AGE STRUCTURE AND ORIGINS OF BRITISH & IRISH GUILLEMOTS *URIA AALGE* RECOVERED IN RECENT EUROPEAN OIL SPILLS

MARK GRANTHAM

Grantham M.J. 2004. Age structure and origins of British & Irish Guillemots *Uria aalge* recovered in recent European oil spills. Atlantic Seabirds 6(3/S.I.): 95-108. *Following several recent major oil spills affecting British & Irish breeding Guillemots Uria aalge, I carried out analyses of the origin of ringed birds recovered following these incidents to describe the importance of different wintering areas for this species. The results show significant differences in the age structure and natal origin of birds affected in the different oil spills, indicating the existence of different wintering areas for different breeding populations of Guillemots. Birds wintering in the south western approaches to the English Channel and south into the Bay of Biscay (affected by the Prestige spill) tended to be immature birds from colonies in the west of Britain and Ireland, whereas birds wintering in the English Channel and North Sea (affected by the Tricolor spill) tended to be adults from colonies in eastern Britain. In general, immatures appear to winter further from their natal colony than adults. By understanding the dispersal patterns and winter distribution of such birds, we can assess the likely impacts on bird populations of pollution incidents.*

British Trust for Ornithology, Thetford, Norfolk, IP24 2PU, UK, E-mail: mark.grantham@bto.org

INTRODUCTION

With increased sea transport of petroleum products, there is always the risk of oil spills at sea. In the 1960s, the number of oil spill incidents rose markedly, though the number of incidents has been reduced by tighter controls on shipping since the late 1970s. However, the larger size of modern tankers means that any incident will potentially result in a larger oil spill and hence greater environmental problems. The Guillemot *Uria aalge* is usually the species most affected by large-scale oil spills, with many oiled birds eventually washing up on beaches (Baillie & Mead 1982).

Britain & Ireland have a substantial percentage of the European breeding population of Guillemots (Lloyd *et al.* 1991), though little has been published of the wintering areas of specific populations. Analyses of ring recovery data (Harris & Swann 2002) show that immature birds appear to winter further from breeding colonies than adults, but this is a general assumption, with no detail for individual colonies or populations. It is essential to understand which areas are

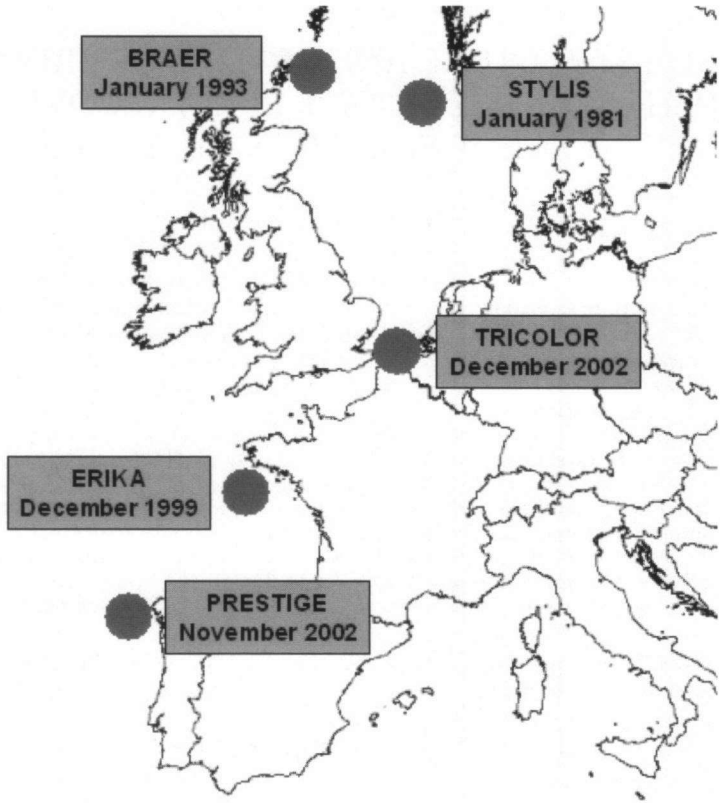


Figure 1. Locations and dates of recent major oil spills in European waters.
Figuur 1. Locaties en data van recente grote olieverontreinigingen in Europese wateren.

important to the birds outside of the breeding season if we are to ensure their long-term protection.

In November 2002, the tanker *Prestige* sank off the coast of Galicia, Spain, and the following month the tanker *Tricolor* sank in the English Channel. Following these spills, the British Trust for Ornithology (BTO) received many reports of ringed birds (both dead and alive) that had been found on beaches. To assess the impact of the two spills, I describe the features of the population(s) of birds affected by five recent oil spills in European waters.

METHODS

Selection of recoveries Recoveries (found either dead or alive) of BTO-ringed Guillemots after five major oil spills in European waters were used to investigate the age structure and origin of the birds affected by the spills. These were from the vessels *Stylis* (North Sea, January 1981), *Braer* (Shetland, UK, January 1993), *Erika* (Brittany, France, December 1999), *Prestige* (Galicia, Spain, November 2002) and *Tricolor* (Netherlands, December 2002) (Fig. 1).

Recoveries of birds were initially selected where the birds were noted as being oiled, and the finding date fell shortly after each spill date. The period after the spill when reports were selected was judged by eye from recovery totals shown by week. The finding locations of the birds were plotted and I identified which recoveries were likely to relate to each particular oil spill, based on proximity to the spill site, with those in adjacent coastal areas selected for analyses. For example, recoveries of oiled birds following the *Prestige* spill spread from the Galician coast near the spill site along the coast of the Bay of Biscay to southern France (Fig. 2). The selection of recoveries may have included some that were unrelated to each individual oil spill, though this number will have been small. The total number of filtered recoveries from each of the five major spills is shown in Table 1, and recoveries from each spill were then analysed separately.

From each spill sample, birds were initially grouped by age class. Most Guillemots do not return to breeding colonies until after their second year (Cramp 1985), though some studies (i.e. Harris et al 1994) have shown that many birds will not actually breed until they are six years old. Where possible, birds were classed as immatures (first and second year birds) or breeding age birds (third year birds and older). The majority of Guillemots had been ringed as chicks so this allowed the birds to be classified as immatures (found less than two years after ringing) or adults (found more than two years after ringing). The birds not ringed as nestlings were classed as adults if they were found more than a year after ringing. Not all birds ringed when fully-grown could be assigned to an age class, as many were of unknown age when ringed and found soon after ringing. These birds were therefore excluded from all analyses of age structure. Differences in the age classes between adjacent spills were tested using chi-square tests of association.

Effects of ringing place Birds of known breeding origin were selected from the full dataset for each spill. This dataset included only those birds ringed as nestlings or those that were ringed as breeding adults (actively nesting or in a colony). Colonies were then grouped into four geographical areas (Fig. 3):

- Wales and Ireland

Table 1. Number of BTO-ringed Guillemot reported following five large European oil spills, and the total number of BTO-ringed casualties
Tabel 1. Aantal met BTO-ringen geringde Zeekoeten die werden doorgegeven na Europese olieverontreinigingen, en het totaal aantal BTO-slachtoffers.

	Stylis	Braer	Erika	Prestige	Tricolor
Number of Guillemot reported	33	15	230	98	45
Total number of BTO-ringed birds reported	51	73	267	149	71

Figure 2. Geographical selection of ringing recoveries relating to the Tricolor *and* Prestige *oil spills by finding location.*
Figuur 2. Geografische selectie naar vindplaats van ringvondsten gerelateerd aan de Tricolor *en* Prestige *olieverontreiniging.*

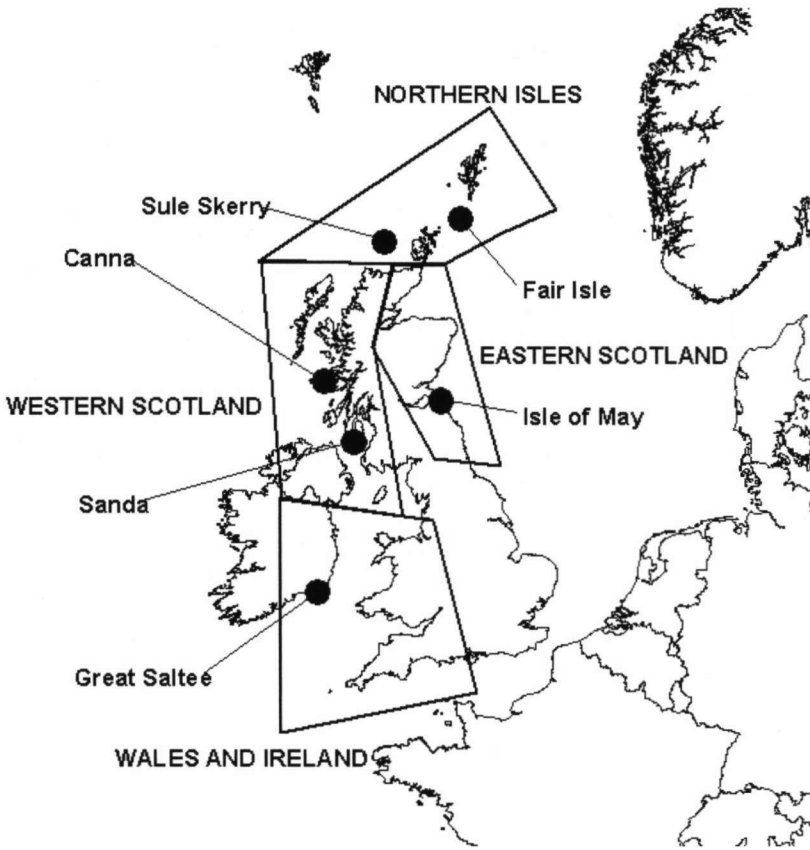


Figure 3. Location of six main seabird colonies used for population analyses and the boundaries used to define geographical areas for analyses.

Figuur 3. Ligging van de zes belangrijke zeevogelkolonies die werden gebruikt voor de analyses en de begrenzing van de gebieden die voor de analyses gebruikt werden..

- Western Scotland (including the Western Isles and coastal locations between Dumfries and Cape Wrath)
- Northern Isles (Shetland, Orkney, Sule Skerry and North Rona (politically part of the Western Isles, but geographically closer to the Northern Isles))
- East Scotland (from Caithness south to the Firth of Forth)

Differences in the origins of birds found in the different spills were tested using chi-square tests of association.

To assess the impact of the spills on different colonies, I estimated the number of Guillemots killed from the main colonies in Britain & Ireland in each spill (Fig. 3). Colonies were selected with a long run of both annual ringing totals and colony count data. Count data were provided by JNCC from the Seabird 2000 survey results (Mitchell *et al.* 2004) and the Seabird Colony Register (R. Mavor pers. comm.) I also only considered birds ringed as nestlings, as I had to use annual productivity (of nestlings) as a measure of birds entering the population. This was not considered to be a major bias in the data as a large majority of Guillemots (>80%) are ringed as nestlings (Clark *et al.* 2002).

For each spill and each colony I calculated the number of birds recovered from each annual cohort of ringed nestlings. Using the annual ringing totals (of nestlings) for each colony, I calculated the proportion of the ringed cohort from each year that had been found in the spill. For each breeding season at each colony, I then knew the proportion of ringed nestlings that were recovered following each spill. Assuming that the same factors affect ringed birds as unringed birds, the proportion of ringed birds found can be estimated to give the minimum number of birds affected (see Appendix 1 for calculations).

RESULTS

The number of BTO-ringed birds reported following each of the five spills is shown in Table 1. The *Erika* and *Prestige* spills resulted in the largest numbers of recoveries, with Guillemots making up a large proportion (69%) of this overall total.

The age distribution of known-age Guillemots from each of the five large spills is shown in Fig. 4. Those reported following the *Prestige* spill were predominantly immatures (89%) whilst those from the *Tricolor* spill were predominantly adults (79%, Table 2). Following the *Erika* spill, 58% of birds recovered were immatures, significantly different from both the *Prestige* and *Tricolor* spills. Following the *Stylis* and *Braer* spills, 87% and 77% (respectively) of ringed birds found were immatures, a difference that was insignificant.

Table 2. χ^2 results and significance levels for comparing the ages of BTO-ringed Guillemots reported following five large European oil spills (*** p<0.0001; ** p<0.001; * p<0.01). Sample sizes are shown in Table 1

Tabel 2. Vergelijking van de leeftijd van Zeekoeten met BTO-ringen die werden gemeld na vijf grote Europese olieverontreinigingen, met een χ^2-toets. (*** p<0.0001; ** p<0.001; * p<0.01). Steekproefgroottes staan in tabel 1.

	Braer	Stylis	Tricolor	Erika
Prestige	1.56	0.10	60.65***	84.45***
Erika	1.85	9.80*	18.58***	-
Tricolor	13.52**	30.77***	-	
Stylis	0.71	-		

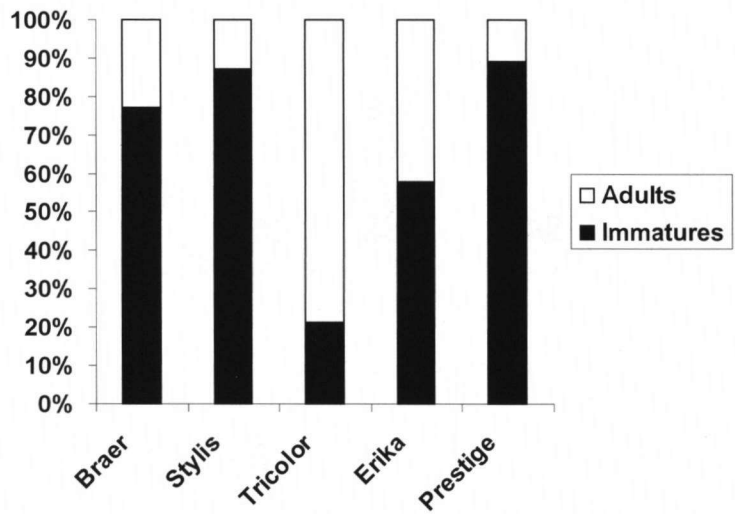


Figure 4. Proportion of immature and adult Guillemots found following five large oil spills. Sample sizes are given in Table 1

Figuur 4. Aandeel onvolwassen en adulte Zeekoeten die werden gevonden na vijf grote olieverontreinigingen. Steekproefgroottes staan in tabel 1.

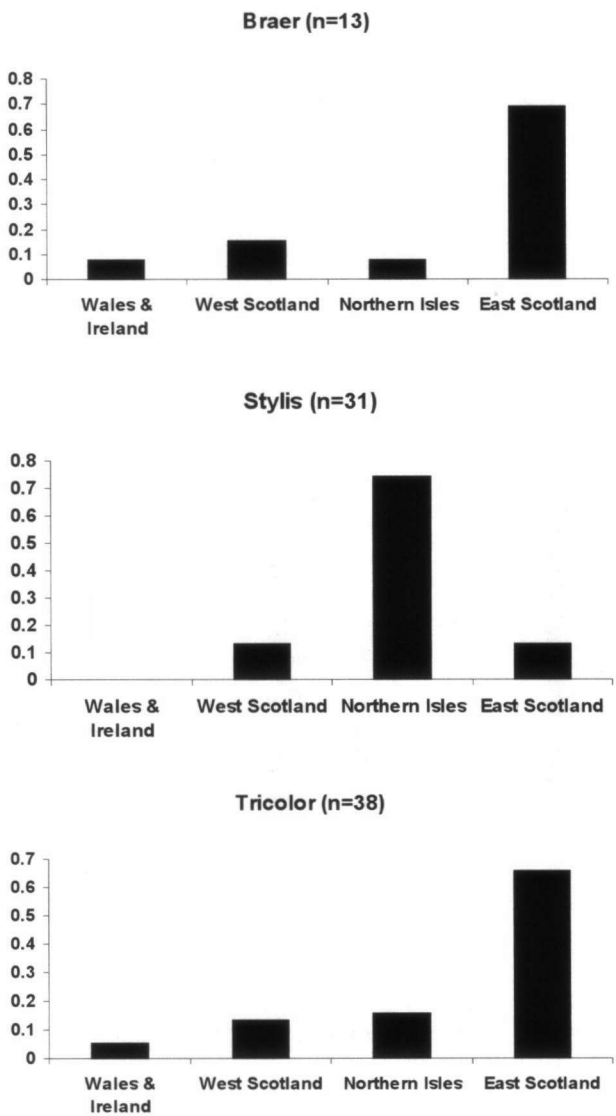
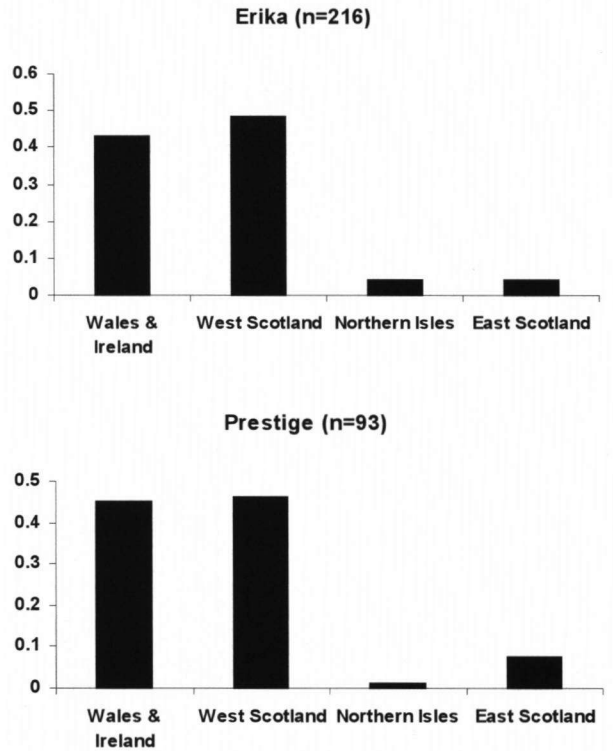


Figure 5. See opposite page for legend.
Figuur 5. Zie tegenoverliggende pagina voor bijschrift.



This page and opposite page: figure 5. Proportions of Guillemots originating from four geographical areas found following five major oil spills.

Deze pagina en tegenoverliggende pagina: figuur 5. Geografische verdeling van Zeekoeten die werden gevonden na vijf grote olieverontreinigingen.

The origins of the birds found following each spill also varied significantly. A large proportion (91%) of birds found following the *Prestige* spill originated from colonies along the western coasts of Britain and Ireland (Fig. 5), whereas those found after the *Tricolor* spill originated from colonies in eastern Scotland (66%); a significant difference (Table 3). Birds found following the *Erika* spill originated from colonies similar to *Prestige* birds, though significantly different from *Tricolor* birds. Birds from the *Stylis* spill originated predominantly from the Northern Isles, significantly different to the east Scottish origin of *Braer* birds.

Table 3. χ^2 results and significance levels for comparing the origins of BTO-ringed Guillemots reported following five large European oil spills (*** $p<0.0001$; ** $p<0.001$; * $p<0.01$). Sample sizes are shown in Table 1

Tabel 3. Vergelijking van de herkomst van Zeekoeten met BTO-ringen die werden gemeld na vijf grote Europese olieverontreinigingen, met een χ^2-toets. (*** $p<0.0001$; ** $p<0.001$; * $p<0.01$). Steekproefgroottes staan in tabel 1.

	Braer	Stylis	Tricolor	Erika
Prestige	1176***	383***	537***	3163
Erika	1613***	1164***	1190***	-
Tricolor	803	2292***	-	
Stylis	1880**	-		

Table 4. Estimated minimum numbers of birds from five large colonies affected by three large oil spills

Tabel 4. Geschat minimum aantal vogels afkomstig van vijf grote kolonies die door drie grote olieverontreinigingen zijn getroffen.

	Fair Isle	Great Saltee	Canna	Isle of May	Sule Skerry	Sanda	TOTAL
Prestige		185	22	89	29	33	358
Erika	54	333	44	99	37	40	607
Tricolor		10		126	28	5	169

In both the *Tricolor* and *Prestige* spills, there was also a tendency for all immature birds to originate from western colonies, whereas adult birds originated from eastern and northern colonies. Unfortunately the sample sizes of known-age, known-colony birds were too small to carry out statistical analyses.

The estimates of total number of birds killed in each colony further highlighted the differences between the spills (Table 4). These figures also show an easterly bias to the origin of birds found following North Sea spills. For birds ringed on the Isle of May, an estimated minimum of 126 birds were probably affected by the relatively small *Tricolor* spill, with only 99 affected by the much larger *Erika* spill further to the south. From such spills further south, birds affected originated from more westerly colonies (e.g. Great Saltee Island).

DISCUSSION

Guillemots are regularly the species most affected by large oil spills in the North Sea and adjacent waters, and the spills considered here were no exception, with large numbers of ringed birds being reported to the BTO.

As the birds from each colony are though to winter in different areas (Harris & Swann 2002), the population (or particular part of the population) of Guillemots affected by an oil spill depends on its location. The significant differences between the age structure and origin of the birds found between the spills are similar to those of previous analyses of BTO-ringed birds. This showed that, on average, immature Guillemots were recovered 587km from their initial ringing location, whereas adult birds were reported on average only 357km distant (Harris & Swann 2002). It is thus not surprising to find a larger number of immature birds further south into the Bay of Biscay than in the English Channel or North Sea.

The significant differences between both the age class and origin of recovered Guillemots following the three more southern spills (*Tricolor*, *Erika* and *Prestige*) were interesting. Birds found after the two spills in the Bay of Biscay were predominantly immatures from colonies in the west of Britain and in Ireland, whereas birds found after spills further north into the English Channel were predominantly adults from colonies in the east of Britain. It appears that in the winter, birds from eastern colonies do not penetrate to sea areas beyond the English Channel, but winter in more northern areas. Birds from more western colonies winter in these southern areas, with immatures tending to winter further south. This may explain why we see a significant difference between the age structure of *Erika* and *Prestige* birds, but no difference in their origin.

In the North Sea, the pattern was not so clear, though a high proportion of Guillemots recovered after North Sea and English Channel spills originated from colonies in eastern Scotland and the Northern Isles. In general, birds recovered further north were more likely to be immatures, whereas those recovered further south in the North Sea were more likely to be adults. Interestingly, the two adjacent spills in the North Sea (*Braer* and *Stylis*) occurred at a similar time of year, but lead to recoveries of birds from significantly different areas. Birds found after the *Stylis* spill originated from colonies in the Northern Isles, whilst those from the *Braer* spill (which occurred in the Northern Isles) originated from eastern Scotland.

The calculations of the estimated minimum numbers of birds affected by the three largest spills can give an indication of the possible impact on these breeding colonies. What is of most interest is the age structure of those birds killed. Knowing that most birds in the English Channel in winter are likely to be adults, any pollution incident will have a very direct impact on the numbers of returning breeding birds to eastern colonies. The effect of a spill further south will be less severe, as this would be expected to affect mostly immature birds that have not yet entered the breeding population. In this case, unless a very high proportion of an age class died, it is less likely that a population effect

would be found as the mortality could be compensatory rather than additive. If the mortality is compensatory, the same number of birds would still be available to enter the breeding population in later years.

ACKNOWLEDGEMENTS

The BTO is indebted to all of its volunteer ringers who annually visit seabird colonies to ring thousands of birds. I thank all of the volunteers who religiously reported ringed birds back to us allowing these analyses to be carried out, especially Rubén Moreno-Opo Díaz-Meco from the Ministerio de Medio Ambiente in Spain. Thanks also to Roddy Mavor of the JNCC seabird team for supplying colony count data and to Jacquie Clark and Rob Robinson for comments on earlier drafts of the paper.
The BTO Ringing Scheme is funded by a partnership of the British Trust for Ornithology, the Joint Nature Conservation Committee (on behalf of English Nature, Scottish Natural Heritage and the Countryside Council for Wales, and also on behalf of the Environment and Heritage Service in Northern Ireland), National Parks and Wildlife (Ireland) and the ringers themselves.

LEEFTIJDSSAMENSTELLING EN HERKOMST VAN BRITSE EN IERSE ZEEKOETEN GEVONDEN TIJDENS RECENTE EUROPESE OLIERAMPEN

Na diverse recente grote olieverontreinigingen die invloed hadden op Zeekoeten *Uria aalge* broedend in Groot-Brittanië en Ierland, heb ik onderzoek gedaan naar de herkomst van de geringde vogels die werden gemeld tijdens deze incidenten. Doel hiervan was het beschrijven van het belang van de verschillende overwinteringsgebeiden voor deze soort. De resultaten laten significante verschillen zien in leeftijdsamenstelling en herkomst van broedvogels die betrokken waren bij de verschillende olieverontreinigingen. Dit wijst op het bestaan van verschillende overwinteringsgebieden voor verschillende broedpopulaties. Overwinteraars in de 'Southwestern Approaches' en zuidelijker in de Golf van Biskaje (betrokken bij de *Prestige*-ramp) waren over het algemeen onvolwassen vogels van kolonies in het westen van Groot-Brittannië en Ierland. Overwinteraars in het Kanaal en de Noordzee (betrokken bij de *Tricolor*-ramp) waren over het algemeen adulte vogels uit kolonies in het oosten van Groot-Brittannië. Generaliserend, onvolwassen vogels leken verder van hun (geboorte)kolonies te overwinteren dan adulte vogels. Door een beter begrip van de dispersiepatronen en overwinteringsgebieden van dergelijke vogels kunnen we inschatting maken van de mogelijke invloed van olierampen op populaties.

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Appendix 1. Estimating numbers of birds from main colonies affected by each spill

To estimate the numbers of birds from Great Saltee affected by the Erika spill, we need to know the number of birds recovered from each annual cohort, the number of birds ringed each year and the colony size in those years.

To calculate the total number of birds affected, we need to calculate the proportion of birds ringed in each year that were later recovered in the spill:

Proportion of birds recovered = number recovered / total number ringed
e.g. From the 1999 cohort, the proportion of birds recovered = 28 / 1,799 = 0.01556

This figure can then be extrapolated by multiplying by the number of nestlings fledged from the colony. This is calculated using population figures (in number of individual adults counted) from Seabird 2000. This figure is multiplied by 0.67 to give the number of occupied sites (AOS) (see Lloyd *et al.* 1991), and then multiplied by 0.8 (productivity per nest), to give a measure of annual productivity. A figure of 0.8 chicks per pair was used for productivity as Cramp (1995) shows figures from several studies of productivity ranging from 0.75-0.85.

Nestlings fledged from colony = number of individuals counted x 0.67 x 0.8
For the 1999 example, nestlings fledged from colony = 19,700 x 0.67 x 0.8 = 10,559

Assuming the same factors affect ringed and unringed birds, we can extrapolate the data for ringed birds to the whole population (ringed and unringed), and estimate the total number of birds affected:

Number affected = proportion of ringed birds recovered x number fledged
In the 1999 example, number affected = 0.01556 x 10,559 = 164

This same calculation is then run for each year where ringed birds were recovered, giving a minimum estimate of mortality for the whole colony.

Ringing year	Number of cohort recovered	Number ringed	Number of individuals in colony	Total number affected
1981	1	1,775	16,963	5
1985	1	1,822	16,963	5
1992	1	2,541	15,600	3
1993	1	2,998	15,000	3
1994	9	2,799	14,584	25
1995	4	2,798	15,700	12
1996	7	2,791	16,936	23
1997	3	2,316	17,600	12
1998	18	2,174	18,274	81
1999	28	1,799	19,700	164
TOTALS	73			333