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Introduction

Between 1st January and 15th February 1970 some 12,856 birds, mostly oiled, were recorded dead or dying on beaches in northeast Britain. In this paper we describe the incident and discuss its possible causes, the steps taken to deal with it and future prospects. A brief report has already appeared (Greenwood 1970).

Wrecks of oiled birds in northeast Britain have increased in recent years. In 1968 an accidental spillage of 87 tons of crude oil in the Tay estuary killed over 1,300 birds (Greenwood and Keddie 1968). In spring 1969 large numbers of oiled birds were washed up on almost the whole length of the east coast of Britain (Bourne and Devlin 1970; Greenwood 1969). The present incident quite outranks these. Indeed, in terms of birds known to have been killed, it is the second largest seabird disaster recorded in the waters around Britain so far, surpassing even the *Torrey Canyon* incident (10,000 known dead: Bourne, Parrack and Potts 1967) and nearly equalling the mysterious Irish Sea wreck of autumn 1969 (15,000 known dead: Bourne 1970). The only larger oil-pollution disaster, off the Friesian Islands in 1969, produced over 14,500 birds known dead (Swennen and Spaans 1970).

Methods

Counts of birds found dead or destroyed were made by many individuals, often under the aegis of the RSPB Beached Birds Survey or of more intensive local schemes, and by various public bodies, especially the animal-welfare societies. Careful analysis has been made to detect all possible cases of duplication in recording. In fact there were few, because most observers removed or buried corpses or cut off wings. However, because some beaches were not visited, many beached birds were probably not recorded at all. Thus over the weekend 28th February/1st March, 380 dead seabirds (30 of them

Table 1. Total numbers of beached birds found, 1st January-15th February

	Yorkshire	Co. Durham	Northumberland	Berwick and The Lothians	Fife	Angus and Kincardine	Aberdeen	Total
Great Northern Diver *Gavia immer*	0	0	1	1	12	2	0	16
Black-throated Diver *G. arctica*	0	0	0	1	1	0	1	3
Red-throated Diver *G. stellata*	2	0	14	6	37	8	2	69
Diver *Gavia spp.*	0	0	0	0	15	28	0	43
Great Crested Grebe *Podiceps cristatus*	2	0	0	1	4	2	0	9
Red-necked Grebe *P. grisegena*	1	0	0	2	0	0	0	3
Slavonian Grebe *P. auritus*	0	0	0	1	6	0	0	7
Black-necked Grebe *P. nigricollis*	1	0	0	0	0	0	0	1
Grebe *Podiceps spp.*	0	0	0	6	1	2	0	9
Petrel *Hydrobates spp.*	0	0	0	2	0	0	0	2
Fulmar *Fulmarus glacialis*	2	0	0	0	7	5	6	20
Gannet *Sula bassana*	1	1	0	3	11	23	6	45
Cormorant *Phalacrocorax carbo*	3	4	2	9	14	29	8	69
Shag *P. aristotelis*	1	0	3	2	5	11	1	23
Heron *Ardea cinerea*	0	0	0	0	0	0	1	1
Mallard *Anas platyrhynchos*	0	2	0	1	1	4	0	8
Wigeon *Anas penelope*	0	0	0	0	0	1	0	1
Scaup *Aythya marila*	1	1	0	20	19	1	0	42
Tufted Duck *Aythya fuligula*	0	0	0	0	1	0	0	1
Goldeneye *Bucephala clangula*	0	0	0	1	2	2	0	5
Long-tailed Duck *Clangula hyemalis*	1	0	0	5	24	5	0	35
Common Scoter *Melanitta nigra*	5	0	0	9	251	20	2	287
Velvet Scoter *M. fusca*	0	0	0	3	47	7	1	58
Scoter *Melanitta spp.*	0	0	0	2	155	18	0	175
Eider *Somateria mollissima*	1	0	11	87	1055	934	36	2124

Table 1 (continued)

	Yorkshire	Co. Durham	Northumberland	Berwick and The Lothians	Fife	Angus and Kincardine	Aberdeen	Total
Goosander *Mergus merganser*	0	0	0	0	0	1	0	1
Red-breasted Merganser *M. serrator*	0	0	0	0	10	12	0	22
Shelduck *Tadorna tadorna*	0	0	0	1	11	2	0	14
Duck *Anatinae*	0	0	0	6	3	0	0	9
Grey Lag Goose *Anser anser*	0	0	0	0	1	0	0	1
Pink-footed Goose *A. brachyrhynchus*	0	0	0	1	1	5	0	7
Grey goose *Anser spp.*	0	0	0	0	0	0	6	6
Mute Swan *Cygnus olor*	1	0	0	0	1	0	0	2
Whooper Swan *C. cygnus*	0	0	0	0	1	0	0	1
Oystercatcher *Haematopus ostralegus*	0	0	0	1	6	1	0	8
Turnstone *Arenaria interpres*	0	0	0	0	0	2	0	2
Curlew *Numenius arquata*	0	0	0	0	4	0	0	4
Bar-tailed Godwit *Limosa lapponica*	0	0	0	0	0	3	0	3
Skua *Stercorariinae*	0	0	1	0	0	0	0	1
Great Black-backed Gull *Larus marinus*	15	1	0	0	1	19	5	41
Herring Gull *L. argentatus*	15	5	0	0	6	1	5	32
Common Gull *L. canus*	27	2	0	0	5	0	3	37
Black-headed Gull *L. ridibundus*	10	3	4	0	3	1	4	25
Kittiwake *Rissa tridactyla*	4	2	1	0	5	1	6	19
Gull *Larinae*	0	0	19	5	3	12	0	39
Razorbill *Alca torda*	48	27	122	191	282	840	89	1599
Little Auk *Plautus alle*	26	15	36	55	132	254	437	955
Guillemot *Uria aalge*	985	272	1082	783	562	1362	157	5203
Puffin *Fratercula arctica*	6	0	42	12	19	37	71	187
Auk *Alcidae*	263	0	19	8	28	0	2	320
Unidentified	0	0	0	62	31	889	280	1262
	1421	335	1357	1287	2783	4544	1129	12856

oiled and long-dead) were found between Rattray Head, Aberdeenshire, and Inverbervie, Kincardineshire, and 760 more (600 of them oiled and on shores unvisited earlier in the year) between Gourdon, Kincardineshire, and Dundee; presumably these were the remnants of previously unrecorded birds.

Much of the organisation of counting and all the compilation and analysis of the data in England and Aberdeenshire were done by RJD and CJF respectively. In the area between, which suffered heavier mortality, NJG and GW gathered the data from most sources. JJDG made the overall analysis.

The number of birds killed

If we rule out possible duplicate counts, 12,856 birds were found dead or dying on the beaches. The incomplete coverage makes this a minimum figure, and, of course, some affected birds may not even have reached land. For example, when 410 marked Guillemot corpses were dropped into the Irish Sea in May 1969, only 20% were found ashore later, despite intensive searches (Hope Jones *et. al.* 1968). Similarly, only about 25% of Shags killed by a 'red tide' off Northumberland in May 1968 were found (Coulson *et. al.* 1968). Finally, Tanis and Mörzer Bruyns (1968) found during an oil pollution incident off the Low Countries that eight to 11 times more birds died at sea than were later found ashore. Thus these findings indicate that only a proportion of dead birds is found ashore, and the most conservative estimate suggests that our count of 12,856 could represent 50,000 birds killed.

Distribution of beached birds

The numbers and species of birds found in each area are given in table 1. The Aberdeenshire and English beaches were well surveyed, so the apparent concentration of birds in Angus and Fife is probably real.

In late December there was minor oil pollution in the Firth of Forth; 211 Scaup and 11 other birds were killed by light diesel oil, apparently from a shore source. After 26th December, however, no beached birds were reported until 6th January, when three Razorbills and three Guillemots were found badly oiled at North Berwick, East Lothian. The subsequent course of the incident in southeast Scotland is shown in fig. 1. Two points are to be borne in mind when fig. 1 is interpreted: first, the scale is logarithmic, giving comparatively more weight to small numbers; secondly, the numbers partly reflect searching effort and are probably relatively too small at the very start of the incident and towards its end. Fortunately, undated records were too few to cause bias.

Fig. 1 shows the patterns in Fife and Angus to be similar, and rather different from that on the southern shores of the

Forth, where the beachings began a few days earlier and showed a trough around 20th January rather than a peak a day or two later. In Yorkshire and Durham the pattern resembled that around the Tay; the beachings started on 10th January, reached a peak around 17th to 25th and petered out in

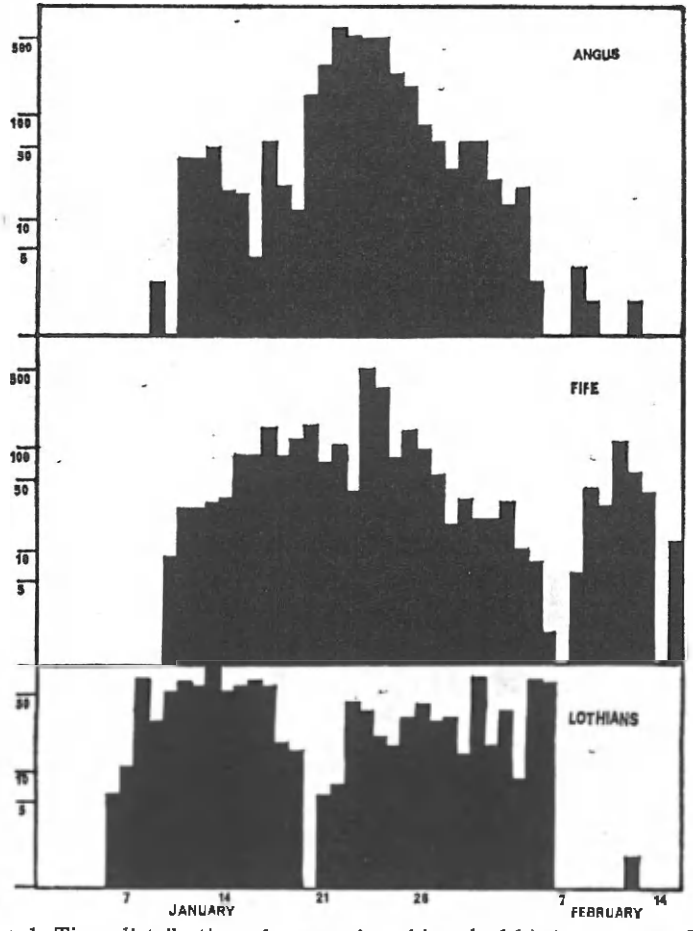

FIG. 1. Time distribution of recoveries of beached birds in Angus, Fife and the Lothians. The scale is logarithmic, exaggerating small numbers.

early February. In Northumberland, no birds were reported until 20th January, but the pattern was otherwise similar. In Aberdeenshire few birds came ashore until the last week in January, during which 117 were reported. The main wave landed overnight on 1st/2nd February, and 733 were found

between Peterhead and Aberdeen on 4th and 5th February. (Also reported for the county were 229 undated birds.)

Species involved

The identifications given in table 1 are mostly those of the observers, except that all scoters are listed as unidentified unless experienced birdwatchers identified them. Most of the unidentified birds comprise records such as "*x* dead birds between A and B" rather than unidentified remnants at the end of species lists, and so they are probably a random selection of species. Some records, especially of common species, referred to "many" rather than to specific numbers; because of this, the numerical totals are much too low for gulls and somewhat too low for Guillemots and Razorbills. Even allowing for gross underestimation of gulls, however, it is clear that this incident involved mainly divers, Cormorants and Shags, auks and sea-ducks, thus following the usual pattern for oil pollution (Battelle-Northwest 1967; Bourne 1968a; Clark and Kennedy 1968; Tanis and Mörzer Bruyns 1968; Rowan 1968). This is explicable if it is generally true, as Bourne (1968b) observed on one occasion, that gulls fly away on swimming into oil, whereas auks merely dive. Waders, of course, are oiled only if

Table 2. Distribution of auks

	Yorkshire	Co. Durham	Northumberland	Berwickshire and the Lothians	Fife	Angus and Kincardineshire	Aberdeen
Razorbill	3.6	8.6	9.4	18	28	35	12
Guillemot	74	87	84	75	55	55	21
Puffin	0.5	0	3.2	1.0	1.9	1.5	9.4
Little Auk	2.0	4.8	28	5.2	13	10	58
Auk	19.8	0	1.5	0.8	2.8	0	0.2
	1328	314	1301	1049	1023	2493	756

Note. The figures for individual species are the percentages of the totals for each area contributed by each species.

the shores they haunt are heavily polluted (Harrison and Buck 1967).

The number of wildfowl oiled in Fife and Angus reflects their winter distribution—Scaup particularly in the Forth, scoters and Long-tailed Duck in St Andrews Bay and Eider around the Tay (Atkinson-Willes 1963; Thom 1969). The distribution of auks is of interest (table 2). Not unexpectedly, Guillemots and Razorbills generally outnumbered Puffins and Little Auks, but the latter reached extraordinary numbers in

Aberdeenshire, where Puffins were also abundant. The ratio of Razorbills to Guillemots increased markedly from south to north.

The composition of the counts changed in time as well as in space. In Fife and Angus the proportion of inshore species, wildfowl, waders and gulls, was lower around 21st-26th January than before or after. (Elsewhere it was too low for variations to be significant). In Fife Little Auks were commonest around 21st January. In Angus this peak persisted until the beginning of February, possibly because patrols of the coast north of Arbroath, where Little Auks were commoner, were made only in the last week of January and later. In Aberdeenshire Little Auks formed 8% of the total in the last week of January, 58% on 4th and 5th February.

Cause of death

Few reports stated whether individual birds were oiled. However, the degree of oiling was noted fully in three sets of records (table 3) and occasionally in other reports. These show that external oiling affected over 99% of divers, grebes, Cormorants, Shags and auks; over 90% of seaducks; over 75% of other wildfowl; about 50% of gulls, petrels and Gannets; and few of the waders.

Table 3. Degree of oiling of beached birds in three areas

	Tayport, North Tentsmuir				St Andrews, Tentsmuir				Aberdeenshire			
	0	1	2	3	0	1	2	3	0	1	2	3
Divers and grebes	0	0	86	14	*0*	*0*	*40*	*60*	0	50	50	0
Petrels and Gannet	100	0	0	0	0	0	0	0	11	44	44	0
Cormorant and Shag	0	0	100	0	0	0	100	0	0	50	50	0
Seaducks	*0*	*20*	*48*	*32*	*1*	*38*	*52*	*9*	*18*	*68*	*14*	*0*
Other wildfowl	0	50	50	0	0	75	0	25	0	0	0	0
Waders	0	0	0	0	100	0	0	0	0	0	0	0
Gulls	100	0	0	0	25	0	75	0	27	64	9	0
Razorbill	*0*	*0*	*44*	*56*	*0*	*0*	*66*	*34*	*4*	*0*	*50*	*46*
Guillemot	*0*	*0*	*27*	*73*	0	0	*76*	*24*	*1*	*4*	*45*	*49*
Little Auk	0	50	50	0	*0*	*0*	*13*	*87*	*0*	*0*	*2*	*98*
Puffin	0	0	0	0	0	0	100	0	0	2	3	95

Note. Degree of oiling estimated as **0**—none, **1**—slight, **2**—moderate, **3**—severe. Estimation is consistent within areas but not between areas. Figures show the percentage of dead birds in each category. Figures in italic are based on a total of ten or more. "Seaducks" comprise Scaup, Long-tailed Duck, scoters and Eider.

Many of the birds found were alive and obviously suffering from oil, but it might be suggested that the dead ones had been oiled only after death from other causes. We think this highly improbable : enough oil to contaminate over 10,000 birds after death would be enough to kill them in the first place. Furthermore, mortality on this scale has always been associated with

oil pollution since J. P. F. Keddie started keeping detailed records at Tentsmuir, Fife, in September 1966. However, in February near Dundee some Eiders were caught, weak but with no oil on their feathers or in their gut. It is possible that they had been oiled but had cleaned themselves and survived. On the other hand, since none were analysed chemically or bacteriologically, one cannot discount the possibility that they were suffering from some other form of pollution or disease. In general terms this is not important, since these birds form such a small proportion of the total.

Table 4. Minimum estimates of the number of seabirds found that had been affected by oil

	Number found	Minimum percentage affected by oil	Minimum number affected by oil
Divers	131	99	130
Grebes	29	99	29
Petrels and Gannet	67	50	34
Cormorant and Shag	92	99	91
Seaducks	2721	95	2500
Other wildfowl	78	75	58
Waders	18	0	0
Gulls	194	50	97
Auks	8264	99	8200
Unidentified	1262	95	1200
	12856		12400

Many birds beached in eastern Britain in 1969 had oil in their gut but none on their feathers (Greenwood 1969). Dundee Museum staff examined internally all birds they handled during the 1970 incident except Eiders; again, all had oil in their gut. Whether apparently unoiled birds have oil inside through eating lumps of it or through cleaning their plumage is not clear. What is clear is that more birds are affected by oil than show it externally. Thus the figures given in table 4 are minimum estimates of the numbers killed by oil. (The figure of 95% for unidentified birds is based on the belief that most were seaducks or auks.)

The oil that killed these birds had at least two sources, for an underlying, harder layer and a superficial, softer layer were found on birds by several observers around the Tay. The oil in these layers must have differed in age or kind. It appears that at least one source was well out to sea; oiling was very heavy in the more marine species (Puffin and Little Auk), less in the more inshore ones (Guillemot and Razorbill) and least in coastal ones (ducks), and it is reasonable to suppose that the degree of oiling depends on the freshness and quantity of the oil and on length of exposure to it. This view is supported by evidence from Aberdeenshire, where the strandings of

early February contained more heavily oiled and greatly decayed corpses than were found in late January. In the Tay area the majority of casualties in the first half of January were dead, decayed auks, with fewer live auks and ducks. This indicates oiling of offshore auks some time before, with later oiling of coastal auks and ducks as the oil moved inshore with the corpses. After mid January the proportion of live birds increased, presumably because fewer corpses were arriving from offshore and more coastal birds were being affected. In the final stages, as all affected birds succumbed, none were found alive. The proportion of auks was higher in the middle of the incident than in these later stages, perhaps because the ducks, being larger, lost heat less rapidly and so died more slowly : heat loss is the most important aspect of death from oiling (Hartung 1967).

Distribution and nature of the oil

Little oil came ashore in the Forth area or southwards, though small amounts were found on 7th January and subsequently. Sandy shores round Tentsmuir, Fife, retained a scattering of tarry lumps, one inch to one foot in diameter, especially around 13th January. Lumps were distributed every couple of yards along the strandline, with the oily flotsam. On 20th January thick oil hit parts of the esplanade and rocks at Arbroath, Angus, and in the next few days small amounts of similar oil were reported at various towns along the rocky coast to the north. Indeed, at the end of February JJDG found that there were small, scattered patches of oil all along this coast, their splashed nature suggesting that the oil had been rather liquid when deposited. At the beginning of February the sandy shores from Aberdeen north to Cruden Bay received a light oiling, similar to that at Tentsmuir earlier.

On 12th January the Board of Trade alerted fishing vessels and the armed services to keep special watch for oil off eastern Scotland. Perhaps because bad weather reduced traffic, none was reported until 20th January, when a trawer found a slick three-quarters of a mile offshore in the Arbroath-Auchmithie area, Angus. The slick, four miles long and several hundred yards wide, comprised thick oil in its central half mile but was thin elsewhere. Presumably it was linked with the oiling of the Arbroath beaches on the same day.

On 26th January an RAF helicopter on a training flight found small patches of oil off the Angus coast, and the next day a Shackleton reported a number of small slicks just north of the Tay mouth, up to 15 miles offshore. Two days later, however, a helicopter search mounted by the Board of Trade found no oil in the area, and another aerial search on 31st January from Berwick, Northumberland, to Bridlington, Yorkshire, extending up to 50 miles offshore, was equally fruitless.

Between 7th and 16th January 17 samples of oil were taken from birds and beaches at various places from North Berwick to the Tay. All were of the same type of weathered heavy fuel oil, according to gas-chromatographic analyses by the Lothians River Purification Board. On 21st and 22nd January 26 oil samples were taken from birds and beaches between Arbroath, Angus, and Inverbervie, Kincardineshire. These samples resembled the previous ones except that they contained more volatile fractions. However, after weathering, these volatile fractions disappeared, and the characteristics of the two sets of samples were then identical. In general there were lower boiling-point fractions present (i.e. fresher oil) in samples from ducks than in those from auks, indicating that the latter tended to have been oiled earlier.

Four samples taken in Aberdeenshire on 2nd February were of a similar weathered heavy fuel oil, but one from Northumberland on 30th January was of a rather different type of heavy fuel oil.

Winds and surface drift

Birds move at their own volition, and corpses may sink and be carried by deep currents (Hope Jones *et. al.* 1970). Thus the observation that corpses of Guillemot and Razorbill are drifted by the wind at 2.2% of its own velocity (Hope Jones *et. al.* 1970) is of limited use in determining the origin of corpses. Movement of oil is more useful; Smith (1968) found that it travelled at about 3.4% of the wind-speed, as Hughes (1956) and others have found for the surface layer of water (though Tomczak (1964) found a rate of 4.2%). Thus, by plotting a chain of wind-vectors, one can determine roughly the previous track of any oil. We have attempted this, using wind records from Bell Rock Lighthouse (56° 29'N, 2° 23'W) and North Carr Light Vessel (56° 16'N, 2° 31'W), and the resultant track is given in fig. 2.

Had there been any oil in coastal waters in the third week in December, it would have been blown in by the southeasterly winds of that week—at least from Fife northwards. None appeared until 7th January. This suggests the oil was spilled in late December, perhaps off northern England, then moved northwards as far as the Tay, becoming spread out by the variability of the winds in the two weeks around the New Year. It was then deposited widely by the ensuing southeasterly winds—more on the Fife coast than further south simply because of the aspect of these coasts. This oil was already weathered and broken up by the winds, which, by agitating the sea, may also have reduced the amount of oil deposited on beaches; the peak deposition at Tentsmuir was on 13th January, a calm day following two days of light winds.

The wind pattern clearly explains the apparent northward drift of the oil from the Arbroath slick of 20th January, the south-southeasterlies depositing this oil all along the coast of Angus, Kincardineshire and Aberdeenshire. Had the coast been parallel to the wind, the oil would have travelled the 50 miles in three or four days : deflection of its drift by the southeast aspect of the coast is presumably why it took about ten.

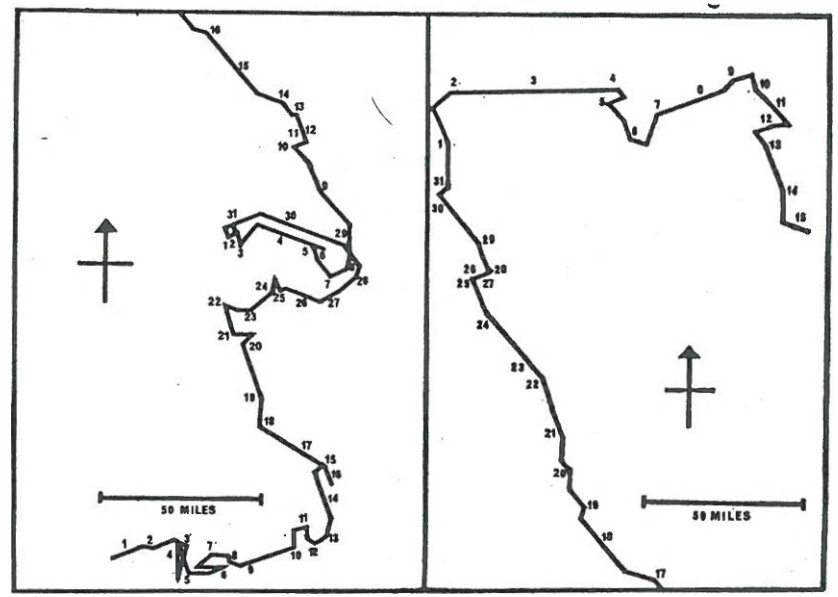

Fig. 2. Track of drifted oil. The track is drawn on the assumption that the oil drifted in the direction of the wind and at 3.4% of its speed. The numbers indicate dates. The track begins on 1st December 1969 at the bottom of the left-hand diagram, crosses to the bottom of the right-hand diagram on 17th January 1970 and terminates on 15th February. Oil seen on any date during the period in any place can be back-tracked by reading directions and distances off this diagram and plotting them on the map.

Even such details as the small number of birds beached on the southern shores of the Forth around 20th January (fig. 1) may be explained, for at this time the winds were almost due south, so holding corpses off this north-facing coast. The late peak on Fife beaches, in the second week of February, cannot be explained by the wind-pattern, however. It may be that the spring tides of 8th February were responsible, for most of these corpses were found at Tentsmuir, where certain areas retain flotsam only on the higher tides, because of the topography of the beach.

Since the angle the winds made to the coast was generally small, it is impossible to say accurately how far offshore the oil originated. (For example, a southeast wind blowing onto an east-facing coast would carry oil from 80% further offshore than a south-southeasterly wind of the same strength.)

Drift of bottles and buoys

A concomitant of the oil pollution was the deposition of about 200 foreign bottles on the shores of Tentsmuir, a remarkable number (M. Smith, pers. comm.). They were bottles that had contained cognac, Dutch genever, Belgian and French aperitifs and anise, and Alsace wines. In addition there were whisky bottles of blends specially bottled for the European market and also whisky bottles themselves specially designed for the same market. Their identities clearly suggest an origin some way from British shores, and their number confirms this. Their track must have coincided with that of the oil while it was still rather sticky, for most were oiled. We do not wish to suggest that the oil originated on the east side of the North Sea but that the pattern of drift in late 1969 and early 1970 was such that the oil could have been brought in from well offshore. This is confirmed by a hydrographic buoy that reached Lerwick, Shetland, at about the end of February, having been released three months before off Germany, 600 miles southeast (*Aberdeen Press and Journal* 1970).

Conclusions on the course of the incident

These several lines of evidence having been examined, a general picture emerges. It seems that heavy fuel oil was discharged off the east coast during December, probably towards the end of the month and possibly some way offshore (since southeasterly winds during 14-22nd December deposited none on beaches). By early January it was well spread out, for the southeasterly winds then started to bring it ashore on a front extending from the Humber to the Tay. The wide spread may have been due to variable winds around the New Year but could also have resulted from more than one source being involved (Northumberland oil seemed different from that sampled elsewhere). The oil killed numbers of auks offshore and affected seaducks as it entered coastal waters.

A fresh discharge occurred in the mouth of the Tay overnight on 19th/20th January. The slick broke up within 24 hours, having soiled Arbroath shores, but, driven by the wind, the oil moved relentlessly north, depositing oil as far north as Rattray Head within the succeeding ten days or so, and affecting more birds. Around the Tay, coastal species were involved (so ducks carried fresher oil than auks, and some individuals carried oil of two ages). Further north, it seems to have oiled more Little Auks and Puffins, though the very decayed

state of the heavily oiled corpses in Aberdeenshire suggests they had been caught in earlier oil.

As the wind started to blow offshore in early February, fewer birds were deposited on beaches. There were still some on the sea, however, for the spring tides of 8th February seem to have caused fresh beachings, at least at Tentsmuir. Thus, though only 12,400 birds are definitely known to have been oiled, more were almost certainly involved, but lost at sea. The best estimate is that about 50,000 birds were killed. Yet the amount of oil found was small, and though more than one discharge was involved, none appears to have been large. Indeed, the nature of the oil suggests it originated from bunker-cleaning operations of general-cargo vessels, which would not individually produce much. Even the area involved was restricted; it seems unlikely that there was much oil south of the Humber or, until the wind took it there, north of the Tay. This being so, the number of birds killed is remarkable.

Dealing with the oil

Two criticisms were levelled at the Board of Trade (now the Department of Trade and Industry) during this incident: first, that it did not take greater action to deal with the oil and, secondly, that some of its officials were slow to accept that the seabird mortality was at all abnormal. The first is really a criticism of the Board's remit in that it is required to deal only with pollution that threatens coastal amenities (Board of Trade 1970). Recent top-level discussions between the Nature Conservancy and the Department of Trade and Industry will, it is hoped, lead to an extension of this remit to cover oil threatening seabirds. Especially if this happens, we hope that the second criticism will not need to be repeated. Naturalists now have some experience of levels of mortality, and their views on whether any particular level is normal or not should be accepted by those who are not expert in this field.

The oil on most accessible beaches was insufficient for action to be taken outside the holiday season. However, several hundred yards of the esplanade at Arbroath were oiled and had to be cleaned by smothering with sand. The treatment proved effective and was, of course, much cheaper than the the use of detergents would have been, as well as less likely to disturb local ecosystems.

Tankers are usually blamed for all oil pollution. The many samples analysed in this incident were fuel oil, however, and therefore more likely to have come from the bunkers of genral-cargo vessels. Such vessels discharge oily water either because they have used it as ballast or because they have cleaned their tanks with it. Though they have separators to remove the oil from discharged water, it is clear that they are

not always used and that there is room for considerable improvement in this matter.

Sampling deposited oil is a good way to determine its source, and local oil-pollution officers should arrange the analysis of samples taken by naturalists. Samples are best kept in glass containers to prevent escape of volatile components; polythene does not do this and may even contaminate samples.

Dealing with the birds

It is now generally considered that there is little point in attempting to rehabilitate oiled birds. Most of the live birds picked up in this incident were, therefore, destroyed. Marsault (1969) found, however, that Guillemots will recover to the point of laying eggs in captivity and has now found that Razorbills will do so as well (Greenwood and Marsault 1971). The latter authors have detailed methods (individual care, with good feeding and judicious medication) by which such success may be achieved. Using these methods, Alf Robertson of Dundee had some success in 1970 : of about three dozen birds he took into care, some 75% survived until the summer to be released in natural or seminatural conditions. It is clear, therefore, that future research on rehabilitation needs to be directed not so much to the methods of restoring the birds but to finding out if the present methods are producing birds that are viable after release. Of course, rehabilitation is but a small part of the problem of oiled birds, and research on other aspects must not be neglected.

One type of research is simply to monitor the damage. The Bird Disasters Enquiry of the RSPB, which is an expansion of the Beached Birds Survey, needs widespread support. Local intensive schemes, like that already operating in northern England, can complement the national scheme by providing more complete information on particular incidents and for specific areas. If the extrapolation from the counts made under such schemes is to be accurate, we must know more about the behaviour at sea of oiled birds and corpses. Finally, all can help in the accurate census of seabirds now being attempted on the biggest scale in Operation Seafarer. Only from this information can the long-term effects of oil pollution be judged.

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Summary

Counts of beached birds in northeast England and east Scotland in the period 1st January to 15th February, 1970 have been collated. The counts were not systematic, so many beaches were not covered, though possible overlaps have been excluded. The number of dead or dying birds found was 12,856, which probably means that about 50,000 were affected altogether. The species affected are shown in table 1, and the time distribution of the beachings in fig. 1. Between the Humber and the Tay, most birds came ashore between about 7th January and 7th February, with a peak in the middle of this period. In Aberdeenshire the birds did not arrive until near the end of January. Among the beached birds there were regional differences in distribution of the species, some of which reflected their known natural distributions; Little Auks were especially abundant in Aberdeenshire.

Of the 12,856 birds, 12,400 were probably killed by oil. Oil was obvious on nearly all the natatorial seabirds, on most of the other wildfowl and on half of the aerial seabirds but on few of the waders. It was found in the gut of many apparently unoiled birds. The oil on the birds was of at least two types or ages; ducks tended to have fresher oil on them than did auks. Small amounts of oil were deposited between the Humber and the Tay during January. On 20th January a large slick was seen off Arbroath, and thick oil contaminated some beaches there. Small amounts of oil were subsequently deposited to the north, reaching Aberdeenshire at the beginning of February. Nearly 50 samples of oil were taken. All were of weathered heavy fuel oil, though one from Northumberland was of a rather different type from the others.

The distribution of the oil can be explained by the action of a long period of generally southeasterly winds on oil spilled off northern England or southern Scotland in late December and in the mouth of the Tay on 20th January. Unusually large numbers of bottles of continental types were cast ashore as a result of the same winds, and a buoy travelled from Germany to Lerwick during the same period.

We conclude that heavy fuel oil, perhaps from more than one source, was discharged off the east coast, probably late in December. It was brought ashore by the southeasterly winds that developed in January, along with the seabirds it had affected. A second discharge in the mouth of the Tay on 20th January affected more birds in that region and then even more up to the north as it was blown up the coast. Since so little was seen, the quantity of oil involved could not have been large, though it killed many birds.

We are glad that the only action taken to deal with the oil was not biologically destructive and that the remit of the Department of Trade and Industry may be widened to include oil pollution which threatens seabirds but not beaches. We hope that in future the views of natural-

ists as to what constitutes abnormal seabird mortality will be accepted, that there will be tighter control over the discharge of oil from general-cargo vessels and that naturalists will take samples of any polluting oil for analysis. For the good of birds, more knowledge is required of their numbers, of the number killed by oil and of the proportion surviving after good rehabilitation.

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