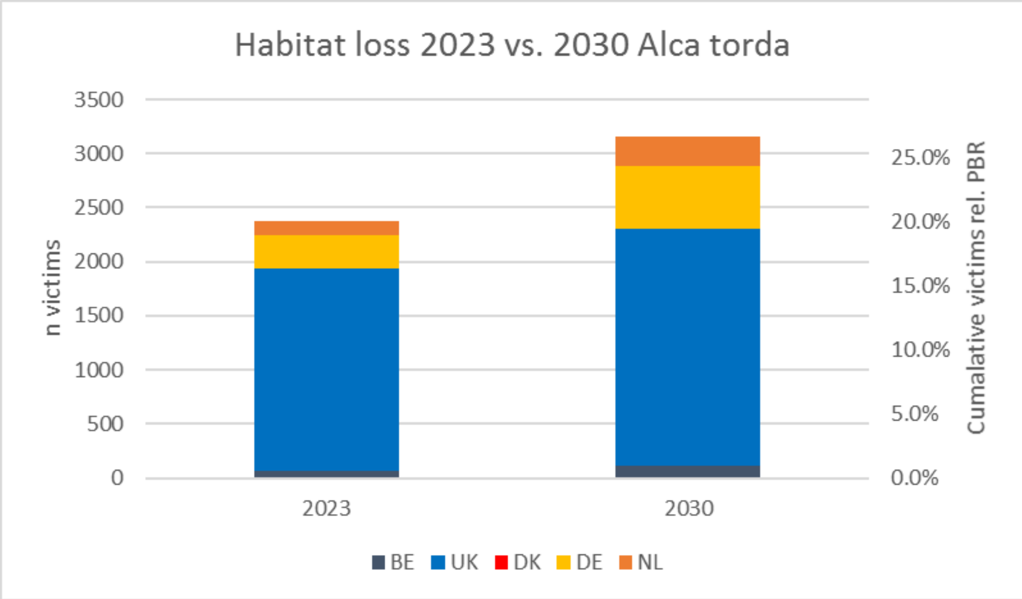


Figure 23 International habitat loss (numbers of victims and PBR percentages) for Razorbills in 2023 and 2030 by country

Table 13 shows the numbers of victims in 2023 (20.1%) and 2030 (26.7%) for Razorbills, including the percentages compared with the totals for 2030 and PBR respectively. Figure 23 shows the contribution by country. Even more so than is the case for the Common Guillemot, the loss of habitat for the Razorbill is primarily seen in British waters: more than two thirds in 2030. However, part of the increase from 2023 to 2030 is also accounted for by OWFs in German and Dutch waters.

4.3 Comparison national and international: seasons

A comparison of the seasons with the maximum and minimum occurrences of seabirds in the OWF areas provides an image of the seasonal occurrence of the species in the various areas. The seasons with the maximum and minimum occurrences of the various bird species in the OWF footprints are different (Table 14) in the national and international scenarios. These differences reflect numbers on the DCS and in the international range of the North Sea. Four of the five species breed outside the Netherlands in locations further north. They spend the winter in the southern North Sea or further south. The Sandwich Tern is the only species that also breeds along the Dutch coast and this species spends the winter elsewhere (Africa).

Table 14 Comparison of the period with maximum and minimum occurrence in OWF areas for the national and international scenarios

EUring	Scientific name	English name	Nat.	Nat.	Int.	Int.
			Max.	Min.	Max.	Min.
59	*Gavia spec.*	Divers	Dec-Jan	Oct-Nov	Apr-May	Aug-Sep
710	*Morus bassanus*	Northern Gannet	Oct-Nov	Apr-May	Oct-Nov	Dec-Jan
6110	*Thalasseus sandvicensis*	Sandwich Tern	Apr-May	Feb-Mar	Apr-May	Oct-Nov
6340	*Uria aalge*	Common Guillemot	Dec-Jan	Jun-Jul	Aug-Sep	Oct-Nov
6360	*Alca torda*	Razorbill	Feb-Mar	Jun-Jul	Feb-Mar	Apr-May

4.4 Comparison national and international: distribution and density

For the purposes of this study, it was decided during a workshop to base the seabird density maps for the national scenario on a shorter series of years (2000-2017). The survey effort for the MWTL database was constant and high during this period (0). The international seabird density maps were

drawn up using data from the period 1991-2017. The early initial year (which was also used in the study by Leopold *et al.* 2014) was maintained because, without this period, geographical coverage outside the DCS would have been too weak.
The series of figures below (Figure 24 to Figure 28 inclusive) all show a national density map alongside the international version. This comparison is used to determine whether there are striking differences between the two series of maps due to the use of time series with different lengths. In addition, the various map images show how distribution and density on the DCS fit into the broader geographical context of the southern and central North Sea.

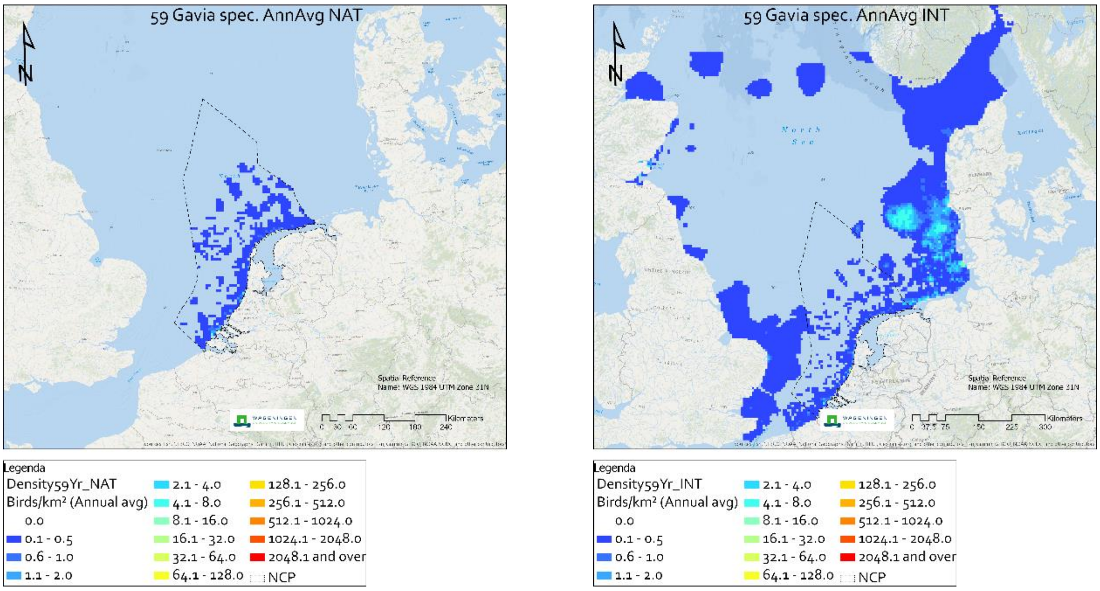


Figure 24 Comparison of distribution and density of divers in the national scenario (left) and the international scenario (right)

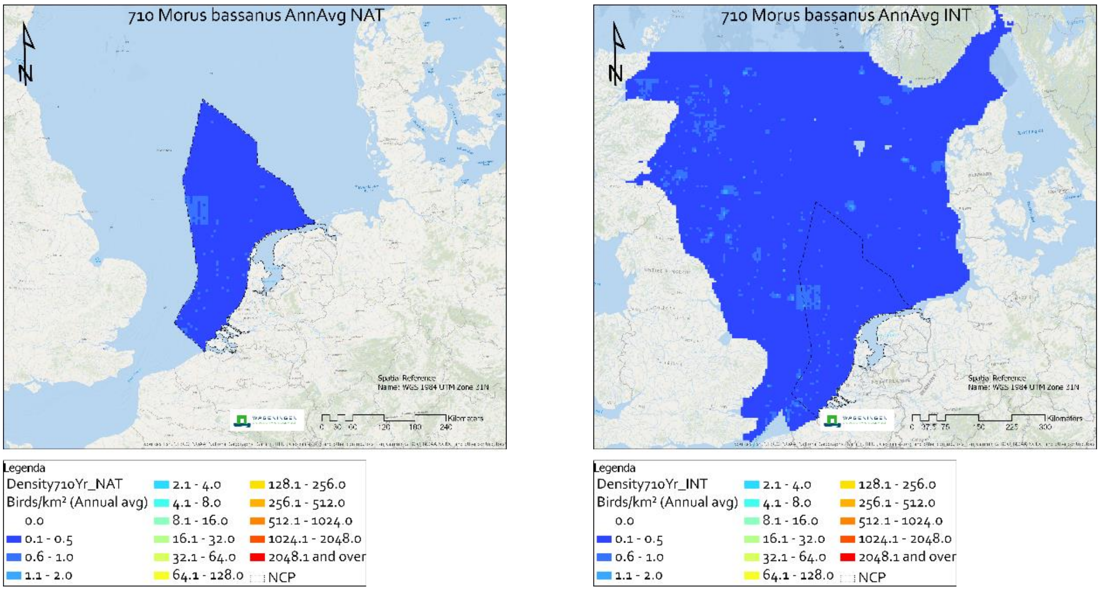


Figure 25 Comparison of distribution and density of Northern Gannets in the national scenario (left) and the international scenario (right)

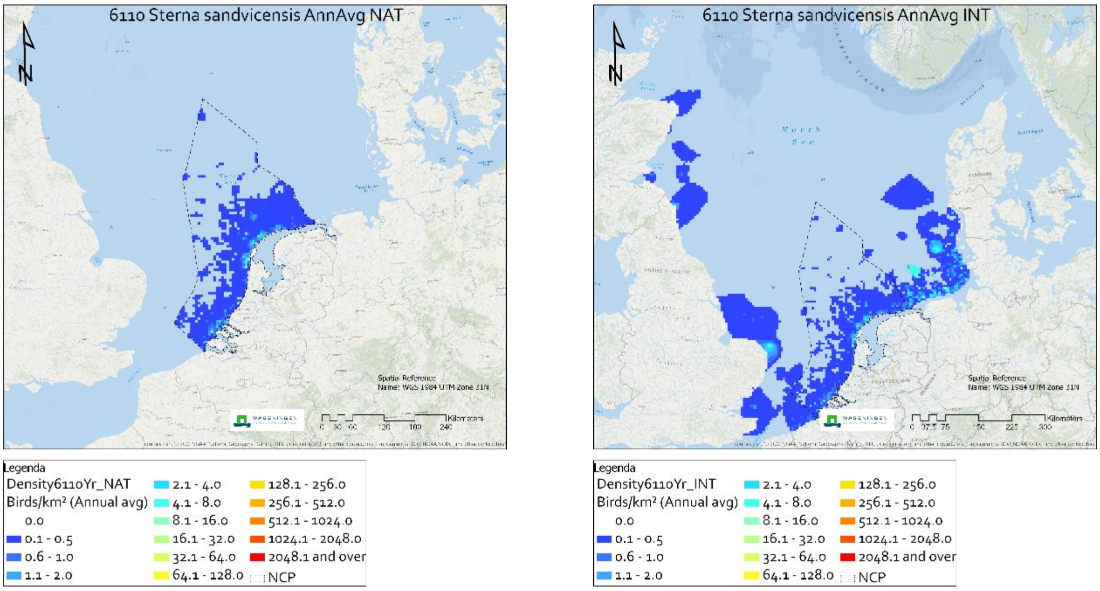


Figure 26 Comparison of distribution and density of Sandwich Terns in the national scenario (left) and the international scenario (right)

For divers (Figure 24), Northern Gannet (Figure 25) and Sandwich Tern (Figure 26), there are no striking differences between the national and international density maps on the DCS. This can be interpreted as an indication that the distribution and densities of these species on the DCS have not changed significantly in the period 2000-2017 (nationally) in comparison to the longer period, 1991-2017 (internationally).
Differences can be seen for the Common Guillemot (Figure 27) and Razorbill (Figure 28). The Common Guillemot appears to be present on the DCS in slightly lower densities on the national map (2000-2017) than on the international map (1991-2017). A similar picture can also be seen for the Razorbill. This is most evident in the absence of increased densities of this species to the north of the Wadden Islands in the national density map in comparison to the international map. This may indicate that the densities in the more recent period have fallen for both species or that concentrations were found here earlier but not later. Differences of this kind emphasise that distribution patterns at sea are not constant. It is reasonable to expect that this will continue to be the case in the future and that the validity of future scenarios based on data collected in the past may turn out to be limited.

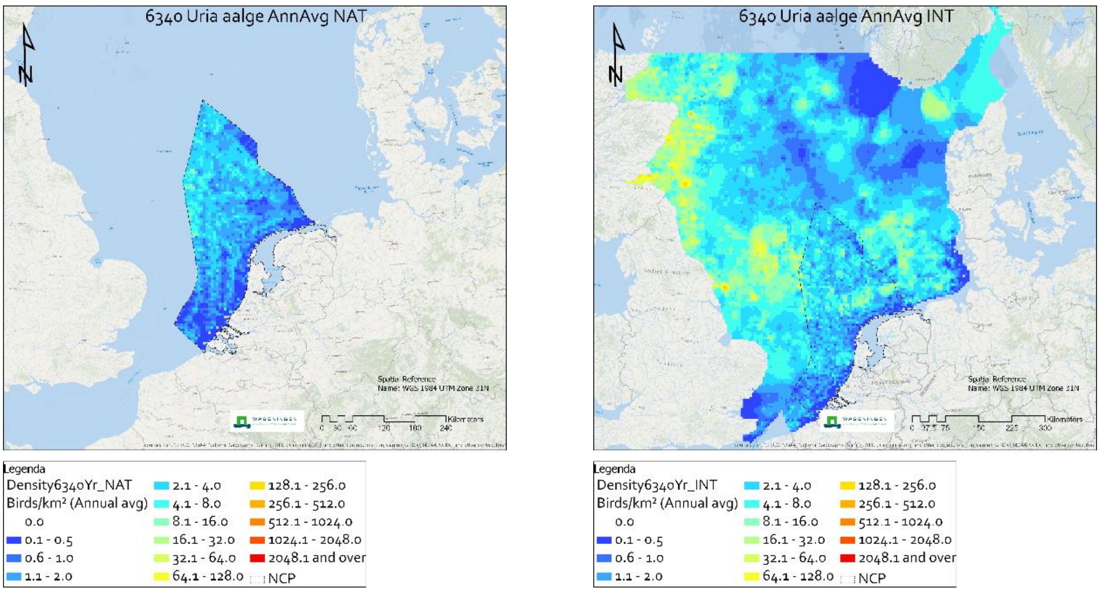


Figure 27 Comparison of distribution and density of Common Guillemots in the national scenario (left) and the international scenario (right)

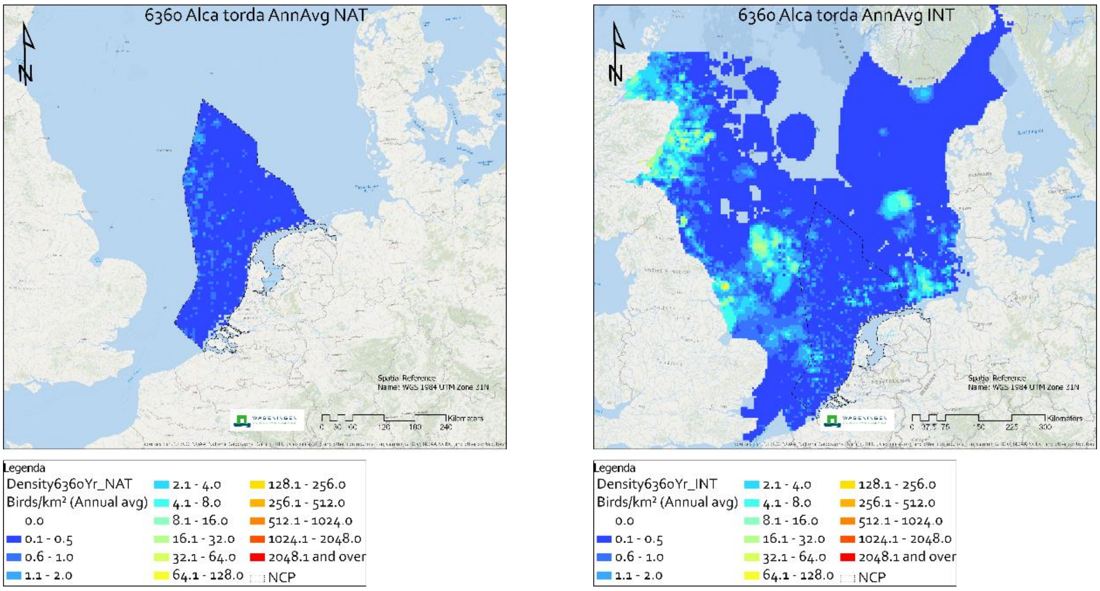


Figure 28 Comparison of distribution and density of Razorbills in the national scenario (left) and the international scenario (right)

5 Discussion and conclusions

5.1 Extent of habitat loss

With regard to the farms that are already in place and that are still to be built on the DCS, the analysis shows that the impact, in terms of victims as a result of habitat loss, is relatively small (Table 15). For the reference year 2030, the number of victims in relation to the national PBR is 0.4% for divers and almost 1% for both the Northern Gannet and Sandwich Tern. The percentage for the Common Guillemot is higher by comparison with the PBR at about 4% and it actually rises to 23% for the Razorbill. The international percentages (Table 15) are generally higher than the national figures at 4.1% for divers in relation to the international PBR, less than 1% for the Northern Gannet and more than 1% for the Sandwich Tern. Internationally also, the Common Guillemot (5%) and the Razorbill (more than 25%) are the species with the largest numbers of victims (both in absolute numbers and %PBR) as a result of habitat loss due to OWFs. The British wind farms in particular will overlap with areas of high densities of Common Guillemots and Razorbills. However, divers (mainly Red-throated Divers: according to Mendel *et al.* (2019), 90% of divers in the German Bight belong to this species) are mainly affected by the developments in Germany and Denmark.

The densities of the seabirds studied are relatively low on the DCS in comparison to the densities in the southern and central North Sea. Moreover, the development of offshore wind farms will not be permitted in some of the most bird-rich areas on the DCS, namely the Frisian Front, Brown Ridge and the 12-mile zone. As a result, the effects on seabirds in Dutch waters are relatively limited for three of the five species analysed here: divers, Northern Gannets and Sandwich Terns. The effects calculated for Common Guillemots and Razorbills in the national situation are less limited. The difference in the estimates for these two species is due to a difference in the status of the European population. The Razorbill population is smaller and its distribution is also less extensive and more restricted to the Atlantic Ocean. A declining population and the classification of this species as Near Threatened by the IUCN are important factors, as a result of which the habitat loss has become a more significant factor as expressed in relation to the PBR.

Internationally, the estimates of numbers of victims in relation to the PBR for Common Guillemot and Razorbill are similar. Furthermore, divers (and especially the Red-throated Diver) also come into the picture internationally as a third species/species group with a sizeable number of victims as a result of habitat loss.

Table 15 Number and percentage of victims by comparison with PBR for the various seabird populations due to habitat loss Reference year 2030.

Scientific name	English Name	National Number victims (2030)	National % PBR (2030)	International Number victims (2030)	International % PBR (2030)
Gavia spec.	Divers	2	0.4%	575	4.1%
Morus bassanus	Northern Gannet	22	0.7%	160	0.7%
Thalasseus sandvicensis	Sandwich Tern	11	0.9%	92	1.6%
Uria aalge	Common Guillemot	513	3.8%	16140	5.1%
Alca torda	Razorbill	110	23.1%	3159	26.7%

6 Recommendations and knowledge gaps

6.1 Change in behaviour of seabirds

Table 15 shows, that for four of the five seabird species studied, the Dutch waters compare relatively favourably with the international situation.

Assuming unchanged behaviour, in other words if these birds do not adapt to the new built areas, the DCS may therefore become relatively more attractive in the future. Outside the breeding season, when the seabirds are not bound to the location of the colonies, some of the 'British' Common Guillemots and Razorbills, as well as some of the 'German' divers, could move to the DCS. This could be the result of not having enough remaining room in British or German waters to accommodate locally the birds that move away from wind farms. These British and German waters may also have a quality that Dutch waters have to a lesser extent. Razorbills, for example, return to the vicinity of their colonies very early in the winter, perhaps in response to competition with members of their own species. Such birds will not readily move to other locations. Furthermore, the premise of unchanged behaviour is no more than an assumption. Birds can learn and are able to adapt to their environment. Seabirds may also adapt to the increasing levels of construction of the North Sea, but the extent and speed at which this will happen is still unknown. However, the arrival of more and more offshore wind farms will in surely produce increasing pressure on seabirds and it is known that at least some of the birds move away from offshore wind farms. It can therefore be expected that more birds will visit the DCS in the future than at present. As a result, it will be all the more important to provide good protection for areas without wind farms such as the 12-mile zone, the Frisian Front and the Brown Ridge. The effects of farms on the DCS would seem to be less than expected for the only species analysed here that breeds in considerable numbers in the Netherlands, the Sandwich Tern, because most Sandwich Terns do not go far enough offshore to come into contact with OWFs. However, this may change due to, for example, changes in the breeding area of this species, as was recently the case with the emerging breeding colony at De Putten. It has recently been established that these birds go foraging from this colony at least as far as the OWEZ wind farm (Leopold *et al.*, in preparation; Doorvaart project). In addition, both surveys at sea and counts using tagged Sandwich Terns have shown that these birds regularly fly many tens of kilometres into the North Sea area. However, not a great deal of information is available yet about the use of the waters around breeding colonies of Sandwich Terns and it would be good idea to investigate dispersion from the colonies in more detail.

Any changes in the behaviour of seabirds in response to, for example, the shared use of wind farms represent another unknown factor. Mendel *et al.* (2019) have shown that disturbance may be caused not only by the wind turbines but also by the shipping traffic associated with the wind farms and maintenance work on the farms. A possible future switch from maintenance using boats to maintenance with helicopters could have repercussions for the level of disturbance resulting from offshore wind farms. Shared use, such as fishing or shellfish farming in wind farms, also results in more shipping traffic. On the other hand, wind farms could develop into areas where fish feel very much at home (Degraer *et al.* 2016), and this could actually make these areas more appealing to seabirds. It would be advisable to organise studies that can establish a picture of the factors that may lead to possible changes in seabird behaviour in and around OWFs.

6.2 International survey and scenario refinement

It would be advisable to update the density maps and habitat loss calculations periodically. New survey data will be available in a few years' time (especially if foreign parties can be encouraged to add their recent data to ESAS), and new insights relating to the effects of habitat loss resulting from offshore wind energy or other offshore renewable energy production may also emerge. The same species may be involved but other species may also come into the picture. International consultations will be necessary to update the foreign input and the maintenance of the ESAS database. The relevance of this database has declined in recent years and most of the data added in this study relate to the DCS. This is hardly surprising for the MWTL database, which is a national survey programme for the Dutch government. The fall-off in additions to ESAS from outside the Netherlands was one of the reasons why it was necessary to include all years from 1991 onwards again for the international scenario, even though there are other arguments in favour of this long observation period, including in particular the inclusion of as much variation as possible in areas where seabirds may be found. It would be desirable if there was to be a renewed effort to update ESAS internationally with survey data for the entire North Sea or if there were to be a worthy successor.

A large proportion of the recent seabird surveys suffer from another shortcoming: they tend to focus on specific, relatively small, areas like OWFs and their immediate surroundings, or on special Marine Protected Areas (such as Natura 2000 sites). Accordingly, they do not systematically cover either a representative national (as in the case of, for example, the MWTL survey) or international area of the North Sea. It would therefore be advisable to encourage a North Sea-wide approach to representative future seabird surveys for monitoring purposes.
Both of the above issues were discussed at the project workshop (Bravo Rebolledo & Gyimesi 2018).

An alternative to the PBR method used here, which is based on virtual population sizes and mortality rates, is to approach the problem using population models based on realistic population estimates for each species and corresponding estimates of annual mortality.

The current report looks at the cumulative effects for a number of seabird species as a result of increasing spatial use due to development in a single sector: offshore wind energy. In practice, these species must also cope with changing, and generally increasing, human use in other sectors.

7 Quality assurance

Wageningen Marine Research has an ISO 9001:2008 certified quality management system, number 124296-2012-AQ-NLD-RvA). This certificate is valid until 15 December 2015. The organisation has had certification since 27 February 2001. The certification was carried out by DNV Certification B.V. In addition, the chemical laboratory of the Fish department has a NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 27 March 2013 and was first granted on 27 March 1997; the accreditation was granted by the Dutch Council for Accreditation.

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Reporting

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This report was produced with great care. The scientific quality was tested internally by a fellow researcher and the relevant department head at Wageningen Marine Research.

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Appendix 1 Table Offshore wind farms 2018 KEC

Classification: alphabetically by country, then OWF name.

Fields/columns:

OWF name:	name of the offshore wind farm
Country:	abbreviation for the country to which the farm belongs
Status:	status of the farm (as at summer 2018) order: Proposed; Development; Application; Authorised; Construction; Operational
OWF max. MW:	MW installed capacity (RWS estimate for KEC 2018)
n OWT:	number of offshore wind turbines (RWS estimate for KEC 2018)
OWT MW:	capacity per turbine (RWS estimate for KEC 2018)
Construction Start:	year in which construction of the farm began. For existing farms or farms under construction, this is a year in the past; in the case of new farms, it is an estimate (Rijkswaterstaat based on 2018 KEC).
GIS area (km2:	Area of the site based on the GIS (on maps).
Estimated area (km2.:	Estimated surface area (mainly of OWFs yet to be constructed). This is based on the planned number of MW and known spatial use for an OWT of 6 MW (RWS based on 2018 KEC)
Area (km2) of habitat loss:	Surface area of OWF, GIS plus 500 m buffer around the circumference. This surface/area has been used for habitat loss to determine the average density of seabirds in the area for each farm because the boundary in GIS for existing and approved farms represents the site for construction. The outer turbines are just outside this boundary. It is therefore useful to maintain a slightly larger contour for habitat loss. The value used for the buffer distance was also used in previous KEC calculations (see Leopold *et al.* 2014).
Scale Factor:	Scale factor (ratio of estimated area to GIS area) for wind farms where search areas have been defined in order to arrive at a more realistic final result in terms of the number of birds that experience habitat loss. The ratio results in a difference primarily when search areas are still large/very large given their target (OWF max. MW) and currently cover a significantly larger area in GIS than is ultimately expected to be used. For operational farms, the scale factor is generally ~1.

Disclaimer regarding comprehensiveness: Given the time pressure on the project, an agreement was made at a given moment about the database to be used. At that time, some responses had still not been received from the foreign farms and so these were not included, or not included completely. In addition, information is changing about whether or not certain farms will be built and the years in which they will be built. The list below is therefore not exhaustive but a reasonably accurate overview of developments up to 2030.

OWF name	Country	Status	OWF max. MW	n OWT	OWT MW	Construction Start	Area (km2) GIS	Area (km2) Estim.	Area (km2) Hab.Loss	Scale Factor
Belwind	BE	operational	165.0	110.0	3.0	2009	13.3	13.3	23.4	1.00
Belwind Alstom Haliade Demonstration	BE	operational	6.0	1.0	6.0	2013	0.2	0.2	1.8	1.00
Fairy Bank 1	BE	development	700.0	70.0	10.0	2025	93.2	115.0	113.8	1.23
Fairy Bank 2	BE	development	700.0	58.3	12.0	2027	85.1	115.0	107.3	1.35
Fairy Bank 3	BE	development	700.0	46.7	15.0	2030	45.0	115.0	60.9	2.56
Nobelwind	BE	operational	165.0	110.0		2016	22.0	22.0	41.9	1.00
Norther	BE	authorised	230.0	28.8	8.0	2019	38.2	61.7	53.4	1.61
Northwester 2	BE	authorised	224.0	23.6	9.5	2023	11.7	37.3	20.4	3.20
Northwind	BE	operational	216.0	72.0	3.0	2013	14.2	14.2	23.5	1.00
RENTEL	BE	construction	309.0	44.1	7.0	2018	20.6	51.5	31.3	2.50
Seastar	BE	authorised	246.0	30.8	8.0	2023	19.9	41.0	30.6	2.06
Thornton Bank I	BE	operational	30.0	6.0	5.0	2008	0.9	0.9	5.3	1.00
Thornton Bank II	BE	operational	184.5	30.0	6.2	2012	12.4	12.4	27.2	1.00
Thornton Bank III	BE	operational	110.7	18.0	6.2	2011	6.6	6.6	15.7	1.00
THV Mermaid	BE	authorised	246.0	30.8	8.0	2023	16.7	41.0	26.0	2.46
Alpha Ventus Nord	DE	operational	31.0	6.2	5.0	2009	1.9	5.2	5.6	2.66
Alpha Ventus Süd	DE	operational	31.0	6.2	5.0	2009	2.0	5.2	5.6	2.63
Amrumbank West	DE	operational	302.0	80.0	3.6	2014	30.2	30.2	43.5	1.00
BARD Offshore 1	DE	operational	400.0	80.0	5.0	2013	58.9	58.9	76.8	1.00
Borkum Riffgrund I	DE	operational	312.0	78.0	4.0	2014	35.7	35.7	48.6	1.00
Borkum Riffgrund II	DE	construction	448.0	56.0	8.0	2019	44.6	37.0	68.8	0.83
Borkum Riffgrund West 1	DE	authorised	240.0	24.0	10.0	2024	29.7	30.0	41.9	1.01
Borkum Riffgrund West 2	DE	authorised	240.0	24.0	10.0	2024	16.1	16.0	30.7	0.99
Borkum West II Phase 1	DE	operational	200.0	40.0	5.0	2014	22.6	22.6	37.8	1.00
Borkum West II Phase 2	DE	construction	200.0	33.3	6.0	2018	33.1	31.0	52.3	0.94
Butendiek	DE	operational	288.0	80.0	3.6	2014	31.5	31.5	44.9	1.00

OWF name	Country	Status	OWF max. MW	n OWT	OWT MW	Construction Start	Area (km2) GIS	Area (km2) Estim.	Area (km2) Hab.Loss	Scale Factor
DanTysk	DE	operational	288.0	80.0	3.6	2014	66.0	66.0	89.2	1.00
Deutsche Bucht	DE	authorised	260.0	31.0	8.4	2019	22.6	18.0	33.9	0.80
EnBW He Dreiht	DE	authorised	900.0	90.0	10.0	2025	62.8	62.0	82.7	0.99
EnBW Hohe See	DE	construction	497.0	71.0	7.0	2019	41.8	40.0	56.8	0.96
Global Tech 1	DE	operational	400.0	80.0	5.0	2014	43.3	43.3	58.2	1.00
Gode Wind 03	DE	authorised	110.0	11.0	10.0	2023	11.6	4.0	27.7	0.34
Gode Wind 04	DE	authorised	132.0	13.2	10.0	2023	29.3	22.0	17.1	0.75
Gode Wind 1 and 2	DE	operational	330.0	55.0	6.0	2016	69.2	40.0	96.6	0.58
Kaskasi II	DE	authorised	325.0	32.5	10.0	2022	17.5	18.0	27.6	1.03
Meerwind Süd/Ost	DE	operational	288.0	80.0	3.6	2013	40.1	40.1	55.2	1.00
Merkur Offshore	DE	construction	396.0	66.0	6.0	2018	46.9	37.0	62.9	0.79
N-3.5 DE-tender 2025	DE	development	300.0	25.0	12.0	2029	21.3	21.0	35.0	0.99
N-3.6 DE-tender 2024	DE	development	750.0	63.0	12.0	2028	47.0	46.0	62.5	0.98
N-3.7 DE-tender 2026	DE	development	230.0	19.0	12.0	2026	20.0	20.0	31.1	1.00
N-3.8 DE-tender 2022	DE	development	350.0	29.0	12.0	2026	25.7	25.0	46.7	0.97
N-6.6 DE-tender 2026	DE	development	670.0	45.0	15.0	2030	41.6	42.0	58.7	1.01
N-6.7 DE-tender 2029	DE	development	280.0	23.0	12.0	2029	22.8	22.0	48.3	0.97
N-7.2 DE-tender 2027	DE	development	900.0	90.0	10.0	2027	52.3	52.0	75.8	0.99
Nordergründe	DE	operational	111.0	18.5	6.0	2016	5.9	18.5	12.4	3.14
Nordsee One	DE	operational	332.0	54.0	6.2	2017	33.6	33.6	47.9	1.00
Nordsee Ost	DE	operational	295.2	48.0	6.2	2014	35.8	35.8	49.2	1.00
OWP West	DE	authorised	240.0	24.0	10.0	2024	14.3	14.0	27.7	0.98
Riffgat	DE	operational	108.0	30.0	3.6	2013	6.0	18.0	13.0	3.00
Sandbank 24	DE	operational	288.0	72.0	4.0	2016	59.9	48.0	83.1	0.80
Veja Mate	DE	operational	402.0	67.0	6.0	2017	50.1	51.0	66.3	1.02
Horns Rev 1	DK	operational	160.0	80.0	2.0	2002	19.7	19.7	29.4	1.00
Horns Rev 2	DK	operational	209.3	91.0	2.3	2009	31.4	31.4	45.1	1.00

OWF name	Country	Status	OWF max. MW	n OWT	OWT MW	Construction Start	Area (km2) GIS	Area (km2) Estim.	Area (km2) Hab.Loss	Scale Factor
Horns Rev 3	DK	construction	400.0	50.0	8.0	2018	144.6	144.0	172.0	1.00
Horns Rev Reserved Area	DK	development	800.0	80.0	10.0	2025	2958.0	133.3	3122.6	0.05
Vesterhav Nord	DK	authorised	180.0	21.0	8.4	2019	58.8	58.8	81.1	1.00
Vesterhav Syd	DK	authorised	170.0	20.0	8.4	2019	48.9	48.9	70.6	1.00
Borssele 1	NL	authorised	329.0	41.0	8.0	2020	49.1	49.0	81.8	1.00
Borssele 2	NL	authorised	423.0	52.0	8.0	2020	63.5	63.0	81.2	0.99
Borssele III	NL	authorised	366.0	39.0	9.5	2020	64.0	61.0	91.3	0.95
Borssele IV	NL	authorised	366.0	38.0	9.5	2020	57.9	61.0	92.9	1.05
Borssele V	NL	authorised	19.0	2.0	9.5	2020	0.6	1.0	3.1	1.70
Eneco Luchterduinen	NL	operational	129.0	43.0	3.0	2014	15.9	15.9	25.6	1.00
Gemini East	NL	operational	300.0	75.0	4.0	2015	34.3	34.3	47.5	1.00
Gemini West	NL	operational	300.0	75.0	4.0	2015	33.4	33.4	46.4	1.00
Hollandse Kust (west)	NL	development	1520.0	152.0	10.0	2024	348.3	253.3	379.9	0.73
Hollandse Kust Noord (search area)	NL	development	760.0	95.0	8.0	2021	271.5	117.0	313.3	0.43
Hollandse Kust Zuid Site 1	NL	authorised	412.0	51.0	8.0	2021	57.0	57.0	88.4	1.00
Hollandse Kust Zuid Site 2	NL	authorised	340.0	43.0	8.0	2021	47.7	47.0	62.4	0.98
Hollandse Kust Zuid Site 3	NL	development	313.0	39.0	8.0	2022	45.6	45.0	68.5	0.99
Hollandse Kust Zuid Site 4	NL	development	439.0	55.0	8.0	2022	63.6	63.0	107.8	0.99
IJmuiden Ver	NL	development	4000.0	400.0	10.0	2027	1170.9	666.7	538.4	0.57
OWEZ #	NL	operational	108.0	36.0	3.0	2006	26.1	26.1	38.2	1.00
Prinses Amaliawindpark #	NL	operational	120.0	60.0	2.0	2007	21.6	21.6	31.0	1.00
Ten Noorden van de Waddeneilanden (2)	NL	development	1040.0	104.0	10.0	2025	111.3	127.0	121.6	1.14
Aberdeen Offshore Wind Farm (EOWDC)	UK	construction	93.2	11.0	8.4	2018	20.0	20.0	30.7	1.00
Beatrice	UK	construction	588.0	84.0	7.0	2018	131.8	131.0	157.4	0.99
Blyth Offshore Wind Demonstration site	UK	authorised	41.5	5.0	8.0	2017	13.6	13.6	35.3	1.00
Dudgeon	UK	operational	402.0	67.0	6.0	2016	55.2	55.0	72.3	1.00
East Anglia One	UK	construction	714.0	102.0	7.0	2018	205.8	119.0	238.5	0.58

OWF name	Country	Status	OWF max. MW	n OWT	OWT MW	Construction Start	Area (km2) GIS	Area (km2) Estim.	Area (km2) Hab.Loss	Scale Factor
East Anglia ONE North	UK	development	800.0	80.0	10.0	2025	208.0	133.3	238.4	0.64
East Anglia Three	UK	authorised	1200.0	150.0	8.0	2030	306.4	200.0	348.1	0.65
East Anglia TWO	UK	development	800.0	80.0	10.0	2024	255.4	133.0	295.1	0.52
Galloper	UK	operational	336.0	56.0	6.0	2017	113.5	113.5	150.6	1.00
Greater Gabbard	UK	operational	504.0	140.0	3.6	2012	146.2	146.2	180.3	1.00
Gunfleet Sands Demonstration Project	UK	operational	12.0	2.0	6.0	2012	2.5	2.5	6.6	1.00
Gunfleet Sands I + II	UK	operational	172.8	48.0	3.6	2009	15.8	15.8	26.9	1.00
Hornsea Project One	UK	construction	1218.0	174.0	7.0	2018	407.3	203.0	462.7	0.50
Hornsea Project Three	UK	application	2400.0	300.0	8.0	2030	695.8	700.0	757.1	1.01
Hornsea Project Two	UK	authorised	1386.0	173.3	8.0	2022	461.9	231.0	528.9	0.50
Humber Gateway	UK	operational	219.0	73.0	3.0	2014	26.5	26.5	38.8	1.00
Hywind 2 Demonstration	UK	operational	30.0	5.0	6.0	2017	53.8	15.0	69.8	0.28
Inch Cape	UK	authorised	784.0	131.0	7.0	2018	149.6	150.0	180.2	1.00
Inner Dowsing	UK	operational	97.2	27.0	3.6	2008	8.8	8.8	16.5	1.00
Kentish Flats 1	UK	operational	90.0	30.0	3.0	2005	9.9	9.9	17.5	1.00
Kentish Flats 2	UK	operational	49.5	15.0	3.3	2015	8.3	8.3	18.3	1.00
Kincardine Offshore Windfarm Project	UK	authorised	50.0	6.0	8.4	2019	110.5	110.0	132.4	1.00
Lincs	UK	operational	270.0	75.0	3.6	2012	39.5	39.5	57.7	1.00
London Array 1	UK	operational	630.0	175.0	3.6	2012	122.4	122.4	144.7	1.00
Lynn	UK	operational	97.2	27.0	3.6	2008	7.9	7.9	14.5	1.00
Moray Firth Eastern Development Area	UK	authorised	1100.0	110.0	10.0	2020	296.1	295.0	336.7	1.00
Moray Firth Western Development Area	UK	application	750.0	75.0	10.0	2023	225.7	226.0	261.4	1.00
Neart na Gaoithe	UK	authorised	448.0	54.0	8.0	2022	105.4	105.0	126.5	1.00
Norfolk Boreas	UK	development	1800.0	180.0	10.0	2030	724.8	300.0	781.6	0.41
Norfolk Vanguard	UK	application	1800.0	180.0	10.0	2030	592.1	300.0	664.9	0.51
Race Bank	UK	operational	573.0	91.0	6.0	2017	62.4	62.4	82.4	1.00
Scroby Sands	UK	operational	60.0	30.0	2.0	2004	8.8	8.8	15.8	1.00

OWF name	Country	Status	OWF max. MW	n OWT	OWT MW	Construction Start	Area (km2) GIS	Area (km2) Estim.	Area (km2) Hab.Loss	Scale Factor
SeaGreen Alpha	UK	authorised	525.0	53.0	10.0	2023	197.6	197.0	235.3	1.00
SeaGreen Bravo	UK	authorised	525.0	52.0	10.0	2023	194.0	194.0	233.9	1.00
Sheringham Shoal	UK	operational	316.8	88.0	3.6	2012	35.0	35.0	49.7	1.00
Teesside	UK	operational	62.1	27.0	2.3	2013	4.3	4.3	9.8	1.00
Thanet	UK	operational	300.0	100.0	3.0	2009	34.9	35.0	47.5	1.00
Thanet Extension	UK	application	340.0	34.0	10.0	2023	72.3	56.7	104.0	0.78
Westermost Rough	UK	operational	210.0	35.0	6.0	2014	34.9	34.9	47.5	1.00

In consultation with RWS, a separate status was used for the national scenario for the comparison between 2023 and 2030 for these two farms, namely 'decommissioning'. For the international scenario, this assumption was extended mutatis mutandis by WMR to include three international OWFs that have already been built: Horns Rev 1 (DK), Scroby Sands and Kentish Flats 1 (both UK).

A number of tranches (development phases) have been listed for the Dutch search areas Hollandse Kust - West, IJmuiden Ver and Ten Noorden van de Waddeneilanden: 2 for Hollandse Kust - West, 4 for IJmuiden Ver and 2 for Ten Noorden van de Waddeneilanden. This table uses the earliest construction year in all cases.

Appendix 2 Results for habitat loss per OWF and seabird species, national scenario

The reported numbers are estimated numbers of birds per OWF that may suffer habitat loss associated with the presence of a wind farm per season or totalled for the whole year. This is therefore the number of birds inside the footprint of the farms (including the 500 m buffer zone).
N.B. The Scale Factor has not been applied to the values in this annex!

The following seabird species are listed in this Annex (order: EUring ascending):

EUring	Scientific name	English name	Dutch Name
59	*Gavia spec.*	Diver spec.	Duiker
710	*Morus bassanus*	Northern Gannet	Jan-van-Gent
6110	*Thalasseus sandvicensis*	Sandwich Tern	Grote Stern
6340	*Uria aalge*	Common Guillemot	Zeekoet
6360	*Alca torda*	Razorbill	Alk

Habitat loss	**Gavia spec.**						
	59						59 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
NAT							
Borssele 1	0	0	0	1	0	0	1
Borssele 2	0	0	0	0	0	0	0
Borssele III	0	0	0	0	0	0	0
Borssele IV	0	0	0	0	0	0	0
Borssele V	0	0	0	0	0	0	0
Eneco Luchterduinen	0	0	0	0	0	0	0
Gemini East	0	0	0	0	0	0	0
Gemini West	0	0	0	0	0	0	0
Hollandse Kust (west)	0	0	5	1	0	0	6
Hollandse Kust Noord (search area)	0	0	2	1	0	0	3
Hollandse Kust Zuid Site 1	0	0	2	0	1	0	3
Hollandse Kust Zuid Site 2	0	0	3	0	0	0	3
Hollandse Kust Zuid Site 3	0	0	0	0	0	0	0
Hollandse Kust Zuid Site 4	0	0	7	0	1	0	9
IJmuiden Ver	0	0	0	0	1	0	1
OWEZ	0	0	15	1	0	0	16
Prinses Amaliawindpark	0	0	0	0	0	0	0
Ten Noorden van de Waddeneilanden (2)	1	0	0	1	0	0	3

Habitat loss	Morus bassanus						
	710						710 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
NAT							
Borssele 1	19	40	25	42	4	75	204
Borssele 2	24	48	17	29	4	91	214
Borssele III	29	56	20	41	9	95	250
Borssele IV	22	83	20	63	16	67	271
Borssele V	1	1	1	1	0	3	8
Eneco Luchterduinen	7	5	13	4	7	3	39
Gemini East	4	13	2	3	28	6	56
Gemini West	8	30	2	3	20	3	67
Hollandse Kust (west)	79	135	230	65	74	35	616
Hollandse Kust Noord (search area)	102	101	93	86	90	54	525
Hollandse Kust Zuid Site 1	25	34	39	13	18	10	139
Hollandse Kust Zuid Site 2	24	6	21	7	11	6	76
Hollandse Kust Zuid Site 3	15	7	17	5	9	7	59
Hollandse Kust Zuid Site 4	41	16	44	14	32	13	160
IJmuiden Ver	74	259	202	73	62	45	715
OWEZ	19	5	10	10	11	4	60
Prinses Amaliawindpark	10	6	8	7	6	2	39
Ten Noorden van de Waddeneilanden (2)	21	72	15	11	28	12	161

Habitat loss	Thalasseus sandvicensis						
	6110						6110 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
NAT							
Borssele 1	2	0	0	0	42	6	49
Borssele 2	3	0	0	0	75	7	85
Borssele III	0	0	0	0	45	0	46
Borssele IV	0	0	0	0	10	0	10
Borssele V	0	0	0	0	1	0	1
Eneco Luchterduinen	0	0	0	0	3	4	7
Gemini East	0	0	0	0	29	2	31
Gemini West	2	0	0	0	10	1	13
Hollandse Kust (west)	2	0	0	0	0	0	2
Hollandse Kust Noord (search area)	34	0	0	0	73	31	138
Hollandse Kust Zuid Site 1	0	0	0	0	14	2	17
Hollandse Kust Zuid Site 2	0	0	0	0	8	0	9
Hollandse Kust Zuid Site 3	1	0	0	0	6	2	10
Hollandse Kust Zuid Site 4	3	0	0	0	24	13	41
IJmuiden Ver	13	2	0	0	48	0	63
OWEZ	3	0	0	0	10	34	47
Prinses Amaliawindpark	0	0	0	0	3	3	6
Ten Noorden van de Waddeneilanden (2)	35	0	0	0	16	1	52

Habitat loss	**Uria aalge**						
	6340						6340 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
NAT							
Borssele 1	0	189	200	256	14	0	659
Borssele 2	3	239	257	320	14	0	831
Borssele III	3	232	325	444	7	0	1011
Borssele IV	1	137	315	353	7	0	813
Borssele V	0	11	7	4	1	0	24
Eneco Luchterduinen	0	65	156	33	2	0	255
Gemini East	35	69	33	0	18	5	160
Gemini West	45	66	81	8	17	0	217
Hollandse Kust (west)	24	1168	1159	973	184	4	3512
Hollandse Kust Noord (search area)	8	1030	762	230	51	3	2084
Hollandse Kust Zuid Site 1	0	203	350	65	2	0	619
Hollandse Kust Zuid Site 2	0	142	173	46	0	0	362
Hollandse Kust Zuid Site 3	0	338	170	43	5	0	556
Hollandse Kust Zuid Site 4	0	197	332	76	8	1	613
IJmuiden Ver	112	1150	1120	1744	1880	102	6108
OWEZ	1	75	41	23	1	0	141
Prinses Amaliawindpark	0	70	50	24	1	0	145
Ten Noorden van de Waddeneilanden (2)	131	199	428	36	59	203	1056

Habitat loss	Alca torda						
	6360						6360 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
NAT							
Borssele 1	0	28	8	115	0	0	152
Borssele 2	0	95	39	129	0	0	263
Borssele III	0	16	52	132	0	0	200
Borssele IV	0	16	42	192	0	0	250
Borssele V	0	1	0	1	0	0	2
Eneco Luchterduinen	0	11	18	6	0	0	35
Gemini East	0	3	7	0	0	0	10
Gemini West	0	18	9	5	0	0	32
Hollandse Kust (west)	0	104	128	604	0	0	836
Hollandse Kust Noord (search area)	0	221	79	158	1	0	458
Hollandse Kust Zuid Site 1	0	28	56	23	0	0	107
Hollandse Kust Zuid Site 2	0	33	34	24	0	0	91
Hollandse Kust Zuid Site 3	0	52	22	18	1	0	93
Hollandse Kust Zuid Site 4	0	20	47	25	0	0	92
IJmuiden Ver	4	177	139	978	67	0	1365
OWEZ	0	12	7	18	0	0	37
Prinses Amaliawindpark	0	13	2	13	0	0	28
Ten Noorden van de Waddeneilanden (2)	1	55	43	24	0	0	124

Appendix 3 Results of habitat loss per OWF per seabird species, international scenario

The reported numbers are estimated numbers of birds per OWF that may suffer habitat loss associated with the presence of a wind farm per season or totalled for the whole year.
N.B. The Scale Factor has not been applied to the values in this annex!

The following seabird species are listed in this Annex (order: EUring ascending):

EUring	Scientific name	English name	Dutch Name
59	*Gavia spec.*	Diver spec.	Duiker
710	*Morus bassanus*	Northern Gannet	Jan-van-Gent
6110	*Thalasseus sandvicensis*	Sandwich Tern	Grote Stern
6340	*Uria aalge*	Common Guillemot	Zeekoet
6360	*Alca torda*	Razorbill	Alk

Habitat loss	Gavia spec.						
	59						59 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT							
Aberdeen Offshore Wind Farm (EOWDC)	0	0	133	0	0	0	133
Alpha Ventus Nord	0	0	0	0	2	0	2
Alpha Ventus Süd	0	0	0	0	2	0	2
Amrumbank West	0	0	564	185	2	0	751
BARD Offshore 1	0	2	0	59	4	0	65
Beatrice	0	3	0	0	0	0	3
Belwind	0	0	0	1	0	0	1
Belwind Alstom Haliade Demonstration	0	0	0	0	0	0	0
Blyth Offshore Wind Demonstration site	0	0	0	0	0	0	0
Borkum Riffgrund I	0	0	0	0	13	0	13
Borkum Riffgrund II	0	0	0	0	44	0	44
Borkum Riffgrund West 1	0	0	9	2	0	0	11
Borkum Riffgrund West 2	0	1	2	4	2	0	9
Borkum West II Phase 1	0	0	0	0	2	0	2
Borkum West II Phase 2	0	0	0	0	2	0	2
Borssele 1	0	0	0	1	11	0	11
Borssele 2	0	0	0	2	13	0	15
Borssele III	0	0	0	2	0	0	2
Borssele IV	0	0	0	1	0	0	1
Borssele V	0	0	0	0	0	0	0
Butendiek	0	63	97	20	262	0	442
DanTysk	0	3	27	43	215	0	289
Deutsche Bucht	0	4	0	6	4	0	14
Dudgeon	0	9	0	4	8	0	21
East Anglia One	0	0	0	8	8	0	15
East Anglia ONE North	0	0	58	10	66	0	133
East Anglia Three	0	0	0	0	15	0	15
East Anglia TWO	0	0	22	5	18	0	45
EnBW He Dreiht	0	0	0	0	0	0	0
EnBW Hohe See	0	0	0	0	0	0	0
Eneco Luchterduinen	0	0	0	0	0	0	0
Fairy Bank 1	0	1	0	4	59	0	64
Fairy Bank 2	0	1	0	4	2	0	7
Fairy Bank 3	0	36	0	3	0	0	39
Galloper	0	0	0	10	0	0	10
Gemini East	0	7	0	0	12	0	19
Gemini West	0	0	0	8	40	0	48
Global Tech 1	0	0	0	1	0	0	1
Gode Wind 03	0	0	0	19	0	0	19
Gode Wind 04	0	0	0	14	0	0	14
Gode Wind 1 and 2	0	2	0	23	9	0	34
Greater Gabbard	0	0	0	9	0	0	9
Gunfleet Sands Demonstration Project	0	2	0	7	0	0	9
Gunfleet Sands I + II	0	7	2	25	1	0	35

Habitat loss	Gavia spec.						
	59						59 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT							
Hollandse Kust (west)	0	0	1	1	0	0	2
Hollandse Kust Noord (search area)	0	6	4	5	44	0	59
Hollandse Kust Zuid Site 1	0	0	1	0	1	0	2
Hollandse Kust Zuid Site 2	0	0	2	3	0	0	4
Hollandse Kust Zuid Site 3	0	0	0	6	0	0	6
Hollandse Kust Zuid Site 4	0	0	5	0	1	0	6
Horns Rev 1	0	26	36	85	250	0	397
Horns Rev 2	0	16	205	70	131	0	422
Horns Rev 3	0	47	281	108	365	0	801
Horns Rev Reserved Area	0	629	3129	2142	6543	0	12443
Hornsea Project One	0	0	0	0	0	0	0
Hornsea Project Three	0	0	0	0	0	0	0
Hornsea Project Two	0	0	0	0	0	0	0
Humber Gateway	0	15	1	0	0	0	15
Hywind 2 Demonstration	0	0	0	0	0	0	0
IJmuiden Ver	0	0	5	0	1	0	6
Inch Cape	0	0	0	0	0	0	0
Inner Dowsing	0	3	2	9	0	0	14
Kaskasi II	0	0	274	37	0	0	311
Kentish Flats 1	0	4	10	9	2	0	25
Kentish Flats 2	0	4	10	5	2	0	22
Kincardine Offshore Windfarm Project	0	0	0	0	0	0	0
Lincs	0	10	6	38	0	0	55
London Array 1	0	17	8	141	8	0	174
Lynn	0	3	0	9	0	0	12
Meerwind Süd/Ost	0	29	46	9	1	0	85
Merkur Offshore	0	0	0	0	26	0	26
Moray Firth Eastern Development Area	0	11	0	0	0	0	11
Moray Firth Western Development Area	0	37	0	0	0	0	37
N-3.5 DE-tender 2025	0	1	0	0	0	0	1
N-3.6 DE-tender 2024	0	2	0	0	0	0	2
N-3.7 DE-tender 2026	0	0	0	17	0	0	17
N-3.8 DE-tender 2022	0	3	0	0	0	0	3
N-6.6 DE-tender 2026	0	2	0	0	2	0	4
N-6.7 DE-tender 2029	0	2	0	46	5	0	53
N-7.2 DE-tender 2027	0	0	0	1	0	0	1
Neart na Gaoithe	0	0	0	0	0	0	0
Nobelwind	0	0	0	2	0	0	2
Nordergründe	0	5	23	1	0	0	29
Nordsee One	0	0	0	0	6	0	6
Nordsee Ost	0	0	84	1	0	0	85
Norfolk Boreas	0	18	0	56	41	0	115
Norfolk Vanguard	0	4	8	0	222	0	234
Norther	0	8	60	15	0	0	83

Habitat loss	Gavia spec.						
	59						59 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT							
Northwester 2	0	0	0	1	0	0	1
Northwind	0	0	0	1	0	0	1
OWEZ	0	5	13	3	6	0	28
OWP West	0	0	6	0	1	0	8
Prinses Amaliawindpark	0	0	0	0	8	0	8
Race Bank	0	9	1	109	0	0	119
RENTEL	0	0	1	1	0	0	2
Riffgat	0	84	28	1	28	0	141
Sandbank 24	0	125	6	27	755	0	914
Scroby Sands	0	1	66	0	0	0	67
SeaGreen Alpha	0	0	0	0	0	0	0
SeaGreen Bravo	0	0	0	0	0	0	0
Seastar	0	0	0	1	0	0	1
Sheringham Shoal	0	12	0	13	7	0	32
Teesside	0	0	0	0	0	0	1
Ten Noorden van de Waddeneilanden (2)	0	1	2	10	41	0	54
Thanet	0	3	5	29	4	0	42
Thanet Extension	0	8	14	61	10	0	93
Thornton Bank I	0	0	0	0	0	0	0
Thornton Bank II	0	0	1	0	0	0	1
Thornton Bank III	0	0	6	0	0	0	6
THV Mermaid	0	0	0	0	0	0	0
Veja Mate	0	6	0	29	6	0	41
Vesterhav Nord	0	0	7	5	3	0	14
Vesterhav Syd	0	0	20	4	114	0	139
Westermost Rough	0	4	0	0	0	0	4

Habitat loss	Morus bassanus						
	710						710 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT							
Aberdeen Offshore Wind Farm (EOWDC)	39	5	0	0	7	6	57
Alpha Ventus Nord	1	0	0	1	0	0	4
Alpha Ventus Süd	1	0	0	1	0	0	4
Amrumbank West	4	0	6	5	4	4	23
BARD Offshore 1	12	45	6	6	9	6	83
Beatrice	22	40	31	50	22	22	188
Belwind	8	13	5	9	4	69	108
Belwind Alstom Haliade Demonstration	1	1	0	1	0	1	4
Blyth Offshore Wind Demonstration site	10	4	2	3	6	20	45
Borkum Riffgrund I	11	7	4	6	4	5	36
Borkum Riffgrund II	16	10	6	8	5	7	52
Borkum Riffgrund West 1	13	6	2	3	4	4	31
Borkum Riffgrund West 2	9	5	3	2	3	2	24
Borkum West II Phase 1	11	3	3	4	3	4	28
Borkum West II Phase 2	16	5	4	6	4	5	40
Borssele 1	19	38	25	34	6	74	195
Borssele 2	24	41	21	28	13	86	213
Borssele III	29	69	25	40	18	94	275
Borssele IV	28	76	21	53	17	63	257
Borssele V	1	1	1	1	1	3	8
Butendiek	5	1	103	5	5	4	122
DanTysk	9	0	8	8	10	8	44
Deutsche Bucht	5	22	3	1	1	3	35
Dudgeon	41	4	0	1	3	25	74
East Anglia One	42	137	24	59	33	48	343
East Anglia ONE North	49	75	33	10	10	35	212
East Anglia Three	40	130	147	82	35	6	441
East Anglia TWO	125	24	13	31	63	129	384
EnBW He Dreiht	16	8	8	9	27	6	74
EnBW Hohe See	11	2	5	4	17	5	44
Eneco Luchterduinen	6	6	13	4	6	3	38
Fairy Bank 1	42	85	32	68	50	12	289
Fairy Bank 2	32	107	27	106	46	18	336
Fairy Bank 3	21	45	18	40	25	13	163
Galloper	67	39	8	24	18	47	202
Gemini East	12	12	5	3	22	5	58
Gemini West	8	29	2	3	20	3	65
Global Tech 1	9	2	5	5	7	5	32
Gode Wind 03	2	2	0	31	2	2	40
Gode Wind 04	1	1	0	15	1	1	20
Gode Wind 1 and 2	13	9	4	29	8	8	71
Greater Gabbard	90	61	10	22	16	54	253
Gunfleet Sands Demonstration Project	1	2	0	0	1	1	5
Gunfleet Sands I + II	6	7	1	0	4	3	22

Habitat loss	Morus bassanus						
	710						710 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT							
Hollandse Kust (west)	76	138	226	64	74	33	612
Hollandse Kust Noord (search area)	95	105	81	89	88	49	508
Hollandse Kust Zuid Site 1	27	39	38	13	18	9	144
Hollandse Kust Zuid Site 2	19	14	20	8	11	11	83
Hollandse Kust Zuid Site 3	15	12	17	5	8	6	63
Hollandse Kust Zuid Site 4	28	28	44	14	29	12	153
Horns Rev 1	0	0	0	1	0	3	5
Horns Rev 2	16	0	0	0	3	2	21
Horns Rev 3	68	17	0	15	0	5	105
Horns Rev Reserved Area	963	199	100	81	52	183	1577
Hornsea Project One	94	899	67	47	138	82	1327
Hornsea Project Three	168	786	353	707	42	126	2181
Hornsea Project Two	101	495	37	50	75	78	837
Humber Gateway	4	0	0	2	0	6	12
Hywind 2 Demonstration	16	32	0	63	7	15	133
IJmuiden Ver	95	265	194	71	94	37	756
Inch Cape	31	75	23	51	119	60	359
Inner Dowsing	1	0	0	0	0	5	6
Kaskasi II	3	1	10	6	3	3	25
Kentish Flats 1	0	4	3	0	1	2	10
Kentish Flats 2	0	4	3	0	1	2	10
Kincardine Offshore Windfarm Project	61	8	22	63	29	22	204
Lincs	3	0	0	0	0	18	21
London Array 1	19	38	12	17	31	30	147
Lynn	1	0	0	0	0	4	5
Meerwind Süd/Ost	5	5	41	16	6	6	80
Merkur Offshore	21	5	5	7	4	6	48
Moray Firth Eastern Development Area	41	98	42	344	44	54	624
Moray Firth Western Development Area	36	113	37	462	35	59	742
N-3.5 DE-tender 2025	6	3	3	5	3	4	24
N-3.6 DE-tender 2024	14	6	6	8	5	7	46
N-3.7 DE-tender 2026	3	3	0	17	3	2	28
N-3.8 DE-tender 2022	8	5	4	6	4	5	32
N-6.6 DE-tender 2026	10	32	5	4	2	5	59
N-6.7 DE-tender 2029	7	30	4	1	4	3	50
N-7.2 DE-tender 2027	18	8	7	10	9	7	59
Neart na Gaoithe	34	61	30	23	59	58	265
Nobelwind	16	25	9	18	4	90	162
Nordergründe	1	0	0	1	1	1	4
Nordsee One	8	5	4	6	4	5	32
Nordsee Ost	5	4	25	14	5	6	60
Norfolk Boreas	121	265	104	42	83	0	615
Norfolk Vanguard	131	363	72	93	123	19	801
Norther	16	24	9	30	10	55	144

Habitat loss	**Morus bassanus**						
	710						710 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT							
Northwester 2	7	11	4	8	4	50	85
Northwind	9	27	6	12	4	27	85
OWEZ	19	5	10	10	11	4	60
OWP West	7	4	2	2	3	3	21
Prinses Amaliawindpark	8	7	6	6	6	2	34
Race Bank	8	0	0	0	0	25	33
RENTEL	12	30	7	12	9	32	102
Riffgat	1	1	0	0	1	1	4
Sandbank 24	3	0	2	4	9	12	30
Scroby Sands	6	0	0	1	0	8	15
SeaGreen Alpha	35	61	11	77	67	62	314
SeaGreen Bravo	42	72	14	78	75	51	331
Seastar	12	21	7	14	1	32	88
Sheringham Shoal	8	0	0	0	0	13	21
Teesside	3	1	0	0	4	1	9
Ten Noorden van de Waddeneilanden (2)	21	72	15	11	29	11	159
Thanet	23	19	8	21	2	13	86
Thanet Extension	50	40	18	41	6	29	184
Thornton Bank I	2	5	2	1	0	3	13
Thornton Bank II	9	25	7	24	7	23	95
Thornton Bank III	5	13	5	2	1	12	37
THV Mermaid	10	15	6	13	5	33	81
Veja Mate	10	44	5	3	2	5	69
Vesterhav Nord	6	49	0	12	5	11	83
Vesterhav Syd	71	35	0	0	0	1	108
Westermost Rough	6	2	2	5	2	8	24

Habitat loss	Sterna sandvicensis						
	6110						6110 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT							
Aberdeen Offshore Wind Farm (EOWDC)	19	0	0	0	0	14	33
Alpha Ventus Nord	8	0	0	0	9	0	18
Alpha Ventus Süd	8	0	0	0	9	0	18
Amrumbank West	43	0	0	0	8	0	51
BARD Offshore 1	0	0	0	0	3	0	3
Beatrice	0	0	0	0	0	0	0
Belwind	11	0	0	0	4	0	15
Belwind Alstom Haliade Demonstration	0	0	0	0	0	0	0
Blyth Offshore Wind Demonstration site	0	0	0	0	1	0	1
Borkum Riffgrund I	76	0	0	0	79	124	280
Borkum Riffgrund II	98	0	0	0	100	156	353
Borkum Riffgrund West 1	5	0	0	0	4	0	9
Borkum Riffgrund West 2	0	0	0	0	2	0	2
Borkum West II Phase 1	1	0	0	0	65	28	93
Borkum West II Phase 2	1	0	0	0	90	34	124
Borssele 1	7	0	0	0	52	7	66
Borssele 2	5	0	0	0	64	16	85
Borssele III	6	0	0	0	35	13	55
Borssele IV	1	0	0	0	10	0	10
Borssele V	0	0	0	0	1	0	1
Butendiek	5	0	0	0	0	0	5
DanTysk	4	0	0	0	130	0	134
Deutsche Bucht	0	0	0	0	0	0	0
Dudgeon	0	0	0	0	91	0	91
East Anglia One	0	0	0	0	8	0	8
East Anglia ONE North	1	0	0	0	2	0	3
East Anglia Three	0	0	0	0	1	0	1
East Anglia TWO	14	0	0	0	1	0	15
EnBW He Dreiht	0	0	0	0	0	0	0
EnBW Hohe See	0	0	0	0	0	0	0
Eneco Luchterduinen	1	0	0	1	2	3	7
Fairy Bank 1	0	0	0	2	21	25	48
Fairy Bank 2	0	0	0	0	45	5	51
Fairy Bank 3	0	0	0	0	34	0	35
Galloper	0	0	0	0	0	0	0
Gemini East	0	0	0	0	4	0	4
Gemini West	0	0	0	0	3	0	3
Global Tech 1	0	0	0	0	0	0	0
Gode Wind 03	36	0	0	0	9	0	45
Gode Wind 04	27	0	0	0	7	0	34
Gode Wind 1 and 2	106	0	0	0	21	0	127
Greater Gabbard	0	0	0	0	0	0	0

Habitat loss	Sterna sandvicensis							
		6110						6110 Total
Estimated number of birds per OWF	Season							
OWF name		1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT								
Gunfleet Sands Demonstration Project		8	0	0	0	1	3	12
Gunfleet Sands I + II		28	0	0	0	4	10	42
Hollandse Kust (west)		2	0	0	0	1	0	3
Hollandse Kust Noord (search area)		20	0	0	0	98	11	128
Hollandse Kust Zuid Site 1		3	0	0	0	10	2	15
Hollandse Kust Zuid Site 2		4	0	0	0	25	0	28
Hollandse Kust Zuid Site 3		8	0	0	0	38	2	49
Hollandse Kust Zuid Site 4		17	0	0	1	43	6	67
Horns Rev 1		0	0	0	0	0	0	0
Horns Rev 2		0	0	0	0	0	0	0
Horns Rev 3		0	0	0	0	11	0	11
Horns Rev Reserved Area		1	0	127	0	699	0	826
Hornsea Project One		0	0	0	0	0	0	0
Hornsea Project Three		0	0	0	0	0	0	0
Hornsea Project Two		0	0	0	0	0	0	0
Humber Gateway		3	0	0	0	16	0	19
Hywind 2 Demonstration		0	0	0	0	0	0	0
IJmuiden Ver		6	1	0	0	32	8	48
Inch Cape		0	0	0	0	0	0	0
Inner Dowsing		5	0	0	0	18	0	23
Kaskasi II		0	0	0	0	6	0	6
Kentish Flats 1		12	0	0	0	4	8	24
Kentish Flats 2		13	0	0	0	5	7	25
Kincardine Offshore Windfarm Project		0	0	0	0	0	0	0
Lincs		15	0	0	0	65	0	80
London Array 1		86	0	0	0	13	41	140
Lynn		4	0	0	0	16	0	20
Meerwind Süd/Ost		0	0	0	0	74	0	74
Merkur Offshore		17	0	0	0	37	40	94
Moray Firth Eastern Development Area		0	0	0	0	0	0	0
Moray Firth Western Development Area		0	0	0	0	0	0	0
N-3.5 DE-tender 2025		3	0	0	0	10	0	13
N-3.6 DE-tender 2024		7	0	0	0	38	0	45
N-3.7 DE-tender 2026		59	0	0	0	15	0	74
N-3.8 DE-tender 2022		8	0	0	0	14	0	22
N-6.6 DE-tender 2026		0	0	0	0	6	0	7
N-6.7 DE-tender 2029		0	0	0	0	0	0	0
N-7.2 DE-tender 2027		0	0	0	0	0	0	0
Neart na Gaoithe		0	0	0	0	0	0	0
Nobelwind		12	0	0	0	7	0	18
Nordergründe		14	0	0	0	0	83	97
Nordsee One		25	0	0	0	0	0	25
Nordsee Ost		0	0	0	0	17	0	17

Habitat loss	Sterna sandvicensis							
		6110						6110 Total
Estimated number of birds per OWF	Season							
OWF name		1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT								
Norfolk Boreas		0	0	0	0	0	0	0
Norfolk Vanguard		0	0	0	0	0	0	0
Norther		16	0	0	0	14	10	39
Northwester 2		7	0	0	0	3	0	10
Northwind		5	0	0	0	8	6	20
OWEZ		7	0	0	0	9	8	24
OWP West		4	0	0	0	2	0	6
Prinses Amaliawindpark		4	0	0	0	3	0	7
Race Bank		0	0	0	0	108	0	108
RENTEL		10	0	0	0	14	9	33
Riffgat		8	0	0	0	36	4	49
Sandbank 24		0	0	0	0	5	0	5
Scroby Sands		0	0	0	0	111	0	111
SeaGreen Alpha		0	0	0	0	6	0	6
SeaGreen Bravo		0	0	0	0	20	0	20
Seastar		4	0	0	0	7	3	14
Sheringham Shoal		0	0	0	0	66	0	66
Teesside		0	0	0	0	0	0	0
Ten Noorden van de Waddeneilanden (2)		1	0	0	0	4	0	5
Thanet		0	0	0	0	10	10	20
Thanet Extension		1	0	0	0	17	22	40
Thornton Bank I		4	0	0	0	1	0	5
Thornton Bank II		10	0	0	0	10	5	25
Thornton Bank III		9	0	0	0	4	0	14
THV Mermaid		0	0	0	0	3	0	3
Veja Mate		0	0	0	0	1	0	1
Vesterhav Nord		0	0	0	0	0	0	0
Vesterhav Syd		0	0	0	0	0	0	0
Westermost Rough		0	0	0	0	9	0	9

Habitat loss	Uria aalge						
	6340						6340 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT							
Aberdeen Offshore Wind Farm (EOWDC)	1506	1166	381	153	1468	322	4998
Alpha Ventus Nord	0	74	68	76	8	0	226
Alpha Ventus Süd	0	75	68	76	8	0	228
Amrumbank West	613	151	160	68	7	7	1006
BARD Offshore 1	1797	58	60	21	19	351	2305
Beatrice	108	72	15178	158	956	5228	21701
Belwind	0	7	84	117	1	0	210
Belwind Alstom Haliade Demonstration	0	0	6	6	0	0	12
Blyth Offshore Wind Demonstration site	476	51	450	150	693	167	1988
Borkum Riffgrund I	152	308	276	837	18	0	1591
Borkum Riffgrund II	191	413	379	1121	38	4	2146
Borkum Riffgrund West 1	134	347	1179	152	93	542	2447
Borkum Riffgrund West 2	236	331	848	216	125	540	2295
Borkum West II Phase 1	91	183	344	683	137	4	1441
Borkum West II Phase 2	110	265	681	703	137	9	1905
Borssele 1	1	328	213	231	34	0	807
Borssele 2	3	298	292	239	30	0	863
Borssele III	8	337	401	340	11	0	1096
Borssele IV	3	149	319	292	12	0	775
Borssele V	0	11	7	9	1	0	28
Butendiek	136	700	184	0	2	7	1027
DanTysk	76	1309	797	103	5	452	2742
Deutsche Bucht	289	22	12	1	2	123	450
Dudgeon	1391	220	36	257	346	431	2680
East Anglia One	82	343	966	360	1284	2176	5210
East Anglia ONE North	65	416	1265	273	1599	3097	6715
East Anglia Three	515	593	4460	997	1117	551	8234
East Anglia TWO	60	228	702	274	1085	3169	5516
EnBW He Dreiht	1460	74	200	414	37	589	2775
EnBW Hohe See	1084	37	329	121	8	3850	5431
Eneco Luchterduinen	1	42	217	33	13	0	306
Fairy Bank 1	3	173	436	566	115	0	1293
Fairy Bank 2	0	67	604	520	67	0	1258
Fairy Bank 3	0	28	456	223	17	0	724
Galloper	9	51	196	230	77	396	958
Gemini East	926	1136	888	553	249	1541	5292
Gemini West	796	572	568	626	164	1006	3732
Global Tech 1	2309	53	457	1	3	4300	7124
Gode Wind 03	357	152	306	198	22	0	1034
Gode Wind 04	242	90	181	134	14	0	660
Gode Wind 1 and 2	673	197	1271	267	44	0	2451
Greater Gabbard	9	72	201	256	48	500	1086
Gunfleet Sands Demonstration Project	0	1	14	0	0	0	15
Gunfleet Sands I + II	0	4	48	0	0	0	52

Habitat loss	Uria aalge						
	6340						6340 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT							
Hollandse Kust (west)	54	1817	1597	1276	216	5	4965
Hollandse Kust Noord (search area)	183	2753	2432	1173	546	3	7089
Hollandse Kust Zuid Site 1	3	269	436	104	58	0	870
Hollandse Kust Zuid Site 2	1	185	442	121	109	0	857
Hollandse Kust Zuid Site 3	0	327	276	45	54	0	703
Hollandse Kust Zuid Site 4	5	229	481	98	84	1	898
Horns Rev 1	111	302	30	22	1	0	466
Horns Rev 2	82	158	52	40	41	56	428
Horns Rev 3	334	480	217	168	37	556	1793
Horns Rev Reserved Area	7197	9775	9239	2780	938	17115	47044
Hornsea Project One	5248	3021	5003	8385	2701	8005	32363
Hornsea Project Three	7880	1250	8179	5215	2341	4897	29761
Hornsea Project Two	4924	2677	4547	10223	2522	7027	31918
Humber Gateway	47	60	65	94	133	838	1237
Hywind 2 Demonstration	22680	291	47	2131	261	2045	27455
IJmuiden Ver	415	1598	2266	1982	1432	61	7754
Inch Cape	13145	326	1393	650	1070	4213	20797
Inner Dowsing	61	28	5	65	42	360	560
Kaskasi II	127	117	124	87	8	0	463
Kentish Flats 1	0	2	14	0	0	0	16
Kentish Flats 2	0	2	15	0	0	0	16
Kincardine Offshore Windfarm Project	9930	2700	985	8543	4565	2860	29583
Lincs	244	97	21	218	138	1038	1757
London Array 1	1	88	410	85	4	0	589
Lynn	57	26	2	57	34	257	433
Meerwind Süd/Ost	21	245	91	201	50	10	618
Merkur Offshore	171	375	1076	1990	94	0	3706
Moray Firth Eastern Development Area	315	273	15309	3051	3104	10058	32111
Moray Firth Western Development Area	39	626	11371	1566	2515	4991	21109
N-3.5 DE-tender 2025	13	170	290	148	3	0	625
N-3.6 DE-tender 2024	0	438	277	417	41	0	1173
N-3.7 DE-tender 2026	378	83	451	108	32	0	1051
N-3.8 DE-tender 2022	33	177	403	222	4	0	839
N-6.6 DE-tender 2026	1179	40	63	2	9	180	1473
N-6.7 DE-tender 2029	462	26	12	1	5	192	697
N-7.2 DE-tender 2027	640	138	397	319	56	872	2422
Neart na Gaoithe	3049	199	2114	352	3149	1483	10347
Nobelwind	1	50	166	167	4	0	388
Nordergründe	0	20	4	0	0	0	24
Nordsee One	17	338	358	98	3	0	814
Nordsee Ost	7	139	117	152	39	0	453
Norfolk Boreas	911	7132	2912	1855	3306	137	16253
Norfolk Vanguard	2250	1499	5532	1868	3026	629	14804
Norther	0	118	318	77	1	0	513

Habitat loss	Uria aalge						
	6340						6340 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT							
Northwester 2	0	5	95	88	1	0	188
Northwind	1	189	117	88	1	0	397
OWEZ	16	212	383	122	21	0	754
OWP West	227	227	584	116	50	276	1479
Prinses Amaliawindpark	4	306	140	137	88	0	675
Race Bank	730	156	128	258	185	536	1994
RENTEL	1	202	252	95	1	0	551
Riffgat	0	191	83	69	1	1	343
Sandbank 24	388	204	273	417	133	614	2029
Scroby Sands	71	6	52	84	39	136	386
SeaGreen Alpha	10425	719	814	3534	13860	5000	34352
SeaGreen Bravo	17047	328	1046	4510	16025	8575	47533
Seastar	1	122	128	100	5	0	357
Sheringham Shoal	327	127	47	109	251	287	1148
Teesside	175	27	45	23	154	87	512
Ten Noorden van de Waddeneilanden (2)	1957	1295	1222	1178	658	2625	8936
Thanet	4	48	147	44	3	0	246
Thanet Extension	18	86	294	118	7	0	523
Thornton Bank I	0	40	51	8	0	0	99
Thornton Bank II	0	171	229	48	1	0	449
Thornton Bank III	0	99	115	25	0	0	239
THV Mermaid	0	4	128	118	1	0	251
Veja Mate	969	45	38	2	8	159	1221
Vesterhav Nord	98	22	142	0	33	28	322
Vesterhav Syd	127	32	79	41	0	459	737
Westermost Rough	263	87	165	87	228	89	919

Habitat loss	**Alca torda**						
	6360						6360 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT							
Aberdeen Offshore Wind Farm (EOWDC)	199	0	37	6	618	27	887
Alpha Ventus Nord	0	0	14	5	0	0	20
Alpha Ventus Süd	0	0	14	5	0	0	20
Amrumbank West	0	9	10	2	0	0	22
BARD Offshore 1	0	2	1	829	0	0	832
Beatrice	74	19	1053	105	762	430	2443
Belwind	0	16	9	44	1	0	70
Belwind Alstom Haliade Demonstration	0	1	0	5	0	0	7
Blyth Offshore Wind Demonstration site	675	13	28	31	0	11	758
Borkum Riffgrund I	0	91	82	7	0	0	180
Borkum Riffgrund II	0	117	106	9	0	0	231
Borkum Riffgrund West 1	0	414	23	616	304	0	1356
Borkum Riffgrund West 2	0	333	14	398	230	0	975
Borkum West II Phase 1	0	74	178	199	0	0	450
Borkum West II Phase 2	0	79	225	274	0	0	577
Borssele 1	0	202	6	82	0	0	290
Borssele 2	1	261	20	67	0	0	350
Borssele III	1	108	32	239	0	0	380
Borssele IV	0	30	31	162	0	0	223
Borssele V	0	1	0	0	0	0	1
Butendiek	0	149	19	49	0	0	217
DanTysk	0	0	70	143	0	0	213
Deutsche Bucht	1	0	0	25	0	0	27
Dudgeon	36	22	18	24	17	124	241
East Anglia One	0	32	24	445	9	0	510
East Anglia ONE North	0	70	30	214	83	0	396
East Anglia Three	0	606	250	2033	51	0	2940
East Anglia TWO	0	1	168	181	16	0	367
EnBW He Dreiht	0	38	10	339	0	0	388
EnBW Hohe See	0	49	14	37	0	0	100
Eneco Luchterduinen	0	8	18	3	15	0	44
Fairy Bank 1	0	21	79	99	1	0	201
Fairy Bank 2	0	25	108	251	30	0	414
Fairy Bank 3	0	39	35	78	20	0	172
Galloper	0	0	96	80	0	0	176
Gemini East	0	495	38	535	130	0	1198
Gemini West	0	333	81	63	12	0	489
Global Tech 1	0	31	0	11	0	0	43
Gode Wind 03	0	984	592	0	0	0	1576
Gode Wind 04	0	546	398	0	0	0	944
Gode Wind 1 and 2	0	1278	1850	39	0	0	3168
Greater Gabbard	0	0	146	68	0	0	214
Gunfleet Sands Demonstration Project	0	0	0	0	0	0	0
Gunfleet Sands I + II	0	0	0	0	0	0	0

Habitat loss	Alca torda						
	6360						6360 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT							
Hollandse Kust (west)	0	107	292	1122	0	0	1522
Hollandse Kust Noord (search area)	11	111	158	261	113	0	654
Hollandse Kust Zuid Site 1	0	24	45	35	19	0	123
Hollandse Kust Zuid Site 2	0	85	32	58	3	0	179
Hollandse Kust Zuid Site 3	0	115	34	19	4	0	172
Hollandse Kust Zuid Site 4	0	71	38	32	29	0	169
Horns Rev 1	0	10	1	0	0	0	12
Horns Rev 2	0	2	17	0	1	0	21
Horns Rev 3	0	45	2	0	0	0	47
Horns Rev Reserved Area	0	578	333	1346	40	0	2296
Hornsea Project One	141	202	340	2241	19	1214	4157
Hornsea Project Three	237	58	860	1754	10	52	2970
Hornsea Project Two	143	210	448	1982	194	1042	4018
Humber Gateway	2	12	0	29	9	1934	1986
Hywind 2 Demonstration	2	260	1	0	32	194	489
IJmuiden Ver	1	220	738	1499	42	0	2500
Inch Cape	3306	25	153	61	96	464	4104
Inner Dowsing	0	1	2	3	0	735	741
Kaskasi II	0	0	7	9	0	0	16
Kentish Flats 1	0	0	1	0	0	0	1
Kentish Flats 2	0	0	1	0	0	0	1
Kincardine Offshore Windfarm Project	6570	49	151	176	1940	451	9337
Lincs	0	4	10	8	0	1983	2006
London Array 1	0	3	1	50	0	0	55
Lynn	0	2	1	2	0	636	641
Meerwind Süd/Ost	0	50	7	4	0	0	62
Merkur Offshore	0	298	499	385	0	0	1182
Moray Firth Eastern Development Area	77	108	1303	811	1213	1481	4993
Moray Firth Western Development Area	54	269	1160	598	936	724	3742
N-3.5 DE-tender 2025	0	108	190	40	0	0	337
N-3.6 DE-tender 2024	0	118	130	107	0	0	355
N-3.7 DE-tender 2026	0	778	767	2	0	0	1547
N-3.8 DE-tender 2022	0	127	426	60	0	0	612
N-6.6 DE-tender 2026	0	5	1	644	0	0	650
N-6.7 DE-tender 2029	0	1	0	89	0	0	90
N-7.2 DE-tender 2027	0	58	16	507	3	0	584
Neart na Gaoithe	2252	60	219	87	107	273	2998
Nobelwind	0	24	14	119	1	0	158
Nordergründe	0	0	5	0	0	0	5
Nordsee One	0	273	124	9	0	0	406
Nordsee Ost	0	26	4	16	0	0	46
Norfolk Boreas	0	1860	315	1115	69	0	3360
Norfolk Vanguard	482	965	824	1624	94	67	4056
Norther	2	65	49	25	0	0	141

Habitat loss	**Alca torda**						
	6360						6360 Total
Estimated number of birds per OWF	Season						
OWF name	1 AS	2 ON	3 DJ	4 FM	5 AM	6 JJJ	Yr_Total
INT							
Northwester 2	0	14	5	31	0	0	51
Northwind	0	63	16	98	0	0	177
OWEZ	1	24	53	21	2	0	101
OWP West	0	263	19	412	250	0	944
Prinses Amaliawindpark	0	4	16	26	0	0	46
Race Bank	8	6	63	7	0	270	353
RENTEL	0	69	19	66	0	0	153
Riffgat	0	91	3	13	0	0	107
Sandbank 24	0	82	106	2	198	0	387
Scroby Sands	8	0	1	10	9	21	48
SeaGreen Alpha	3653	16	352	565	249	740	5576
SeaGreen Bravo	3049	8	468	786	392	579	5283
Seastar	0	12	15	104	1	0	132
Sheringham Shoal	22	8	38	6	8	127	208
Teesside	8	13	9	0	0	0	31
Ten Noorden van de Waddeneilanden (2)	0	580	170	183	47	11	991
Thanet	0	3	11	22	0	0	35
Thanet Extension	0	4	17	53	0	0	74
Thornton Bank I	0	4	3	1	0	0	8
Thornton Bank II	1	63	15	19	0	0	96
Thornton Bank III	0	13	7	11	0	0	31
THV Mermaid	0	7	7	69	0	0	83
Veja Mate	1	2	1	183	0	0	187
Vesterhav Nord	0	19	17	0	0	0	36
Vesterhav Syd	0	44	4	0	1	0	50
Westermost Rough	55	16	29	25	20	605	750

Appendix 4 Data work-up

For the update for the KEC in 2018, the approach to the data work-up was on the same lines as in 2014 (see Leopold *et al.* 2014).
The final agreements about the selected seabird species and the selected scenarios (national or international) and about which data (databases) would be used as a basis for new seabird density maps were made during a workshop on 12 July 2018 (Bravo Rebolledo, E.L. & A. Gyimesi 2018).
Parties represented at the workshop: Rijkswaterstaat, Bureau Waardenburg and Wageningen Marine Research.
In short, the new density maps were calculated as shown in the table below.

Birds	International	National
'non-gulls' 5690, *S. skua* 6360, *A. torda* 6340, *U. aalge* 59, *Gavia spec.* 6110, *T. sandvicensis*	ESAS+MWTL 1991-2017	ESAS+MWTL 2000-2017
'gulls' 5910, *L. fuscus* 5920, *L. argentatus* 6000, *L. marinus* 6020, *R. tridactyla* 710, *M. bassanus*	ESAS+MWTL 1991-2017 (fishy-tail and therefore spread to >10/km2 in observation)	MWTL 2000-2017 (fishy-tail and therefore spread to >10/km2 in observation)

Additional database files were supplied for the update in the same formats as in 2014. The additional datasets provided data for ESAS and MWTL for the period 2013-2017. The ESAS supplement was supplied by M. Leopold (WMR) and primarily includes surveys in the Dutch section of the North Sea carried out on a project basis and therefore generally in the vicinity of either OWFs or nature areas (Marine Protected Areas). The MWTL supplement was supplied by J. de Jong (Bureau Waardenburg). This supplement also includes observations on the DCS.
During the working up of the data, use was made of existing queries taken from the Access database used previously. On this occasion, additional script was made in R (M. van Puijenbroek) for a number of processes, among other things to circumvent a difficulty that arose because, as a result of the spread of the seagulls (Python script), the number of records increased to a number that was difficult to handle of more than 29 million. The R-script was also used to generate all the necessary confirmed baseline observations so that the follow-up operations in GIS (ESRI ArcGIS Pro) could be performed with modified versions of the Python script that was also used for the previous KEC calculations. Adjustments to the Python script therefore primarily consisted of the transition from Python 2 to Python 3 and changes to the syntax and approach in the arcpy library (ESRI), which is different for ArcGIS Pro than it was previously in ArcMap. The number of records available for the IDW calculations (interpolation) is 5.4 million.
One important difference in the IDW calculations is with the previous KEC seabird density maps. The spread observations were mistakenly included in this operation as totals last time. On this occasion, each of the spread observations was processed as a separate observation, which is more in line with reality. This improvement will also result in significantly lower population sizes as shown 'on the map'. This change is also favourable with respect to a discussion about population sizes during the workshop. It emerged at the workshop that the population estimates based on the density maps for the non-spread species (non-gulls) were usually in line with estimates from other sources (literature). The spread of the species that follow fishing boats ('gulls') did indeed result in a lower estimated population size but not as much as expected. It is expected that the current improvement will adequately address this issue.

Table 16 Overview of seabird species for which updated density maps have been calculated, including why these species are at risk).

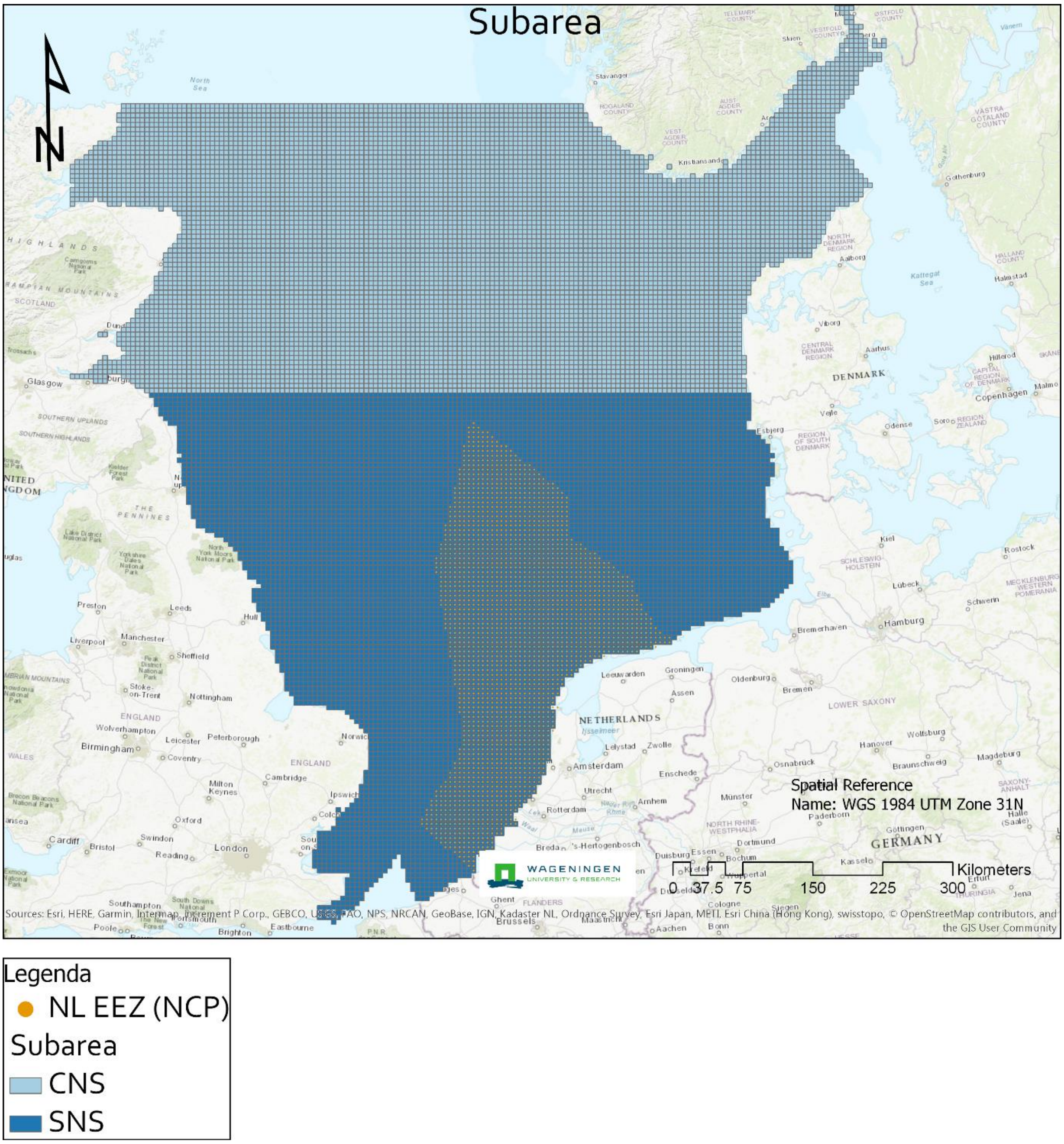
EUring	Scientific name	English name	Dutch name	Reason for risk
6000	*Larus marinus*	Great Black-backed Gull	Grote Mantelmeeuw	Collision
5910	*Larus fuscus*	Lesser Black-backed Gull	Kleine Mantelmeeuw	Collision
5920	*Larus argentatus*	Herring Gull	Zilvermeeuw	Collision
6020	*Rissa tridactyla*	Black-legged Kittiwake	Drieteenmeeuw	Collision
5690	*Stercorarius skua*$	Great Skua	Grote Jager	Collision
6360	*Alca torda*	Razorbill	Alk	Habitat loss
6340	*Uria aalge*	Common Guillemot	Zeekoet	Habitat loss
59	*Gavia spec.*	Diver spec.	duiker	Habitat loss
710	*Morus bassanus*	Northern Gannet	Jan-van-gent	Habitat loss
6110	*Thalasseus sandvicensis*#	Sandwich Tern	Grote Stern	Habitat loss

$ *Catharacta skua* (recent name change)

formerly *Sterna sandvicensis* (recent name change)

In this report, which is about habitat loss, reporting is limited to the species in which the Reason for Risk is Habitat Loss. The group of species for which the Reason for Risk is Collision are the subject of a report from Bureau Waardenburg. Bureau Waardenburg received the necessary files from WMR (from J.T. van der Wal) in late July 2018. At the request of Bureau Waardenburg, these data included including the Northern Gannet (EUring=710), which will also be assessed for collision risks. The data supplied to Bureau Waardenburg included a GIS file (feature class) with seasonal values for each of the six species and also a corresponding feature class with annual average densities (average for 6 seasons). In addition, for each species, there were two population estimates – one national estimate (DCS) and one international estimate (the SNS, southern North Sea, and CNS, central North Sea, areas) – in the form of an Excel spreadsheet. See also the figure below for the boundaries/size of the listed areas.

Figure 30 Area classification as used for population estimates based on the calculated seabird density maps. International scenario is CNS+SNS (including DCS); national scenario is DCS.



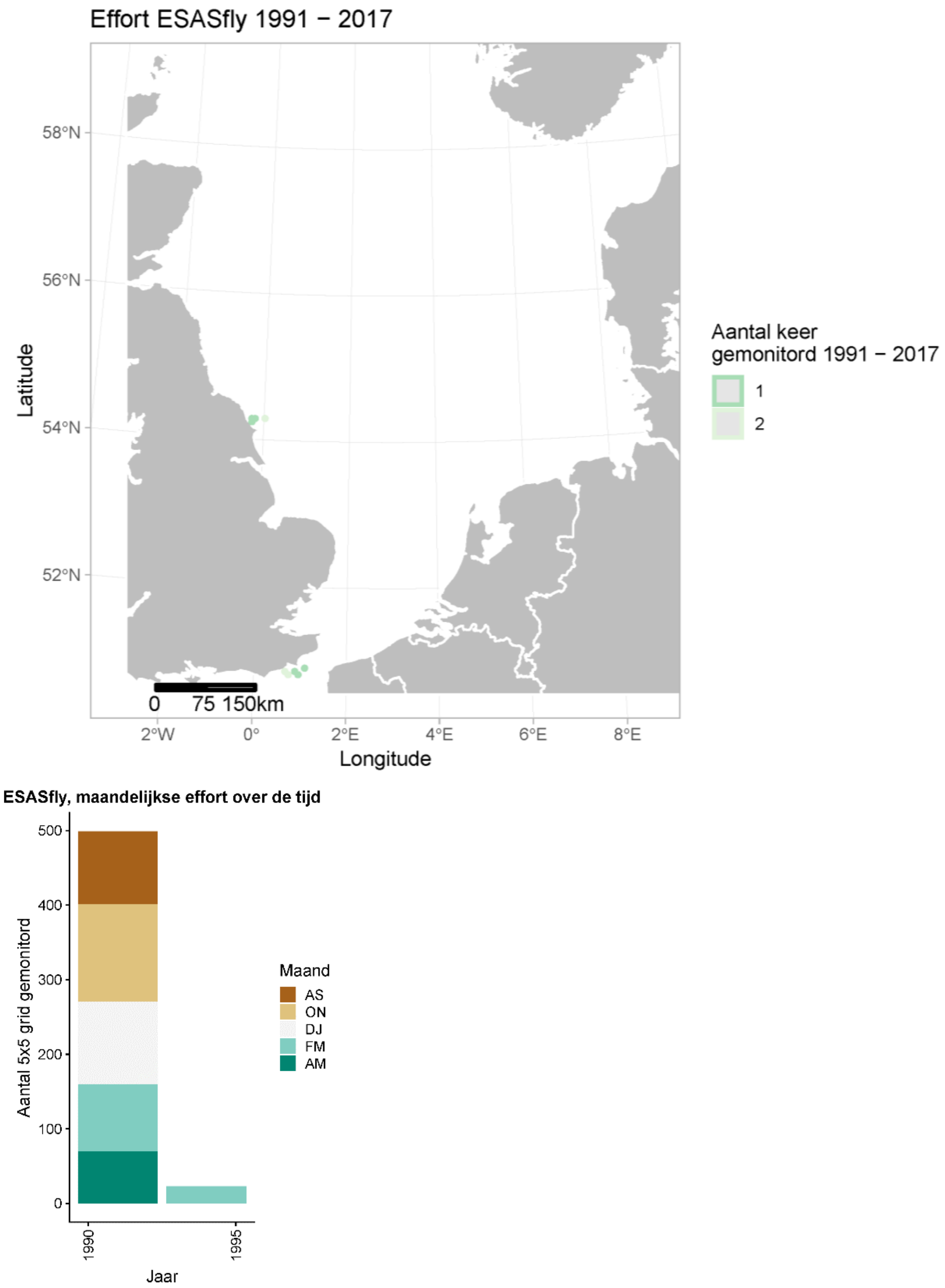
Appendix 5 Survey Effort

A map and a figure (histogram) have been included for each database showing the survey effort. These data were used for, among other things, the project workshop (12 July) to determine the choices for the selected years for each scenario.

Three databases were used: ESASfly, ESASship and MWTL.

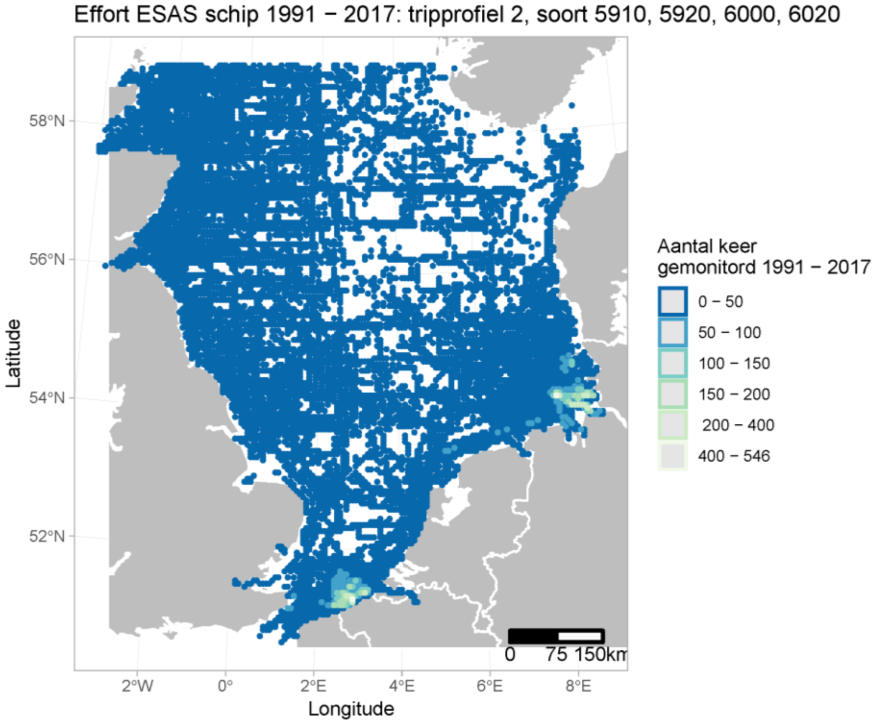
ESASfly

Figure 29 ESASfly survey effort for the period 1991-2017, geographical distribution (above), breakdown by year and season (below)



ESASShip

Figure 30 ESASship survey effort for the species 5910 Larus fuscus, 5920 Larus argentatus, 6000 Larus marinus and 6020 Rissa tridactyla for the periods 1991-2017 (above) and 2004-2017 (below)



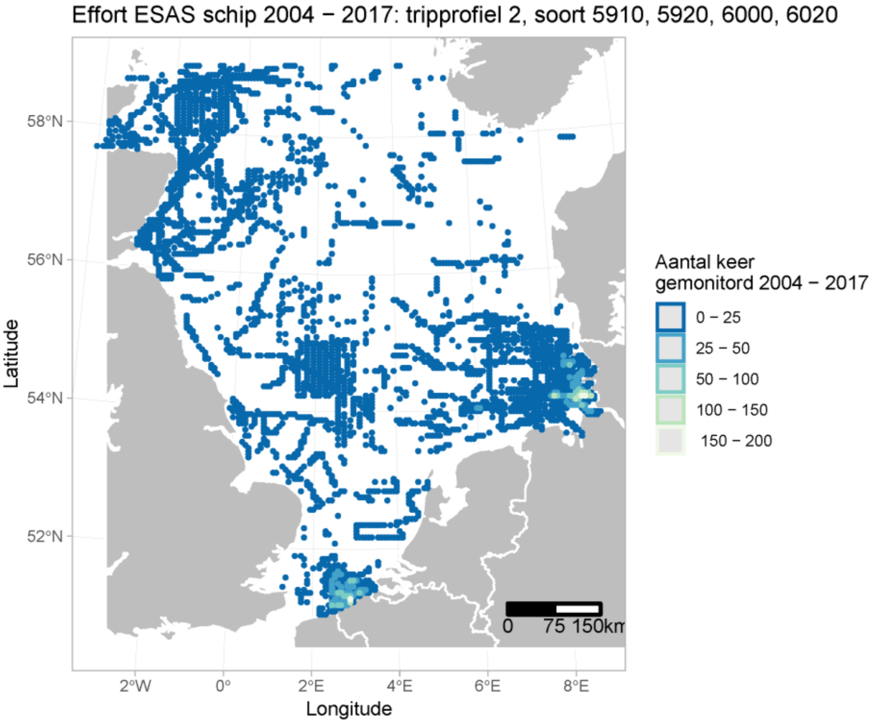


Figure 31 **Survey effort for the period 1991 - 2017 for ESASship for the species 5910 Larus fuscus, 5920 Larus argentatus, 6000 Larus marinus and 6020 Rissa tridactyla broken down by season**

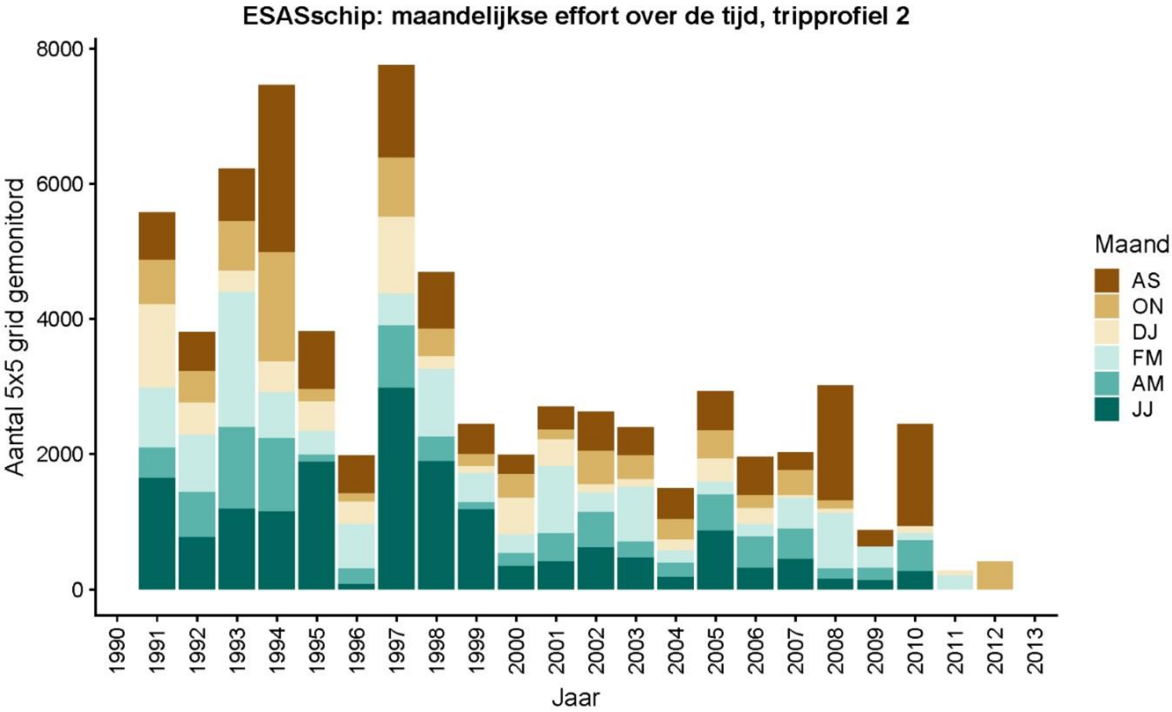
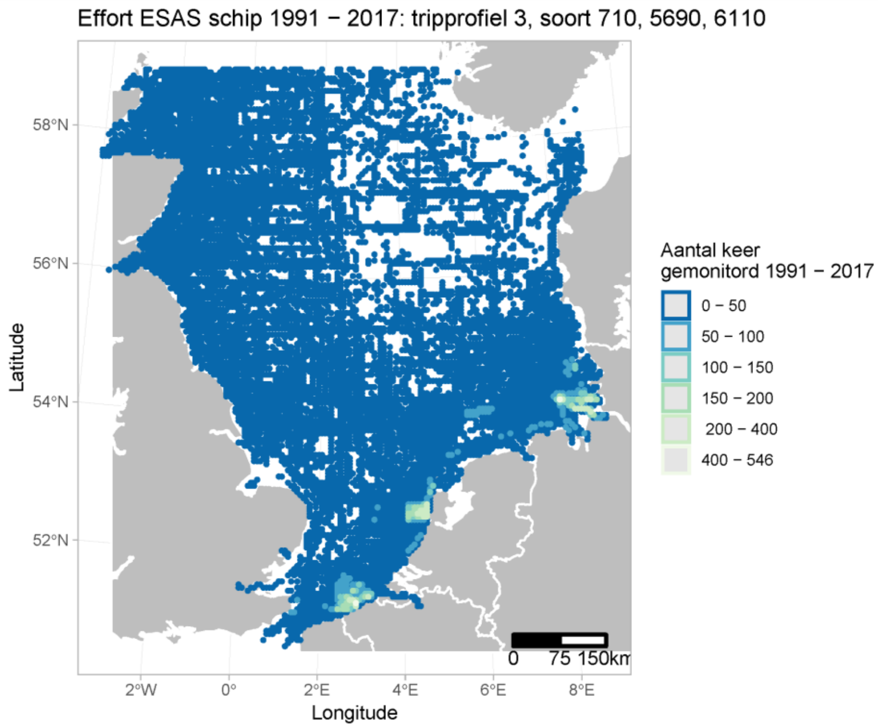


Figure 34 ESASship survey effort for the species 710 Morus bassanus, 5690 Stercorarius skua and 5110 Sterna sandvicensis for the periods 1991-2017 (above) and 2004-2017 (below)



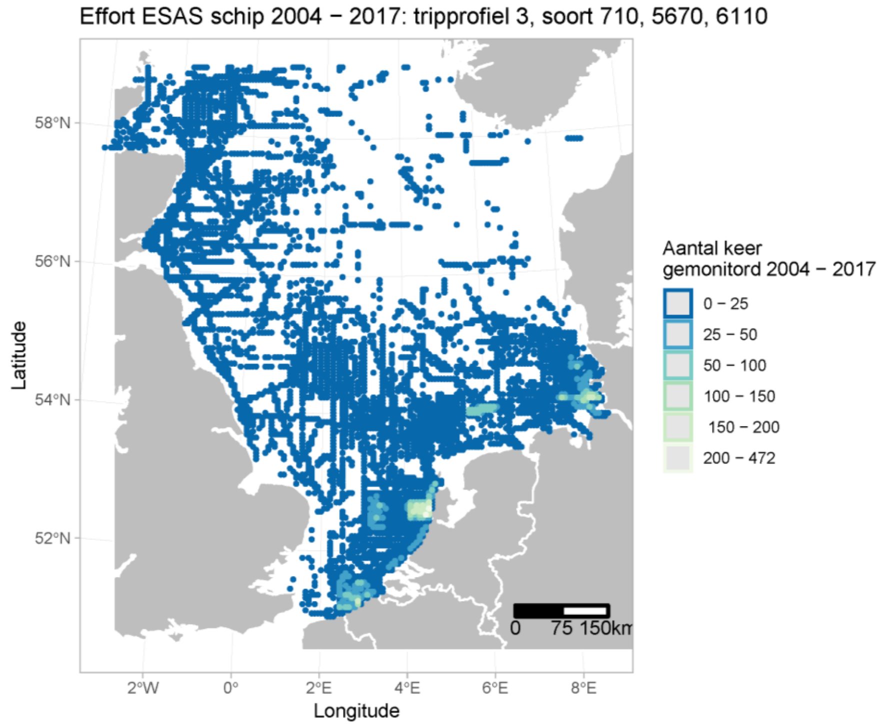


Figure 32 Survey effort for the period 1991 - 2017 for ESASship for the species 710 Morus bassanus, 5690 Stercorarius skua and 5110 Sterna sandvicensis broken down by season

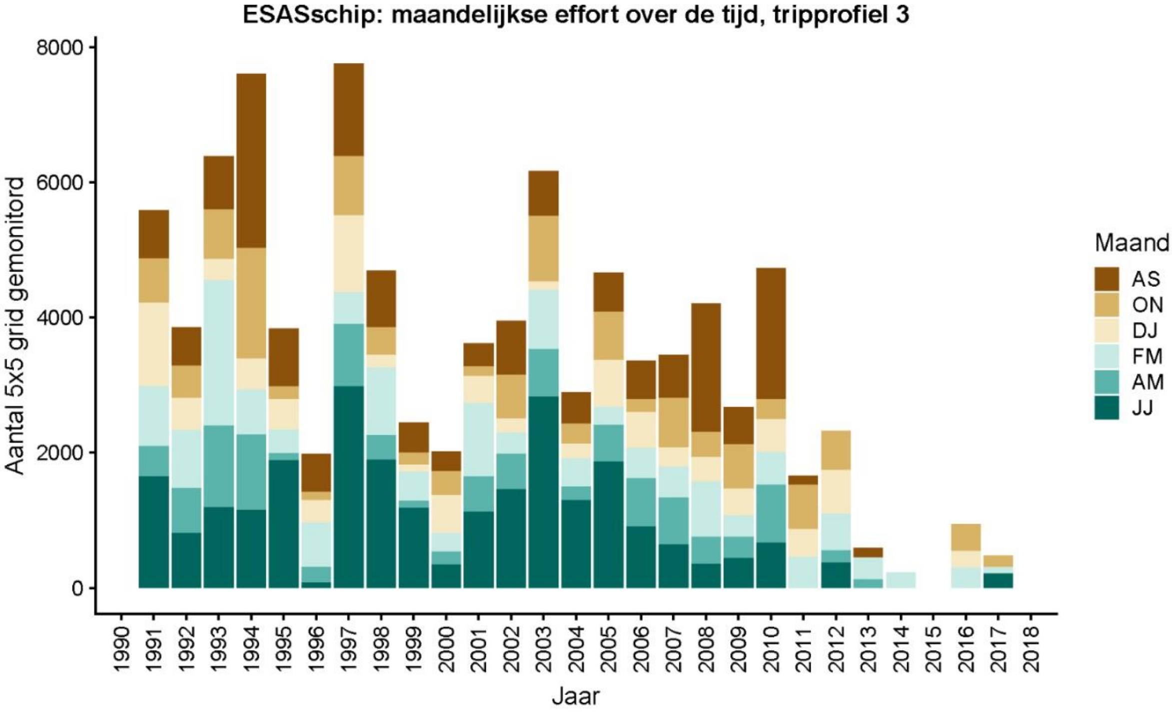
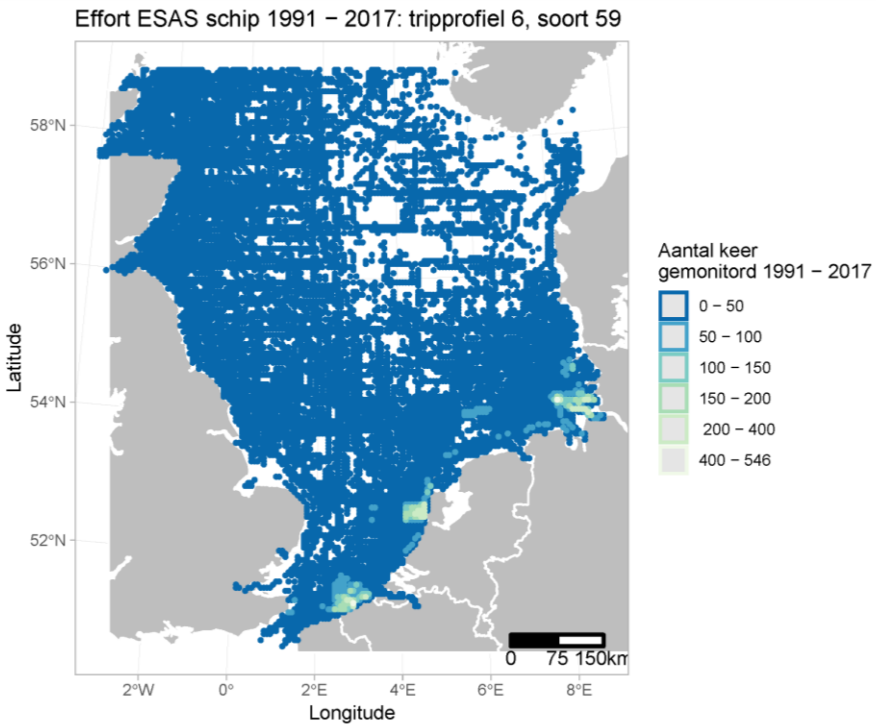


Figure 33 Survey effort for ESASship for the species 59 Gavia spec. for the periods 1991-2017 (above) and 2004-2017 (below)



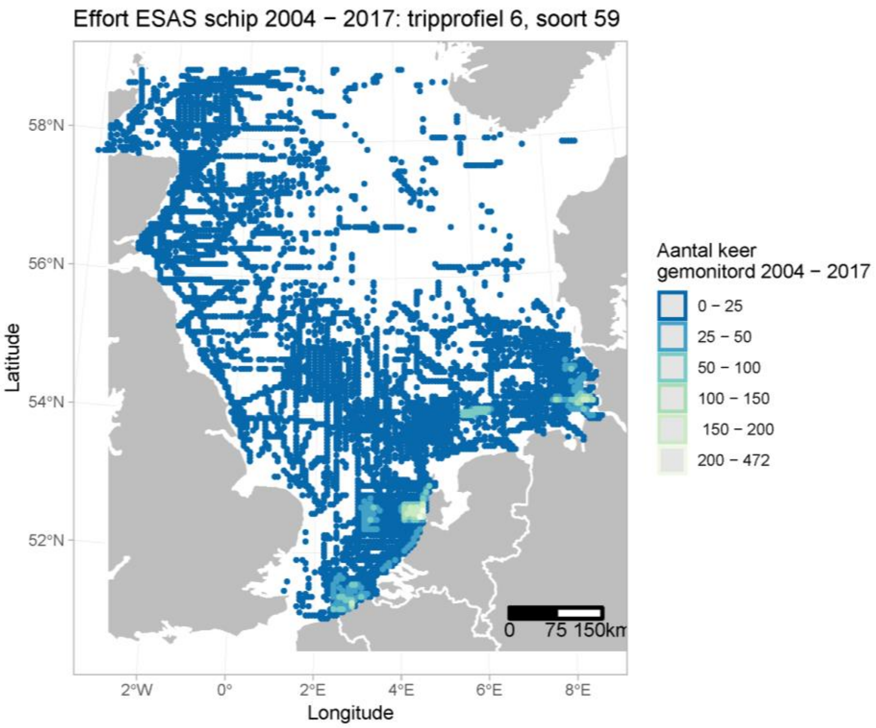


Figure 34 Survey effort for ESASship for 59 Gavia spec for the period 1991 - 2017 broken down by season

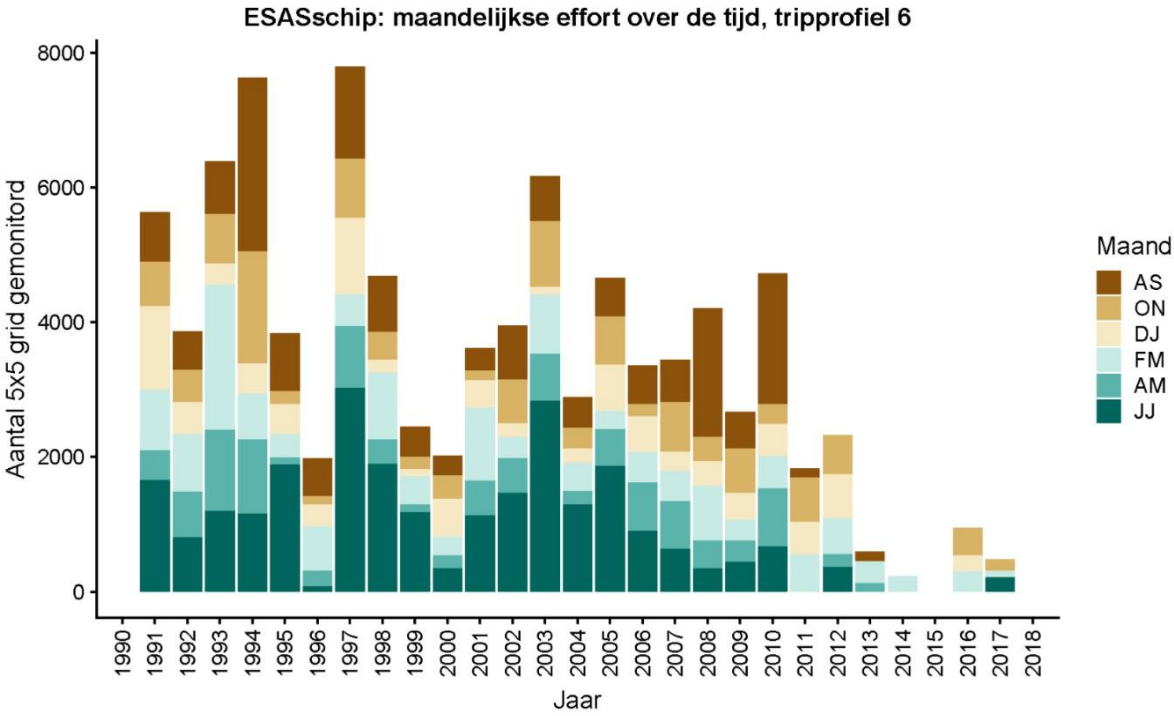
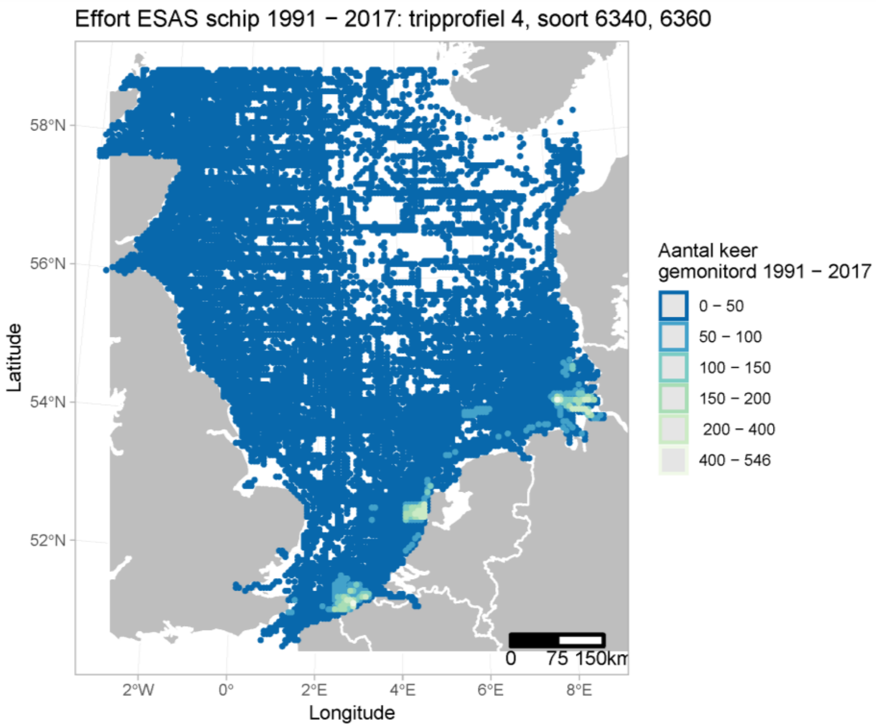


Figure 35 Survey effort ESASship for the species 6340 Uria aalge and 6360 Alca torda for the periods 1991-2017 (above) and 2004-2017 (below)



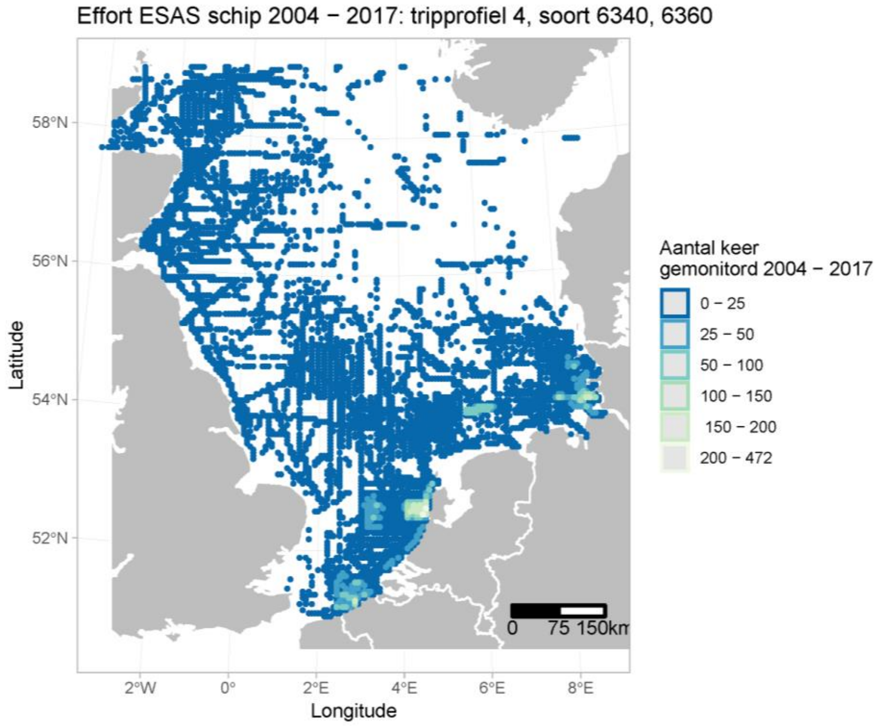
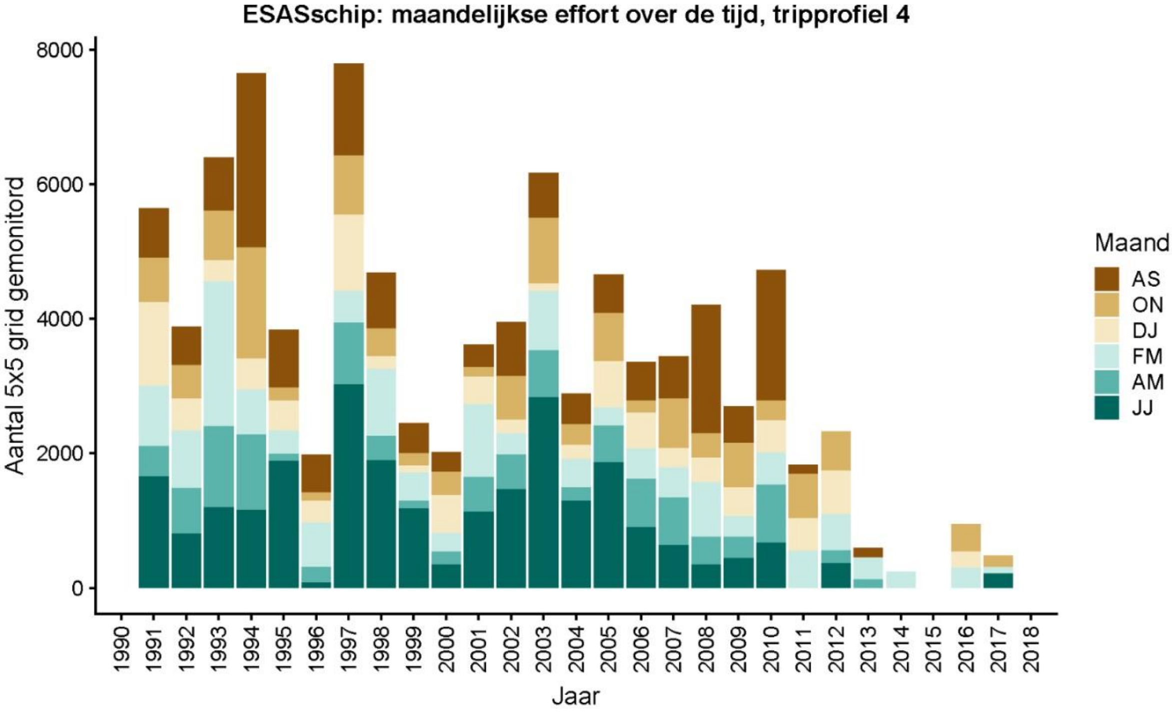


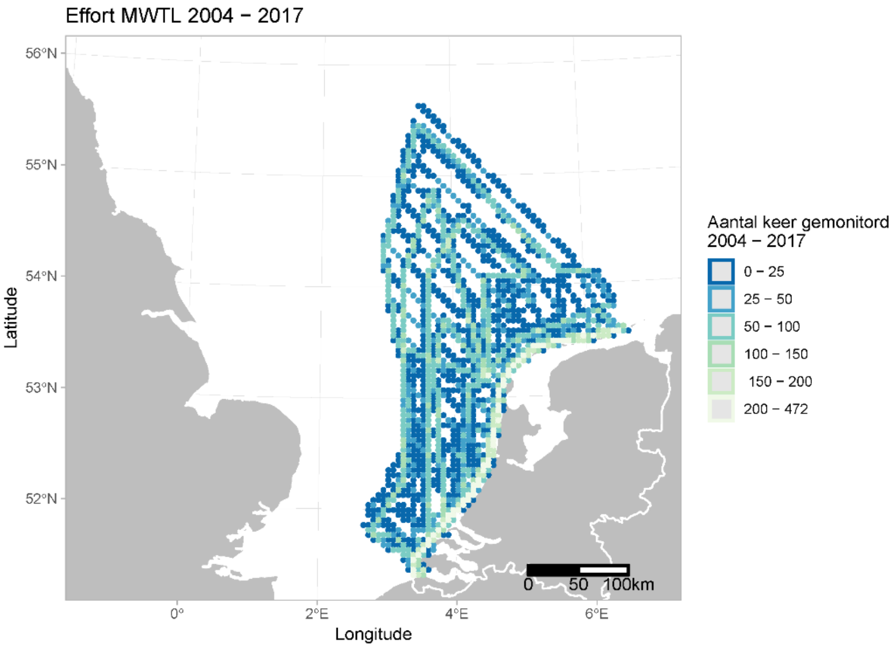
Figure 36 Survey effort for the period 1991 - 2017 for ESASship for the species 6340 Uria aalge and 6360 Alca torda broken down by season



MWTL

Figure 37 Survey effort for MWTL, geographical distribution for two periods: 1991-20217 (above) and 2004-2017 (below)

Longitude



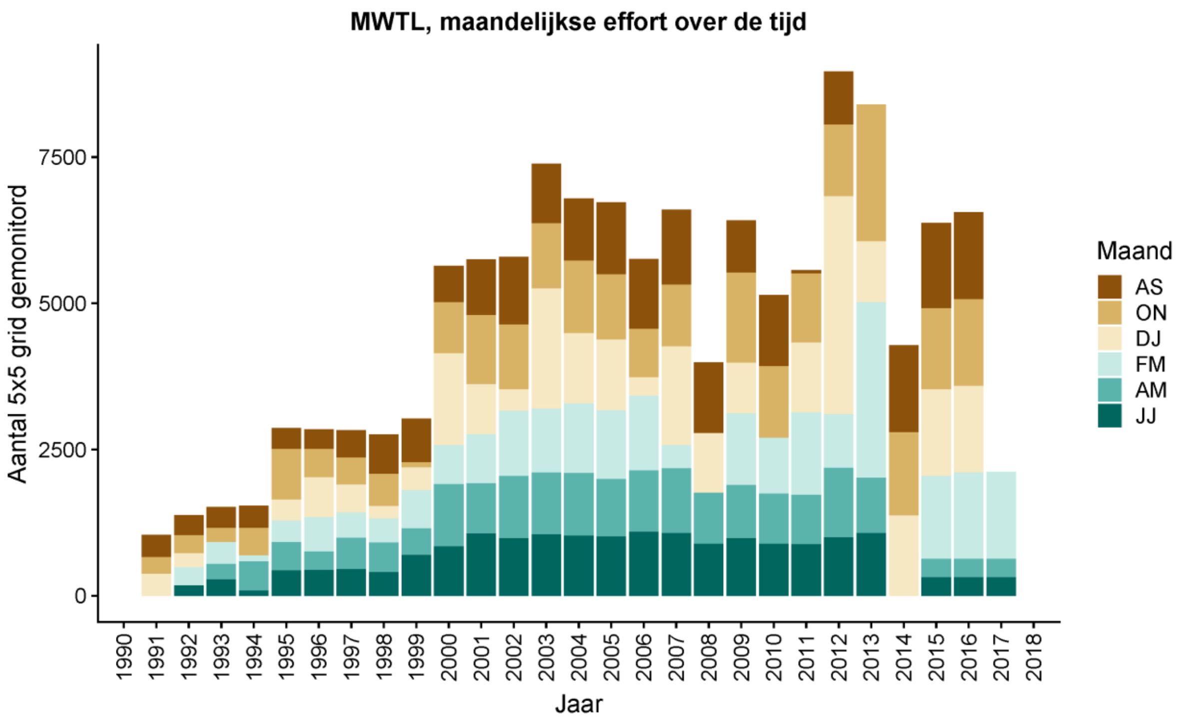


Figure 38 Survey effort for the period 1991 - 2017 for MWTL broken down by season

Appendix 6 Atlas of Seasonal Maps, International and National

The following seabird species are listed in this Annex (order: EUring ascending):

EUring	Scientific name	English name	Dutch Name
59	*Gavia spec.*	Diver spec.	Duiker
710	*Morus bassanus*	Northern Gannet	Jan-van-Gent
6110	*Thalasseus sandvicensis*	Sandwich Tern	Grote Stern
6340	*Uria aalge*	Common Guillemot	Zeekoet
6360	*Alca torda*	Razorbill	Alk

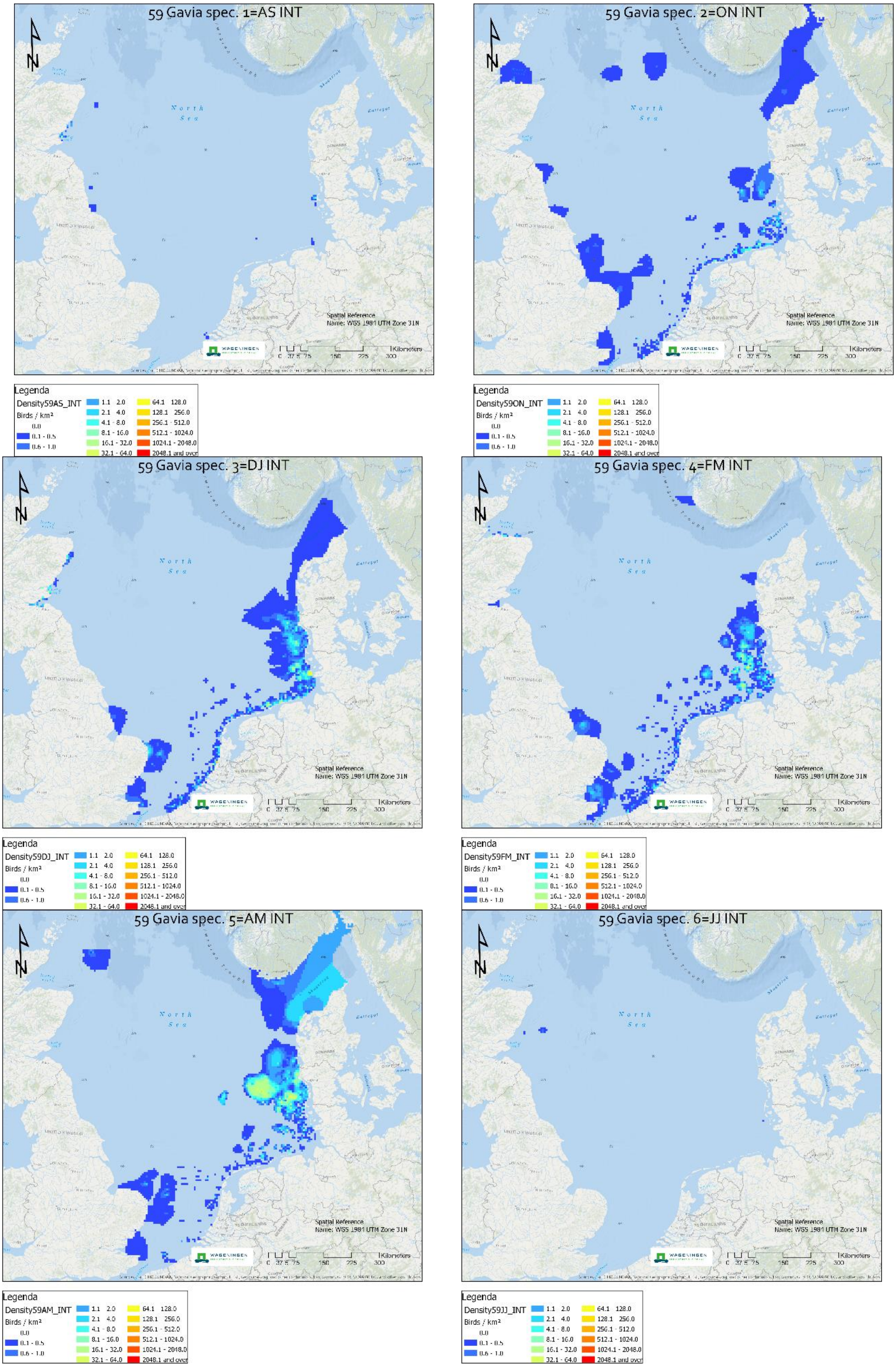


Figure 42 Diver: international distribution in August/September, October/November, December/January, February/March, April/May and June/July, from top left to bottom right

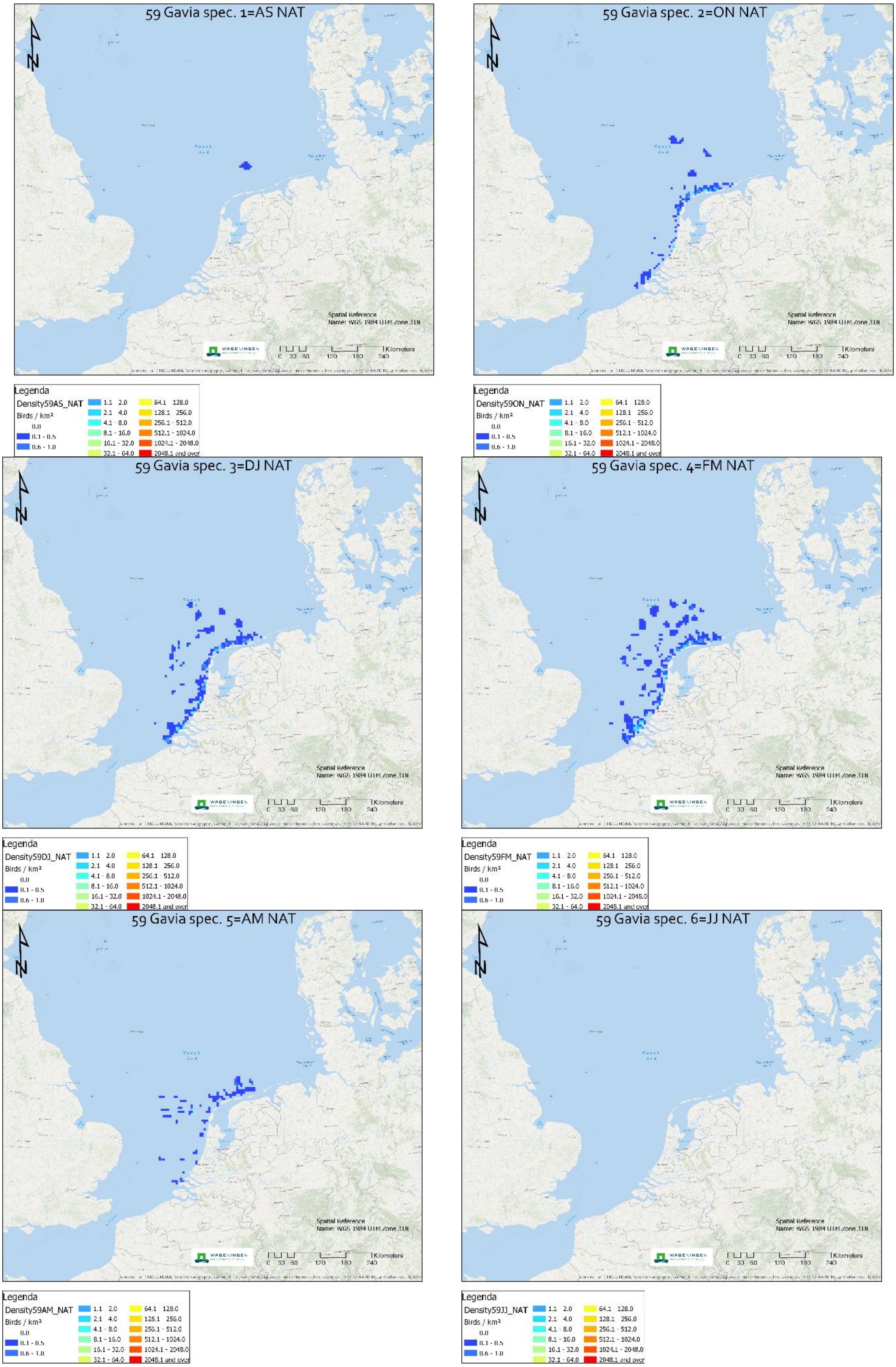


Figure 43 **Diver: national distribution in August/September, October/November, December/January, February/March, April/May and June/July, from top left to bottom right**

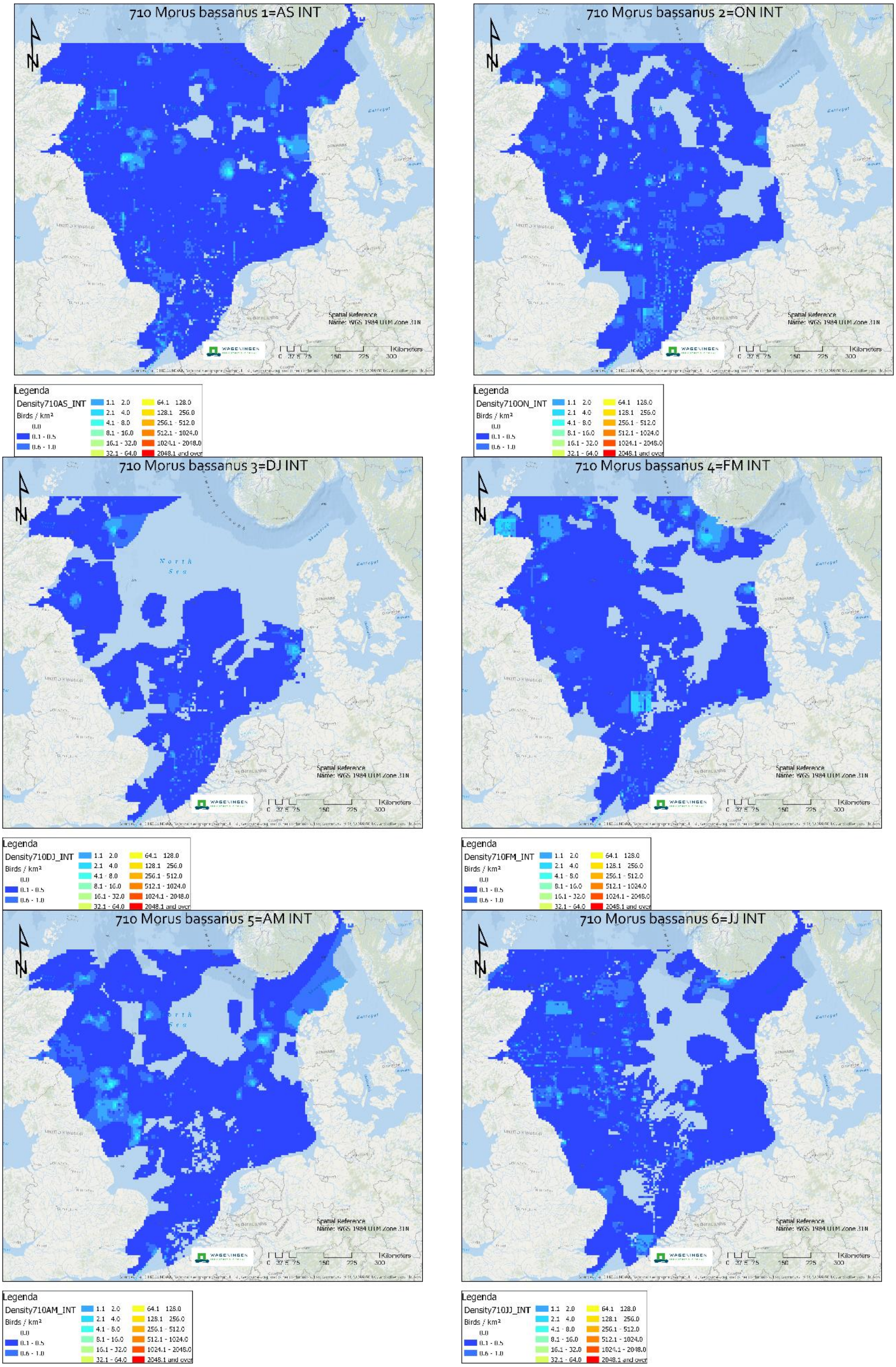


Figure 44 Northern Gannet: international distribution in August/September, October/November, December/January, February/March, April/May and June/July, from top left to bottom right

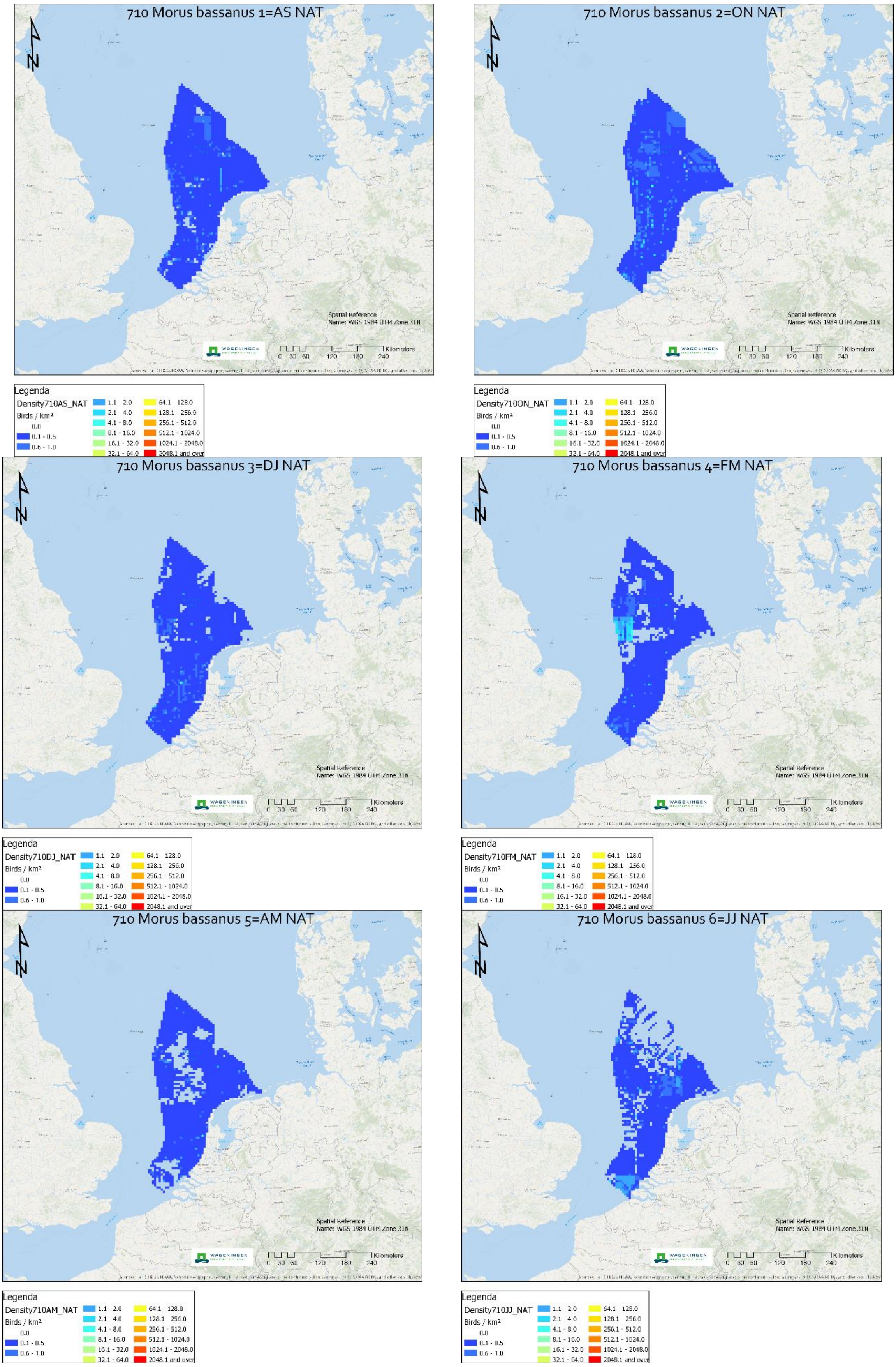


Figure 45 Northern Gannet: national distribution in August/September, October/November, December/January, February/March, April/May and June/July, from top left to bottom right

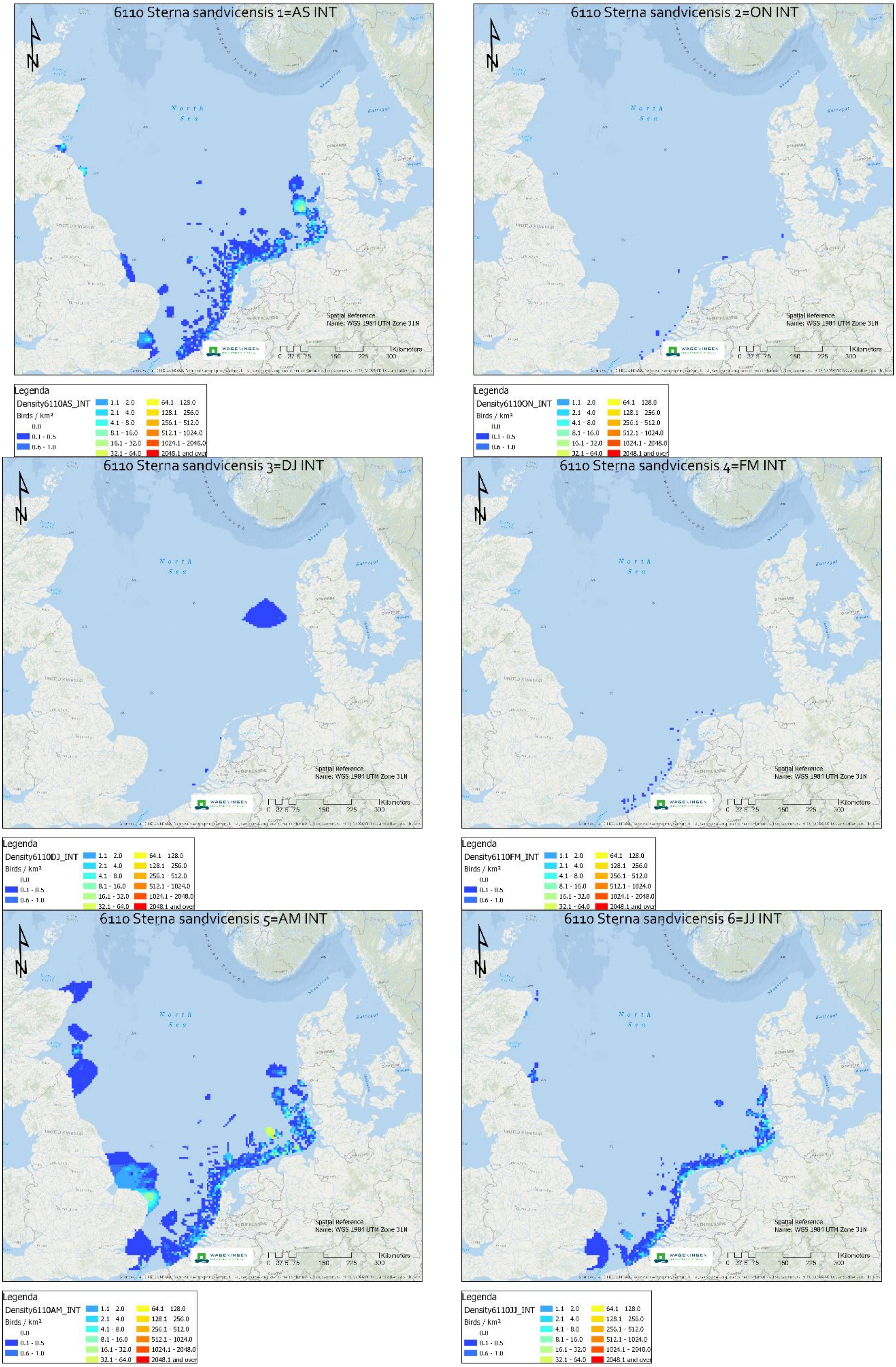


Figure 46 Sandwich Tern: international distribution in August/September, October/November, December/January, February/March, April/May and June/July, from top left to bottom right

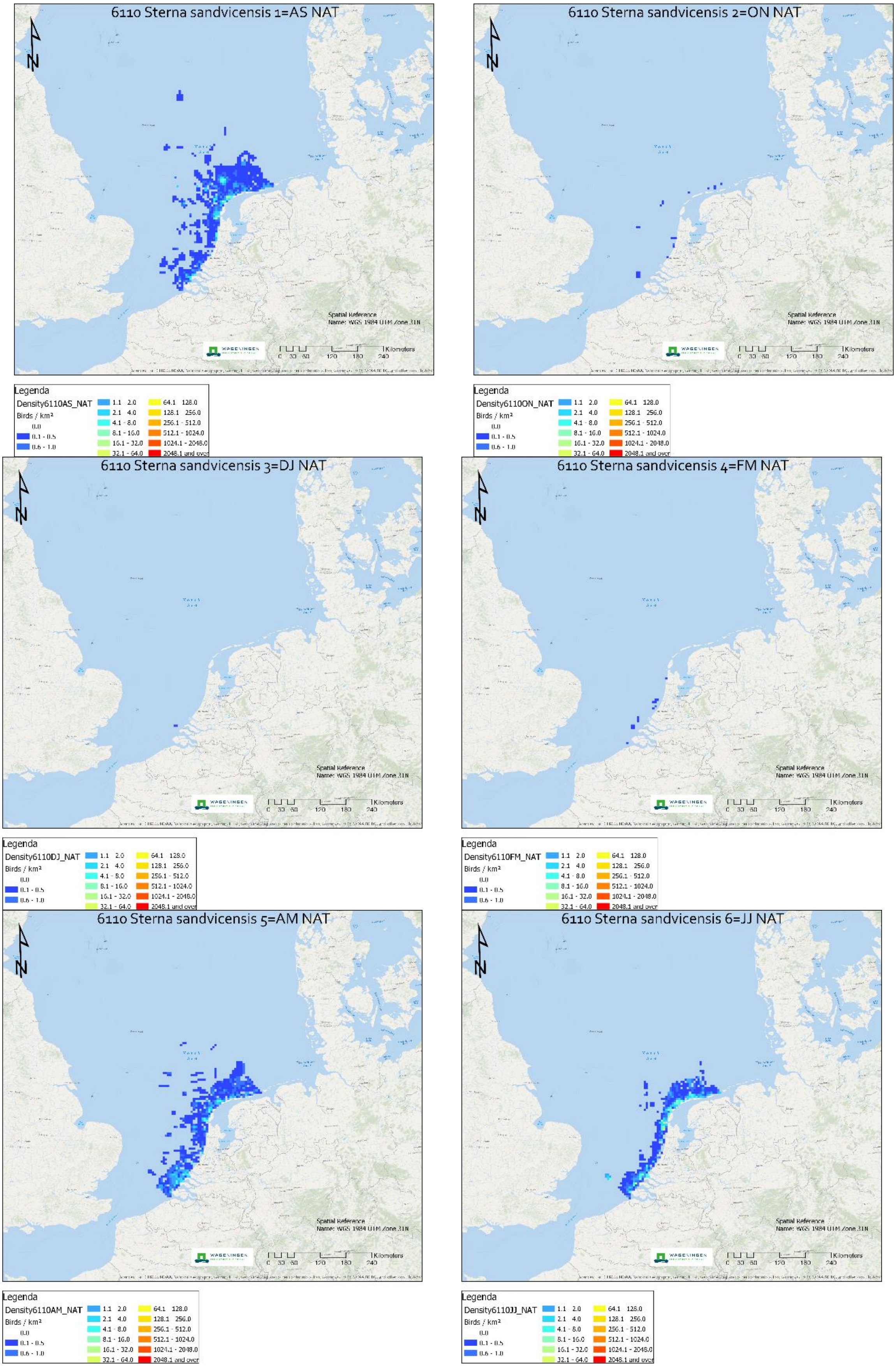


Figure 47 6110, Sandwich Tern: national distribution in August/September, October/November, December/January, February/March, April/May and June/July, from top left to bottom right

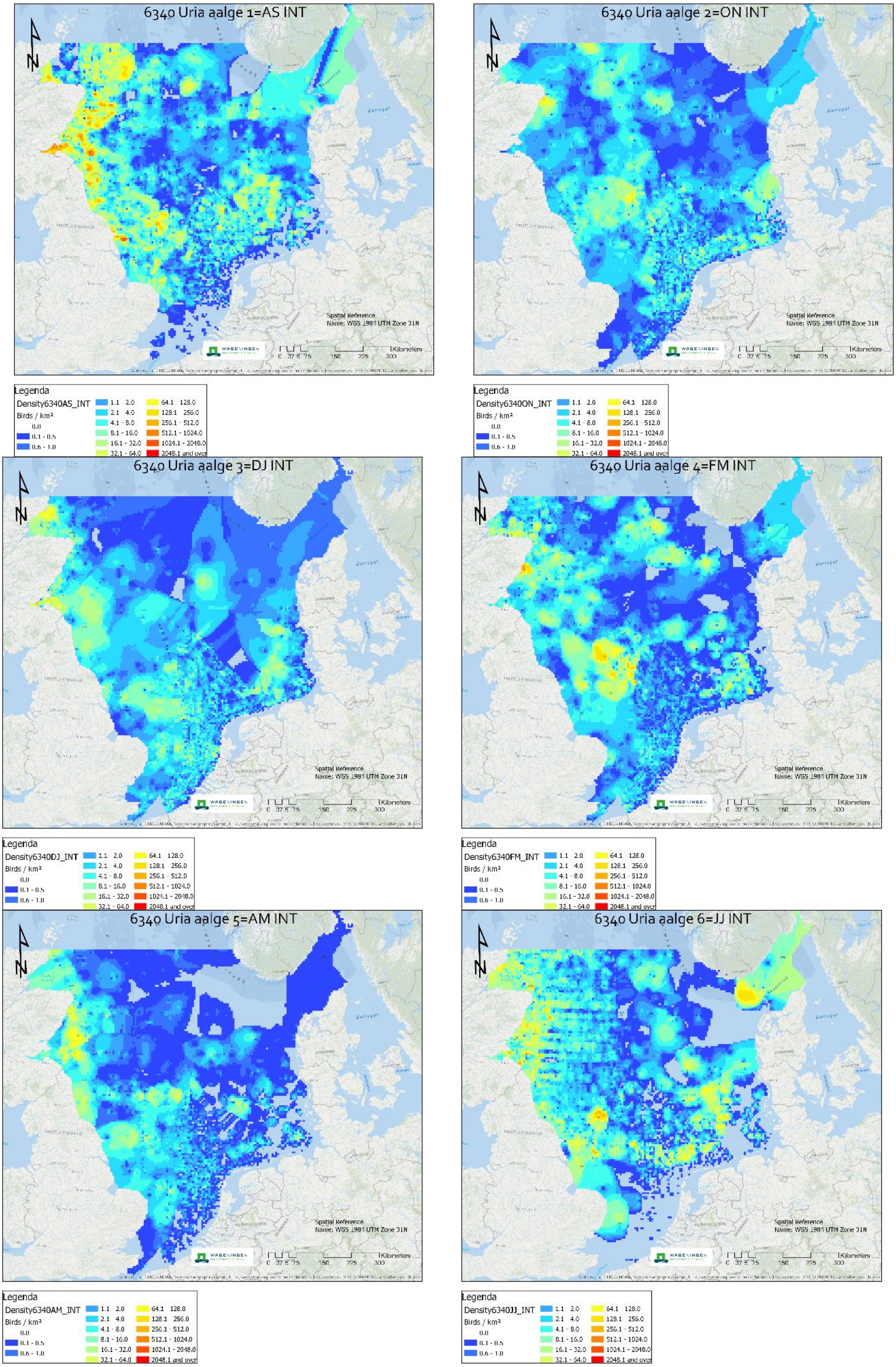


Figure 48 Common Guillemot: international distribution in August/September, October/November, December/January, February/March, April/May and June/July, from top left to bottom right

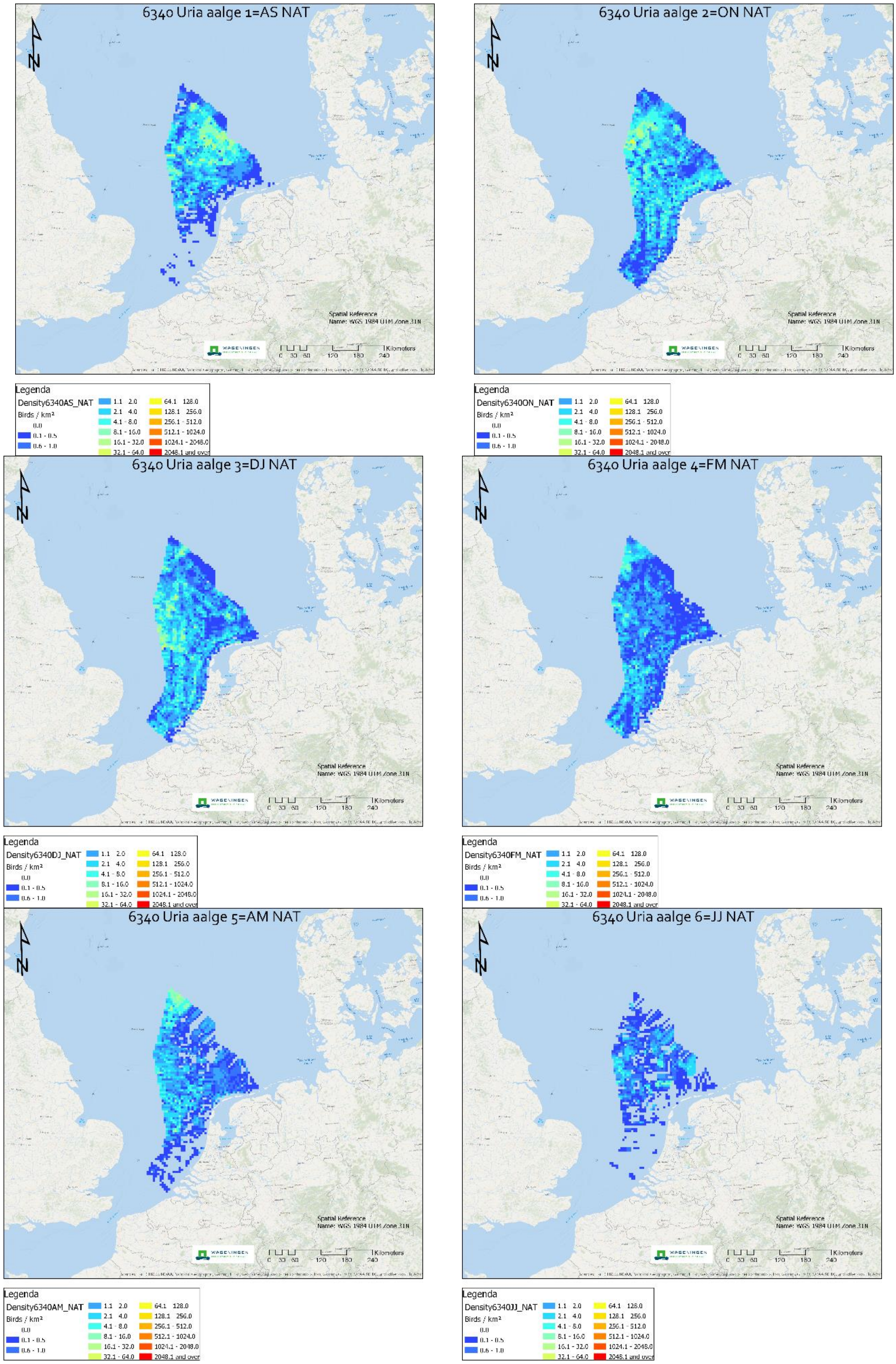


Figure 49 Common Guillemot: national distribution in August/September, October/November, December/January, February/March, April/May and June/July, from top left to bottom right

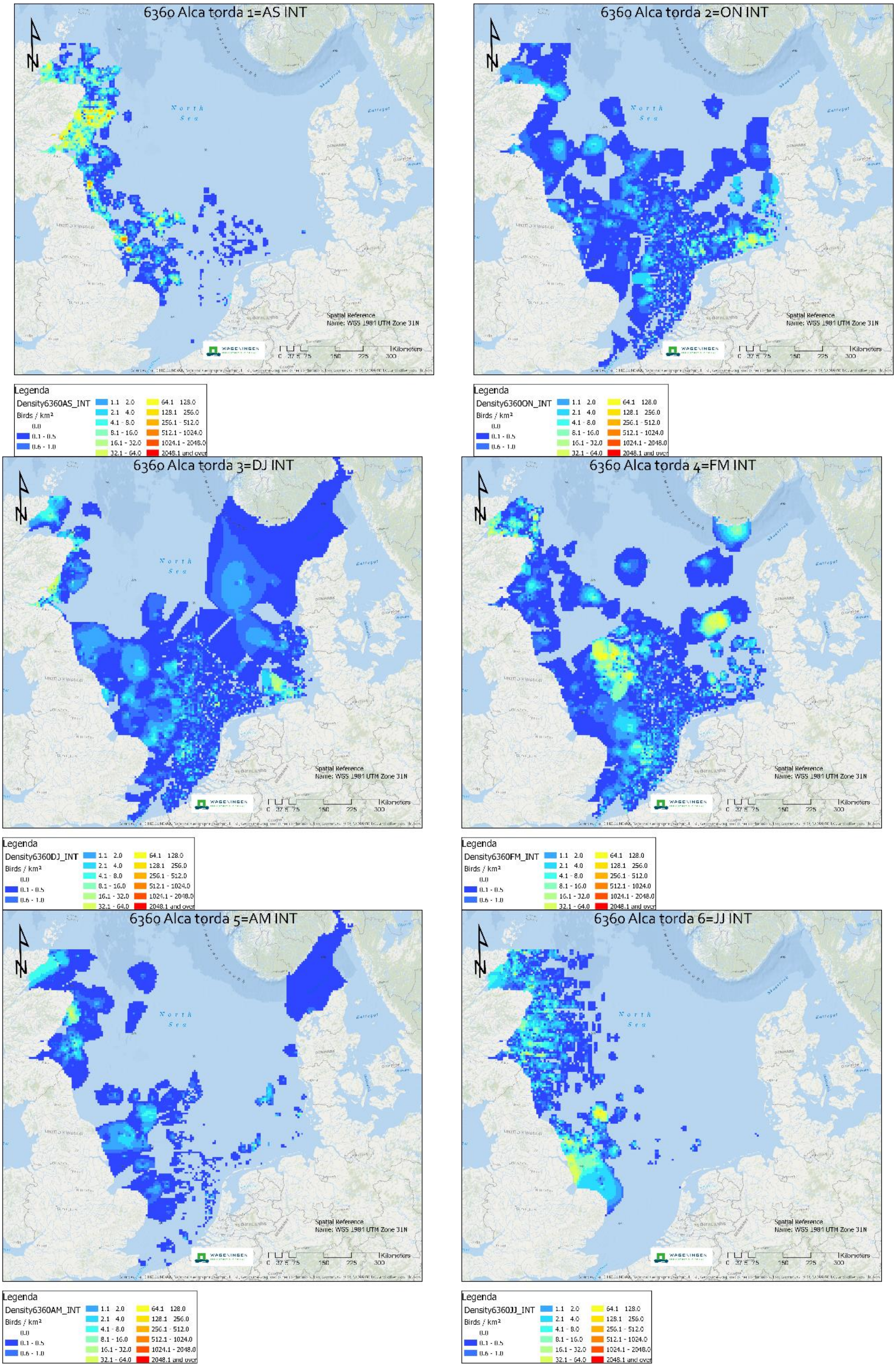


Figure 50 Razorbill: international distribution in August/September, October/November, December/January, February/March, April/May and June/July, from top left to bottom right

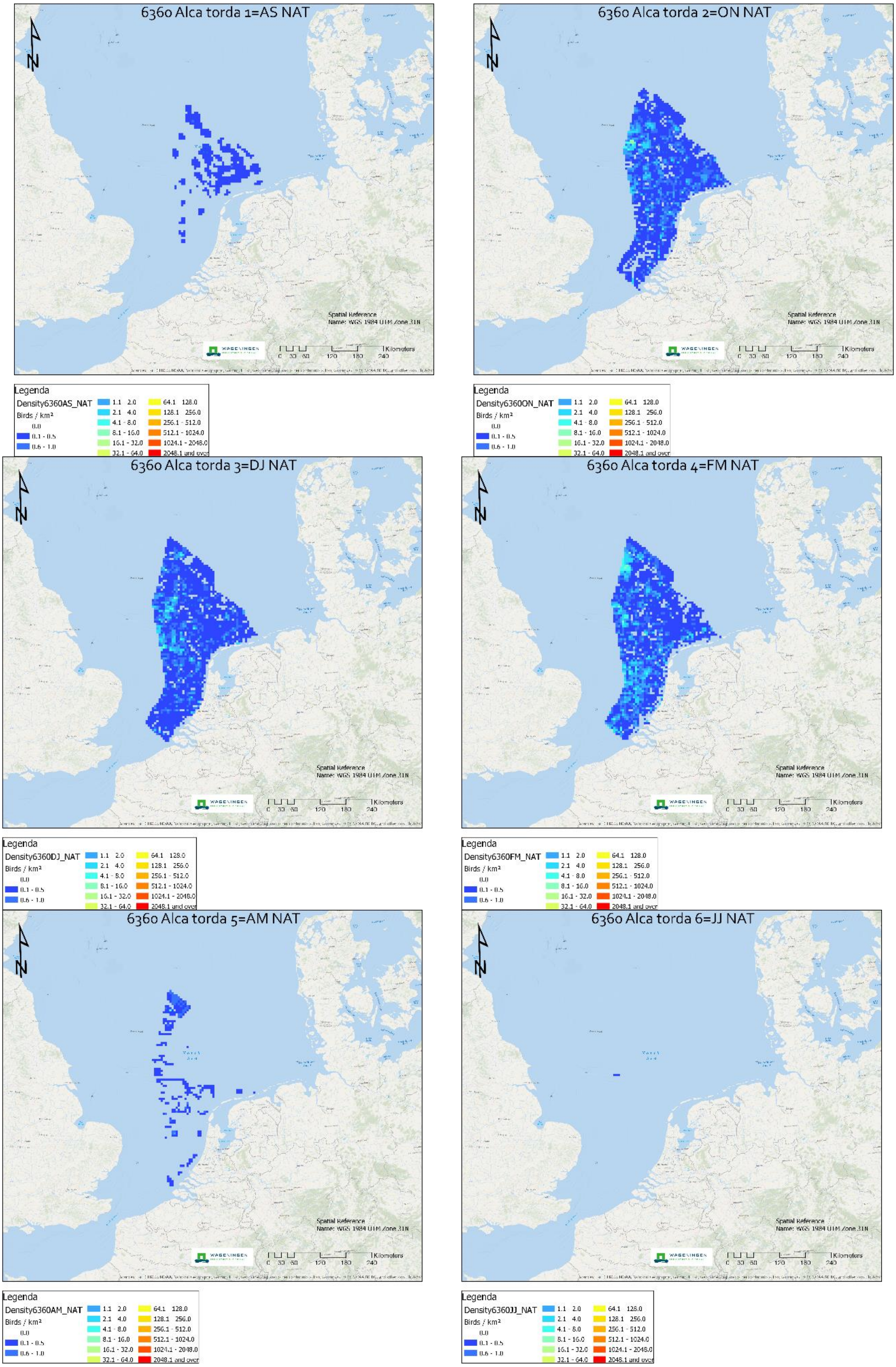


Figure 51 Razorbill: national distribution in August/September, October/November, December/January, February/March, April/May and June/July, from top left to bottom right

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'To explore the potential of nature to improve the quality of life'

The Wageningen Marine Research mission
- To conduct research with the aim of acquiring knowledge and offering advice on the sustainable management and use of marine and coastal areas.
- Wageningen Marine Research is an independent, leading scientific research institute

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