Pergamon

0025-326X(93)E0008-I

Marine Pollution Bulletin, Vol. 28, No. 5, pp. 305–310, 1994

0025-326X/94 $7.00+0.00

12383

Oiled Seabirds—Comparative Investigations on Oiled Seabirds and Oiled Beaches in the Netherlands, Denmark and Germany (1990–93)

G. DAHLMANN*, D. TIMM*, Chr. AVERBECK†, C. CAMPHUYSEN‡, H. SKOV§ and J. DURINCK§
**Bundesamt für Seeschiffahrt und Hydrographie, Bernhard-Nocht-Str. 78, D-20305 Hamburg, Germany*
†Norddeutsche Naturschutzakademie, Hof Möhr, D-29640 Schneverdingen, Germany
‡Netherlands Institute for Sea Research, P.O. Box 59, NL-1790 AB Den Burg, Texel, The Netherlands
§ORNIS-Consult, Vesterbrogade 140, DK-1620 Kopenhagen, Denmark

In a 3-year inventory of oil pollution on the coasts of the Netherlands, Denmark, and Germany, oily residues from ships' engine rooms were identified as the main, common source of oil found in birds' feathers and on beaches. Illegal discharges of oil-sludge from 'normal' shipping operations lead to a widespread distribution of oil on the coasts. On this kind of pollution are superimposed single, more severe cases of pollution in the Netherlands and Germany which originate from the transport of oil and chemical products by tankers. One major new finding of the Oiled Seabirds project, however, is that the northwestern coast of Denmark is also *continuously* affected by crude oil pollution. Illegal discharges from crude oil tankers at the outlet of the Skagerrak are the source of this kind of pollution. The great number of cases of severe crude oil pollution in this area might mean that illegal discharges from crude oil tankers leaving the Baltic Sea are common practice. The high level of oil pollution documented on the Danish west coast and in the Netherlands indicates that the current surveillance by aircraft is inadequate, and that improvement of counter-measures is needed. The detection of products other than mineral oil, such as dodecylphenol, bis-phenol, vegetable oil or different kinds of paraffin wax, in the feathers of birds or on beaches is a second striking feature.

The Oiled Seabirds project consisted of two parts:
1. Regular surveillance of the beaches in the Netherlands (Netherlands Institute for Sea Research), Denmark (ORNIS-Consult), and the Federal Republic of Germany (Norddeutsche Naturschutzakademie), and sample taking.
2. Analyses of the samples in the laboratory of the Bundesamt für Seeschiffahrt und Hydrographie (initiation and coordination of the project).

Sampling strategies in the three countries varied because of differences in their coastlines which are not affected by oil pollution in the same way. Whereas in Germany samples were taken twice a month at specific sampling sites which were evenly distributed throughout the whole German Bight, samples in Denmark were taken over the whole Danish coast twice a year in February and March and, in addition, at four sites every month. Because of the great number of oiled birds found annually in the Netherlands—and a limited analytical capacity—three samples had to be selected from the 20 sampling sites which were surveyed each month from November to March. In addition, samples were taken in each country immediately after more severe incidents. Although the term 'oiled' was used in the project title, the investigations were not restricted to mineral oil: an attempt was made to identify all the chemical products found on beaches which could have caused the deaths of seabirds.

The total numbers of samples, which mainly consisted of contaminated feathers (70%) but also of small amounts of beached material (30%), are given in Table 1. Hundreds of observers (mainly volunteers) were involved in sample taking. This report, therefore, represents a comprehensive inventory of pollution by oil and chemical products on our coasts—pollution which occurs even though a larger accident with a ship has not happened.

Chemical Analysis

All samples were analysed by UV-fluorescence spectroscopy and capillary gas chromatography. In

TABLE 1
Number of samples taken.

	1990	1991	1992	Total
The Netherlands	195	101	76	372
Germany	155	112	116	383
Denmark	156	340	183	679
Total	506	553	375	1434

addition, gas chromatography/mass spectrometry coupling was used for complete identification (see Table 2 for instrumental conditions). More detailed descriptions of analytical methods used and former results are given by Dahlmann (1984, 1985, 1987) and Theobald & Dahlmann (1989).

TABLE 2

Chemical analysis.

Sample preparation	Dissolution of the oil samples in *n*-hexane. Slight addition of dichloromethane (to dissolve the more polar components)
Oil concentrations	3–4 $\mu g\ \mu l^{-1}$
UV-fluorescence	Synchronous spectra 25 nm wavelength difference
Gas chromatographic conditions	
Instrument	Hewlett-Packard 5890
Column	Capillary, fused silica, 5% phenyl-silicone
Internal diameter	0.25 mm
Column length	8 m
Initial temperature	50°C (1 min)
First rate	20°C min^{-1} up to 90°C
Second rate	15°C
Final temperature	300°C
Carrier gas	H_2 5 ml min^{-1}
GC/MS conditions	
Instrument	1. Hewlett-Packard 5985 2. VG-Tribrid
Column	Capillary, fused silica, 5% phenyl-silicone
Column length	25 m
Initial temperature	50°C (1 min)
First rate	10°C min^{-1} up to 150°C
Second rate	5°C min^{-1}
Final temperature	300°C
Carrier gas	He 2 ml min^{-1}

Results (statistics)

The statistical results are given in Table 3 and Fig. 1. They suggest at first sight that 'normal' shipping operations are the main source of the chronic oil pollution in the three countries involved. Engine room residues, i.e. bunker- and lubricating oil, were mainly found. There is a relatively high proportion of crude oil residues, however. In addition, paraffin wax and palmoil (in general MARPOL Annex II products (category C, D) and Annex III products) and even toxic chemicals (MARPOL Annex II, category A products), such as dodecylphenol and bis-phenol were found in the feathers of birds and on beaches. Only the biogenic lipophilic esters of the birds themselves were found in 5% of the samples ('No pollution' in Table 3 and Fig. 1).

These statistics must be interpreted, however, with great care even when the results from the three different countries are compared (Fig. 2): differences are in part the result of the dissimilar sampling strategies used. Single, more severe cases of pollution have also significantly influenced these proportions.

Such a case occurred in November 1990 in the Netherlands. All of the Dutch crude oil samples from 1990 (33.5% of the total number of samples collected on the Dutch coast in 1990) were identified as Venezuelan ('Bachaquero') crude and belonged to a single case of oil pollution which affected nearly the whole Dutch coast from the Rhine up to the island of Schiermonnikoog. This has been proved by a detailed analysis of the samples by means of GC/MS. Since 'always the same black stuff' (citation) is found on the coasts, samples from special cases, in which the 'normal' rank of pollution was exceeded, had to be separated from the bulk of the samples in the laboratory. In those cases, chemical analysis is especially required because it may be possible to trace the pollution to its actual source. Figure 2, which shows the results for the countries and the years separately, gives a first indication of special cases: whereas, for example, in the Netherlands crude oil pollution was mainly detected in 1990 ('Bachaquero' crude), this kind of pollution contributes considerably to the total pollution in Denmark in all 3 years. A summary of the special cases is given in Tables 4–7.

Results (in detail)

In the Netherlands, seabird strandings during the project were not unusual compared to earlier years (Camphuysen & Franeker, 1992; Camphuysen, 1989). Seabird wrecks (i.e. mass strandings of seabirds) occurred as well as several minor incidents.

The *chronic* oil pollution is mainly caused by normal shipping operations: oil residues from ships' engine rooms are discharged illegally into the sea.

Pollution by crude oil must be regarded as an exception in the Netherlands despite the fact that Rotterdam has one of the biggest crude oil terminals in the world. The reason for this could be merely technical: tank-washing by crude oil tankers, which is the major source of crude oil pollution in Denmark, has either already been done or has not yet been completed by the time tankers reach or leave Dutch waters because the area is relatively small.

TABLE 3

Results (see text).

	Fuel oil	Crude oil	Paraffin/ palm oil	Chemicals	No pollution	Total
The Netherlands	273	69	6	14	9	371
Germany	321	13	1	21	26	382
Denmark	427	182	15	21	36	681
Total	1021	264	22	56	71	1434

Chemicals including: Dodecylphenol+lubricating oil; crude oil residue+detergent; alcohols (C12+); thiophenes; alkylated bis-phenol; phthalates (plasticizer); halogenated hydrocarbons (insecticide); alkylated aromatics.

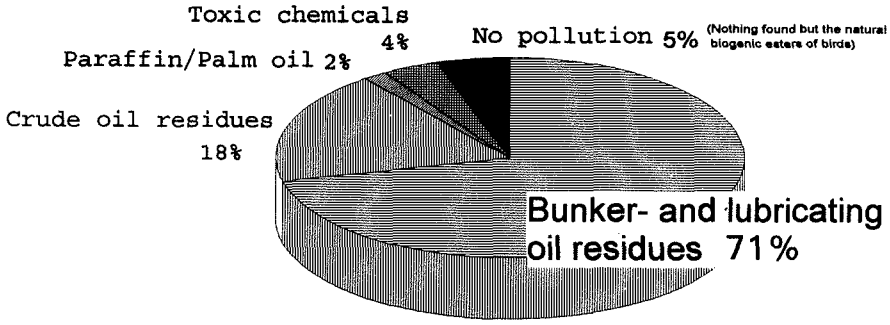

Fig. 1 Analytical results.

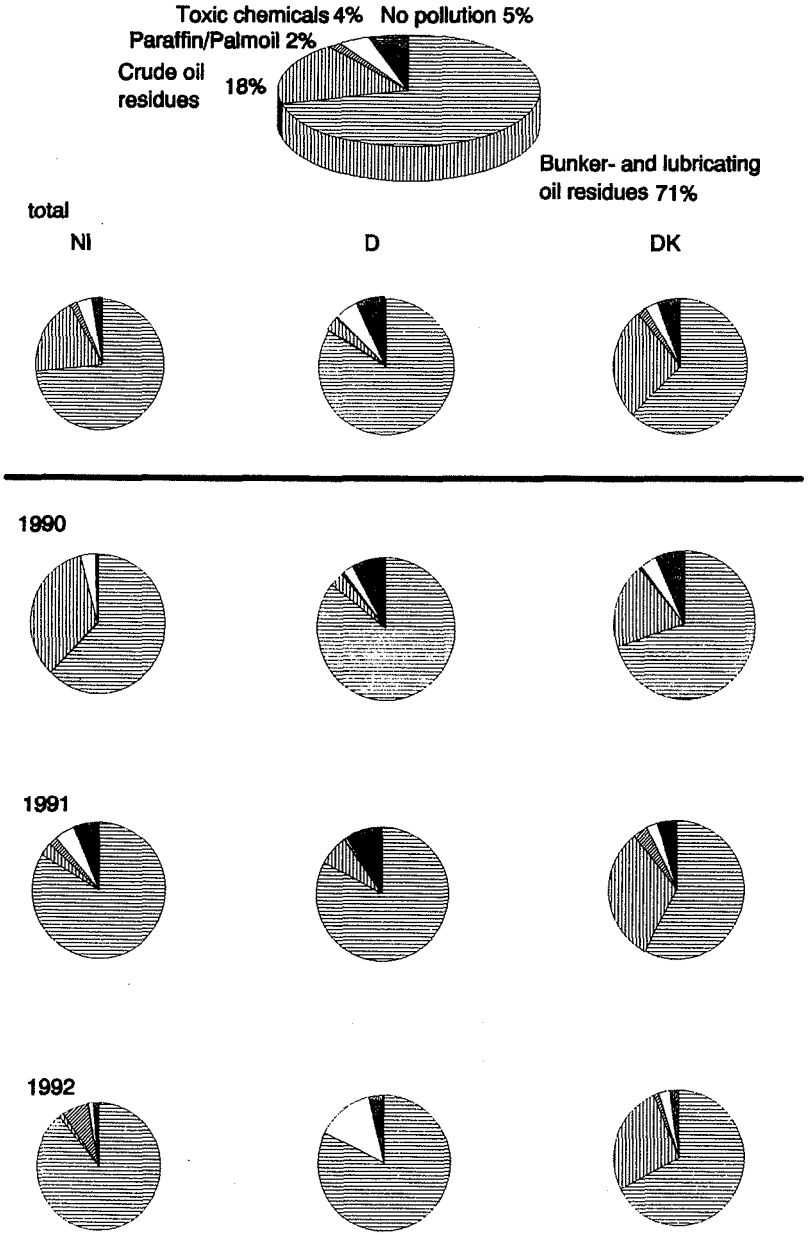

Fig. 2 Results separated.

In general, oiled seabirds are only found on Dutch beaches when winds from the west or north prevail. The general drift of oil spills and floating dead oiled seabirds along the Dutch coast to the north and north-east is determined by the residual current. It is therefore probable that only a small number of birds affected off the Dutch coast actually reach it.

A more serious incident which caused the deaths of many Dutch seabirds in February/March 1990 involved relatively high amounts of dodecylphenol (isomeric dodecylphenols) in lubricating oil. Immediate investigations showed the dodecylphenate, detectable as dodecylphenol during gas chromatographic analysis and converted into dodecylphenol in environmental

TABLE 4

More severe cases of pollution by crude oil residues.

Date	Area		Type	Remarks
November 1990	NL	Whole coast	Bachaquero crude	Heavily polluted beaches
March/April 1990	DK	NW-coast	Brega (crude) (Lib.)	Big pollution
February 1991	DK	NW-coast	Nigerian crude	'Several tons' on the beaches
June 1991	D	Juist, Sylt	North Sea crudes (2 types)	Big pollution (in coincidence with bis-phenols)
July 1991	DK	NW-coast	Ninian (?) crude (NS)	'Several hundred kilos'
August 1991	D	Amrum, Pellworm	Ekofisk crude (NS)	Big pollution
September 1991	DK	NW-coast	South American	Big pollution
October 1991[§]	DK	NW-coast	Beatrice(?) crude	'16 tons'
November 1991	DK	NW-coast	North Sea crude	'Hundreds of kilos'
March 1992	D	Amrum, Hörnum, St. Peter	Tia Juana light (Venezuela)	Heavily polluted beaches
March 1992	DK	N-coast	Tia Juana light (Venezuela)	Big pollution
April 1992	DK	NW-coast	Ekofisk crude (NS)	Big pollution

TABLE 5

More severe cases of pollution by bunker oil residues.

Date	Area		Type	Remarks
February 1991	D	Helgoland	Bunker oil residues	Many birds oiled and killed
April 1991	DK	NW-coast	Bunker oil residues (different types)	'500 kg'
June 1991	DK	NW-coast	Bunker oil	'Some hundred kilos'
July 1991	NL		Bunker oil residues	Big pollution
December 1991	NL		Bunker oil residues	Big pollution
February 1992	NL	Texel	Bunker oil	Lot of oiled/killed birds and heavily polluted beaches
1991/92	D	Juist, Sylt	Different bunker oils	24 different bigger cases of oil pollution on German beaches

TABLE 6

Special cases of pollution by non-toxic chemicals (legal discharges).

Date	Area		Type	Remarks
1990–92	D/NL/DK		Paraffin wax	11 different cases of pollution on different sampling sites
August 1991	D	Pellworm, Langeoog, Juist, Amrum	Paraffin wax (Petrolatum)	Big pollution
September 1991	D	Friedrichskoog	Paraffin wax	Big pollution
December 1991	D	Sylt	Paraffin wax	Big pollution
November 1992	D	St. Peter	Paraffin wax	About 8 t from a tank-washing
December 1992	D	Amrum	Paraffin wax	Big pollution
February/March 1993	NL	Northern part	Paraffin wax	'About 2000 birds killed', big beach pollution
February 1991	DK	Bornholm	Palm oil	Oiled birds
November 1991	NL		Palm oil	Big lumps, diameter up to 70 cm
April 1992	NL	Texel	Palm oil	Big pollution caused by a shipwreck
November 1992	NL		Palm oil	Bigger pollution
July 1991	D	Sylt	Palm oil	Bigger pollution
November 1991	D	Föhr	Palm oil	Pollution (8 kg)
May 1991	D	Helgoland	Palm oil	Big pollution
November 1992	D	Sylt	Palm oil	Pollution
November 1992	DK	W-coast	C12-fatty-acid	Pollution

TABLE 7

Special cases of pollution by—more or less—toxic chemicals.

Date	Area		Type	Remarks
February 1990	NL		Dodecylphenols + lubricating oil	Polluted birds
March 1990	DK	Bornholm	Dodecylphenols + lubricating oil	Polluted birds
November 1990	NL		Dodecylphenols + lubricating oil	Polluted birds
	DK	Juist		
January 1991	D	Helgoland	Dodecylphenols + 1	Polluted birds
February/March 1991	NL		Thiophenes(?)	Polluted birds
March 1991	DK	Baltic	Phenols (insecticides)	Pollution
	VII			
April 1991	DK	NW-coast	Alk. bis-phenols	'300 kg', beaches heavily polluted
June 1991	D	Juist, Sylt	Alk. bis-phenols	Several tons on the beaches
January/February 1992	D	Helgoland, Sylt	Alkylated aromatics	Many polluted birds
	NL		(special fuel oil?)	
	N	Roga		
April 1992	DK	Bornholm	Plasticizer (phthalates)	Pollution
July 1991	DK	NW-coast	Detergent (di-t-butyl-phosphin?)	Pollution

samples, is used as a lubricating oil additive. Comparisons between a typical ships' oil containing this additive, an additive concentrate, and the Dutch samples showed the amount of dodecylphenol in the samples from the birds to be as high as in the concentrate. It is, therefore, strongly suspected that criminal dumping of industrial waste was the source of the pollution.

The same products were found to have caused the deaths of about 50 seabirds in November 1990 on the German islands of Juist and Norderney—an incident which was investigated in cooperation with the water police. Moreover, dodecylphenol was even found in the feathers of birds which were washed ashore on the beaches of Bornholm. Therefore, taking into account further cases of pollution by phenolic compounds used as lubricating oil additives (see later), one may conclude that mainly industrial waste which originates from the oil additive industry is illegally dumped into the sea. These cases only came to our attention because winds forced the floating products or floating dead birds ashore. In addition, chemicals which are dissolved in the water column or sink to the bottom of the sea are hardly detected. It is, therefore, strongly suspected that illegal dumping of chemical waste is conducted much more often than it is detected.

In contrast to the Dutch samples the proportion of crude oil residues in Denmark is the result of more than one case of pollution: 12 different incidents of crude oil pollution were found in 1990, 36 in 1991 and 25 in 1992. All of these incidents happened on the western (North Sea) coast of Denmark between Esbjerg and Skagen. The majority of the samples was also taken in this area because of limited amounts of beached materials on the coasts of the inner (Baltic) Danish waters. The proportion of oiled seabirds found dead on the Danish North Sea coast has remained at a high level compared to investigations in the period 1984 to 1989 (Skov & Durinck, 1989), while a much lower proportion was found oiled on the coasts of the Baltic Sea. In addition, more than 100 km of the Danish North Sea coast were covered by crude oil residues which originated from one single source.

A significant decrease in the oiling rate of seabirds has occurred over the last few years on the German North Sea coast (Averbeck *et al.*, 1992). This could be attributed to counter-measures such as free reception facilities for oil residues in German harbours and increased surveillance of the German Bight by ships and aircraft.

As in the Netherlands, mainly oil residues from machinery spaces from ships were found. But the proportion of crude oil pollution in Germany does not adequately reflect the two massive pollution incidents in June 1991 on the East- and North Frisian islands, where about 70 t of crude oil had to be removed from the beaches. At the time of the crude oil incidence extensive parts of the German North Sea coast were polluted, heavily in places, by a mixture of (weakly) toxic alkylated phenols (Theobald & Dahlmann, 1992). Its main component (>90%) was identified as 4,4'-methylene-bis(2,6-di-tert.butylphenol). This compound is used as oxidation inhibitor in lubricating oil. The remainder consisted mainly of tert.butylphenols: (2,6-di-tert-butylphenol; 4-methyl-2,6-di-tert.butylphenol; 2,4,6-tri-tert.butylphenol). Small pebble-size pieces of the product were found as well as football-size lumps. The islands of Borkum, Juist, and Wangerooge were especially affected, where about a ton of the product had to be removed from the beaches by authorized personnel. The appearance of this kind of pollution at the beginning of the holiday season was a serious problem: children playing on the beaches were particularly at risk. Adults were also at risk as the lumps were mistaken for amber.

This special incident showed impressively the value of *international* surveillance of our coasts: the same kind of pollution was found earlier in the year on Danish beaches: in April wide stretches of the coast around Hanstholm were affected. Smaller quantities were found on 16 May in Ringköbing Fjord and on 5 June around Agger Tange. It could, therefore, immediately be concluded that industrial waste was illegally discharged into the sea (obviously this has happened more than once). The very similar composition of the product at different times and widely separated places could indicate a distinct manufacturer (Theobald & Dahlmann, 1992).

The appearance of these major cases of oil pollution in June 1991 in the German Bight must be attributed to the extraordinary weather situation in May/June: strong northern gales prevailed over a time period of more than 4 weeks. All the material floating between the outlet of the Skagerrak and the German Bight must have been washed onto German beaches during this time.

The German North Sea coast (especially the west coast of Schleswig-Holstein) and the coasts of the Netherlands are continuously affected by paraffin wax and vegetable oil pollution (Table 6): in some cases several tons of paraffin wax had to be removed from the beaches, and thousands of birds were killed by one major case of pollution by palmoil. Birds are affected by these products in the same way as by mineral oil:

- the products destroy the heat insulating properties of the birds' feathers (hypothermia),
- the contaminated birds cannot actively seek food (starvation),
- the birds are poisoned.

The effects of these products are, therefore, contradictory to their MARPOL-classification as 'presenting a minor or recognizable hazard to marine resources or cause minor or minimal harm to amenities' when discharged into the sea.

Conclusions

Oily water residues discharged in accordance with MARPOL-Regulations, Annex I, can neither lead to pollution on beaches nor to visible, black oil in the feathers of seabirds. Nevertheless, no substantial reduction in the number of casualties was observed since MARPOL came into force in 1983 in many parts

of the North Sea and Channel area (Camphuysen & Franeker, 1992—comprehensive overview).

The Dutch coast is especially affected because of the density of shipping traffic: main shipping routes converge in this area. Nevertheless, there should be no reason for ships entering either side of the Channel to offend against international regulations by dumping oil even in the Dutch area—as they could do so in the much more open waters of the North Atlantic. Oil is easily detected in the Dutch area where, for several years now, surveillance by anti-pollution aircraft has been a regular occurrence. Offenders against the MARPOL Regulations clearly have no objections to polluted beaches; even the possibility of detection and prosecution is not a sufficient deterrent. This would seem to indicate that regular aerial surveillance is ineffective as ships' crews are not prevented from indulging in a criminal practice. This is verified by the annual reports about the number of oil spills observed in the Dutch area: no decrease has been apparent over the last decade (Anon., 1990, 1991—annual Dutch reports about detected oil slicks). A more stringent prosecution of the offenders against the MARPOL Regulations by the Dutch authorities is, therefore, urgently required.

There are two possible sources of crude oil pollution on Danish beaches: oil platforms in the North Sea and tank-washings by crude oil tankers. Only the latter source can be valid for the crude oils which have been identified as originating from the Libyan, Nigerian, Middle East and Venezuelan oil fields. The composition of the majority of crude oils identified as originating from North Sea oil fields also indicated that tankers were responsible for their discharge: in addition to mid-boiling crude residues, they contained a disproportionately high amount of higher boiling *n*-alkanes, i.e. paraffin wax, which originates from adsorption on walls in tankers. This kind of pollution might originate from the tanker shuttle service with the Baltic Sea states when tankers which have unloaded crude oil at a Baltic port start tank-washing on their return journey (normal operational procedure) and discharge residues (illegal practice) immediately on leaving the Baltic Sea which is a 'Special Area' under the MARPOL Convention.

The great number of detected cases of crude oil pollution in this area must lead to the conclusion that illegal discharges from crude oil tankers leaving the Baltic Sea are common practice. The 'Special Area' status of the Baltic Sea and the greater risk of detection due to the vicinity of land might prevent ships from discharging oil in this area. There should be again no reason—or even possibility—for tankers leaving the Baltic Sea to discharge oil residues: because of the 'Special Area' status of the Baltic, these ships must be equipped with all means to retain oil residues on board, for example 'Load on Top' (LOT), 'Crude Oil Washing' (COW), 'Segregated Ballast Tanks' (SBT), and oil separating and monitoring instruments. Even the financial values of the relatively high amounts of the residues should prevent the responsible persons from the discharge. There is no explanation for this contradiction—not even from the oil industry.

The chronic pollution by crude oil residues on the northwestern coast of Denmark is one major new finding of the Oiled Seabirds project. Countermeasures, such as an increased aerial surveillance of this area and a more stringent prosecution of offenders against the MARPOL Convention should follow. There is a good chance to trace actual sources of crude oil pollution, i.e. distinct tankers, once the type of oil is chemically identified. This should encourage responsible Danish authorities to take action. Tanker movements are registered world-wide, and special registration is necessary for tankers moving through the Danish Belt Sea, the Kattegat, and the Skagerrak.

Dangerous chemical substances on the coasts of all three countries indicate that dumping of industrial waste is a more serious, international problem. Beside regular international surveillance of the beaches and a corresponding cooperation of prosecuting authorities, preventive means such as more stringent controls of chemical tankers in harbours are required.

The results also show the influence on seabirds and beaches of tank-washings from vegetable oil and paraffin tankers. Although legal, the discharge of such tank-washings obviously adversely affects the marine environment. Accordingly the discharge of those products (in general: floating lipophilic products) should be prohibited—even in our heavily industrialized areas.

We gratefully acknowledge support by the European Community for the Oiled Seabirds project, and support for sample taking in Germany by the Umweltbundesamt.

Also many thanks to the numerous people who collected the samples without whom the project would not have been possible.

Anon. (1990, 1991). Verontreinigingsrapportage. Rijkswaterstaat, Directie Noordzee, Notitie NZ-N-90.05, NZ-N-91.06.

Averbeck, C., Korsch, M. & Vauk, G. (1992). Der Einfluß von Ölverschmutzungen auf Seevögel an den deutschen Nordseeküsten von 1984 bis 1990. *Seevögel* **13**(1), 12–16.

Camphuysen, C. J. & Franeker, J. A. (1992). The value of beached bird surveys in monitoring marine oil pollution. Techn. Rep. Vogelbescherming 10, Nederland, Zeist, 193 p.

Camphuysen, C. J. (1989). Beached Bird Surveys in the Netherlands 1915–1988. Techn. Rep. Vogelbescherming 1, Werkgroep Noordzee, Amsterdam, 322 p.

Dahlmann, G. (1984). Eine neue sichere Methode zur Identifizierung der Verursacher von Ölverschmutzungen. *Dt. hydrogr. Z.* **37**(5), 217–220.

Dahlmann, G. (1985). Herkunft der Ölverschmutzungen an der deutschen Nordseeküste. Seevögel 6 (Sonderband), 73–80.

Dahlmann, G. (1987). Identification of oil pollutions. In *Seminar on Oil Pollution Questions*, Norrköping, *Baltic Sea Environment Proceedings* No. 22, pp. 149–160. Baltic Marine Environment Protection Commission, Helsinki Commission.

Skov, H., Danielsen, F. & Durinck, J. (1989). Dead seabirds along European coasts 1987–1988, Results of the International Beached Bird Survey. *Sula* **3**(1), 9–19.

Skov, H. & Durinck, J. (1991). Beached birds as a basis for monitoring of seabird mortality: examples from the International Beached Birds Surveys 1972–1991. Unpublished report to International Beached Bird Survey Workshop, Copenhagen, November 1991. Ornis Consult, 30 p.

Theobald, N. & Dahlmann, G. (1989). Unequivocal identification of the sources of oil pollutions by means of chemical analysis. Kongressband zum Internationalen Umweltkongress, Hamburg, 1989.

Theobald, N., Dahlmann, G. & Dick, S. (1992). Verschmutzungen durch alkylierte phenole in der Deutschen Bucht. *Dt. hydrogr. Z.* **44**(5/6), 345–360.