Chapter 3

TRAPPED WITHIN THE CORRIDOR OF THE SOUTHERN NORTH SEA: THE POTENTIAL IMPACT OF OFFSHORE WIND FARMS ON SEABIRDS

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ABSTRACT

The cuneiform southernmost part of the North Sea is an important corridor for seabird migration. An estimated total of 1-1.3 million seabirds may fly through the area each year. The great majority (40-100%) of the flyway population of great skua and little gull use the Strait of Dover to leave the North Sea, as well as 30-70% of the population of terns and lesser black-backed gulls. In addition 10-20% of the red-throated divers and great crested grebes may pass through this bottleneck. Except for great skua, all other species are mainly found in inshore areas (i.e. within 20 km of the shoreline), where the first generation of wind farms will be located. At present, very little is known about the impact of offshore wind turbines on seabirds. Being k-selected species, seabirds are extremely vulnerable to human impacts that affect adult survival. Because of this, and because of a major lack of information on nocturnal migration of seabirds and their reaction towards offshore structures like clusters of wind turbines, great care must be taken. New developments that might have a detrimental impact on resident as well as migrating seabirds must be carefully investigated, especially in this bottleneck area.

INTRODUCTION

Many European countries have engaged themselves in the production of considerable amounts of "non-polluting" energy as part of national strategies to reduce carbon dioxide emissions. As far as renewable energy sources are concerned, offshore wind farms in particular offer attractive prospects. With the first offshore power plants already built and many more projects under consideration, wind farms may soon be a common feature along the North Sea coasts For economical reasons, shallow coastal waters will attract the most interest to situate power plants. From an ecological point of view these waters generally constitute a high biological value and are important feeding, resting and migratory habitats for seabirds (Skov *et al.* 1995). It is intuitively appealing to claim that avoiding areas of concentrated bird activity would eliminate many potential bird-turbine problems. Surveys can be used to determine if a proposed site is located in areas of high seasonal density, or in the range of a threatened or endangered species. Using such data most existing terrestrial wind plants at least tried to avoid areas of concentrated bird use in order to avoid potential conflicts between economical and ecological interests. In this chapter we will show that site selection based on scientific data is much less obvious in offshore areas

This paper is confined to the potential impact of offshore wind farms on seabirds. Seabirds can be defined as birds that spend an important part of their life at sea predominantly feed in marine waters and are well adapted to the marine environment (Furness & Monaghan 1987). The definition includes species that breed inland, but prefer marine or coastal areas outside the breeding season *(e g.* little gull *Larus minutus*, black-headed gull *L. ridibundus* and common scoter *Melanitta nigra).* Non-seabirds include waders (except phalaropes) and all other birds that may migrate over sea but do not primarily depend on the marine environment for feeding. For convenience we selected a list of 18 seabirds that dominate the species spectrum in the southern North Sea (Table 1). In the following paragraphs we will mainly focus on these species and this particular area.

A common feature of seabirds is that they are long-lived (individuals ot most species can exceed 20 years of age), have delayed maturity and lay small clutches. Species adopting these life-history strategies are generally referred to as k-selected. As opposed to r-strategists, these species are especially vulnerable to human impacts. Typical for k-selected species is that a small change in adult survivorship can have a substantial impact at the population level. In the second place it takes them much longer to recover their numbers after a catastrophic decline than it does for short-lived species, because low reproductive rate and delayed maturity hamper a fast recovery. In other words, if offshore wind farms affect adult seabirds the impact at the population level might be serious. Among seabirds, species that are confined to inshore areas are most at risk, at least with regard to the first generation of offshore wind farms that will be located in shallow coastal areas. In the near future, inshore migrants will encounter several wind farms during their flight along the European coasts and their populations will have to face the accumulated impact of a chain of wind parks.

Borrowing some general findings from terrestrial studies one can conclude that wind turbines can have direct as well as indirect impacts on seabirds. A direct impact is mortality caused by collision with the rotor blades or the tower,

Table 1. *Estimated maximal proportion of the fly way population that cross or reside in the southernmost part of the North Sea (51 -52 N) during an average year, distance to the coast (I = inshore species most abundant within 20 km from the shoreline, 0 = offshore species rarely observed within 20 km for the shoreline and D - dispersed occurring both in inshore and offshore waters) and European Threat Status (after Heath et* ***al*** *2000; V = vulnerable, S = stable, E = localized,D = declining) of J8 common seabird species. See Seys 2002 for detailed information about the estimates.*

Species	Total flywuy population	Estimated maximal numbers migrating through the strait of Dover	Estimated maximal number of resident birds (after Seys 2001)	Proportion of the biogcographical population residing in or flying over the southernmost part of the North Sea	Distance to the coast Status	European Threat
Gavin stellata	75,000	10-15,000	4,176	13-20	I	V
Podiceps cristatus	150,000	15-30,000	5,826	10-20	I	S
Pulmonis glacialis	10,000,000	-	4,051	<0.01	0	S
Sulci bassana	892,000	40-60.000	10,024	4-7	O	L
Mehmitta nigra	1,600,000	60-80,000	40,028	4-5	I	S
Stercorarius skua	27,200	<27,200	539	< 100	0	S
hints minutus	75,000	30-75,000	5.626	40-100	I	D
Larus ***ridibundus***	>5,000,000	370-500,000	6,460	7-10	I	S
Larus canus	1,600,000	45-100,000	20,527	3-6	I	D
Larus fuscus	450,000	125,000	28,788	28	I/D*	S
Larus ***argentatus***	1,400,000	-	64,172	4.6	I/D*	S
Larus maritius	480,000	6-9,000	25,117	5.2	D	S
Rissa tridactyla	8,400,000	-	30,467	0.4	0/D*	S
Sterna sandvivensis	150,000	100,000	3,970	67	I	D
Sterna hirundo	180,000	100,000	**9,540	56	I	S
Sterna albifrons	34,000	15,000	***2 264	44	I	D
Uria aalge	1,990,000	20-50,000	29,291	1.5-3	0	S
AIca tarda	482,000	4-10,000	6,161	1.3-2	0	S

* = distribution pattern varies with the seasons.

and accidents that happen because birds are swept down through the wake behind the rotor (e.g. Petersen & Nøhr 1989, Winkelman 1989, 1992a). Most coastal birds collide with wind turbines at night, during the crepuscular hours or during periods of poor visibility (e.g. fog or heavy rain; Winkelman 1992b). More indirect effects of wind turbines consist of disturbance of resting or feeding birds and avoidance of wind parks causing a reduction in the habitat used for feeding, resting or migration (e.g. Petersen & Nøhr 1989, Winkelman 1989, 1992b, c, d, Van der Winden *et al.* 1996). Studies on the effects of offshore wind farms are very limited and there is poor access to the research results. The small offshore wind farm at Tun0 Knob (Denmark), however, has been extensively studied for potential impact on the avifauna. The area holds important numbers of common eider *Somateria mollissima* and common scoter *Melanitta nigra.* Although the number of eiders significantly decreased after the construction of the Tun0 Knob wind farm, the decrease was caused by natural fluctuations in food abundance (Guillemette *et al.* 1998, 1999). The researchers concluded that the wind park had no effects on the daylight distribution and abundance of common eiders. The only impact they found was that the birds avoided flying or landing within the vicinity of the wind park, but instead swam towards the park. Also during night eiders tended to avoid flying within 1500 m distance from the wind park (Tulp *et al.* 1999). Although the authors themselves are very much reserved in their conclusions and point out that more research is needed to assess the impact of the wind park under various conditions, the positive results of these studies are often used by energy producers to show that there are no conflicts between birds and offshore wind farms. However, such hasty generalisation of research results is fundamentally wrong. It goes without saying that impact assessment studies must, by necessity, be site- and species-specific. The Danish park is by no means comparable to other offshore situations. Not only is the wind park small (it consists of 2 rows, each of 5 windmills) and comprises low power (500 kW) turbines, but also the composition of the avifauna does not compare to other sites.

STATE OF THE ART

In the last few decades, research on the spatial and temporal distribution of seabirds has gained much attention. Since the start of systematic seabird counting in the North Sea in the late 1970s, six atlases have been published of the area (Baptist & Wolf 1993, Carter *et al.* 1993, Camphuysen & Leopold 1994. Anonymous 1995, Stone *et al.* 1995, Offringa *et al.* 1996). Intensive surveys by ships and aeroplanes have provided data for the designation of important areas for seabirds in the North Sea (Skov *et al.* 1995). Although this was an important step forward towards the conservation of seabirds, the 'rough' scale of these maps (e.g. the entire coastline of the southern North Sea is classified as an Important Bird Area) is not sufficient to predict local patterns in seabird densities. The maps are often based on smoothing smallscale data over

By Wouter Courtens.
Collision victim (Common tern. Stern hirundo) at the wind turbines in the Zeebrugge port. Belgium.

large areas and time-intervals, obscuring the detailed spatial and temporal patterns. As a result, the maps have only a limited value for those interested in relatively small-scale effects, like those of offshore wind farms. Although the southern North Sea, and the Belgian part in particular, is probably the best-studied area of the entire North Sea (Offringa *et al.* 1996, Seys 2001), even here information is not sufficient to predict the impact of offshore wind parks on the marine avifauna because important information on flight behaviour of seabirds is missing.

Although crucial for weighing up the potential impact of offshore wind farms, information on migration patterns and other flight patterns (e.g. roosting and foraging flights) of seabirds is limited. Migration in marine areas is mainly known from onshore daytime observations: so-called seawatches. From these seawatches we know that typical coastal species and waders dominate bird migration along the borders of the southern North Sea (Camphuysen & Van Dijk 1983, Borrey *et al.* 1986, Van Westrienen 1988, Platteeuw *et al.* 1994). Furthermore, they show a strong dependency on wind speed and direction. True seabirds can only be seen along the coast during spells of heavy northwestern winds. Although seawatches provide useful information on nearshore migration patterns, they are not sufficient to evaluate the impact of wind farms on migrating birds. Not only is the information confined to the areas very close to the shore, it also provides no details on the altitude at which birds fly. Probably the most important gap in this respect concerns nocturnal and concentrated migration in marine areas. Also, species-specific risks for collision with windmills and sensitivity to disturbance are generally unknown for seabirds, making it impossible to derive proper estimates of the impact of offshore wind farms on the marine avifauna. At present, new studies are being conducted to measure flight altitude of seabirds in offshore areas. A recent study showed a strong influence of wind direction and speed on flight altitudes of migrating seabirds in coastal areas and strong differences in this respect between species (Kriiger & Garthe 2001). The European Seabird at Sea team is currently working on a species-specific disturbance index for seabirds, in which all available information on sensitivity and collision-risk of seabirds will be combined. Such an index can be used to make a vulnerability atlas that maps particularly vulnerable areas with respect to interactions between wind turbines and seabirds. These are the first important steps towards a better understanding of the possible impact of offshore wind farms on seabirds. Although in some areas this knowledge will not become available in time, it can certainly contribute to a sound choice of wind farm locations in the future.

THE SOUTHERN NORTH SEA AS A CORRIDOR FOR MIGRATING SEABIRDS

The southernmost part of the North Sea (51-52°N: Figure 1) is bordered by the Strait of Dover and the central North Sea. Its shallow (average depth < 30 m), turbid and well-mixed water masses are characterised by the North Atlantic Drift and the freshwater input by the rivers Rhine, Scheldt and Thames. The area is intensively used for fishery, sand and gravel extraction, and shipping (Maes *et al* 2000). With various sand ridges resulting from sediment and melt water displacements during several glacial periods, the structural variation in topography is unique for the North Sea (Houbolt 1968, Eisma *et al.* 1979) and causes strong gradients within the benthic communities (Cattrijsse & Vincx 2001). Extensive surveys from ships and aeroplanes performed in the 1980s and 1990s showed that the area is an important staging and feeding area for seabirds (Stone *et al* 1995, Offringa *et al* 1996, Seys 2001). It holds internationally important numbers (i.e. more than 1% of the total biogeographical population) of red-throated diver *Gavia stellata,* great crested grebe *Podiceps cristatus,* northern gannet *Sula bassanus,* common scoter, great skua *Stercorarius skua,* little gull, mew gull *Larus canus,* lesser black-backed gull *L. fuscus,* herring gull *L. argentatus,* great black-backed gull *L. marinus.* Sandwich tern *Sterna sandvicensis,* common tern *S. hirundo,* little tern *S. albifrons* and common guillemot *Uria aalge* (Offringa *et al* 1996, Seys 2001), and forms a stepping stone for several seabirds wintering in the Channel (Offringa *et al* 1996).

Although the excellent knowledge on seabird distribution patterns that exists for this part of the North Sea can be taken into account when choosing future locations for offshore wind farms, important information on flight patterns is missing. Probably the most uncertain factor is the importance of the area for migrating seabirds. Looking at the map of the southern North Sea (Figure 1) it is clear that the cuneiform entrance to the Strait of Dover may act as a fyke net within which seabirds become temporarily concentrated when they leave or enter the southern North Sea. Table 1 summarises the results of an extensive literature search on the importance of the southern North Sea for migrating and staging seabirds (detailed information can be found in Seys 2002). Altogether an estimated 1-1.3 million seabirds may migrate through the area each year. The great majority (40-100%) of the flyway population of great skua and little gull use the Channel to leave the North Sea, as well as 30-70% of the summer resident terns and lesser black-backed gulls. In addition, 10-20% of the flyway population of red-throated diver and great crested grebe may pass **this** bottleneck, and 3-10% of the *Larus*-gulls (except for little gull), northern gannets and common scoters. Pelagic species (northern fulmar *Fulmaris glacialis*, kittiwake *Rissa tridactylus* and auks) usually have large populations and estimates of dispersing movements are very difficult to make for these species. Hence, conservative percentages of <l-3 % are used for these species.

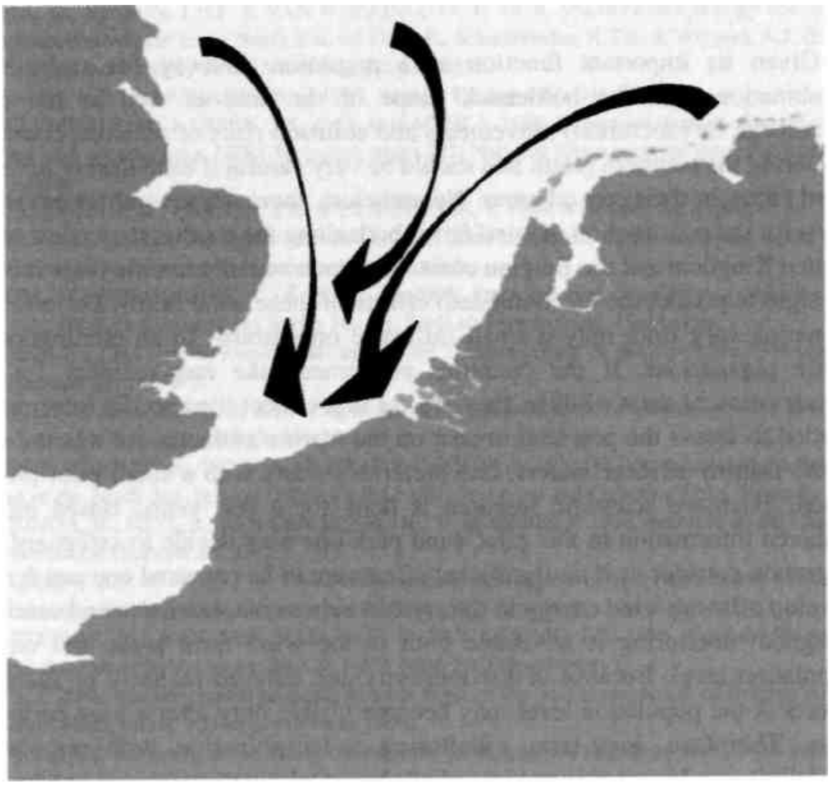

Figure 1. *Map of the North Sea showing that southwards migrating seabirds become concentrated within the cuneiform southern North Sea.*

From Table 1 it follows that for at least eight species the area plays a key role (i.e. more than 10 % of their total flyway population passes through the southern North Sea) as a migratory pathway. However, not all species are at equal risk of disturbance or collision with wind turbines; birds passing close to the coast will be most impeded. Although there is no particular information available on bird migration routes over sea, general distribution patterns can provide a clue on the habitat preference of migrating seabirds. Except for great skua, all species potentially at risk are mainly found at short distances from the coast (Offringa *et at.* 1996, Seys 2001) and can be classified as inshore species. Assuming that the distribution patterns more or less reflect their migration pathways, we can cautiously conclude that eight species are particular at risk. Many of these species at least partly (and some even predominantly) migrate during night or during crepuscular hours (Cramp & Simmons 1977, Camphuysen & Van Dijk 1983, Allein & Boudolf 1998), when collision risks are largest. Taking their conservation status into account, red-throated diver, little gull, Sandwich and little tern are internationally considered as threatened species.

HOW TO PROCEED?

Given its important function as a migration pathway for seabirds in combination with the bottleneck shape of the area as well as the poor knowledge on (nocturnal) movements and collision risks of seabirds, countries bordering the southern North Sea should be very careful if establishing offshore wind farms in their coastal areas. Nevertheless, there are several far-advanced plans for the construction of wind farms both along the southeastern coast of the United Kingdom and the Belgian coast. Without a sound scientific basis it is not possible to predict the (accumulated) effects of these wind farms. For now, the scenarios vary from only a small influence on seabirds to an elimination of entire populations. If the countries concerned take responsibility for the conservation of their wildlife, they should first collect the specific information needed to assess the potential impact on the marine avifauna. As was the case in the Danish offshore waters, one preferably starts with a small pilot project where extensive scientific research is done for a few years. Based on the gathered information in this pilot wind park one may decide to safeguard this migration corridor or if no significant effects are to be expected one can further develop offshore wind energy in the area. In either case, extensive and carefully designed monitoring is advisable both in the wind farm areas and on the population level. Because of the longevity and delayed maturity of seabirds, effects at the population level may become visible only after a long period of time. Therefore, long-term monitoring in combination with population modelling would certainly not be out of place. Only in this way can one be sure that the important natural value of the southern North Sea is preserved for the future.

REFERENCES

ALLEIN, S. & BOUDOLF, L. 1998. Mijden Dwergsterns Sterna albifrons de Belgische kust tijdens de voorjaarstrek en verkiezen ze die tijdens de najaarstrek? Mergus 12: 111-125 (with English summary). ANONYMOUS 1995. An atlas of seabird distribution in North-west European waters - Electronic version 2.1. Joint Nature Conservation Committee, Peterborough. BAPTIST. H.J.M. & WOLF. P.A. 1993. Atlas van de vogels van het Nederlands Continetaal Plat. Rapport DGW 93.013. Rijksinstituut voor Kust- en Zee. Middelburg (with English summary). BORREY, J., DEWULF. L., RAES. D.. TAHON, R. & VERCRUIJSSE, B. 1986. 5 jaar zeevogelwaamemingen te Nieuwpoort. CAMPHUYSEN. C.J. & VAN DIJK. J. 1983. Zee-en kustvogels langs de Nederlandse kust, 1974-79. Limosa 56: 83-230 (with English summary). CAMPHUYSEN, C.J. & LEOPOLD. M.L. 1994. Atlas of seabirds of the southern North Sea. IBN-research report 64/6. Institute for Forestry and Nature Research, Texel. CARTER, I.C., WILLIAMS, J.M., WEBB, A. & TASKER. M.L. 1993. Seabird concentrations in the North Sea: an atlas of vulnerability to surface pollutants. Joint Nature Conservation Committee, Aberdeen. CATTRIJSSE, A. & VINCX, M. 2001. Biodiversity of the benthos and the avifauna of the Belgian coastal waters. Summary of data collected between 1970 and 1998. Federal Office for Scientific. Technical and Cultural Affairs, Brussels. CRAMP, S. & SIMMONS, K.E.L. (Eds.) 1977. Birds of the western Palearctic. Vol. I. Oxford University Press. Oxford EISMA. D.. JANSEN, J.H.F & VAN WEERING, T.C.E. 1979. Sea-floor morphology and recent sediment movement in the North Sea. In: Oele. E.. Schutterhelm. R.T.E. & Wiggers. A.J. (Eds.), The quaternary history of the North Sea, pp. 217-231. FURNESS, R.W. & MONAGHAN, P. 1987. Seabird Ecology. Blackie, Glasgow. GUILLEMETTE, M., LARSEN, J.K. & CLAUSAGER. I. 1998. Impact assessment of an off-shore wind park on sea ducks. NERI Technical report 227. National Environmental Research Institute, Roskilde. GUILLEMETTE, M.. LARSEN, J.K. & CLAUSAGER. I. 1999. Assessing the impact of the Tun0 Knob wind park on sea ducks: the influence of food resources. NERI Technical report 263. National Environmental Research Institute, Roskilde. HEATH. M.. BORGGREVE, C. & PEET. N. 2000. European bird populations: estimates and trends. BirdLife Conservation Series No. 10. BirdLife International, Cambridge. HOUBOLT. J.J.H.C. 1968. Recent sediments in the Southern Bight of the North Sea. Geologie en Mijnbouw 47: 245-273. KRUGER. T. & GARTHE, S. 2001. Flight altitudes of coastal birds in relation to wind direction and speed. Atlantic Seabirds 3: 203-216. MAES, F. CLIQUET, A., SEYS, J., MEIRE. P. & OFFRINGA, H. 2000. Limited atlas of the Belgian part of the North Sea. Federal Office for Scientific, Technical and Cultural Affairs, Brussels. OFFRINGA, H.. SEYS, J.. VAN DEN BOSSCHE, W. & MEIRE, P. 1996. Seabirds on the Channel doormat. De Giervalk 86: 3-71. PETERSEN, B.S. & N0HR, H. 1995. Konsekvenser for fuglelivet ved etableringen af mindre vindmøller. Ornis Consult, Copenhagen (with English summary). PLATTEEUW, M., VAN DER HAM, N.F & DEN OUDEN, J.E. 1994. Zeetrektellingen in Nederland in de jaren tachtig. Sula 8: 1-203 (with English summary). SEYS. J. 2001. Sea and coastal bird data as tools in the policy and management of Belgian marine waters. Ph.D. thesis, University of Gent. Gent. SEYS. J. 2002. Estimates of the number of seabirds residing in and migrating through the southern North Sea. Report IN.D.2002.2. Institute of Nature Conservation, Brussels. SKOV. H.. DURINCK, J., LEOPOLD, M.F. & TASKER. M.L. 1995. Important bird areas for seabirds in the North Sea. BirdLife International. Cambridge.

STONE, C.J.. WEBB, A.. BARTON. C. RATCLIFFE. N.. REED. T.C.. TASKER, ML.. CAMPHUYSEN, C.J. & PIENKOWSKI. M.W. 1995. An atlas of seabird distribution in northwest European waters. Joint Nature Conservation Committee, Peterborough.

TULP, I. SCHEKKERMAN. H.. LARSEN, J.K., VAN DER WINDEN, J., VAN DE HATERD. R.J.W.. VAN HORSSEN, P.. DIRKSEN. S. & SPAANS. A.L. 1999. Nachtelijke vliegbewegingen van zee-eenden bij het windpark Tuno Knob in de Oostzee. Rapport 99.30. Bureau Waardenburg, Culemborg (with English summary).

WESTRIENEN, R. VAN 1988. Zichtbare trek langs de Zeeuws-Vlaamse kust. In: Suisse, M.A. & Tombeur. F.L.L. (Eds.). Vogels tussen het Zwin en Saeftinghe. De avifauna van Zeeuws-Vlaanderen. pp. 55-62.

WINDEN, J. VAN DER. DIRKSEN, S.. VAN DEN BERGH. L.M.J. & SPAANS. A.L. 1996. Nachtelijke vliegbewegingen van duikeenden bij het Windpark Lely in het Ijsselmeer. Bureau Waardenburg rapport 96.34. Bureau Waardenburg, Culemborg (with English summary).

WINKELMAN, J.E. 1989. Vogels en het windpark nabij Urk (NOP): aanvaringsslachtoffers en verstoring van pleisterende eenden, ganzen en zwanen. RIN-rapport 98/1. Rijksinstituut voor Natuurbeheer. Arnhem (with English summary).

WINKELMAN, J.E. 1992a-d (in series). De invloed van de SEP-proefwindcentrale te Oosterbierum (Fr.) op vogels. 1: aanvaringsslachtoffers. 2: nachtelijke vliegbewegingen. 3: nachtelijke aanvaringskansen, 4: verstoring. RIN-rapport 92/2-5. Instituut voor Bos- en Natuuronderzoek (IBNDLO), Arnhem (with English summary).