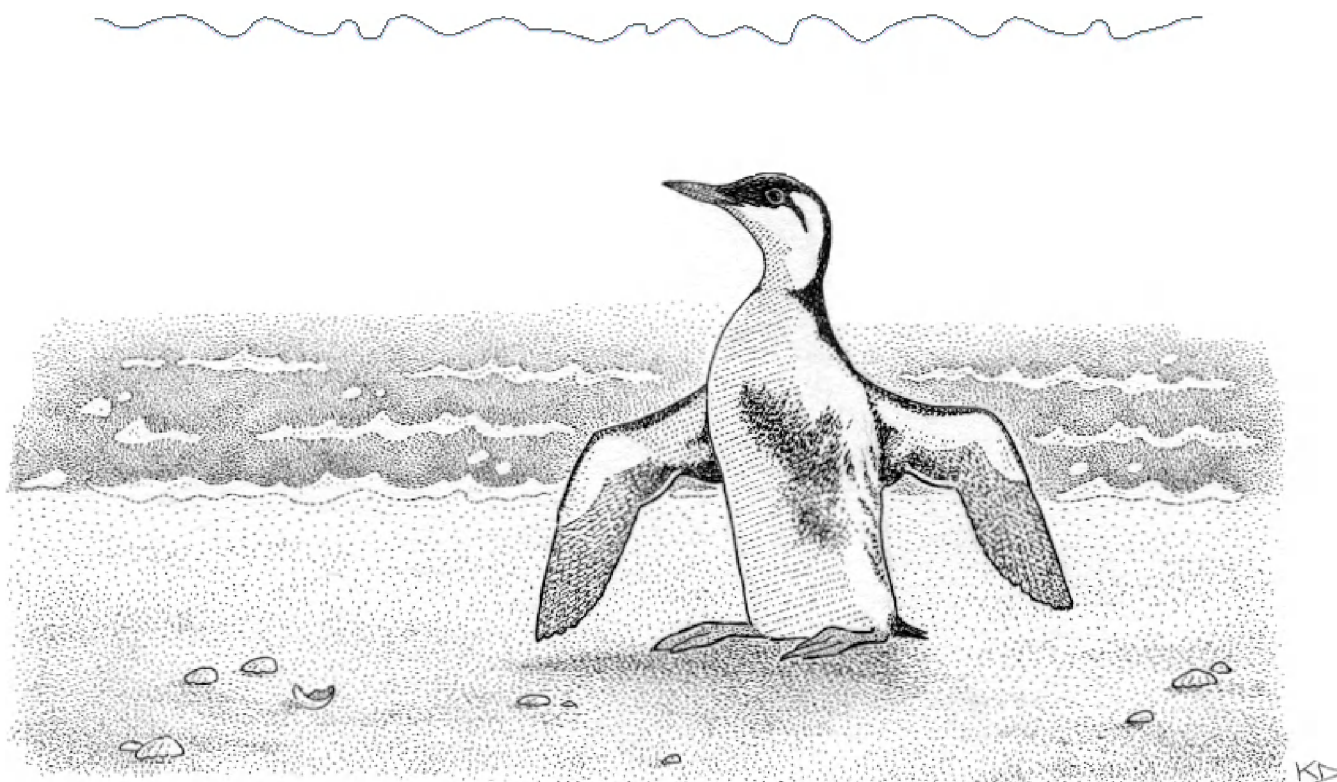


CHAPTER SIX

LONG-TERM CHANGES IN OIL POLLUTION OFF THE BELGIAN COAST: EVIDENCE FROM BEACHED BIRD MONITORING



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Long-term changes in oil pollution off the Belgian coast: evidence from beached bird monitoring

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ABSTRACT

Trends in oil pollution in the southernmost (Belgian) part of the North Sea were analysed using a dataset of 37 years (1962-99) of annual national beached bird surveys in February. The most abundant seabird groups were auks (31%), gulls (28%), scoters (17%) and Kittiwake (9%). Oil rates of most bird species/taxa indicate a decline in oil pollution, though only *Larus*-gulls, Common Guillemot and Razorbill show significant reductions. For the other taxa no significant decrease in proportion of oiled birds could be demonstrated, often due to the relatively small study-area and hence insufficient number of birds collected. The slope in the linear decreasing trend is steeper in inshore and midshore species, than in offshore species. A power analysis of the results demonstrated that statistical significant trends were expected with annual indices within 17 years for Razorbill, 29 years for *Larus*-gulls and 31 years for Common Guillemot. For other species/taxa, at least 50 years of surveying would be required. In terms of densities of beached birds four separate periods, coinciding with the decades, can be distinguished. In both the 1960s and 1980s large numbers washed ashore. Divers, Northern Gannet, Eider/scoters and gulls, dominated the 1960s whilst the latter period was characterised by high densities of Common Guillemot and Kittiwake. In the 1970s, the total densities of all species remained surprisingly low. Likewise, after a peak in 1990, numbers levelled off in the following years, except for some important wrecks of Common Guillemot and Fulmar. Over the entire study period densities declined for most species, but only significantly for divers, Northern Gannet, scoters, Coot, skuas and *Larus*-gulls. The Common Guillemot is the only species that increased significantly in density throughout the study period. We conclude that long-term oil pollution monitoring in Belgium should be continued but only in an international context and with a major focus on a set of abundant bird taxa, sensitive to oil-pollution and occurring in various marine habitats. Most appropriate for this purpose are grebes (inshore), *Larus*-gulls, Common Guillemot, Razorbill (midshore), Kittiwake and Fulmar (offshore).

INTRODUCTION

Seabirds are highly vulnerable to surface pollutants. The sporadic occurrence of large numbers of sea- and coastal bird corpses on North Sea beaches has been noted over a century ago (GRAY 1871, ANONYMOUS 1876). Nowadays estimates of illegal oil input in the North Sea range from 15,000 tonnes per year to as much as 60,000 tonnes (PEET 1993). The governments of North Sea countries endeavoured to seize the contamination of the marine environment by subscribing international agreements (OILPOL, MARPOL 73/78 and Bonn 1983), in which they agreed to take measures for prevention and surveillance. Despite the execution of the accompanying laws (MARPOL was extended with an act of enforcement in Belgium in 1995), important numbers of oiled birds continued to wash ashore on North Sea beaches during the 1980s and early 1990s (DUNNET 1987, CAMPHUYSEN 1989, CHRISTENSEN 1989, SKOV *et al.* 1989, VAUK *et al.* 1990, HEUBECK *et al.* 1992, RAEVEL 1992). Oil slicks are particularly common in the shipping corridor between the Straits of Dover and the German Bight (OSPAR COMMISSION 2000), including the Belgian marine waters. As from 1 August 1999, the North Sea has been established as a Special Area under MARPOL Annex I (oil), meaning that every discharge of oil is illegal.

Oil pollution at sea is basically monitored in two different ways: beached bird surveying and aerial surveillance of oil slicks. Both methods have some

drawbacks and should be considered complementary. However airborne surveillance catches only a small fraction of the shortly exposed oil slicks (SCHALLIER *et al.* 1996), is costly and seriously hampered in adverse weather conditions. Counting stranded birds and scoring the proportion of the corpses that are oiled is an indirect but effective method. Beached bird surveys provide relatively cost-effective and 'all-weather' additional information on the occurrence of oil and the frequency of illegal spills that could not be collected from the air. Hence beached bird surveying was acknowledged at the 4th International ministerial Conference on the Protection of the North Sea (8-9 June 1995) at Esbjerg (Denmark) as a useful oil-monitoring tool. In Belgium aerial surveillance started in 1991 (JACQUES *et al.* 1991). In this short period of monitoring no trends could be discerned so far (DI MARCANTONIO 1999). Beached bird surveying has a much longer tradition here and first standardized data go back as far as 1962. With Belgian data obtained at the annual International Beached Bird Surveys (IBBS) in February 1962-1999, we will investigate whether trends in densities and oil rates of sea- and coastal birds can be demonstrated and if any policy action undertaken under MARPOL or Bonn has resulted in less pollution so far. An analysis of oil rates in various taxa of seabirds can shed light on the impact of oil pollution in onshore versus offshore marine waters.

MATERIAL AND METHODS

STUDY AREA

The part of the sea under Belgian jurisdiction (further referred to as the Belgian marine waters) is heavily exploited by various users (MAES *et al.* 2000). Situated at the entrance of the Channel, this area is characterised by a very intensive and still increasing shipping traffic (OSPAR COMMISSION 2000) and by high densities of sea- and coastal birds, migrating to and from the Channel (SEYS *et al.* submitted).

The Belgian shoreline has a length of 65.4 km, of which 3.3 km is situated in between the moles of the outer harbour of Zeebrugge (constructed in 1974-86). Narrow, sandy beaches prevail, with broad beaches restricted to the west coast near De Panne (± 3 km) and at both sides of the Zeebrugge harbour piers (± 1 km). Breakwaters are a characteristic feature at the

Belgian shoreline (on average at every 200-400 m). More than half of the entire length of the coast (34 km) is bordered with buildings and boulevards (Fig. 1) and many beaches are frequently cleaned, particularly during summer. The tidal range amounts to 3-5 metres. Tidal currents are oriented parallel to the coast and attain maximal velocities of 1.7 knots at spring tide and 0.6 knots at neap tide. There is a small net residual NE-circulation through the Straits of Dover. With persistent strong winds however, the wind-induced currents may approach or even exceed the rate of tidal streams. Persistent W or SW gales can produce an overall movement of surface water as high as 35 miles over a period of 24 hours. The prevailing wind direction in Oostende (as compiled from meteorological data in the period 1941-1992) is S-SW (BELL 1994).

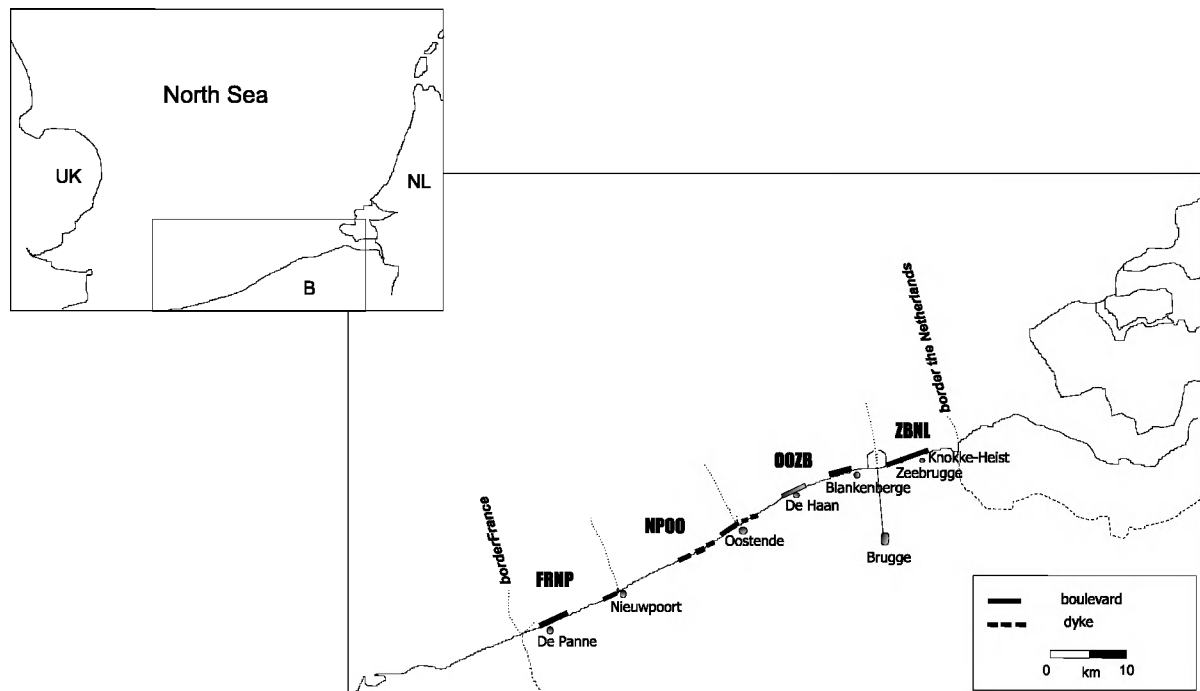


Fig. 1. Study-area showing the boundaries of the beach sections used in Belgian beached bird surveys.

HISTORY

In Belgium the first occasional counts of beached birds go back as far as the 1950s and early 1960s (KESTELOOT 1953, HAUTEKIET 1955, 1956, 1961, 1965, DE RIDDER 1961, HOUWEN 1968). Counts of the entire Belgian coastline were coordinated by Kuijken from 1962 onwards and extended to substantial parts of the Dutch and northern French coasts in 1965 (BLANKENA & KUIJKEN 1967). This was the earliest step towards the International Beached Bird Surveys (IBBS), at first supervised by Belgian and Dutch Youth Organisations

for Nature Studies (BJN and NJN). Pioneers as KUIJKEN & ZEGERS (1968), KUIJKEN (1978a,b) and VERBOVEN (1978, 1979) published early reviews of time series on Belgian data. A period of centrally governed counts was concluded with counts coordinated by MEIRE (1978a,b). The 1980s were characterised by many individual actions, instigated by several large seabird strandings (DE WAELE 1981, VAN GOMPEL 1981, 1984, 1987, VERBOVEN 1985, SHERIDAN & PAMART 1988). From the winter 1991-92 onwards, beached bird surveys were

centralised again, now by the Institute of Nature Conservation (SEYS & MEIRE 1992). Since then, annual updates are available (SEYS & MEIRE 1993, SEYS *et al.*

1993,1999, OFFRINGA & MEIRE 1995, OFFRINGA *et al.* 1995,1997.

DATA COLLECTION AND ANALYSIS

In many countries bordering the North Sea, the Channel, the Bay of Biscay and the Baltic, IBBS are organised annually in late February. Beached bird corpses are searched for at the high water mark and bodies are checked for species, age, condition and (for complete corpses) the presence of oil. The output of the surveys is a list of birds, containing information on the distance covered and the number of oiled and clean birds. All results have been centralized by the Royal Society for the Protection of Birds (Sandy, England; 1972 to 1985) and later by Ornis Consult (Copenhagen, Denmark; from 1992 onwards) to be included in an international database. For the study-period 1962-99, the Belgian IBBS database includes a surveyed overall distance of 1976 km. From 1962 till 1979, and again from 1990 onwards, the February counts covered a major part of the entire coastline. During the 1980s the effort decreased and ranged from 7.1 km to 50.5 km (Appendix VIIIa-d). Although the effort in 1981 was

small, the results are considered not unreasonable and retained. No results for 1980 were available. Throughout the entire study period the coastal villages and towns served as boundaries for different beach sections (Fig. 1). Despite the expected strong coherence among the relatively short and close sections, local differences in strandings exist (SEYS *et al.* 1993, OFFRINGA *et al.* 1995). The problem manifested in years with incomplete coverage when surveys were biased to specific beach stretches (1980s). A correction factor for every section was calculated by comparing the section density with the mean density of the entire Belgian coast ($d_{\text{coast}}/d_{\text{transect}}$). The factors are mean values of 20 years of IBBS in Belgium, in which all beach sections were covered (Table 1). They were applied to the density values in years with incomplete coverage, by taking the average of the factors of corresponding (combinations of) beach sections.

Table 1. Correction factors for Belgian beach sections, based on 20 complete IBB surveys during 1962-1999.

Beach section	Code	Correction factor
French border - Nieuwpoort	FRNP	0.69
Nieuwpoort – Oostende	NPOO	1.14
Oostende - Zeebrugge	OOZB	0.90
Zeebrugge – Dutch border	ZBNL	2.14

Grouping of species in taxa roughly follows STOWE (1982) and CAMPHUYSEN (1989). We focus on birds that occupy different habitats and are unequally vulnerable for oil pollution: divers (Red-throated Diver *Gavia stellata* and Black-throated Diver *G. arctica*), grebes (Great-crested Grebe *Podiceps cristatus*), Fulmar (*Fulmarus glacialis*), Northern Gannet (*Morus bassanus*), Eider (*Somateria mollissima*), scoters (Common Scoter *Melanitta nigra* and Velvet scoter *M. fusca*), Coot (*Fulica atra*), waders, skuas (Great Skua *Stercorarius skua*, Pomarine Skua *S. pomarinus*, Arctic Skua *S. parasiticus*), *Larus*-gulls, Kittiwake (*Rissa tridactyla*), Common Guillemot (*Uria aalge*) and Razorbill (*Alca torda*). Total numbers are of little value when comparing years with different effort, change in environmental conditions, etc. This is accounted for by using 'N km⁻¹' (density), and 'oil rate' (the proportion of complete bird corpses with oil: $N_{\text{oiled}}/N_{\text{all birds}} * 100\%$). The latter is widely accepted as a good condition indicator of oil pollution (SKOV 1991, CAMPHUYSEN 1993, 1995, 1998), and is presumably only influenced by post

mortal contamination or rejection by scavengers. Oil rates were calculated on less than 10 complete bird corpses (SKOV *et al.* 1996). Trends in oil rates were calculated after logit-transformation of the data by means of linear regression (by least-squares estimation), conform CAMPHUYSEN (1995). The power ($1-\beta$) or the probability that a trend, if present, will be detected as statistically significant, is studied by means of a power analysis (NETER *et al.* 1990). The power depends on the size of the trend (slope b), the error variance (rms), the sample size (number of years, N) and the size of the test (α). Clusters of closely related years or taxa are revealed with multidimensional scaling (KRUSKAL & WISH 1978), which was applied on bird densities by mapping distances in pairs of Bray-Curtis similarities between years. The hypothesis for a priori defined groups is tested with ANOSIM (CLARKE & WARWICK 1993). The overall association in densities and oil rates over the years is ascertained by Kendall's Coefficient of Concordance (SIEGEL 1959).

RESULTS

OVERALL TREND IN DENSITY AND OIL RATE OF BEACHED BIRDS

The total (non-corrected) numbers, effort and oil rates are summarized in *Appendices VIIId* and Table 2. A total of 6743 birds of 80 different species have been recorded at Belgian IBB surveys during 1962-99. The Shannon-Wiener diversity index decreased significantly over the years (Kendall $t = -0.285$, $N = 37$, $P < 0.05$), whilst the effort did not go down significantly ($t = -0.221$, $N = 37$, $P = 0.051$).

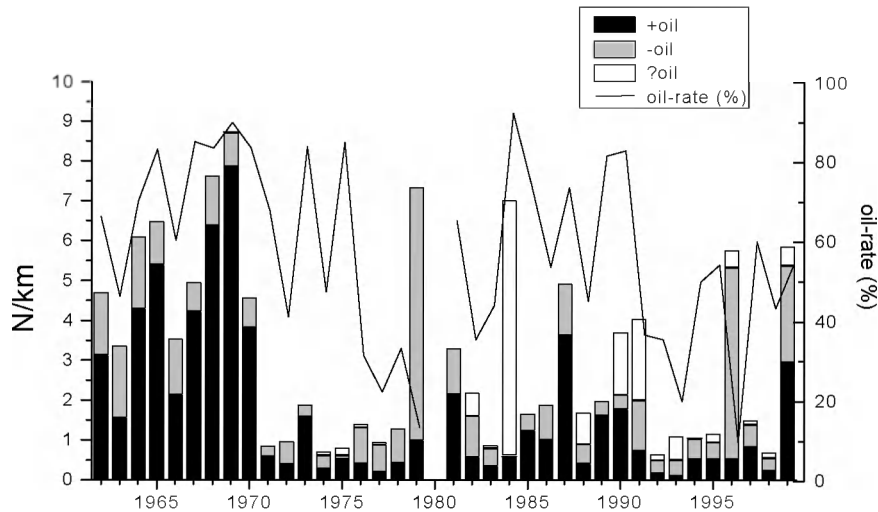


Fig. 2. Densities (bars) and oil rates (line) of all beached birds collected during IBB surveys in Belgium during 1962-99. Densities are subdivided into 'oiled', 'unoiiled' and 'not scored' specimens.

The total density of beached birds does not show a significant linear trend during the study-period ($R^2 = 0.041$, $rms = 11.7$, $b = -0.06$, $N = 37$, $P = 0.23$). However four discrete periods can be demonstrated, coinciding more or less with the four decades: group 1: 1962-69, group 2: 1970-79, group 3: 1981-89 and group 4: 1990-99 (Fig. 2). The 1960s were characterised by high densities (average 5.7, SD 1.9 birds km^{-1}) and high oil rates (average 73.2, SD

15.0%). In the 1970s the situation had changed impetuously (2.1, SD 2.2 birds km^{-1} and 51.0, SD 27.1%), but by the end of that decade numbers slowly increased again. The agony of the 1960s was repeated in the 1980s, but now the birds came in pulses (2.8, SD 2.0 birds km^{-1} and 62.8, SD 19.2%). The densities were slightly reduced again in the 1990s (2.6, SD 2.1 birds km^{-1}) and oil rates markedly declined (44.7, SD 20.8%).

Table 2. Total number of birds collected per taxon during IBBS in Belgium and mean oil rates (calculated as the cumulative $N+oil/N_{tot} * 100$ for the entire period 1962-99).

Taxon	N	oil rate (overall)
auks	1641	84
<i>Larus</i> -gulls	1465	53
scoters	887	88
Kittiwake	450	74
waders	454	4
grebes	330	67
Coot	348	26
Fulmar	268	48
others	527	6
divers	124	94
other waterbirds	139	32
Northern Gannet	71	91
Eider	23	76
other seaducks	9	-
skuas	5	-
Cormorant/Shag	2	-

A MDS of Bray-Curtis similarities between densities with 18 taxa in 37 years confirmed this global picture (stress=0.141). Ignoring some odd data from severe winters with lots of cold victims, we find four clusters that agree for the greater part with our postulation (Fig. 3). Taxa are clustered according to their sensitivity to severe winter weather (e.g. Coot, waders) and the likelihood to occur in 'wreck'-conditions (e.g. Kittiwake, Common Guillemot, Fulmar)(Fig. 4). Pair-wise comparison of groups in 5000 random labelling, showed in all but one case significant greater distances between groups than within groups (ONE-WAY ANOSIM, group 1 vs. 2: $R=0.537^{**}$, 1 vs. 3: $R=0.424^{**}$, 1 vs. 4: $R=0.557^{***}$, 2 vs. 3: $R=0.288^{**}$, 2 vs. 4: $R=0.426^{***}$

and 3 vs. 4: $R=0.002^{n.s.}$, with: $***P<0.001$, $**P<0.01$, $*P<0.05$, $n.s.$ non significant). In other words: based on density data the a priori defined groups are not unlikely. Only the difference between the 1990s and 1980s in terms of densities is not significant. These two periods however are clearly different in the proportion of oiled versus unoled birds. Best discriminating taxa between the assumed clusters were scoters, *Larus*-gulls, Kittiwake and Common Guillemot. They account for most of the dissimilarity between subsequent periods (Table 3). Scoters and *Larus*-gulls were most abundant as beached birds during the 1960s; Kittiwake and Common Guillemot were particularly common in the 1980s (and 1990s for the Common Guillemot).

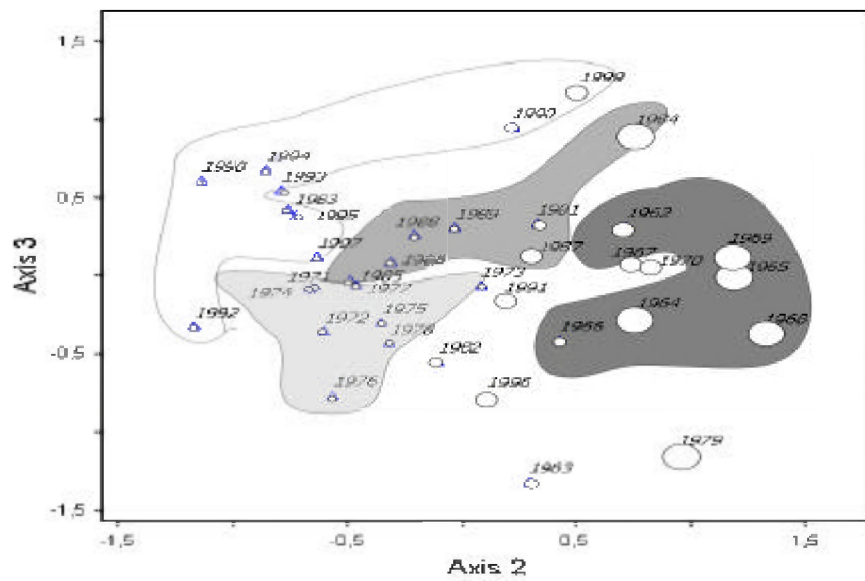


Fig. 3. MDS ordination of total densities of beached birds during 1962-99, indicating clusters of winters (fitted by eye). Circle sizes reflect total densities.

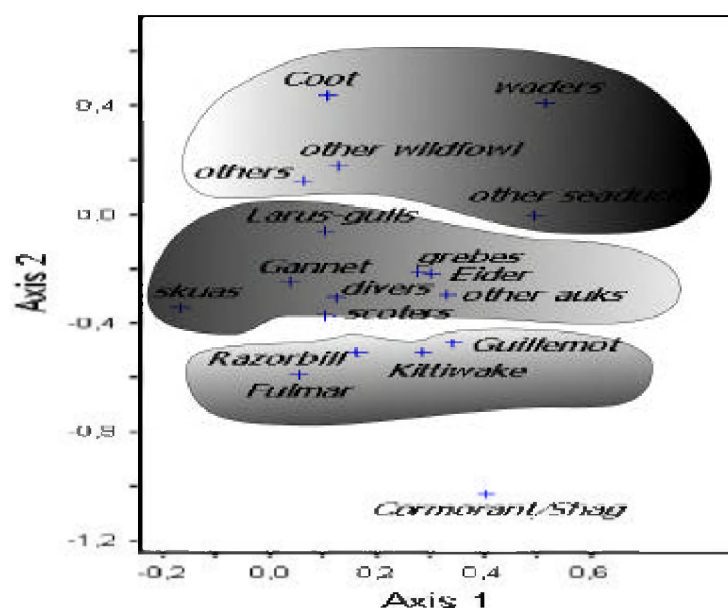


Fig. 4. MDS ordination of total densities of beached birds during 1962-99, indicating clusters of taxa (fitted by eye).

Table 3. Average abundance per group of most distinctive species in BBS. The ? denotes a contribution of > 10% to the total dissimilarity between subsequent periods. Average dissimilarities (Bray-Curtis) between 1 and 2: 65.93, between 2 and 3: 59.08, between 3 and 4: 55.42.

Taxon	1 (1962-69)	2 (1970-79)	3 (1981-89)	4 (1990-99)
divers	0.16	0.03	0.03	0.02
grebes	0.19	0.16	0.21	0.10
Fulmar	0.27	0.03	0.10	0.18
Northern Gannet	0.10	0.02	0.02	0.01
Eider	0.02	0.00	0.02	0.02
scoters	1.23 ?	0.22	0.21	0.07
Coot	0.29	0.20	0.03	0.01
waders	0.12	0.13	0.14 ?	0.46
skuas	0.01	0.00	0.00	0.00
Larus-gulls	1.52 ?	0.65 ?	0.44 ?	0.29
Kittiwake	0.42	0.11 ?	0.48 ?	0.14
Common Guillemot	0.56	0.10 ?	0.78 ?	1.00
Razorbill	0.48	0.20	0.28	0.16

ONSHORE VERSUS OFFSHORE BIRD TAXA

Larus-gulls, Northern Gannet, scoters and divers significantly decreased in densities at IBB surveys during 1962-99. The Common Guillemot is the only common species that became significantly more abundant during the study-period (Table 4, Fig. 5).

Taxa or species that do not show significant trends appear to be either offshore species (Fulmar, Kittiwake, skuas) or birds known to be sensitive to cold winter weather (Coot, grebes, waders).

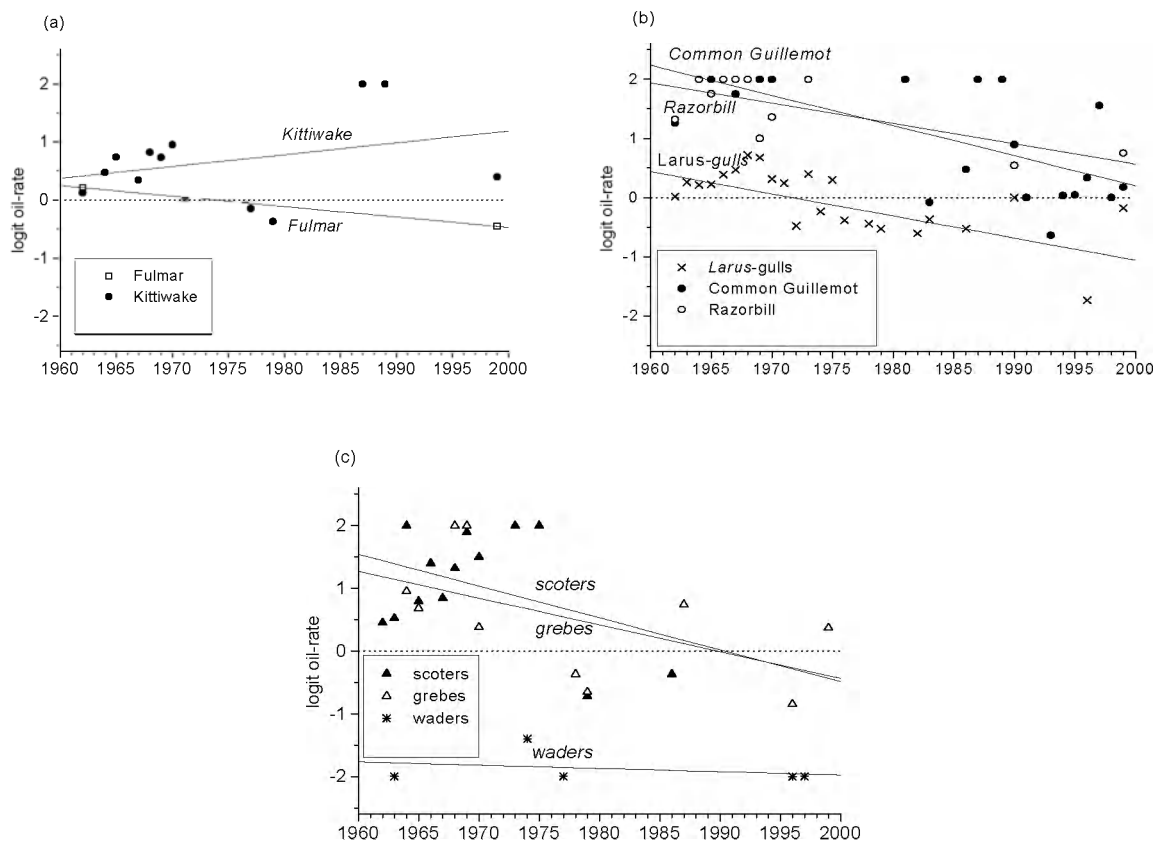


Fig. 5. Trends in oil rate of sea- and coastal bird groups in Belgium based on results of February IBB surveys during 1962-99. Trends for an offshore (a), midshore (b) and inshore group of species are shown.

Oil rates of two typically offshore species, the Fulmar and the Kittiwake did not change significantly during the 37 years of study, although lowest values were recorded for both species in the 1990s (Table 4). Two groups of birds that are very common at 10-30 km from the shoreline, the *Larus*-gulls and the Common Guillemot, show significant declines in oil rate. The oiling among gulls was heaviest in the 1960s (70%) and decreased to 12% in the 1990s. The average oil rate in the Common Guillemot was higher, both in the 1960s (99%) and in the 1990s (66%). The decline in oil rate in the Razorbill – a species occurring in the same wintering areas as the Common Guillemot – was less

pronounced but still significant (1960s: 96%, 1990s: 72%). Inshore and coastal species all show lower oil rates now than some forty years ago, though none of the trends were significant (Table 4). That this should be attributed to the sample size, being too small to reveal trends, can be demonstrated with a power analysis. For waders, grebes and scoters we need at least 50 years of surveying to get a 90% probability to find an existing trend (Fig. 6). Only for Razorbill (17 years), *Larus*-gulls (29 years) and Common Guillemot (31 years), the international BB surveys can already produce significant trends at a 90% probability.

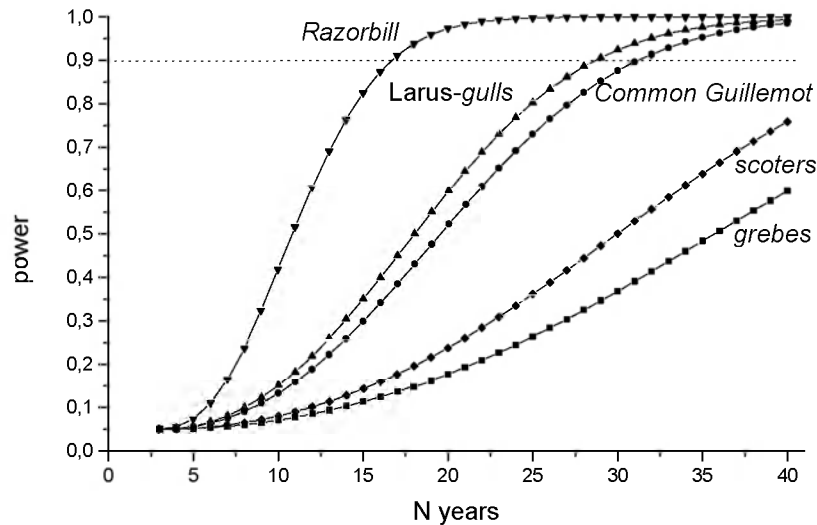


Fig. 6. Power of trend test of oil-rates in seabird taxa versus number of years sampled based on IBB surveys at the Belgian coast in February during 1962-1999.

The slopes of the linear regression in various species confirm the general pattern of oil rates for offshore birds decreasing less quickly than for inshore and midshore species. It can be concluded that densities of

most beached bird species are much smaller now than in the past, and that oil rates show consistent declines that are more prominent in coastal, inshore and midshore bird species than in offshore taxa.

Table 4. Trends in (a) densities ($N km^{-1}$) and (b) logit-transformed oil rates of sea- and coastal bird taxa at the Belgian coast during the winters of 1962-99. Shown are mean values of densities and non-transformed oil rates by decade and linear trends (rms = residual variance; b = slope of regression; R^2 ; N = number of winters; significance = n.s.: non significant, *: $P < 0.05$, **: $P < 0.01$, ***: $P < 0.001$).

(a) Taxon	Density ($N km^{-1}$) by decade				trend		R^2	N	P
	1960s	1970s	1980s	1990s	rms	slope b			
divers	0.19	0.05	0.05	0.03	0.008	-0.004	0.228	37	**
grebes	0.19	0.17	0.27	0.10	0.053	-0.003	0.020	37	n.s.
Fulmar	0.31	0.04	0.13	0.23	0.118	-0.001	0.002	37	n.s.
Northern Gannet	0.11	0.03	0.05	0.02	0.002	-0.002	0.276	37	***
scoters	1.23	0.22	0.21	0.08	0.411	-0.029	0.212	37	**
Coot	0.33	0.33	0.08	0.02	0.249	-0.009	0.040	37	n.s.
waders	0.12	0.17	0.21	0.57	0.312	0.011	0.045	37	n.s.
skuas	0.02	0.02	0.03	0.00	0.000	-0.000	0.075	37	n.s.
<i>Larus</i> -gulls	1.52	0.65	0.44	0.29	0.444	-0.035	0.268	37	**
Kittiwake	0.42	0.11	0.54	0.16	0.189	-0.004	0.009	37	n.s.
Common Guillemot	0.56	0.10	0.78	1.00	0.456	0.021	0.110	37	*
Razorbill	0.48	0.20	0.32	0.18	0.136	-0.009	0.074	37	n.s.

(b) Taxon	Oil rate (%) by decade				trend		R^2	N	P
	1960s	1970s	1980s	1990s	rms	slope b			
divers	99	93	50	-	-	-	-	2	-
grebes	88	55	76	42	0.755	-0.043	0.305	10	n.s.
Fulmar	53	75	40	45	-	-	-	2	-
Northern Gannet	99	75	-	-	-	-	-	2	-
scoters	89	71	83	55	0.746	-0.051	0.153	13	n.s.
Coot	47	3	-	-	0.079	-0.100	0.902	4	n.s.
waders	18	10	0	1	0.088	-0.005	0.082	5	n.s.
<i>Larus</i> -gulls	69	41	22	20	0.315	-0.037	0.318	24	**
Kittiwake	76	59	93	62	0.527	0.020	0.105	12	n.s.
Common Guillemot	99	84	82	61	0.474	-0.051	0.492	23	***
Razorbill	98	88	92	64	0.163	-0.034	0.521	11	*

DISCUSSION

QUALITY OF THE DATA

In IBB surveys during the 1980s the Belgian beaches were not completely covered. Hence, geographical differences may influence the outcome of the survey. RAEVEL (1992) demonstrated that a minimum of 25-30% of the (Nord-Pas-de-Calais to Picardie) coastline must be surveyed to get reliable densities and oil rates for the whole coast. Accordingly SEYS *et al.* (accepted) found oil rates of Common Guillemot to stabilize above a sample of 10-15 bird corpses, a figure corresponding to a mean surveyed distance of 25-30 km (or 40-50% of the entire Belgian coast). More than half of the coast, some 65%, (RAEVEL 1992, SEYS *et al.* accepted) must be covered to approach the actual species richness. These figures underscore the necessity to put substantial effort in the beach surveys. This is normally met in Belgian BBS, but put the results of years with low effort (1981, 1984, 1985, 1987) in question.

OIL POLLUTION TRENDS IN THE NORTH SEA

In many countries bordering the North Sea, long-term trends in oil pollution have been described, as derived from the proportion in beached birds with oil (STOWE 1982, AVERBECK *et al.* 1992, HEUBECK 1995, SKOV *et al.* 1996, FLEET & REINEKING 2000, CAMPHUYSEN & HEUBECK 2001). Measurable declines have been observed in several species along the north-east English and Scottish coasts, in south-east England, in parts of Denmark (see SKOV *et al.* 1996), in The Netherlands (CAMPHUYSEN 1998, CAMPHUYSEN & HEUBECK 2001) and in Germany (AVERBECK *et al.* 1992, FLEET & REINEKING 2000). The Belgian coast borders the southernmost part of the North Sea, an area heavily affected by chronic oil pollution (NORTH SEA TASK FORCE 1993, OSPAR 2000). Our data show downward trends in oil rate for most species, trends that are highly significant for the two most abundant taxa (Common Guillemot, *Larus*-gulls) only. STOWE (1982) and SKOV *et al.* (1996) showed that in the countries around the Southern Bight, the proportions of oiled Common Guillemots – an important target species – were higher than in other

West European countries. That the proportion of oiled Common Guillemots in the late 1980s and early 1990s in Belgium is relatively low (approximately 50%) compared to surrounding countries (more than 75%, CAMPHUYSEN 1995) can partly be attributed to a different approach: CAMPHUYSEN (1995) considered data collected on Dutch beaches during ten winters (1985/86-1994/95) and used extensive material of six monthly surveys for each winter. For Belgian beaches however, only data from IBB February surveys (1986-1995) (SKOV *et al.* 1989, SKOV 1991) and additional information from January 1992 up to March 1995 were used (SEYS & MEIRE 1992, 1993, OFFRINGA & MEIRE 1995, OFFRINGA *et al.* 1995). Several important Common Guillemot wrecks in the early 1990s (with small proportions of bird corpses oiled) caused oil rates to be lowered quite drastically. When all existing Common Guillemot data from Belgian beaches (i.e. including monthly and weekly winter surveys) would be used, a mean oil rate of 65% for the period 1986-1995 is found, a value intermediate between the 50% mentioned above and the 75% recorded on Dutch beaches.

In our data offshore species such as Fulmar and Kittiwake do not show significant changes in oiling. These species occur around the offshore shipping lanes, where most oil slicks were recorded over the past eight years (DI MARCANTONIO 1999, SCHALLIER *et al.* 1996). Both species are not considered particularly vulnerable here for oil since they winter in small numbers (approximately 250 Fulmars and 3800 Kittiwakes, OFFRINGA *et al.* 1996) in Belgian offshore waters and spend much time on the wing. Nevertheless it is surprising that no downward trend can be discerned as found in The Netherlands, Germany, England and Scotland in the period 1984-1995 (CAMPHUYSEN 1995, SKOV *et al.* 1996). The smaller slope in the downward trend (Fig. 5) – as found in The Netherlands as well (CAMPHUYSEN 1998) – probably explains why the trend is not (yet) significant for the Fulmar. The same applies to waders. They were often found oiled during the 1960s (indicating the beaching of oil slicks or post-mortal contamination) but now clearly have a smaller chance to get oil-fouled. That we don't find significant downward trends in oil rate yet, must be ascribed to

the relatively slow decrease and hence the need for a high number of sampling years (58 years to have a power of 90%). The very low numbers of most sea- and coastal birds beaching these days in combination with the exceedingly high number of surveying years needed to find a trend, necessitates the focus on the most common taxa (auks, *Larus*-gulls) and the collection of additional data during the rest of the winter.

TARGET SPECIES FOR OIL MONITORING

Future research should focus on several species and/or groups of species simultaneously to avoid problems caused by certain mortality incidents in individual species and to sample different subregions (inshore vs. offshore). For The Netherlands, CAMPHUYSEN (1995) selected Common Guillemot, Razorbill, Kittiwake, Fulmar, Northern Gannet, scoters and *Larus*-gulls as target species for beached bird surveying. A power analysis on Dutch data reveals that trends should be demonstrable – even for species showing linear trends with high residual variance and small slope – within 13-17 years. The trends we find by using only IBB surveys have a much lower power, meaning that at least some 30 years are needed before an existing trend will be detected with a chance of 90%. Considering the small length of the Belgian coastline and hence the comparatively small total number of beached birds that can be collected on each February IBB survey, oil impact monitoring should: (1) focus on abundant species/taxa that occur throughout the winter, are sensitive to oil-pollution and preferably include species typical for each of the different marine habitats (inshore, midshore, offshore); (2) always be

organised synchronic with counts in neighbouring countries; (3) be complemented with monthly surveys at least during winter.

In designing future beached bird surveys, one of the main considerations in relation to analysing trends in the proportion of oiled corpses, should be the limited number of beached birds (Skov *et al.* 1996). Due to decreasing densities of beaching corpses, it might become more and more difficult to collect large enough samples (and keep the numerous volunteers motivated). Assuming that a sample of at least ten complete corpses is required to calculate reliable oil rates, only the Common Guillemot (as species) and auks (as taxon) can provide the necessary data in Belgium these days. The beach environment and adjacent surf zone can probably be monitored much better during winter by scoring oil rates on living birds, such as Sanderlings *Calidris alba* (a small coastal wader, pale in colour and intensively foraging near the water mark). For the inshore zone, the most suitable potential target species is the Great-crested Grebe *Podiceps cristatus* (common in February in inshore waters), for the midshore area the Common Guillemot, Razorbill and several *Larus*-gull species can fulfil the role of oil indicators. For the offshore zone probably only Kittiwake and Fulmar can do. Although the IBB surveys may have some drawbacks compared to repeated monthly or weekly beached bird surveys (SEYS *et al.* accepted) they provide invaluable information, can build on large historical datasets collected in a standardized way over a vast area and hence should be continued and strengthened in the future.

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