CHAPTER 5

SEABIRDS AND OFFSHORE WIND FARMS – DISPLACEMENT MONITORING 2.0

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Abstract

This report sets out the count results collected in the period February 2021 to April 2023, following a revised monitoring design. The results presented at this stage need to be considered as indicative since more data and advanced spatial modelling are needed to detect seabird avoidance or attraction effects with sufficient confidence. Nevertheless, making use of a limited dataset and mean values only, it is interesting to see that the results are often in line with what has been found before and/or elsewhere, such as indications of attraction effects for great black-backed gull and great cormorant, and of avoidance by northern gannet. On the other hand, our results no longer seem to indicate (strong) avoidance of common guillemots and even increased numbers of razorbills between the turbines. It is yet unclear whether the results for auks indicate habituation rather than a specific habitat preference. The new monitoring strategy not only aims to detect displacement responses and is also designed to detect disturbance distances (with regard to migration corridors) and the effect of turbine density on seabird displacement levels. Ultimately, considering the huge expansion of offshore wind farm development in the North Sea, this monitoring approach hopes to fill important knowledge gaps and to inform future planning decisions regarding wind farm configuration and mitigation of impact on seabirds.

1. Introduction

Since the end of 2020, the Belgian offshore wind farm (OWF) concession zone is fully operational and now holds 399 turbines. As this is a very different situation compared to the isolated clusters of turbines that were present in the period 2009–2016, a new seabird monitoring program was initiated in February 2021. While continuing to assess species-specific displacement effects, we will also look for temporal trends and spatial patterns in wind farm impact on seabirds. The potential habituation to OWFs, the mitigating effect of migration corridors or the correlation between seabird displacement levels and wind farm configuration characteristics, to name just a few, are highly relevant knowledge gaps in the light of future planning and (cumulative) impact assessments. The new seabird monitoring program aims to add some pieces to this puzzle. As a first step towards these analyses, this report provides an overview of the count results collected during six seabird monitoring campaigns between February 2021 and April 2023.

2. Methods

The new seabird monitoring program encompasses eight SE–NW oriented tracks across the full extent of the OWF concession zone as well as through an area southwest of and adjacent to the wind farms (Fig. 1), the latter serving as the control area. The monitoring can be completed in two days, and is intended to be carried out 5 times per year (in February, April, August, October and December).

The seabird counts were carried out from a research vessel, following a standardised and internationally applied method, combining a *transect count* for birds in contact with the water and repeated *snapshot counts* for flying birds (Tasker *et al*. 1984). The focus is on a 300 m wide transect along one side of the ship's track, and while steaming at a speed of about 10 knots all birds in touch with the water (swimming, dipping, diving) within this transect are counted (i.e., the *transect count*). Applying four distance categories (A = 0–50 m; B = 50–100 m; C = 100–200 m; D = 200–300 m), the distance to each observed bird (group) is estimated, allowing to correct for decreasing detectability with increasing distance afterwards. Counting all flying birds encountered inside this transect, however, would be measuring bird flux rather than bird density (Tasker *et al*. 1984). The density of flying birds is therefore assessed through one-minute interval counts of all birds flying within a quadrant of 300 by 300 m inside the transect (the so-called *snapshot counts*). As the ship covers a distance of approximately 300 m per minute when sailing the prescribed speed of 10 knots, the full transect is covered by means of these subsequent 'snapshots'. Birds observed outside the transect and

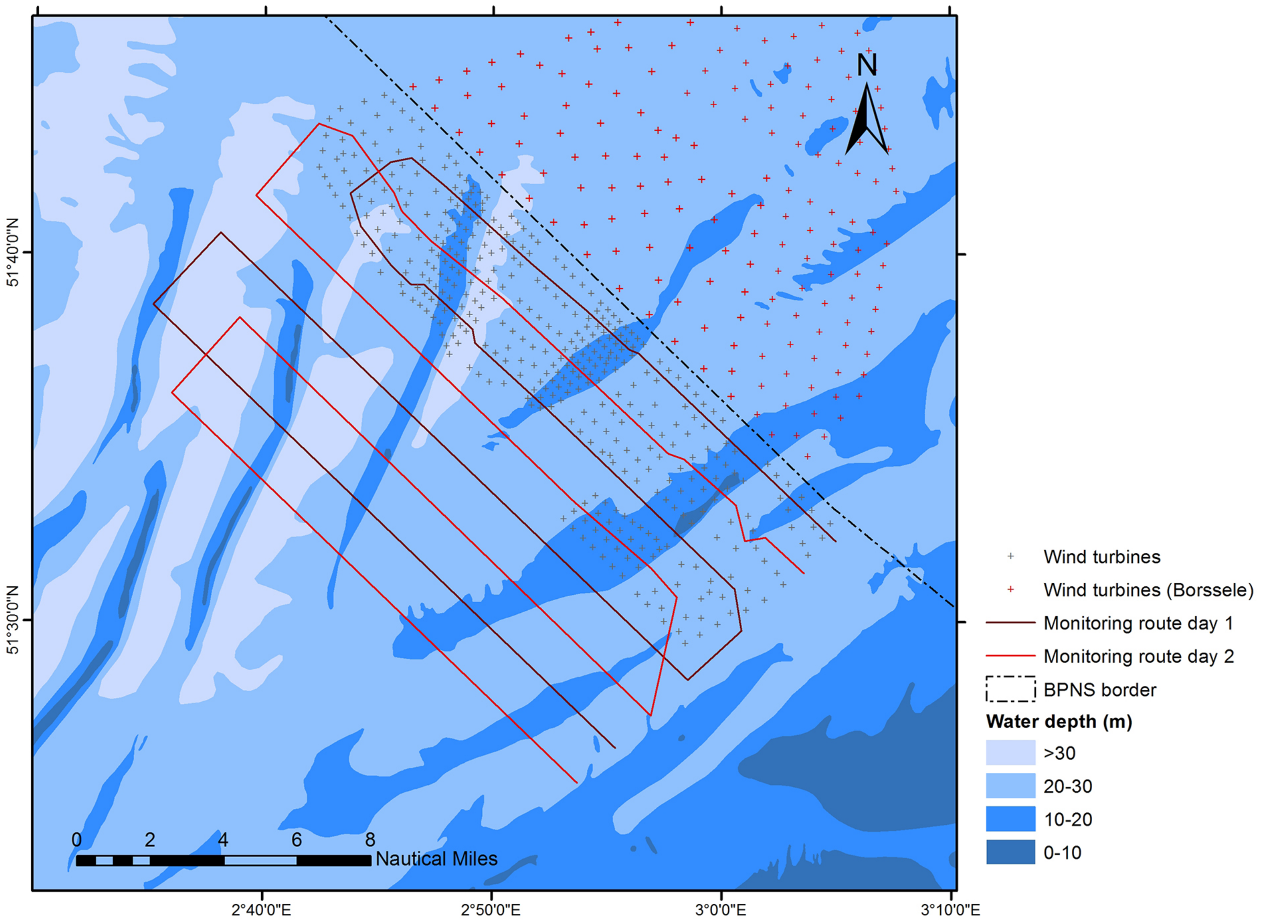

Figure 1. Seabird displacement monitoring strategy since February 2021.

Table 1. Overview of the surveys executed within the new seabird displacement monitoring program.

Campaign	Date	Remarks
February 2021	23/02/2021 24/02/2021	Counts performed from the 'old' *Belgica* Counts performed from the 'old' *Belgica*
August 2022	21/08/2022 22/08/2022	
October 2022	10/10/2022 13/10/2022	
December 2022	14/12/2022 15/12/2022	
February 2023	15/02/2023 17/02/2023	The transects crossing the wind farms could not be sailed
April 2023	19/04/2023 20/04/2023	

snapshot counts are noted down as well, yet cannot be included in the calculation of seabird densities.

Between February 2021 and April 2023, six monitoring campaigns were carried out (Table 1). Only during the first campaign, counts were performed from the 'old' RV Belgica, while all other campaigns were executed with the new vessel. The campaign in February 2023 was only partly executed as we were not allowed to enter the wind farms during the second monitoring day due to adverse weather conditions with wind speeds exceeding 25 knots.

In total we collected 2404 counts within the study area, the effort per count varying between 0.05 and 0.24 km² (calculated by multiplying the sailed track length with the transect width of 300 m). In the results section we present both the density (N/km²) as well as the number observed per km (N/km) for each of two zones, i.e., the concession zone (the area built with turbines) and the control area outside the wind farms (>1 km away from the nearest turbine). For some species, the number of individuals observed per km (including those outside the transect) is a more representative measure for their occurrence, especially in case of scarcer species generating few data and also for species that tend to concentrate around the wind turbines. The latter is due to the fact that the turbine foundations are often well outside the 300 m wide count transect that is used for density calculations. In the Results section (§3), the number observed per km is further used to illustrate species distribution across the study area.

3. Results

In total we observed 46 species of birds, with a total number of 11 585 individuals counted (see Table 2 in Annex). The most abundant (positively identified) species was lesser black-backed gull (*Larus fuscus*) (N = 2763). We further counted 3219 unidentified large gulls (*Larus* sp.), generally birds associated with fishing trawlers and observed from a long distance. Other common species were northern gannet (*Morus bassanus*), great cormorant (*Phalacrocorax carbo*), little gull (*Hydrocoloeus minutus*), common gull (*Larus canus*), herring gull (*Larus argentatus*), great black-backed gull (*Larus marinus*), black-legged kittiwake (*Rissa tridactyla*), Sandwich tern (*Thalasseus sandvicensis*), common guillemot (*Uria aalge*) and razorbill (*Alca torda*). Each of these species will be discussed in more detail in the paragraphs below.

3.1. Northern gannet

In total we observed 567 northern gannets in the study area. Outside the wind farms we observed 0.46 birds per km, compared to 0.26 birds per km between the turbines. The difference is even more pronounced when considering densities, with 0.40 birds per km² outside compared to 0.10 birds per km² inside the wind farms. The species occurred quite homogenously distributed in the control area, with the highest numbers encountered in far offshore waters, as opposed to a more limited and scattered presence inside the concession zone (Fig. 3). The results for northern gannet thus seem to point towards wind farm avoidance. Only at the Norther wind farm, in the SE corner of the concession zone, presence seems to reflect background numbers. Interestingly this wind farm is characterised by wide spacing between the turbines, and is also outside the 'shadow' of the Borssele wind farm.

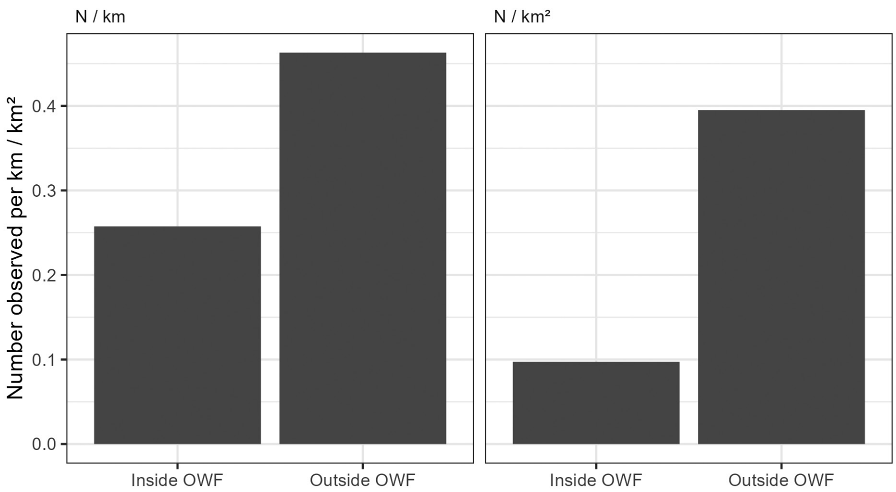

Figure 2. Occurrence of northern gannet inside and outside the OWF concession zone, expressed as the number observed per km on the left and the number per km² on the right.

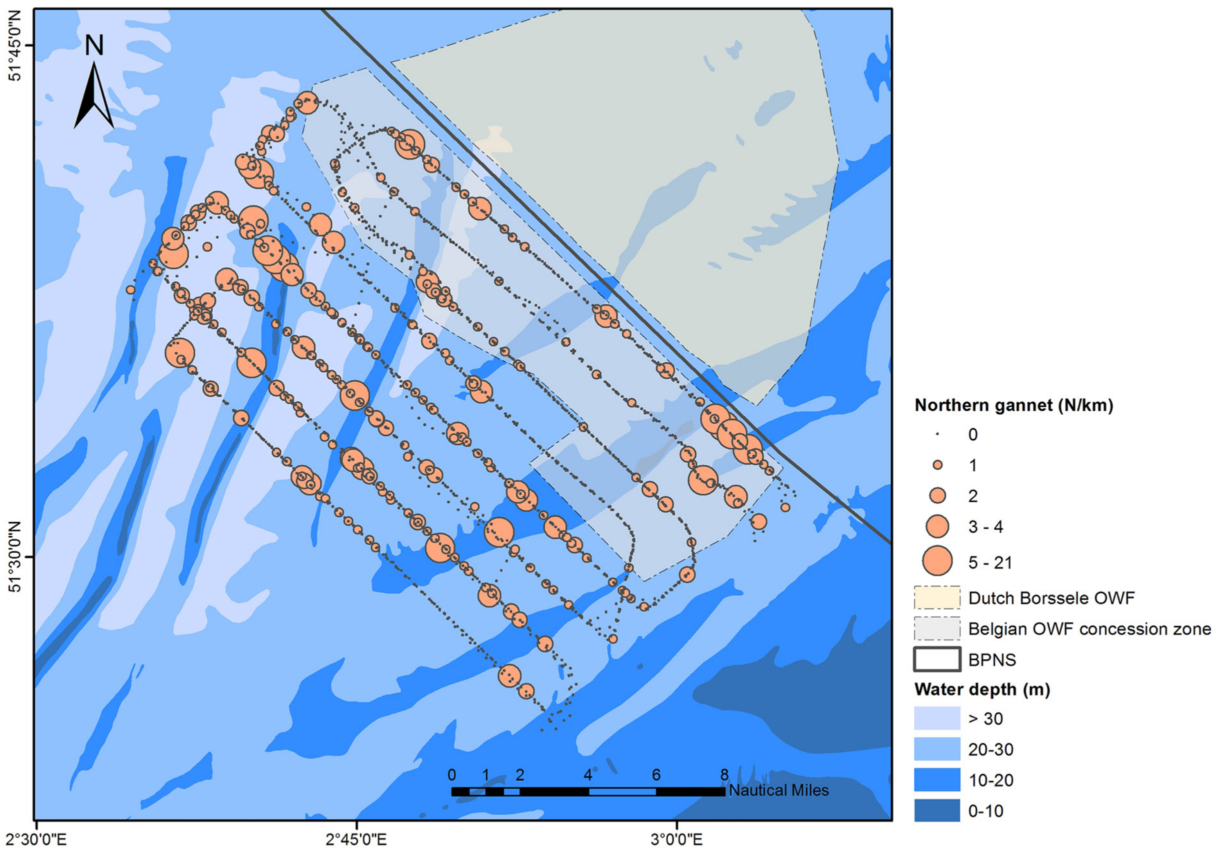

Figure 3. Northern gannet observations (N/km) in the study area.

3.2. Great cormorant

With only 99 individuals counted, great cormorant was the least common of the species discussed in this report. The major part of these birds (N = 61) was associated with the turbine foundations, with a clear preference to the jacket foundations in the C-Power wind farm. As the turbines are generally located (just) outside our 300 m wide count transect, the number observed per km is a more representative parameter to describe the species' presence compared to their measured density. As such, we observed 0.18 birds per km inside the wind farms, compared to only 0.001 birds per km outside the concession zone, suggesting a strong attraction effect. Note that the species' preference to rest on (and concentrate near) turbine foundations also explains the very low densities shown in the right panel of Fig. 4.

3.3. Little gull

Little gulls were encountered relatively often during the campaigns of December 2022 (N = 174) and April 2023 (N = 240), during which we observed the highest numbers outside the wind farms. This difference is most pronounced when considering densities, with 0.30 birds per km² inside compared to 0.76 birds per km² outside the OWF concession zone. Figure 6 further shows a distinct onshore-offshore gradient in the species' distribution across the study area, with the major part of the observations located within 30 km away from the coast, and no more little gulls over 40 km offshore.

3.4. Common gull

The results for common gull suggest attraction to the OWFs. The numbers observed per km as well as the encountered densities were about three times higher inside compared to outside the OWF concession zone. Interestingly, highest numbers occurred along the outer transect next to the Dutch border (Fig. 8). This should, however, not be mistaken for an edge effect as the Dutch Borssele wind farm is located right across the border, with no actual corridor in between the Belgian and Dutch turbines.

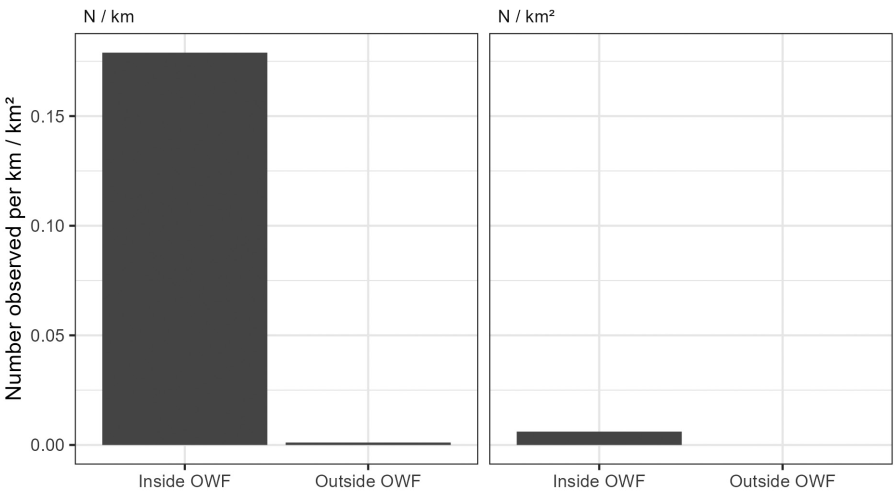

Figure 4. Occurrence of great cormorant inside and outside the OWF concession zone, expressed as the number observed per km on the left and the number per km² on the right.

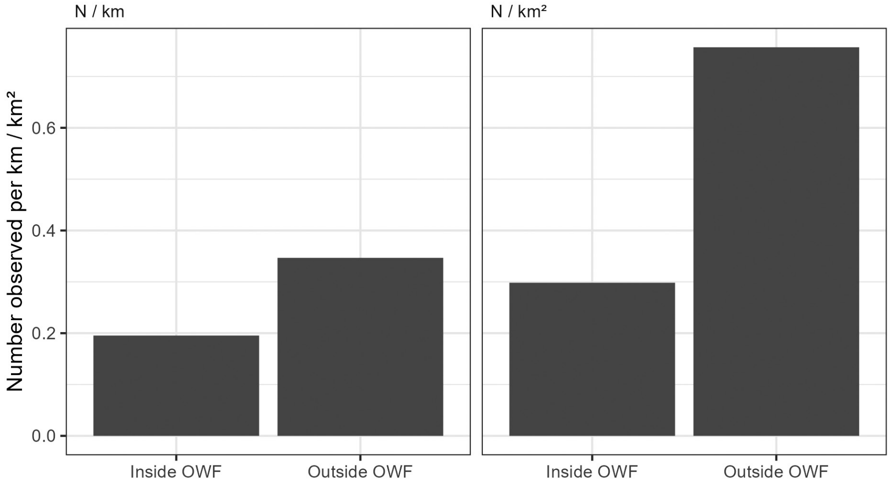

Figure 5. Occurrence of little gull inside and outside the OWF concession zone, expressed as the number observed per km on the left and the number per km² on the right.

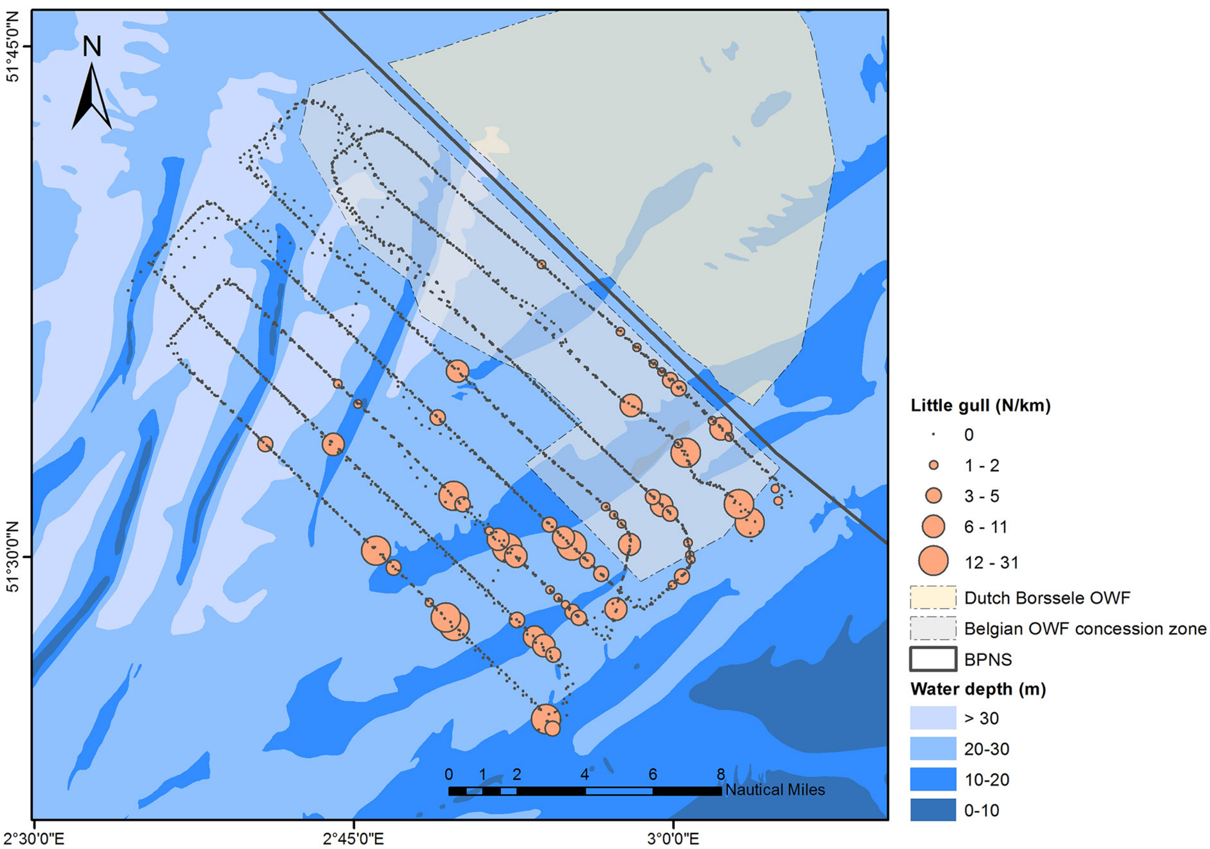

Figure 6. Little gull observations (N/km) in the study area.

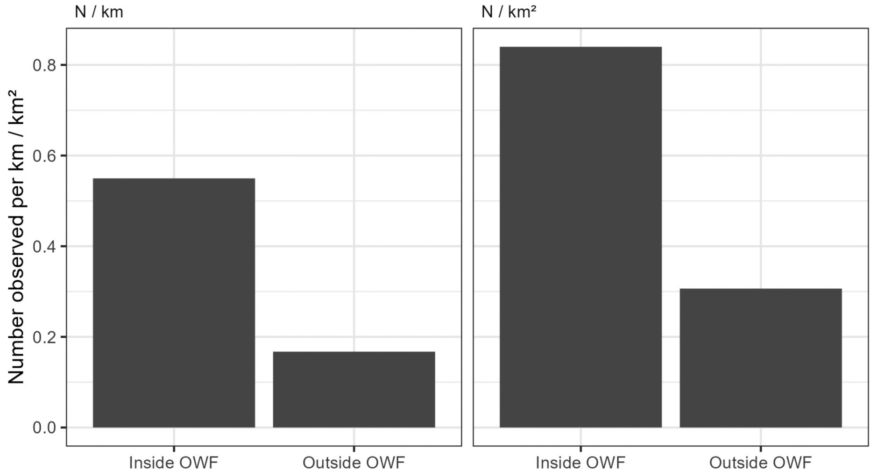

Figure 7. Occurrence of common gull inside and outside the OWF concession zone, expressed as the number observed per km on the left and the number per km² on the right.

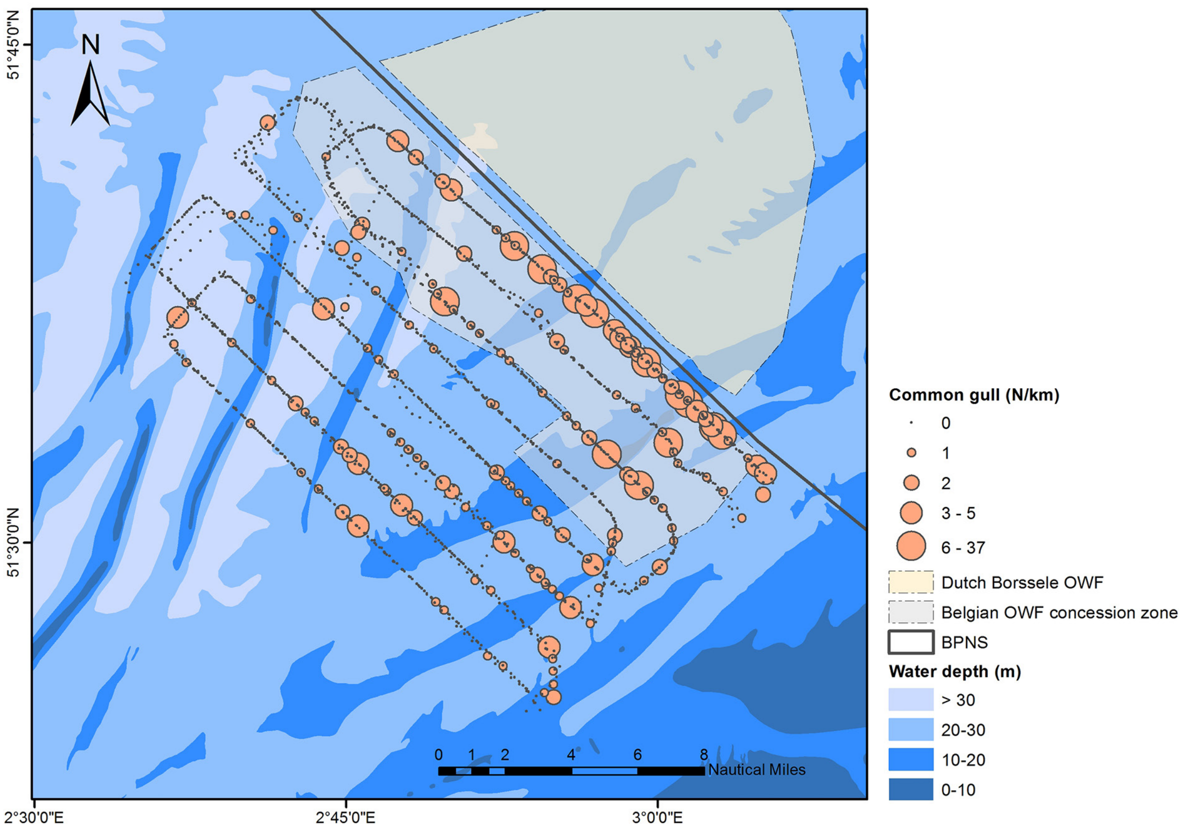

Figure 8. Common gull observations (N/km) in the study area.

3.5. Lesser black-backed gull

With 921 observations of 2763 individuals, lesser black-backed gull was the most common species observed in the study area. Only a small minority (7%) of the birds observed in the wind farms was associated with the turbines. The species' distribution across the study area shows somewhat lower presence in the more offshore part of the control area, and based upon this pattern one could suspect an attraction effect (Fig. 10). The observed density of 4.7 birds per km² outside as opposed to only 1.3 birds per km² inside the concession zone, however, rather indicates avoidance of the wind farms. Note that the high densities of lesser black-backed

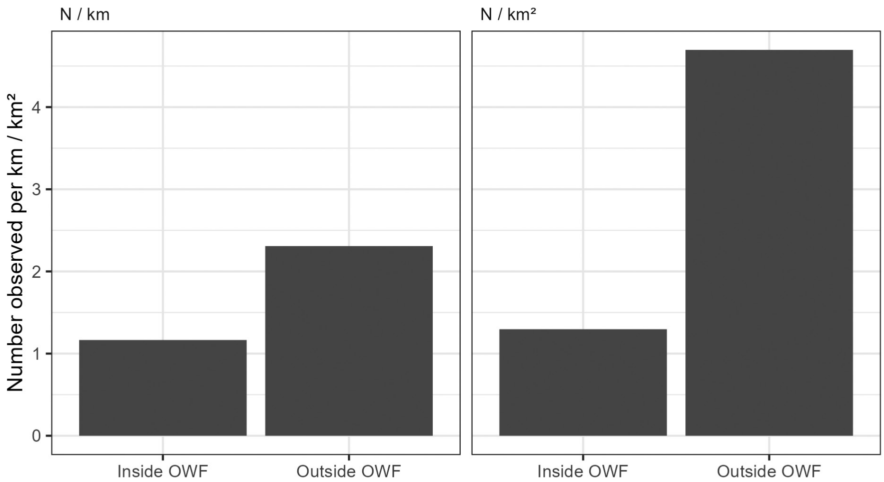

Figure 9. Occurrence of lesser black-backed gull inside and outside the OWF concession zone, expressed as the number observed per km on the left and the number per km² on the right.

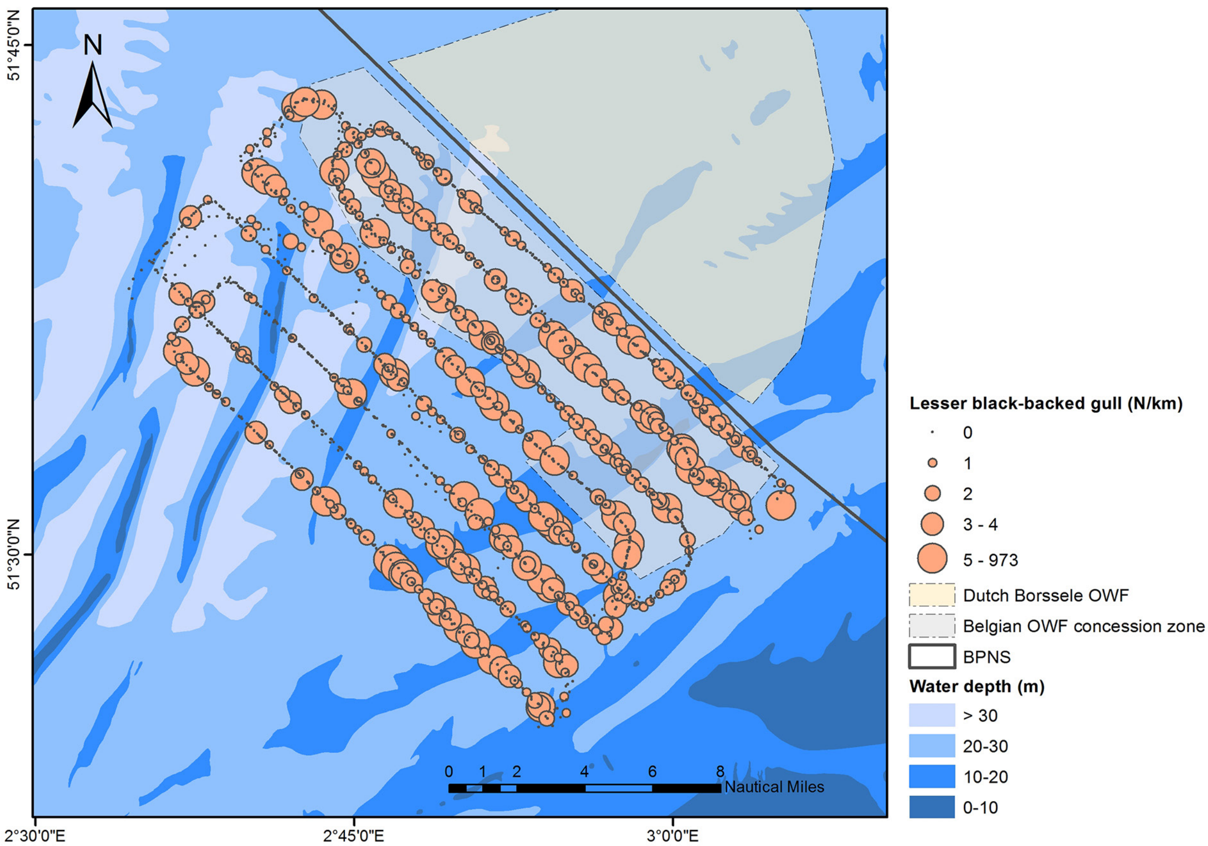

Figure 10. Lesser black-backed gull observations (N/km) in the study area.

gull in the southern part of the control area could not be linked to fishery activities, at least not directly. Though we did encounter large numbers of *Larus* gulls associated with trawlers in the study area, these were mostly observed from a large distance and were not determined to species level (and thus not included in the results).

3.6. Herring gull

About one third of the herring gulls observed in the concession zone was associated with the turbines, showing a preference to jacket foundations. This implies an underestimation of the actual densities inside the wind farms, considering the methodological constraints of a 300 m wide transect. At the same time, this explains the large difference in measured densities between the control and impact area (Fig. 11). Looking at the numbers observed per km indeed shows that only slightly more herring gulls were seen outside compared to inside the OWFs (0.17 versus 0.14 birds per km respectively).

3.7. Great black-backed gull

Great black-backed gulls clearly concentrated inside the OWF concession zone (Fig. 13). At the same time, nearly 60% of the birds observed inside the wind farms was associated with the turbine foundations, implying that the number observed per km is the most reliable measure to assess the species' occurrence in the impact area. As such, the number observed per km inside the wind farms was 5 times higher inside compared to outside the OWFs (0.31 versus 0.06 birds per km), suggesting a strong attraction effect.

3.8. Black-legged kittiwake

With 936 individuals observed, black-legged kittiwake was one of the most common species in the study area. Inside the wind farm concession zone, the species' density measured 1.3 birds per km², opposed to a considerably lower density of 0.82 birds per km² outside the wind farms. The difference, however, is less pronounced when considering the number of birds observed per km. Despite these results suggesting an attraction effect, there was no clear pattern in the distribution of black-legged kittiwakes across the study area (Fig. 15).

3.9. Sandwich tern

Sandwich tern densities encountered outside the wind farm concession zone measured more than twice the densities inside the wind farms (0.11 versus 0.05 birds per km²). The difference is even more pronounced when considering the number of birds observed per km. Interestingly, most observations occurred in the extreme southeastern end of the study area, reflecting a strong onshore-offshore gradient in the species' distribution (Fig. 17). For this reason, it seems doubtful that the difference in densities as shown in Fig. 16 reflects an actual avoidance response.

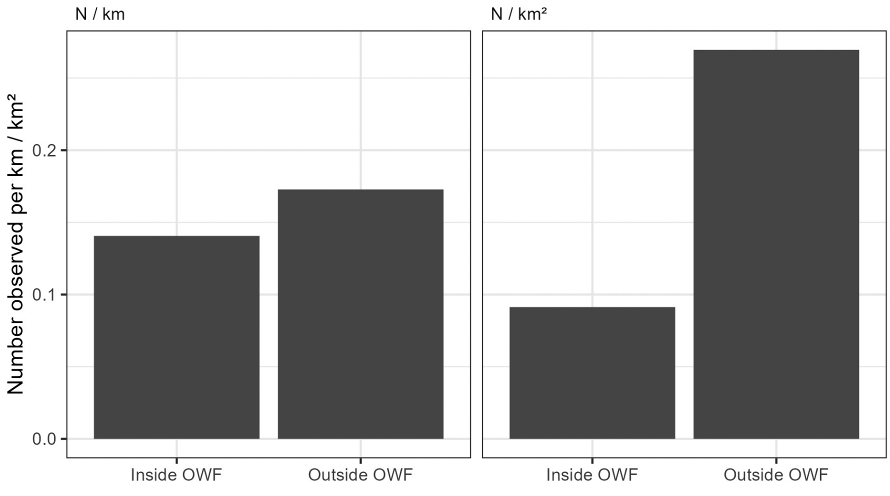

Figure 11. Occurrence of herring gull inside and outside the OWF concession zone, expressed as the number observed per km on the left and the number per km² on the right.

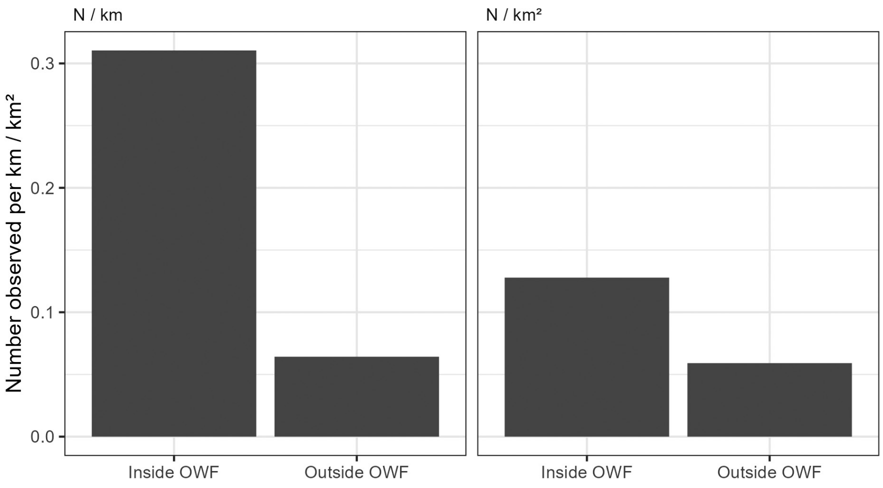

Figure 12. Occurrence of great black-backed gull inside and outside the OWF concession zone, expressed as the number observed per km on the left and the number per km² on the right.

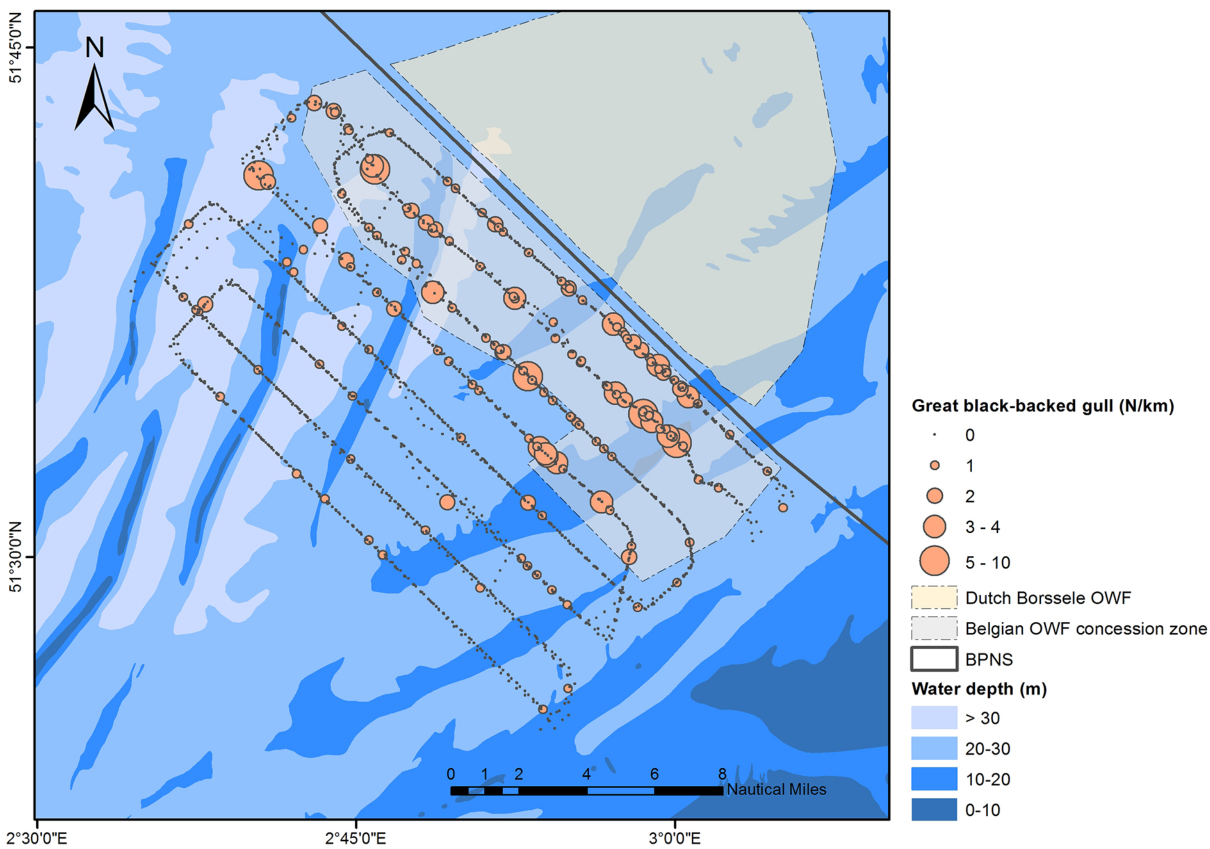

Figure 13. Great black-backed gull observations (N/km) in the study area.

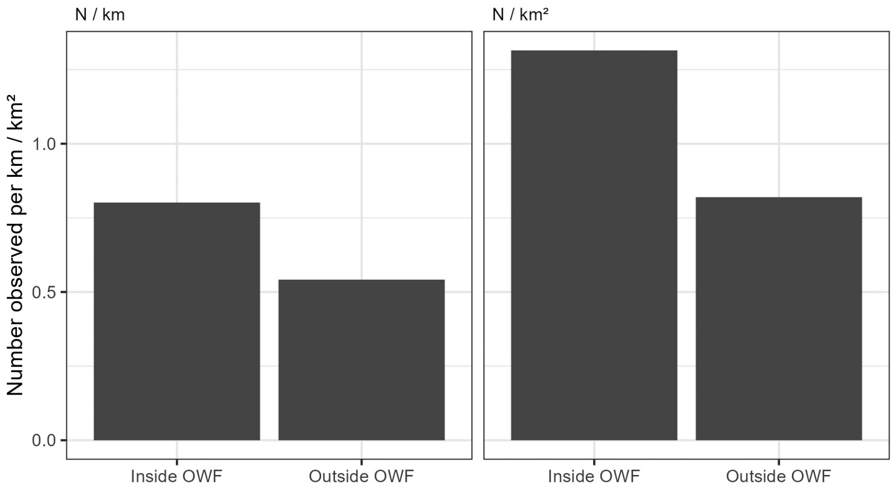

Figure 14. Occurrence of black-legged kittiwake inside and outside the OWF concession zone, expressed as the number observed per km on the left and the number per km² on the right.

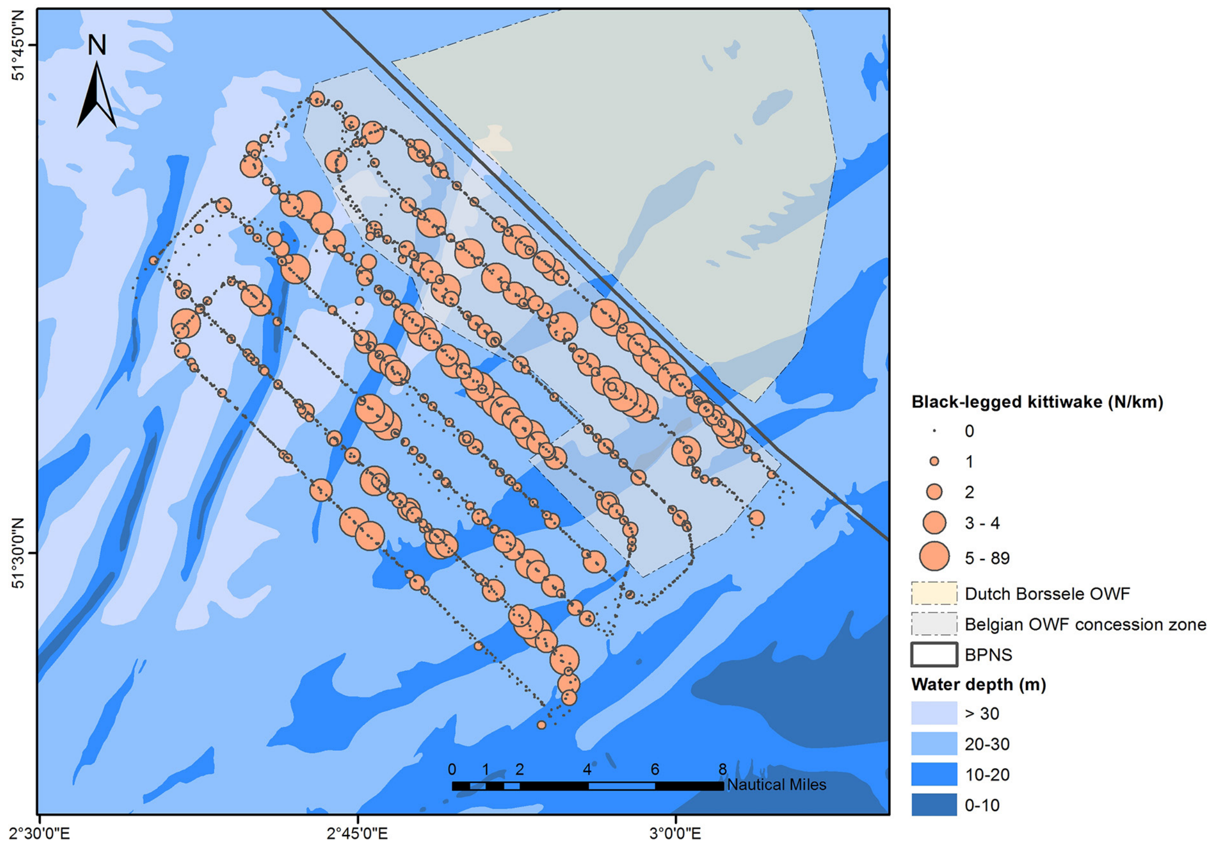

Figure 15. Black-legged kittiwake observations (N/km) in the study area.

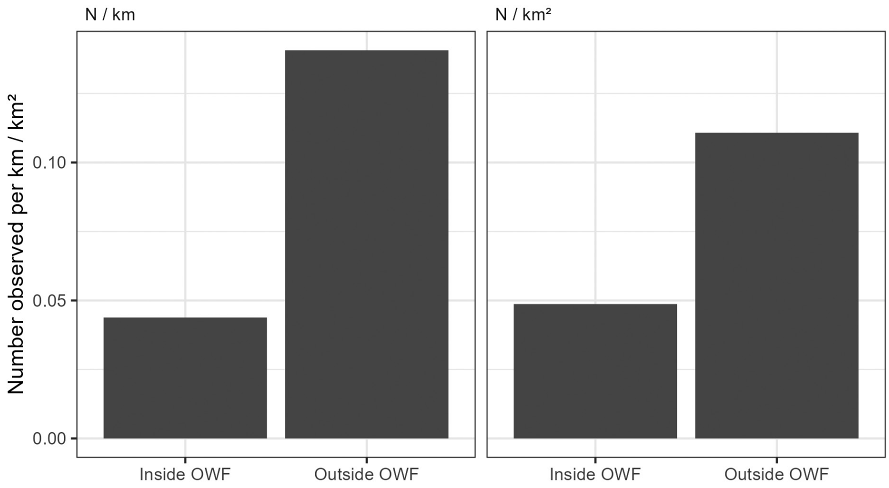

Figure 16. Occurrence of Sandwich tern inside and outside the OWF concession zone, expressed as the number observed per km on the left and the number per km² on the right.

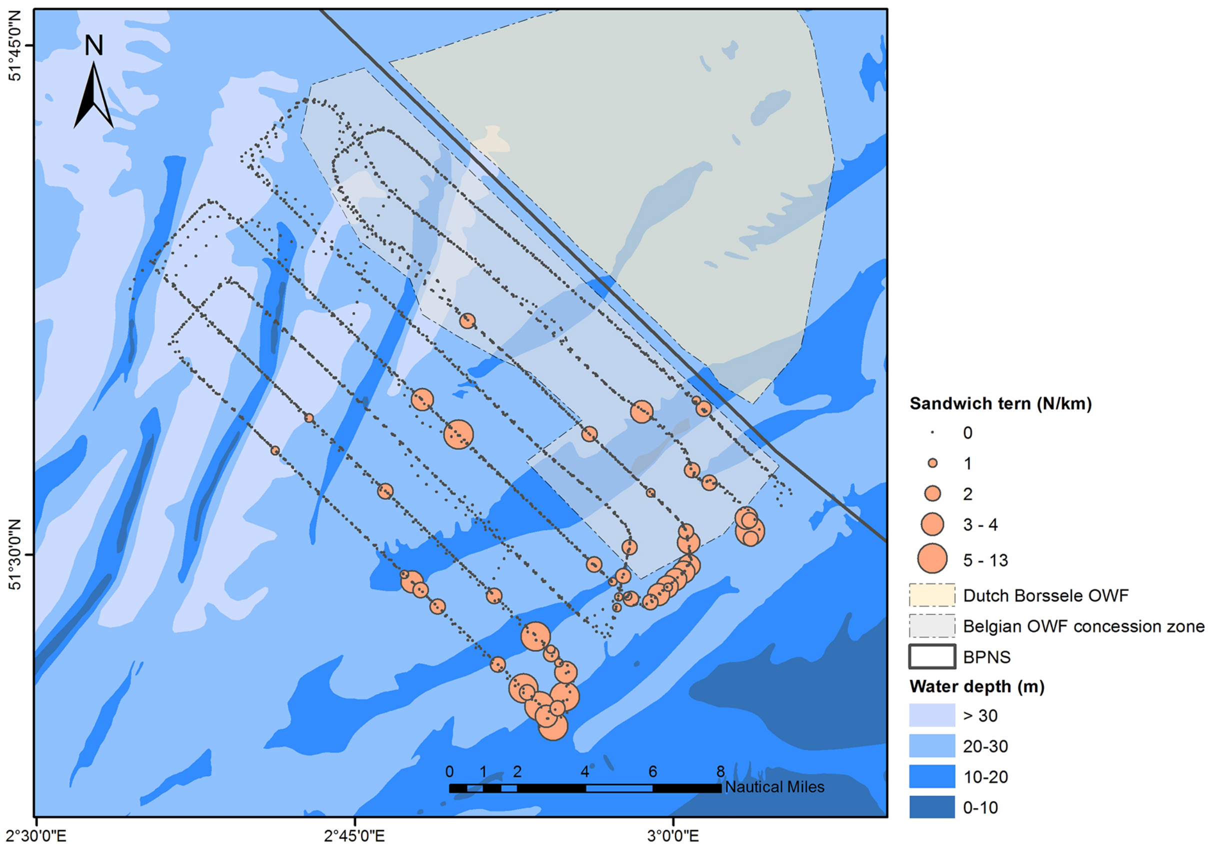

Figure 17. Sandwich tern observations (N/km) in the study area.

3.10. Common guillemot

Common guillemots occurred homogenously spread across the study area, with no clear distributional pattern. Accordingly, densities encountered in the impact and control area differed only slightly, with 0.35 birds per km² encountered inside the OWF concession zone, opposed to 0.45 birds per km² outside this area.

3.11. Razorbill

Interestingly, razorbills (N=628) were far more numerous in the study area compared to common guillemots (N=288), though in general the latter is much more abundant at the Belgian part of the North Sea. Furthermore, razorbill densities inside the wind farm concession zone outreached those outside, with 1.25 and 0.83 birds per km² respectively. This difference is less pronounced when considering numbers observed per km. The species does not display a clear distributional pattern across the study area, apart from a concentration of observations in the southern corner of the study area (Fig. 20).

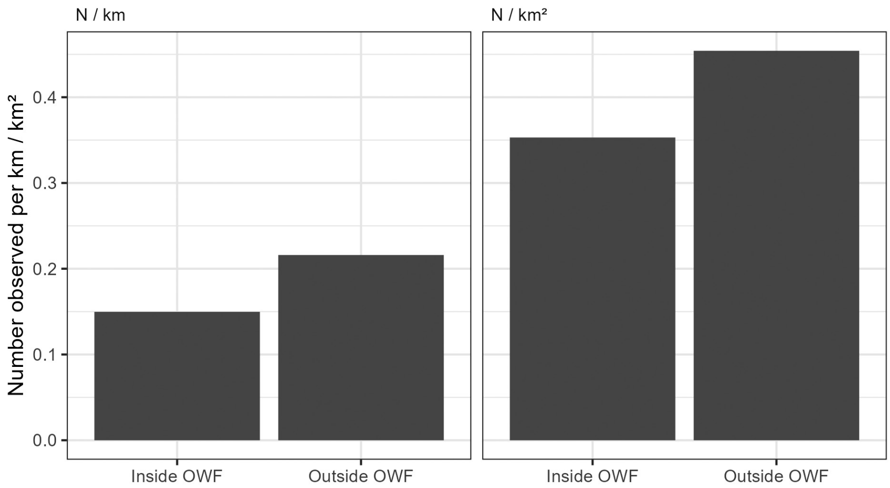

Figure 18. Occurrence of common guillemot inside and outside the OWF concession zone, expressed as the number observed per km on the left and the number per km² on the right.

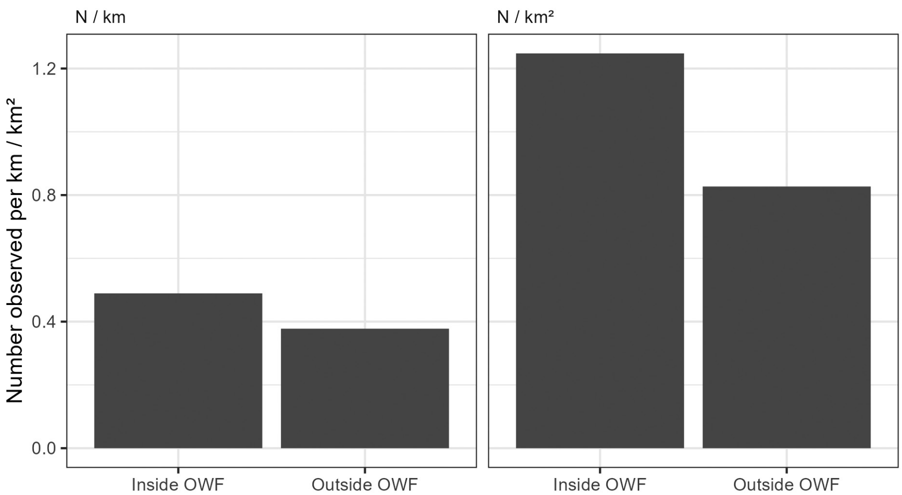

Figure 19. Occurrence of razorbill inside and outside the OWF concession zone, expressed as the number observed per km on the left and the number per km² on the right.

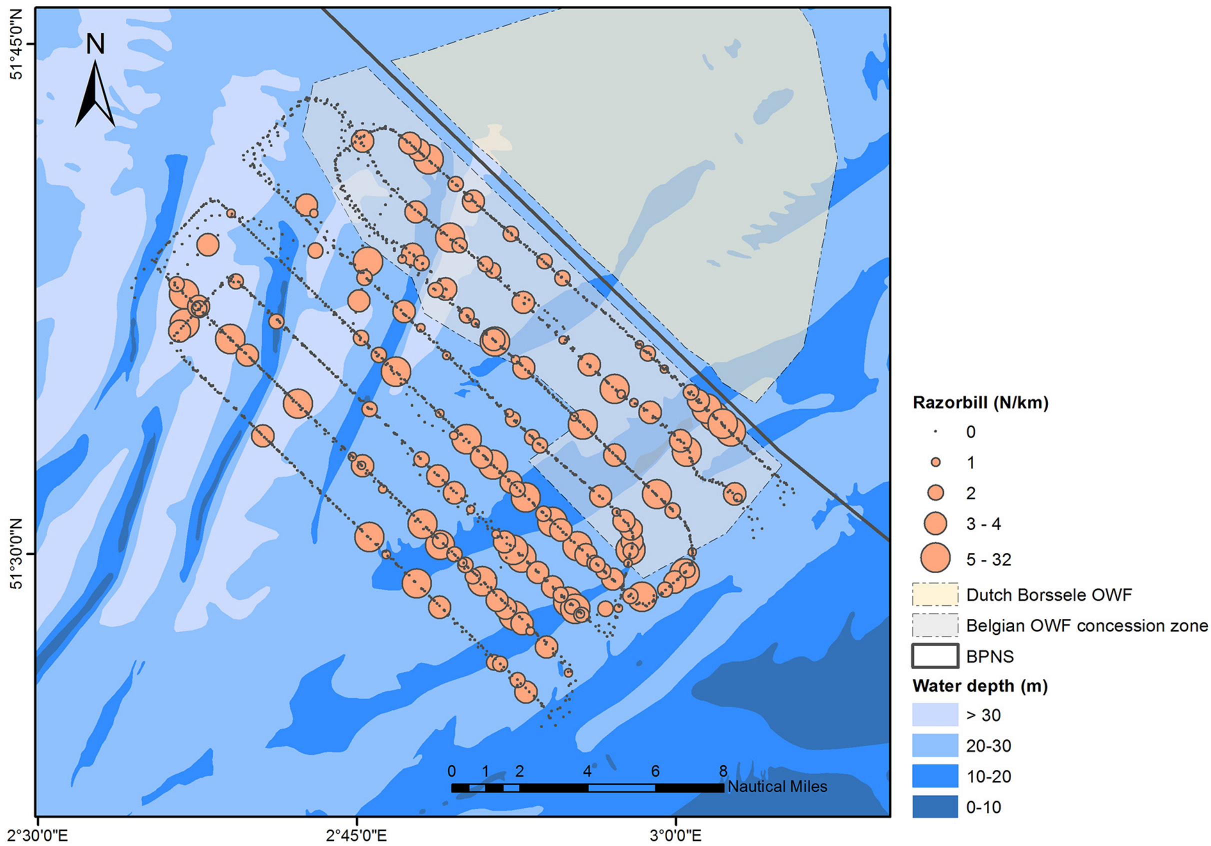

Figure 20. Razorbill observations (N/km) in the study area.

4. Discussion

This report sets out the count results collected over the period February 2021 to April 2023, following a revised monitoring design across the full extent of the Belgian OWF concession zone. It is important to highlight that the results presented here are provisional, and need to be considered as indicative. More data need to be collected before we will be able to detect seabird avoidance or attraction effects with sufficient confidence, by means of the intended spatial modelling. Considering the strong dynamics characterising marine environments and the high natural variability in seabird abundance, it can be statistically challenging to detect (potentially small) displacement effects (Vanermen *et al*. 2015; Cuttat & Skov 2020). As such, taking account of key habitat features and their effect on seabird distribution may be necessary to reliably detect seabird displacement, and is only possible when using monitoring data with high spatial resolution. Also note that this monitoring design does not include seabird densities present prior to construction, further stressing the importance of including habitat features in the modelling process.

Nevertheless, though making use of a limited dataset and mean values only, it is interesting to see that the results so far are often in line with what has been found before and/or elsewhere (Vanermen & Stienen 2019), such as indications of attraction in great black-backed gull and great cormorant, and of avoidance by northern gannet. On the other hand, current results no longer seem to indicate (strong) avoidance of common guillemots and even increased numbers of razorbills between the turbines. Spatial modelling will tell whether displacement effects on auks have actually decreased over time, providing proof for habituation, or whether the observed numbers in the wind farms result from specific habitat features inside the concession zone.

The new monitoring strategy not only aims to detect displacement responses. It is also designed to detect disturbance distances (with regard to migration corridors) and the effect of turbine density on seabird displacement levels. Regarding the latter, Leopold *et al*. (2013) found stronger negative responses of gannets and auks towards the PAWP wind farm compared to the OWEZ wind farm, which was hypothesised to result from the higher turbine density at the former. In another study including a third wind farm, Heinänen & Skov (2018) too found a decreasing impact on both auk species comparing the PAWP, Luchterduinen and OWEZ wind farms, reflecting the decreasing density of turbines in the respective wind farms. Note that the distance between the turbines at OWEZ ranges between 650 and 1000 m, which is considerably less than the distance between turbines at more recently built OWFs (see Fig. 1 to compare the configuration of the Borssele wind farm - built after 2020 - with the configuration of wind farms in the Belgian concession zone for example). With advancing technology, wind turbines tend to grow larger each year, and since there is a clear correlation between the necessary spacing between wind turbines and their rotor diameter, turbine density is expected to decrease even further in the future.

Taking account of all actually planned OWFs, wind farm capacity in the North Sea will soon increase from 26 to 61 GW. Actual ambitions reach even further, and aim for 117 GW by 2030 (RHDHV 2022). Clearly, the need to achieve a rapid transition from fossil to renewable energies is high, but unfortunately the precautionary principle regarding marine biodiversity impact seems to be abandoned. Politics now aim to achieve biodiversity goals by mitigating (rather than avoiding) the effects of large-scale wind exploitation. As such, granting procedures now often incorporate the demand for installing effective mitigating measures. However, wide knowledge gaps still persist regarding the latter and with this monitoring approach we hope to be able to inform future planning decisions regarding wind farm configuration and mitigation of impact on seabirds.

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Annex

Table 2. List of all bird species recorded during seabird monitoring campaigns in the period 2021–2023.

Species (scientific name)	Species (English name)	Number of observations	Sum
Gavia stellata	Red-throated diver	6	**6**
Gavia sp.	Unidentified diver	2	**5**
Podiceps grisegena	Red-necked grebe	1	**2**
Fulmarus glacialis	Northern fulmar	1	1
Hydrobates pelagicus	European storm petrel	1	**1**
Morus bassanus	Northern gannet	424	**567**
Phalacrocorax carbo	Great cormorant	35	**99**
Phalacrocorax aristotelis	European shag	3	**4**
Phalacrocorax sp.	Unidentified cormorant	1	1
Anser / Branta sp.	Unidentified goose	1	**16**
Anser anser	Greylag goose	1	**18**
Branta bernicla	Brent goose	3	**71**
Mareca penelope	Eurasian wigeon	2	**12**
Anas acuta	Northern pintail	1	20
Melanitta nigra	Common scoter	6	**29**
–	Unidentified duck	3	**170**
Accipiter nisus	Eurasian sparrowhawk	1	**1**
Falco tinnunculus	Common kestrel	2	**2**
Falco columbarius	Merlin	1	1
Pluvialis squatarola	Grey plover	1	**1**
Gallinago gallinago	Common snipe	1	**1**
Limosa lapponica	Bar-tailed godwit	3	**32**
Numenius phaeopus	Eurasian whimbrel	1	**8**
Arenaria interpres	Ruddy turnstone	1	1
Stercorarius parasiticus	Arctic skua	3	**3**
Stercorarius skua	Great skua	1	**1**
Larus melanocephalus	Mediterranean gull	1	**1**
Hydrocoloeus minutus	Little gull	115	**425**
Larus ridibundus	Black-headed gull	22	35
Larus canus	Common gull	278	**464**
–	Unidentified small gull	1	**15**

Species (scientific name)	Species (English name)	Number of observations	Sum
Larus fuscus	Lesser Black-backed gull	921	**2763**
Larus argentatus	European Herring gull	197	**240**
Larus michahellis	Yellow-legged gull	45	50
Larus cachinnans	Caspian gull	10	**10**
Larus marinus	Great Black-backed gull	194	**251**
Larus sp.	Unidentified *Larus* gull	37	**3219**
Rissa tridactyla	Black-legged kittiwake	544	**936**
–	Unidentified gull	5	505
Sterna sandvicensis	Sandwich tern	71	**157**
Sterna hirundo	Common tern	10	**39**
Sterna hirundo / paradisaea	Common / Arctic tern	1	**2**
Sterna paradisaea	Arctic tern	2	**2**
Chlidonias niger	Black tern	1	1
Uria aalge	Common guillemot	240	**288**
Uria aalge / Alca torda	Common guillemot / Razorbill	103	**362**
Alca torda	Razorbill	256	**628**
Columba livia domestica	Feral dove	2	**7**
Streptopelia decaocto	Eurasian collared dove	1	1
Alauda arvensis	Eurasian skylark	2	**7**
Anthus pratensis	Meadow pipit	4	**6**
Motacilla alba	White wagtail	1	**1**
Turdus pilaris	Fieldfare	1	**1**
Turdus sp.	Unidentified thrush	1	**1**
Sturnus vulgaris	Common starling	14	**93**
Fringilla coelebs	Common chaffinch	1	**1**
Passeriformes	Unidentified passerine	1	**1**