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BEACHED BIRD SURVEYS IN PORTUGAL 1990-1996

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SUMMARY.—*Beached bird surveys in Portugal 1990-1996.* Between 1990 and 1996 a large proportion of the Portuguese coast was systematically surveyed for dead seabirds during the winter (October to March). About 5330 km of beaches were walked during this period and 2660 dead seabirds were recorded. Razorbill *Alca torda* was the most common species, followed by Gannet *Morus bassanus*, Yellow-legged Gull *Larus cachinnans* and Lesser Black-backed Gull *L. fuscus*. Together, these species accounted for 73.7% of all corpses found. Most casualties were found in the central area of the Portuguese coast. Beaches in these regions face predominant northwesterly winds and are close to an important upwelling area which represents a potentially good feeding zone for seabirds. Oil contamination of the corpses was generally low, especially when compared with those recorded in similar surveys in some northern European countries. Deaths due to entanglement in fishing gear were significantly lower than those reported in previous surveys and they apparently no longer represent a major threat to seabirds in the Portuguese coast.

Key words: Beached Bird Survey, monitoring, oil contamination, Portuguese coast, seabirds, winter mortality.

RESUMEN.—*Recuentos de aves orilladas en Portugal, 1990-1996.* Entre 1990 y 1996, una gran parte de la costa portuguesa fue recorrida sistemáticamente durante el invierno (de octubre a marzo) buscando aves marinas muertas. Durante este periodo, se recorrieron unos 5330 km y se encontraron 2660 cadáveres de aves marinas. La especie más comúnmente encontrada fue el Alca Común *Alca torda*, seguida por el Alcatraz Atlántico *Morus bassanus*, la Gaviota Patiamarilla *Larus cachinnans* y la Gaviota Sombría *L. fuscus*. Los cadáveres de estas especies supusieron el 73,7% del total. La mayoría de las aves muertas se encontraron en la zona central de la costa portuguesa. Las playas de esta región están expuestas a los vientos predominantes del noroeste, y se sitúan cerca de un área importante de ascenso de nutrientes desde el fondo del mar que representa una zona potencialmente rica para la alimentación de las aves marinas. Los cadáveres presentaban una baja contaminación por petróleo en comparación con la registrada en estudios similares desarrollados en países del norte de Europa. Las muertes debidas a enmalle en redes de pesca fueron significativamente menos frecuentes que las registradas en estudios anteriores, de modo que la pesca no parece representar en la actualidad una amenaza importante para las aves marinas en las costas portuguesas.

Palabras clave: Aves marinas, contaminación por petróleo, costa portuguesa, mortalidad invernal, recuentos de aves orilladas, seguimiento.

INTRODUCTION

Beached Bird Surveys (BBS) have been organized in Portugal since 1982, in order to monitor seabird winter mortality and their level of oil contamination (Teixeira, 1986a; Granadeiro & Silva, 1992, 1993). After 1985, surveys were only carried out in the northern part of the country (A. Reis, unpl. data), but since 1990 the programme has been re-established as a national monitoring scheme.

The main purpose of this project is to assess which seabird species are affected as well as the intensity, geographical distribution and causes of mortality along the Portuguese coast. These surveys produce useful baseline information against which any exceptional mortality incidents (e.g. due to oil spills, bad weather, drowning in fishing gear) can be quantitatively assessed. Moreover, they enable the detection of particular events of mass mortality induced by factors acting at local or regional levels. In fact, while Teixeira (1986b) reported the local occurrence of mass mortality of auks due to fishing gear, recent BBS data showed that this mortality factor is no

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longer a major threat to seabirds in the Portuguese coast.

The results obtained with BBS suffer from some statistical limitations and are difficult to interpret in terms of assessing overall seabird mortality at sea (e.g. Camphuysen, 1989, 1995; Furness, 1993). However, they are widely recognized as an useful tool to assess temporal and geographical patterns of oil contamination (Stowe & Underwood, 1984; Camphuysen, 1989; Camphuysen & van Franeker, 1992). This paper examines the national BBS data collected between 1990 and 1996, in terms of temporal and geographical patterns of corpse distribution, and compares these results with similar data collected in earlier years.

Material and methods

Standard methods were adapted from similar schemes running elsewhere in Europe (e.g. Stowe, 1982; Camphuysen, 1989; Camphuysen & van Franeker, 1992). One hundred and thirty one stretches of sandy beach were selected along the Portuguese coasts. Ten sectors (numbered I to X - see Fig. 1) were defined to permit geographical comparisons, and the data from the beaches were pooled accordingly. Previous published accounts for 1990/91 and 1991/92 included data from the central and southern areas of the Portuguese coast, organised according to three sectors (Granadeiro & Silva, 1992, 1993). In this paper, the information from the northern part of the country referring to this period was incorporated and national data were reanalysed according to the new sectors defined.

Some stretches were not selected for our surveys because their sandy areas were too small and sometimes totally washed by the tide, so no corpses could be retained. This was particularly frequent in sectors V and IX (see Fig. 1). Sector X was the most poorly covered (Fig. 1), especially along the southern coast. This area is well protected from the dominant north and northwesterly winds and so usually has a very low density of corpses. Furthermore, some stretches are regularly cleaned during the winter by the local authorities, so no comparable data can be collected. Most of these stretches were walked monthly by volunteer teams between late October and late March each year. All seabirds found dead were identified, sexed and aged (whenever possible) and either removed from the beach or permanently marked with ink to avoid duplicate counts. Additional information collected included the degree of oil contamination (clean, slight, moderate or heavy), probable cause of death, and the distance walked on each beach.

Between 1990 and 1996 about 5330 km of sandy beaches were surveyed. The distances covered increased during the study period from 542.5 km in the winter 1990/91 to about 1183 km in 1994/95 (Table 1), thus covering in this year about 40% of the available beach length, but decreased in 1995/96 to 806 km (Table 1).

In order to correct for differences in sampling distances in each sector/month/year, the results are expressed as "density" of corpses, defined as number of birds found dead per 10 km walked. Statistical procedures follow Zar (1996).

Results

Species involved, temporal and geographical variation

Overall 2666 seabird corpses were found, 6 (0.2%) of which could not be identified and so they were excluded from the analysis. Most known-age casualties involved first-year birds (53.3%), while 37.8% were classified as adults and only 8.9% as immatures. The density of corpses peaked in December (6.5 birds/10 km) while the lowest values occurred in March (2.8 birds/10 km; Table 2). There was a significant decrease in the density of birds from October to March (Spearman rank correlation $r = -0.83$, $n = 6$, $P < 0.05$).

During the study period, the Razorbill *Alca torda* was the most frequent species with 768 casualties (Table 1). This species, together with the Gannet *Morus bassanus*, the Yellow-legged Gull *Larus cachinnans*, the Lesser Black-backed Gull *L. fuscus* and first-year Yellow-legged/Lesser Black-backed Gull *L. cachinnans/fuscus*, accounted for 73.7% of all casualties detected in the study period. The importance (proportion) of these species in

Sectors	Coast length (Km)	Sandy Beach length (Km)	Mean Dist. surveyed/year	% Coast surveyed	% Sandy beach surveyed	Number of stretches	Dist. surveyed 1990-1996
I	86	60	117.3	22.7	32.7	14	703.6
II	56.5	52.7	138.3	40.8	43.7	12	829.7
III	52.5	51.5	112.2	35.6	36.3	7	673.3
IV	62.3	49	84.3	22.5	28.7	12	505.7
V	51.7	24.7	64.5	17.6	36.7	9	284.4
VI	83.5	35.3	34.1	6.8	16.1	9	204.5
VII	52.5	29.5	114.8	36.4	64.9	18	688.9
VIII	92.5	68.7	122.7	22.1	29.8	13	736.2
IX	89.3	22	31.1	5.8	23.5	16	186.4
X	158.5	100	69.4	7.3	11.6	21	416.3
TOTAL	785.3	493.4	889.1	18.9	30	131	5334.3

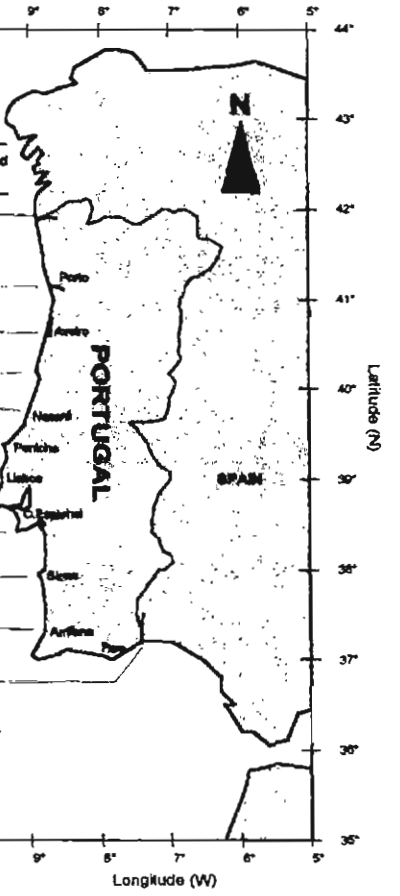

FIG. 1.—Sectors (I to X) defined on the Portuguese coast for the Beached Bird Surveys carried between the winters 1990/91 and 1995/96. The coastal length, as well as the sampling effort devoted along the whole study period, for each sector is also shown.
[Sectores (I a X) en que se dividió la costa portuguesa durante los recuentos de aves orilladas llevados a cabo entre los inviernos de 1990/91 y 1999/96. Se indica también la longitud de las costas y el esfuerzo de muestreo llevado a cabo en cada sector para el conjunto del período de estudio.]

TABLE I

Number of birds found dead in the Portuguese coast between 1990/91 and 1995/96.
[Número de aves encontradas muertas en las costas portuguesas entre 1990/91 y 1995/96.]

	Year of survey						
	90/91	*91/92*	*92/93*	*93/94*	*94/95*	*95/96*	*Total*
Gavia sp.	2	1	—	1	1	1	6
G. stellata	—	—	—	1	—	1	2
G. immer	—	1	—	1	—	1	3
Procellariidae.	—	—	—	—	—	1	1
F. glacialis	—	1	3	4	—	1	9
C. diomedea	1	—	7	1	2	—	11
Puffinus sp.	1	—	—	—	—	2	3
P. gravis	—	—	—	3	1	—	4
P. griseus	1	—	2	1	—	—	4
P. puffinus	—	1	2	2	1	1	7
H. pelagicus	—	—	—	3	—	4	7
Oceanodroma sp.	—	—	—	—	—	2	2
O. leucorhoa	—	1	2	—	—	22	25
O. castro	—	—	—	—	—	1	1
M. bassanus	55	42	71	90	93	82	433
Phalacrocorax sp.	—	—	—	1	—	1	2
P. carbo	—	—	2	2	4	1	9
P. aristotelis	5	—	6	5	2	2	20
M. nigra	6	9	1	30	20	55	121
C. skua	—	2	1	—	1	1	5
Larus sp.	5	11	19	21	40	26	122
L. melanocephalus	—	1	—	—	—	—	1
L. minutus	—	—	—	2	8	2	12
L. ridibundus	9	7	10	12	20	21	79
L. canus	—	1	3	2	1	—	7
L. fuscus	19	23	26	36	61	77	242
L. cachinnans	21	27	42	71	87	87	335
L. cachinnans/fuscus	35	18	38	34	43	14	182
L. marinus	1	—	—	2	—	—	3
R. tridactyla	7	—	7	5	13	2	34
Sterna sp.	2	—	—	—	1	—	3
S. sandvicensis	—	—	—	2	—	2	4
S. hirundo	—	—	1	3	—	—	4
Chlidonias niger	—	—	—	1	—	—	1
Alcidae	2	—	7	12	6	4	31
U. aalge	10	4	13	13	11	17	68
A. torda	87	33	197	273	99	79	768
A. alle	1	—	—	—	—	—	1
F. arctica	24	3	—	45	14	2	88
Total	294	186	460	679	529	512	2660
Distance (Km)	542.5	634.8	949.3	1218.9	1182.8	806.0	5334.3
Density (birds/10 Km)	5.42	2.93	4.85	5.57	4.47	6.35	4.99

relation to the total number of casualties did not change during the study period ($\chi^2_5 = 4.56$, $P > 0.05$). For all other species, the frequency of occurrence was less than 5% (Table 1). The Yellow-legged Gull was the most frequent species among the Larids. The most numerous Families were the Alcidae (4 species), Laridae (9 species) and Sulidae (1 species) which accounted for about 90.5% of all corpses found. The highest densities were recorded in

TABLE 2

Temporal distribution of casualties in the Portuguese coast between 1990/91 and 1995/96.
[Distribución mensual de las aves muertas encontradas en las costas portuguesas entre 1990/91 y 1995/96.]

	Month of survey						
	Oct.	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Total*
Gavia sp.	—	3	1	1	—	1	6
G. stellata	—	—	—	—	1	1	2
G. immer	—	1	2	—	—	—	3
Procellariidae.	—	—	1	—	—	—	1
F. glacialis	2	2	3	1	1	—	9
C. diomedea	6	3	2	—	—	—	11
Puffinus sp.	2	1	—	—	—	—	3
P. gravis	4	—	—	—	—	—	4
P. griseus	4	—	—	—	—	—	4
P. puffinus	4	2	—	1	—	—	7
H. pelagicus	—	2	1	3	1	—	7
Oceanodroma sp.	—	2	—	—	—	—	2
O. leucorhoa	—	—	20	5	—	—	25
O. castro	—	—	—	1	—	—	1
M. bassanus	168	103	77	35	30	20	433
Phalacrocorax sp.	—	—	—	1	—	1	2
P. carbo	1	4	1	3	—	—	9
P. aristotelis	1	9	4	2	3	1	20
M. nigra	22	39	36	11	6	7	121
C. skua	1	1	3	—	—	—	5
Larus sp.	42	22	21	10	13	14	122
L. melanocephalus	—	—	1	—	—	—	1
L. minutus	3	1	1	5	1	1	12
L. ridibundus	13	11	17	19	13	6	79
L. canus	2	—	1	3	1	—	7
L. fuscus	24	53	55	45	43	22	242
L. cachinnans	66	64	49	73	55	28	335
L. cachinnans/fuscus	44	48	28	23	25	14	182
L. marinus	—	—	1	1	1	—	3
R. tridactyla	—	2	12	13	4	3	34
Sterna sp.	—	1	1	1	—	—	3
S. sandvicensis	1	—	—	1	1	1	4
S. hirundo	—	1	1	—	1	1	4
Chlidonias niger	—	—	1	—	—	—	1
Alcidae	—	3	8	5	6	9	31
U. aalge	3	5	8	13	33	6	68
A. torda	7	147	241	175	126	72	768
A. alle	—	—	—	—	1	—	1
F. arctica	—	3	8	19	30	28	88
Total	420	533	605	470	396	236	2660
Distance (Km)	706.4	1011.6	927.8	893.5	962.5	832.4	5334.3
Density (birds/10 Km)	5.95	5.27	6.52	5.26	4.11	2.84	4.99

the winter of 1995/96 (6.4 birds/10 km) and no overall trends were detected during the study period (Spearman rank correlation $r = 0.43$, $n = 6$, $P > 0.05$; Table 1).

There was a significant variation in the age structure of Razorbill casualties, as compared to data reported for the 1982/1986 period. While Teixeira (1986a) reported 45.6% of first-year birds ($n = 923$), most of them drowned in fishing nets, in our study this proportion

was 79.1% (n = 729, χ^2_5 = 190.15, P < 0.01), suggesting a decrease in this type of mortality.

The highest density was recorded in sector V (about 25 birds per 10 km) followed by sectors VI and I (about 9 and 7 birds per 10 km, respectively; Table 3). The densities in the remaining sectors were less than 5 birds/10 km and the lowest values occurred in sector IV, where only 39 birds were detected (0.8 birds/10 km).

Overall stranding estimates

The number of birds found dead was used to estimate the total number of casualties on the

TABLE 3

Geographical distribution of casualties in the Portuguese coast between 1990/91 and 1995/96. Sectors are as in Fig. 1.
[Distribución espacial de las aves muertas encontradas en las costas portuguesas entre 1990/91 y 1995/96. Los sectores se definen en la Fig. 1.]

	Sectors										
	I	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*X*	*Total*
Gavia sp.	—	3	—	—	3	—	—	—	—	—	6
G. stellata	—	2	—	—	—	—	—	—	—	—	2
G. immer	—	1	—	—	2	—	—	—	—	—	3
Procellariidae.	—	1	—	—	—	—	—	—	—	—	1
F. glacialis	1	1	—	—	4	2	—	1	—	—	9
C. diomedea	—	—	—	—	9	1	1	—	—	—	11
Puffinus sp.	—	—	1	—	1	—	1	—	—	—	3
P. gravis	—	—	—	—	4	—	—	—	—	—	4
P. griseus	—	—	—	—	3	1	—	—	—	—	4
P. puffinus	—	—	—	—	1	1	3	1	—	1	7
H. pelagicus	—	—	—	—	3	—	—	—	1	3	7
Oceanodroma sp.	—	1	—	—	1	—	—	—	—	—	2
O. leucorhoa	—	15	—	—	3	—	—	2	2	3	25
O. castro	—	—	—	—	—	—	—	—	1	—	1
M. bassanus	40	42	23	15	94	45	43	56	8	67	433
Phalacrocorax sp.	—	1	—	—	—	—	—	—	1	—	2
P. carbo	3	—	1	—	—	—	4	—	1	—	9
P. aristotelis	—	—	10	—	5	4	1	—	—	—	20
M. nigra	21	53	26	5	10	—	2	3	—	1	121
C. skua	—	—	—	—	1	—	1	2	—	1	5
Larus sp.	25	35	18	7	12	4	7	3	3	8	122
L. melanocephalus	—	—	—	—	—	—	—	—	—	—	1
L. minutus	10	2	—	—	—	—	—	—	—	—	12
L. ridibundus	41	8	1	—	3	1	13	4	4	4	79
L. canus	5	—	—	—	—	—	1	1	—	—	7
L. fuscus	69	32	9	2	17	12	41	11	9	40	242
L. cachinnans	170	16	14	4	72	18	13	—	6	22	335
L. cachinnans/fuscus	27	21	2	—	64	26	23	8	5	6	182
L. marinus	3	—	—	—	—	—	—	—	—	—	3
R. tridactyla	7	1	2	—	10	5	4	2	1	2	34
Sterna sp.	—	—	—	—	1	—	2	—	—	—	3
S. sandvicensis	1	1	—	—	—	—	—	—	1	1	4
S. hirundo	3	—	—	—	—	—	7	—	—	—	4
Chlidonias niger	—	1	—	—	—	—	—	—	—	—	1
Alcidae	6	4	—	—	9	1	8	3	—	—	31
U. aalge	7	17	1	1	33	4	3	1	1	—	68
A. torda	27	43	16	4	433	54	131	11	32	17	768
A. alle	—	—	—	—	1	—	—	—	—	—	1
F. arctica	5	5	5	1	24	9	14	8	8	9	88
Total	471	306	129	39	823	188	317	117	85	185	2660
Distance (Km)	703.5	892.7	673.3	505.7	326.7	204.5	688.9	736.2	186.4	416.3	5334.3
Density (birds/10 Km)	6.70	3.43	1.92	0.77	25.19	9.19	4.60	1.59	4.556	4.44	4.99

coast. Since the sectors were not fully covered during our surveys, the numbers obtained resulted from sub-sampling the total coastal length. In order to estimate the number of seabirds that would be found in the event of full coverage, we extrapolated from the densities obtained for each month to the whole coastline, accounting for the differences found according to years and sectors (Table 4). This method is believed to provide accurate results concerning the number of seabirds thought to have reached each sector during the study period (Camphuysen, 1989). Overall, more than sixteen thousand birds were estimated to have been washed ashore over the six years, corresponding to an average of 2726 birds per year. Again, no trends were detected in the absolute number of birds between 90/91 and 95/96 (Spearman rank correlation $r = 0.60$, $n = 6$, $P > 0.05$). The distribution of casualties along the coast varied significantly, as the frequency recorded in each sector was not independent of the year ($\chi^2_{45} = 4926.3$, $P < 0.001$; Table 4).

Causes of death

For most of the casualties, the cause of death could not be determined accurately, either due to poor condition of the corpses or to the lack of adequate facilities for a detailed autopsy.

Two hundred and ten birds (7.9% of all casualties) showed some degree of oil contamination (light to heavy), but in some cases such contamination possibly occurred after death, due to contact with floating oil at sea or, most likely, with tar pellets on the beach. The proportion of oiled birds found during the study period did not differ significantly from that obtained by Teixeira (1986a) between 1982 and 1986 (348 oiled corpses out of 4159; $\chi^2_1 = 0.35$, $P > 0.05$).

One hundred and eighty seven birds showed evidence of death due to fishing gear and this represented up to 7.0% of all cases detected. Guillemots *Uria aalge* and Razorbills were the most affected species and most observations suggested deaths due to entanglement in gillnets (as assessed by broken wings, missing heads and/or legs), with only a few attributable to fishhooks. Forty two birds showed evidence of having been shoot.

DISCUSSION

Between 1990 and 1996, 5330 km of sandy beaches were walked during the winter and 2660 corpses belonging to 30 seabird species were found, resulting in an overall density of 5.0 birds per 10 km. No large seabird wrecks occurred during this period, but there was an increased mortality of Leach's Storm Petrels

TABLE 4

Number of seabirds estimated (by extrapolation) to have been washed ashore each year in each sector of the Portuguese coast.
[Número total de aves marinas muertas, estimadas por extrapolación a partir de los recorridos realizados, para cada sector de la costa Portuguesa y año de estudio.]

Sector	Year of the Survey *[Año de estudio]*						Total
	90/91	91/92	92/93	93/94	94/95	95/96	
I	111	77	159	378	581	1102	2408
II	36	13	106	120	148	190	612
III	60	50	42	41	62	109	364
IV	0	0	24	45	19	52	139
V	1099	463	1197	1288	469	395	4911
VI	555	312	415	643	914	239	3077
VII	252	118	142	160	168	64	902
VIII	217	86	53	129	29	73	586
IX	150	36	66	486	272	161	1171
X	222	656	263	231	365	48	2185
Total	2701	1811	2465	3520	3027	2833	16356

(*Oceanodroma leucorhoa*) in the winter 1995/96, following severe weather conditions. These mortality events were reported in a larger scale on three occassions in previous surveys: the first involved Leach's Storm Petrel (about 100 casualties; Teixeira, 1987), the second affecting Kittiwake *Rissa tridactyla* (about 1000 corpses found -Teixeira, 1986b), and the third involving Puffin *Fratercula arctica* (about 150 corpses recovered; Teixeira, 1986b).

The Razorbill was the most numerous species detected in the surveys and accounted for 28.8% of all casualties. In 1992/93 and 1993/94 they represented more than 40% of all birds found, dropping to 18.7% in 1994/95 and 15.4% in 1995/96, when they showed their lowest frequency. Gannets were the second most frequent species, but overall accounted for only 16.3% of the strandings. Larids were the next group in terms of abundance and were mainly represented by 1st year and immature *Larus cachinnans* and *L. fuscus*. The Scoter *Melanitta nigra* was the next species in terms of number of casualties, with most birds found in the northern sectors (I to III). The distribution of this species matched well with their distribution at sea, as assessed by aerial surveys (Rufino & Neves, 1990, 1992).

Most casualties occurred in sectors V and VI. These sectors lie close to an upwelling area (Fiuza, 1983), which can probably offer good feeding conditions for seabirds during the winter, and so may lead to high concentrations in this area. Moreover, most beaches surveyed in this region face the dominant northwesterly winds and so tend to retain a relatively large number of corpses. In fact, it has been shown that the geographical distribution of casualties on the coast is related to the directional component of a sea condition index (Granadeiro & Silva, 1993) as assessed by a model of daily sea disturbance characters based on a time series of surface wind fields at sea (Pires & Rodrigues, 1988). However, it is widely recognized that numbers of corpses washed ashore depend on a variety of factors such as densities at sea, local currents, predominant winds and type and intensity of the mortality factors (Bibby, 1981; Camphuysen, 1989, 1995; Camphuysen & van Franeker, 1992) so these geographical patterns can only be fully understood with reference to the numbers and distribution of birds at sea, so far not available for the Portuguese coast.

The densities recorded in our surveys were only one fourth to one fifth of those reported by Teixeira (1986b), which covered about the same areas and obtained an average density of 23.7 birds/10 km between 1982 and 1986. If we assume that the geographical and temporal distribution of the casualties in previous surveys was similar to the period 1990/95, this would then represent an average of more than 13400 seabirds washed ashore each year along the entire coast compared with an average of 2726 birds per year in our study (Table 4).

The levels of oil contamination were generally low and scored among the lowest reported for west European countries (Camphuysen, 1989; Skov *et al.*, 1989; Camphuysen & van Franeker, 1992). Moreover, a number of birds may have been contaminated after death, therefore overestimating the real proportion of oiled birds in our sample.

No major yearly variations in the proportion of oiled birds were apparent and the values obtained do not differ significantly from those reported by Teixeira (1986a) between 1982 and 1986. These observations suggest that oil contamination is not a major threat to seabirds on the Portuguese coast, despite the fact that the area includes an important route for many oil tankers to and from Europe.

Fishing gear is widely recognized as a potential threat to seabirds (e.g. Northridge, 1991; Robins, 1991). In our study, entanglement in gill-nets accounted for a relatively low number of casualties. This situation contrasts with data from previous years, when large numbers of Razorbills were found with clear evidence of death in this type of fishing gear (Teixeira, 1986a). In fact, this threat was considered to be locally important in the Iberian Peninsula (De Juana, 1984; Teixeira, 1985, 1986b; Garcia *et al.*, 1988; Robins, 1991), but it appears to have decreased significantly in recent years (Granadeiro & Silva, 1992, 1993). The significant increase in the proportion of first-year birds in recent years also indicates that the density of auks represents natural mortality, providing further evidence of a decrease in mortality induced by fisheries. In Portugal this trend could be partly responsible for the reduction in the overall densities of corpses in relation to previous surveys.

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