

any obvious community modification. However, sponges collected from 75 m, 5 km NNW of the Ile de Batz gave off a strong smell of oil. Levels of hydrocarbons in their tissues are currently being determined at the Museum National d'Histoire Naturelle.

### Conclusions

These first fragmentary notes just presented can only lead to tentative conclusions. However, it can be assumed that the final development of the disruption produced by hydrocarbons in sublittoral benthic communities is going to depend largely on two general conditions: on the one hand on the natural capacity of the various types of habitat present to speed up or hinder their own cleansing; on the other on the proximity of more or less large reserves for recolonisation. The peculiar benthic structure of northern Brittany, characterised by the presence of coarse, pebbly substrates continually exposed to strong tidal currents, has resulted in the harmful consequences of pollution being felt primarily by and

even being concentrated in communities in fine sediment, isolated from each other in bays and estuaries. Without any doubt, we have here a long term problem which, in any event, is a very unhappy blow to a maritime region whose exceptional faunistic and floristic diversity is the result of, among other things, the variety of its ecological conditions.

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## Birds Oiled during the *AMOCO CADIZ* Incident —an Interim Report

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Over 4500 oiled birds were collected from beaches in Northwest France and the Channel Islands following the oil spillage from the *AMOCO CADIZ* in March 1978. Auks were the most abundant casualties: 1391 puffins *Fratercula arctica*, 978 razorbills *Alca torda* and 731 guillemots *Uria aalge*, but there were also 126 divers *Gavia* spp. A total of 33 bird species were recorded oiled. A corpse drift experiment suggested that after 30 March at least 3450 seabirds died off north Finistère alone; the total mortality in the first fortnight of the incident was probably considerably larger.

The super-tanker *AMOCO CADIZ* was wrecked on rocks near Portsall, on the northwest coast of Brittany, on 16 March 1978, and she subsequently spilled her cargo of 220 000 tons of light Iranian and Arabian crude oils. The incident occurred almost on the eleventh anniversary of the grounding of the infamous *TORREY CANYON*. Oil from that incident enveloped the seabird reserve of Les Sept Isles and apparently severely reduced the auk population (Monnat, 1969). In recent years these auks had begun to show a slight increase but the latest incident is likely to have reduced the numbers

again. This report examines the situation concerning oiled seafowl; a detailed collation will be made at a later date.

In the first fortnight of the incident there were predominantly strong westerly winds, and later south-westerly winds. The sequence of events following the wreck has been described by O'Sullivan (1978) for the period up to 31 March. After that date, a change in wind direction to the northeast caused extensive secondary contamination of beaches. Oil also drifted around the western tip of the Brittany peninsula, and came ashore, under the influence of north- and south-westerly winds, on the coast as far as Pointe du Raz, about 66 km south of the wreck.

### Emergency arrangements

With the previous experience of oil pollution in Brittany from the *TORREY CANYON* in 1967, and the wrecking of two other tankers, *OLYMPIC BRAVERY* and *BÖHLEN*, both in 1976, an operations centre was quickly established at Brest by the Société pour l'Etude et la Protection de la Nature en Bretagne (SEPNB). Members of this society, together with university

students, the general public, and a team of volunteers from Belgium were organized to search the beaches along the north coast of Brittany (north Finistère and Côtes du Nord) frequently throughout the early phases of the incident. At least six subsidiary collecting centres were opened and the Ligue Française pour la Protection des Oiseaux (LPO) also ran a bird rehabilitation centre at Perros Guirec. Most live and dead birds were however sent to Brest where, under the direction of J.-Y.M. many corpses were examined to determine their age, sex and physical condition. Tissues were taken for subsequent chemical and histological examination. Responsibility for much of this work was given to P.H.J. who was sent over by the Royal Society for the Protection of Birds at the invitation of the SEPNEB.

Members of the LPO together with T. R. and T. J. Dixon, who were also sent over by the RSPB, combed the eastern-most beaches of the Côtes du Nord, and the west-facing beaches of the Département of Manche. Shores in the Channel Islands were covered by the local RSPB Beached Bird Survey teams and additional volunteers.

#### Observed mortality

Excluding a number of live gulls *Larus* spp which were lightly contaminated, at least 4572 birds of 33 species were known to have been oiled during this incident. They included the first record of Brunnich's guillemot *Uria lomvia* for France. Most of these birds were recorded on the heavily polluted north coast of Brittany, and of the 2752 birds taken to the centre at Brest by 25 May, only 258 had been found alive. There were also about 600 birds in the Département of Manche, and 423 in the Channel Islands (Table 1).

Oiled birds were first reported in Jersey on 21 March, Guernsey on 24 and Alderney on 28. However, preliminary analysis by the Laboratory of the Government Chemist of eleven Channel Island oil

samples taken arbitrarily from birds and the beach revealed that only two (one each from a bird and the beach and both from Alderney) were similar to the AMOCO CADIZ crudes. Two other samples were crude oil from tank washing operations, and the remainder were fuel oils, though whether these were from AMOCO CADIZ has not been established. It is not possible to determine what proportion of casualties in the Channel Islands were contaminated by AMOCO CADIZ crude oils, but some at least were oiled from other sources. Some birds recovered in Département of Manche may too have been contaminated by other oils, since the eastward limit of significant pollution of beaches and debris by AMOCO CADIZ crudes did not extend to that coast (T. R. and T. J. Dixon, personal communication).

#### Corpse drift experiment

The total number of birds that died as a result of the AMOCO CADIZ oiling is likely to have been well in excess of the 4572. This figure represents only those birds recorded by ornithologists and excludes the many (species unknown) destroyed by well-meaning members of the public, as well as those not found in the morass of oil and tideline debris and those removed with the oil from the beaches in clean-up operations. Other corpses may have sunk at sea whilst some birds (shags *Phalacrocorax aristotelis* in particular) are known to have died after struggling ashore on remote rocky islets.

In an attempt to establish an approximate 'finding and reporting' rate for casualties three batches of 48 corpses of herring and lesser black-backed gulls *Larus argentatus* and *L. fuscus* were dropped by G. Mudge from the Plymouth-Roscoff ferry on 30 March at distances of 30, 15 and 7.5 km north of Roscoff (Fig. 1). By 21 April only 3 (6%) of the outermost drop (outside the main polluted zone) had been found, and it is probable that most of the remainder were blown out into the Atlantic by the strong northeast winds (2-8 April - see Fig. 1). 29 (30%) of corpses of the two inner drops were found, all within a section of 70 km of North Finistère coast.

Of the 2089 oiled birds brought to the centre at Brest by 25 May from the coast of North Finistère 1035 arrived after 30 March. If the 30% 'finding and reporting' rate of gull corpses in the two inner drops was typical for seabirds oiled in the later phases of the incident, the number affected by AMOCO CADIZ oil off this section of coast after 30 March could have been 3450. Mortality in the first two weeks of the incident is also likely to have been considerably greater than that observed, especially since winds were offshore for most of this period.

Bibby & Lloyd (1977) have demonstrated that bird corpses drift at between 2.5% and 4% of wind speed, and that wind is the major influence in determining the direction of drift of corpses at sea. The occurrence of a peak in numbers of corpses, especially puffins, on 22 and 23 March is noteworthy. The strong north-westerly onshore winds on 21 March following 3 days of south-westerly (offshore) and westerly winds may have contributed to this pattern. A second peak in numbers, most pronounced for razorbills, occurred between 11

TABLE 1  
Provisional totals of birds (dead and alive) oiled during the AMOCO CADIZ incident.

	Finistère north	Côtes du Nord	Manche west coast	Channel Is.	Totals	%
Blk. Thd. Diver <i>Gavia artica</i>	42	11	4	1	58	1.3
Gt. N. Diver <i>G. immer</i>	43	9	0	14	66	1.4
Gannet <i>Sula bassana</i>	39	8	14	15	76	1.7
Shag <i>Phalacrocorax aristotelis</i>	348	106	6	10	470	10.3
<i>Phalacrocorax</i> sp.	15	112	0	1	128	2.8
Gulls <i>Larus</i> spp.	105	25	34	22	186	4.1
Razorbill <i>Alca torda</i>	409	406	53	110	978	21.4
Guillemot <i>Uria aalge</i>	384	247	20	80	731	16.0
Puffin <i>Fratercula arctica</i>	640	276	315	160	1391	30.4
Others (20 spp)	64	251	163	10	488	10.7
Totals	2089	1451	609	423	4572	

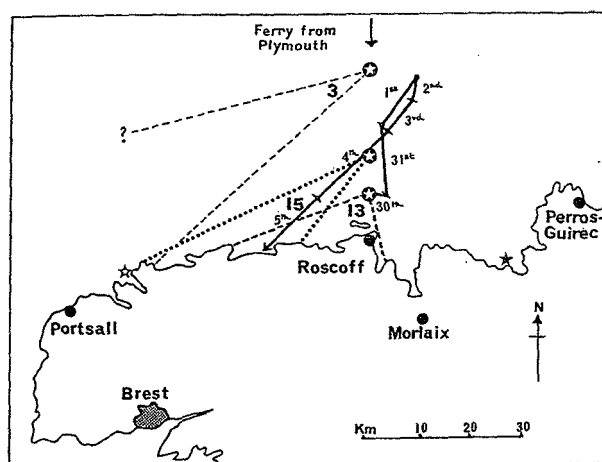


Fig. 1 Map of the north coast of Brittany showing three drop points for gull corpses, the subsequent areas of recovery and the predicted course of drifting corpses from the innermost drop. ● Drop points 30 March, 30, 15, and 7.5 km from Roscoff. ★ One aberrant recovery from innermost drop. ☆ Westernmost recovery from outermost drop. — Course of drifting corpses from the innermost drop predicted by wind vector analysis. Calculations based on a summation of hourly vectors reduced to 2.5% as the estimated rate of drift of gull corpses.

and 16 April and similarly may be associated with strong north-westerlies of 9–14 April. The wind in the preceding 7 days (2–8 April) had also been onshore but northeasterly, yet no influx of corpses was recorded. This suggests that the second peak in numbers of corpses may have been related to seabirds, especially razorbills, moving into the area.

#### Auk mortality

One of the notable features of the *AMOCO CADIZ* incident was the high proportion of puffins *Fratercula arctica* among the birds known to have been oiled. In normal years, puffins are considered to be relatively uncommon off Brittany in spring and so the high proportion of this species among the casualties was unexpected. Some of the razorbills *Alca torda* and guillemots *Uria aalge* examined at Brest still had fat deposits, indicating that they may have died as a result of the toxic effects of the oil or from stress and chilling rather than starvation. However, most of the puffins were in an emaciated condition and some found in the first few days of the incident were already dead and in a state of advanced decomposition. Mead (1978) reported unusually large numbers of dead puffins, including British-ringed birds, on the Biscay coasts from the end of January. He suggested that some of the survivors from what appears to be a 'weather wreck' of puffins had remained close to the shore and had been caught in *AMOCO CADIZ* oil. Harris (*in litt.*) reported that approximately one third of a sample of 202 puffins from this incident were still in the process of moulting their flight feathers. In the course of normal puffin moult, the primaries are dropped synchronously (Harris & Yule, 1977) and the birds become flightless for a period; in this condition, they are particularly vulnerable to oil pollution. Hence we may suggest an unfortunate combination of circumstances: storms in

Biscay probably led to large numbers of debilitated puffins, many of them in moult, some perhaps already dead, occurring off Brittany in mid-March; the oil spillage added to the damage caused by the storms, and the onshore winds after the wreck deposited large numbers of puffin corpses on the shores of northwest France.

Comparison between the *TORREY CANYON* incident and the *AMOCO CADIZ* reveals differences in the relative frequency of the three auk species in the Brittany casualties, notably the higher proportion of puffins in 1978 (Table 2).

Among the 3100 auk victims, 24 had been ringed in Britain and Ireland. Origins of 20 of these were plotted by Mead (1978) and they indicate that many of the razorbills involved in this incident were from breeding populations in the southern Irish Sea and the Hebrides, whereas the puffins were largely from remote colonies in north and west Scotland. The two guillemots were from southeast Ireland. Of a sample of 48 cleaned guillemot wings, 29 were from birds of the southern form *U. a. albionis* which breeds in Brittany, Ireland and Britain as far north as southern Scotland. Only 5 were thought to resemble guillemots of the northern form *U. a. aalge*, whilst the remaining 14 were intermediate in colour and wing-length.

Clearly British and Irish auks were involved in this oiling incident. Though at least half the sample of 213 puffins examined by M. P. Harris (*in litt.*) were probably of breeding age, the majority of guillemots were judged by P.H.J. to be immatures. If the auk ringing recoveries are a guide to the origin of the British component among the casualties, it will be difficult to assess (or even detect) any reduction in the large populations of these species in west Britain.

From the data available it is not possible to assess the impact of *AMOCO CADIZ* oil on puffins breeding on Les Sept Isles. The numbers of guillemots at the small colonies at Cap Fréhel and to the south of Brest on coasts that largely escaped contamination, were apparently similar to those in 1977.

#### Effect on other species

A relatively large number of shags and divers *Gavia* spp. were oiled. Most shags were probably from local populations (about 1700 pairs breed in Brittany), but one ringed bird from Pembrokeshire and two from the Isles of Scilly indicate the presence of some 'foreigners'. The relatively high number of oiled divers may partly be

TABLE 2  
Relative frequency of oiled auks recorded on the north coast of Brittany in the *TORREY CANYON* and *AMOCO CADIZ* incidents.

	Torrey Canyon 1967	Amoco Cadiz 1978
Total numbers	600	2362
Puffin <i>Fratercula arctica</i>	17%	39%
Razorbill <i>Alca torda</i>	65%	34%
Guillemot <i>Uria aalge</i>	18%	27%

attributed to the fact that many were in wing moult and unable to escape. It may also reflect the large number of these birds off the Brittany coast in spring. The impact on divers is likely to be serious in view of their relatively small populations: only about 300 pairs of great northern divers *Gavia immer* breed in the Palearctic region, virtually all in Iceland (Cramp & Simmons, 1977).

Only 23 common scoters *Melanitta nigra* were recorded among the victims of this incident, mostly in the Baie de Lannion, an area known to hold a small wintering population. In April, especially with light westerly winds, large numbers of common scoters have been observed by Henty (1976) and others from promontories in northwest France and southeast England, moving up the Channel from their winter quarters between the Bay of Biscay and Morocco.

Sea watches from cross-Channel ferries (G. Mudge & P.H.J.) and from a vantage point at Brignogan on the Brittany coast (G. Mudge) during the period 22 March to 7 April revealed little more than local feeding movements of gannets *Sula bassana*, shags and gulls. Few auks were recorded and there was no evidence of scoter passage. It is possible that the strong winds and turbulent seas inhibited seaduck movements during this period.

Up to the time of the wreck, normal numbers of waders were recorded on the coast of northern Brittany, but shortly afterwards a marked decrease was noted. A few oiled waders were observed but the main exodus may have resulted from the destruction of littoral

invertebrates which comprise their food. The few waders remaining took to feeding and roosting in unusual sites. The oil apparently enhanced natural erosion on some sandy beaches; as a result one colony of about 30 pairs of little terns *Sterna albifrons* was displaced.

The AMOCO CADIZ incident once again emphasized that there are large numbers of birds vulnerable to oil spills in the Channel and its approaches in early spring. The impact extends to breeding populations far outside the immediate area; to seabird stations of the Irish Sea and northern Scotland and great northern divers which may breed as far afield as Greenland and Canada. This paper demonstrates the value of biometrics and corpse drift experiments which are among the wide range of aspects that need to be studied to assess the implications of an oil spill on birds.

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## Reports and Publications

French and other studies reported at a meeting appear in *Journées spéciales d'études Amoco Cadiz - Brest, 7 Juin, 1978*. L. Laubier (ed.). Publications du CNEXO Serie 'Actes de Colloques', no. 6, 1978 (Oct.). It contains 17 papers: -

Laubier, L. Avant-Propos.

Berne, S., R. Brossier, A. Fontanel, L. D'Ozouville, J. Serriere et A. Wadsworth. Télédétection des pollutions par hydrocarbures de l'AMOCO CADIZ.

Marchand, M. Estimation par spectrofluorométrie des concentrations d'hydrocarbures dans l'eau de mer en Manche Occidentale à la suite du naufrage de l'AMOCO CADIZ, du 30 mars au 18 avril 1978.

Morel, G. et P. Courtot. Résultats préliminaires de la Pollution pétrolière par l'AMOCO CADIZ. Teneurs en hydrocarbures totaux dans les eaux de mer, de la Rade de Brest à la presqu'île du Cotentin (mars-avril 1978).

Aminot, A. et R. Kerouel. Premiers résultats sur l'hydrologie, l'oxygène dissous et les pigments photo-synthétiques en Manche Occidentale après l'échouage de l'AMOCO CADIZ.

D'Ozouville, L., E. R. Gundlach et M. O. Hayes. Effect of coastal processes on the distribution and persistence of oil spilled by the AMOCO CADIZ. Preliminary conclusions.

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