CHAPTER 5

BELGIAN SEABIRD DISPLACEMENT MONITORING PROGRAMME: A FEASIBILITY STUDY ON FUTURE RESEARCH POSSIBILITIES

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Abstract

As a first step towards a meaningful continuation of the Belgian seabird displacement monitoring programme, this chapter aims to identify relevant knowledge gaps and feasible research possibilities. After a decade of baseline displacement monitoring in and around single offshore wind farms, future focus should be oriented towards more targeted research, aiming to address specific issues on the actual impact of offshore wind farms on individual birds or bird populations, next to aspects supporting mitigation. As such, we identified three major future research themes: the correlation between displacement and wind farm characteristics, large gull movements in and around offshore wind farms and an empirically informed species-distribution model to support marine spatial planning.

1. Introduction

From 2008 until 2019, our research programme has focused on seabird displacement in two individual offshore wind farms (OWFs) located at the Bligh Bank and Thornton Bank. This has revealed distinct patterns in the tendency of seabird species to either avoid or to be attracted to these OWFs (*e.g.* Vanermen *et al.* 2019a). For a certain range of species we found striking parallels in displacement results between both Belgian wind farms as well as between Belgian and foreign North Sea studies. Not unexpectedly, for other species there was substantial inconsistency between results. Local seabird distribution, densities, seasonality and wind farm characteristics (overall size of the development, turbine size and density) are all hypothesised to potentially affect seabird displacement rates. Yet because of limited insight in what is driving the variation in observed patterns, impact study results so far have had limited value in predicting expected displacement rates elsewhere. Clearly, increased knowledge on cause-effect relationships would strongly benefit future planning and impact assessments. This chapter will therefore look for additional, yet feasible research possibilities to continue to provide valuable input in the ongoing scientific discussions on seabird displacement caused by offshore wind farms.

2. Feasibility study on cause-effect relationships

Degraer *et al.* (2013) strongly promoted the continuation of a 'basic monitoring programme' studying the impact of OWFs on all ecosystem components. Such 'basic monitoring' should be designed in a manner that it allows to keep track of major and unforeseen impacts, thus functioning as a finger on the pulse of environmental impact development. Additionally, the Belgian wind farm research programme aims at conducting 'targeted monitoring', in search for cause-effect relationships. In the end, the results of such monitoring research may allow to extrapolate observed impacts and to provide valuable input for future wind farm planning and design regarding mitigation strategies.

Displacement research at the Bligh Bank and Thornton Bank was continued until five and six years after construction respectively. In order to assess possible habituation effects, we originally planned to repeat the displacement research from 10 years after construction on. However, this is now considered unfeasible as the overall setting has changed tremendously, with new wind turbines now present in areas that were used for monitoring the reference situation before. It might therefore be difficult to disentangle habituation effects from effects due to an increased number of turbines in the direct vicinity of the wind farm under study. Meanwhile, the near-future situation also offers new research opportunities. The concession zone will soon become one large wind

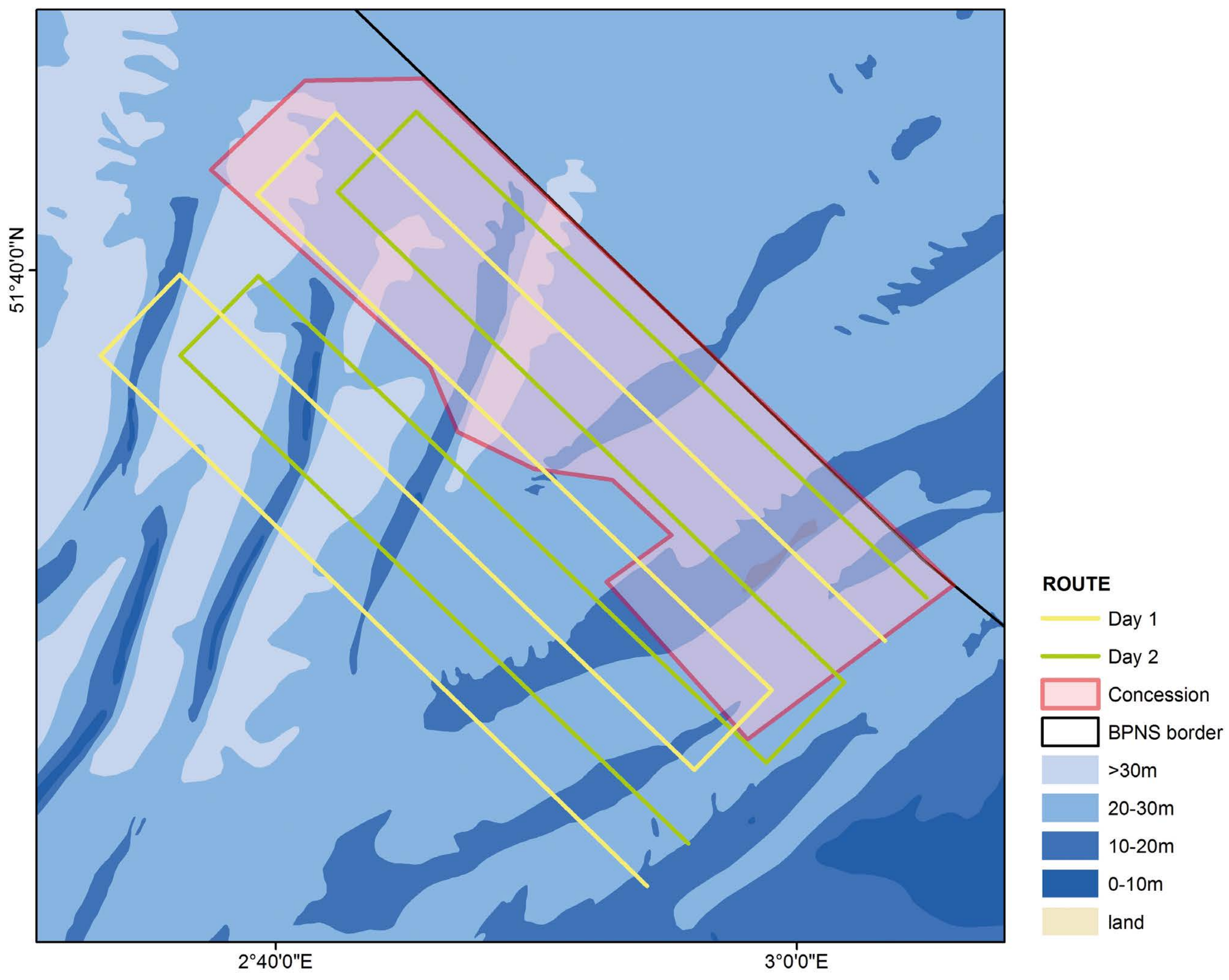

Figure 1. Proposal for a concession-wide seabird displacement monitoring scheme.

farm area of nearly 500 turbines, consisting of nine adjacent wind farms, each with their own specific features (see chapter 1). Next to wide-scale displacement patterns, monitoring the full concession zone and an adjacent control area would allow us to look for a **correlation between wind farm characteristics and locally observed displacement rates**, thus offering a perfect integration between basic and targeted monitoring. In Vanermen *et al.* (2019a), we already proposed a ship-based seabird monitoring scheme covering the area in two days (see fig. 1). Actually performing this scheme will not be planned before all wind farms have become operational, to avoid local access limitation due to construction activities, and to assure a stable situation throughout the programme.

In the near past, the Dutch government (Rijkswaterstaat) already commissioned a study to investigate whether the varying response of common guillemots *Uria aalge* observed at different sites could be related to wind farm configuration, by bringing together data from eight European OWFs. Unfortunately, Zuur (2018) could not find convincing displacement responses in any of the wind farms, let alone a correlation between displacement rate and OWF configuration. But despite applying state of the art Bayesian statistics (INLA), the analysis was performed in a way that makes it very hard to reliably detect OWF-induced guillemot displacement. The authors looked for displacement by modelling the spatial distribution of common guillemots and considering the percentages of 'importantly' negative and positive spatial random field (SRF) values inside distance bands of 5, 10, 15, 20 and 25 km around the wind farm. It was further hypothesised that OWF disturbance would result in a general increase in the percentage of importantly positive SRF values with increasing (incremental) distance from the OWF, as opposed to a decrease in the percentage of importantly negative SRF values. However, in this set-up the wind farm itself covers only a minor part of the inner 5 km circle. Clearly, wind farm disturbance could simply involve the redistribution of birds within this first 5 km distance band (*i.e.* from inside the wind farm boundaries to its near vicinities), in which case this particular displacement effect could never be detected applying this strategy. And even if birds would be displaced outside the first 5 km distance band and numbers would spread over a wide area up to 25 km, it still seems unlikely that this would generate a substantial increase in the percentage of positive SRF values. Therefore, we aim to perform more targeted analyses to look for response differences between sites, either at the scale of the wider North Sea region (as performed by Zuur 2018) or more locally within the Belgian wind farm concession zone.

Another (hypothesised) cause-effect relationship is the **attraction of large gulls to OWFs** as a result of increased food availability. Vanermen *et al.* (2013) therefore recommended conducting research on behavioural and foraging-related actions of large gulls inside OWFs. Tracking studies may generate valuable and detailed information on the movements and behaviour of individual birds inside OWFs. At the same time, tracking data may help to fill in notable knowledge gaps on meso- and micro-scale avoidance, nocturnal activity and whether or not a bird's response varies according to meteorological circumstances, all of which would provide valuable input for collision risk assessments. In the framework of the Belgian OWF research programme, efforts have been made in describing turbine-associated foraging behaviour of large gulls and analysing GPS data of lesser black-backed gulls *Larus fuscus* to assess their movements inside OWFs (Vanermen *et al.* 2018, 2019b). Also note that the tagging of lesser black-backed gulls in Belgian colonies only goes back to 2013, the year in which the Thornton Bank OWF became fully operational, and that the current data therefore do not allow a before-after comparison of bird movements. Furthermore, during the breeding season, the Thornton Bank is just outside the gulls' main distribution range, resulting in a relatively low number of records inside and near the wind farm. Interestingly, the current installation of the Norther wind farm just southeast of the Thornton Bank (and closer to the shore) does offer the opportunity to compare the distribution of tracked lesser black-backed gulls in and around an OWF site before and after construction, provided a comparable tagging effort of lesser black-backed gulls in the colonies of Zeebrugge and Ostend is ensured (Vanermen *et al.* 2019b). Up until now, most gull tracking studies in relation to OWFs focused on aspects regarding collision risk, for example on flight height distribution (Corman & Garthe 2014; Ross-smith *et al.* 2016; Borkenhagen *et al.* 2017) and on potential overlap with OWFs in terms of foraging range (Wade *et al.* 2014; Thaxter *et al.* 2015) or year-round movements (Thaxter *et al.* 2019). Surprisingly, few studies have thus reported on within-OWF movements and behaviour (but see Thaxter *et al.* 2018; Vanermen *et al.* 2019b), aiming to unravel why large gulls visit wind farms and to reveal whether gull behaviour inside wind farms may lead to additional or decreased collision risk. Increased knowledge on the matter may also be accomplished by analysing accelerometer data incorporated in the GPS tags, through which Bouten *et al.* (2013) could easily distinguish between standing, soaring, floating and flapping behaviour in lesser black-backed gulls.

A third major knowledge gap which we would like to highlight here is the impact of displacement on the survival and reproduction rate of individual birds. Investigating this particular impact implies assessing the effect of habitat loss on a bird's energy balance and studying the correlation between bird condition and demographic parameters. Being central-place foragers, GPS tagging of breeding birds offers opportunities to link foraging habitat and at-sea behaviour with their reproductive success. This kind of research, however, grows increasingly difficult when targeting wintering seabirds that often do not come to land for several months in a row, such as wintering divers, gannets and auks in Belgian waters. Despite these difficulties, this is the exact study aim in the 'red-throated diver energetics' JNCC project (https://jncc.gov.uk/our-work/rtde-project/). In this project, red-throated divers Gavia stellata are tagged with geo-locators and time-depth recorders (TDRs) to reveal where and for how long divers forage during the non-breeding season. During the 2018 breeding season, 74 adults breeding in Scotland, Finland and Iceland have been tagged, with tags retrieved during 2019 and further retrievals planned for 2020. Data analysis will provide an indication of where each individual wintered next to detailed information on dive depth, duration and frequency. If divers would appear to forage for only a small part of each day, it could be inferred they are easily capable of meeting their energetic requirements in the non-breeding season and so may have the capacity to accommodate the additional energetic costs of displacement (O'Brien *et al.* 2018, 2020). In Belgian waters, the main species displaced by OWFs do not breed anywhere close, and birds would need to be captured at sea. Divers have been caught at sea and subsequently tagged by German researchers (see for example, www.divertracking.com), and this has been demonstrated to work for auks and gannets too (Bugoni *et al.* 2008; Ronconi et al. 2009; Chimienti *et al.* 2017). The main problem, however, lies in the need to recapture birds in case one wants detailed information of diving behaviour through the use of a TDR. Note that a raw classification in bird behaviour with no necessity of recapturing is possible by applying a tri-axial accelerometer (often incorporated in GPS trackers), designed to monitor body movement (*e.g.* Bouten e*t al.* 2013; Patterson *et al.* 2019). Accelerometer data can further be used to calculate the 'overall dynamic body acceleration', which in turn is a proxy for energy expenditure (Sotillo *et al.* 2019).

Lately, individual-based models (IBMs) are considered to be a most promising tool to determine the (cumulative) effect of displacement on demographic parameters (*e.g.* Topping & Petersen 2011; Searle *et al.* 2014; Warwick-Evans *et al.* 2018), while not necessarily relying on GPS tracking data. Topping & Petersen (2011) defined an IBM as 'a computational model for simulating the actions and interactions of autonomous individuals in a defined virtual world, to assess their effects on the system as a whole'. In a recent study by Kooten *et al.* (2019), a method was developed to estimate the effect of habitat loss on five seabird species (red-throated diver, northern gannet *Morus bassanus*, sandwich tern *Thalasseus sandvicensis*, razorbill *Alca torda* and common guillemot), over their full life cycle and across the larger North Sea area. First, the authors constructed habitat maps linking distributional seabird at sea data with abiotic variables. Next, they determined the cost of habitat loss using an individual-based energy-budget model, by combining this with the habitat model predictions and the expected degree of displacement. Eventually, the 'cost' of habitat loss is expressed in terms of reduced survival rates following a change in the availability of foraging area in several OWF scenarios. The authors highlight that there are large sources of uncertainty that may influence the outcome, for example the unbalanced coverage of seabird at sea data across the North Sea and a lack of insight in density-dependent mechanisms.

3. Seabird sensitivity map of the Belgian part of the North Sea

Regarding the potential cumulative effect of the current and new wind farm concession zone (delineated at the Hinder Banks), and the potential need for mitigating measures by means of a marine protected area, we also aim to perform an analysis on the number of seabirds expected to be impacted by displacement at the Belgian part of the North Sea. This would further allow to identify possible bottlenecks for the objectives set for the Marine Strategy Framework and Bird Directives. We will therefore develop species distribution models, linking observational seabird at sea data with a range of explanatory environmental variables (Waggit *et al.* 2019; Kooten *et al.* 2019). Overlaying this with current prospects of wind energy developments, next to empirically assessed displacement rates would result in species-specific estimations of the number of birds affected. Species distribution models at the scale of the Belgian part of the North Sea could meanwhile serve as an instrument to delineate areas which are particularly valuable to seabirds. In the first place we should focus on those species known to be vulnerable to displacement in Belgian waters: northern gannet, common guillemot and razorbill. Next we could extend to those species for which results are yet unclear due to low detection rates or statistically insignificant avoidance effects, *i.e.* northern fulmar *Fulmarus glacialis*, great skua *Stercorarius skua*, little gull *Hydrocoloeus minutus* and black-legged kittiwake *Rissa tridactyla*.

4. Conclusion

Seabird displacement research in the coming years should evolve around the following three major themes. First of all, the new basic monitoring programme, as proposed in Vanermen *et al.* (2019a), will continue assessing species-specific displacement rates, meanwhile looking for correlations with wind farm configuration characteristics. Secondly, a continuation of the tracking network of large gulls in Belgian colonies with suitable GPS trackers will be assured. Focus will be on lesser black-backed gull, a species which ranges far more offshore compared to herring gull *Larus argentatus*, and that has been demonstrated to interact with OWFs much more frequently, at least in Belgian waters. Finally, we will perform a detailed study on the potential effect of OWF-related habitat loss on the scale of the Belgian part of the North Sea, based on a species distribution model (making use of environmental explanatory variables) and empirically observed seabird displacement rates. Such should allow to do profound recommendations for mitigating and compensating measures in future marine spatial planning. The focus here should be on species known to be sensitive to displacement such as divers, gannets and auks. It should further be noted that these species do not occur as breeding birds anywhere near Belgian waters. Extending the monitoring programme with research on the impact of displacement on survival and reproduction rates is therefore much less feasible, considering the logistic and budget-related bottlenecks.

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