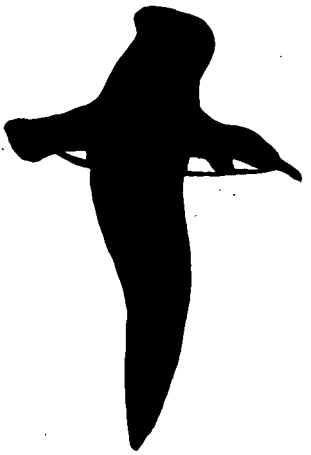
SEABIRD REPORT 1977-1981



SEABIRD GROUP No. 6

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1977–81
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Editors:
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CONTENTS

EDITORIAL

It is twelve years ago that the Seabird Group undertook its most ambitious project, a national census of seabirds in Britain and Ireland. This project involved a few hundred people, a full-time organizer and a committee to oversee it. It provided a more detailed review of our breeding seabirds than had ever before been undertaken, and as such it served as a valuable baseline for future surveys. However, it also highlighted the need for more accurate and meaningful methods for censusing seabirds. For many species, a single count can represent an error as high as 50% of the mean number present at the colony. Since most of the censuses carried out during 'Operation Seafarer' involved single counts, the figures obtained must be taken with some caution, particularly for species such as Puffin, Razorbill and Guillemot whose attendance may vary greatly at different times of day, stages of the season and weather conditions. So one may ask, is there any point in counting seabirds at all, at least if only single counts are possible? Was 'Operation Seafarer' all in vain? Fortunately the answer to the latter question is no. 'Operation Seafarer' at least provided the order of magnitude for most species, identified the more important colonies, and located a number of others previously undocumented. Since then many studies have been examining carefully those factors most important in determining colony attendance patterns. We have clearer definitions of the best counting unit to use for each species, and counting conditions have now been refined to take account of diurnal and seasonal variation and the effects of weather. Thus single counts may themselves give us a reasonable idea of the numbers present. Such whole colony assessments are necessary for an approximate estimate of overall population size. If colonies are carefully mapped and photographed these will provide important additional information to identify the colony location since colonies come and go with time. A number of the papers included in this volume attempt to compare recent counts with ones made during 'Operation Seafarer' or before. Often they have run into problems to discover the counting methods used previously, the timing of the counts and weather conditions prevailing. Without this information it has been difficult to make a meaningful comparison of changes in numbers from year to year.

Whereas whole colony counts are useful for estimates of overall population size, they cannot be used to determine changes in status of a species over a period of years since they are rarely sufficiently accurate. This requires more detailed counts (at least five per season) at carefully selected study plots. The Seabird Group in conjunction with the RSPB and NCC have set up a number of such study plots for colonies of Fulmars, Kittiwakes, Razorbills and Guillemots distributed over the whole of Britain with a small number in Ireland. Already their results are indicating general changes in status for certain species: Kittiwakes have declined in recent years in colonies at Orkney and Shetland, and elsewhere their increase has slackened off; Guillemots have increased in colonies off North Scotland although in western Scotland numbers have remained stable or declined slightly. It would be useful if further species such as Black Guillemot and Puffin were included in these monitoring studies, and if certain areas of Britain and Ireland such as Cornwall, West Wales, North-East Scotland and South-West Ireland were given better coverage.

Such apparent changes of status do not by themselves indicate the causes for them. Changes in numbers counted at a colony may be due to a change in the proportion of non-breeders (since study plot counts can rarely separate breeders from non-breeders although it is possible to minimise counts of the non-breeding element in some species). If the breeding population size has altered this may result from previous changes in

reproductive success or from post-fledging mortality. It is quite important to identify which occurs. A shortage of food available to a species during the breeding season may result in low reproductive output; so may high predation or disturbance. After fledging, there are many factors which may affect mortality: food shortages (and this may operate through unfavourable weather conditions for obtaining that food, or by declines in the food species themselves, or competition with other bird and mammal species including man); oil pollution; pesticide or heavy metal contamination; incidental kills in fishing nets; or higher levels of predation. Higher rates of mortality may occur in the first few months after fledging or in the immature phase of the life cycle or in adulthood. If we are to understand changes in breeding seabird numbers, we must address ourselves to these problems. We must monitor breeding success and output, causes of egg and nestling mortality and growth rates of young at selected colonies and then follow up these studies by long-term colour ringing programs to construct life tables for different species in a number of areas geographically spread over Britain and Ireland. Some of these studies may be more the province of professionals but many can be carried out by amateurs so long as they are prepared to 'work their patch' over the long term. By such means they can not only reap the rewards of a greater understanding of the population dynamics of their own colonies, but they will add important dimensions to our overall knowledge and understanding of the population changes of seabirds.

Knowledge of the factors determining breeding success and production at the colony will provide partial understanding of the population dynamics of seabirds. However, the great gap in our understanding lies in our knowledge of the ecology of birds at sea. This is not surprising because of the difficulties of studying seabirds at sea. Rarely do we know what food species are taken by seabirds outside the breeding season, nor the differences in diet between adult and young. We are only beginning to learn some details of the movements of particular seabird species but there are many specific questions unanswered. Why, for example, do guillemots move across the northern North Sea from Shetland and Orkney after the breeding season as preliminary results suggest? How much mixing of populations occurs in autumn and winter for many auk species? Do some age groups remain in the vicinity of breeding colonies throughout the year, and if so, are they from those local colonies or from elsewhere?

If we are to extend this knowledge we must spend more time at sea studying these problems. It is for these reasons that the Seabird Group in conjunction with the Nature Conservancy Council has concentrated efforts to build up a data bank from regular sea-watching sites, improving coverage of ferry routes to determine geographical and seasonal variation in densities of different species, and carrying out more detailed ecological work at sea with research cruises and aerial surveys. Any further help towards these aims from volunteers would be greatly welcomed.

P. G. H. Evans
T. R. Birkhead

Population, breeding biology and diets of seabirds on Foula in 1980

R. W. Furness

Continuing a series of annual expeditions to study seabirds on Foula, a team of nine (I. Burrows, B. L. Furness, R. W. Furness, E. Galbraith, H. Galbraith, S. McGinlay, M. L. Tasker, N. Williams and A. Wood) visited Foula between 24 June and 15 July 1980. The primary aims of the expedition were:

1. to ring large numbers of the species considered by SOTEAG to be vulnerable to oil pollution
2. to ring, measure and weigh about 50% of the skua chicks
3. to dye seabirds as part of a cooperative study
4. to census and map Great Skuas, Arctic Skuas, *Larus* gulls and Arctic Terns

TABLE 1. NUMBERS OF BIRDS RINGED BY OUR EXPEDITION ON FOULA IN 1980. (IN ADDITION SMALL NUMBERS WERE RINGED BY A BRATHAY EXPEDITION: THEIR TOTALS ARE NOT INCLUDED HERE)

Species	*Age*	*Number ringed*	*Controls, retraps and recoveries*
Red-throated Diver	adult	1	1
Fulmar	adult	278	78
	chick	1	
Storm Petrel	adult	60	3
Leach's Petrel	adult	1	
Shag	adult	93	12
	chick	1047	
Eider	adult	2	1
Oystercatcher	chick	7	
Ringed Plover	chick	2	
Dunlin	chick	1	
Snipe	adult	1	
Great Skua	adult	0	48
	chick	1793	
Arctic Skua	adult	0	2
	chick	178	
Great Black-backed Gull	chick	38	
Common Gull	chick	5	
Kittiwake	adult	7	2
	chick	38	
Arctic Tern	chick	1048	
Razorbill	adult	192	1
	chick	99	
Guillemot	adult	433	8
	chick	342	
Black Guillemot	adult	6	2
Puffin	adult	401	7
	chick	95	
Starling	adult	1	
	chick	2	
Rock Pipit	chick	3	
Total		6175	165

5. to record numbers, distribution and breeding success of Red-throated Divers and Eiders
6. to determine timing of breeding and productivity of Arctic Terns, Kittiwakes, Shags and skuas
7. to sample seabird diets
8. to collect (under licence) a sample of adult Great Skuas of known age for pollutant analysis
9. to obtain biometrics for adult seabirds, particularly auks
10. to continue annual monitoring of selected sites.

TABLE 2. TIMING OF BREEDING SEASONS ON FOULA IN 1980. FIRST DATES OF HATCHING, FLEDGING FOR SPECIES.

Species	*Criterion*	*Date*
Red-throated Diver	1st hatched	10 June (estimated from chick size on 24 June)
Fulmar	1st hatched	3 July
Shag	1st fledged	1 July
Eider	median bird onto sea	10 July (estimated from coastal counts)
Oystercatcher	1st fledged	7 July
Great Skua	1st fledged	14 July
Arctic Skua	1st fledged	11 July
Great Black-backed Gull	1st fledged	12 July
Kittiwake	1st fledged	13 July
Arctic Tern	1st fledged	10 July
Razorbill	1st on sea	24 June (or earlier)
Guillemot	1st on sea	24 June (or earlier)
Black Guillemot	1st hatched	4 July
Puffin	1st hatched	1 June (sample of 76 chicks)
	median hatching date	18 June (sample of 76 chicks)

RESULTS

Ringing

The expedition ringed a total of 6,175 birds and recovered, controlled or retrapped a further 165 birds ringed elsewhere or on Foula in earlier years (Table 1). For most species the numbers ringed were higher than in previous years as we obtained free rings for auks (BTO), Shags, Eiders, Arctic Terns, Red-throated Divers and Kittiwakes (SOTEAG). Owing to the exceptionally early breeding season the totals for many species were lower than they might have been, while inclement weather impeded ringing of auks and Storm Petrels.

Skua chick measurements

Most of the skua chicks we ringed were also measured and these will be used to compare timing of breeding and chick condition and growth with data from previous seasons.

Dye-marking

CIBA-GEIGY water soluble dye supplied by P. G. H. Evans was used to mark 200 adult Fulmars at inland nest sites at the start of the expedition. Visits to these nests over the next four days showed that the dye had washed off very rapidly and was no longer detectable after four days. Dissolving the dye in 95% alcohol with a drop of detergent added improved the binding properties marginally but further dye-marking was abandoned as the dye was clearly inappropriate for staining feathers (or human skin).

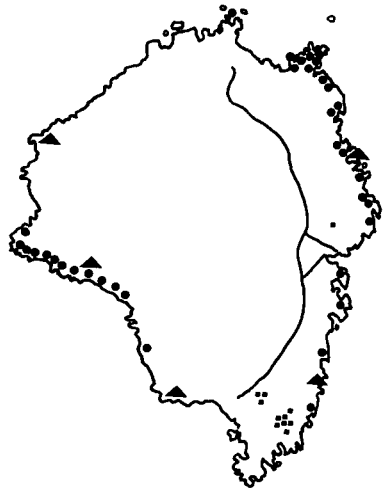

Figure 1. Distribution of Great Black-backed Gull, Herring Gull and Common Gull nests on Foula in 1980. The road is marked on this and Figure 2 as a continuous heavy line. Crofted areas of the island are confined to the vicinity of the road.

● 35 pairs Great Black-backed Gull
▲ 5 pairs Herring Gull
■ 11 pairs Common Gull

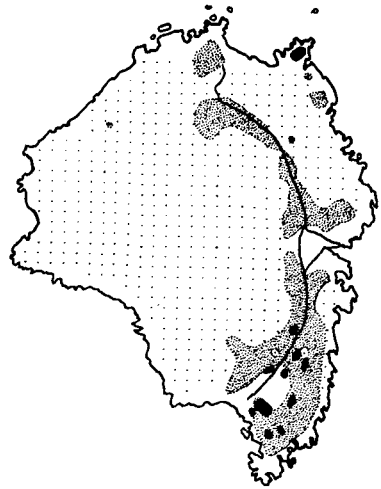

Figure 2. Distribution of Great Skua, Arctic Skua and Arctic Tern colonies on Foula in 1980. Arctic Skua colonies are marked by solid black, Arctic Skua by heavy stippling and Great Skua by a star grid pattern. Numbers of pairs in each colony were estimated at 4200 pairs of Arctic Terns, 262 pairs of Arctic Skuas and 2670 pairs of Great Skuas.

Numbers and distribution of skuas, gulls and Arctic Terns

All gull nests are individually mapped (Figure 1). Numbers of incubating or brooding Arctic Terns were counted on 25 June, when laying was probably completed but very few eggs had hatched. Skua territories were mapped and counted over several days between 1 and 7 July (Figure 2). Changes in numbers of these species are discussed elsewhere (Furness 1977, 1981, in press).

Red-throated Divers

Eleven pairs attempted to breed. All the traditional lochs and lochans were occupied (Furness 1981). Both adults were caught at Sandvatten Loch. One had been ringed there in 1979, adding to the evidence that birds breed at the same site each year. Few data are available on adult measurements in Britain. The male weighed 1,870 g, with wing length 297 mm and bill length 55.5 mm. The female weighed 1,730 g, had a wing length of 288 mm and a bill length of 52.5 mm. On 15 July three pairs had failed, but the remaining eight had six chicks and two unhatched clutches. Their progress will have been recorded by the Brathay expeditions.

Eiders

Coastal counts on 25 June, 7 and 12 July gave between 70 and 87 males, but only 27 to 43 females on the sea. Many females were still incubating and yet to take their chicks to sea. The first count gave 1.4 chicks per female but this proportion declined to 0.5 chicks per female on 12 July. These results are similar to those of previous years but indicate that the Foula Eider population is slowly declining.

Arctic Terns

Total numbers of nests were similar to 1979, with an estimated 4,200. An increasing proportion of nests occur in the hayfield at Bankwell (3,000) with the dry heath areas around the Airstrip where most birds used to nest now holding only 1,000 pairs. At the small colony at Strem Ness contained 200 pairs. At Strem Ness and Bankwell most eggs were hatching on 26 June but very few hatched on the dry heath areas before 5 July. On 7 July large numbers deserted the island. Virtually all pairs which had not hatched left their eggs. As a result probably no chicks fledged from the Airstrip area, but 100 fledged or were close to fledging on Strem Ness on 15 July and 2,000 were fledged or nearly fledged at Bankwell. A sample of 98 nests was examined at Bankwell on 26 June. Eighteen contained one egg, 67 contained two, 11 contained three and two contained four. However, both clutches of four and some of three are likely to have been laid by more than one female using the same nest.

Kittiwake

Numbers of nests in the two monitoring areas were again lower than previously. Selchie held 347 apparently occupied nests on 13 July compared to 408 found there in 1973. Logat held 109 where there had been 148 in 1975. A single boat trip round the island also gave the impression that Kittiwake numbers were down at most other breeding stations on the island. Breeding success in 1980 was higher than in 1979 but lower than in 1976, 1977 or 1978. On average 1.2 chicks per nest were reared to large size compared to 1.19 in 1979 and 1.48 in 1976.

Timing of breeding

Detailed data for skuas have yet to be examined. First dates are given in Table 2. These show that the season was generally an early one for seabirds, but slightly later than usual for waders and *Larus* gulls.

Diets

Food samples were obtained by collecting dropped fish, regurgitates, and by mist netting. Regurgitated pellets and prey remains were collected at skua and gull nests and gathering areas and have yet to be analysed. Species composition and fish sizes are given in Table 3 for auks, Kittiwake, Arctic Tern and Shag.

TABLE 3. SPECIES AND SIZES OF FISH BROUGHT TO CHICKS BY AUKS, KITTIWAKES, ARCTIC TERNS AND SHAGS AT FOULA IN 1980. EACH RAZORBILL, GUILLEMOT AND ARCTIC TERN CARRIED ONLY ONE FISH BUT OTHER SPECIES CARRIED SEVERAL. WHERE SEVERAL FISH FELL INTO THE SAME 5 MM LENGTH CATEGORY THE NUMBER IS GIVEN IN PARENTHESES.

Species	*Date*	*sandeel (Ammodytes marinus) lengths (mm)*	*Other prey (mm)*
Guillemot	5 July	150, 153(3), 165, 170(2)	
	6 July	105, 120(2), 150, 155(2)	Gadoid (species not determined) 65(2)
Razorbill	5 July	65, 75(7), 85(2), 90(2), 95, 100, 105, 120(3)	
Puffin	24 June	40(3), 100(2)	
	5 July	75(2), 90, 110, 120(4), 130	
	7 July	65, 80, 85, 95, 105, 110(2), 115(2), 120(3), 125(2), 135(3), 170	
	12 July	100(2)	Gadoid (species not determined) 30(12) Angler Fish (*Lophinus piscatorius*) 65(2)
Kittiwake	28 June	120(10), 130(8)	
Arctic Tern	24 June	30(21), 40(16), 50(8), 90(3), 100(8), 110(2)	
	3 July	40, 75, 80, 90	
	5 July	100	Butterfish (*Pholis gunnellus*) 95
	8 July	40(12), 50(6), 60(22), 70(38), 80(18), 90(6), 100(4), 110(3)	
Shag	25 June	120(4), 130(8)	
	4 July	120(4), 130(4)	
	5 July	80(10)	
	9 July	95(8)	
	12 July	100(8), 120(31), 160(4)	

Biometrics

Measurements of adult seabirds are given in Table 4 (Great Skua) and 5 (Guillemot and Razorbill).

TABLE 4. BIOMETRICS OF ADULT GREAT SKUAS SHOT FOR POLLUTANT ANALYSES OR TRAPPED ON FOULA 26–28 JUNE 1980.

Sex	*Age (years)*	*Weight (g)*	*Wing length (mm)*	*Bill length (mm)*	*Bill depth (mm)*	*Tarsus length (mm)*	*Crop content*
Male	5	1300	418	50.0	17.3	69	Sandeels
	5	1250	412	—	16.7	66	—
	9	1340	393	48.2	17.2	71	—
	6	1480	419	50.0	17.9	73	—
	15	1300	424	47.8	17.2	71	—
	5	1340	418	50.2	18.2	71	—
	13	1370	416	48.3	17.7	71	—
	13	1300	413	49.2	18.2	68	—
	—	1270	410	49.8	16.8	67	Whitefish
	—	1500	431	51.8	18.2	70	Sandeels
	—	1180	412	46.4	16.9	67	—
	—	1420	411	48.8	17.8	69	Squid
	—	1330	414	49.8	17.0	68	Sandeels
	—	1330	415	51.5	17.2	66	Sandeels
	—	1300	407	48.0	17.5	68	Sandeels
	—	1340	399	49.6	17.9	65	—
	—	1300	407	47.7	17.4	68	—
	—	1240	421	48.4	18.0	69	—
	—	1380	413	47.8	17.9	71	Sandeels
	—	1340	397	49.0	17.6	69	—
	—	1500	402	50.2	17.7	71	Sandeels
Female	5	1420	416	50.7	18.1	68	Sandeels
	11	1490	424	52.0	17.3	70	Sandeels
	9	1490	417	48.3	17.2	71	—
	—	1550	425	47.5	17.1	68	Sandeels
	—	1480	416	49.2	17.3	70	Sandeels
	—	1650	425	49.8	18.2	68	—
	—	1550	417	50.0	17.5	71	Sandeels
	—	1450	421	50.3	18.1	68	Sandeels
	—	1450	421	50.3	18.1	68	Sandeels
	—	1520	426	44.4	17.9	63	—
	—	1300	427	51.5	18.3	66	—
	—	1460	414	49.2	17.5	69	—
	—	1550	423	49.8	17.6	67	Sandeels
	—	1580	424	50.2	18.1	73	Sandeels
	—	1450	417	50.3	18.0	68	Sandeels
	—	1490	425	51.0	18.3	66	Sandeels
	—	1500	420	49.7	18.5	70	Sandeels
	—	1450	417	51.4	17.3	68	—
	—	1470	434	47.8	17.6	70	—
	—	1540	425	51.8	17.6	69	Sandeels
	—	1440	427	48.5	17.7	68	—

TABLE 5. SUMMARISED MEASUREMENTS OF ADULT RAZORBILLS AND GUILLEMOTS CAUGHT AT BREEDING COLONIES AND THOUGHT TO BE BREEDING ON FOULA IN JUNE-JULY 1980.

(all in mm)

Species	*Wing length* mean ± SD	*Bill length (culmen)* mean ± SD	*Bill depth (gonys)* mean ± SD
Razorbill	197.8 ± 4.0	33.0 ± 1.7	20.6 ± 1.0
sample size	63	70	70
Guillemot	207.3 ± 3.7	47.1 ± 2.4	13.45 ± 0.66
sample size	38	66	67

1. Many of the Guillemots had severely abraded primaries and were not measured so this mean is larger than it would be if all individual wing lengths had been taken.

Colour ringed Great Skuas

Great Skua chicks on Foula have been colour ringed by year class since 1968. Many of these are now breeding or attend nonbreeder gatherings. Information on ages of first breeding and maximum ages of nonbreeders was gathered by searching for colour marked birds whose status could be determined. Ages of colour marked birds in breeding territories, holding territories but not breeding, and on nonbreeder gathering areas are given in Table 6.

TABLE 6. NUMBERS OF GREAT SKUAS OF KNOWN AGE (COLOUR RINGED OR TRAPPED RINGED INDIVIDUALS) (a) IN AREA PARTIALLY CULLED OVER A NUMBER OF YEARS (b) IN BREEDING TERRITORIES IN OTHER PARTS OF FOULA (c) IN TERRITORIES ESTABLISHED IN 1980 AND NOT YET BREEDING, AND (d) ON PREBREEDING GATHERING SITES (CLUBS) ON FOULA IN JUNE JULY 1980.

Age (years)	*a adults in a culled area*	*b adults in breeding territories*	*c birds moving into territory but not yet breeding*	*d birds on club sites*
3	0	0	0	11
4	1	0	1	29
5	8	2	5	34
6	4	2	3	22
7	1	1	1	2
8	0	0	0	0
9	4	0	0	0
10	1	0	0	0
11	4	1	0	0
12	2	4	0	0
13	4	0	0	0
14	0	0	0	0
15	2	0	0	0
Total located	31	10	10	98

Chick growth

Data for skua and Shag chicks have yet to be examined. 76 Puffin chicks were weighed and measured on 10 July. Ages of these chicks were estimated by Dr M. P. Harris using growth curves for Isle of May chicks. The median age was 22 days, suggesting a median hatching date of 18 June. Regression of weight on wing length gave the equation weight = 21.2 + 2.33 Wing length. Similar data for Boreray gathered in 1980 showed that the Foula chicks had a greater weight increase per millimeter of wing length (Harris in litt.) suggesting that food supplies of the Foula birds may have been better.

Retraps, controls and recoveries

Most of the ringed birds found on Foula in 1980 had been ringed there in previous years. One Puffin had been ringed as an adult in July 1960 and was found dead and incorporated into a Shag nest near to the site of ringing on 6 July 1980. An Arctic Skua caught by dazzling at its nest on 27 June 1980 had been ringed as a chick on Foula in 1973. Several adult Shags were caught with partly illegible rings. The oldest had been ringed in 1969 or 1970, but a ring put on in 1974 had one digit illegible. We have experimented with a different ringing technique which may reduce wear on the inscription but will have to wait to see if this works. A Black Guillemot caught on its nest on 12 July 1980 had been ringed as a chick in the same colony on 7 August 1961, although ring wear made it impossible to identify the individual concerned.

CONCLUSIONS

Although impeded by bad weather we achieved ringing totals close to our objectives. We plan to continue seabird work on Foula in future years but with emphasis on studies of seabird diets, Shag and skua biology. The influence of food availability was clearly evident in 1980. For some unknown reason food became very short around 7 July, causing terns to desert, Shag chicks to lose rather than gain weight, skuas to indulge in cannibalism and to spend unusually long feeding at sea. In most years almost all the fish brought to Foula by auks, terns, Shags and Kittiwakes are Sandeels but in 1980 a number of Gadoids, Angler fish, Butterfish and invertebrates were recorded. Although the evidence points to a scarcity of Sandeels, Shetland fishermen caught record quantities of Sandeels in 1980 and catches had to be limited at one stage as they exceeded the capacity of local processing plants. Any relationship between Sandeel stock size, fish landings and seabird diets is impossible to determine at present as Sandeel stocks are still unmeasured.

ACKNOWLEDGEMENTS

I thank I. Burrows, B. L. Furness, E. Galbraith, H. Galbraith, S. McGinlay, M. L. Tasker, N. Williams and A. Wood for taking part in the expedition. We thank the Seabird Group and Glasgow University for financial support towards travel costs and purchase of rings, the BTO and SOTEAG for free rings for certain species, Dr M. G. Richardson and D. Okill for assistance during our travel in Shetland, and all the Foula islanders for their help and interest.

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Breeding seabird populations in the coastal regions of Yell Sound, Shetland

D. A. Hill and J. A. Fowler

INTRODUCTION

Cramp, Bourne and Saunders (1976) describe a census of seabird species conducted in 1969/70 (Operation Seafarer). One of the main aims of the census was to provide a baseline against which future changes in seabird populations could be assessed. In 1978 the west coast of Yell from Gloup Ness in the north to Ulsta in the south was censused. In 1979 this same piece of coastline was censused together with that from Ulsta to Salt Ness at the south of Yell, and the mainland east coast from Gluss Isle to the Isle of Fethaland. This enables a comparison to be made between the census counts of 1969/70 and both 1978 and 1979. The aims of this paper are to consider: (a) changes in the spatial distribution of breeding seabirds along the coast; and (b) significant increases or decreases in numbers, for breeding populations of Fulmar, *Fulmarus glacialis*; Puffin, *Fratercula arctica*; Shag, *Phalacrocorax aristotelis*; Herring gull, *Larus argentatus*; and Great Black-backed gull, *Larus marinus*.

METHODS

The coastline divisions are the same as those employed in Operation Seafarer except that on the mainland coast a number of small divisions are aggregated, dividing the entire west coastline of Yell into six units (Fig. 1). Counts were made between 11-17 July 1978 and 25-30 June 1979.

Census counts of seabirds considered to be breeding were obtained by walking predetermined divisions of the coast. Fulmars were accepted as breeding if birds were sitting on eggs and considered not to be 'loafing'; censusing is made difficult in this species by many non-breeders settling and displaying on ledges, and also by the presence of mates at the nest-site. Counts of Puffins were probably underestimated and Harris (1976) notes that the number of Puffins visible at a colony can fluctuate markedly in a single day; counts are most usefully done early in the morning or in the evening, when numbers usually peak. Counts in this study were undertaken before midday. Shags were censused by counting birds sitting on nests, and nests surrounded by guano when no birds were sitting. Estimates of both Great Black-backed and Herring gull were obtained mainly from nest counts as adults were incubating eggs during the census. Herring gull numbers were probably underestimated; when in a mixed colony with Lesser Black-backed gulls, care was taken not to confuse nests of either species.

Counts from the three censuses were analysed firstly by evaluating the equality of the within variances. If, in the between year comparisons the within variances were significantly different then the non-parametric Wilcoxon signed ranks test was used to test for a significant difference of means; the parametric paired comparisons test was used when the within variances were not significantly different (Sokal and Rohlf, 1969). The F test effectively identifies significance in the difference in spatial distribution, between the two counts being compared.

Results and Discussion

A comparison of mainland coast counts from 1969/70 and 1979 showed no statistically

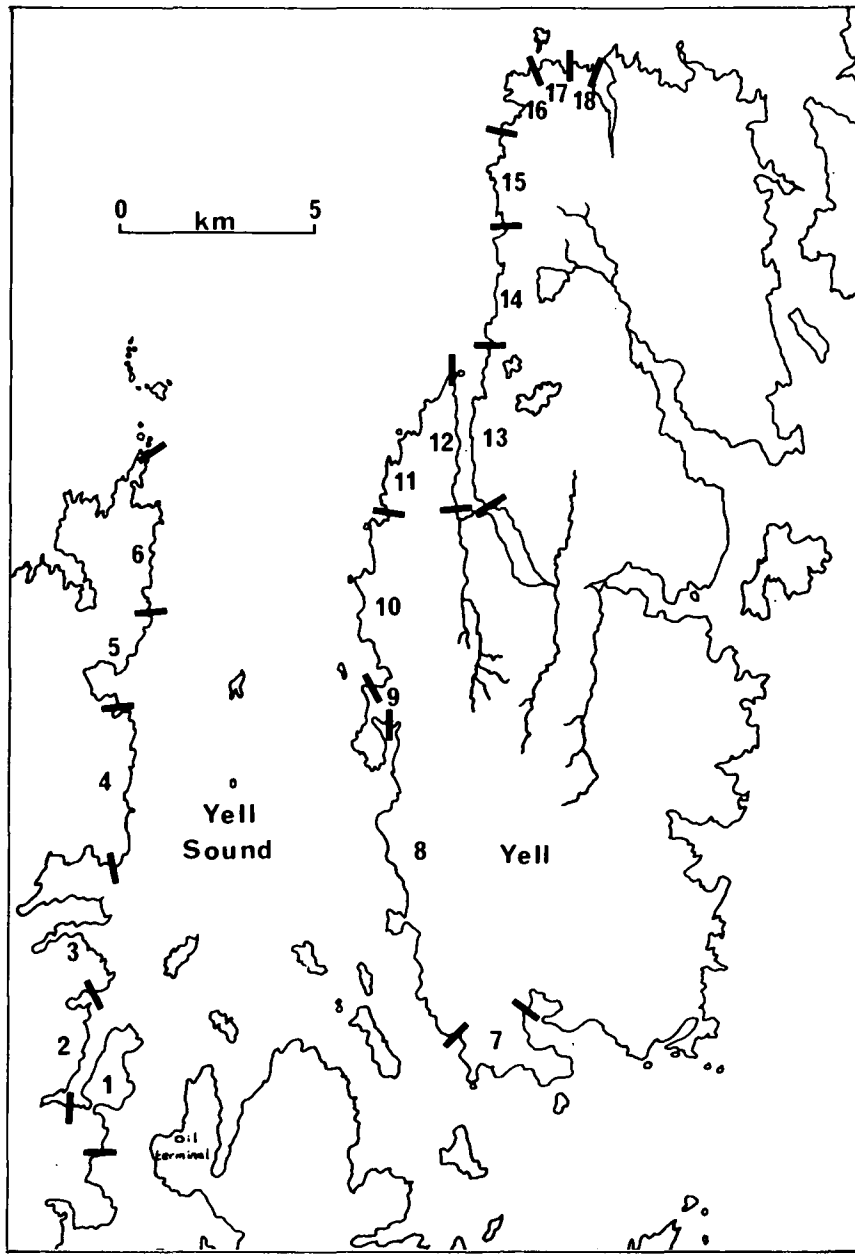

Figure 1. Map of Yell Sound with divisions of coastline for counting marked.

significant increases in any of the four species studied: Fulmar Shag, Herring gull and Great Black-backed gull. However the Shag and Great Black-backed gull occurred in significantly different stretches of coastline (F test, $P<0.005$ and $P<0.025$ respectively; Appendix I). Numbers of these two species were higher further north towards the Isle of Fethaland (area 6, Fig. 1) in 1969/70. The numbers of breeding Fulmars and Herring gulls remained remarkably constant between counts, the majority of birds being found around the Isle of Fethaland at the northern tip of the mainland (Fig. 1).

The east coast of Yell Sound, censused in 1969/70 and 1978, showed no significant increase in the numbers of breeding Fulmar, Puffin, Herring or Great Black-backed gull (Appendix II). Numbers of Fulmar were only 7% higher in 1978 than in 1969/70. Both Herring and Great Black-backed numbers have increased although not significantly, which may be an artifact of such a small sample size. Puffin, Herring and Great Black-backed gull may have changed their distribution slightly; Puffins were observed along the west coast of Graveland (areas 10, 11 and 12, Fig. 1) in 1978 but not in 1969/70 as most in that year were seen near Gloup Ness (areas 15, 16 and 17, Fig. 1). The 400 birds seen in 1969/70 at the most northern tip of Yell (areas 16 and 17, Fig. 1) were not present in 1978, and only 30 were seen there in 1979. Problems in evaluating the numbers of breeding Puffins and the interpretation of available counts have already been discussed. Herring gulls were more abundant further north along the west Yell coast from Operation Seafarer counts; two areas which were observed to have breeding Herring gulls in 1978 were west Graveland (area 11, Fig. 1), and the west coast of Whale Firth (area 13, Fig. 1).

Comparing the two census counts of 1978 and 1979 for the east coast of Yell Sound, breeding populations of Puffin, Herring gull and Great Black-backed gull showed no significant increase (Appendix II). These three species were also observed in the same divisions of coastline. However the breeding Fulmar population showed a significant 61% increase from 2452 to 3951 (t test; $P<0.05$), the majority of this difference being due to much larger concentrations on the west Graveland coast. Fulmar numbers were also much higher in 1979 between Westsandwick and the Point of Burgarth (areas 9 and 10, Fig. 1). No significant change in breeding distribution was exhibited by the Fulmar.

From the present evidence derived from counts which may contain a number of biases, none of the five species censused were shown to have declined significantly between 1969/70 and 1979. Of these five only the Fulmar has shown a significant increase, which occurred between 1978 and 1979. The reason for this increase is not known.

Few Shags were observed breeding in the area censused in either 1969/70, 1978 or 1979. This may be due to good quality nest sites being unavailable, which Potts, Coulson and Deans (1980) suggests is an important factor restraining the growth of Shag populations; only 4% of nest sites were considered to be satisfactory.

Puffin numbers were low around the coast censused in this study compared for example with Hermaness, the highest counts being obtained from the Isle of Fethaland.

The effects of recent oil spillages in the Sullom Voe area on breeding seabird populations is difficult to determine from the above analyses since there are likely to be a number of biases in the census technique. Tidal action in Yell Sound is likely to increase the effects of crude oil in that it is swept first one way and then the other, penetrating many geos and remaining in them for long periods of time. The land adjacent to the oil terminal has few seabird colonies; however spillages are hardly ever contained within such discrete areas and more serious effects may be felt further north and to the south where there are larger breeding colonies.

ACKNOWLEDGEMENTS

Contributions towards the costs of the Leicester Polytechnic expedition in collaboration with Loughborough University were gratefully received from the British Ecological Society, British Petroleum, the British Trust for Ornithology, the Nature Conservancy Council, the RSPB, the Seabird Group, SOTEAG and the World Wildlife Fund. We thank R. J. Tulloch of Mid Yell for his courtesy and guidance.

SUMMARY

Comparisons are made between census counts of breeding seabirds of the maritime approaches to Sullom Voe from Operation Seafarer in 1969/70, and others carried out by a Leicester Polytechnic expedition in collaboration with Loughborough University in 1978 and 1979. Analysis was confined to five species: Fulmar, Puffin, Shag, Herring gull and Great Black-backed gull to determine (a) significant changes in numbers, and (b) changes in the spatial distribution between censuses. Only the Fulmar showed a significant increase in its breeding population between 1978 and 1979 on the east coast of Yell Sound. The Shag moved further north between 1969/70 and 1979 on the west coast of Yell Sound, and the Puffin, Herring gull and Great Black-backed gull changed their distributions between 1969/70 and 1978 on the east coast of Yell Sound. Difficulties in census techniques are outlined.

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APPENDIX I. COUNTS OF SEABIRDS (OCCUPIED NEST SITES) ALONG THE WEST COAST OF YELL SOUND FOR 1979. FIGURES IN PARENTHESES ARE COUNTS FROM OPERATION SEAFARER IN 1969/70.

Division of coastline	*Fulmar*	*Shag*	*Herring gull*	*Great Black-backed gull*
1. Gluss Isle	20 (13)	1 (—)	2 (—)	— (—)
2. Gluss Ayre to East Ness	14 (12)	— (—)	— (—)	2 (—)
3. East Ness to Neap of Skea	267 (472)	— (—)	11 (—)	1 (—)
4. Neap of Skea to Ness of Houlland	426 (257)	2 (—)	— (—)	— (—)
5. Ness of Houlland to Ness of Burravoe	223 (149)	6 (—)	— (—)	— (—)
6. Ness of Burravoe to Isle of Fethaland	1071 (820)	5 (34)	10 (22)	6 (18)
TOTALS	2021 (1723)	14 (34)	23 (22)	9 (18)

APPENDIX II. COUNTS OF SEABIRDS (OCCUPIED NEST SITES) ALONG THE EAST COAST OF YELL SOUND FOR 1979. FIGURES IN ROUND AND SQUARE BRACKETS ARE COUNTS FROM 1978 and OPERATION SEAFARER (1969/70) RESPECTIVELY.

Division of coastline	*Fulmar*	*Puffin*	*Herring gull*	*Great Black-backed gull*
7. Saltness to Ulsta	11	—	—	—
8. Ulsta to Westsandwick	229	—	—	—
	(145)	(—)	(—)	(—)
	[c.30]	[—]	[—]	[—]
9. Westsandwick to Point of Burgarth	662	—	—	—
	(265)	(—)	(—)	(—)
	[c.30]	[—]	[—]	[—]
10. Point of Burgarth to Fogla Lee	312	30	—	—
	(278)	(10)	(—)	(—)
	[c.30]	[—]	[5]	[—]
11. Fogla Lee to N. Birka Lee	1140	1	12	8
	(687)	(15)	(15)	(6)
	[850]	[—]	[—]	[—]
12. N. Birka Lee to Ayre of Grommond	246	7	—	4
	(59)	(—)	(—)	(1)
	[—]	[—]	[—]	[—]
13. Ramma Geo to Fugla Geo	435	30	80	14
	(291)	(35)	(54)	(31)
	[420]	[—]	[—]	[—]
14. Fugla Geo to Hill of Markamouth	296	(—)	8	4
	(108)	(—)	(—)	(6)
	[280]	[40]	[1]	[1]
15. Hill of Markamouth to Bagi Stack	292	—	60	65
	(350)	(52)	(66)	(36)
	[200]	[10]	[15]	[—]
16. Bagi Stack to Rivvalee	171	50	10	—
	(168)	(23)	(10)	(—)
	[200]	[10]	[15]	[—]
17. Rivvalee to Tonga	168	30	10	10
	(71)	(—)	(—)	(—)
	[240]	[400]	[1]	[—]
18. Tonga to Gloup Ness	—	—	—	—
	(30)	(—)	(—)	(—)
	[—]	[—]	[—]	[—]
TOTALS 1979	3951	148	180	109
1978	(2452)	(155)	(150)	(105)
1969/70	[2290]	[460]	[37]	[2]

The Birds of Boreray, St. Kilda

N. Duncan, K. Taylor, S. Wanless, V. Wood

"The girls generally live on this island for three weeks in July, and have no male protectors."

Sands 1877.

INTRODUCTION

BORERAY AND ITS WILDLIFE

The St Kildan archipelago, lying some 55 km to the north-west of North Uist comprises four main islands, three large stacks and a large number of smaller stacks and skerries. Boreray (76.5 ha) is the third largest of the islands, separated from the main island of Hirta by 6 km of open sea. It is an impressive cliff-bound island of craggy ridges, pinnacles and gullies, with steeply sloping grasslands on the southern side. It is composed almost entirely of olivine eucrite, the highest point being 384 m a.s.l. Over half the island (40 ha) consists of grassland (predominantly *Poa, Holcus, Agrostis* and *Festuca*), the remainder being made up of rock, cliffs and ravines. The vegetation is much modified by the grazing of a flock of feral Blackface sheep (left behind after the evacuation of the St Kildans) and the nutrient input from the faeces of thousands of seabirds. A detailed description of the ecology and natural history of the island will appear in the Boreray 1980 Expedition Report (1981). Figure 1 indicates the locations of place names referred to in the text.

These notes are compiled from ornithological observations made on Boreray from 8–25 July 1980. Many references have already been made to the spectacular bird life of the island (summarised in Harris and Murray 1978). The fullest descriptions of Boreray wildlife are in the accounts of Williamson and Boyd (1961, 1963).

While the St Kilda village on Hirta was inhabited, villagers made a number of trips each year to Boreray and the nearby stacks, Stac Lee and Stac an Armin, to harvest seabirds and eggs. Published accounts of Boreray bird life prior to the evacuation of St Kilda in 1930 are largely descriptions of Gannet and Puffin catching. Since the evacuation, there have been 38 landings on Boreray. Most of these have been one-day visits. An expedition led by S. Murray spent nine days on the island in 1979, mainly censusing Gannets. The 1980 Boreray Expedition thus had an opportunity to survey the ecology of the island more thoroughly than has been possible in the past.

The most striking ornithological features of Boreray are its Gannets and Puffins. Boreray and the stacks hold the largest Gannet colony in the North Atlantic, and the Boreray Puffin colony is the second largest on St Kilda (Harris and Murray 1978). We arrived on the island too late to count accurately the numbers of some breeding species. Despite information lacking on some species, these notes may serve as a useful supplement to past records. Full accounts of studies on Gannet, Puffin, Great Black-backed Gull and Herring Gull conducted during the expedition will be presented in the Expedition Report (1981).

METHODS

For the duration of our stay, a daily bird census was compiled. The less numerous species were easier to count, and attempts were made to record accurately the number of breeding

pairs in each part of the island. Activities were totally curtailed by bad weather on three days. On the final day, the island was circumnavigated by the recovery vessel and a complete photographic record was made of the colonies on the cliffs and stacks. Puffin census methods are described in the systematic list below.

SYSTEMATIC LIST

Fulmar *Fulmarus glacialis*

Approximately 3,100 occupied sites were counted, including 1,870 with visible chicks. This figure is probably an under-estimate, since without considerable climbing, it is impossible to reach many of the nesting areas. Nests in the region between Roachan and Ant Sail were not well covered. Harris and Murray (1978) estimated 2,000-3,500 pairs, but our counts suggest the population may be in excess of this. However, it seems that Boreray is a much less important colony than Hirta, Dun or Soay.

Manx Shearwater *Puffinus puffinus*

Single birds heard calling on several nights, but no indication of breeding.

Storm Petrel *Hydrobates pelagicus* (see Ringing Report)

The lack of suitable breeding areas on the grassy slopes may restrict this species to breeding in the area of the Cleit Village (Cleitan McPhaidein) and the lower crags.

Leach's Petrel *Oceanodroma leucorhoa* (see Ringing Report)

Far commoner than Storm Petrel on Boreray. The main colony stretches from Clagan na Rusgachan round to Creagan na Rubhaig Bana and to an altitude of about 200 m. Also probably breeds in Sunadal, where birds were heard calling, and a few burrows found at about 200 metres a.s.l.

Gannet *Sula bassana*

Very common, breeding mainly on north-eastern and north-western cliffs of Boreray and the cliffs and summits of Stac Lee and Stac an Armin. The population was previously thought to be increasing, counts being made of 21,300 adults in 1931 (Harrisson, 1933), 16,000 pairs in 1939 and 17,035 pairs in 1949 (Fisher and Lockley 1954), 44,526 pairs in 1959 (Boyd 1961), 52,099 pairs in 1969 (Cramp *et al.* 1974) and 59,258 pairs in 1973 (Dixon 1973). The most recent count of Boreray (excluding Stac Lee and Stac an Armin) was 19,000 nests in 1979 (Murray in press). However, different sampling methods make comparisons between this and previous totals impossible. Sample counts made during this expedition were consistent with Murray's totals. The number of nests on Boreray was estimated at 20,000. In mid-July, the majority of chicks were three weeks old, indicating egg laying in the first half of May. This is later than other British gannetries (Nelson 1978), but similar to the Bonaventure gannetry in the Gulf of St Lawrence (Poulin 1968). Mackerel *Scomber scombrus* was the most common food item identified from chick regurgitations. Herring *Clupea harengus* and squid species were also recorded.

Shag *Phalacrocorax aristotelis*

Young fledged by July. Colonies were difficult to locate from land, but were found between Rubha Bhrengadal and Creagan na Rubhaig Bana. Population perhaps in the order of 50 pairs.

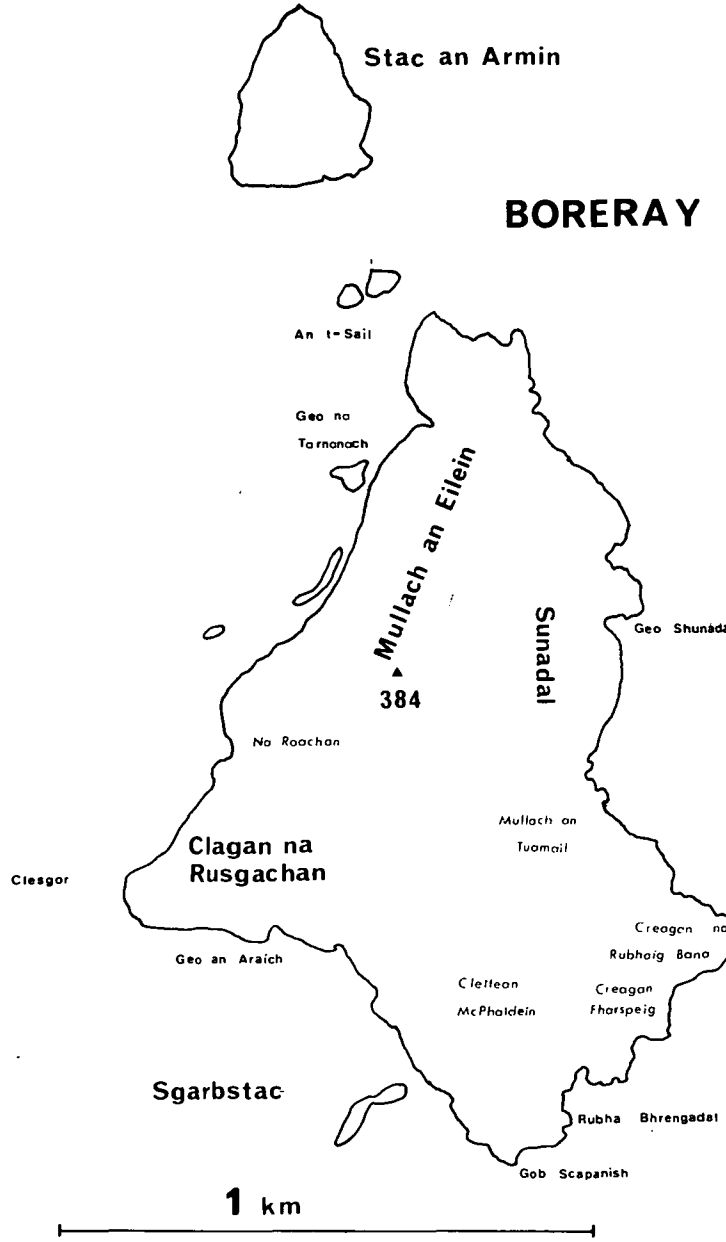

Figure 1. Map of Boreray

Grey Heron *Ardea cinerea*

One seen on 21 July being mobbed by Gannets in Sunadal.

Pintail *Anas acuta*

One female seen on 9 and 10 July on the slopes below Clagan na Rusgachan.

Eider *Somateria mollissima*

A few with young on the sea were seen most days. The maximum count was 24, most of which were juveniles. The remains of a recent nest were found below the Cleit Village.

Peregrine *Falco peregrinus*

Single bird seen and heard calling on at least five days.

Oystercatcher *Haematopus ostralegus*

One pair continuously present.

Ringed Plover *Charadrius hiaticula*

The maximum count was 17 (15 July) on the rocks at low water at Gob Scapanish.

Curlew *Numenius arquàta*

Heard and seen flying overhead on most days.

Arctic Skua *Stercorarius parasiticus*

Singles seen at sea between Boreray and Hirta on 20 and 22 July.

Great Skua *Stercorarius skua*

One pair breeding, the single egg hatched on 16 July. This is the second year the species has bred on Boreray and is an indication of the continued increase of this species on St Kilda in recent years. The pair was frequently seen interacting with up to three others at a time. Commonly seen at sea, especially close to feeding Gannets.

Lesser Black-backed Gull *Larus fuscus*

Four pairs were found breeding on the slopes above Creagan Fharspeig. A few additional birds of unknown status were also present.

Herring Gull *Larus argentatus*

In contrast to its status on Hirta (Harris and Murray 1978), this is the commonest *Larus* gull, with 49 occupied nests or territories located. An average of 1.6 chicks per pair was counted from 35 territories, and young were fledging by 20 July. Nesting was confined to crags and the tops of gullies which gave commanding views. Regurgitates collected from chicks near Clagan na Rusgachan consisted of small fish (Rockling, Sprats *Sprattus sprattus*, and Sandeels *Ammodytes marinus*), in similar proportions to those found in Puffin food loads collected by mist netting in the same area. Together with detailed observations of gull behaviour over a ten-day period, this suggests that much of the Herring Gull's food on Boreray was collected by kleptoparasitising Puffins.

Great Black-backed Gull *Larus marinus*

Twenty-seven occupied sites and three possible sites were found. Nests were situated mainly on or overlooking the island's rocky perimeter at an altitude of 50–300 m. Nests were in vegetated areas, lined with sheep's wool and grasses. Food remains in middens near the nests indicated a diet mainly of birds, including adult Puffins, petrels and the chicks of other seabirds. Fledging began in the third week of July, indicating egg laying in late April and hatching in late May. Since the breeding season was well advanced by the time of the study, 30 pairs should be considered a minimum for the island.

Kittiwake *Rissa tridactyla*

This species is very difficult to count from land, but a count from photographs of the main colonies taken from the sea gave about 1,450 nests. This was almost certainly an underestimate. Harris and Murray (1978) counted 1,759 nests in 1977, whilst Flegg *et al.* (in Harris and Murray 1978) gave 3,760 nests and Boyd (1960) counted 2,330 nests in 1959. Not many fledged young were seen, but some tarrock carcasses were found eaten by Great Black-backs.

Guillemot *Uria aalge*

Counts were made on 9, 10 and 12 July, which was probably too late to establish the number of birds which possibly bred. At Geo an Fheachdaire there were at least 120 on ledges, and 90 in Geo an Araich. The maximum count on Sgarbhstac was 285. The small colony in Coinneag had no more than 25 birds visible on any day. The Geo Shunadal colony was the largest with 450, and almost 200 were counted in Geo na Tarnanach, but the extent of this colony is not known since it was difficult to reach good vantage points. Counts of Boreray Guillemots in previous years were made earlier in the season. Boyd (1960) counted 2,190 pairs in 1959, and Harris and Murray (1978) counted 1,996 birds in 1977.

Razorbill *Alca torda*

Counts were too late in the season to give a good estimate of the population. Eighteen birds were counted on ledges and cracks in the Clagan na Rusgachan Gannet colony (11 July) and a further 28 on Roachan (13 July). The only previous count of Boreray Razorbills is that of c. 100 pairs in clefts at the base of cliffs overlooking Sunadal in 1939 (Nicholson and Fisher 1940).

Black Guillemot *Cepphus grylle*

No reliable indication of breeding. Largest number seen on one day (16 July) was 34 on the water.

Puffin *Fratercula arctica*

Accurate figures for numbers of breeding Puffins are notoriously hard to obtain. However, the cropped vegetation in the main colony between Clagan na Rusgachan and the Cleit Village permitted unusually favourable viewing. Numbers were estimated by two methods.

1. Visual estimates. Counts of peak numbers during rough weather were made when Puffins were ashore, particularly in the evenings. These were purely subjective, but on several days numbers of Puffins visible in the main colony were in the region of 25,000–35,000.

2. Burrow densities from measured quadrats. Twelve quadrats (60 m²) were laid down haphazardly across the length of the main colony. Densities ranged from 37 apparently occupied burrows down to one. (Mean = 31.3 S.D. = 7.7). Occupied and unoccupied burrow density was 35.1/60 m² mean = 0.585 burrows per m². Estimating the area of the main colony as 100,000 m², and using different survey methods, Brooke (1977) estimated 41,000 occupied burrows for this area in 1971, and Harris and Murray (1978) estimated 55,000 occupied burrows in 1975–76. Assuming a similar colony area, our figures suggest that there were over 50,000 occupied burrows in the main colony in 1980. The total area of the main colony was, however, estimated to be close to 125,000 m² in 1980.

Numbers breeding in Sunadal were comparatively low, perhaps not more than 5,000 pairs, but flooding of burrows may have depressed breeding activity there in 1980. Smaller colonies on the west side from Geo an Fheachdaire to Ant Sail were not censused. A total population of over 80,000 pairs is suggested.

Collared Dove *Streptopelia decaocta*

On 10 July one spent much of the day in the vicinity of the Cleit Village.

Swift *Apus apus*

One seen circling the slopes on 19 July.

Meadow Pipit *Anthus pratensis*

One juvenile seen on 14th July.

Rock Pipit *Anthus spinoletta*

Although late in the season, 17 territories were located. Many young were noted and one brood was observed while being fed fish (probably picked up from Puffins) by a parent bird.

Wren *Troglodytes troglodytes hirtensis*

At least nine territories were found. Usually the birds were located by their song, but many were also visible.

Wheatear *Oenanthe oenanthe*

One seen on regular occasions on higher slopes. No evidence of breeding, though past records exist.

Hooded Crow *Corvus corone cornix*

Seen most days, and probably bred. Maximum number seen together was seven (12 July).

Raven *Corvus corax*

One pair present. Maximum number seen together on one day was nine (20 July). A nest of bones and sheep fleece was found in a deep cleft on the Sunadal side of Mullach an Eilein and presumably had been used this year.

Starling *Sturnus vulgaris*

Seen daily in flocks of up to 19 individuals. Many juveniles, but no nest sites were found.

RINGING REPORT

Ringing totals and movements of ringed birds are shown in Table 1.

Ringing effort was concentrated on Puffins and petrels, but small numbers of gulls, Gannets and Fulmars were also caught. Most of the Fulmar sites were inaccessible and the adults were extremely wary. Of the nests which could be reached, most of the chicks were too small to be ringed during the period we were on the island. Very few of the Gannets could be reached safely and without disturbance.

Puffins were caught in their burrows on the South Slope and in Sunadal, and by use of mist-bets and an improvised hand-net in the area around Cleitean McPhaidein. In both Sunadal and the South Slope, burrows were densest in a band at the lowest edge of the grass above the cliffs. They also extended up the numerous gullies, but were few or absent on the ridges and higher parts of the slopes. It was especially noticeable in Sunadal that the success rate for finding chicks in burrows declined rapidly and was extremely low up the slope; many of the burrows were very wet and apparently unoccupied. Wing length and weight was recorded for each chick caught and these data will be compared with those from other colonies, including neighbouring Dùn. Each chick was carefully examined for ectoparasites before being returned to its burrow; less than 2% carried ticks, though in places many were found around burrow entrances. Adults were also examined for ectoparasites (the only species found was the rare *Ixodes rothschildi*). The number of grooves in the bill sheath of Puffins was counted as a guide to age.

Nets were set for petrels on the calmer nights during our stay; they were sited around Cleitean McPhaidein. Observations indicated that the cleits were the stronghold of the rather limited Storm Petrel colony, which were at highest densities here. The area covered by Leach's Petrels was more extensive than the Storm Petrel colony, with a few near the top of the South Slope, and calling heard from Sunadal.

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TABLE 1. RINGING TOTALS AND MOVEMENTS OF BIRDS HANDLED ON BORERAY, JULY, 1980.

Ringing Totals

Species	*No. ringed*		*Total*
	Adult	*Pullus*	
Fulmar	14	20	34
Storm Petrel	94	—	94
Leach's Petrel	165	—	165
Gannet	10	40	50
Herring Gull	—	8	8
Great Black-backed Gull	—	9	9
Puffin	342	73	415

Controls

Species	*Ringing Site*	*Date ringed*	*Handled Boreray*
Storm Petrel	Calf of Man	12.8.78	15.7.80
Storm Petrel	Foula, Shetland	30.7.79	20.7.80
Storm Petrel	Eilean an Tighe, Shiant Islands	2.7.80	20.7.80
Leach's Petrel	North Rona	30.7.71	15.7.80
Leach's Petrel	Hirta, St Kilda	— 7.78	20.7.80
Retraps			
Leach's Petrel	Boreray	19.8.76	20.7.80
Recovery			
Gannet	ringed Boreray (pullus) found sick, Santiago de Compostela, Spain, September 1980.		14.7.80

Census of breeding seabirds at Horn Head, County Donegal, in June 1980

P. S. Watson and D. J. Radford

INTRODUCTION

Horn Head, Co. Donegal, is situated in north-west Ireland at 55°14′ north, 7°59′ west, facing the Atlantic Ocean (Fig. 1). It has been recognised as one of Ireland's largest seabird breeding colonies since at least 1832 (Thompson 1851), and additional features of note are that it is a fairly accessible mainland site and there is a considerable excess of Razorbills[1] over Guillemots in the colony (Kennedy *et al.* 1954). The latter situation is unusual in British and Irish Seabird colonies, occurring principally in some smaller populations of the south-west Irish islands (Evans and Lovegrove 1974).

This excess of Razorbills, plus the large numbers of this species reported in the 1969 Operation Seafarer count (W. R. P. Bourne pers. comm.) prompted our 1980 census. In addition to assessing the seabird populations a decade after Seafarer, we aimed to establish permanent study plots for future surveillance of Razorbills and Guillemots.

Following a reconnaissance visit on 2–3 May 1980, the authors completed a whole colony assessment of breeding seabirds over the period 1–8 June, and returned on 28–29 June to establish six study plots.

HISTORICAL REVIEW

Early accounts of visits to Horn Head, in June 1832 and August 1875, appear in Thompson (1851) and Patterson (1880) respectively. Although qualitative, these leave no doubt that in the nineteenth century Horn Head was a major mainland breeding site for Kittiwakes, Razorbills, Guillemots and Puffins, with six other seabird species also nesting. Some indication of the distribution of the birds around this extensive area is given by these authors.

Ussher and Warren (1900) state for Razorbills at Horn Head "one of the most extensive colonies in Ireland", for Guillemots "the greatest breeding place in the north of Ireland", and for Puffins "possibly the largest colony in Ireland". Praeger (1937) also comments on the magnitude of the seabird community, and gives a geological description of the cliffs. Fisher (1952) records the arrival of the Fulmar at Horn Head in 1907, one of the first appearances of this species on Ireland's cliffs.

In the light of further information on Ireland's seabirds, Kennedy *et al.* (1954) refer to Horn Head in more cautious terms, noting for Razorbills that it contains "what is probably one of the most extensive colonies on our coasts", for Guillemots "Horn Head has long been considered the great breeding place in the north of Ireland and although the statement holds good today the proportion of Guillemots breeding there is small in comparison with the Razorbills", and for Puffins "we consider that even at Horn Head ... the numbers fall short of the whirring multitudes that tenant the north Mayo cliffs".

No further information was given twelve years later (Ruttledge 1966), and therefore the Operation Seafarer counts of 1969 appear to be the first attempted quantitative survey of this seabird community. The totals from the latter counts are given in Table 1 with the results of the present census.

[1] All scientific names of birds are given in the census results section.

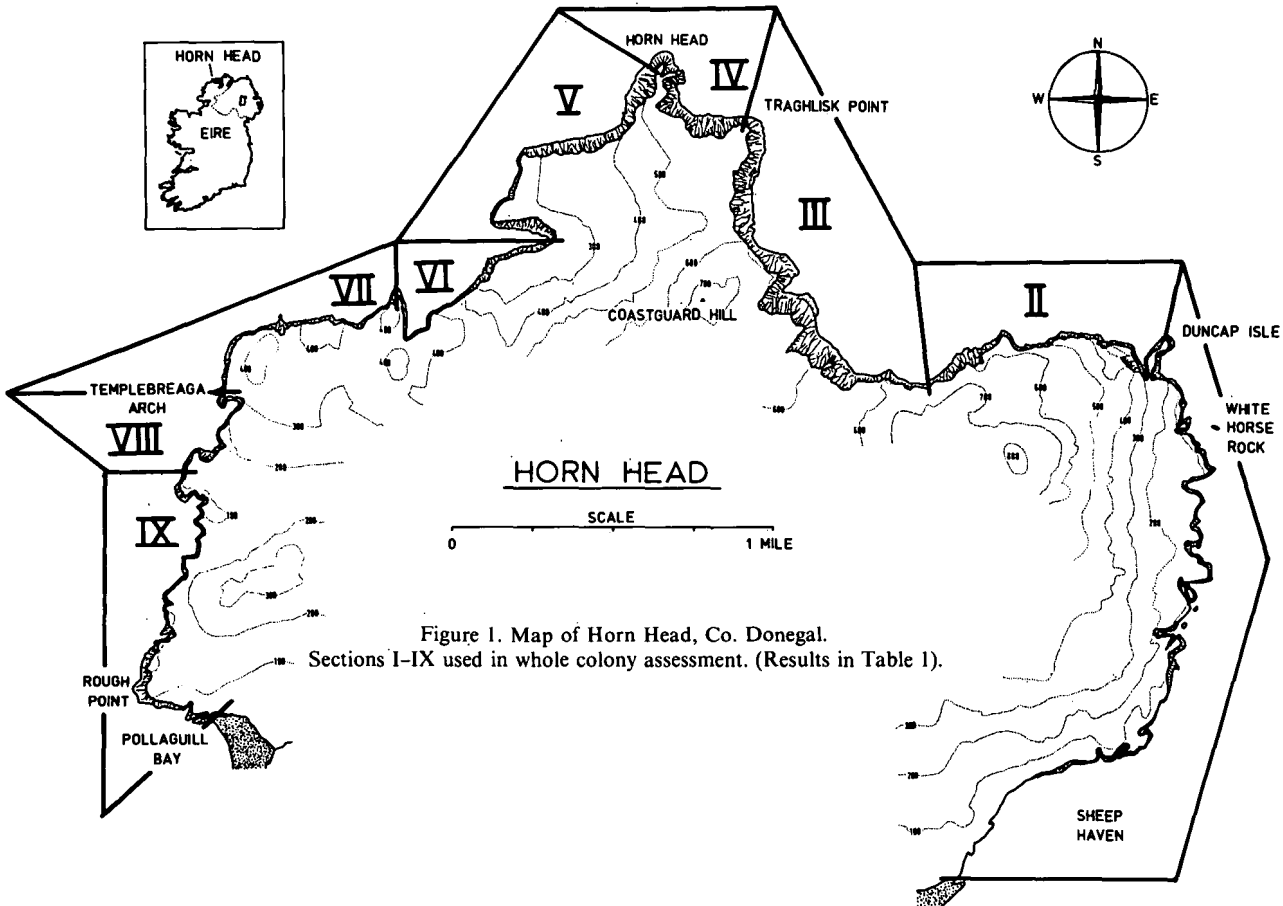

Figure 1. Map of Horn Head, Co. Donegal.
Sections I–IX used in whole colony assessment. (Results in Table 1).

DESCRIPTION OF SURVEY AREA

Figure 1 shows the extent of the main cliffs of the Horn Head peninsula, together with altitude in feet and place names referred to in this paper; these have been taken from the Ordnance Survey of Ireland Six-Inch Series (Second Edition), sheets 15 and 16. Much of the peninsula is riddled with caves at sea level, and the cliffs are deeply indented with large vertical clefts. The cliffs are composed of quartzite with dark bands of diorite (Praeger 1937), although the rock is broken and weathered in many places. The vegetation on the cliffs, most extensive on the irregular eastern sections, comprised mainly Heather (*Calluna vulgaris*), Woodrush (*Luzula* sp.), Bracken (*Pteridium aquilinum*) and grasses (Gramineae).

All the cliffs from Sheep Haven to Pollaguill Bay (Fig. 1) were surveyed, a distance of about eight miles. Five miles of these cliffs, varying in height from 200 to 700 feet above sea level, were heavily populated by seabirds.

METHODS

As far as was practical for two people working on this extensive area for one week, we followed the methods recommended in the Seabird Group's Auk Censusing Manual (Evans 1980) for counting Razorbills, Guillemots, Black Guillemots and Puffins. The individual was the counting unit for these four species, although because of the size and complexity of the cliffs repeated counts were not possible in most places. Since the census we have seen Birkhead and Nettleship's (1980) paper on counting guillemot species, and are satisfied that our methods also corresponded with theirs. The counting units for other species were occupied nests (for Shags, Herring Gulls, Great Black-backed Gulls and Kittiwakes), occupied sites (for Fulmars) and pairs (for Common Gulls).

The extent and structural complexity of the cliffs meant that the entire week in early June was required for the whole colony assessment, and another visit was necessary to set up the study plots. The whole census area was surveyed from the sea, and as much of it as possible from the land. Full details of dates, times of day and weather for each count are given in Appendix 1.

Six study plots were established, so that future comparable counts can be made of parts of the colony. Four plots were selected for the surveillance of Guillemots only, and two for both Guillemots and Razorbills. The difficulties of censusing these species, especially Razorbills, are well known (e.g. Lloyd 1975, Birkhead and Nettleship 1980), and the Horn Head colony is no exception. Full details of these study plots, including photographs, are in reports lodged with the Seabird Group, Royal Society for the Protection of Birds, the British Trust for Ornithology, the Edward Grey Institute, the Irish Wildbird Conservancy and the New University of Ulster.

WHOLE COLONY ASSESSMENT

For the purpose of presenting the results of the whole colony assessment, we have divided the survey area into nine sections (I-IX) based on topography (Fig. 1). Table 1 summarises the results for all species over the survey area. It is inadvisable to sum columns as different counting units were employed.

The results for each species are discussed below. The order of species follows that of Voous (1977).

Fulmar (*Fulmarus glacialis*)

The first published records of this species prospecting cliffs in Ireland were in "the early years of the century" (before 1909) at Great Skellig, Co. Kerry, and at Horn Head and in Co. Mayo, both in 1907. Breeding was established at Horn Head in 1912, the year after the first recorded nesting in Ireland in Co. Mayo (Fisher 1952). The figures below give selected Fulmar counts at Horn Head (from Fisher 1952, the Seabird Group 1969, and this study):

Year	*1907*	*1912*	*1939*	*1947*	*1969*	*1980*
Status	Prospecting	2 young hatched	41 occ. sites	421+ occ. sites	1200 ± 200 pairs	1730+ occ. sites

In 1980 Fulmars were widely distributed, nesting at heights varying from less than 100 feet to over 500 feet. The majority were on the vegetated ledges and slopes of section III, while few nested in sections I, VIII and IX where the cliffs were mainly under 100 feet high. In the sections with larger numbers of this species, the nest sites were generally in the higher strata of the cliffs.

Few Fulmars were seen on the sea below the colony in June, but they were plentiful further offshore and at trawlers working in Sheep Haven and off Templebreaga Arch. A dark-phase bird (plumage class 'D', after Jan Andries van Sraneker, Seabirds at Sea Team Instruction Sheets, Aberdeen) was present around the cliffs of section VI on 29 June, eventually flying off out to sea to the north-west.

Manx Shearwater (*Puffinus puffinus*)

Four in Sheep Haven on 4 June was our only record of this species, which has never been recorded breeding at Horn Head.

Gannet (*Sula bassana*)

Seen frequently off Horn Head. Nearest recorded breeding colony is at Ailsa Craig (Cramp *et al.* 1974).

Cormorant (*Phalacrocorax carbo*)

Occasional adult birds were observed in Sheep Haven but there was no evidence of nesting in the survey area.

Shag (*Phalacrocorax aristotelis*)

Our survey missed the peak incubation period, since many juveniles were seen loitering on rocks below the breeding sites as early as 1 June. Therefore occupied nest counts probably underestimated the total breeding population. Many of the sites were in caves and deep clefts in the cliffs, and nests still occupied in early June contained from half-grown to almost fully fledged young.

Common Gull (*Larus canus*)

Five pairs were located, nesting almost at sea level in sections I and IX.

Lesser Black-backed Gull (*Larus fuscus*)

Although some adults and 2nd/3rd year birds were seen at sea and on Pollaguill Strand, no nesting birds were found.

TABLE I. THE BREEDING SEABIRD POPULATIONS OF HORN HEAD, CO. DONEGAL, IN JUNE 1980 AND IN JUNE 1969 (OPERATION SEAFARER). SECTIONS ARE ILLUSTRATED IN FIG. 1.

	Section									*1980*	*1969*
Species	*I*	*II*	*III*	*IV*	*V*	*VI*	*VIi*	*VIII*	*IX*	*Totals*	*Totals*[1]
Fulmar (occ. sites)	30	231	647	252	135	243	168	18	6	1730	1200 ± 200[2]
Shag (occ. nests)	20+	8+	23	0	3	3	0	7	5	69+	50 ± 10[2]
Herring Gull (occ. nests)	68	3	0	0	9	6	0	0	17[3]	103	500 ± 100[2]
Great Black-backed Gull (occ. nests)	1	0	0	0	2	0	0	0	0	3	0
Common Gull (pairs)	2	0	0	0	0	0	0	0	3	5	0
Kittiwake (occ. nests)	0	979	169	470	968	203	1661	94	0	4544	7500 ± 2500[2]
Razorbill (birds)	11	7938+	659	284	250	843	1407+	899	121	12412+	45000 ± 10000
Guillemot (birds)	0	1523	228	639	521	480	1756	401	2	5550	10000 ± 5000
Black Guillemot (birds)	6	1	0	0	0	0	0	0	9	16	2[2]
Puffin (birds)	0	75+	133	75+	0	29	30	0	2	344+	250 ± 50[2]

NOTES: [1] The 1969 counts were available only as totals (W. R. P. Bourne, R. Hickling, pers. comm.)
[2] Expressed as pairs
[3] Includes 12 nests just south of section IX

Herring Gull (*Larus argentatus*)

Apart from occasional nesting pairs of small groups on the mainland cliffs, Herring Gulls were restricted to two small colonies, on White Horse Rock (44 nests) and on another un-named grass-topped rock (12 nests), both in section I. About a dozen pairs were nesting on the low cliff just south of Pollaguill Bay, outside our survey area. Most of the total of 103 nests contained half-grown young.

Great Black-backed Gull (*Larus marinus*)

Although some adults and immatures were seen at sea and on Pollaguill Strand, only three nests were located.

Kittiwake (*Rissa tridactyla*)

The narrow ledges of the lower parts of the cliffs in Sections II, V and particularly VII, held 80% of the total breeding population. Most of the nest sites are uncountable from land, and need to be observed from the sea. The total of 4,544 occupied nest sites does not include loitering individuals or those occupying sites without nests. This non-breeding component of the population appeared to be quite large. As four of the study plots contain a total of about 1,400 occupied nests (about 31% of total in whole colony), and these can be viewed closely enough to establish breeding details, an indication of the proportion of non-breeders could be established.

Guillemot (*Uria aalge*)

The structure of the cliffs facilitates the nesting of Razorbills rather than Guillemots. Nevertheless, there were numerous ledges densely packed with the latter species, particularly on the lower strata of the cliffs of sections II and VII. Our total of 5,550 individuals excludes loitering birds on rocks below the breeding ledges. Sample counts in early June indicated that 61% of birds on the ledges were apparently incubating or brooding (257 out of 421 counted). The six study plots contain a total of about 1,200 birds, about 21% of the total present in the whole colony.

Razorbill (*Alca torda*)

The great bastions of quartzite of section II, split by deep vertical rifts and broken and weathered in many places, were the stronghold of the Razorbills on the Horn Head peninsula. In places the birds were present over the full vertical extent of the cliffs, from near sea level to over 600 feet. Elsewhere, particularly on sections III, VI, VII and VIII, the birds were also present at all levels.

Throughout the whole colony, numerous incubating and brooding birds were completely out of sight in crevices and behind broken slabs, only betraying their presence when off-duty birds returned or a scare caused all birds to leave the cliffs (a situation not witnessed often). The 1980 total was 12,400+ birds visible on the cliffs, and is a conservative count. The six study plots contained a total of about 630 Razorbills, only about 5% of the total for the whole colony. Unfortunately for counters, the greatest densities occur on the sections only fully visible from the sea (II and VII), where it is extremely difficult to establish study plots.

Black Guillemot (*Cepphus grylle*)

There is no doubt that few Black Guillemots breed at Horn Head. Small concentrations of birds, some of which were flying in and out of crevices in loose rocks, were encountered

on sections I and IX. This species seemed to favour the areas of loose rocks on and below some of the lower cliffs, and more may be present elsewhere in Sheep Haven or to the south-west of Pollaguill Strand.

Puffin (*Fratercula arctica*)

Most of the breeding sites were grassy slopes near the bottom of the cliffs, although some birds were using crevices in the cliff face of section II as high as 500 feet above sea level. There were some slopes near the cliff tops in sections III, IV and VI which contained many old burrows, but these are now covered by heather. Access to the occupied slopes from both land and sea would be difficult and a proper census of this species would therefore take some time.

In early June, Puffin attendance at breeding slopes was most obvious from 1900 GMT to dusk, many birds standing singly at the entrances to burrows. The limitations of our count of 344+ individuals are discussed below

DISCUSSION AND CONCLUSIONS

By present standards, the 1969 visits were not designed as a detailed survey, and a follow-up trip in 1970 gave an impression of fewer auks (R. Hickling pers. comm.). A minimum estimate was taken for the final Razorbill figures included in the Co. Donegal Seafarer totals (Cramp *et al.* 1974). We are therefore, in retrospect, unwilling to attempt a comparison between the 1969 and 1980 censuses. Future counts and records of attendance patterns of Razorbills and Guillemots at the Horn Head study plots would enable this difficult but important site to be properly documented for these two species at least.

As outlined in the methods the whole colony assessment was based mainly on single counts, a limitation imposed by the size of the area. Such a procedure can result in variations of up to 46% for Razorbills and up to 26% for Guillemots (Lloyd 1975), or even higher (Merne and Lloyd 1980). Various studies have resulted in a recommended counting period for these species between 0700–1600 GMT (Evans 1980). Many of our counts from the sea were within the period 1500–2000 GMT due to most of the boatmen having day employment ashore.

The major factor influencing the Razorbill counts was undoubtedly the broken nature of the cliffs (q.v.). However, the assessment of this species on Section II, where the majority was concentrated, took place in excellent weather conditions between 1500 and 1700 GMT on 4 June. (Appendix I).

In the sections where both Razorbills and Guillemots are well represented (II–VIII inclusive, Table 1), the ratio of the former to the latter varies from 0.5:1 to 5:1 with an average for the whole colony of 2.2:1. This variation within sections at the Horn Head peninsula illustrates the risks of extrapolating counts from any one site to the whole area.

Harris (1976) states that single counts of Puffins will underestimate the numbers of birds attached to a colony, and that late in the season many non-breeding and immature birds will be present. We found a large variation in our Puffin count at one slope in section VI, where 29 birds were present at 1730 GMT on 1 June and 120+ counted at 1000 GMT on 29 June, many of the latter standing outside burrows. Weather conditions were similar on both dates.

Many auks were reported as accidentally drowned in salmon drift nets at Horn Head. Local commercial fishermen mentioned kills from previous years varying from about 50 to "several hundred" birds per net in a night's fishing. Mortalities of the latter magnitude were stated to be infrequent, but the impression of a chronic kill over the height of each

season (June–July) was quite clear. Razorbills and Guillemots seem to be the main species involved. In June 1980, two salmon drift-netting boats were operating out of Port-na-blagh, one fishing directly below sections II and III during our stay in early June. Counts of auks on the sea in this boat's vicinity on 3 June, between 1700 and 2000 GMT, in the above area, gave 414 birds (86% Razorbills, 12% Guillemots and 2% Puffins). These proportions are similar to those for birds on the adjacent cliffs (N = 10,556, 81% Razorbills, 17% Guillemots and 2% Puffins). Reports of auk kills in salmon nets off Co. Donegal are mentioned by Whilde (1976).

Using the site assessment criteria given by Fuller (1980), Horn Head is an internationally important concentration of nesting seabirds, exceeding 10,000 pairs (excluding *Larus* gulls). There is also little doubt that it is still Ireland's largest Razorbill colony and that a significant proportion of the world's breeding population of this species is represented here (Lloyd 1976). On a more regional basis, the Horn Head seabird community added to those along the north coast of Ireland (Watson 1980) and taking into account birds from Ailsa Craig, illustrates that these north Ulster waters are rich in seabirds.

ACKNOWLEDGEMENTS

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We are grateful to Dr Tim Birkhead for providing the Auk Census Manual and a copy of his paper (with D. N. Nettleship) on census methods for murres (guillemots), and we also thank C. Mead for advice.

Finally, we thank H. Field for renting his cottage in Muntermellan to us in early June, and our stays in that area were made all the more pleasant by the kind hospitality of Mr and Mrs Campbell.

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APPENDIX I. DETAILS OF WHOLE COLONY ASSESSMENT COUNTS, 1–7 JUNE 1980. COUNTS FROM LAND MADE USING 9 × 35 AND 10 × 40 BINOCULARS AND A TRIPOD-MOUNTED 20× TELESCOPE; COUNTS FROM SEA MADE USING UNAIDED EYE, 9 × 35 AND 10 × 40 BINOCULARS.

Date	*Sections visited*	*Time (GMT)*	*Land or Sea Counts*	*Date*	*Sections visited*	*Time (GMT)*	*Land or Sea Counts*
1.6.80	IV, V, VI	10.15–17.50	Land	4.6.80	V	10.000–12.00	Land
2.6.80	I, II	08.30–10.30	Land	4.6.80	I, II, III	15.00–18.15	Sea
2.6.80	I, II, III, IV	16.00–20.00	Sea	5.6.80	II, III, IV, VI, VII, VIII	11.30–20.00	Land
3.6.80	III, IV	10.05–11.15	Land	6.6.80	VI, IX	11.00–13.00	Land
3.6.80	II, III, IV, V, VII, VIII	17.00–20.00	Sea	7.6.80	I, III, IV, VII, VIII	08.30–12.00	Sea

Date	*Cloud cover*	*Rain*	*Sea*	*Swell*	*Visibility at colony*	*Visibility at sea*	*Wind force (Beaufort)*	*Wind Direction*
1.6.80	1/8	None	Small waves	Light	Good	Good	2	West
2.6.80	8/8	Continuous, heavy	Flat calm	Light	Poor	Poor	1	West
2.6.80	8/8	Discontinuous, light	Large waves	Moderate	Fair	Poor	3–4	South-West
3.6.80	7/8	Discontinuous, heavy	Small waves	Light	Fair	Fair	3	West-South-West
3.6.80	6/8	None	Small waves to flat calm	Light	Good	Good	3–4	South
4.6.80	4/8	None	Flat calm	NONE	Good	Good	0	—
4.6.80	4/8	None	Flat calm	NONE	Good	Good	0	—
5.6.80	4/8–8/8	None	Small waves to flat calm	Light	Good	Fair	0	—
6.6.80	6/8	None	Small waves	Light	Good	Good	2	North-East
7.6.80	7/8	Discontinuous, light	Large waves	Moderate	Good	Good	4–5	North-West

Accuracy of measuring trends in seabird numbers

T. J. Stowe

Counts of cliff breeding Guillemots *Uria aalge* are known to vary with stage of the breeding season, time of day and weather. Hence, estimates of numbers at study plots are difficult to obtain with precision (Lloyd 1975, Birkhead 1978). Over a period of years numbers might be changing, but the rate of change is likely to be small compared with the variation of individual counts in any one year. Nevertheless, estimation of long-term trends is the primary objective of the annual sample census organised by the Royal Society for the Protection of Birds in conjunction with the Seabird Group. When counts are made to recommended standards (Evans 1980), how accurate is the estimate of change at a study plot likely to be and which of the variables of the census method within our control have most effect on the accuracy? These questions are answered by a simple model investigating the effects of the number of counts per year, and the number of years in which counts were made.

METHODS

The model population, representing a hypothetical study plot, contained 100 birds in the first year and was increased at 5% per annum. Counts in any year were taken so that they were distributed with a standard deviation of 10% of their mean, since field observation at study plots of varying size had produced estimates of the average coefficient of variation (standard deviation/ $\times$ 100) of 9% (Hope Jones 1978) and 10% (Lloyd 1975) with little variation about those averages for counts in calm weather during June. Count data were computed using a random number generating program, and rounded to the nearest integer. The population trend was then calculated by fitting a logarithmic regression

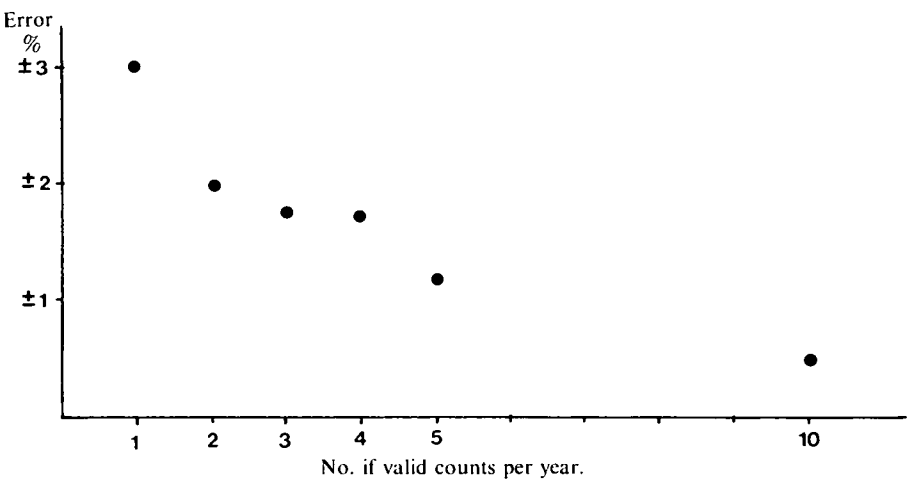

Figure 1. Degree of deviation (95% confidence) between the estimated and known (+5%) rates of change for different numbers of counts per year over nine years.

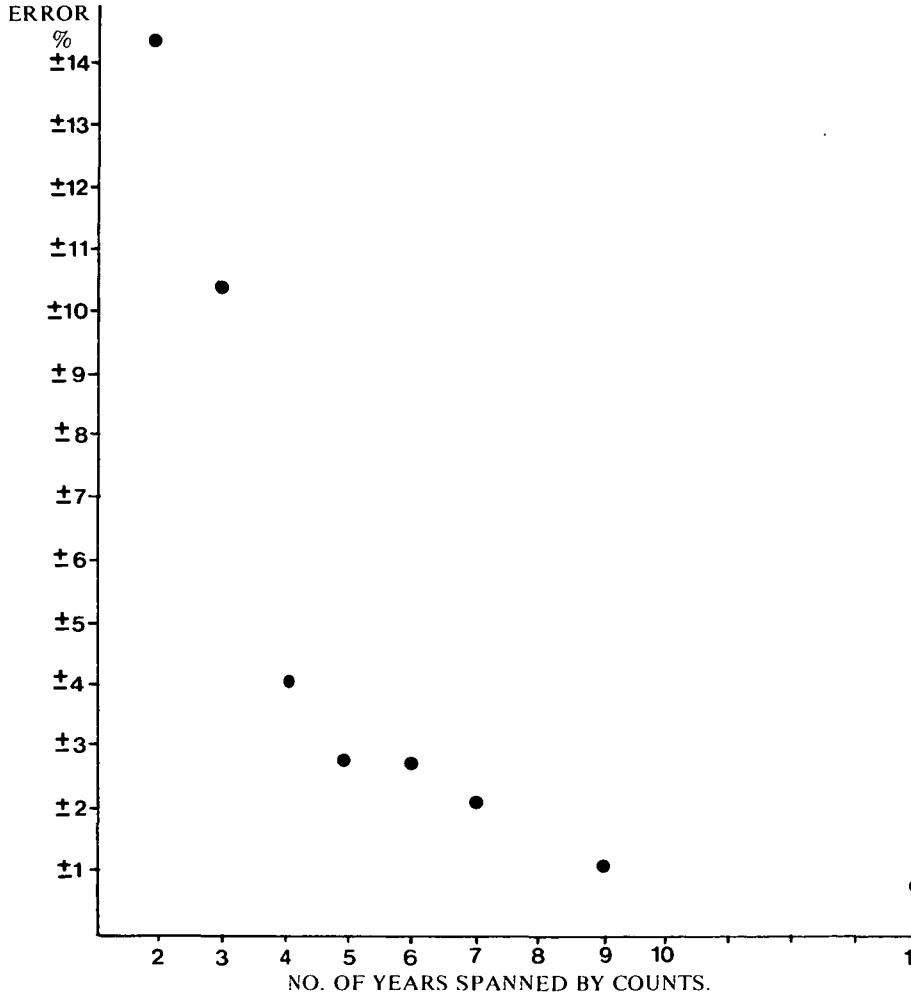

Figure 2. Degree of deviation (95% confidence) between the estimated and known (+5%) rates of change for different numbers of consecutive years spanned by counts (five counts per annum).

equation to the total number of counts e.g. 45 when five counts per year were made for nine years. For each counting frequency (i.e. number of counts per year) or each number of years in which counts were taken, 20 such regression equations were obtained from independent sets of count data. The 95% confidence limits of each group of 20 estimates were calculated, and the deviations (moduli) from the known 5% rate of increase were taken as measures of the degree of agreement between the estimated and known changes. Plotted figures thus show how inaccurate the estimate of the rate of change at a study plot might be. Three variables were considered.

NUMBER OF COUNTS EACH YEAR

Over a nine year period, trends computed from single counts each year are likely to be within ±3.0% of the actual change (+5%), i.e., in the range +8.0% to +2.0%, whereas with ten counts per annum the error is reduced to ±0.5% (Fig. 1). A minimum of five counts per year has consistently been recommended (Lloyd 1975, Evans 1980, Birkhead & Nettleship 1980) for such censuses. Over nine years this gives a result accurate to within ±1.3%. Although reasonable accuracy may be demonstrated from single counts, large confidence limits produce statistically non-significant results for changes of small magnitude.

NUMBER OF YEARS SPANNED BY COUNTS

Although the present survey has been running for nine years, some study plots have only been counted recently. Runs of counts of less than four years are likely to give rather inaccurate results for rates of population change (Fig. 2). Year to year changes based on five counts each year show considerable error of up to ±14.5% (i.e., in the range +19.5% to -9.5%), which is likely to be sufficient to conceal any real changes.

COUNTS IN NON-CONSECUTIVE YEARS

Especially in remote areas, it is not always possible to make counts every year. The effect of taking counts at intervals of more than one year is shown in Figure 3. This suggests that although more frequent visits are desirable, the number of counts taken per year is of greater consequence for long-term monitoring, than whether counts are taken in consecutive years.

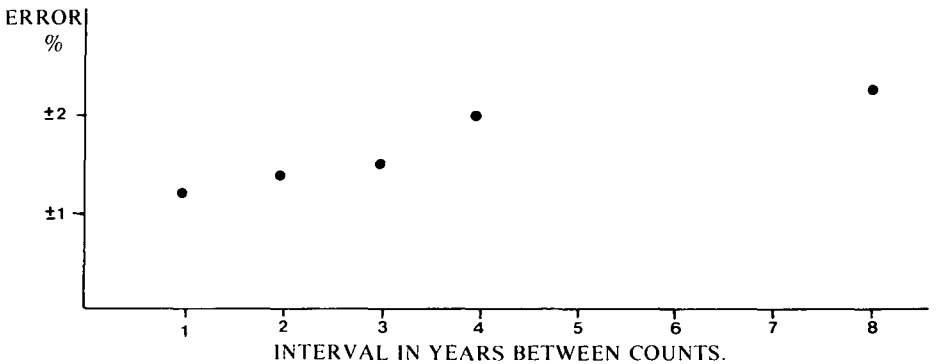

Figure 3. Degree of deviation (95% confidence) between the estimated and known (+5%) rates of change for counts in non-consecutive years (five counts per annum; nine or ten year period).

DISCUSSION

The model suggests that trends of small magnitude can be detected in numbers of Guillemots at a study plot by current methods of census and analysis, especially where nine years' data have been assembled. The value of the results will continue to improve as further years' data are included. While visits each year are not essential, the recommendation to undertake at least five counts per visit is strongly supported. For Razorbills *Alca torda* calculated rates of change will be less accurate since coefficients of

variation are higher than those for Guillemot (Lloyd 1975, Hope Jones 1978). Counts of Kittiwakes *Rissa tridactyla* have lower coefficients of variation (Hope Jones 1978) giving greater accuracy.

This study thus boosts confidence in the seabird sample census whose first results are shortly to be published (Stowe in prep.). Variations in counts have received considerable attention, but are not found to produce insurmountable obstacles. There remains the less considered question of the degree to which changes at selected study plots represent changes in the colonies themselves, or in the populations at large.

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Seabird attendance at the Isle of May, Fife 1-6 April 1979

Martin Sharp

INTRODUCTION

In recent years, attention has focussed on patterns of colony attendance of seabirds as a factor influencing the accuracy of census procedures, and it has become apparent that attendance patterns may vary between species, between colonies, with weather conditions and with stage of the breeding season (e.g. Birkhead, 1978). This paper presents new data on the attendance of four species of seabird (Guillemots, *Uria aalge*; Razorbills, *Alca torda*; Shags, *Phalacrocorax aristotelis*; and Kittiwakes, *Rissa tridactyla*), during the pre-laying period at the Isle of May, Fife, in April 1979.

METHODS

From 1-6 April 1979, the number of individual Guillemots, Razorbills, Shags and Kittiwakes present at a sample site at the Mill Door, Isle of May, was recorded every two hours from 08.00 to 20.00 GMT, as visibility permitted (Fig. 1). From 4-6 April a section of cliff containing 28 sites occupied by Kittiwakes was also monitored, and the number of birds present at each site was recorded at two hour intervals from 08.00 to 20.00 GMT.

RESULTS

a) *Guillemots*—Peak counts tended to occur in the early morning, and on some days numbers may already have peaked before counts began at 08.00. Numbers generally declined after 10.00, but on 1 April were high throughout the day, peaking at 16.00. A period of high numbers on 1 and 2 April was followed by almost total absence on the next two days, the birds returning to the colony on 5 and 6 April. On 2 April, peak numbers occurred at 08.00 after which the birds left the cliffs and gathered in rafts on the sea. At approximately 15.00, birds in these rafts flew south along the west cliffs of the island and south-east into the Forth. Their absence from the colony on the following two days coincided with the 'Baron Venture' oil spill in the Forth east of Dunbar. The direction of departure and the presence of oiled birds on the cliffs on 6 April suggests that some of the birds had spent at least part of the intervening period in the area affected by the slick.

b) *Razorbills*—The pattern of colony attendance was very similar to that of the Guillemots. Peak numbers occurred in the early morning and the birds had usually completely left the cliffs by 18.00 h., and often earlier. Birds were almost totally absent on 4 April. As the weather during the study period was calm and dry it was not possible to assess the effects of weather on colony attendance. There was no evidence of a tidal rhythm in the attendance of Guillemots or Razorbills, such as found by Slater (1976).

c) *Shags*—Over the study period peak numbers showed a consistent increase from 77 on 1 April to 106 on 5 April, suggesting that birds may still have been returning to the colony for the breeding season. Peak numbers were recorded in the evenings and the birds spent the nights ashore, leaving to feed on the first falling tide of the next day, and starting to return to the colony 2-3 hours after high tide. Shags were seen to move away from the island as the tide fell, but normally stayed within sight of it, suggesting that feeding probably occurred close to the colony. Pearson (1968) suggested that the maximum feeding range of Farne Islands Shags in the breeding season was 12 miles.

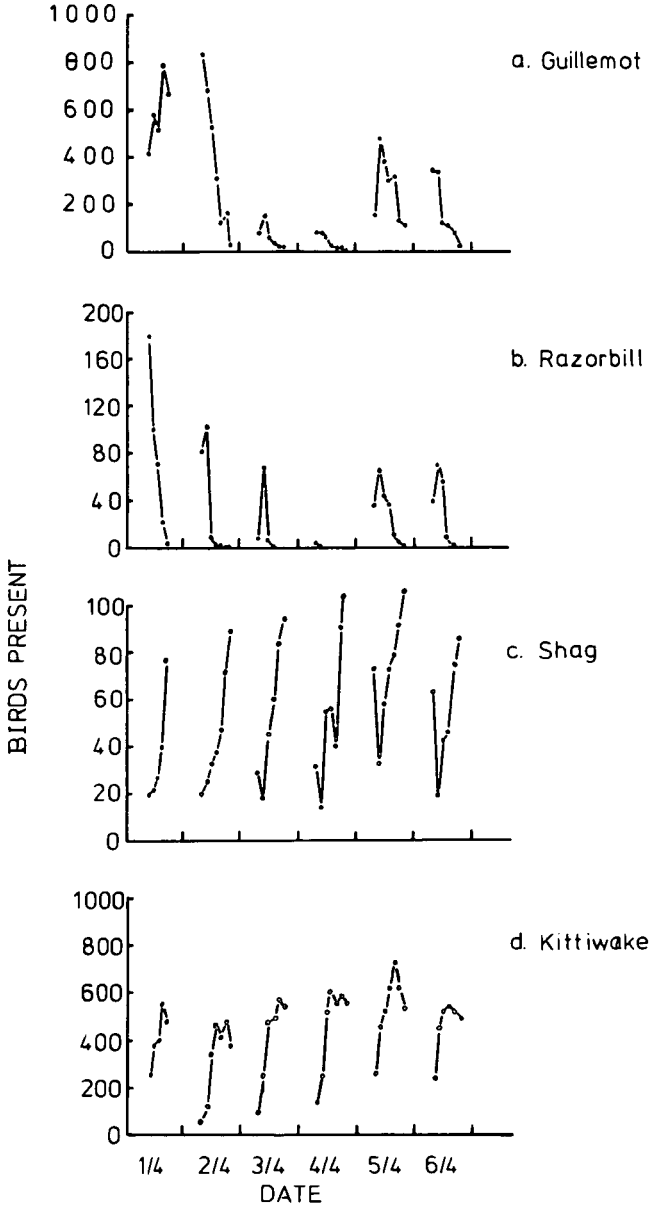

Figure 1. Daily variations in numbers of four seabird species at the Isle of May, Fife, 1st April to 6th April 1979 (based on two-hourly counts 08.00 to 20.00).

d) *Kittiwakes*—Birds were present at the colony on all days, but there was some day to day variation in peak numbers. The high numbers on 5 April occurred on the only cloudless day in the study period. Total numbers were low in the early morning, building up to a peak between 12.00 and 14.00 h. They then remained stable until the birds started to leave the cliffs shortly before dusk.

TABLE 1. PRESENCE OF KITTIWAKES AT SITES IN MONITORED SUB-COLONY (08.00-20.00 h, 4-6 APRIL, 1979)

	NO. OF OBSERVATIONS			
Birds present	*2*	*1*	*0*	*Total*
Sites where pairs were observed	130	131	81	342
Sites where single birds only observed	0	61	129	190
Total	130	192	210	532

Over a three day period each site in the monitored sub-colony was observed on 19 occasions, a total of 532 site observations (Table 1). On each occasion the presence of 2, 1 or 0 birds at each site was recorded. Pairs were present at 23.4% of these observations, and the overall probability of a bird attending a site between 08.00 and 20.00 h was 0.425

$$\text{Probability of a bird attending} = \frac{\text{Total no. of birds present}}{\text{2x no. of sites observed}}$$

Pairs were only observed at 18 of the 28 sites during the study period, and a comparison of the attendance of birds at sites where pairs were and were not observed reveals marked differences.

Within the group of sites at which pairs were recorded at some time during the study period, the probability of a site being occupied ranged from 0.37 at 08.00 h to 0.92 at 16.00 h. The probability of a pair being present was lowest at 08.00 h (0.06) and highest at 18.00 h (0.59). For sites at which pairs were never recorded, the probability of a site being occupied ranged from 0.03 at 08.00 h to 0.43 at 12.00 h and 18.00 h.

At sites where pairs were recorded, pairs were present 37.4% of the time and the overall probability of a bird attending was 0.57. Once the first bird had arrived for the day, the site tended to be occupied continuously for the rest of the day, though not necessarily by the same bird. 95.6% of occupied sites observed were still occupied two hours later. Sites used by pairs had some sort of nest structure, whereas those used only by single birds were bare rock ledges, usually at the edges of the sub-colony.

TABLE 2. COMPARISON OF ATTENDANCE OF INDIVIDUAL KITTIWAKES AT SITES WHERE PAIRS WERE AND WERE NOT OBSERVED (08.00-20.00, 4-6 APRIL 1979).

	No. of bird observations		
	Bird present	*Bird not present*	*Total*
A. Sites where pairs observed	391	293	684
B. Single birds only observed	61	129	190
Total	452	422	874

In Category A, each ledge observation is scored as two bird observations. In Category B, each ledge observation is scored as one bird observation. If pairs are in fact associated with Category B sites, this would increase the difference between the two categories.

H_0 = Individual birds spend the same amount of time at the site irrespective of whether or not they are known to be paired.

$$\chi^2 = 37.54 \qquad df = 3 \qquad p < 0.005$$

The probability of a bird attending such a site was 0.16 (0.32 if only one bird was assumed to be attached to the site). The difference between the attendance of single and known paired birds was significant at the 0.005 level (χ^2 test; Table 2). Thus individual birds attached to sites where pairs were seen spent more time at the colony than those attached to sites where pairs were never seen. The attendance of single birds seemed to be more erratic as well as less frequent overall than that of paired birds. Only 66.7% of occupied sites were still occupied two hours later. This difference was significant at the 0.005 level (χ^2 test; Table 3), and suggests that single birds were more likely to vacate the site temporarily during the day than paired birds.

The two groups of birds may have been existing pairs which were likely to attempt to breed, and single birds which may have been seeking sites and/or mates. It is not, however, possible to say whether sites at which pairs were not observed were always attended by the same bird. Coulson (1972) showed that non-breeding Kittiwakes showed little site and mate retention from season to season, and little coordination of attendance. The opposite was true for breeding birds, and successful partnerships were maintained by a relatively early return to the colony.

The data from this study were compared with those of Hodges (1977) for the attendance of Kittiwakes at North Shields in July. Whilst the overall probability of attendance (0.425) was slightly less than for birds in Hodges' study (0.463–0.491), that for birds known to be paired was rather higher (0.57). In this study, pairs represented 23.4% of all observations, compared with 7.5% at North Shields in July. Although Hodges' data is based on a single count between 09.00 and 11.00 each day, pairs were more likely to be observed together in April than July (Table 4). The differences were significant at the 0.005 level (χ^2 test),

TABLE 3. CONTINUITY OF OCCUPATION OF KITTIWAKE NEST SITES IN MONITORED SUB-COLONY, 08.00–20.00, 4–6/4/79.

	No. of observations		
	Occupied site still occupied 2 hrs later	*Occupied site vacated 2 hrs later*	*Total*
Sites where pairs present	207	9	216
Single birds only present	30	15	45
Total	237	24	261

H_0 = Continuity of site occupation is the same irrespective of whether one or two birds are attending the site.

$\chi^2 = 39.86$ df = 3 $p < 0.005$

TABLE 4. COMPARISON OF KITTIWAKE ATTENDANCE AT THE ISLE OF MAY 4–6/4/79 WITH DATA OF HODGES (1977) FOR ATTENDANCE OF KITTIWAKES AT NORTH SHIELDS IN JULY 1969 AND 1970.

i-H_0 = No. of pairs present is proportional to total observations of ledges.

	Pairs	*No. pairs*	*Total*
April	130	402	532
July	258	3148	3406

$\chi^2 = 147.27$ df = 3 $p < 0.005$

ii-H_0 = No. of pairs present is proportional to total observations of guarded ledges.

	Pairs	*Singles*	*Total*
April	130	192	322
July	258	2700	2958

$\chi^2 = 278.91$ df = 3 $p < 0.005$

whether the number of pairs was considered in relation to total observations of sites, or to total observations of guarded sites.

Hodges concluded that in July breeding birds coordinated their attendance so as not to duplicate each others' efforts in guarding the nest. He also suggested that while constant attendance on eggs and young chicks was probably essential for successful breeding, pair attendance might endanger grown chicks on restricted nest ledges. The pattern on the Isle of May in April was very different. Paired birds attended the site for a greater part of the day and the attendance of the two members of the pair was to some extent synchronised.

DISCUSSION

The four seabird species considered here showed three different patterns of attendance in the pre-laying period. Guillemots and Razorbills showed a cyclical pattern in which days of high numbers alternated with days of low numbers or absence. The cycle was the same for both species, and on any one day numbers were highest in the early morning. Such a cyclic pattern of attendance has been described for these species in the pre-laying period in Pembrokeshire (Corkhill 1970, Lloyd 1972, Birkhead 1978), although it may be disrupted by bad weather. It seems that periods of absence involve feeding trips and that on days of peak attendance almost the entire breeding population of Guillemots is present at the colony (Birkhead 1978).

The Shag showed a diurnal rhythm with birds spending the nights ashore, leaving the colony to feed on the first falling tide of the day, and returning from two to three hours after high tide, to peak in numbers at dusk. Birds spend most of the day near the colony and breeding birds may still have been returning to the colony in early April.

The Kittiwakes showed a diurnal rhythm, with low numbers in the early morning, a peak in the early afternoon, and a major exodus at dusk. Individuals tended to follow this pattern, and once returned to the colony for the day tended to stay until dusk. This pattern was different to that observed at North Shields later in the breeding season, when the attendance of paired birds at the site was poorly synchronized (Hodges 1977), and the population may have contained several components each with different attendance patterns. Synchronization of attendance of paired birds in the pre-laying period might allow both members of the pair to feed at the optimum time and place, and would probably also facilitate site establishment and maintenance of the pair bond, allowing breeding to begin as early as possible. In April the population probably contained a component of unpaired birds, which spent less time on the ledges than the paired birds, but had a similar diurnal rhythm of attendance.

ACKNOWLEDGEMENTS

Thanks are due to Tricia Asquith for help in the field, to the Isle of May B.O. Committee for permission to visit the Island, and to Tim Stowe, Peter Evans and Tim Birkhead for criticism of an earlier draft.

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Methods used to census skua colonies

R. W. Furness

Two species of skua breed in northern Britain. The Great Skua *Catharacta skua* is a large, conspicuous seabird which nests in loose colonies on open moorland in Shetland, Orkney, the Hebrides and north Scotland. The Arctic Skua *Stercorarius parasiticus* is a smaller species with similar nesting habitat and range. Although widespread in the arctic, the Arctic Skua is one of the least numerous seabirds in Britain (Cramp *et al.* 1974, Everett in prep.). It is subject to competition with the increasing Great Skua population (Furness 1977a) and to human persecution. Census data indicate that some colonies are increasing, others are decreasing. The Great Skua is one of the least numerous breeding seabirds in the North Atlantic. Roughly 6,000 pairs nest in Iceland and the Faroes, where numbers are declining slightly. A similar number nest in Britain, where most colonies are increasing at rates between 5 and 10% per annum (Furness 1977b). Eight colonies hold more than 100 pairs of Great Skuas. These contain 96% of the British population. Arctic Skua colonies tend to be smaller and more numerous.

Because both species are scarce, one globally, one nationally, their population changes are of particular interest. Their histories have been well documented and comprehensive surveys have been carried out recently (Furness 1977b, Everett in prep.). It should be possible to follow future trends with accuracy. However, during a detailed study of skua biology on Foula, Shetland, I found that different census techniques could give very variable estimates of colony size. In particular, the census method recommended by Cramp *et al.* (1974) is unsuitable.

Full details of the different census methods, results and conclusions are given in thesis form (Furness 1977b). They are outlined here to guide future census work on skuas and to show the accuracy of the methods used.

METHODS

In four years two ornithologists visited Foula independently and published estimates of the Great Skua numbers. These appear to have been obtained by walking through the colony and subjectively assessing its size. Comparing these pairs of 'guesstimates' gives an idea of their accuracy.

I used three census methods: 1. Repeated searching of the colony each day to locate and mark all nests with eggs; 2. Walking slowly through the colony to count skuas as they react by diving at the intruder (reactions of pairs were also scored at each marked nest on each visit during incubation and chick-rearing); 3. Counting territory-holding birds or pairs from a distance so the birds being counted were undisturbed. Cramp *et al.* (1974) recommend method 2 to census Great Skua colonies and method 2 or 3 for Arctic Skuas.

RESULTS AND DISCUSSION

Subjective estimates

Evans and Buckley (1899) estimated that there were 60 breeding pairs of Great Skuas on Foula in 1887. Barrington (1890) estimated 84 pairs in 1889 and 80 pairs in 1890. Raeburn (1891) estimated 60 pairs in 1891 and Clarke 40 pairs in 1890 (Evans and Buckley 1899) and 100 pairs in 1891 (Clarke 1892). Dickens (1958) gave an estimate of 500 pairs in 1958 and Perdeck (1960) noted 1,000 pairs for the same year. These 'guesstimates' differ by

40–100% for the same or successive years, so it is clear that they can be used to detect major changes in colony size, but are not adequate for most monitoring purposes.

Marking nests

Marking nests has been used to census Arctic Skuas on Fair Isle (O'Donald 1972) and Foula (B. L. Furness unpubl.) and Great Skuas on Noss (Perry 1948, Kinnear 1974), at Hermaness (Albon *et al.* 1976) and on Foula (RWF). Arctic Skuas can be watched returning to eggs so nests are easily found. Great Skuas are more timid, so their nests must usually be found by random search. Census accuracy is likely to be lower for the Great Skua so only data for this species are considered here.

The interval between laying and finding the nest on Foula (laying dates estimated from hatching dates or egg densities (Furness and Furness in press)) varied from 0–38 days, for a sample of 372 nests. The distribution of intervals would follow a Poisson distribution if all nests were equally difficult to find. The mean interval was 7.7 days (variance 58 days). The variance: mean ratio of 7.5 indicates that some nests are far more difficult to locate than others. Finding is not a random process. Nevertheless, only six territories were found where chicks hatched from an unlocated nest, so 98% of nests were located before hatching.

Laying occurred between 1 May and 25 June. As some clutches will have hatched before others are laid, nests must be marked through the entire laying period. Up to 25% of clutches may be lost before hatching (Furness 1977b). Some may fail before the nest has been found. In my study this proportion was 1.6% (estimated from the distributions of clutch age at disappearance and interval between laying and finding). Thus the nest count underestimated the number of breeding pairs by six nests never found and six nests which were lost before being located (a 3% error). Most clutches lost before mid-June are replaced. Replacement clutches are usually in new nests and are likely to be counted as first clutches if the lost clutch had not been marked. This will cancel out part of the error.

In general, marking nests should estimate numbers of breeding pairs to within 2% of the total, with the error likely to be an underestimate of the actual number. The method requires the observer to visit the colony from laying to late hatching.

Counting aggressive encounters

This (recommended) method requires several assumptions to be satisfied. Observers must cover the colony sufficiently thoroughly to enter every territory without entering territories twice, and must be able to distinguish between attacking birds from neighbouring territories. At least one adult must be present in each territory and must be sufficiently aggressive to mob the intruding observer.

Watches of individually marked skuas on Foula over 24-hour periods showed that at least one adult is normally present all the time from before egg-laying to shortly before fledging (Furness 1978, B. L. Furness unpubl.). Aggression of Great Skuas is greater when both adults are together, and reaches a peak around hatching. Late in incubation, pairs in 881 territories on Foula were scored for aggression. In 6% of cases both adults left the territory when disturbed. In 20% they circled above but did not swoop. In 40% swooping was sporadic or short-lived. Only 34% of territories contained one (or two) adults which swooped consistently. Lack of swooping could lead to at least 26% of territories being overlooked, depending on the experience and diligence of the observer. Albon *et al.* (1976) marked 739 Great Skua nests or broods in July 1974 at Hermaness, Unst. Territorial defence was only elicited in 467 (63%) of these territories.

Similar proportions of Arctic Skuas fail to attack or distract intruders to their territories on Foula (personal obs.) or Fair Isle (Cooper pers. comm.). As a result, this census technique will lead to gross underestimation of skua numbers, and is little better than applying 'guesstimates'.

TABLE 1. A COMPARISON OF SKUA CENSUS ESTIMATES OBTAINED BY MARKING NESTS AND BY .COUNTING APPARENTLY OCCUPIED TERRITORIES IN DIFFERENT AREAS OF THE COLONIES ON FOULA, SHETLAND.

Species	*Year*	*Nests marked**	*Territories counted*	*Percentage difference*
Great Skua	1975	184	170	- 7.6%
	1975	261	238	- 8.8%
	1975	32	30	- 6.2%
	1976	372	332	-10.8%
	1976	32	32	0.0%
Arctic Skua	1975	253	240	- 5.1%
	1979	14	14	0.0%
	1979	39	38	- 2.6%
	1979	79	80	- 3.8%
	1979	85	80	- 5.9%

* Arctic Skua nests marked in 1975 by Drs P. O'Donald and J. W. F. Davis and in 1979 by B. L. Furness.

Territory counts

Skuas prefer to nest on high ground but avoid slopes, so that all British colonies are on flat or gently sloping surfaces. They can easily be scanned from a distance with binoculars, to count apparently occupied territories. Using this method the following errors may arise: a) Members of a pair, standing apart, may be counted as two single territory holders (and vice versa); b) Birds may not be noticed against a similarly coloured background, or may be in the air or out of the territory; c) Difficulties in subdividing large colonies may occur. d) Counts in July may be higher than counts in May because a few young birds seek to establish a territory in the latter part of the season. Experience has shown that Great Skuas are more difficult to locate than Arctic Skuas but the ability to pick birds out as they stand or sit against a similarly-coloured background improves with practice. Sample counts of apparently occupied territories were made in the skua colonies on Foula and compared with nest counts made by other observers or later in the season. The comparisons are in Table 1. For both skuas counts of apparently occupied territories underestimate the number of nests in the area. The bias is slightly greater for Great Skuas (6.7%) than for Arctic Skuas (3.5%) and may be greater in areas where large numbers of pairs nest. These counts suggest that very few pairs hold territories but do not lay. This is in agreement with my general observations.

A count of 500 territories can be completed in less than five hours, so even large colonies can be counted in this way in three or four days by one person.

CONCLUSIONS

Subjective estimates of colony size are sufficiently accurate to be useful, but cannot show a range in numbers of less than 50–100%. Marking nests gives great precision but is laborious. A census based on scoring aggressive behaviour of skuas in territories is likely

to be inconsistent and will grossly underestimate numbers. Counts of birds in apparently occupied territories are easily carried out and give consistent results. These underestimate Great Skua numbers by about 7% and Arctic Skua numbers by about 4%.

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SUMMARY

The recommended method for counting skuas is grossly biased and inappropriate. Subjective assessments are useful but not adequate to detect small changes. The best method is to mark nests but counts of 'apparently occupied territories' can be made quickly and easily. These show a small, consistent bias. They underestimate numbers of breeding pairs by 4–7%. Counting occupied territories is recommended for future censuses of skua colonies.

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Breeding populations of gulls in the inner Bristol Channel, 1980

Greg P. Mudge and Peter N. Ferns

INTRODUCTION

Populations of breeding gulls in the inner Bristol Channel area, in common with those throughout much of Britain (and elsewhere in Europe and North America), have increased dramatically during the present century (Cramp *et al.*, 1974; Drury, 1973; Harris, 1970; Mudge, 1978a, b). Up to 1975 (when the last full census was carried out) the Bristol Channel Herring Gull (*Larus argentatus*) population had been increasing at an average annual rate of 10.1%, and the Lesser Black-backed Gull (*Larus fuscus*) population at 9.1%. The main objective of the present work was to repeat the census and see what changes had occurred since 1975. The detailed results, together with methodology, are recorded in an unpublished report (Mudge and Ferns, 1980). This short article aims to summarise the findings.

TABLE 1. THE NUMBERS OF PAIRS OF BREEDING GULLS AT COLONIES IN THE INNER BRISTOL CHANNEL IN 1975 AND 1980.

Colony	*Year*	*Herring Gull*	*Lesser Black-backed Gull*	*Great Black-backed Gull*
Steep Holm	1975	8113	593	41
	1980	2723	555	30
Flat Holm	1974	4055	4055	2
	1980	1302	2379	3
Stert Island	1975	2062	46	6
	1980	60	4	0
Denny Island	1975	100	0	30
	1980	62	1	40
Welsh coastal cliffs	1974	906	2	0
	1980	430	3	0
River Wye cliffs	1975	90	0	0
	1980	47	1	0
Quarries	1976	133	1	0
	1980	48	3	0
Rooftops	1975	728	316	0
	1980	728	565	0
Other sites	1980	64	5	0

The area covered included the counties of Mid Glamorgan, South Glamorgan, Gwent, Gloucestershire, Avon and Somerset, and, as far as is known, all gull breeding colonies were visited and counted.

RESULTS AND DISCUSSION

The results of the counts (Table 1) yielded overall totals for the area of c. 5,464 pairs of Herring Gulls, c. 3,516 pairs of Lesser Black-backed Gulls, and c. 73 pairs of Great Black-backed Gulls (*Larus marinus*). The largest colonies were on Steep Holm, Flat Holm, coastal cliffs and rooftops. Breeding was recorded on rooftops in 19 towns, with Cardiff, Newport, Barry, Hirwaun, Gloucester, Bristol, Bath, Portishead and Bridgwater having the largest concentrations.

When the 1980 results are compared with those for 1975 (Table 1) it is clear that considerable declines have taken place over this five year period. In terms of overall numbers, Herring Gulls were down by 67%, Lesser Black-backed Gulls by 30%, and Great Black-backed Gulls by 8%. For the first two species these changes reverse the trend of rapid increase that had been taking place up to 1975. Great Black-backed Gulls reached peak numbers in the area in the early 1960's and have been slowly declining ever since. The drop in numbers between 1975 and 1980 is a continuation of this trend.

The only real exceptions to this decline have been rooftop colonies. For Herring Gulls there was no overall change in the use of these sites (though at different individual towns both increases and decreases were recorded), but Lesser Black-backed Gulls increased markedly (up by 77.1% overall). Indeed there has been a substantial change in the overall breeding distribution of these two species, with higher proportions of the populations now using rooftops (Herring Gull—4.3% in 1975 and 13.3% in 1980; Lesser Black-backed Gulls—6.0% in 1975 and 16.1% in 1980).

The largest declines, for all species, were on Stert Island. However, special circumstances, namely predation and disturbance by foxes, provide the explanation here. At other colonies the extent of the declines, particularly for Herring Gulls, was remarkably constant. This suggests that there is a general reason for the declines, rather than that they are due to adverse changes at particular colonies, e.g. increased disturbance by visitors on Steep Holm. Available evidence suggests that unusually high adult mortality during the breeding season due to botulism may be the underlying cause. In the last few years we have regularly found large numbers of dead and dying gulls at the main breeding colonies during the summer months. Moribund individuals displayed symptons that were consistent with *botulinus* poisoning. Tests on blood sera collected in 1980 from seven such birds gave positive results in four cases.

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Breeding Great and Arctic Skuas in Scotland in 1974–75

M. J. Everett

INTRODUCTION

The first counts of the Scottish breeding populations of Great Skuas or Bonxies *Stercorarius skua* and Arctic Skuas *S.parasiticus* were made during 'Operation Seafarer' in 1969-70. These showed the Arctic Skuas as our scarcest regularly breeding seabird (1086 pairs) and the Bonxie nearly three times as numerous (3172 pairs). It was thought that both species were increasing in their strongholds in Orkney and Shetland and while the Arctic Skua had decreased in its Hebridean outposts the Bonxie was slowly colonising new sites there (Cramp, Bourne and Saunders, 1974).

'Seafarer' counts were incomplete in some areas and the population figures were too low for both species. This was inevitable when the emphasis was on coastally nesting birds: many skuas of both species nest well inland. A second, more complete survey was carried out on behalf of the Seabird Group in 1974 and 1975. Orkney was fully counted in 1974; Shetland was partly covered in 1974 but mainly in 1975. At the end of 1975 there remained some gaps in the counts on Mainland in Shetland, but it is believed that relatively few skuas were missed.

METHODS

Teams of observers visited almost all known sites for both species (including many not visited five years earlier)—and found a number of previously unknown sites—during the second half of June and the first half of July, counting and where possible drawing sketch-maps to show the distribution of nesting skuas. In addition, they were asked to provide information on threats to the two species and on their inter-relationships where they occurred together.

The results are discussed by species and by regions, with reference to past counts where these are available and are sufficiently complete for comparative purposes. It must be stressed that the 1974–75 figures are estimates—almost certainly under-estimates. The difficulties in obtaining accurate counts of breeding seabirds are well known and while skuas may be relatively easier than some other species they do present a number of problems. While large concentrations of breeding birds were not uncommon, there were also many small groups and odd pairs scattered over large areas; large numbers of competent and energetic observers were required to do justice to both species and this survey showed clearly that allotting large areas to single observers would be unsatisfactory if repeat surveys are done in future. The period when reasonably accurate counts can be made, i.e. June to mid-July, does not allow an observer much leeway and, as happened in Shetland in 1975, his effective time in the field can be shortened still further by bad weather. Thus, single counts were made at most sites, rather than a series of counts spread over several days and undertaken at different times of day—which would have provided more reliable figures. The margin of error resulting from these 'spot-checks' is unknown.

Ideally, where sizeable colonies exist it would be preferable to count active nests, but often shortages of time and manpower rendered this impracticable. Counts of pairs holding territory proved more realistic and this unit is used here whenever 'breeding pairs' are quoted for 1974–75.

TABLE 1. NUMBER OF PAIRS OF GREAT AND ARCTIC SKUAS BREEDING IN SCOTLAND IN 1969–70 AND 1974–75.

	GREAT SKUA		*ARCTIC SKUA*	
	1969/70	*1974/75*	*1969/70*	*1974/75*
Shetland	3060	5451+	770	1631+
Orkney	90	482+	230	716
O Hebrides	18	24+	40	37
Sutherland	4	12	1	3
Caithness	—	1?	20	28+
Argyll	—	—	25	26
TOTAL	3172	5970+	1086	2441+

RESULTS

A comparison between the totals for 1974–75 and 1969–70 as given by Cramp *et al.* (1974) (Table I) suggests that staggering increases of both species occurred in Orkney and Shetland, but the incompleteness of the 'Seafarer' counts makes such a straightforward comparison meaningless. Clearly Great and Arctic Skuas have increased in both regions but in the absence of strictly comparable data the rate of this increase remains largely unknown. However, some trends were discernible at a more local level and these are discussed below.

TABLE 2. NUMBER OF PAIRS OF GREAT AND ARCTIC SKUAS BREEDING IN ORKNEY AND SHETLAND 1974-75.

		Great Skua	*Arctic Skua*
SHETLAND	Unst	1228	219
	Yell	257	327
	Hascosay	55+	18
	Fetlar	237	201
	Mainland	230+	290+
	Whalsay	3+	17
	Bressay	160+	104
	Noss	260	44
	Foula	3000	275+
	Fair Isle	21	136
	(Total)	(5451+)	(1631+)
ORKNEY:	Papa Westray	4	88
	Westray	—	93
	Calf of Eday	1	—
	Eday	1	59
	Sanday	—	45
	Rousay	5	48+
	Eynhallow	10	10
	Wyre	—	3
	Gairsay	1	19
	Stronsay	2+	18
	Auskerry	1+	—
	Mainland	5	34
	Hoy	462	237
	Other Islands	—	62
	(Total)	(482+)	(716+)
	Grand Total	5933+	2347+

GREAT SKUA

Shetland

The numbers of Bonxies counted in Shetland in 1974-75 are shown in Table 2. Shetland has long been the Bonxie's British stronghold and indeed 91% of those counted in 1974–75 were found there. The first British breeding record dates from 1774 when six pairs were present on Foula and three or four others elsewhere in Shetland (Low, 1879). By the late 19th century small numbers were breeding on Foula, Yell, Unst and northernmost Mainland, sustained on Foula and Unst by protection (Clarke, 1892), but in the present century numbers increased substantially and by 1969–70 the species had spread to other islands (Cramp *et al.*, 1974). Unfortunately the 'Seafarer' figures for 1969–70 are incomplete and there were probably rather more than the 3,060 pairs recorded then. Cramp *et al.* (*loc. cit.*) were able to document the history of the best-known sites, however, and good comparisons were possible in many cases. The figures quoted below are from their table.

On Unst, most of the birds counted in 1969–70 were at two main sites, Hermaness and Saxa Vord. The Hermaness colony had probably reached 100 pairs by the mid 1920's; there were 286 pairs by 1965 and 300 pairs five years later. In 1974 there were some 800 pairs on the whole peninsula (a somewhat greater area than that covered by the previous counts) and it was clear that the population there was growing. At Saxa Vord, where breeding was first recorded in the 1890's, 45 pairs were present by 1949 and 80 by 1969–70. About 140 pairs were found there in 1974. Nearly 300 pairs were located elsewhere on Unst in 1974, with a major concentration to the south of Hermaness, and it was clear that this island had a growing Bonxie population second only to that on Foula.

Yell was colonised between 1887 and 1896, and by 1946, 96 pairs were recorded. Numbers were lower by 1951, but 125 pairs were estimated in 1969–70. This was certainly too low as 256 pairs were found in 1975 and R. J. Tulloch (pers. comm.) considered that numbers had been fairly stable since the 1960's. Numbers on Hascosay have fluctuated due to culling; Bonxies were breeding there by 1913 and 60–70 pairs were recorded in 1932, 30–40 in 1947–49, 75 in 1952 and 40 in 1969–70. At least 55 pairs were found in 1974–75. On Fetlar, which was first colonised early this century, numbers remained low until the early 1950's (15-25 pairs in 1952) but 200-300 pairs were present in 1969-70, and 237 pairs were counted in 1975.

It was difficult to assess trends on Mainland and its nearby small islands, due to incomplete counts in the past, but 'Seafarer' recorded around 135 pairs. The total during the present survey was at least 200 pairs, with 66 of these in the North Roe area (79 in 1969–70, where Cramp *et al.* refer to the area as Ronas Hill only), 56 between Scalloway and Dunrossness and 30 around Fitful Head (a few pairs by 1948 and 13 in 1969-70). On Mousa, where 3–4 pairs were present in 1949–51 and 12 by 1969–70, there were nine pairs in 1974. The 1975 figure for the Sullom Voe area—at least 15 pairs—was probably an under-estimate due to the late dates of the counts there. Gaps in the coverage on Mainland in 1974–75 no doubt mean that Bonxies were missed elsewhere on Mainland: the true total may have been as high as 280 pairs (P. K. Kinnear, pers. comm.).

No breeding birds were recorded on Whalsay in 1969–70 or in 1975, although one pair had tried to breed more or less annually since about 1960 and had always failed due to persecution. On nearby West Linga, however, there were at least three pairs in 1975 after none was recorded by 'Seafarer'; a pair bred there in 1952 and this had been a traditional site since the 1930's. On Bressay, nesting first occurred in 1913, with 20 pairs by 1946 and 92 in 1969–70; numbers were still higher by 1975 when 160 pairs were located.

The well-known colony on Noss is one of the best documented in Shetland. Two pairs are recorded for 1910, increasing to 30 by 1929, 50 by 1932, 90–100 by 1939, 113 by 1946 and 165 by 1952. 'Seafarer' produced a total of 210 and the increase was continuing in 1974 when 260–270 pairs were present.

There were six pairs on Foula in 1774 and during the present century it has been the major British stronghold of the species. Certainly its Bonxies are the best documented. With protection from persecution, the increase here has been dramatic in the last two decades: 500 pairs in 1956, 900 in 1963, around 1800 in 1969 (Cramp *et al.*, 1974, and Furness, 1974), around 2500 in 1973 (Furness, 1974) and about 3,000 in 1975. The 'Seafarer' counts showed that Foula held 56% of the British population in 1969–70, a slight over-estimate since counts elsewhere were incomplete; in the present survey the corresponding figure was 50%.

Fair Isle has probably been a breeding station since 1804, but persecution kept the population small over a long period—although 30 pairs were recorded in 1963. The birds are still shot there. Ten pairs were counted in 1969–70 and 21 in 1975.

Orkney

Table 2 shows the numbers of pairs counted in Orkney in 1974. Bonxies first bred in Orkney in 1915 when there were two pairs on Hoy (Jourdain 1918, 1919) and since then this island has remained the Orkney stronghold. There were some 20 pairs in 1941 (Lack 1942–43), 60 in 1961 (Balfour 1968) and 72 in 1969; the tremendous increase to 462 pairs in 1974 must reflect fuller coverage than in 1969 as well as a probable increase.

'Seafarer' found 18 other pairs of Bonxies on ten other islands (six of them on Papa Westray) and the pattern was broadly similar in 1974 when at least 20 pairs were found on eight islands. None was found in 1974 on Westray (two pairs in 1969) nor on Cava and Fara (one pair each in 1969), but there were five pairs on Rousay (one in 1969). On Mainland, where there were no 1969 records, five pairs bred at two sites in 1974. As in 1969–70, no Bonxies were found breeding on Eynhallow, where pairs have nested at intervals since 1956.

Other Areas

A single pair was apparently on territory at Dunnet Head, Caithness, where one or two pairs bred between 1949 and 1955 but have not done so subsequently (Cramp *et al.*, 1974). In Sutherland, two sites which held single pairs in 1969–70 were not visited in 1974–75, but one of these, Eilean Roan, had two pairs in 1973 and this total is included here. Eight pairs nested on Handa in 1975; numbers here have grown slowly since 1964 when the first breeding occurred (Waterston, 1965). Two pairs bred south of the Clo Mor area in 1975 and at least one in 1971 (J. L. F. Parslow and P. G. H. Evans, pers. comm.).

In Lewis, 10 pairs were found at two sites in 1969 and in 1975 there were 11 at three sites. Breeding was first confirmed in 1945 (Campbell, 1959; Cunningham, 1959). Bonxies first bred on St Kilda in 1963 (Pollock, 1963), with at least six pairs by 1969 and at least nine in 1974.

Bonxies were first noted on North Rona in 1938 (Darling, 1938), but breeding (two pairs) was not recorded until 1965 (Eggeling, 1965); there were 3–4 pairs in 1972 and 4–5 in 1974 (Evans 1978).

ARCTIC SKUA

Shetland

The numbers of pairs counted in Shetland in 1974–75 are shown in Table 2. As with the

Bonxie, past records are incomplete and comparisons are possible only for a few of the better documented sites. It has been suggested (e.g. by Perry, 1948 for Noss, and Venables and Venables, 1955 for Hermaness and Foula) that in areas where Bonxies and Arctic Skuas breed side-by-side, the expanding population of the former has led to local declines in numbers of the latter; this possibility is discussed below, but taking the Shetland Arctic Skua population as a whole there were good grounds for saying that it was increasing. 'Seafarer' recorded 770 pairs in Shetland in 1969–70, while 1,631 pairs were counted in 1974–75, although again it must be stressed that the 'Seafarer' figures were incomplete, so that the true rates of increase cannot be measured. In addition, the 1974–75 survey missed several areas on Mainland where it was estimated that there could well be another 50–100 pairs (P. K. Kinnear, pers. comm.), so that the true population figure for Shetland in 1974–75 was probably around 1,700 pairs.

TABLE 3. NUMBER OF PAIRS OF ARCTIC SKUAS BREEDING IN ORKNEY IN 1941, 1961, 1969/70 and 1974.

	1941	*1961*	*1969/70*	*1974*
Papa Westray	18	18+	25	88
Westray	—	'a few'	67	93
Eday	—	6–8	11	59
Sanday	—	up to 10	9	45
Stronsay	—	1–2	7	18
Rousay	—	15–20	11	48+
Gairsay	—	2–3	3–4	19
Wyre	—	2–3	3–4	3
Eynhallow	—	1	10	10
Hoy	60+	100–150	68	237
Mainland	—	2–3	5	34
Other Islands	—	—	8	62
Totals	79+	160–220	227–229	716+

Fewer than 70 pairs were found on Unst and its associated small islands in 1969, with 30 of these at Hermaness (where there were 40–50 pairs in 1970). 219 pairs were found in 1974–75, with 70 on the Hermaness peninsula, 36 in the area east of Burra Firth, 39 to the east of the Loch of Cliff and 49 in the region between Balta Sound and Skuda Sound. Yell and the Yell Sound islands were apparently not counted in 1969–70, but the population missed there must have been quite a large one, judging from the 1975 estimate of 327 pairs. R. J. Tulloch (pers. comm.) considered that numbers on Yell had remained stable for 20 years or so.

Hascosay held about ten pairs in 1969 and 18 in 1975, possibly reflecting a genuine increase. On Fetlar, at least 200 pairs were estimated for 1969 and with 201 counted in 1975 it seems that the position there had remained stable.

The 'Seafarer' estimate of under 80 pairs on Mainland in 1969-70 was certainly too low. More extensive (but still incomplete) coverage of this large and difficult area produced 260 pairs in 1974–75, the pattern being one of widely scattered pairs or small colonies, hardly ever exceeding 20 pairs together in any one place. Some 50–100 more pairs may have been present in areas not covered and the late dates of the counts in the Sullom Voe area may have meant that numbers there were under-estimated.

Whalsay is not mentioned in the 1969–70 counts, but a few pairs have nested there since the 1930's and in the mid-1950's 10–16 pairs were present at one site (P. K. Kinnear, pers. comm.); 17 pairs were found in 1975. 'Seafarer' recorded fewer than 20 pairs on Bressay,

probably another under-estimate as 104 pairs were found in 1975. Reliable documentation for Noss shows that the population there has been stable over a relatively long period. Baxter and Rintoul (1953) quote 40-50 pairs in 1922 and 60 in 1930, while there were 37 in 1946 (Perry, 1948), 40 in 1969 and 44 in 1974.

The Foula population is also well documented. There were 60 pairs in 1890, 100 in 1948, 130 in 1960, 100 in 1969 and 130 in 1973 (Furness, 1974). An increase to 200 pairs is recorded for 1974 and at least 275 were present in 1975 (J. W. F. Davis; pers. comm.)—although some of this recent increase may well be due to much more accurate censusing than in the past.

Fair Isle numbers remained low until 1948 but there was a considerable increase from 15 pairs in 1949 (Davis, 1965) to 180 in 1969; numbers then decreased, with 106 pairs in 1973, and 136 in 1975.

Orkney

Table 3 shows the 1974 totals and distribution compared with the figures for 1941, 1961 and 1969–70 as collated by Cramp *et al.* (1974). Fortunately the past data for Orkney make some comparisons possible, although some of the more spectacular increases apparent between 1969–70 and 1974 may be partly the result of incomplete 'Seafarer' counts: it seems unlikely that the Orkney population more than trebled between 1969–70 and 1974 (230 pairs to 716 pairs) even though some expansion undoubtedly took place.

Westray and Papa Westray have long been important Arctic Skua islands, but by 1974 it was obvious that others which had held smaller populations in the past had also become important—Eday, Sanday, Rousay and Mainland in particular. The 'other islands' in the 1974–75 totals include Fara (14 pairs) and Flotta (about 21 pairs), both of which held only single pairs in 1969–70, and the newly-colonised Switha and Swona, each with single pairs.

Hoy, another important island for this species, seems to have been the Orkney stronghold until 1961 at least. The 1969–70 figures suggest a decrease back to the numbers recorded 30 years earlier, but the 'Seafarer' total was probably a considerable under-estimate in view of the far greater figure of 237 pairs produced in 1974 when Hoy was more fully covered than ever before. In 1974, 33% of the Orkney population (and almost 10% of the entire Scottish population) was found on this island.

Other Areas

Elsewhere in Scotland, Arctic Skua numbers in 1974-75 were much the same as in 1969–70. The Caithness population (20 pairs in 1969–70, 28 in 1974) consisted of scattered pairs, apart from one colony of ten pairs; in the last 100 years or so numbers there have decreased markedly (Pennie, 1953) but the population seems to have stabilised in recent times. Baxter and Rintoul (1953) list Sutherland as another mainland county where breeding occurred in the past. In 1974 a single pair was found in mainland Sutherland and in 1975 there were two pairs on Handa, a site first colonised in 1968 with one pair in 1970 and three in 1974.

In the Outer Hebrides, where Arctic Skuas were formerly quite numerous (Gray 1871), the population seemed to have stabilised at around 40 pairs. In 1969–70 there were about 32 pairs on Lewis, seven on North Uist and one on South Uist; in 1974–75 the totals were 22, 15 and none respectively. A few more pairs were probably undetected in these islands. In the Inner Hebrides ('Argyll' in Table 1) there were about 20 pairs on Jura in 1969-70 and at least 15 in 1974, while on Coll there were six pairs in 1969–70 and about ten in 1975. Birds have been seen quite regularly on Colonsay in recent years and a single pair is said to

have bred there in 1975—possibly the first breeding record. Although Arctic Skuas are present on various other islands in summer (e.g. North Rona) there are no breeding records from these so far.

Threats to Breeding Skuas

Although the main aim of the survey was counting, many observers made some comment on possible threats to both species. Inevitably this was often largely subjective, but some useful points emerged.

In most areas, disturbance and other threats were regarded as minimal or non-existent. Grazing sheep (occasionally cattle and, on Jura, Red Deer *Cervus elaphus*) were listed as possible disturbers of breeding Arctic Skuas in some areas, but since these birds vigorously defend their territories against livestock this seems to be of little consequence. Not surprisingly, Bonxies were hardly mentioned in this context! In a few areas, e.g. Caithness and Orkney, peat-digging and heather burning may have caused disturbance or altered nesting habitats, but these are probably unimportant factors except perhaps on a local scale.

Human disturbance varies from being insignificant in most areas to fairly serious in others where well-known colonies are subjected to pressure from birdwatchers, photographers and other visitors. With their famous aggressiveness, Bonxies may cope better than Arctics with human disturbance, except where this is prolonged. On Noss, Kinnear (1974, unpubl.) found that Arctic Skuas breeding in 1974 suffered 27% egg loss, deserting clutches, losing their eggs and even eating them as a direct result of prolonged and frequent human disturbance. When visitors were re-routed to go around rather than through the colony, the situation improved markedly. The extent of predation on both species by egg collectors is unknown but probably very small, although one or two clutches of Arctic Skuas' eggs may have been taken on Noss in 1974.

In 1974–75 no attempt was made to predict the effects of the 'oil boom' on skua populations. Habitat loss through construction works of various kinds (including on some small islands), more people and more recreational use of previously little-disturbed moorland areas, as well as a gradual run-down in the crofting way of life in some areas, might reduce the numbers of breeding birds, or at least change their distribution; only time will tell.

Direct pollution by oil is a threat of unknown proportion at present, but clearly it could be a serious hazard to skuas, even if at a lower level than to some other seabirds. It is worth adding, however, that the Beached Birds Survey suggests that skuas are rarely oil victims (RSPB records). No attempt was made to assess the threats from pollution of the marine environment by organochlorines and other substances.

Direct Human Persecution

Direct persecution of Arctic Skuas by man seems to be virtually non-existent, except on Fair Isle where this species has been shot fairly regularly. No interference with the birds was reported outside Shetland. Shetlanders have usually felt benevolent towards Arctic Skuas as they are useful in keeping corvids *Corvus* spp. and large gull *Larus* spp. away from sheep and lambs in the birds' breeding areas (Furness, 1974; R. J. Tulloch, pers. comm.).

With the Bonxie the situation is quite different. There is a long history of antagonism by Shetland crofters towards Bonxies and that they established themselves there at all was due to protection by a few individuals. They are disliked not only because they kill other seabirds but also because they attack men, sheepdogs and livestock entering their

territories and because they have long been suspected of (and often wrongly blamed for) killing lambs. They were protected under the 1880 Protection of Birds Act and thereafter crofters were compensated for damage done by the birds; as a result, Bonxies increased and spread. The controversy went on, however, and in 1929 Zetland County Council made an unsuccessful bid to have the bird removed from the protected list. There is no doubt that persecution continues: it has been quite widespread even in recent years and on some sheep islands there may still be what amounts almost to a regular cull.

All who commented on this paper have considerable experience of Bonxies in Shetland and were unanimous in their view that little or no damage is done to livestock by Bonxies. None of them considered the bird to be a serious predator of young lambs, nor was any one of them able to quote any confirmed report of a Bonxie killing a lamb. A report by Houston (1973, unpubl.) on the predation of sheep by birds in Shetland indicated that heavy mortality among sheep, especially at lambing time, was due to bad management practices and that deaths caused by birds (Great Black-backed Gulls *Larus marinus*, Hooded Crows *Corvus corone* and Bonxies) were minimal. Like the other species, Bonxies were known to feed on dead and dying sheep and lambs, but in spite of the suspicion and allegations of sheep farmers no firm case could be made against the Bonxie as a lamb killer.

Furness (1974) investigated the situation in 1974 on Foula, where Bonxies are more numerous than anywhere else and are both increasing and expanding their breeding areas. He found that no more than a handful of individual Bonxies could have been involved in lamb killing and neither he nor any of the islanders saw any killing actually taking place. He concluded that any predation was minor when compared with the mortality which is a normal hazard of hill sheep farming, even in good years. Small numbers of sheep are lost in pools or over cliffs as a result of aggression by Bonxies but there was no indication that sheep or ponies were actually prevented from grazing in peace except in the immediate vicinity of nests. Perhaps the increase and spread of the birds meant that more interactions involving Bonxies were taking place and were in turn being noticed more by the islanders. In suggesting that action could be taken against individual birds if the case against them were proven, Furness stated firmly that any attempts at general or indiscriminate culling should be treated with extreme caution.

Bonxies and Arctic Skuas

Many observers commented on the well-known interactions between the two species where their breeding areas overlap, but no evidence was found in support of the theory that, in Shetland at least, the Bonxie is increasing and expanding at the expense of the Arctic Skua. Despite a lack of reliable past data for many areas, it was clear that the Arctic Skua was increasing in 1974-75. Furthermore, there was no indication of any decline of Arctic Skuas in the three main areas of Bonxie expansion on Unst, Noss or Foula.

Furness (1977) has subsequently examined this question in more detail. He found that Bonxies tend to usurp Arctic Skuas' territories and to kill adults and fledglings, reducing breeding success by as much as 20% on Noss and increasing adult mortality by 25% and fledgling mortality by 100% on Foula. Nevertheless, these activities have not caused any decrease in Arctic Skua numbers in Shetland colonies. Arctic Skua populations are basically regulated by the numbers of their main victim species—Arctic Terns *Sterna paradisaea* and Kittiwakes *Rissa tridactyla* and the surplus of non-breeding adult Arctic Skuas is sufficient to make good any losses caused by Bonxies. Furness also considered it unlikely that Bonxies would ever increase so much that this surplus would be eliminated.

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SUMMARY

'Operation Seafarer' recorded a British breeding population of 1,086 pairs of Arctic Skuas and 3,172 pairs of Great Skuas in 1969-70. A subsequent, fuller survey in 1974-75 gave figures of 2,441 and 5,970 respectively. Though strictly comparable data for the past are lacking for many areas, it was clear that both species were increasing in Orkney and Shetland; the Arctic Skua population on the Scottish mainland and in the Hebrides was more or less stable, while the Great Skua was slowly increasing and expanding its range there.

Threats to both species, both direct and indirect, are briefly discussed, and reference is made to continuing human persecution of Great Skuas, despite the negligible effects they have on sheep and lambs. The interaction between both species where they breed near one another is discussed, but no evidence is found to support the view that the Great Skua population is expanding at the expense of the Arctic Skua.

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Breeding terns in Britain and Ireland, 1975–79

G. J. Thomas

INTRODUCTION

Terns breeding in the coastal areas of Britain and Ireland were counted in 1968–70 during Operation Seafarer (Cramp *et al.* 1974). The RSPB in conjunction with the Seabird Group continued to collect data from as many colonies as possible. The 1970–74 results were published by Lloyd *et al.* (1975). The 1975–79 results are presented here and are compared to the two previous accounts. The British and Irish breeding numbers of Roseate tern *Sterna dougallii*, Sandwich tern *S. sandvicensis*, Common tern *S. hirundo*, Arctic tern *S. paradisaea* and Little tern *S. albifrons* are considered in a European context.

About 90 people have contributed to the survey during the five year period. Counting methods were not always specified, but where they were, they almost always referred to the counting of nests. The comprehensive counts of Arctic terns in Orkney and Shetland in 1980 (Bullock & Gomersall 1980) are summarised as data has been scarce for these areas since 1969–70.

TABLE 1. COUNTRY AND MAIN COLONY TOTALS OF PAIRS OF BREEDING ROSEATE TERNS 1969–79.

Colonies	*1969/70*	*av. 1970–74*	*75*	*76*	*77*	*78*	*79*
Strathclyde, Horse Island	15	8	0	0	0	0	0
Lothian, Inchmickery	46	43	61	100	54	51	40+
Fidra	50	38	0	0	0	0	0
Total Scotland	126	89	61	100	54	51	41+
Northumberland, Holy Island	25	0	4	4	8	10	9
Farne Islands	60	24	12	17	9	17	28+
Coquet Island	230	83	60	27	16	28	36
Isles of Scilly	20	17	—	9	10	8	12
Total England	338	124	78	58	45	64	87+
Gwynedd, Anglesey (= Wales total)	202	207	173	197	176	158	189
Co. Antrim, Swan Island	190	114	80	90	38	41	45
Co. Down, Green Island	228	329	169	200	186	188	125
Strangford Lough	10	?	40	128	100	166	163
Co. Dublin, Rockabill	60	100	0	6	0	10	40
Co. Wexford, Tern Island	1,350	742	400	250	0	0	0
Lady Island Lake	0	0	32	0	—	150	286
Total Ireland	1,851	1,285	811	674	324	594	659
Total Britain and Ireland	2,517	1,705	1,123	1,029	599	867	976+

The country totals include counts from smaller colonies which are not listed in tables 1–4.
— = no information available.

RESULTS

Roseate tern

The number of pairs breeding at the main colonies in Britain and Ireland are given in Table 1. All but a few pairs were found at the 9 main colonies, all of which are offshore islands. In 1979 all of the breeding Roseate terns reported were at reserved or protected

TABLE 2. COUNTRY AND MAIN COLONY TOTALS OF PAIRS OF BREEDING SANDWICH TERNS 1969–79.

Colonies	*1969/70*	*av. 1970–74*	*75*	*76*	*77*	*78*	*79*
Orkney	290	198	137	—	210	88	110
Grampian, Sands of Forvie	740	1,050	828	1,189	1,139	967	1,194
Highland, Stroma	0	(130)	—	150	—	—	120
East Ross	1,000	99	225	—	—	250	3
Strathclyde, Horse Island	108	25	60	27	0	0	0
Lothian, Inchmickery	46	218	660	566	580	430	604
Fidra	60	109	0	0	0	0	0
Total Scotland	2,496	1,886	1,909	1,933	1,929	1,735	2,066
Northumberland,							
Holy Island	62	26	6	0	0	5	0
Farne Islands	2,000	2,550	2,074	1,750+	1,750+	3,000	2,537
Coquet Island	208	1,041	1,676	1,260	1,260	1,137	797
Norfolk, Scolt Head	3,850	3,126	3,200	4,000	3,000	3,000	2,000
Blakeney	0	0	0	200	1,800	2,100	3,800
Stiffkey	96	970	—	—	91	—	—
Suffolk, Minsmere	13	538	260	150	164	18	0
Havergate Island	60	30	150	250	220	150	240
Essex, Foulness	17	15	22	—	95	110	—
Kent, Dungeness	0	0	0	2	0	0	17
West Sussex,							
Chichester Harbour	0	0	20	35	105	54	66
Hampshire,							
Needs Oar Point	179	209	220	105	17	0	—
rest of Solent	44	22	1	7+	—	197	70
Dorset, Brownsea Island	0	5	0	54	98	55	120
Isles of Scilly	0	0	—	—	6	20	—
Channel Islands	0	0	—	—	12	20	—
Cumbria, Walney	147	184	12	0	0	0	0
Foulney	10	38	70	120	350	600	700
Ravenglass	458	742	736	708	136	0	0
Total England	7,152	9,496	8,447	8,641+	9,089+	10,444	10,347
Gwynedd, Anglesey (= Wales total)	3	96	230	298	375	276	446
Co. Antrim, Swan Island	0	3	2	0	1	2	1
Co. Down, Green Island	477	834	700	1,000	1,107	968	1,302
Strangford Lough	666	458	—	600	844	595	799
Co. Fermanagh, L. L. Erne	4	69	99	92	129	119	134
Co. Wexford, Tern Island	246	516	460	474	0	0	0
Lady's Island Lake	0	0	—	—	5	137	204
Total Ireland	2,143	1,877	1,431	2,166	2,091	1,961	2,605
Total Britain & Ireland	11,794	13,355	12,017	13,038+	13,484+	14,416	15,464

areas. The Irish Sea colonies held the bulk of the breeding birds. The breeding numbers in Britain and Ireland have declined by about 61% over the last decade.

Consistently high numbers have bred on Anglesey, Green Island and Strangford Lough. The biggest loss has been that of Tern Island in Wexford. It has disappeared due to winter storms and there has almost certainly been a partial redistribution of terns to

TABLE 3. COUNTRY AND MAIN COLONY TOTALS OF PAIRS OF BREEDING COMMON TERNS 1969–79 (*1980).

Colonies	*1969/70*	*av. 70–74*	75	76	*77*	*78*	*79*
Grampian, S. of Forvie	475	351	700	390	375	133	180
L. of Strathbeg	—	—	—	—	70	121	110
Lothian, Inchmickery	100	426	750	635+	548	561+	500+
Aberlady Bay	75	291	217	253	318	221	216
Orkney, all	285	100+	—	—	148+	—	231*
Shetland, all	390	—	—	—	—	—	1,014*
Total Scotland	4,680	2,194+	2,518	1,770+	1,900+	1,660+	2,590+
Cumbria, Colloway Msh	152	128	115	100	302	225	260
Rockcliffe (C/A)	112	173	244	240	302	175	177
Foulney	10	137	250	140	80	225	150
Northumberland, Ld'farne	120	48	32	100+	75	46	35
Coquet Island	1,200	1,240	1,080	1,520	1,120	1,037	1,038
Farne Islands	182	116	40	78	220	200	247
Norfolk, Blackeney	1,200	1,600	1,600+	1,660	1,400	1,000	850
Scolt Head	500	580	420	425	300	300	300
Snettisham	32	38	79	70	60	75	120
Stiffkey	130	134	130	130	119	46	104
Suffolk, Minsmere	250	284	130	148	108	91	47
Essex, all	66	66	118	47	88	105	114
Kent, Dungeness	110	164	150	245	210	185	250
West Sussex,							
Chichester Harbour	33	46	66	24	57	69	89
Hants, Needs Oar Point	120	195	200+	300	200+	230	250
rest of Solent	125	68	85	80	60	64	80
Dorset, Brownsea	74	53	54	50	65	55	75
Chesil Beach	80	140	73+	83	51	60	60
Cornwall, Scilly Isles	150	100+	—	120	—	200+	200
Channel Islands	100	40	38+	37+	49+	175	113
Total England	6,224	5,568+	6,095+	5,735+	5,162+	4,863+	4,790+
Gwynedd,							
Ynys Gorad Goch	70	—	100	175	150	137	174
Cemlyn Bay	21	100	100	100	100	90	100
Clwyd, Shotton	10	0	127	—	160	160	160
Total Wales	290	100+	327+	275+	466	448	555
Co. Down, Green Is. (C/A)	523	269	284	250	482	260	432
Strangford Lh. (C/A)	562	813	800	2,200	800	775	738
Co. Antrim, Swan Is.	380	269	150	200	96	109	172
Co. Wexford, Tern Is.	800	382	315	230	30	0	0
Lady Is. Lake (C/A)	56	—	36	—	20	165	220
Total Ireland	3,406	1,773+	1,880+	2,923+	1,789+	2,029+	1,700+
Total Britain & Ireland	14,600+	9,635+	10,820+	10,703+	9,317+	9,000+	9,635+

C/A = Common Arctic.

nearby Lady's Island Lake, Strangford Lough and possibly Rockabill. Inchmickery, the only Scottish site, has probably absorbed the terns that bred on nearby Fidra.

Sandwich tern

The number of pairs breeding at the main colonies in Britain and Ireland are given in Table 2. The nine largest colonies held about 90% of the total number of breeding terns reported. Four of these are mainland and five are offshore island sites. In 1979 about 96% of the breeding terns were reported from reserved or protected areas. The breeding numbers reported in Britain and Ireland have shown an overall increase of about 30% over the last decade. The North Sea coast held the bulk of the breeding birds. Breeding numbers in Scotland and Ireland have remained about the same over this period but there have been increases in England and Wales.

Consistently high numbers have bred at the Sands of Forvie, Inchmickery, Farne Islands, Coquet Island, Green Island, Strangford Lough, Scolt Head and Blakeney. Blakeney has increased over the last four years, probably receiving some of the birds that had previously bred at Scolt Head. Other, short distance movements have probably occurred with birds moving from Fidra to Inchmickery, Minsmere to Havergate, Needs Oar to other parts of the south coast, Walney and Ravenglass to Foulney and Tern Island to Lady's Island Lake. Drops in the number of breeding birds at these sites have been matched by corresponding increases at nearby ones.

The biggest colony extinctions have occurred at Tern Island and Ravenglass.

Common Tern

The breeding pairs at the main colonies in Britain and Ireland are given in Table 3. Sometimes Common and Arctic terns were not distinguished, but where it was suspected that Common terns predominated, the whole Common/Arctic totals have been used at four sites in Table 3. Coquet Island and Blakeney Point are the only ones to regularly hold over 1,000 pairs with only two others, Inchmickery and Strangford Lough regularly holding over 500 pairs. These four sites, between them, held between a third to a half of the breeding Common terns reported over the last five years. By 1979 about 80% of the terns reported were breeding in reserved or protected areas.

The total British and Irish population was estimated to be in the order of 15,000 pairs in 1969/70 (Cramp *et al.* 1974). The terns reported during 1975–79 have ranged between 9,000 and 10,820 pairs. Cover was much better in 1969/70. Taking 31 colonies that were adequately covered in 1969/70 and 1979 (Table 3) we find that the breeding terns reported were about the same (8,413 and 8,521 pairs respectively). If these colonies can be regarded as an adequate sample then the results suggest that the Common tern population has remained at around 15,000 pairs.

There have been remarkably few large scale colony shifts. The loss of Tern Island has probably led to increased numbers of terns breeding nearby at Lady's Island Lake and Strangford Lough.

Arctic tern

The breeding pairs at the main colonies (or island groups) in Britain and Ireland are given in Table 4. The results have been greatly enhanced by the comprehensive survey of Orkney and Shetland in 1980 by Bullock & Gomersall (1980). They estimated the breeding numbers to be about 33,000 pairs in Orkney and 32,000 pairs in Shetland. Adding on estimates for other areas: 6,000 pairs in the rest of Scotland; 4,000 pairs in England and Wales and up to 2,000 pairs in Ireland; we get an estimate of 77,000 pairs for Britain and

TABLE 4. COUNTRY AND MAIN COLONY TOTALS OF BREEDING PAIRS OF ARCTIC TERNS 1969-70 (+ 1980 FOR ORKNEY AND SHETLAND ISLAND GROUPS).

Colonies	*1969/70*	*av. 70-74*	*75*	*76*	*77*	*78*	*79*	*80*
Orkney, Westray	9,780	(6,446)	—	5,000	—	—	—	2,282
Papa Westray	17,865	(8,588)	—	5,000+	6,000+	1,500+	4,000+	7,653
Eday	180	—	900	150+	—	300+	—	669
Sanday	470	—	816+	—	—	—	450+	3,179
Stronsay	640	—	—	1,450+	600+	—	—	2,430
Rousay	624	—	1,750	1,750	1,300	—	—	4,951
Shapinsay	41	—	—	—	—	—	—	169
North Ronaldsay	950	—	605+	—	—	—	—	1,537
Mainland etc.	797	—	—	—	—	—	—	1,682
South Ronaldsay	449	—	—	2,500+	—	—	—	4,501
Hoy & Graemsay	68	—	—	—	—	500+	—	1,699
Walls & Flotta	207	—	—	—	—	—	—	2,317
Shetland, Unst	739	(800)	1,200	—	—	—	1,000+	1,393
Yell	450	(2,019)	—	—	—	3,000+	—	5,354
Fetlar	750	(1,292)	1,585	500	2,990	2,670	4,673	2,372
Northmaven	654	—	—	1,000+	—	550+	—	1,326
Delting, etc.	202	—	—	—	—	—	—	2,080
Papa Stour	375	(750)	—	—	3,000	3,000	3,000	4,394
Vagaland	60	—	—	—	—	—	—	1,749
Whalsay	384	—	—	—	—	—	—	2,377
Skerries	780	600	—	—	—	—	—	1,091
South Mainland	1,127	—	—	—	—	—	—	5,456
Foula	262	1,090	6,000	5,650	3,000	2,000	4,500	4,200
Strathclyde,								
Horse Is.	40	135	54	60	66	—	26	
Tiree	139	—	276	—	130	—	816	
Western Isles,								
Monach Is.	—	—	—	—	300+	200	900	
Stornoway	240	(160)	200	250	—	270	—	
Highland, Stroma	80	(1,965)	—	100	—	—	3,086	
Grampian,								
Sds of Forvie	125	92	100	112	125	162	136	
Total Scotland	44,837	23,937+	13,486+	23,522+	17,511+	18,230+	22,587+	
Northumberland,								
Lindisfarne	80	36	36	25+	40	42	42	
Farne Is.	3,208	2,464	1,137	1,750	1,840	2,000	2,547	
Coquet Is.	700	610	770	670	502	595	667	
Cumbria, Foulney	20	137	100	70	120	100	100	
Total England	4,334	3,337	1,972+	2,522	2,513	2,751	3,524	
Gwynedd, Anglesey (= Wales Total)	440	250	982	807	750	900	671	
Co. Wexford,								
Tern Is.	40	61	—	30	30	0	0	
Total Ireland	1,041	100+	100+	100+	100+	314+	358+	
Total Britain & Ireland	50,652	27,624+	16,540+	26,951+	20,874+	22,195+	27,140+	

TABLE 5. COUNTRY AND COUNTY TOTALS OF BREEDING PAIRS OF LITTLE TERNS 1967-79.

Colonies	*1967*	*1969/70*	*71*	*75*	*76*	*77*	*78*	*79*
Dumfries & Galloway	2	3	1	—	—	—	—	—
Strathclyde	49	66	58+	14	8	15	5	30
Western Isles	25	66	30+	65	18+	84	68	—
Highland	6	9	15	—	11	—	5	7
Grampian	34	74	85	110	156	125	106+	73
Tayside	30	10	6	25	35	25	—	40
Fife	7	10	5	11	51	8	—	—
Lothian	19	13	35	33	30	24	34	52
Total Scotland	172	251	235+	258	309+	281	218+	202+
Northumberland	7	15	14	8	26	34	29	7
Durham	4	2	4	—	—	—	—	—
Yorkshire	9	4	4	—	—	—	—	—
Lincolnshire	32	60	131	—	—	211	107+	150
Norfolk	304	416	390	357	519	497	354	488+
Suffolk	71	70	80+	19	25	26	23	70
Essex	152	130	130	220	254	318	344	407
Kent	92	55	42	9	9	21	7	26
East Sussex	102	160	36	—	8	16	14	32
West Sussex				102	175	88	80	61
Hampshire	59	80	56	149	149	171	132	203
Isle of Wight	5	5		—	—	—	—	—
Dorset	200	120	125	52+	48	54+	73	60
Lancashire	18	35	44	2+	—	—	—	15
Cumbria	41	70	119	59	—	56	60	43
Isle of Man	14	20	—	—	—	—	—	—
Total England	1,110	1,242	1,268+	977+	1,213+	1,492+	1,223+	1,562+
Gwynedd	22	21	20+	32+	32	47	48	32
Clwyd	13	4	9	16	16	30	60	43
Total Wales	35	25	29+	48+	48	77	108	75
Co. Dublin	3	13	55	—	—	—	12	—
Co. Wicklow	2	50	5	—	—	—	15	—
Co. Wexford	37	100	78	26+	9+	5+	29+	1+
Co. Waterford	—	0	13	9	5	5	4	—
Co. Cork	11	2	2	—	—	—	—	—
Co. Kerry	11	11	10	—	—	—	9	—
Co. Galway	13+	60	4	—	—	—	10	—
Co. Mayo	13+	12	4	—	—	—	—	10
Co. Sligo	—	2	2	—	—	—	—	—
Co. Donegal	—	40	6	—	—	19	20	—
Co. Londonderry	20	6	0	—	—	—	—	—
Total Ireland	110	296	179	35+	14+	29+	99+	11+
Total Britain & Ireland	1,427+	1,814	1,711+	1,318+	1,584+	1,879+	1,648+	1,850+

Ireland. Lloyd *et al.* (1975) gave a revised estimate of the 1969/70 Seafarer count of 50,000 pairs. Allowing for the extra (inland) cover in the 1980 survey it appears that the Arctic tern numbers have certainly maintained themselves over the last decade.

There were ten colonies holding 1,000 pairs or more in 1979/80. They were on Papa Westray (6,610 pairs), Pentland Skerries (3,731), Rousay (2,707), Hoy (1,623), Flotta (1,391) and Auskerry (1,283) in Orkney; on Papa Stour (1,626) and Foula (3,000 and 1,000) in Shetland and 2,547 on the Farne Islands. These sites hold about a third of the estimated breeding population of Britain and Ireland. Only Papa Westray and the Farne Islands are nature reserves.

Bullock and Gomersall (1980) draw attention to the fact that there may have been a redistribution of birds from Westray and Papa Westray to other parts of Orkney. The small numbers breeding in England and Wales have been remarkably stable over the last ten years.

Little tern

The number of breeding pairs reported for each county are given in Table 5. In recent years about two thirds of the birds have been reported from the four counties bordering the North Sea (Lincs, Norfolk, Suffolk and Essex), and all but a few birds breed in reserved or protected areas. The status of birds in areas in other parts of the British Isles is not so clear but, overall, at least 80% of the terns breed at reserved or protected sites.

Allowing for gaps to be filled with data from recent years (e.g. Western Isles in Scotland) the 1979 breeding numbers can be estimated as follows: Scotland 300 pairs, England 1,600 pairs, Wales 75 pairs and Ireland 100–200 pairs. The British and Irish population is certainly around 2,100 pairs which represents about a 15% increase during the last decade.

TABLE 6. TOTAL NUMBER OF TERN COLONIES REPORTED BETWEEN 1975-79.

	Sandwich	*Common*	*Arctic*	*Roseate*	*Little*
Scotland	15	145*	641*	2	25
Ireland	17	38	25	12	14
Wales	4	9	9	3	5
England	22	41	13	7	40
Totals	58	233	688	24	84

* includes 1980 totals from Orkney and Shetland (Bullock & Gomersall 1980).

Consistently high numbers of Little terns have bred in the Scottish counties of Grampian and almost certainly in the partly covered Western Isles. The English counties of Lincolnshire, Norfolk, Suffolk, Essex, West Sussex, Hampshire and Dorset have all held high numbers throughout the last ten years. The size of the relatively small Irish population is not known. Cover was poor but the numbers of terns in the better counted areas seem to be down on the numbers reported in 1969/70. The three-fold increase in Wales over the last ten years is thought to be due almost entirely to the colonies being protected during the holiday season.

There may have been intra-regional movements in southern England with numbers down in Kent, Dorset and Sussex, compensated by a large increase in Hampshire. Numbers in most of the eastern counties have increased, the biggest increase occurring in Essex, mainly due to the creation of a large safe offshore island.

Number of terneries

The numbers of terneries reported between 1975-79 are given in Table 6. The number of Little terneries is smaller than previously reported e.g. 150+ in Lloyd *et al.* (1975). This may be due to the poor cover in Ireland and to some English records being reported for

'districts' rather than individual colonies. Most of the 611 colonies of Arctic terns in Orkney and Shetland contained less than 50 pairs (Bullock & Gomersall 1980).

TABLE 7. ADVERSE FACTORS HAVING MARKED EFFECTS AT WELL-WATCHED TERNERIES 1975-79.

Terneries	*Sandwich*	*Common*	*Arctic*	*Roseate*	*Little*
n	*33*	*67*	*47*	*10*	*58*
	%	%	%	%	%
Environmental					
High tides	9	9	4	10	17
Wind blown sand	6	2	2	10	7
Bad weather	6	5	4	10	7
Oil pollution	3				
Human					
Disturbance	24	11	15	30	17
Egg collecting	9	6	9	20	16
Predation					
Fox		5	2	10	12
Rat	12	5	6	20	7
Mink/stoat	3	2	2		5
Kestrel	3	2			5
Sparrowhawk	3	2			2
Crow/magpie					5
Tawny owl/Short-eared owl					5
Gull problems	21	15	11	40	5
Total % of terneries affected	52	51	53	50	57

Threats at tern colonies

Correspondents contributing to the survey were asked to give the factors which, in their opinion, were having definite effects on the numbers of terns breeding, their nesting distribution and breeding success. The results are summarised in Table 7. In all five species about a half of the terneries were reported to be seriously affected by one or more of the factors listed. Human disturbance and problems with large gulls seem to be the most widespread threats.

In 1971, 35% of the Little terneries were reported to be threatened by human disturbance, compared with 17% being definitely affected between 1975–79. Disturbance has almost certainly lessened in this period as a result of the many voluntary tern protection schemes in operation, coupled with increased protection measures on nature reserves. However, there may have been increased mammal and avian predation at some of the protected areas where the densities of breeding terns have increased.

The disappearance of Tern Island in Co. Wexford has already been mentioned. Green Island in Co. Down has also been seriously eroded by winter storms in the 1970's, but so far the tern numbers seem unaffected; all continue to find nesting space on the 0.2 ha island.

DISCUSSION

In Europe the breeding populations of Arctic and Roseate terns are confined to the North and Northwest respectively. The majority of Sandwich terns are found in northwest Europe, whilst substantial numbers of Common and especially of Little terns breed in southern Europe (Table 8). The British and Irish breeding terns should probably be considered in the context of northwest Europe, where the countries border northeast Atlantic, the Irish, North or Baltic seas.

About 89% of the breeding Roseate terns in northwest Europe are found in Britain and Ireland with the remainder in Brittany. The population here has fallen from 600 pairs in 1969 to 120 pairs in 1979. The decline in Europe has been mirrored in Eastern United States (Nisbet 1980). Here, breeding numbers have fallen from about 5,000 pairs to 2,500 pairs over the last two decades. In both Europe and the USA the trapping of Roseate terns in their winter quarters has been cited as an important factor in the decline of the breeding numbers. Dunn (1981) discusses the importance of trapping in Ghana where most of the European ringed birds are recovered. Nisbet (1980) reports that most of the recent recoveries (especially since 1968) of terns ringed in the United States have been from Guyana, where the birds are killed for food and/or feathers. He also reports that the numbers of Roseate terns breeding in the Caribbean are also falling and currently number about 1,500 pairs.

In continental Europe, large numbers of Common terns breed in Norway and the countries bordering the Baltic Sea and the Waddensea. At least 8,000 pairs breed in southern Europe.

TABLE 8. ESTIMATED NUMBERS OF BREEDING PAIRS OF TERNS IN EUROPE.

Area		*Common*	*Arctic*	*Sandwich*	*Roseate*	*Little*
North-west Europe						
Faroes	1960's	?	6,000+	?	0	?
USSR (White Sea & Murmansk)	1963–67	?	35,000	?	0	?
Norway	1975	13,000	21,000	5	0	0
Sweden	1975–79	40,000	10,000	1,100	0	540
Finland	1978	5,000+	10,000	0	0	30
Estonia	1973–77	5,000	12,500	100	0	300
Latvia	1978	1,000+	?	0	0	?
Poland	1974–79	2,000	?	60	0	800
East Germany	1977	1,500	200	950	0	150
West Germany	1978–79	6,000	2,500	7,000	0	500
Denmark	1970's	600	6,000	4,000	0	800
Holland	1978–79	10,000+	1,500	7,450	0	350
Belgium	1976–77	210	1	0	0	0
N. France	1979	1,000+	0	4,800	120	300
Ireland	1978–79	2,500	2,000	2,600	660	100
Great Britain	1978–80	12,500	75,000	13,000	320	2,000
Total		100,300+	181,700+	41,065	1,100	5,870
Some southern European Countries						
Portugal	1979	?	0	0	0	100+
Spain	1979	1,100	0	150	0	500
S. France	1970's	2,000+	0	500	0	400
Sardinia	1965–75	200	0	0	0	600
Italy	1978–79	2,000	0	10	0	3,200
Greece	1978	300+	0	0	0	400
Switzerland	1978	310	0	0	0	0
Hungary	1970's	2,000+	0	0	0	10
Austria	1980	200	?	?	?	?
Total		8,110+	0	660	0	5,210+
Total Europe (minimum)		108,400+	181,700+	41,725	1,100	11,080+

NOTE: In NW Europe, no recent details for Iceland, Faroes and parts of European Russia.

High numbers of Arctic Terns are found in the Baltic areas of Finland and Estonia, and in the northern part of the North Sea. Orkney and Shetland alone held 65,000 pairs in 1980. There does not seem to be any recent information available from northwest Russia, Iceland, or the Faroes, but the following figures give some indication of the numbers involved: at least 25,000 pairs in the White Sea (1967) and about 10,000 pairs on the Murmansk coast (1963) (Bianki 1977); somewhere between 10,000 and one million pairs in Iceland (A. Petersen per P. G. H. Evans pers. comm.). Because of the lack of data from a number of Commen and Arctic terns, it was considered unwise to calculate the proportion of the European populations that breed in Britain and Ireland.

Almost all of the European Sandwich terns reported breed in northwest Europe with Britain and Ireland holding about 38% of the population. Substantial numbers are also found in the Waddensea parts of West Germany, Denmark and Holland. Numbers here have increased since the population crashed as a result of telodrin and dieldrin poisoning in the mid-1960's (Rooth & Jonkers 1972). The largest numbers of Sandwich terns in southern Europe are in the Camargue.

The known population of Little terns in northwest Europe is about 5,870 pairs of which about 36% breed in Britain and Ireland. The remainder are well spread out along the coasts of the North Sea and the Baltic. The population seems to have been stable in the 1970's as increasing numbers of sites were protected from human disturbance and from tourist developments. Large numbers of Little terns also breed in southern Europe, especially in Italy. Scott (1980) estimates the Mediterranean population at around 10,000 pairs.

SUMMARY

The numbers of breeding Common (15,000 pairs) and Arctic terns (77,000 pairs) appear to have been fairly stable in Britain and Ireland between 1969 and 1979. The 15,600 pairs of Sandwich and 2,100 pairs of Little terns in 1979 represent increases of about 30% and 15% respectively in the last decade. At almost 1,000 pairs Roseate terns have decreased by about 61% over the last decade. Almost all of the Roseate and Sandwich terns and over 80% of the Little terns bred at protected or reserved areas.

By 1979 Britain and Ireland held the largest proportions of the known northwest European breeding populations of three of the five species of terns, with 89% of the Roseate, 37% of the Sandwich, and 36% of Little terns. They also held substantial numbers of Common and Arctic terns, although that proportion of the north-west European populations breed in Britain and Ireland cannot yet be assessed.

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Little Terns (Sterna albifrons) in England and Wales 1977-79, with details of conservation work carried out at Rye Harbour local nature reserve

R. C. Knight and P. C. Haddon

INTRODUCTION

Much has been written about the biology and status of the Little Tern *Sterna albifrons*, but has enough physical effort really been made to help and encourage this vulnerable species?

Lloyd *et al.* (1975) state that "The conservation possibilities for this species should be investigated more fully", that "an increase in breeding success is obviously desirable", and also that "Britain and Ireland which are the major North European breeding sites of Roseate, Little and Sandwich Terns merit special conservation effort".

In 1976 we became responsible for a remnant and declining colony of Little Terns (7 pairs), in a part of Britain once renowned for its seabird colonies. We proceeded to investigate the conservation possibilities, by establishing the reasons for their poor breeding success and then developing and implementing a protection scheme (detailed in Section 1 of this report) which has, over the past four years, proven successful.

However, following our investigation in 1979/80 into the conservation and breeding successes of Little Terns at other sites in England and Wales (detailed in Section 2 of this report), it was apparent that the statements of Lloyd *et al.* (1975) were still in many instances very appropriate. This situation prompted in our minds the urgency for national liaison, the publication of this report and later our "Guide to practical methods of Little Tern conservation" which, it is hoped, will be fully circulated and become a starting point for a much needed national approach to species protection.

SECTION 1
CONSERVATION OF LITTLE TERNS AT RYE HARBOUR L.N.R.

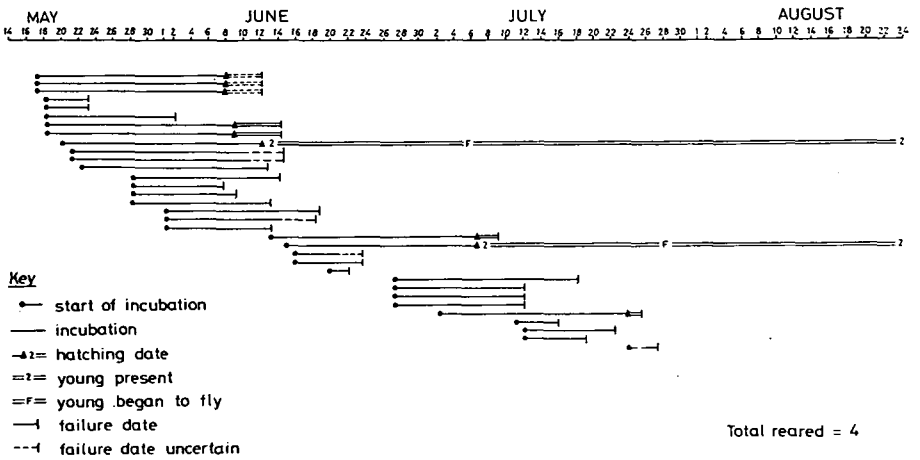
History

As far back as is known the Little Tern has nested on the shingle spits and bars around the now reclaimed and canalised estuary of the River Rother. In more recent times a small number of scattered colonies persisted on the shingle ridges near the shore at Winchelsea Beach, Rye Harbour, The Midrips and Dungeness. However, well before 1970 the species had disappeared as a breeding bird at The Midrips and the Dungeness population had diminished to less than a dozen pairs. At the Rye Harbour and Winchelsea Beach sites the population fell from 83 pairs in 1946 through several fluctuations to five pairs in 1963. Recovery to the 55 pairs found during Operation Seafarer in 1969 was sudden and short-lived, numbers falling rapidly again to an all-time low of just two pairs in 1972. Since then the population has gradually grown to the 43 pairs present in 1980, but this is mainly due to recruitment from elsewhere, as the breeding success of the colony is known to have been poor throughout the 1970's. The remnant Dungeness colonies became extinct in 1979.

Since the establishment of a local nature reserve at Rye Harbour in 1970 and the increased concern and intensive protection offered since 1976, the future for the colony seems far more secure, though we are confronted with the ecological problem of man-imposed species control if the Little Tern and other ground-nesting species are to remain.

FIGURE 1

Little Tern nesting attempts (by 16 pairs) at Rye Harbour Local Nature Reserve in 1977



Reports on the seasons 1977–80

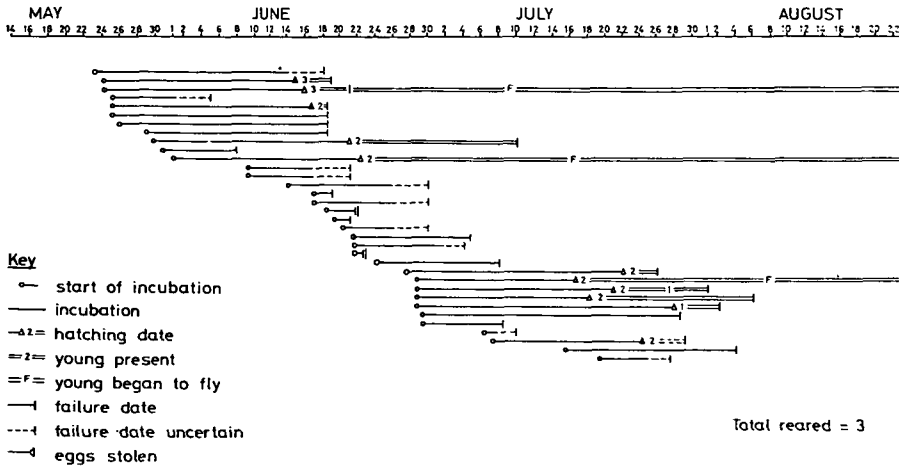
1977 (see Fig. 1)

Preliminary fencing of the nesting areas with single-strand wire accompanied by notice boards to deter human trespass was made prior to the birds' arrival, and the site was wardened for between eight and 15 hours a day. 16 pairs attempted to nest, only two pairs being successful, rearing to the flying stage two young each. The other 14 pairs attempted to nest at least twice; some failed after just a few days of incubation, others at after 15 days or more. A small number of these unsuccessful pairs did hatch their eggs, but the young lived only a few days. A high failure rate was also experienced by Ringed Plovers *(Charadrius hiaticula),* Lapwings *(Vanellus vanellus)* and Oystercatchers *(Haematopus ostralegus)* nesting within the safety area.

No evidence of daytime predation was detected, most failures being proved to occur during the hours of darkness. Generally, the nests were empty with no sign of damage. A few, however, contained tiny egg fragments and a little egg white. Despite dawn and dusk watches, the predator was not seen. Foxes (*Vulpes vulpes*) or Badgers (*Meles meles*) were suspected, and after we read an article on the use of electric fencing as a deterrent to Foxes (Patterson 1977), an enclosure 10 x 10 metres was erected around a single nest in an area where nine other nesting attempts had recently failed. The fencing was checked daily to ensure continuous service. Results were most encouraging and indicated that Fox, Badger or some other large mammal was indeed the main culprit. The enclosed nest was the only one to hatch in this area of the beach, but the two young soon wandered from the fenced area and disappeared when about five days old. The night-time predator(s) was remarkably thorough: for example, only one Ringed Plover chick from 15 pairs is known to have reached the flying stage. It was concluded after this, our first and basic exploratory year, that we should enclose for 1978 a larger area with electric fencing and undertake nocturnal observations during the breeding season. A list of volunteers was gathered so that a constant daylight watch could be maintained during 1978.

FIGURE 2

Little Tern nesting attempts (by 14 pairs) at Rye Harbour Local Nature Reserve in 1978



1978 (see Fig. 2)

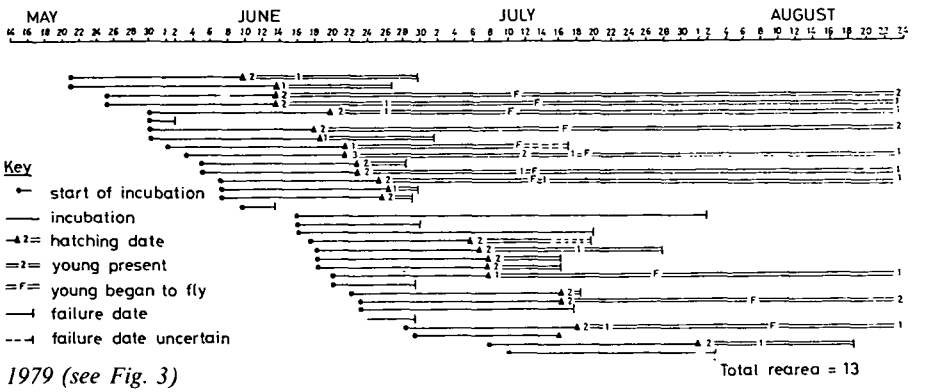
Prior to the nesting season, the single-strand fencing accompanied by notice boards was extended to enclose permanently all suitable Little Tern nesting habitat. An electric fence was also erected around three hectares of a favoured nesting area. Fourteen pairs attempted to nest, only three pairs being successful, rearing to the flying stage one young each. The remaining 11 pairs each made at least two attempts to nest, but all eventually failed, some after feeding small young for several days.

All but four pairs nested outside the electric fenced area in a completely different area of beach approximately 1½ km to the west. Night-time observations confirmed that Foxes were the primary cause of the breeding failure of the ground-nesting birds, up to five Foxes hunting the beach every night, with singles in the colony on several occasions from 18 June. They were particularly active between the hours of 01.00 and 02.30 B.S.T. The electric fence, which consisted of three live wires mounted at 15 cm intervals above the ground and was powered by a Wolseley Scorpion agricultural fencer unit, proved to be quite ineffective as a barrier to Foxes. No more success was achieved inside the fenced area and, although no Foxes were actually seen within it, evidence of Fox activity was made very apparent by the pungent smell of Fox at a number of Sea Kale (*Crambe maritima*) plants. In areas of fine shingle, paw marks were also detected. It was considered in retrospect that the enclosure erected in 1977 must also have been ineffective as a shock barrier but, being small, had the effect of steering Foxes around the single nest enclosed. The reason for the ineffectiveness of the electric fence was discovered to be the high insulative properties of the shingle, which protect the Fox from the possibility of a shock except in very wet conditions. Plans were made to erect a new, much improved, design of fence incorporating both live and earthed wires, to replace the one already present and enclose an additional area of about four hectares at the 1978 site.

Wardening of the site was maintained with the assistance of 80 volunteers throughout all the hours of daylight from 15 May to 31 July.

FIGURE 3

Little Tern nesting attempts (by 29 pairs) at Rye Harbour Local Nature Reserve in 1979



1979 (see Fig. 3)

Single-strand fencing accompanied by notice boards remained as for 1978. Electric fencing was erected as mentioned above prior to the birds' arrival, and in addition an enclosure of about 0.4 hectare was erected in early June around an outlying group of five nesting pairs. Wardening was maintained throughout the hours of daylight, and night-time observations were made whilst eggs and small chicks were present.

Twenty-nine pairs made a total of 33 nesting attempts. Ten pairs were successful, rearing 13 young to the flying stage, directly from their first clutches. Of the other 26 nesting attempts made by 19 pairs, 14 produced young (totalling 29+ chicks) but all died before flying; four clutches of probably infertile eggs were deserted (some after very long incubation periods); two were deserted after 3–6 days; one was predated by dogs and two were predated by Foxes. Only two pairs are known to have re-nested, both after early loss of eggs. Pairs which lost young did not re-nest.

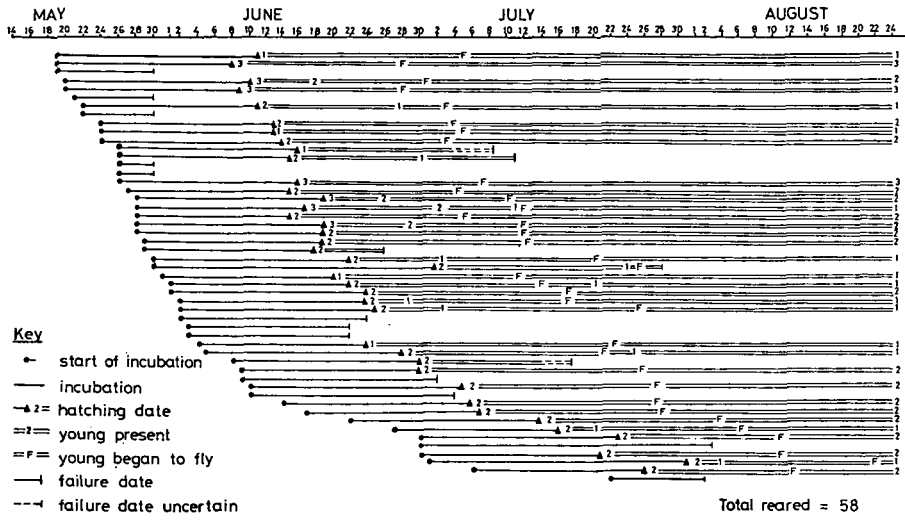
The first 10 pairs that took interest in mid-May began prospecting 50 metres outside the western electric fenced enclosure, and the first eggs were laid in that area on 21st May. In order to discourage the other pairs interested in this site, 22 plastic flags were erected on 1.5 metre stakes spaced out over the favoured area. The desired result was achieved and all but two pairs moved to prospect and later nest within the nearby fenced enclosure. The flags were left in place until the end of the season. Twenty-eight of the total of 33 nesting attempts were made within electric fenced areas.

Results were most encouraging and not one egg or chick was lost to Foxes from within the enclosures, whereas predation occurred as in previous years throughout the rest of the unfenced study area. It appeared that birds nesting close to the fence also derived protection. Unfortunately, however, the colony experienced considerable losses of chicks to an adult male Kestrel (*Falco tinnunculus*) which was seen to take several chicks and is believed to have taken a total of approximately 28 between 16th June and 19th July. Six realistic scarecrows were erected around the main colony in the hope of deterring the Kestrel. This may have had some initial effect, but later, although the scarecrows were regularly moved, it was totally ineffective.

Diesel fuel was sprinkled around the nests of some birds which were outside the electric fence in the hope of deterring Foxes. This proved to have no effect whatsoever; one nest of an Oystercatcher was predated by a Fox only a few hours after being treated in this way.

FIGURE 4

Little Tern nesting attempts (by 43 pairs) at Rye Harbour Local Nature Reserve in 1980



1980 (see Fig. 4)

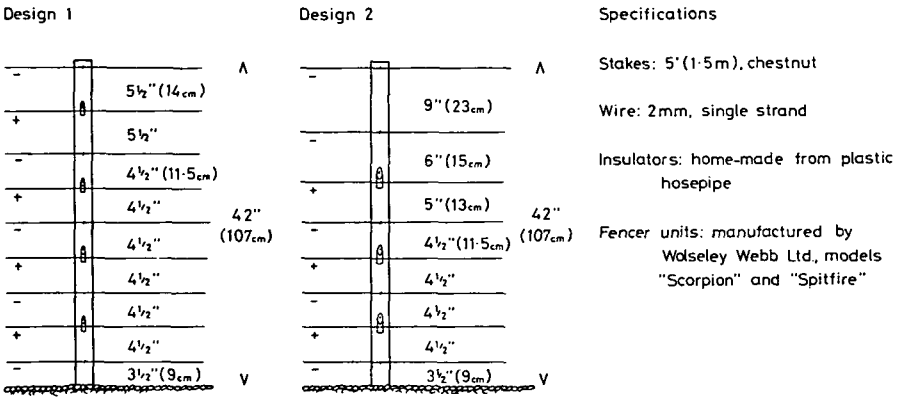
The most successful breeding season in recent years.

The single-strand fencing and accompanying notice boards were maintained as in previous years, two of the three electric fencing enclosures were extended, and all three enclosures effectively protected a total of about ten hectares of the favoured nesting areas. A constant watch throughout the daylight hours was again maintained from 17 May to 17 August with the invaluable assistance of voluntary wardens, and a 24-hour watch maintained during the terns' incubation period.

43 pairs made a total of 51 nesting attempts and hatched 80 young, all but two pairs nesting within electric fenced areas. 34 pairs were successful, rearing to the flying state a total of 58 young. A further four young also reached a flying stage but succumbed to a disease, similar to Puffinosis. Of the losses, seven young died as a result of the terrible weather conditions this summer (but four more which would almost certainly have died were taken in, revived and then returned to their parents eventually to fly). Three young were taken by a Kestrel; two young died, each being the weakest in broods of three; a brood of two young chicks was deserted for no apparent reason; and four young died of unknown causes. Of the 12 nesting attempts in which the eggs failed to hatch, five were deserted, one on the point of hatching, three after prolonged incubation periods (therefore thought to be infertile eggs), and one as a very late nesting attempt (21 July). The remaining seven clutches were taken by Foxes. Two of these were approximately 2½ km from the main two colonies and were the only clutches laid outside the electric fencing enclosures. The other five were taken along with single Oystercatcher and Redshank (*Tringa totanus*) clutches, from within an electric fenced enclosure during a night of heavy rain and wind; it was found in the morning that the electric fence had been shorted out by a piece of wind-blown, wet plastic. Fox activity outside the enclosures was very evident

FIGURE 5

Electric fences designed at Rye Harbour Local Nature Reserve to exclude foxes from Little Tern nesting areas



+ = live wire − = earthed wire θ = insulator

Both 8 and 9 wire designs have proved effective. Design 2 (8 wires), was introduced in 1980 to reduce material costs.

through the season, as proved by night watches carried out during the period 19 May–4 July. Three Foxes were shot in the course of the season and at least one other is known to have remained in the area surrounding the colony throughout the breeding season.

The first pair of terns to lay eggs began incubation on 19 May and there followed a gradual build-up in numbers, it being the end of June before all 43 pairs were settled. The last chick hatched on 31 July and first took to the air on 22 August, a breeding season of 14 weeks' duration.

Summary of the years 1977–80

Following our initial observations at the colonies in 1977 and the decision to make a concerted effort to re-establish more favourable breeding conditions, the enormous effort involved has been suitably rewarded.

We are extremely fortunate in that the colonies at Rye Harbour Local Nature Reserve can be closely overlooked from a vehicle on a private road. Consequently, individual nests can be accurately monitored and, even more importantly, easily protected from human interference.

By the 1978 season, 80 voluntary wardens had been enlisted to operate a constant daylight watch over the colony throughout the breeding season and a night-time watch while eggs and young chicks were present. A similar wardening regime was maintained for each of the years 1978–80 and will continue into the future. The number of volunteer wardens has constantly grown, with well over 100 helping in 1980.

The erection of permanent single-strand wire fencing during 1977–78, accompanied by polite notices reading "Rye Harbour Local Nature Reserve, Wildlife Sanctuary Area, Please Do Not Enter" was a vital and effective measure which instantly gave a logical approach to our planned protection strategy. The general public now know precisely

where they can and cannot go, and wardening is made quite simple as a result. Human interference was virtually eliminated during 1978 and completely so by 1979.

As the human influences, such as unwitting disturbance and egg collection, were removed it became increasingly clear that by far the most significant control over the colony's success was mammalian and avian predators. The following predatory species are present locally: dog, cat, Mink (*Mustela vison*), Ferret (*M. furo*), Stoat (*M. erminea*), Weasel (*M. nivalis*), Grey Squirrel (*Sciurus carolinensis*), Rat (*Rattus norvegicus*), Hedgehog (*Erinaceus europaeus*), Fox, Badger, Carrion Crow (*Corvus corone*), Magpie (*Pica pica*), Jackdaw (*C. monedula*); Little (*Athene noctua*), Long-eared (*Asio otus*), Barn (*Tyto alba*) and Tawny Owls (*Strix aluco*); Kestrel, Heron (*Ardea cinerea*); Great (*Larus marinus*) and Lesser Black-backed (*L. fuscus*), Herring (*L. argentatus*), Common (*L. canus*) and Black-headed Gulls (*L. ridibundus*), and Oystercatcher, with the occasional possibility of Short-eared Owl (*Asio flammeus*), Marsh (*Circus aeruginosus*) and Montagu's Harriers (*C. pygargus*) and Hobby (*Falco subbuteo*). However, the only species so far proved to predate Little Terns at Rye Harbour Local Nature Reserve are dog, Fox and Kestrel. Two other possible, though not proven candidates are Carrion Crow and Magpie but both are strictly controlled, since they have been proved to seriously predate eggs and young of associated species such as Ringed Plover, Redshank and Oystercatcher.

Of the species proved to prey upon Little Terns, the dog has been limited by wardening to only a very occasional threat. The Fox and Kestrel are considered to be potentially equal in their destructive power and both are difficult to detect without careful and persistent observation. The Kestrel will take young of any age, and in a colony of almost any size, a single pair may inflict serious losses; it has also been known to take adults from the nest. The Fox is a better known cause of overwhelming losses, being highly proficient at finding eggs and chicks, even on an extensive and quite barren shingle beach. The control of Foxes has become a basic necessity in the protection strategy at Rye Harbour and is implemented through the gassing of earths, shooting of individuals and the use of our own specially designed electric fencing. The effectiveness of the latter deterrent is the primary reason for our successes.

It is interesting to note that as human interference was eliminated so Fox predation became apparent, and as Fox predation was controlled so Kestrel predation became apparent, food for Kestrels in the form of young ground-nesting birds during the years 1977–78 being relatively scarce after the predations of Foxes.

Unfavourable weather conditions caused the deaths of some young each year but no serious losses occurred, even in the appalling summer of 1980. We believe that heavy losses are rarely caused by poor weather alone but may occur more often when brooding adults are forced to leave the nest during bad weather by marauding predators. During the 1979 and 1980 seasons a total of eight chicks were successfully rescued from torpidity caused by cold, wet weather, revived on a hot water bottle, fed with slivers of fish and returned to their parents. Some of the parents involved were chickless for several hours, one pair for as many as 40 hours. Nevertheless, all chicks were readily accepted by their parents and six went on to fly. This certainly expresses parental determination to find lost chicks and indicates the potential for overcoming a bad weather disaster at well-monitored sites.

Flooding is not a problem at Rye Harbour and the shingle banks and ridges are merely scattered with vegetation. Consequently, no land management has yet been felt necessary.

The programme of research and improvement over these four years has been rewarded

by a dramatic build-up in the number of breeding pairs. Clearly, this is mainly due to recruitment from elsewhere, as past successes have been rare. Some of these birds are believed to be refugees from the Dungeness colony which finally became extinct in 1979.

The Rye Harbour Local Nature Reserve, through careful management, now offers relative safety and extensive potential breeding habitat for the speices. Continued success and hopefully an increased population seems likely but is entirely dependent on factors beyond our control, such as the availability of food, climatic change, pollution, and survival in the birds' wintering grounds.

SECTION 2
LITTLE TERN BREEDING SITES IN ENGLAND AND WALES

It took three years of intensive wardening and experimentation to discover for ourselves the reasons for breeding failure of Little Terns at Rye Harbour and the steps necessary to overcome the problems.

This state of affairs led us to speculate what went on at other Little Tern sites: did all other wardens already know the problems and their solutions, did they all experience the same problems, or were they as much in the dark as we were in the beginning? Speculation led to investigation of the facts and figures and eventually to this report and the 'Guide' we have produced.

In the autumn of 1979 and spring of 1980 we visited 18 Little Tern sites along the south and east coasts of England, talking where possible to other wardens and collecting all information available. Data were also collected from a further 14 sites which for lack of time we were unable to visit.

With the exception of a few minor colonies (i.e. with less than five pairs), these 32 sites represent the total existing population of Little Terns from The Wash in Lincolnshire south and westwards around the coasts of England and Wales (for reasons of security, sites are not specifically named in this report). All this information has been carefully reviewed and is represented in tabular form for ease of comparison, the results of which are summarised below. However, owing to the absence of past information from some sites and continually changing circumstances, we have decided to restrict all the records and figures to the three most recent breeding seasons—1977, 1978 and 1979. All information refers to this three-year period unless otherwise stated.

From this we learnt a great deal but were very distressed at the great lack of co-ordination and co-operation between societies and reserves all concerned with the same aim—the conservation and protection of one of our rarest seabirds. Also lacking were accurate facts and figures with regard to numbers of young reared to the flying stage and any reasons for failure where this occurred. It is not the behaviour of Little Terns which dictates this situation but the amount of time spent observing the happenings at each colony. Unfortunately, at the majority of sites the time and manpower required to ascertain this most important information are just not available. Consequently, and quite understandably, many figures recorded for the numbers of young fledged are estimated, several of the larger colonies have no such figures, and general comments such as 'poor success' and 'fairly good year' are common. Likewise, where serious losses occurred to eggs or young there is a tendency to assume egg collectors, predatory gulls or bad weather led to their mysterious disappearance. These general assumptions so easily made, but with no real evidence to back them up, can be very misleading to future wardens or helpers, especially when recorded in print. (In the following tables a clear distinction is made between proven incidents and suspected causes.)

Hopefully, this report, backed up by the use of the 'Guide', will encourage and aid the collection of more accurate data, detection of the various forms of predation, and an improvement in the protection of the Little Tern.

Summary of results

Status of the breeding sites (see Table 1)

Of the 32 sites included in this report, 11 are owned by various conservation bodies, e.g. County Trusts, R.S.P.B., National Trust and Nature Conservancy Council, and represented in 1979 a total of 408 pairs of Little Terns; eight are leased by conservation bodies and designated as nature reserves, representing a further 336 pairs; ten sites containing 532 pairs are wardened or at least monitored by agreement with the

TABLE 1. THE STATUS, WARDENING REGIME AND USE OF FENCING AT 32 LITTLE TERN BREEDING SITES IN ENGLAND AND WALES IN 1979.

Sites (see Key)	*Owned/ Leased by a conservation body*		*Wardened by agreement with the land owners*	*Wardens employed*	*Wardens voluntary*	*Nesting area sign-posted*	*Nesting area fenced off*
Group 1: a			x				
b	x			x			
c	x			x		x	x
d	x			x		x	x
e		x		x		x	x
f		x		x	x	x	x
g		x			x	x	
h		x		x	x	x	x
i		x		x		x	
Group 2: a		x		x	x	x	x
b	x			x	x	x	x
c	x				x	x	x
d			x	x	x	x	x
Group 3: a			x	x	x	x	x
b	x			x	x	x	x
c	x			x		x	x
d	x			x	x	x	x
e			x		x	x	
f			x	x		x	
g	x			x		x	
h		x		x	x	x	
i			x	x	x	x	x
Group 4: a			x		x	x	x
b			x		x		
c		x			x		
Group 5: a			x				
b	x						
c	x						
d						x	
e							
f							
g							

landowners; while the remaining three sites, with 27 pairs, have no safeguard or monitoring whatsoever. Consequently, sites falling into the latter two categories (holding 43% of all pairs) are more at risk from any threatened change of land use, developments for tourism, caravan parks, etc.

Human interference (see Tables 1 and 2)

Whether in the form of unwitting disturbance by holiday makers, 'treasure hunters', persistent fishermen, local inhabitants (often assuming right of access through established use) or misguided naturalists, human interference exists as an occasional threat at the majority of sites, although at this level actual losses caused to the Little Terns are not great. Except at the naturally isolated island sites, such disturbance is inversely proportional to the extent of sign-posting, fencing and wardening maintained around each colony, indicating the importance of these protection techniques. However, at the unprotected sites this ever-increasing human pressure remains a most serious threat to their continuation as viable breeding colonies.

Egg collecting (see Table 2)

Twelve of the 32 sites have recorded incidents of egg collecting in the past three years, and four more have suspected this to be the cause of losses. Fortunately, through wardening and good liaison with local police, several attempts have been thwarted and further losses prevented by deterring other would-be egg collectors. Cases detailed in the various wardens' reports mainly involve youths between the ages of ten and 20 years.

Adverse weather conditions

Occurrence of bad weather, heavy rain and chilling winds is a natural hazard which causes losses at all sites. However, Little Tern chicks affected by adverse weather can be taken, revived and successfully returned to their parents (see Section 1, Summary of the years 1977–80). At two sites, wind-blown sand covering nests has caused losses.

Tidal flooding (see Table 2)

Tidal flooding occurs at half the sites: at 11 only occasionally, but regularly at the other five less fortunate sites where it is a serious annual problem. At two of the four sites where the actual nesting habitat is diminishing due to washing out by tides and storms, groins and concrete structures have been built to combat the erosion and similar work is planned for a third site. Three other reserves have successfully reduced losses due to tidal flooding by either (1) moving the endangered nests further up the beach into a new position, (2) raising the height of the nest scrape onto a sand-filled box, or (3) removing the eggs or chicks, keeping them (carefully labelled) in cotton wool-lined eggboxes and then returning them to the original nest scrape when the water has receded. This last method has proved the most effective, some clutches having been moved up to ten times in this way and still proceeding to hatch.

Ground predators (see Table 3)

By far the most serious ground predator is the Fox, proven or suspected at half the listed sites. This elusive night-time hunter may unsuspectedly take a toll at several of the other less intensively wardened sites. They are a yearly recurring menace and five sites attempt control measures.

TABLE 2. THE OCCURRENCE OF HUMAN DISTURBANCE, EGG COLLECTING AND TIDAL FLOODING AT 32 LITTLE TERN BREEDING SITES IN ENGLAND AND WALES, 1977–79.

Sites (see Key)	*Human disturbance at site:*			*Egg collecting*	*Tidal flooding:*	
	Serious threat	*Occasional threat*	*Eliminated*		*Severe losses*	*Occasional losses*
Group 1: a			x			x
b			x			
c			x			x
d			x	x	x	
e		x				x
f		x				
g		x		x	x	
h		x				x
i		x				
Group 2: a			x	x		
b		x			x	
c		x		x		
d			x	x		
Group 3: a		x		x		x
b		x				x
c		x		x		x
d		x		?		x
e		x		x		x
f		x		?		
g		x				
h		x		x	x	
i		x		x		x
Group 4: a	x			?		x
b	x			x		
c	x			x	x	
Group 5: a	x					
b	x					
c	x					
d						
e						
f						
g						

Stoats and Weasels have caused no significant losses in recent years. Rats, though less frequently recorded, have been suspected of more serious damage. Other ground predators mentioned at a few sites are Hedgehog, dog and cat.

Avian predators (see Table 3)

Of the avian predators, both crows and gulls are usually very effectively repelled by the attacks of Little Terns. While gulls are known to harass terns carrying fish, only one incident (in 1975) of actual predation of eggs or young has been recorded. (However, Little Tern sites may become unsuitable if encroached on by larger colonial nesting species such as gulls.) Crows are noted as predators at nine of the colonies and may be a menace when present in any numbers. Individual terns nesting at some distance from a main colony may be more vulnerable. Control of crows is carried out at three sites.

The Kestrel is shown to be the most serious avian predator, although its depredations

TABLE 3. THE OCCURRENCE OF PREDATION AT 32 LITTLE TERN BREEDING SITES IN ENGLAND AND, 1977-79.

The letter P = proven cause of losses, S = suspected cause, and c = control of the predator species is carried out.

Sites (see Key)	*Fox*	*Stoat or Weasel*	*Rat*	*Kestrel*	*Crow*	*Gulls*
Group 1: a						
b						
c				P		
d	P	c	c	P		
e			S			
f				S	Pc	
g						
h						
i						
Group 2: a	Pc			P	c	
b	Pc	S		P	P	S
c	Pc	P		S		
d	P			P		
Group 3: a	P			P	P	
b	Pc	S				
c			S	P		
d	S					
e	S			S	P	S
f	P	P		S	S	P
g	P			S	P	
h	Pc					S
i	P			P	Pc	S
Group 4: a						
b	P	S		P	P	
c						
Group 5: a						
b	P			P		
c	P				P	
d				S		
e		S			P	S
f						
g						
Totals	14P 2S	2P 4S	2S	10P 6S	9P 1S	1P 5S

are not as apparent when other forms of disturbance and predation are also occurring. They have been proven or suspected as predators at half of the sites studied, sometimes more than one bird predating the same colony. This has proved to be another annually recurring problem; at one reserve Kestrel predation causing considerable losses occurred for eight consecutive years, at another reserve for four years and at another for three years. Kestrels can nullify the results of other protection methods and pose a considerable problem because any measures of control are illegal. Potentially as destructive but, fortunately for Little Terns, not as common as the Kestrel is the Short-eared Owl, a recorded predator at two colonies. Other incidents of Little Tern predation by birds include Sparrowhawk (*Accipiter nisus*), Oystercatcher (in 1971, 1975 and 1977), Montagu's Harrier (in 1968) and Heron, with Tawny and Little Owls suspected.

TABLE 4. BREEDING PAIRS OF LITTLE TERNS AND NUMBERS OF YOUNG REARED AT 32 SITES IN ENGLAND AND WALES, 1977-79.

A dash indicates that no figures are available.

Sites (see Key)	1977		1978		1979	
	No. of pairs breeding	*No. of young fledged*	*No. of pairs breeding*	*No. of young fledged*	*No. of pairs breeding*	*No. of young fledged*
Group 1: a	175	—	235	—	285	'good'
b	31	38	41	21	33	0
c	68	18	65	7	71	83
d	180	—	180	—	182	—
e	100	—	82	—	90	—
f	70	20	55	14	35	23
g	29	0	31	1	26	13
h	20	—	45	—	55	—
i	0	0	2	5	11	9
Group 2: a	16	4	14	3	29	13
b	19	1	12	4	18	16
c	30	20	30	25	24	8
d	36	35	36	12	17	0
Group 3: a	30	24	60	10	43	4
b	1	2	5	3	5	1
c	24	4	28	15	33	30
d	9	'several'	10	7	0	0
e	25	—	15	—	33	30
f	0	0	3-4	—	3+	—
g	0	0	0	0	27	15
h	71	—	50		86	—
i	54	'poor'	70	0	60	25
Group 4: a	16	0	13	5	6	7
b	74	55	32	5	55	20
c	8	12	8	3	4	-
Group 5: a	6	—	11-14	—	15	—
b	6	0	11	9	8	8
c	10	0	3	0	0	0
d	20	—	14	—	15	0
e	20	—	15-20		15-20	
f	—	—	—	—	6	—
g	—	-	—	—	6	—

Key to Tables 1–4

In the tables the 32 sites have been divided into the following five groups:

1. Naturally isolated sites, islands, sand bars, etc., therefore relatively inaccessible to people and ground predators. They include a mixture of wardening regimes, from no wardening up to 18 hours every day.
2. Accessible sites, wardened between 18 and 24 hours every day.
3. Accessible sites, wardened between one and 18 hours every day.
4. Accessible sites, wardened at weekends and evenings only.
5. Accessible sites, no wardening but a little recording of the colony.

N.B. Wardening refers to Little Tern colonies specifically, not to a reserve as a whole, on some part of which Little Terns nest.

Within these groups, individual sites are each represented by a letter which is retained throughout the tables.

TABLE 5. STATUS OF THE LITTLE TERN IN SOUTHERN ENGLAND AND WALES, 1967-79.

	1967*		1971**		1974**		1979	
	Number of		Number of		Number of		Number of	
County	*sites*	*pairs*	*sites*	*pairs*	*sites*	*pairs*	*sites*	*pairs*
Norfolk	11	304	9	390	8	380	10	488+
Suffolk	9	71	9	80+	4	32	5	70
Essex	7	152	6	130	6	166	6	407
Kent	9+	92	9	42	4	29	2	26
Sussex	6	102	5	93	3	150	3	90
I. of Wight	1	5						
Hampshire	7	59	8	93	3	99	3	203
Dorset	1	200	1	125	1	81	1	60
Wales	4	35	4	29+	4	30	4	75
Totals	55	1,020	51	982+	34	967	34	1,419

* Norman and Saunders 1969
** Lloyd *et al.* 1975

Status of the Little Tern

Table 5 gives an insight into the status of the Little Tern and its breeding sites over the last 12 years, for the same area of southeast England and Wales. Encouragingly, there has been an increase in their population of some 400 pairs. This is apparently due in most part to the rapid growth of one particular colony in Essex and two quite successful colonies in Hampshire, although the possibility of recruitment from other British and European colonies cannot be ruled out. A close look at the other counties, however, reveals that the populations of Kent, Sussex and Dorset continue to decline.

Underlying the population figures is a worrying decline in the number of breeding sites, which has fallen from 55 in 1967 to only 34 in 1979. A similar picture is shown in Table 6 on a local scale around the Dungeness peninsula from Hythe to Winchelsea Beach. Here the sites have diminished from 12 in 1962 to only 1 in 1979. As the number of available sites has decreased, the population of terns has become more restricted in its distribution and consequently more vulnerable to any misfortune, despite the overall increase in numbers.

These results give an up-to-date picture of the status of Little Tern colonies in England and Wales, and, while including new information, they show little change from the findings of Norman and Saunders, who stated in 1967 that "various forms of human disturbance are by far the biggest hazards to colonies" and "of the predators recorded, the Fox (*Vulpes vulpes*) is easily the most serious".

DISCUSSION

Over the years, although a considerable amount of effort has been expended in the study and conservation of Little Terns, clearly much still remains to be achieved in order to help the species. At Rye Harbour Local Nature Reserve a remnant colony has been rescued from almost certain extinction, through careful study and management, to a healthy and potentially flourishing condition. There is no reason why similar rescue operations cannot be implemented at other declining colonies; indeed, during the 1980 breeding season a few sites have been experimenting with techniques used at Rye Harbour.

The main requirements for such operations are recruitment of manpower: one or more dedicated individuals based locally all year round to liaise with local inhabitants, land owners and conservation bodies, and a team of voluntary wardens. A summer warden

employed for only a few months and often new to an area is not sufficient. Preparation of the site in the 2–3 months prior to the arrival of the terns is very important. Also, some monetary expenditure for fencing, signposts, temporary accommodation, etc. is needed. Where problems of tidal flooding occur, more research is perhaps needed. (A chance meeting with a Dutch farmer and conservationist brought to light some interesting techniques used in Holland to prevent flooding).

Considering the resources already present at many sites and the potential for an increased enthusiasm to help, the future for the Little Tern in Britain from a purely practical point of view could look very hopeful. It has been seen more than once that a safe site encourages continued breeding and recruitment from other distressed sites.

TABLE 6. STATUS OF THE LITTLE TERN AROUND THE DUNGENESS PENINSULA (HYTHE TO WINCHELSEA BEACH), 1962-1980.

Year	*No. of colonies*	*No. of pairs*	*No. of young reared*
1962*	12	113	48
1964*	10	67	—
1971*	7	68	3
1973	7	39	19
1976	2	16	11
1978	2	17	3
1979	1	29	13
1980	1	43	58

* Scott 1971

The need for national and international liaison in work of this kind is obviously essential. However, in the case of the Little Tern, any up-to-date information on their conservation has in the past been difficult to obtain, as no one organisation has yet become responsible for collating and, more importantly, ensuring the circulation of useful data on this, one of Britain's rarest breeding birds.

This paper has been compiled along with 'A Guide to Practical Methods of Little Tern Conservation', to help fill the gap by supplying initial data which hopefully may encourage a more determined and organised approach to the problems of Little Tern conservation. Indeed, many other declining species could benefit by a more informative, organised, national and international approach to their conservation.

Since records began there has been a noticeable decline in both the number of breeding pairs of Little Terns and the number of breeding sites in Britain (Parslow 1967). The major factor influencing this decline is man and his various activities: increased disturbance of nesting sites by holidaymaking, egg collecting, fishing, etc.; destruction of sites by change in land use for caravan parks, power stations, etc.; changes in the management of areas surrounding colonies, e.g. decline in estates and gamekeeping, new agricultural methods and alterations to the environment which favour species such as Fox, Carrion Crow and Kestrel.

Within the Rye Harbour Local Nature Reserve are many vulnerable species which would no longer remain without recognition of the area as a nature reserve and, even more importantly, the accompanying man-imposed controls. Without our constant and intensive management, the area at the present time is quite unsuitable for continued occupation by the majority of ground-nesting birds. A change to the environment to favour these species seems unlikely in the near future, save some unforeseen happening suitably modifying the area.

To what lengths should one go in order to maintain breeding populations at such sites? We are now experiencing a new problem: legislation imposed to protect one species—the Kestrel— at the cost of another—the Little Tern. The ethics and methods required to conserve vulnerable species in an ever-changing and extensively man-modified environment are indeed questionable. The problems of Little Terns are humanly caused; can they be humanly solved?

ACKNOWLEDGEMENTS

We are greatly indebted to everyone who gave their time to answer questions and contribute information to the Little Tern sites survey; also to the Rye Harbour LNR Management Committee who funded the research trip, to the Southern Water Authority on whose land the Little Terns nest at Rye Harbour and the R.S.P.B. who have printed and circularised this report. Our sincere thanks also go to P. F. Bonham who kindly criticised and typed the final draft and to all who have helped at Rye Harbour Local Nature Reserve over the past four years.

SUMMARY

During the years 1977-80 much effort has been put into protecting breeding Little Terns at Rye Harbour Local Nature Reserve. This has been rewarded by an increase in both the number of pairs breeding and the numbers of young reared. Outlined in Section 1 is the protection scheme developed at Rye Harbour, including the use of a specially designed electric fence which has successfully prevented Foxes from predating the colony.

Section 2 provides information on 32 Little Tern sites in England and Wales. The majority are shown to be fairly well protected from the various forms of human interference, although few can be said to experience reasonable breeding success. The majority of losses are due to predation, mainly by Foxes and Kestrels, and to tidal flooding at certain vulnerable sites.

Although the breeding population of Little Tern in this area of Britain has grown during the last eight years, the number of breeding sites has continued to decline, thus restricting the species' distribution. Further restriction of its distribution is likely without the type of protection strategy implemented at Rye Harbour LNR. The circularisation of information and an organised national and international approach to Little Tern conservation is called for. The report illustrates the problems of maintaining vulnerable species in an ever-changing world.

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The Little Tern at St Cyrus National Nature Reserve

N. K. Atkinson

The Little Tern *Sterna albifrons* has a worldwide distribution, breeding on all continents except Antarctica (Vaurie, 1965). In recent years it has been declining in eastern North America (Nisbet, 1973; Mrs. B. Fisk in Mead, 1973), California (Swickard, 1972), and the mainland of north-west Europe (Lippens and Wille, 1972). In England and Wales it has declined since the 1920's and early 1930's, though information for Ireland and Scotland is sparse and incomplete (Parslow, 1967). However, surveys in 1967 (Norman and Saunders, 1969). 1969/70 (Cramp, Bourne and Saunders, 1974) and 1971 (Lloyd, Bibby and Everett, 1975) indicated a slight increase in the Scottish population.

The most studied Scottish site is St Cyrus, Kincardine. The Tay Ringing Group began ringing Little Tern Chicks there in 1968. In 1971 in conjunction with the Nature Conservancy, J. Dunbar began a protection and research programme which I later took over. The colony was fenced off with warning notices and was wardened throughout the breeding season. From 1975 a full-time summer warden was employed by the Nature Conservancy Council.

History of the colony

The Little Tern is recorded as nesting in Kincardine (presumably St Cyrus) in 1884 (Drummond—Hay, 1885), but it is not mentioned again until 1928 when three pairs bred. During the first half of the 20th century the largest number of pairs mentioned was eight in 1831. No significant change appears to have occurred during the 1950's when the peak number was ten pairs (Boase, 1962). However, in 1967, fifty pairs were found nesting.

Since only three pairs nested in 1965, the influx occurred in either 1966 or 1967. From 1967 onwards the colony increased, reaching a peak of 158 pairs in 1974, but numbers in recent years have been much lower (Table 1). Only two other British colonies, at Blakeney and Scolt Head in Norfolk have held over a hundred pairs this century (Parslow, 1967).

TABLE 1. NUMBER OF PAIRS OF LITTLE TERNS BREEDING AT ST CYRUS AND IN ABERDEENSHIRE, ANGUS AND FIFE. 1967-1977. NUMBERS IN BRACKETS INDICATE THE NUMBER OF COLONIES. N/A—INFORMATION NOT AVAILABLE.

	St Cyrus	*Aberdeenshire*	*Angus*	*Fife*	*Total*
1967	50	11 (3)	30+ (2)	16 (2)	107+
1968	60	17 (1)	11+ (1)	20 (3)	108+
1969	40	24 (2)	13–14 (2)	12 (4)	89–90
1970	50	11 (1)	7 (3)	4 (1)	72+
1971	75	20 (1)	11–12 (2)	10 (2)	116–117
1972	106	4 (1)	10 (3)	20 (2)	140+
1973	140+	42 (2)	? (1)	n/a	182+
1974	158	16 (2)	5 (2)	15 (1)	194
1975	83	15 (1)	25 (3)	11 (2)	134
1976	10	72 (1)	35 (2)	21–33 (3)	138–150
1977	31	25 (1)	25 (2)	8 (2)	89

The sharp decline in 1976 at St Cyrus may be explained by dispersal, since other colonies in Fife, Angus and Aberdeenshire increased in numbers that year. The increase of one colony at the expense of another is paralleled, albeit over a shorter distance, by data for the balancing fluctuations of Sandwich Terns *Sterna sandvicensis* at Blakeney and

Scolt which suggested the existence of regional 'supergroups' of interacting birds (Marples and Marples 1934). Our ringing has shown that some St Cyrus Little Terns breed in other colonies in subsequent years. There have been three such movements to Fife colonies, four to Angus, and one to Lothian. In addition, two chicks ringed at St Cyrus in 1973 were found breeding in Denmark, one in 1976, and the other in 1978. Birds also move to St Cyrus from other colonies; in addition to a movement from an Angus colony, a 1970 chick from the Isle of Man bred at St Cyrus in 1974. Angus colonies show a similar pattern with one local movement from Fife and two longer movements from Lancashire and Lincolnshire colonies. Whilst this explains where the Little Terns go, the reason for the unpredictable nature of colony movements has never been clear. In Massachusetts, U.S.A. older individuals of *S.a. antillarum* shift colony site only in response to habitat alteration (I.C.T. Nisbet, unpubl.) and this seems to be the case here also. At St Cyrus Little Terns prefer a sand and shingle mix on which to nest and, since these areas are generally beside a river backed by sand dunes, their local distribution is never constant from one season to the next. From 1968 to 1974 the shingle at St Cyrus was distributed over a large area of beach due to a breach in the dunes during a winter storm in the late 1960's.

Since 1974 vegetation has recolonised this area and the remaining shingle has been present in solid banks which are unsuitable for nesting. Until this situation changes, St Cyrus does not have sufficient habitat to support more than about thirty pairs.

TABLE 2. TIMING OF EVENTS AT THE ST CYRUS LITTLE TERN COLONY.

	1st arrival	*Dates of peak spring flock*	*1st scrape*	*1st egg*	*1st chick*	*1st fledging*	*Last departure*
1968	24/4			15/5	22/6	28/6	
1969	30/4	10/5					
1970	2/5			22/5	21/6	1/7	
1971	25/4	16/5	13/5	19/5	16/6	11/7	
1972	11/5	13/5	16/5	19/5	12/6	5/7	9/8
1973	28/4	14/5	16/5	18/5	10/6	28/6	26/7
1974	22/4	5/5	15/5	20/5	10/6	2/7	24/7
1975	23/4	6/5	8/5	18/5	24/6	15/7	28/7
1976	20/4	3/5	13/5	22/5	15/6	1/7	28/7
1977	22/4			25/5	18/6	29/7	1/8

Breeding biology

Little Terns normally begin to arrive in St Cyrus in late April but it is mid-May before the majority are present and nesting begins (Table 2). During this time, and throughout the season, flight displays take place over the colony, with terns spending more time in the colony as the middle of May approaches. In most cases these displays involve the male carrying a fish, whether in flight or on the ground, causing the female(s) to follow.

The nest scrape is a shallow depression in the sand, formed by the female using her breast and feet (Smith 1922). A few small pebbles, shell fragments and pieces of grass are occasionally arranged about the scrape, often after incubation has begun. Scraping normally begins mid-May and usually precedes the first eggs by a few days (Table 2). Several scrapes, occasionally as many as seven, are made before the final nest scrape is adopted. The first eggs are normally laid in the third week of May (Table 2) and the colony is usually synchronised to the extent that 74% of the birds have laid their clutches by mid-June. Later clutches are mostly laid by birds which have lost their first clutches though some are laid by birds which arrived later in the season. In 1977, for example, only five

pairs were present until 12th June when a further 26 pairs arrived. Such birds may have already failed at another site.

Little Terns are said to lay one to four eggs (Witherby *et al.*, 1943) though no four egg clutches have been found at St Cyrus out of 967 recorded nests, (Table 3) and I strongly suspect confusion with Ringed Plover nests to be responsible for such reported cases.

TABLE 3. LITTLE TERN CLUTCH SIZE AT ST CYRUS.

	1 egg	*2 egg*	*3 eggs*	*Mean size*
1971	12	49	29	2.19
1972	10	90	36	2.19
1973	8	36	117	2.61
1974	17	63	122	2.52
1975	61	72	19	1.72
1976	3	7	5	2.13
1977	5	22	14	2.22

The eggs are normally laid on alternate days with a three-egg clutch usually taking 4-5 days to complete. Although occasionally parents sit on incomplete clutches, incubation proper does not begin until the laying of the last egg. Both adults share the incubation. Observed incubation shifts vary in length between 40 minutes and four hours. Returning males normally bring a fish for the female but returning females have not been observed to do likewise.

It is during the incubation period that predators, weather and tides play a big part in the eventual success of the breeding season. The parents leave the nest when any predator flies over or enters the colony, or indeed when harmless species such as Shelduck *Tadorna tadorna*, Eider *Somateria mollissima*, and even Brown Hare *Lepus europaeus* enter. Incubation takes 18-24 days with a mean incubation period of 21.5 days. All chicks in a brood normally hatch within 24 hours, though in one case there was a gap of 48 hours. If undisturbed, chicks spend the next three days in the nest and their droppings soon form a white circle. In disturbed areas even two day old chicks will leave the nest area and seek out another scrape amongst shingle and vegetation.

As the chicks get older they do not require a scrape and wander some distance around and often away from the colony. Chicks fledge at 15-21 days, though the minimum is more commonly 19 days. They may spend another three days in the colony then usually leave with their parents. Fledged chicks have been observed still being fed by parents.

TABLE 4. BREEDING SUCCESS OF LITTLE TERNS AT ST CYRUS.

	No. of nests	*No. eggs laid*	*No. chicks hatched*	*% hatching*	*No. chicks fledged*	*% fledging*	*No. chicks fledging/ Nest*
1967					c 30		
1968			c 100				
1969			c 40				
1970			c 90		20+	22	
1971	90	197	95+	48	25–30	25–32	0.28–0.33
1972	151	340	163–241	48–71	20–30	c 12	0.13–0.2
1973	161	431	279–374	69–87	150+	40–54	0.93+
1974	202	509	190	37	24	13	0.12
1975	152	262	40	15	6	15	0.04
1976	15	32	10	31	3	30	0.2
1977	41	91	39	43	2	5	0.05

By the end of June fledged chicks, parents and failed breeders begin to flock together outside the colony, 'loafing' on the sand. As they depart in July, the number of birds in this post-breeding flock declines until they leave in late July or early August (Table 2).

Breeding success

Providing adult survival is adequate, Little Terns need not produce large numbers of chicks each year for the species to survive. At St Cyrus ringing has shown that some birds were still breeding at ten years of age. In the years 1971-1977 inclusive the St Cyrus colony reared at least 230-245 chicks to the flying stage, 12.4-13.2% of the eggs laid. However, breeding success is extremely variable from year to year (Table 4) so the average is strongly dependent on the frequency of 'good' years (e.g. 1973). 1968 was the previous good year (J. Dunbar, pers. comm.).

Since Little Terns nest on the open sand and shingle just above the high water mark, their eggs and chicks are, by any standards, unusually exposed for some seven weeks. Human disturbance has long been recognised as a factor influencing breeding success (Parslow, 1967; Norman and Saunders, 1969) but other factors are also involved. Much of the St Cyrus study was devoted to monitoring nests and their fate.

TABLE 5. FATE OF LITTLE TERN EGGS AT ST CYRUS

	1974		*1975*		*1976*		*1977*		*Total*	
No. eggs laid	509		262		32		91		894	
No. eggs failed to hatch	319		222		22		52		615	
% eggs failing to hatch	63		85		69		57		69	
Causes of Failure	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*Total no.*	*%*
Man	58	18	28	13	—	—	4	8	90	15
Tides	51	16	9	4	12	55	7	13	79	13
Wind	3	1	57	26	—	—	—	—	60	10
Deserted	13	4	11	5	1	4	12	23	37	6
Trampled by animals	—	—	8	3	—	—	—	—	8	1
Infertile	16	5	4	2	—	—	2	4	22	4
Crow	90	28	23	10	7	32	—	—	120	20
Stoat	25	8	—	—	—	—	25	48	50	8
Rat	—	—	43	19	2	9	—	—	45	7
Gulls, *Larus* Spp.	—	—	6	3	—	—	2	4	8	1
Oyster catcher *Haematopus ostralegus*	—	—	4	2	—	—	—	—	4	1
Unknown predator	63	20	29	13	—	—	—	—	92	15

Three main factors affect breeding success—(1) Man, (2) Predators and (3) Tides and Wind. I will deal with each in turn:

(1) Since 1971 when the main area of the Little Tern colony at St Cyrus was both fenced and wardened off, the pressure from humand disturbance has been much reduced. Of the 90 eggs whose losses were caused by man during 1974-1977, 76 were taken by boys and the remainder were lost during salmon-fishing operations. Virtually all of these losses occurred in a part of the colony which could not be fenced. Had wardening not taken place, the losses to small boys would probably have been much greater. In Essex in 1974, for example, no less than 61% of all clutch losses were due to man (Blindell, 1975).

(2) Unlike man, predators affect chicks as much as they do eggs (Tables 5 and 6). Foxes *Vulpes vulpes* are the main predators of Little Terns at other colonies (Norman and

TABLE 6. FATE OF LITTLE TERN CHICKS AT ST CYRUS.

	1974	*1975*	*1976*	*1977*	*Total*
No. chicks hatched	190	40	10	39	279
No. failed to fledge	166	34	7	37	244
% chicks failing to fledge	87	85	70	95	88

Causes of failure	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*Total no.*	*%*
Died in nest	29	18	—	—	1	14	—	—	30	12
Tides	2	1	—	—	—	—	—	—	2	1
Kestrel	c20	12	c10	29	—	—	c25	68	c55	23
Crow	c40	24	—	—	—	—	—	—	c40	16
Stoat	c 5	3	—	—	—	—	c12	32	c17	7
Dog *Canus familiarus*	c10	6	—	—	—	—	—	—	c10	4
Fox	c 5	3	—	—	—	—	—	—	c 5	2
Rat	—	—	c20	59	6	86	—	—	c26	11
Unknown Predator	55	33	4	12	—	—	—	—	c59	24

Saunders, 1969; Owens, 1973) and of Sandwich Terns at Sands of Forvie, Aberdeenshire (A. Smith, pers. comm.) but at St Cyrus they did not present a major threat. The nearest dens are some 15 km away and fox tracks have only been found in the colony on a few occasions each summer. However, Carrion Crows *Corvus corone,* Brown Rats *Rattus norvegicus,* Stoats *Mustela erminea* and Kestrels *Falco tinnunculus* were all important predators at St Cyrus (Tables 5 and 6) though neither crows nor rats were thought to be serious predators prior to 1974. Crows took 19.5% of all the eggs which failed to hatch and 16.4% of all the chicks which failed to fledge. Crows were most successful in the outlying parts of the colony and also where and when Arctic Terns *Sterna paradisaea* were not breeding. Little Terns breeding amongst Arctic Terns reap the benefits of the latter's more successful aggression towards marauding crows.

Rats took at night 7.3% of the eggs which failed to hatch and 10.7% of the chicks which failed to fledge, but they were a major threat only in 1975 when a game firm dumped a load of carcasses and thus attracted rats. Stoats took 8.1% of the eggs which failed to hatch and 7.0% of the chicks which failed to fledge. They were particularly harmful during 1971 when twelve eggs were seen to be taken in 30 minutes.

Stoats preyed upon eggs and chicks during the day usually by rushing out from the dune vegetation towards a nest. Kestrels took 22.5% of the chicks which failed to fledge. Although a pair has bred in the vicinity for many years, Kestrels only began to feed in the colony in 1973. It seems likely that the large number of chicks in 1973 attracted their attention and they have continued to hunt in the colony ever since. Kestrels are known to be an important predator at other Little Tern colonies (Owens, 1973) and are particularly harmful at Aberlady Bay, East Lothian (R. Nisbet, pers. comm.). The only other predators which posed a threat to Little Terns at St Cyrus were two cats which took seven adults from nests during wet, windy nights in 1972.

3) High tides and wind—blown sand are a hazard at a number of colonies (Norman and Saunders, 1969). At St Cyrus, wind caused serious problems only during May 1975 when virtually the whole colony was blown out by south-west gales. This happened early in the season when many clutches were incomplete, which explains the abnormally low mean clutches that year (Table 3). However, high spring tides are a more regular threat (Table 5). In June 1974, when nests were about to be washed out by that afternoon's tide, I experimentally moved them.

Three nests which were raised onto boxes were deserted but all ten nests moved up the beach were later attended by the parents. From that date onwards nests threatened by high tides were moved up the beach whenever possible, one by as much as 7 m. In each case the nest was attended by the parents afterwards. Nest loss to tides after this was mainly due to my inability to visit the nests before high tides, though nests on narrow shingle bars cannot always be saved using this method.

Neither desertion, infertility, nor embryonic death were major factors in the failure of eggs to hatch. Much of the desertion was due to predators when an egg or an adult was taken. A small number of one-egg clutches were deserted soon after laying. Observation of the adults of one such nest suggested that they were unable to remember where they laid the egg; they repeatedly flew over the area, calling anxiously and occasionally landing without finding the egg although they were within 3 m of it on one occasion. This could involve young, inexperienced birds nesting for the first time. It is unlikely that failure to hatch was caused by toxic chemicals since twenty eggs taken from Scolt Head, Norfolk, during 1964–66 had only 0.2–0.6 parts per million DDT residues, 0.01–0.09 parts per million Dieldrin residues and only traces of TDE and DDT; Little Terns had smaller amounts of residues than Sandwich and Common Terns *Sterna hirundo* (J. L. F. Parslow, pers. comm.). Furthermore, most of the infertile eggs at St Cyrus had siblings which hatched.

DISCUSSION

The conservation of the Little Tern will almost certainly depend on the number of protection schemes in operation. At least 28 colonies in Britain and Ireland had some degree of protection in 1967 (Norman and Saunders, 1969). The four Angus Little Tern sites have all had protection schemes at some time or other since 1969 as have most of the Fife and Aberdeenshire colonies (Summers 1972). Some bird-watchers take the view that terns should be left absolutely alone and not even wardened. However, at St Cyrus, active wardening reduced human disturbance and without it the colony would have been less successful.

I agree with Blindell (1975) that the Little Tern benefits least from First Schedule protection. At St Cyrus, as at Essex colonies, most of the people who ignored notices, and indeed challenged wardens, were birdwatchers who felt that they had some right to enter the colony. I feel that we need a campaign amongst birdwatchers to sort out this problem. There are now a number of colonies where hides are provided and birdwatchers must set a good example by not disturbing colonies.

The direct threat from man is egg-collecting and this is mainly the pursuit of boys. When teenagers are involved, the objective often seems to be destruction rather than collecting. Occasionally prosecutions are bound to act as a deterrent but they are extremely difficult to bring to the courts, especially in Scotland. A single visit by a party of boys can wipe out any chance of success for a colony that year. Education is the only answer.

I do not feel that salmon-fishers, who in Scotland live side by side with Little Terns, are a threat to the terns' survival. While the occasional nest is accidentally destroyed, generally the salmon-fisher is very proud of his 'piccies' and I have known tractor-drivers to mark the nests with stakes so that they may be avoided. There are, of course, exceptions: I will never forget the chap who thought Little Tern eggs made a "damned good fry".

Due to increasing leisure hours, the pressure on the Little Tern's breeding beaches will

continue to increase. It is essential to ensure that population decreases are detected immediately they occur. Although the colonies in Fife, Angus, Kincardine and Aberdeenshire are continuing to be monitored, another national survey is due since many population changes may have taken place since the last one in 1971.

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Leach's Petrels present on Ramna Stacks, Shetland

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On 1st August 1980, during a spell of calm settled weather, three members of the Leicester Polytechnic Shetland Expedition landed by means of an inflatable craft on the precipitous island of Gruney, the largest of the Ramna Stacks, Shetland. The Stacks (60°39'N, 01°18'W) lie at the north-west mouth of Yell Sound and mark the landfall and turning point for oil tankers approaching the oil terminal at Sullom Voe. Gruney (ca. 7.0 ha) is flat-topped and covered with a peaty soil layer supporting a maritime grassland community; the dominant breeding birds are about 50 pairs of Great Black-backed Gulls (*Larus marinus*) and several hundred pairs of Puffins (*Fratercula arctica*).

Before nightfall a mist-net was erected in a gully near the centre of the island to catch Storm Petrels (*Hydrobates pelagicus*). During the night a call was heard from the ground which was recognised by reference to a tape recording as the 'chatter' call of a Leach's Petrel (*Oceanodroma leucorhoa*); calls were then heard overhead from birds in flight. Amplified tape-recordings of the chatter-call were played near the mist-net and two petrels were caught and ringed; recordings were also played in various parts of the island in an attempt to induce a vocal response from birds in burrows. Calls from the ground were heard in at least ten places but were extremely difficult to pin-point in thickening fog. At length a chatter-call, followed by a 'purr' call, was located issuing from a burrow entrance concealed in the Scurvy Grass. The nest chamber contained a full-grown Leach's Petrel and nesting material, but no egg or chick. The bird was ringed, and noted to have a brood patch.

The mere occupation of a burrow does not constitute proof of breeding since non-breeders (or pre-breeders) will occupy a burrow, often in the year before breeding (Huntington and Burtt, 1972). The nearest site to the Ramna Stacks where breeding has been confirmed in recent years is on Foula, 70 km to the south-west (Mainwood, 1975); the only other known British colonies are on four remote islands off the north-west of Scotland (Cramp, Bourne and Saunders, 1976). The difference between the Gruney site and any of these is the proximity of a neighbouring landmass—the former is under 2 km from the Shetland mainland. Further surveys of the island are planned.

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Notes on the robbing behaviour of Arctic Terns at Puffin colonies

by K. Taylor

INTRODUCTION

The Arctic Tern (*Sterna paradisaea*) usually feeds by fishing over water. Whilst various members of the Laridae and Stercorariidae commonly obtain fish by kleptoparasitism (Brockman and Barnard 1979) or by gleaning fish dropped on the ground at Puffin (*Fratercula arctica*) colonies, such behaviour is unusual in Arctic Terns, having been recorded regularly only on the island of Mykines in the Faroe Islands (Williamson 1948, Nørrevang 1960). Puffins do not eat fish which they drop either accidentally or after being attacked by a kleptoparasite, and kleptoparasites do not always find all fish dropped by a Puffin after a successful attack. Such fish is thus available as food for birds of other species even if these were not the original protagonists. Feeding on dropped fish in this manner is referred to here as 'gleaning'. 'Pirate' is equivalent to 'kleptoparasite' throughout this paper. These notes extend previous accounts of inland foraging by terns on Mykines, and describe tern foraging behaviour at an Icelandic Puffin colony. This leads to consideration of why tern foraging at Puffin colonies is uncommon.

Elsewhere, the Arctic Tern is not widely recorded as a kleptoparasite of other birds. It has been seen robbing fish from Puffins south of Puffin Island, Co. Kerry and off the Farne Islands (P. G. H. Evans and M. P. Harris pers. comm.); from Black Guillemots at Aedey and Flatey in Iceland (Bardarson 1975, A. Petersen pers. comm.); and from Horned Grebes in Iceland (Bengston 1966).

STUDY SITES

(1) *Mykines* (62°07'N, 7°38'W) is the westernmost island in the Faroes. Puffins breed along much of the Mykines coastline (Nørrevang 1977). Puffin burrow density in the colony areas between Mykines village and the holm Mykinesholmur, a distance of about 750 metres, is up to four burrows per square metre (pers. obs.), one of the more than 50,000 pairs of Puffins bred in these areas in 1979. Nørrevang (1960) estimated that about 1,200 pairs of Arctic Terns bred on Mykinesholmur, at a site less than a kilometre from these Puffin areas, in the 1950's, and stated that Herring Gulls (*Larus argentatus*) were the main pirates of Mykines Puffins.

(2) *Vik i Myrdal* (63°25'N, 19°30'W) is a township close to the southernmost point of Iceland. Puffins at Vik breed inland at two cliff sites, separated from the sea by a glacial outwash plain. The Vik East Cliff Puffin colony lies about one kilometre inland. Puffin burrow distribution at this site has been described by Grant and Nettleship (1971). The total number of Puffins breeding at the East Cliff is of the order of thousands of pairs (the topography makes burrow counting dangerous), and burrow density is lower than at the Mykines study site. Puffins flying to the East Cliff with fish to feed their chicks are attacked by a number of pirates, principally Arctic Skuas (*Stercorarius parasiticus*), Herring Gulls and Lesser Black-backed Gulls (*Larus fuscus*) (Grant 1971, Arnason 1978, Arnason and Grant 1978). The latter two species, and others such as Kittiwake (*Rissa tridactyla*) and Raven (*Corvus corax*) are also gleaners at the East Cliff. Arctic Terns breed within one kilometre of the East Cliff in a colony of a few hundred pairs, seawards of the cliff.

METHODS

Terns were observed at Puffin colony areas near Mykines village between 19 and 23 July 1979, and at the Vik East Cliff between 13 and 16 August 1979. Since my main study at both sites concerned Puffins, tern observations were casual rather than systematic. Notes on Mykines terns were mainly observations of patrolling behaviour. At Vik, individual terns flying near the East Cliff were watched from their arrival at the cliff until they flew out towards the tern colony after patrolling near the Puffin colony. Tern patrol duration, foraging success and interaction with other birds was noted.

RESULTS

Tern patrol times and gleaning success are illustrated for both sites in Table 1. Fish found on the ground at both sites were Sand-eels (*Ammodytes marinus*). Gleaning success was much lower at Mykines (11%) than at Vik (48%).

TABLE 1. TERN PATROL DURATION AND GLEANING SUCCESS.

Site	*Mean patrol time (secs)* ± SE					
	Successful	*n*	*Unsuccessful*	*n*	*Total*	*Success (%)*
Mykines	15.0	1	184.4 ± 73.3	8	9	11
Vik	120.8 ± 44.4	12	108.6 ± 23.4	13	25	48

The normal tern patrol at Mykines was a rapid zig-zag traverse of a Puffin slope, sometimes pausing to hover near the ground. Not all hovers resulted in a bird securing a fish. Flight height was about two metres. Single patrolling birds chased off another tern which flew within ten metres of the patrolling bird in three out of nine patrols monitored for patrol duration and gleaning success. Other chases were seen in more casual observations. Up to three terns were seen simultaneously quartering different areas of the same burrow slope (c150 m by 250 m). Once, when a Herring Gull forced a Puffin to drop a fish load, three terns flew over to the site and chased off the gull. The terns then squabbled over the remnants of the dropped load. Another isolated observation was of a tern which began to hover at a Puffin burrow entrance just before the burrow owner landed with a fish load. The tern dived towards the Puffin, which dropped the fish and bolted down the burrow. The tern then picked up a fish and flew off to a nearby nest. Fish obtained at the Puffin colony were always carried to a tern breeding site.

At Vik, Arctic Terns were seen quartering the lower burrow areas at the East Cliff and gleaning fish on all days of study. As on Mykines, patrols were rapid low level zig-zags with occasional hovers. Intra-specific harrassment was seen only in the context of one tern finding a fish and up to two others flying over and chivvying the gleaner. The gleaner held on to its fish in the four cases where this was observed. Twice, a patrolling tern rapidly switched its patrol track when a Puffin chased by Arctic Skuas passed nearby. These terns flew 'in the wake' of the Puffin chase, but well behind the main protagonists, apparently searching for dropped fish. Terns were also seen to fly over and circle sites where Lesser Black-backed Gulls had recently found fish. Up to four terns were seen simultaneously quartering different parts of a burrow area c 150 m by 100 m. All gleaned fish were carried to the nearby tern colony.

DISCUSSION

Kleptoparasitism in birds occurs most frequently among colonial seabirds and may evolve rapidly if the advantages of obtaining food in this manner outweigh those of other feeding

methods (Brockmann and Barnard 1979). I was not able to quantify the energetic costs and benefits of different tern foraging methods at the two study sites. The present notes thus do not allow rigorous assessment of tern robbing behaviour. Nevertheless they do indicate how conditions at the two sites might lead to a feeding association between terns and Puffins.

A tern can obtain food at a Puffin colony by gleaning or by piracy. If the net energy gained by such foraging is greater than or equal to the energy which could be gained by fishing at sea, foraging at a Puffin colony could be an alternative or better feeding method for a tern than fishing at sea. I suggest that the choice of feeding method may be influenced by the density of fish on the ground, the density of fish-carrying Puffins at the colony, and competition for food with other species. Where kleptoparasitism by species other than terns over land is high, but the traffic of fish-carrying Puffins is low, one might expect gleaning to be the preferred feeding method. Piracy could be costly in comparison to gleaning since it uses energy to chase Puffins and compete with other pirates. Where kleptoparasitism by other species over land is low, and the traffic of fish-carrying Puffins high, piracy may be a better alternative, or additional feeding method to gleaning. Some support for this variation in strategy is provided by gleaning success at Vik and Mykines.

Both Puffin colonies described here are atypical. The Vik colony has an unusually high incidence of successful kleptoparasitic attacks on Puffins by species other than terns. More chases of Puffins by Arctic Skuas at Vik result in the Puffin dropping its fish load than in interactions between these species elsewhere (data in Andersson 1976, Arnason and Grant 1978, Furness 1978), possibly because Vik Puffins have less chance of escaping pirates than at sites nearer the sea (Grant 1971). The limited data presented here indicate that Arctic Terns at Vik gleaned a fish on just under half the patrols monitored; roughly once every four minutes of patrol time. Some Vik terns nested closer to the Puffin colony than to the sea. For such birds, gleaning at the Puffin colony might have been a profitable feeding method. Vik terns were never seen robbing Puffins.

In contrast to Vik, Mykines has a very high density of Puffin nest burrows and although skuas attack fish-carrying Puffins, these attacks take place over the sea. Fish dropped after successful skua attacks will thus be only briefly available for gleaning by other species before they sink. Terns on Mykines thus have access to unusually high densities of fish-carrying Puffins, but unlike Vik, only limited access to fish dropped as a result of piracy by other species. My notes suggest that gleaning was not a profitable feeding method for Mykines terns but that some piracy occurred. Nørrevang (1960) noticed terns fishing at sea near Mykines only on calm days and considered piracy to be the normal tern feeding method at the Puffin colony. Since the fishing ability of Arctic Terns can be adversely affected by increasing wind strength and rain (Bengtson 1966 and see Dunn 1973), Mykines terns may forage at the Puffin colony mainly when adverse weather makes fishing at sea difficult. My observations were made on days when wind strength was Beaufort force 4 or more, with frequent rain.

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Relationship between sardine fisheries and recovery rates of ringed terns in West Africa

E. K. Dunn and C. J. Mead

INTRODUCTION

It is well known from ringing studies that the west Palearctic tern populations which winter in West Africa are subject to high mortality, especially among young birds, and that the bulk of them succumb to trapping by children in the coastal communities (Allison 1959, Bourne and Smith 1974). In view of the increased threats to tern breeding habitats in Europe, and the recent decline of the Roseate Tern *S. dougallii* in particular, mortality in the winter quarters and the underlying reasons for fluctuations in trapping pressure are of considerable importance. Mead (1978 and in prep.) has compared the recovery rates of 1st Year birds between regions and years, and has demonstrated significant annual fluctuations in the recovery indices of Common Tern *S. hirundo*, Sandwich Tern *S. sandvicensis*, and Roseate Tern, the three species for which adequate data exist.

When the recoveries were divided regionally (Mauritania/Senegal, Guinea/Sierra Leone, Liberia/Ivory Coast, Ghana), it was found that when the overall index was very high, it was also high in three of the four regions. Neither annual fluctuations, nor the apparent—and surprising—regional coincidence of recovery rates have been satisfactorily explained. Social factors (education, readiness to report rings, population density etc. are bound to be involved, but intuitively none would seem sufficiently important to induce systematic changes over a geographical range as broad as that under consideration.

The food supply of the terns in West Africa waters comprises a variety of fish species, but of special importance are sardines *Sardinella eba* and *S. aurita*, and anchovies *Engraulis guineensis* (Dunn, unpubl.). Significantly, sardines, and to a lesser extent anchovies, form the basis not only of the terns' survival, but also to a large degree that of the substantial inshore fishing industry throughout West Africa. For terns and man alike, they are a somewhat unpredictable resource—shoaling species subject to violent fluctuations in abundance from season to season and from year to year (Fig. 1). The instability is thought by the 'Working Group on *Sardinella* off Ivory Coast, Ghana and Togo' to have two main causes: (1) Only certain years provide the upwelling conditions suitable for good spawning (see Grimes 1977). This is especially true of *S. aurita* which normally yields the greater sardine biomass, and is enormously abundant when conditions are optimal. (2) Excessive fishing, which is thought (M. Mensah, pers. comm.) to increase the natural variability of the stocks; the implication is (though we know of no hard evidence) that fishing is disproportionately heavy in years of good stocks, accelerating the natural decline that tends to follow a peak. Given these two factors, the Working Group predicts cycles of high and low catches.

Aware of this, some have suggested that at times of fish scarcity terns may be the more ready to explore alternative sources of food, such as fish laid out as bait for beach snares, and thereby may render themselves more vulnerable to trapping. This, in turn, with a relatively constant return rate of rings by the trappers, would result in higher recovery indices in such years. In this paper we wish to suggest the possibility that quite the opposite process operates; namely that in years when fish are abundant, recovery indices are high.

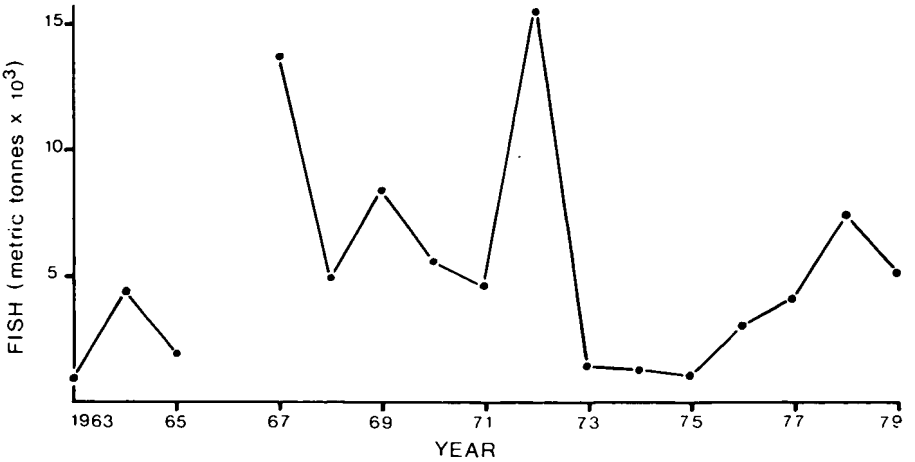

Figure 1. Annual landings by motor-fishing vessels of sardines (*Sardinella aurita* and *S. eba*) in Ghana, 1963-79.

METHODS

The basis of the correlation comprises three sets of data: (1) Landing statistics for sardines compiled by the Fisheries Department, Ministry of Agriculture, Ghana. These consist of the monthly landings (metric tonnes) by inshore motor-fishing vessels and canoes respectively for each year. This discussion is limited to the more complete data on landings by motor-fishing vessels. By and large, the data for each type of craft agree well, reflecting shared fortunes linked to available fish stocks. (2) Annual recovery indices for 1st Winter birds of the three tern species, calculated from B.T.O. Ringing Scheme data. Each index represents the number of recoveries that would have resulted if a hypothetical 10,000 chicks had been ringed in the previous breeding season, thus making indices directly comparable. For Roseate Terns, the index is confined to recoveries from Ghana which is apparently by far the most important wintering ground for this species, accounting for 82% (N = 136) of the ringing recoveries (all ages) from 1967–73. For Common Terns, the indices apply to all West African countries, from Mauritania to the inner Gulf of Guinea, and also embrace the few birds recovered from Zaire, Angola, and southern Africa. Sandwich Tern indices likewise encompass the western seaboard of Africa, but again derive primarily from the West African coast which is the main wintering grounds. (3) Field observations on trapping in Sierra Leone (Jan.–Mar. 1970) and Ghana (Oct. 1979) by E. K. D. and A. J. M. Smith.

RESULTS

1) Field Observations. These are presented first so that the logic of the argument may become clear. The sardines are caught not only by small craft, but also by massive, hand-hauled beach seines. As the boats or nets approach the shore, terns are attracted to them. They feed on offal thrown overboard, fish escaping from nets and accidentally spilled into the sea or on to the foreshore. The arrival of the fish also means fresh supplies of bait for the small boys who set snares along the (usually) receding tideline to coincide with the landing of the boats or nets nearby. Swooping to retrieve fish from the water's edge, terns are thus easily caught when sardines are plentiful.

Boys also use fish to bait hooked lines with which they 'angle' for terns from pierheads, while fishermen sometimes catch terns at sea in the same manner. We saw many birds hooked in this way from the pier at Accra fishing harbour, Ghana. To give some idea of the efficiency of these procedures, 20 Black Terns were snared in two hours on one small stretch of beach at Kedzi, Ghana. On nine days between 5 and 22 Oct. 1979, 128 terns were seen caught by angling at Accra; most of these were 1st Winter Common Terns (44 birds) and 1st Winter Sandwich Terns (30 birds). Royal Terns *S. maxima* (5), Black Terns *Chlidonias niger* (11), Arctic Terns *S. paradisaea* (2), and Roseate Terns (1) were also caught during the same period. Little Terns, though sometimes present, refused to be lured to the dead bait fish floating on the ends of the fishing lines, and were never caught. There is only one recovery of a British Little Tern in the winter quarters which must partly reflect their immunity to trapping. Recreational value apart, catching terns provides a little extra food, or culinary variety, for the fishing community. None are released after capture. Some rings are retained and handed to the authorities but most are discarded or simply lost.

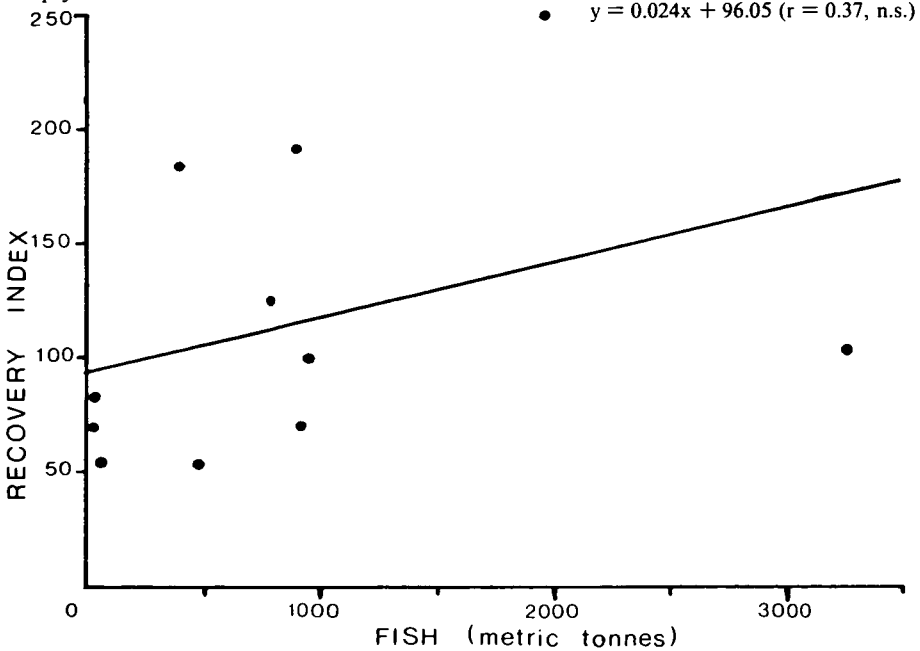

FIGURE 2a. Relationship between sardine landings (Nov-Feb) and annual (Sept 1-Aug 30) recovery indices for Roseate Terns.

The sardine catches vary greatly from day to day, reflecting their mobility and the ability of the fishing vessels to locate them. When readily available, vast numbers were laid out to dry in the fishing communities. A few days later, however, the streets and quaysides would often be bare of fish, indicating that none were being caught. The terns would then desert the neighbourhood, so their susceptibility to trapping mirrored changes in fish catches.

On six days when sardines were abundant at Accra, an average of 4.6 terns were caught per hour at the pier. On 12 days when no sardines were available, the average declined to 2.3 terns per hour. On six out of these 12 days no terns were caught at all because few frequented the harbour and angling activity was low. Interestingly, terns continued to be caught in the first few days of 'no sardines' after a spell of 'abundant sardines', suggesting that birds acquire the habit of visiting the harbour when pickings are good and continue to get caught, albeit in smaller numbers, at the beginning of a period of sardine scarcity. After a few days of scarcity, however, the boys are denied any bait fish, and are forced to abandon trapping or to use as bait the few fish they catch themselves. Often the fish species they do catch are too heavy to float. The boys then have to blow into their mouths to inflate the swim bladders. This keeps them afloat on their lines and makes them accessible to terns.

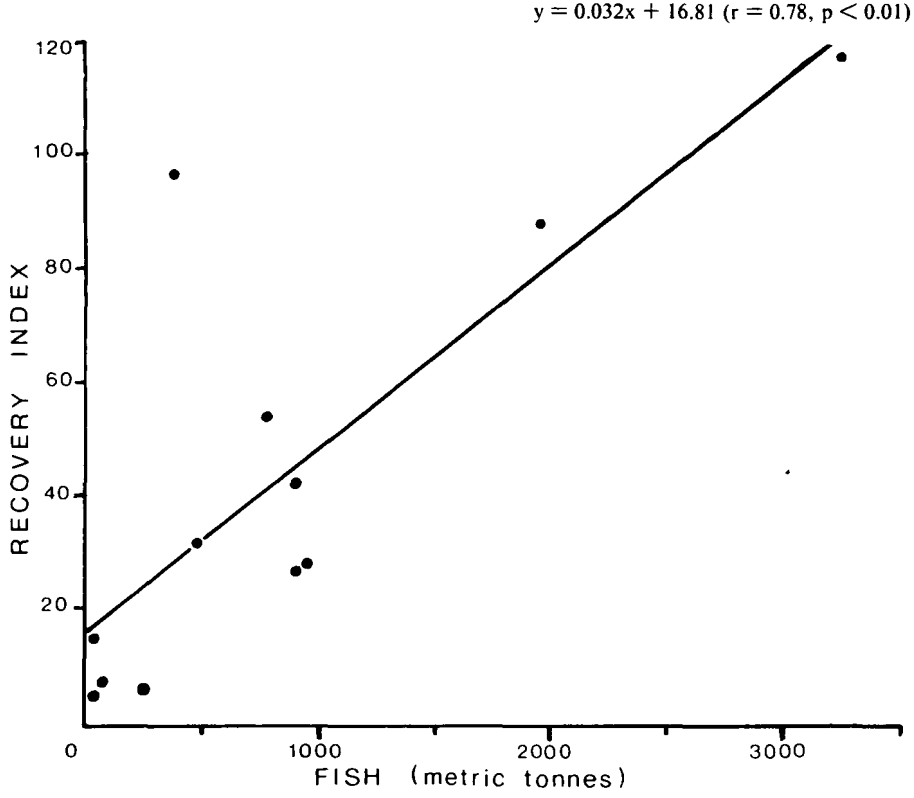

FIG. 2b. Relationship between sardine landings (Nov-Feb) and annual (Sept 1-Aug 30) recovery indices for Common Terns.

(2) Annual recovery indices and sardine landings. Recovery indices of birds run from 1st Sept.–Aug. 30. Indices were plotted against sardine landings for the equivalent 12 months in each of the years 1962–75 for Roseate Terns, and 1962–76 for the other species; there were no significant correlations. In the analysis presented here, sardine landings are restricted to Nov.–Feb. There are three main reasons for this selectivity: (a) 1st Winter birds are at peak numbers in the wintering grounds from about November onwards. (b) they are presumably most vulnerable early in the winter season when their expertise at fishing by natural means is low (Dunn 1972) and when they are naive to trapping situations. (c) In high index years, Common and Roseate Terns are recovered earlier in the season (C. J. Mead).

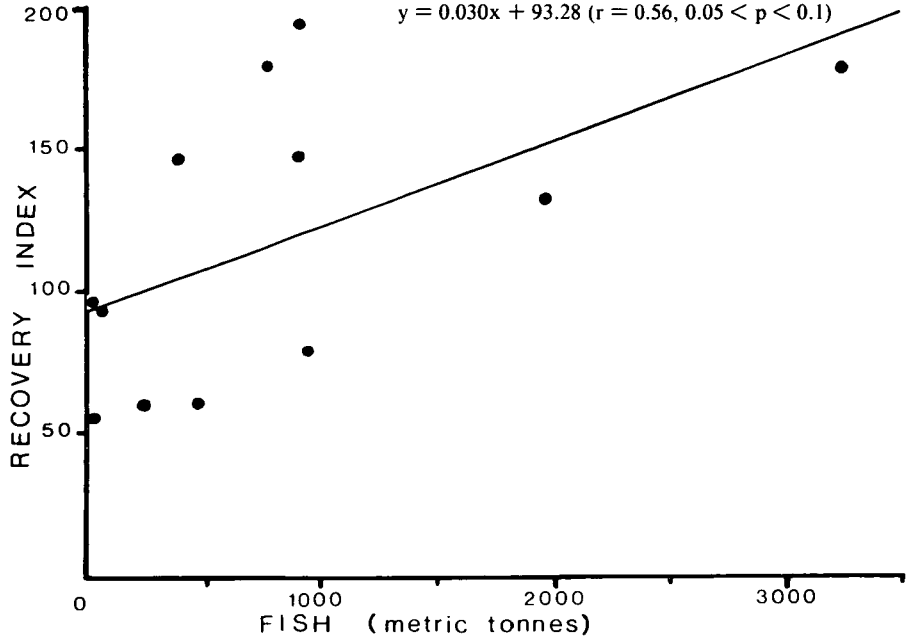

FIG. 2c. Relationships between sardine landings (Nov-Feb.) and annual (Sept 1-Aug 30) recovery indices for Sandwich Terns.

The results are shown in Figs. 2 a–c. Recovery indices were not correlated with sardine landings for Roseate Tern, but the correlation for Common Terns was positive and highly significant ($p < 0.01$). The correlation for Sandwich Terns approached but did not reach significance ($0.05 < p < 0.1$).

DISCUSSION

The field observations showed that trapping pressure varies directly with sardine abundance. In this sense, the boys act as density-dependent predators. The correlation between recovery indices and sardine landings supports the possibility that the relationship observed in the field plays some part in causing annual fluctuations in the frequency of reporting rings. Given the fickleness of the reporting procedure, and the fact that (Roseate Terns apart) the index data are derived from a considerably wider region

than the fishery statistics, it seems remarkable that any of the correlations are significant, and that all three are in the predicted (positive) direction. This indicates that the suggested relationship may be of considerable importance relative to other factors involved. At present no data are available for 1966, and since the period examined for sardine landings is Nov.-Feb., this missing year disposes of two further possible data points (1965-6 and 1966-7). With more data it may thus be possible to establish that the relationship holds for all three tern species.

The lack of correlation for Roseate Terns is at first surprising because it is the only species whose virtually entire wintering grounds fit the region (Ghana) from which the fishery statistics were drawn. With so little data it is somewhat invidious to pick out particular points on the graph for discussion. However, the most aberrant point (extreme lower right on Fig. 2a), representing the 1972–3 'boom' year for sardines might, on the present hypothesis, suggest that when the tern population available for capture is quite small, as it is with Roseate Terns (total European breeding population in 1972–3 about 1200 pairs) enormous catches of sardines may not induce commensurate trapping rates. Common and Sandwich Terns, on the other hand, are always present in many thousands in the Gulf of Guinea in winter, and their availability for capture may faithfully match prevailing sardine abundance, however high.

The interpretation of the relationship as far as annual mortality is concerned is problematical. Good sardine years may enhance the survival of those terns not trapped, so it should not be concluded that high index years imply poor overall survival in those years. The effects of overfishing, which probably caused the fishery to collapse in 1973 (M. Mensah, pers. comm.) are especially difficult to predict. While low catches may have helped to steer terns away from trapping sites, the terns' natural food supply must also have been depleted. That Sandwich and Common Terns have not visibly suffered (as gauged by breeding populations) along with the Roseate Tern through these upheavals may testify to their wider distribution both in Africa and in Europe, where breeding has been good in recent years, buffering them from local upsets. The recovery of the sardine stocks since 1978 in spite of heavy exploitation has surprised the West African fishing authorities, and suggests that cycles of high and low catches may be expected over the years. Only long term studies will reveal the implications of such fluctuations for wintering tern populations.

A final point concerns the convoluted process underlying the number of rings reported. With the erosion of European influence in West African institutions—political, educational and so on, children who trap are probably less knowledgeable today about the significance of ringing, and the desirability of reporting rings, than were their predecessors.

Older generations of the fishing communities that we interviewed were often familiar with the concept of bird migration and the relevance of ringing to it, presumably learned at school. The changed political scene in West Africa may well mean that fewer rings now find their way to institutions like the British Embassies, Universities etc. which have traditionally been the main link in the transfer of recoveries to the European ringing schemes.

This being so, it is more important than ever before that ringed birds be available to be recovered. The species presently giving most cause for concern—the Roseate Tern—has been ringed in regrettably small numbers since 1970 when colonies increasingly came under the protection of the R.S.P.B. Fortunately the policy of ringing a proportion of Roseate Tern pulli at these colonies has recently been re-established. The analysis of

ringing data is full of imponderables, but it remains the only tool at our disposal for determining, however crudely, the fate of these species away from our shores.

SUMMARY

Field observations in West Africa showed that trapping pressure on terns is greatest when sardine catches by man are high. Evidence is presented to suggest that this relationship influences annual fluctuations in the number of rings reported to the BTO ringing scheme. Annual survival is presumably affected by the relationship but, in the present state of knowledge, not in a predictable way.

ACKNOWLEDGEMENTS

Special thanks are due to Alistair Smith at whose kind invitation EKD joined the expedition to Ghana. The basic idea presented in this paper developed from shared experiences and discussions during that venture. Emmanuel Asibey, Director of Ghana Game and Wildlife Department kindly put his facilities, and two of his staff, at our disposal. Martin Mensah, Director of Ghana Fisheries Department generously provided unpublished data and insight on the sardine fisheries. Though they knew we were interested in their catches, the small boys at Accra thankfully never made any special effort to trap terns for us. EKD's fieldwork in Sierra Leone was funded by a N.E.R.C. travel grant. CJM's post at the British Trust for Ornithology is funded by a contract from the Nature Conservancy Council.

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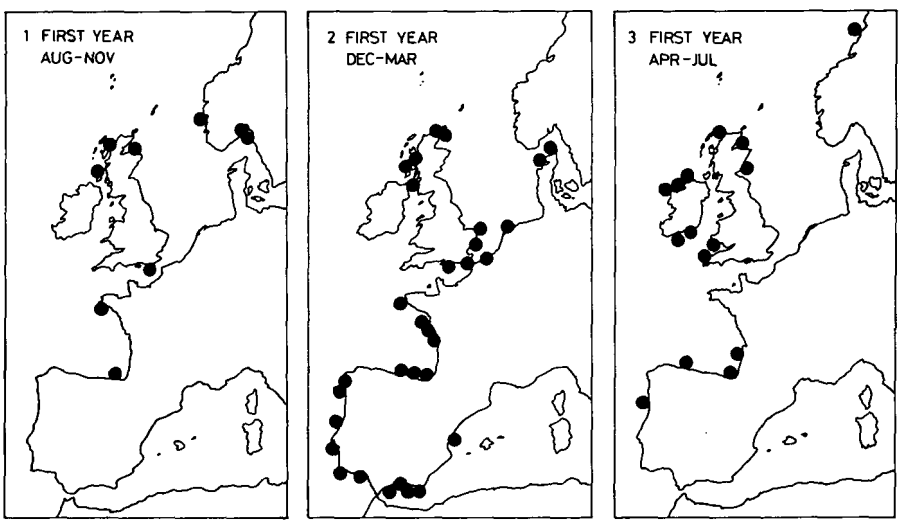
Shiants Razorbills: Movements, first year survival, and age of first return

D. J. Steventon

INTRODUCTION

The Shiant Islands, Outer Hebrides, lie in the Minch approximately 8 km southeast of Lewis and 21 km north of Skye. Their general habitat and topography have previously been described by Brooke (1973). Razorbills (*Alca torda*) have been ringed on all three main islands, Garbh Eilean, Eilean Mhuire and Eilean an Tighe, and on the smaller islands the Galtachean, but the majority, 67% of the total, have been ringed in the largest colony at the base of the east cliffs of Garbh Eilean.

Mead (1974) reviewed Razorbill movements by age and by area of origin. The review considered recoveries up to August 1971, by which time there were only ten Shiants Razorbill recoveries available out of a total of 130 for northern colonies (48 ringed as adults, 82 as pulli). Since that time the Shiants have become established as a major Razorbill ringing site, through a series of annual visits starting in 1970. The Shiants accounted for 29.8% of the 20,725 Razorbills ringed in Britain and Ireland over the period 1970–1978. This varied from 13% to 50% of the total for any one year. Ringing since 1970 has now produced 98 recoveries of Shiants Razorbills to the end of 1979 (10 ringed as adults and 88 as pulli).



Figs. 1-3 Distribution of Razorbill recoveries ringed as pulli, recovered in first year.

Recovery distribution and circumstances

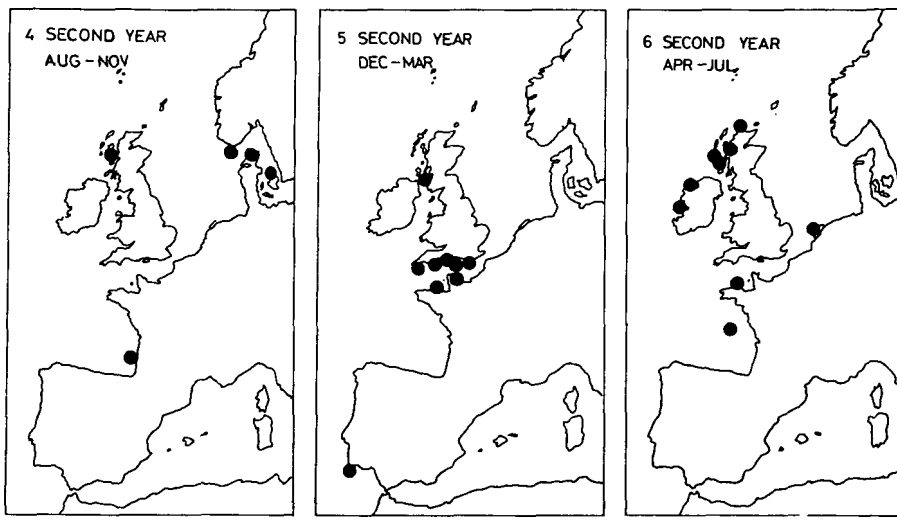
The distributions of recoveries of birds ringed as pulli are shown in figures 1–6, following the four-monthly groupings for first year and immature birds used by Mead (1974). They closely follow the pattern he established. First year birds disperse during the autumn and many winter around the Iberian peninsula from the Bay of Biscay through to

the Mediterranean. They return to British waters in their first summer. They do not move as far in their second winter as in their first, being confined mainly to the English Channel coasts, and in their second summer are generally much closer to their natal colony.

The reported methods of recovery for birds recovered in their first two years of life are summarised in Table 1.

TABLE 1. RAZORBILLS: METHOD OF RECOVERY TABULATED BY REGION.

	Scandinavia	*Britain*	*Ireland*	*Netherlands/France*	*Iberia*
Oiled	2	10	—	4	3
Shot, taken, etc.	6	—	—	—	4
Fish nets or lines	1	5	7	2	4
Other, mostly found dead	—	14	—	8	8



Figs. 4-6 Distribution of Razorbill recoveries ringed as pulli, recovered in second year.

Survival and age of first breeding

A colour ringing scheme was used to help establish the age of first return of pulli to their natal colony. Pulli ringed from 1972 to 1976 had a coloured darvic ring fitted to denote year of ringing, in addition to the metal B.T.O. ring. Subsequent sightings of these at the colony up to and including 1979 are summarised in Table 2, together with data on first recaptures of ringed birds.

Sightings of colour ringed birds showed earlier returns than indicated by retrapping, similar to the situation observed by Lloyd (1974) for Razorbills at Skokholm. Non-breeding immature birds make infrequent landfalls and are therefore more difficult to catch than breeding adults. Thus although major first return is indicated as the third year, retrapping indicates that first breeding is not until from the fourth year onwards.

The biases to which recovery data away from the breeding colony are subject have previously been discussed by Lloyd (op. cit.), with birds more likely to be recovered by one method than another in a particular place at a particular time in their life cycle. It is

TABLE 2. RAZORBILLS: SIGHTINGS OF BIRDS COLOUR-RINGED AS PULLI AND FIRST RECAPTURES OF BIRDS RINGED AS PULLI ON THE SHIANTS.

Year n = number of years after ringing	1	2	3	4	5	6	7
Number of sightings in year n	0	2	20	10	0	1	1
Number colour-ringed n years before	2086	2086	2086	1506	1229	1068	510
Percentage return after n years	0	0.096	0.959	0.664	0	0.092	0.196
Number first recaptured in year n	2	6	2	17	16	13	4
Number ringed n years before	3643	3069	2857	2846	2266	1989	1828
Percentage return after n years	0.055	0.195	0.070	0.597	0.706	0.654	0.219

therefore not possible to use Haldane's (1955) or other similar methods based on recovered birds to estimate the year to year mortality of the immature birds ringed as pulli prior to breeding from four years old. However the survival rate (1-mortality) can be inferred by comparison of the rate of return of pulli to the natal colony with that of adults, a method used by Long (1975) to infer the mortality rate of juvenile Reed Warblers (*Acrocephalus scirpaceus*) from the calculated rate for adults. This method assumes that birds ringed as pulli are as equally likely to return to the colony as birds ringed as adults.

TABLE 3. PERCENTAGES OF ADULT AND PULLI RAZORBILLS RETURNING TO GARBH EILEAN, SHIANTS, AFTER INITIAL RINGING.

Year n	1	2	3	4	5	6	7	8
Ringed as pulli								
Number known to have survived n years	62	61	55	54	36	21	8	5
Number ringed n years before	3643	3069	2857	2846	2266	1989	1828	1276
Percentage known to be alive n years later	1.702	1.988	1.855	1.897	1.589	1.056	0.438	0.392
Ringed as adults								
Number known to have survived n years	212	167	127	95	73	48	29	18
Number ringed n years before	1547	1326	1248	966	762	595	550	399
Percentage known to be alive n years later	13.70	12.59	10.18	9.830	9.580	8.067	5.273	4.511

The percentages of pulli and adults surviving n years after ringing are compared in Table 3. The annual adult survival rate for Shiants Razorbills has previously been calculated by Steventon (1979) at 0.92. Using this, s_n, the annual survival rate of birds ringed as pulli to year n, can be calculated by using the relationship:

$$s_n = 0.92^n \sqrt{\frac{\text{percentage of pulli surviving n years}}{\text{percentage of adults surviving n years}}}$$

On the assumption that the heaviest mortality is in the first year of life, and that after that the adult survival rate applies, a series of first year survival rates can be estimated from the relationship:

Overall survival pullus to year n = First year survival times adult survival over (n–1) years.

The calculated annual survival rates are listed in Table 4.

TABLE 4. RAZORBILLS: SURVIVAL ESTIMATES OF BIRDS RINGED AS PULLI.

Year n	*Pullus annual survival rate to year n*	*Pullus overall survival to year n*	*Adult overall survival to year n*	*Pullus first year survival rate*
1	0.1143	0.1143	0.9200	0.114
2	0.3656	0.1336	0.8464	0.145
3	0.5216	0.1419	0.7787	0.168
4	0.6097	0.1382	0.7164	0.177
5	0.6423	0.1093	0.6591	0.153
6	0.6555	0.0794	0.6064	0.120
7	0.6447	0.0463	0.5579	0.076

A first year survival of about 16% is indicated, with overall survival of about 11% to 14% from fledging to breeding age. Lloyd and Perrins (1977), found survival from fledging to breeding age of about 18% for Skokholm birds, with 100 pairs expected to raise 71 young to fledging each year. There was no attempt in this study to determine the number of pulli reared to fledging per 100 pairs of breeding adults.

DISCUSSION

Within the Shiants group there has not been a case of a bird ringed as an adult changing colony, although an adult breeding on Canna (95 km south) in 1979 was caught on the Shiants in 1980. In estimating the survival rate for pulli, it has been assumed that they stand an equal chance of being caught as adults at the colony as birds ringed as adults there in the first place, i.e. pulli must only return to their natal colony and not join other colonies outside the study area in adulthood. However, of the 2846 pulli ringed on Garbh Eilean up to 1976, 54 were known to be at their natal colony from their fourth year onwards but one had moved to Eilean an Tighe, and seven of the 1375 pulli ringed on other islands on the Shiants group were known to have moved to Garbh Eilean from their fourth year onwards. Furthermore a pullus ringed on the Shiants in 1976 was in a breeding site on Canna in 1980, and a pullus ringed on Canna in 1974 was caught on the Shiants in 1980. Colony changes by pulli have also been recorded by Lloyd and Perrins (1977) for Skokholm. Such emigration results in a low estimate of survival, as some surviving birds are not returning to the study colony where they could be caught to prove that they have survived.

SUMMARY

Over 1600 adult and over 4400 pulli Razorbills were ringed on the Shiant Islands, Outer Hebrides, over the period 1970–1978. For 78 birds ringed as pulli the distribution and methods of recovery in their first two years of life are provided.

The distribution of recoveries of Razorbills bred on the Shiants follows previously established patterns for birds from northern colonies. They can return to their natal colony from as early as their first year, but generally the main return is from three years old, and the age of first breeding would appear to be from four years old. First year survival is estimated to be not less than 16%.

ACKNOWLEDGEMENTS

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Notes on seabirds attending a commercial trawler fishing in shelf waters off Ireland in summer

P. J. Dare

INTRODUCTION

During the period 12–23 June 1980, records were kept of the seabirds observed incidentally whilst I was working aboard the commercial stern trawler 'Junella' (1,600 tons, 180 ft length) fishing along the 80–130 fathom (145–235 m) zone to the west and south of Ireland. Fishing began at Stanton Banks and Eagle Island, off north-west Ireland, and finished at a position approximately 175 miles (280 km) due west of the Isles of Scilly. The most detailed observations were made during 15–22 June when fishing was concentrated in the rectangle between 51°30′N–49°30′N and 10°W–11°15′W, i.e. from some 15 miles (25 km) south-west of the Skelligs (Co. Kerry) to 175 miles (280 km) west of the Isles of Scilly (Fig. 1). Noon positions (BST) of the ship are given in Table I and Fig. 1.

Trawling took place on all but one of the days, and in the main area—around Hurd Bank and South Hake Ground—operations were virtually continuous from approximately 06.00 to 21.00 h BST each day. Hauls were made usually at 3–5 h intervals; 90% of the fish caught were Horse Mackerel (*Trachurus trachurus*) and Mackerel (*Scomber scombus*). Winds were predominantly westerly, moderate to fresh, but with one gale (on 19 June) which generated a considerable swell during 18–20 June.

METHODS

Observations were made at frequent intervals (totalling several hours) throughout each day from the bridge and, when sea conditions permitted, also briefly from the stern; 10 × 50 binoculars were supplemented occasionally by a ×20 telescope. Daily counts or estimates were made of each species. For the commoner species only the maximum numbers of birds present at any one haul were estimated. The regular fishing activity apparently attracted birds from a vast area, and many then maintained station throughout daylight; some apparently also stayed through the night when the ship usually steamed slowly to a new fishing area or lay-to. It was therefore impossible to make meaningful transect counts or records of numbers per unit time.

GENERAL OBSERVATIONS

Seventeen species of seabirds were recorded; their daily numbers are given in Table I. En route to Stanton Banks via the Minch, only few birds had been seen off north and west Scotland. The counts show that both total abundance and species diversity increased as 'Junella' moved south off the west coast of Ireland, and both reached a peak in the area from about 30 miles (50 km) west of Dingle Peninsula (Co. Kerry) south to the South Hake Ground, 110 miles (175 km) SSW of Cape Clear. The small numbers noted on 19–20 June are attributable to a gale and heavy swell on 19 June rendering observations very difficult, whilst by 20 June the ship had moved eastwards for shelter inshore to south of Galley Head where birds were relatively scarce. On returning to deeper waters, on 21–22 June, numbers and variety of seabirds increased once more.

After leaving the primary fishing area on 23 June, seabird numbers and diversity fell markedly as we headed towards Cornwall. During 24–29 June, whilst fishing in the English Channel and Southern Bight, birds were very scarce. Only a few Herring and

Lesser Black-backed Gulls *Larus argentatus* and *L. fuscus* were seen each day together with one or two Fulmars *Fulmarus glacialis* and Kittiwakes *Rissa tridactyla*; Gannets *Sula bassana* were rare and passed at long range. Nearly all species were strongly attracted to the ship and fed on fish and fish waste. However, auks, Manx and Cory's Shearwaters *Puffinus puffinus* and *Calonectris domedea* showed no signs of attraction, whilst the skuas took only a passing interest in the Kittiwakes, larger gulls and Gannets, and made no attempts at piracy. All the rarer species were viewed for considerable periods at ranges down to 20-40 m.

'Seabird numbers were generally highest during mornings and early afternoons whereas evening hauls of the net were often comparatively poorly attended. Such a diurnal pattern was particularly evident with Storm Petrels *Hydrobates palagicus* and Gannets on 15-17 June and 21 June. Numbers of Storm Petrels sometimes declined to 5–10 in the evenings and on 17 June they disappeared altogether after 20.00 h; presumably such decreases late in the day were due to birds returning to Irish breeding colonies. By 07.00 h, good numbers of birds were already waiting around the ship for the first haul of the day.

NOTES ON SPECIES

Cory's Shearwater *Calonectris diomedea*

All passed within 100 m range: a group of five heading E on 15 June when c. 20 miles (32 km) WSW of the Skelligs; one flying SW when 10 miles (16 km) WNW of Mizen Head later that day; one 25 miles (40 km) WSW of Cape Clear on 16 June.

Great Shearwater *Puffinus gravis*

All followed the ship, often landing in the wake apparently to feed among Fulmars, Storm Petrels and Kittiwakes. Some individuals remained all day. Last noted c. 175 miles (280 km) west of Scillies.

Sooty Shearwater *Puffinus griseus*

Behaviour as Great Shearwater but often seen to plunge in a shallow dive for food when landing among other species. Up to 5 in view at one time; last seen c. 175 miles (280 km) west of Scillies.

Manx Shearwater *Puffinus puffinus*

Very scarce: 2 heading W about 20 miles (32 km) WSW of Skelligs; 2 flying N–NE in the evening when c. 175 miles (280 km) west of Scillies. An individual of the Balearic race *mauretanicus* was heading SW 10 miles off Mizen Head on 15 June and passed within 100 m range.

Storm Petrel *Hydrobates pelagicus*

Large numbers persistently followed in the wake every day, feeding actively (with strong Dunlin-like wing action) for long periods after hauls and discarding of fish offal. During quiet interludes, many birds dispersed widely around the ship, but all would converge rapidly as the net was being hauled, apparently reacting to the rising excitement among Gannets and gulls. Last seen when 10 miles (16 km) S of the Scillies on 23 June.

A bird with patches of white on the secondaries and inner primaries of both wings, and some white freckling on throat and upper breast, was observed at close range (< 20 m) for over four hours on 18 June.

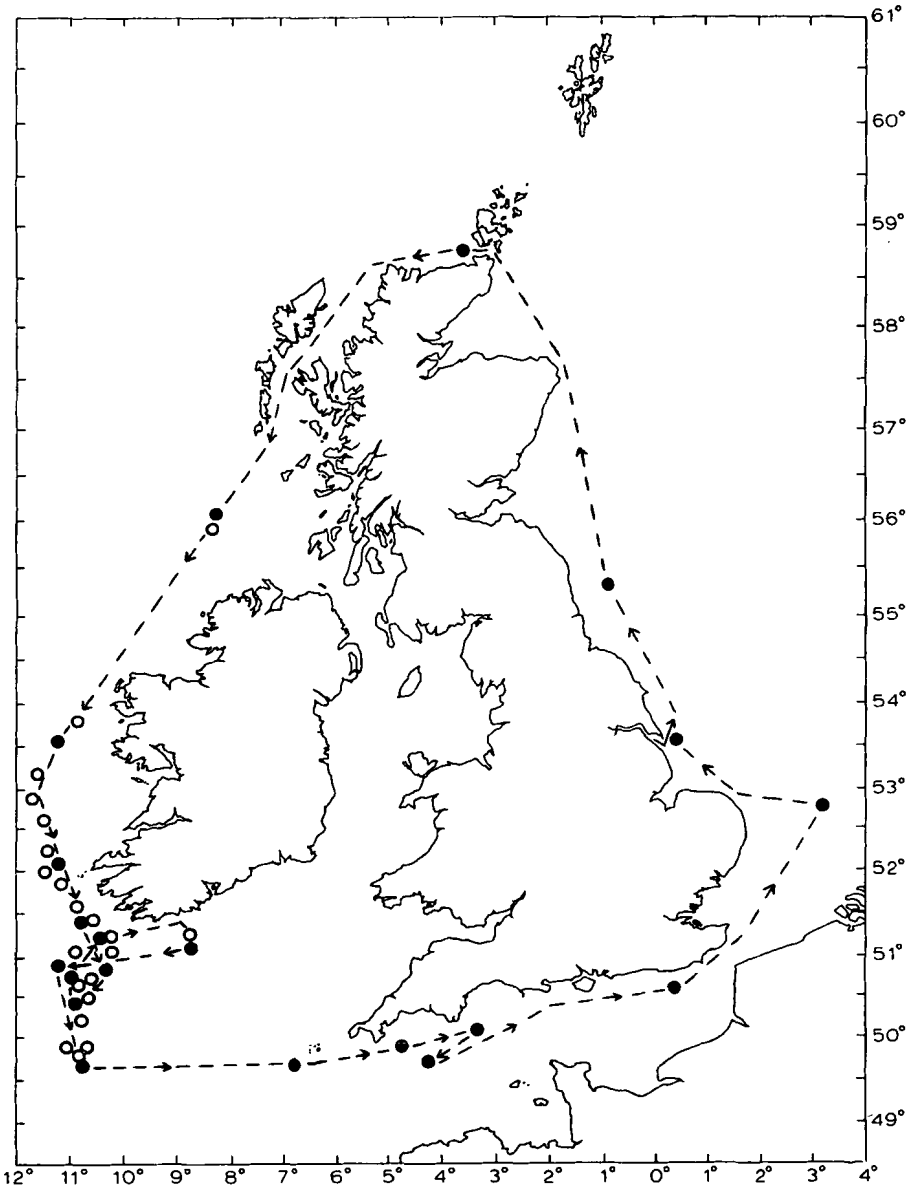

FIG.1. Map showing noon positions (●) and the fishing stations (○) off Ireland

TABLE 1. NUMBERS OF SEABIRDS PRESENT AROUND THE TRAWLER DURING FISHING OPERATIONS OFF W AND SW IRELAND DURING 12-22 JUNE 1980.

Date	12/6	13/6	14/6	15/6	16/6	17/6	18/6	19/6°	20/6°	21/6	22/6	23/6
Noon N	*56.04*	*53.35*	*52.03*	*51.27*	*50.55*	*50.29*	*50.44*	*51.10*	*51.11*	*50.55*	*49.39*	*49.42*
Position W	*08.07*	*11.11*	*11.10*	*10.43*	*10.21*	*10.52*	*10.55*	*10.32*	*08.45*	*11.03*	*10.53*	*06.48*
Wind	*NE 2*	*NE 2-3*	S 2	SW 3-6	WSW 4-5	W 2-4	W 3-4	WNW 7-8	W 4-6	W 4	WNW 4-5	W 4-5
Fulmar		100	125 ± 25	50	50	50	20	10	20	25	30	5
Cory's Shearwater*				6	1							
Great Shearwater					1	2	1	2			1	
Sooty Shearwater			2	3	5	3	1	1		3	2	
Manx Shearwater*				2							2	
Storm Petrel	12	25	125	75 ± 25	50	125 ± 25	100 ± 25	5	25	60 ± 10	225 ± 25	10
Gannet		20	150	300	500	50	50	25	5	225 ± 25	30	5
Pomarine Skua*			1	1								
Arctic Skua*			1								1	
Great Skua*	1		1	2	3		3			1	3	2
Sabine's Gull*					1		2			1	1	
Lesser B-b Gull		10	10	10	5	5	5	5	10	10	5	50
Herring Gull			20	20					10			20
Great B-b Gull			10	2	5		1					5
Kittiwake		10	25	25	25	25	20	10	10	15	30	25
Guillemot*		5										
Puffin*		1								1		

• Total birds per day. Other counts represent maximum number present at hauls.
° see text.

Gannet *Sula bassana*

At least 90% were adults. Large numbers often present around the ship for much of the day, but they did not fish until the trawl was being hauled. Large flocks would set up a circular motion close around the ship, the direction depending on the ship's angle to the wind. Many birds dived to pull fish out of the net; no accidents were seen but the crew reported that Gannets can tangle and drown in wider meshed trawls.

Sabine's Gull *Xema sabini*

All came close to the stern; three fluttered and dipped to feed rather like Black-headed Gulls *Larus ridibundus*, with legs dangling, and they occasionally alighted among Storm Petrels and Kittiwakes; one swallowed a small fish. Two birds stayed together for 5–15 mins, one for at least 30 mins, and one for at least 60 mins, the fifth bird (an adult in breeding plumage) flew past heading NW without pausing. Plumages: 2 in breeding plumage, 1 in transition to breeding plumage, 2 in adult winter plumage. Last observed c. 175 miles (280 km) west of Scillies.

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Notes on the distribution and feeding of Little Gulls at sea in Liverpool Bay

R. A. Eades

INTRODUCTION

The status of the Little Gull *Larus minutus* in Liverpool Bay has changed dramatically since 1965. Lassey and Greenhalgh (1969), and Smith (1974) described the increase of Little Gulls seen from the land in South Lancashire, and the purpose of this paper is to compare their observations with those of Little Gulls seen at sea from ships within the Liverpool Pilotage District, principally Liverpool Bay.

TABLE 1. SIGHTINGS OF LITTLE GULLS AT SEA IN LIVERPOOL PILOTAGE DISTRICT.

Year	*No. of days with sightings*	*Annual total*	*Peak count*	*Date of peak*
1963	1	1	1	Sept. 16th
1964	0	0	0	—
1965	0	0	0	—
1966	2	7	6	Sept. 3rd
1967	7	12	3	Aug. 29th
1968	9	21	5	Oct. 1st
1969*	2	3	2	Nov. 11th
1970	9	36	11	Sept. 5th
1971	5	27	20	Oct. 16th
1972	17	226	35	Sept. 22nd
1973	25	291	35	Sept. 15th
1974	21	145	22	Aug. 29th
1975	34	449	78	Sept. 25th
1976	30	661	91	Oct. 3rd

* Observations not continuous in 1969.

THE INCREASE

My observations at sea started in July 1963 on joining the Pilot Service as an apprentice, and have been almost continuous, practically on a daily basis, to the end of 1976. Table 1 summarises the sightings of Little Gulls annually between 1963 and 1976. There has been a marked increase in the number seen, a similar trend being described by Hutchinson and Neath (1978) throughout Britain. In the early 1960s, the Little Gulf was a scarce autumn passage migrant, none being seen in 1964 and 1965. Apart from a juvenile in 1963, it was not until September 1966 that I first saw small numbers of Little Gulls amongst thousands of Common Terns near Crosby Light Float. In 1967 and 1968 the influxes in August and September were larger and more prolonged. Observations were curtailed in 1969 as I was away from the Mersey until November and missed the main passage period, but 1970 showed a further increase. In February 1971 I started work as a pilot, bringing ships in and out of the Mersey, the Main Channel, and across Liverpool Bay to Point Lynas. As a pilot one spends proportionately more time in those parts of the district which are most productive for this species, i.e. the main channel, and one would expect sightings to increase. However, in 1971 I saw fewer birds than in 1970, indicating that no substantial increase had taken place. Sightings increased in 1972 with no change in the pattern of observations, and they have tended to increase since.

DISTRIBUTION AT SEA

Figure 1 shows the sea area in which Little Gulls were observed. The course followed by an inward bound vessel from a boarding position one mile north of Point Lynas to the entrance of the Main Channel is shown. Most observations from ships are within one nautical mile of this line (one nautical mile equals 1,851 metres). The Main Channel is approximately one km wide, and vessels keep to the starboard side of the channel. Under normal conditions an observer on a ship on one side of the channel can observe Little Gulls on the other side. The speed of most vessels is between 10 and 15 knots, and observation height is between five and ten metres above sea level.

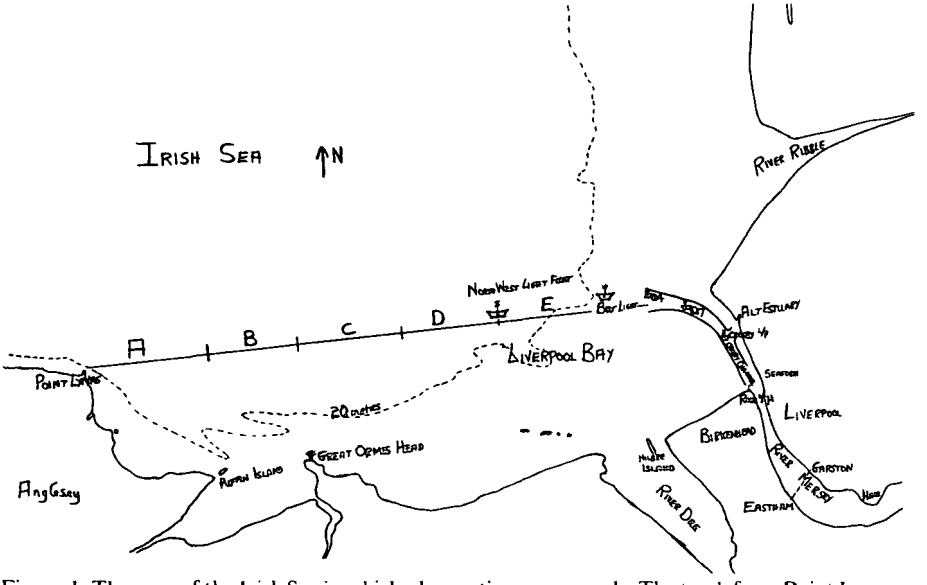

Figure 1. The area of the Irish Sea in which observations were made. The track from Point Lynas to the entrance of the buoyed channel to Liverpool is shown, and is divided into five approximately equal lengths (see Table 2). There is a gradual trend from deep water off Anglesey to shallows and sand banks in Liverpool Bay. Most Little Gulls were seen in the channel between the Bar and the Rock Lighthouse.

TABLE 2. NUMBERS OF LITTLE GULLS SIGHTED IN SEVEN MILE SECTIONS OF SEA AREA (SEE FIG. 1).

	Adults	*Immatures*
Section A	1	2
Section B	0	0
Section C	0	0
Section D	1	0
Section E	3	0
Bar to Q17 Light Float	226	117
Q17 to Rock	924	521
Rock to Eastham/Garston	53	31
Totals	1208	671

For this note the transect from Lynas to the Bar Light Float has been divided into five roughly equal units of seven nautical miles (Figure 1). In general there is a gradual trend from deep water at Lynas to shallower water in Liverpool Bay. The passage up the buoyed channel and River Mersey has likewise been divided into approximately equal lengths of seven nautical miles from the Bar to Q17 Light Float, and from Q17 to the Rock Light House. Q17 forms a reasonably natural boundary between sand banks which are not exposed at low water and sand banks which dry out at low tide. The River Mersey is highly industrialised, and observations cover the seven miles of navigable water between the Rock and an imaginary line joining Eastham Locks and Garston Locks.

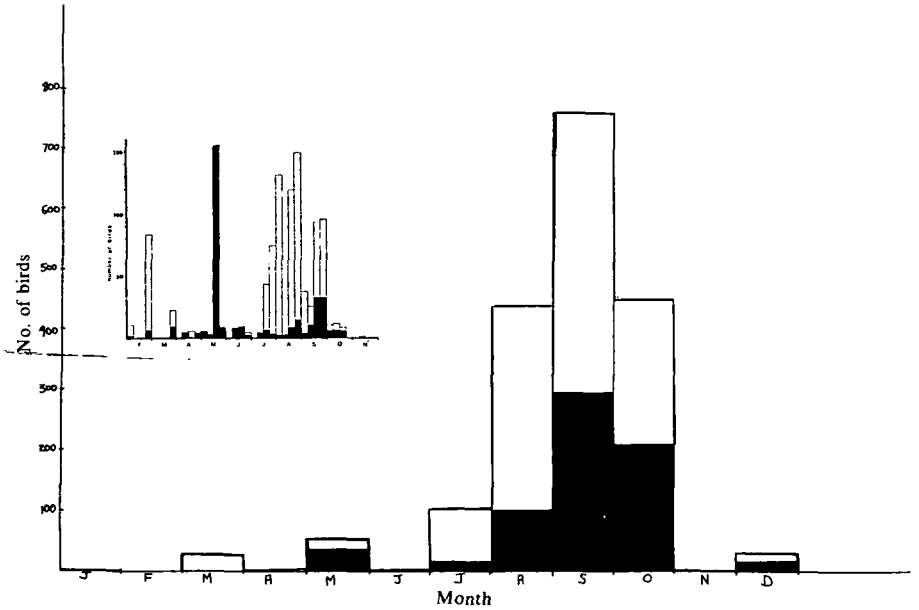

Figure 2. Monthly distribution of 1208 adult and 671 immature Little Gulls seen at sea in Liverpool Bay between July 1963 and December 1976. Shaded blocks indicate first year birds, unshaded blocks adults and second years. The main passage is observed in autumn with a peak in September, and there are indications of two peaks in spring, one of adults in March, and immatures in May. The insert shows weekly distribution of 1138 recorded on the land in the Alt Estuary area by Smith (1974) between February 1969 and February 1974. It is noticeable that the spring passages are more pronounced in Smith's study.

The totals of Little Gulls seen in each seven mile section of sea are given in Table 2. It can be seen that the species is scarce in the offshore zone of Liverpool Bay; over a thousand transects of the central section have yielded only one sighting. The number of observations increases in Queen's Channel, but undoubtedly the main area is Crosby Channel and Crosby Channel Bend. At this point the tidal flow is very strong, producing much disturbed water suitable for surface feeding (see later). This distribution pattern is similar to that reported by Smith (1974). The Alt Estuary, which Smith described as the focus of Little Gull activity in Lancashire, is situated immediately to landward of Crosby Channel.

NUMBERS AND AGE RATIOS THROUGH THE YEAR

Figure 2 presents information on 1,879 sightings of Little Gulls seen by the author at sea between July 1963 and December 1976. As it was not always possible to identify second year birds, I have decided to pool information on them with adults, and to compare this group with the easily identified first summer and first winter birds. Little Gulls occur in every month of the year, but are mainly seen in the autumn. From an almost total absence in midsummer, return passage starts in July, builds up to a peak in September, and then declines. A few birds are seen in the winter and there is an indication of small peaks in March and May.

BEHAVIOUR

I have not noted the wind and tidal state for all records, but some tentative conclusions can be drawn. There seems to be a tendency for Little Gulls to be seen during periods of fresh westerly winds, force 4 to 6 giving maximum numbers. During August and September, if the winds are westerly force 4 or above, a few birds are almost always present near Crosby Light Float, either keeping station by flying into the wind, or slowly beating their way to windward, sometimes as far as Fairway Buoy or even the Bar. Possibly these birds are part of the Alt Estuary flock which finds conditions too rough for roosting. In these conditions the presence of vessels is often ignored, the birds not taking the opportunity to feed in the ship's wake. Should the wind increase above force 7 westerly, the number of sightings decreases, possibly because of poorer viewing conditions. In severe storms, small numbers of Little Gulls occasionally accompany larger numbers of Guillemots and other seabirds in a flight to windward, presumably in an attempt to avoid a lee shore.

Although westerly breezes seem to be optimal for seeing Little Gulls near Crosby Light Float, calm conditions also provide sightings. However, the birds tend to sit on the water in calm sea conditions and are easily overlooked from a ship. Occasionally, large flocks are seen resting on the water in calm conditions, but it is a matter of chance whether a ship passes close enough to detect them. Thus, on 25 September 1975, I observed an unusually compact flock of 75 near Crosby Light Float. If they had been 200 metres further inshore, they would not have been noticed. Flat calm conditions, and light easterly anticyclonic weather are undoubtedly the least favourable conditions for observing Little Gulls from ships, and this introduces an important bias which will be discussed later. Usually, Little Gulls react positively to the presence of a passing ship by flying towards it and past it, then turning round and dropping to feed in the ship's wake. They hover and fly with great agility above the surface of the turbulence, pecking at the surface, landing on the water and pecking sometimes with the head submerged, then taking to the air again, and eventually landing on the sea astern of the ship where the wash has died away. Here they seem to await the passing of the next ship. Large numbers of Common Gulls *Larus canus* feed in a similar manner.

Feeding behaviour is also influenced by the state of the tide. Little Gulls are seldom seen from ships during the high water period when tidal streams are weak. At this time they are at their roosts on the Alt or Seaforth Pools. However, when the tide is flowing or ebbing strongly, they are frequently seen hovering over turbulent water downstream of buoys, anchored ships, and dock walls. The turbulence as the flooding tide covers the stone revetment walls behind the buoy line in Crosby Channel is much favoured as a feeding site. They hover over this line of broken water, feeding in the way already described. I have rarely been able to establish what they are eating, once seeing an adult carrying a small fish sideways in its bill. A flock of twenty adults and fifteen juveniles feeding excitedly in a very

Figure 3. Little Gulls feeding in the turbulence downstream of a buoy. The flock shows a cyclical pattern, birds landing on the water are carried downstream and have to fly back to maintain their position. Despite their attempts to keep up with the tide, most are carried downstream eventually.

compact flock at the Bar on 22 September 1972, was apparently taking small fry.

A Little Gull which lands on the surface of the water is, of course, rapidly carried downstream from the source of turbulence. It then takes to the air and flies upstream to its feeding site. A flock feeding in a strong tideway shows a cyclical feeding pattern (see Figure 3).

However, there is a general tendency to follow a tidal stream, and from about three hours to high water on a spring tide small numbers of Little Gulls enter the Mersey. An individual bird is usually seen flying against the strongly flowing tide, but its net direction of movement is with the tidal stream, because each time it lands on the water it is carried along rapidly by the current. Further flying to seaward fails to make up the lost ground. By one hour to high water Little Gulls become scarce in the Mersey, having settled at their roosts outside the estuary. There is no evidence for a regular roost within the upper estuary, a flock which summered at Hale Point in 1973 being exceptional. As the tide ebbs, they leave their roosts and start feeding. They follow the ebb tide out into Liverpool Bay, so that by low water scattered birds can be seen feeding as far out as the Bar. Sometimes large flocks feed well out to seaward at low water. Thus, on 20 September 1975, a flock of 40 was seen feeding over the turbulence as the last of the ebb tide drained over the end of the revetment at Q4. In Ireland, Ruttledge (1974) described Little Gulls feeding in surf conditions during onshore storms.

COMPARISON WITH OTHER STUDIES

Figure 4 shows the percentage first year birds recorded each month, with data from Lassey and Greenhalgh (1969) and Smith (1974) also plotted. In general, the monthly distribution of records and the percentage of first year birds accord with their results. The greatest difference is in the size of the spring passage. Their observations from the land show a marked spring passage with two peaks, one in late February with a majority of adults, and the second in the third week of May consisting almost entirely of first year birds.

My data show little indication of this, and it is difficult to understand why the spring passage should not be visible in the shipping lanes, when the autumn passage is so conspicuous. Weather conditions may be responsible for the difference, because spring passage observed at the Alt estuary seems to be associated with calm, often misty, weather conditions with an east wind. Such conditions are the least favourable for observing Little Gulls from ships. Observers on land have counted much larger numbers of Little Gulls at roosts (max. 229, Smith 1974) than I have seen in Liverpool Bay (max. 91). This is probably because a shipborne observer will only pass through a proportion of the foraging area, whilst birds from the whole of Liverpool Bay gather at roosts.

DISCUSSION

Hutchinson and Neath (1978) postulate that the presence of Little Gulls in inshore areas like Liverpool Bay permits them to undergo their autumn moult in relatively sheltered

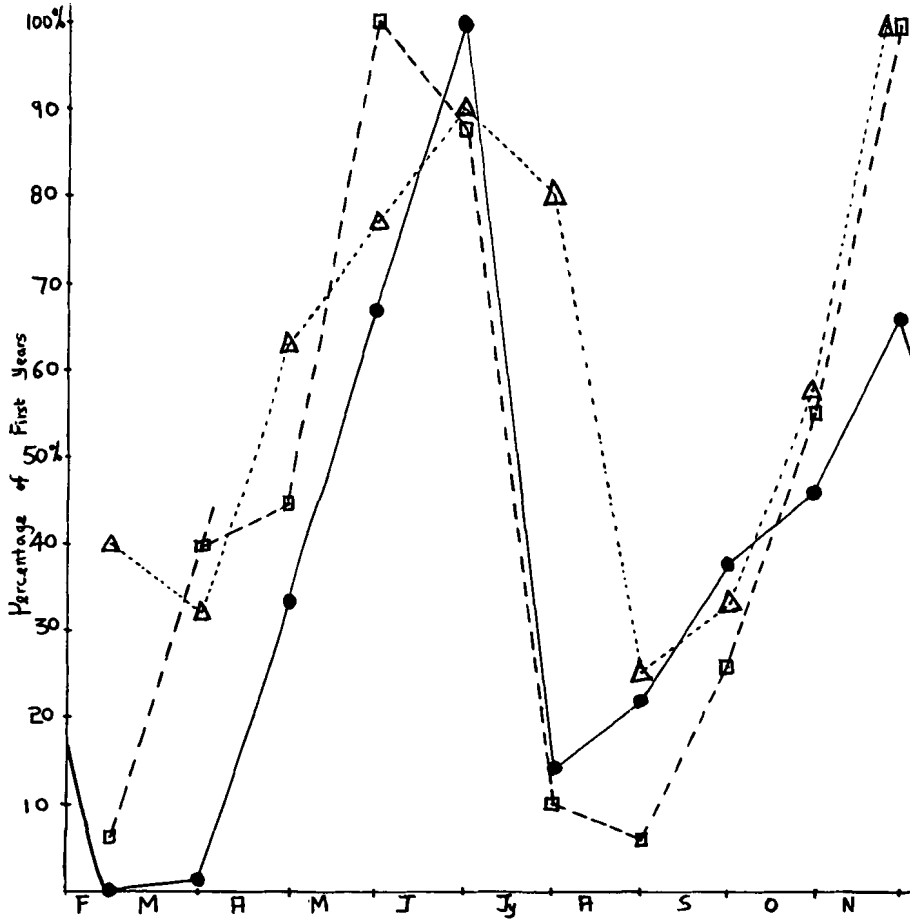

Figure 4. Percentages of first year Little Gulls per month from February to November. The results of the present study (solid circles) are compared to those of Smith (1974) (squares) and Lassey and Greenhalgh (1969). There is good agreement between the three sets of observations.

conditions. Whilst many adults in autumn can easily be seen to be in heavy wing moult, there are also a large proportion of first year birds in the autumn, and these birds do not appear to be using the area for primary moult. Possibly their presence in Liverpool Bay in spring and autumn is partly to provide a transitional period between a Little Gull's pelagic winter life and a fresh water breeding life, as Densley (1979) suggests takes place in Alaska for Ross's Gull and Sabine's Gull.

ACKNOWLEDGEMENTS

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SUMMARY

Sightings of Little Gulls at sea in Liverpool Bay, between 1963 and 1976 are discussed. An increase began in 1965, and continued throughout the period. The distribution of Little Gulls at sea is discussed in relation to tide and weather. Little Gulls feed in turbulent water and follow ships. This study is compared with land based studies of the species in the same area. The main difference is the relative absence of a spring passage at sea, in comparison with a heavy spring passage ashore.

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Origins, age and sex of auks (Alcidae) killed in the 'Amoco Cadiz' oiling incident in Brittany, March 1978

P. Hope Jones, J - Y. Monnat and M. P. Harris

INTRODUCTION

Many birds died following the release of oil into the sea from the wreck of the tanker *Amoco Cadiz* in Brittany, France, on 16 March 1978; early details of the incident were given in Jones *et al.* (1978) and a fuller documentation in Monnat (1978). Of the 4,907 casualties, 35.2% were Puffins *Fratercula arctica*, 18.7% were Razorbills *Alca torda* and 14.6% were Guillemots *Uria aalge*. Several hundred auks were brought in dead to a collection centre at Brest, practically all of them having been collected on beaches along the north and northwest coasts of Brittany. From this sample, many were examined to provide data on the age and sex composition of the kill, and to give a series of specimens and measurements which might prove useful in showing the origins of the affected populations.

This report is compiled from data collected from corpses at Brest by P. H. J. and J-Y. M., and from a series of wings and heads of Puffins examined subsequently by M. P. H. Copies of the raw data are held by the Société pour l'Etude et la Protection de la Nature en Bretagne at Brest, and by the Royal Society for the Protection of Birds at Sandy.

METHODS

Wing length was measured using maximum flattened chord (carpal joint to the tip of the longest primary), care being taken with Puffins to exclude from the analysis any wing with growing primaries. Bill length in Guillemot and Razorbill was measured as the straight distance between culmen tip and the proximal end of the bill sheath; gonys depth was also measured in these species.

Each bird was sexed by dissection, unless too decomposed, and gonad size was measured for some birds: length and breadth of testis in males, and the diameter of the largest egg follicle in each female's ovary.

Bill grooves were counted for Puffins, the number quoted being for grooves outside the diagonal ridge which is pale or white in summer and dark in winter. There were marked differences in the ages and states of moult in Puffins collected before and after 2 April, so these two samples have been kept separate in some analyses. Razorbills were merely divided into two classes: small-billed birds without a vertical white groove on the bill (usually considered to be in their first winter) and other birds *with* the white groove (presumed to be more than one year old).

There were no recoveries of French-ringed auks; details for British and Irish-ringed birds were obtained from the British Trust for Ornithology.

Totals vary from analysis to analysis because not all data could be collected on each specimen.

RESULTS OF CORPSE EXAMINATION

Guillemot

Composition of sexes and of plumage types in the sample is shown in Table 1, and measurements in Table 2.

TABLE 1. COMPOSITION OF SEX AND PLUMAGE TYPE FOR GUILLEMOTS KILLED IN THE AMOCO CADIZ OILING INCIDENT.

	males	*females*	*sex not determined*	*totals*
winter plumage	30	25	8	63
intermediate	3	8	0	11
summer plumage	3	3	1	7
(plumage not identified	28	24	13	65)
totals	64	60	22	146

TABLE 2. WING AND BILL MEASUREMENTS (MM) FOR GUILLEMOTS KILLED IN THE AMOCO CADIZ OILING INCIDENT.

	number in sample	*mean*	*standard error*	*range*	*P*
wing length					
males	64	195.9	0.63	187–208	
females	59	197.1	0.86	184–213	n.s.
bill length					
males	64	47.25	0.29	42–52	< 0.01
females	60	46.04	0.33	41–53	
bill depth at gonys					
males: summer plumage	3	13.83	0.13	13.7–14.1	
winter plumage	30	11.98	0.08	11.1–13.2	
females: summer plumage	2	12.95	0.15	12.8–13.1	
winter plumage	25	11.48	0.11	10.1–12.3	

The proportion of males and females was roughly equal in winter-plumaged (probably immature) birds, whereas in those with intermediate or summer plumage (probably older than first-winter), there were almost twice as many females as males, though the latter sample was very small. Bill depth is perhaps important as an ageing criterion: in this oiling incident, most summer-plumaged birds had deeper, though not necessarily longer, bills than birds of the same sex in winter plumage.

A random sample of 48 wings was taken from sexed Guillemots collected up to 6 April 1978, in order to determine the subspecies composition of the kill. These wings were washed in a solution of mild detergent to remove the oil, and were thoroughly dried before

TABLE 3. WING MEASUREMENTS (MM) FOR SUBSPECIES TYPE OF GUILLEMOTS KILLED IN THE AMOCO CADIZ OILING INCIDENT.

	BROWN (= albionis)			*INTERMEDIATE*			*BLACK (= aalge)*		
	n	*mean*	*range*	*n*	*mean*	*range*	*n*	*mean*	*range*
sample 1 (up to 6.4.78)									
males	16	194.1	188–201	7	202.3	193–208	2	205.0	204–206
females	13	192.4	180–205	7	196.3	191–205	3	203.7	198–210
sample 2 (after 6.4.78)									
males	9	196.7	187–206	4	196.0	193–202	3	203.3	200–207
females	18	193.6	183–201	9	201.7	196–206	4	206.5	198–216

examination. Males (25 specimens) and females (23) showed a gradual cline from brown dorsal colouring (*albionis* type) through to black (*aalge* type); division into groups was somewhat arbitrary because of the absence of obvious steps in the cline, but wings were assigned to three categories before measurement: brown, intermediate and black. Wing length was obviously related to colour category in both sexes (Table 3).

Only the five blackest wings were truly comparable with a long series of *aalge* wings collected in Orkney, 1976–78, and the intermediate colours are perhaps closer to darker *albionis* or to *albionis/aalge* integrades than to true *aalge*. Hence it was concluded that only five out of 48 (c. 10%) of the sample Guillemots were from populations of the *aalge* subspecies. About 15% of a second sample, of 47, collected after 6 April, were referable to *aalge*.

TABLE 4. GONAD MEASUREMENTS FROM SAMPLES OF GUILLEMOTS, DEAD-ON-ARRIVAL AND DEAD-IN-CAPTIVITY, AMOCO CADIZ OILING INCIDENT.

birds found dead early in the incident

males:	winter plumage	(9 birds)	testis length 8–12 mm; testis width c. 0.5–2 mm
	intermediate	(6 birds)	testis length 7–20 mm; testis width c. 1.5–2.5 mm
	summer plumage	(5 birds)	testis length 15–39 mm; testis width c. 4.5–14
females:	winter plumage	(13 birds)	egg follicle diameter c. 0.5–1.5 mm
	intermediate	(9 birds)	egg follicle diameter c. 0.5–3 mm
	summer plumage	(8 birds)	egg follicle diameter 1.5–4 mm

birds which died in captivity, late April to June

males:	winter plumage	(3 birds)	testis length 9–10 mm; testis width 1–2 mm
	intermediate	(5 birds)	testis length 7–14 mm; testis width 1–2 mm
	summer plumage	(1 bird)	testis length 11 mm; testis width 2.5 mm
females:	winter plumage	(5 birds)	egg follicle diameter 0.5 mm or less
	intermediate	(5 birds)	egg follicle diameter 0.5–1 mm
	summer plumage	(4 birds)	egg follicle diameter 1–2.5 mm

In both sexes, summer-plumaged birds showed the greater gonadal development. Gonads of birds which had been cleaned, but which had died in captivity through May and June, showed a similar range (of apparent inactivity) for birds in winter and intermediate plumages.

Razorbill

Among first-winter birds, the sexes were approximately equally represented, with 26 males and 21 females, whereas there were twice as many females (82) as males (40) among the older birds. The measurements indicate that all birds were of the form *A.t.islandica* (Table 5).

A few gonadal measurements were made. Five first-winter males had testis lengths of 5.5–8.5 mm, and two older birds of 8 and 8.5 mm; testis width was 1.5–2 mm in first winter birds but 2.5 and 3 mm in the older birds. Two first-winter females had their largest egg follicles of only 0.5 mm, whereas 16 older females showed follicles which ranged from 0.5 to 3.5 mm in diameter.

Puffin

The number of bill grooves—at least up to the two-groove stage—is related to age; Puffins with two or more grooves are mostly capable of breeding, the normal age of first

TABLE 5. WING AND BILL MEASUREMENTS (MM) FOR RAZORBILLS KILLED IN THE AMOCO CADIZ OILING INCIDENT.

	number in sample	*mean*	*standard error*	*range*	*p*
wing length					
males: 1st winter	26	190.8	0.71	185–198	< 0.001
older	40	198.0	0.80	183–209	
females: 1st winter	21	192.3	1.28	185–207	< 0.001
older	81	197.9	0.60	184–209	
bill length					
males: 1st winter	26	31.80	0.39	29–36	< 0.001
older	40	33.36	0.24	30–36	
females: 1st winter	20	30.87	0.35	28–35	< 0.001
older	80	32.71	0.19	29–37	
bill depth					
males: 1st winter	26	15.69	0.12	14.6–16.9	< 0.001
older	40	19.83	0.17	18.3–23.2	
females: 1st winter	21	15.43	0.17	13.8–16.8	< 0.001
older	81	19.20	0.13	16.6–21.7	

breeding being five years (Harris 1981). Of the 213 specimens collected before 2 April, 106 (50%) were adults old enough to be breeding, 79 (37%) were immature and 28 (13%) were intermediate. Only seven of these birds were in summer plumage. Of the 77 birds collected later, 49 (64%) were adult, 13 (17%) were immature, and 15 (19%) were intermediate; 20 were in breeding plumage. Thus between 53% and 68% would have been breeding birds. There were significantly ($P < 0.05$) more females (87) than males (50) among the adult and indeterminate aged birds which were sexed, but this bias was less evident among immatures where there were 15 females and 11 males.

The limited data on gonad size suggest that the testes enlarge well before the follicles develop. Males showed testes of 2.5–4 mm width (winter-plumaged) and 6–8.5 mm (summer); in females, diameter of largest follicle was 0.5–3 mm (winter-plumaged) and 2–3 mm (summer).

In total, 100 of 200 birds with two or more bill grooves were growing primaries (Table 6) and most would have been incapable of flight.

TABLE 6. STATE OF PRIMARY MOULT IN PUFFINS KILLED IN THE AMOCO CADIZ OILING INCIDENT.

numbers of	*males*		*females*		*all birds*	
bill grooves	*moulting*	*not*	*moulting*	*not*	*moulting*	*not*
23 March–1 April						
less than 1	0	2	0	5	0	33
1	0	2	1	1	1	13
1½	3	0	0	2	5	19
2	2	1	6	4	12	17
more than 2	4	3	13	9	55	47
2–20 April						
less than 1	0	6	0	1	0	8
1	0	1	0	0	0	1
1½	0	2	0	0	0	2
2	3	2	2	7	6	16
more than 2	6	8	18	11	27	20

In marked contrast, only six out of 76 immatures and none out of the 41 youngest birds (less than one bill groove) were in primary moult. This agrees with previous findings that adult Puffins moult just prior to breeding, immatures slightly later (Harris and Yule 1977). However, there was a marked difference between the two periods, in the primaries of birds which were not moulting. Before 2 April, at least 63 birds still had old primaries, whilst only two (males with 2 and 2½ bill grooves) had new primaries; both these birds had summer head and beak colours. The remaining wings were too oiled or damaged for the state of the primaries to be assessed. In contrast, after 1 April only ten of the 23 wings not growing primaries had old primaries, five were immatures, two were adults, and three were intermediate birds. All the 13 birds with new primaries were in summer plumage and had two or more bill grooves. The 19 days' difference between the mean dates of the two samples (24 March and 12 April) was time enough to effect the change between adults moulting or having old primaries to birds moulting or having new primaries.

In general the measurements (Table 7) agree with those of Puffins from the west coast of Britain, e.g. St Kilda, rather than those from the east, e.g. Isle of May. There were no birds typical of Icelandic or northern Scandinavian populations, but birds nesting in the Faroes and the southern tip of Norway are not separable from British birds.

TABLE 7. WING LENGTH (MM) OF PUFFINS KILLED IN THE AMOCO CADIZ OILING INCIDENT, COMPARED WITH MEASUREMENTS FROM ISLE OF MAY AND ST KILDA (HARRIS 1979).

numbers of bill grooves	AMOCO CADIZ			ISLE OF MAY			ST KILDA		
	number	*mean*	*standard error*	*number*	*mean*	*standard error*	*number*	*mean*	*standard error*
juvenile	12	147.3	1.10	0			0		
1*	27	153.9	0.99	75	155.5	0.48	7	154.3	1.23
1	14	156.6	1.13	105	156.4	0.39	12	154.5	1.23
1½	21	156.0	1.14	175	158.2	0.27	35	156.7	0.66
2	25	157.8	0.96	455	160.2	0.21	270	157.2	0.59
more than 2	75	156.0	0.49	1615	161.8	0.10	361	157.9	0.22

* excludes definite juveniles

RING RECOVERIES

Several ringed auks were recovered in this incident, and Figures 1 and 2 show the origins, and age at ringing, for Razorbills and Puffins. These recoveries agree well with the conclusions drawn from measurements. Additionally, three Guillemots had been ringed as chicks on Great Saltee (S.E. Ireland).

Puffins are not normally found washed up oiled on European beaches, so the high numbers in the *Amoco Cadiz* carnage were surprising. However, unusually large numbers of British-ringed Puffins were found on shores of W. France and Iberia in the winter/early spring of 1978 (Fig. 3). This mortality was possibly due to storms near those coasts, so that large numbers of Puffins, many of them debilitated, were off the Brittany coast in early April, thus falling victim in large numbers to *Amoco Cadiz* oil (Mead 1978).

CONCLUSIONS AND SUMMARY

1. Many hundreds of auks, killed in the *Amoco Cadiz* oiling incident on the Brittany coast in March/April 1978, were examined.
2. Of 81 Guillemots, 78% were still in winter plumage (very probably a sign of immaturity); males and females occurred in equal proportions. Amongst the remainder, there were almost twice as many females as males in the small sample; perhaps some older males had already left the area for breeding grounds.

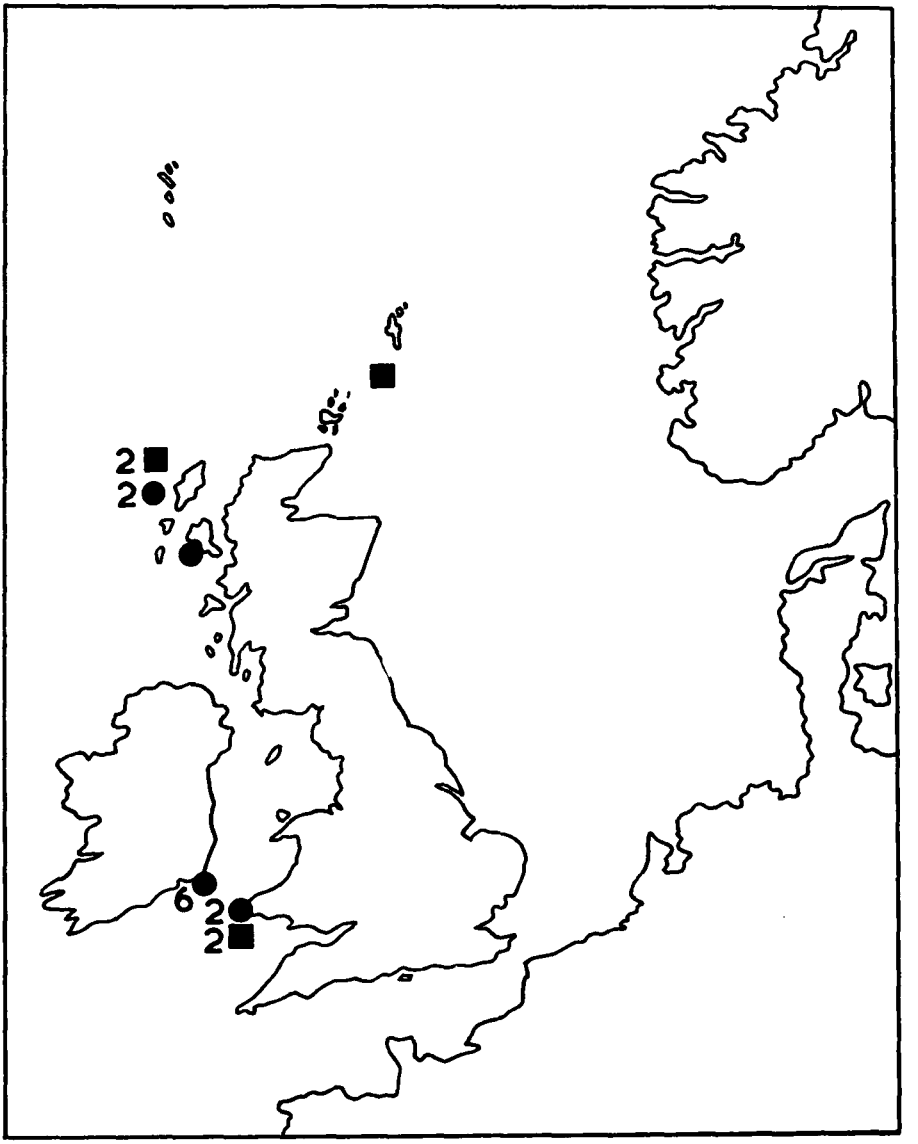

Figure 1. Ringing sites for Razorbills recovered in the Amoco Cadiz oiling incident. Circles = ringed as chicks; squares = ringed as full-grown. The figure gives the number of recoveries from a particular colony.

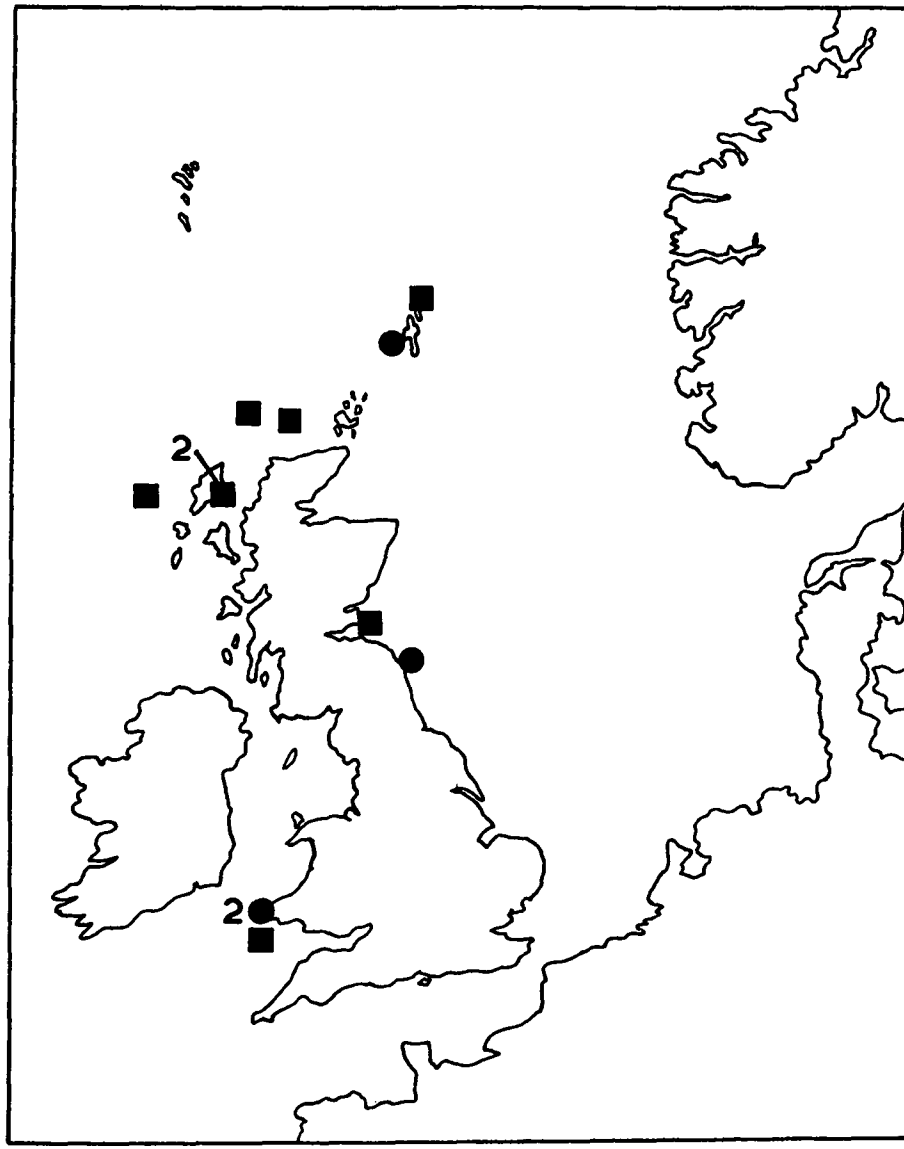

Figure 2. Ringing sites for Puffins recovered in the Amoco Cadiz oiling incident. Circles = ringed as chicks; squares = ringed as full-grown.

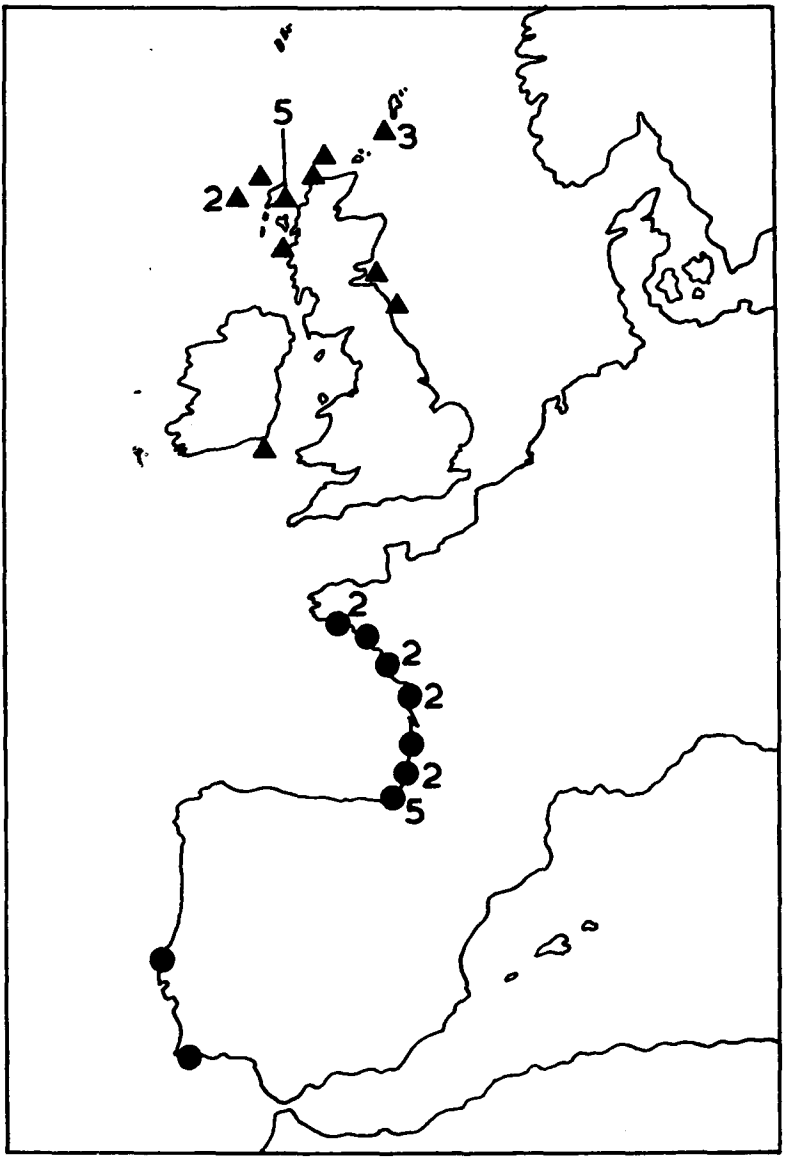

Figure 3. Ringing sites (triangles) of Puffins recovered at localities (circles) in the winter/early spring prior to the Amoco Cadiz oiling incident.

3. Male Guillemots had significantly larger bills than females, but the wing lengths were similar. Guillemots in summer plumage had deeper, though not necessarily longer, bills than birds of their own sex in winter plumage; males tended to have deeper bills than females but there was wide overlap.
4. Of 95 Guillemot wings examined, 13% were referable on colour to the northern form *U.a.aalge* and 59% to the southern form *albionis*. The remaining 28% were intermediate, though more likely belonging to southern than northern populations. Mean wing length was greatest for 12 *aalge* (mean 204.8, sd 5.24 range 198-216) and least for 56 *albionis* (mean 193.9, sd 5.82 range 180-206).
5. Measurements of a small sample of gonads showed that summer-plumaged Guillemots had more mature gonads in both sexes.
6. Of 225 Razorbills, 34% were immature (probably in their first winter by bill shape with males and females in about equal proportions. Amongst the remaining 66% (probably older birds) there were more than twice as many females as males. Again, perhaps older males had returned to the colonies.
7. Wing length, bill length and bill depth of mature and immature Razorbills were significantly different, but within each group there was little sexual difference. All birds appeared to be *A.t.islandica*.
8. Of 213 Puffin heads examined, 32% were immature, 53% adults old enough to breed, and 15% intermediate. Of 92 birds sexed, 38% were males, 62% females; males may have moulted before the females and then left the area.
9. Many of the adult Puffins were moulting their primaries, immatures were not.
10. Wing measurements suggested that most Puffins came from the French and southern and western British populations of *F.a.grabae*. Many breeding birds are back at North Sea colonies by mid-February, so they would not have been at risk even if they had wintered in the area. There is no evidence that the larger birds from more northerly populations winter in this area.
11. Taxonomic evidence and ringing recoveries were helpful in pointing to the origins, and probable breeding areas, of the populations involved. Such examinations of large numbers of dead birds should be carried out at all oiling incidents as a matter of routine.

ACKNOWLEDGEMENTS

The RSPB paid for PHJ's visit to Brittany. Helpful comments on early drafts of this report were made by Dr C. J. Cadbury and by J. L. F. Parslow and T. J. Stowe. We are also grateful to those people who combed the Brittany beaches to retrieve the corpses used in this analysis.

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OBITUARY

GEORGE WATERSTON, O.B.E., LL.D., F.R.S.E.
(10 April 1911–20 September 1980)

On 20th September 1980, the ornithological world lost one of its most ardent and distinguished members. George Waterston died in hospital after a long fight against failing health. One of the great founders of modern Scottish ornithology, George strove tirelessly for the Scottish Ornithologists' Club first as founder Secretary (1936–1972), then as President (1972–5) and finally as Honorary President until his death. During this period he also held the post of Scottish representative of the Royal Society for the Protection of Birds until 1959 when he became Director for Scotland, a post he held until 1972 when his health forced him to retire.

George was born in Edinburgh, educated at Edinburgh Academy where he helped to form the Inverleith Field Club at the age of eighteen, and four years later, the Midlothian Ornithological Club. With the discovery by Misses E. V. Baxter and L. J. Rintoul of the Isle of May as an important staging post for migrating birds, the Midlothian Ornithological Club was asked to become involved and included amongst its first members to visit the island was George in 1932. These were the very earliest days of the bird observatory in Britain jointly manned by a band of enthusiasts.

Three years later, George visited Fair Isle and very quickly vowed to establish a bird observatory there similar to the one now established on the Isle of May. The war intervened with this ambition and George was sent to Crete in 1941 as a lieutenant in the Royal Artillary. When the German forces captured Crete, he remained in hiding with little food or water until he was taken prisoner. The spell in the prison camp had two most significant influences on the rest of his life. Together with George in the camp was a number of other enthusiastic ornithologists. These included Peter Conder who with George devoted so much time and energy to the conservation and bird protection movement, the former becoming overall Director of RSPB and the latter Director of RSPB for Scotland; Nigel Buxton who spent his prison days writing the New Naturalist book 'The Redstart'; and Ian Pitman with whom George planned the Fair Isle bird observatory. It is also remarkable to think that over this period George was corresponding with Professor Erwin Stresemann and providing him with all his Crete bird notes which were to be used in Stresemann's important paper on the birds of Crete. The second great influence upon George's future life was unfortunately a negative one for here he developed the renal troubles which so dominated his later life.

With his illness, George was repatriated and after hospital treatment he joined James Fisher to help him with the Rook survey, organised by the Agricultural Research Council. After this he returned to his family business of printers and stationers and from here set up the headquarters of the SOC. Then with Fair Isle coming on the market in 1948, George with the help of Ian Pitman promptly bought it and was laird of Fair Isle before handing over the ownership to the National Trust for Scotland. George was appointed Secretary of the Fair Isle Bird Observatory Trust and remained so until his death. The fact that Fair Isle has a most healthy and energetic community (when many other small isles have become depopulated) owes much to George.

George moved into full-time ornithological employment when the SOC were able to pay him a salary as their Secretary. Although this work was first carried out from a room at the National Trust for Scotland, in 1959 he realised his dream of forming a Scottish

ornithological centre at 21 Regent Terrace housing the SOC, RSPB and FIBOT. During the next decade George devoted his energies to bird protection and conservation and with Philip Brown he was involved with the tireless nurturing of the Ospreys at Loch Garten and elsewhere, that was responsible for the species re-establishing itself in Scotland besides doing more good for the cause of the RSPB than any other single venture. Later, attention was turned to doing the same for Snowy Owls in Shetland, a project which is yet to show final success.

In 1958 George married Irene Kinnear after his first marriage had broken up, and the two of them worked together for Scottish ornithology for the next 22 years until his death. During the sixties and early seventies, both George and Irene made several expeditions to Greenland and the Canadian Arctic, George surveying the birds (particularly seabirds) and Irene making important plant collections. In 1936 George had made his first visit to the arctic, to Lapland, straying across the Russian border where he was arrested and detained for a period. As with everything, George's interest in the arctic became a passion. He built up an impressive collection of Arctic literature, and besides their scientific expeditions, Irene and he took Lindblad Explorer tours to Baffin Bay, Spitzbergen and Arctic Norway. He was President of the Arctic Club and Irene its first woman member.

By now renal failure forced George to have a kidney transplant and when this unfortunately failed, he was tied to a home kidney machine. Throughout his last few years, George continued to strive tirelessly in all his interests, despite the exhaustion and traumas induced by dialysis on the machine twice a week. He discussed possibilities of visiting his beloved Fair Isle and even contemplated the arctic. Although the latter proved impossible, George flew to Fair Isle complete with portable kidney machine in each of his last two years and indeed was present at the opening of the new hall on Fair Isle two months before his death.

For his devotion to British ornithology and conservation, George was awarded the O.B.E. in 1964 and ten years later the University of Dundee conferred upon him the honorary degree of LL.D. During his life he wrote numerous papers on birds, including a number on seabirds, notably the important paper on the status and distribution of the Fulmar with James Fisher.

Regrettably I was too young to know George until the latter years of his life, but over this period he devoted much time to helping me with my ornithological interests and expeditions to the arctic, latterly encouraging me with my studies on Fair Isle. I am sure that there are many like me who owe him so much for his enthusiasm and kind help. It was very characteristic of George that despite being so very busy, he would give up his time for one, and whenever one passed through Edinburgh, he and Irene would provide generous hospitality at their attractive cottage in Humbie. Like most truly great men, George was a very humble self-effacing person whose energies were directed in a completely selfless manner. I am sure that all who knew him share with me in expressing grief for his loss and extend our deepest sympathies to his family and to Irene who has devoted so much of her own life to him.

P. G. H. EVANS

THE SEABIRD GROUP

The Seabird Group was founded in 1966 to circulate news of work in progress on seabirds and to promote co-operative research on them. It is run by an Executive Committee composed of nine elected members and maintains close links with the three major British national ornithological bodies—the British Ornithologists' Union, the British Trust for Ornithology and the Royal Society for the Protection of Birds. Membership is open to all with an interest in seabirds for details of subscription please contact the Chairman, C. J. Mead. Payment by banker's order and deed of covenant helps the group.

Newsletter. Three duplicated newsletters are circulated each year to members. They contain all sorts of news including reports on research projects (particularly those with a grant input from the group—see below), details of meetings etc. The usual venue for the group's annual meeting is at the BTO Ringing and Migration Conference but, in 1982, the group will be running its own conference at Denstone College, Uttoxeter from 12th to 14th February.

Work at breeding stations. These started with the national survey, Operation Seafarer whose results were published in 1974—*The Seabirds of Britain and Ireland* by Stanley Cramp, W. R. P. Bourne and David Saunders (Collins, London—still in print try your usual bookseller or write to RSPB or SOC sales departments). The Group now co-operates with the R.S.P.B. and N.C.C. in organising sample censuses of birds at representative sites. During 1981 the Group ran a survey of bridling amongst Guillemots—for details contact Tim Birkhead (address below).

Birds at sea. The N.C.C. project based in Aberdeen has introduced standard recordings forms for observers at sea. All members (and even non-members) are encouraged to fill these forms in for any journey they may make at sea. Month long cruises in research vessels are NOT the only useful source of information and the team would dearly like to have a log (ON THE STANDARD FORMS) of your observations next time you take a ferry to the Isle of Man, Calais, Cherbourg or anywhere from Britain or Ireland). Write to Peter Hope Jones for the forms.

Bird mortality on beaches. The Group has long been associated with the Beached Bird Survey organised from the R.S.P.B. HQ. Many beaches are covered regularly but there are some areas where more help is needed. Contact Tim Stowe for information. In recent incidents it has become increasingly obvious that adequate cold-storage facilities for the bodies of birds involved in major mortality incidents would eventually enable much more information to be gathered about the incidents. Peter Morgan has been to the fore in organising such facilities and he is desperate to have as many known age specimens of seabirds as possible. Please contact him if you recover a ringed seabird and have been able to salvage the corpse.

Seabird Group Grants. Each year the Group has some money available to grant aid research work being carried on by members. All applications for grants should be submitted by the end of February each year and all will be considered by the Executive Committee. Certain areas of research may be favoured particularly and details of these will appear from time to time in the Newsletter. Grant applications should be submitted to the Secretary or Chairman.

Seabird Report. At irregular intervals the Group has published a printed report. This is sent to all members. Contact Peter Evans or Tim Birkhead, the joint editors if you have any contributions. Copies of some earlier reports are available at £1 each from Chris Mead—two are now out of print and it is 1969 (blue cover), 1970 (green cover) and 1975-6 (grey cover) which are available. Unless there is an increased flow of contributions to the Seabird Report, it is proposed to enlarge the size of the newsletter to incorporate short referred papers. This means that the Seabird Report would cease to exist in its present form.

Postage & Ireland. Two points about money. Please help the Group to keep its costs down by enclosing S.A.E. or at least stamps if you write and want a reply. If you do not then do not expect a reply to routine things like renewal of subscription or becoming a new member— your reply will be the next Newsletter when it comes out. Also if you come from Ireland please send English money as changing small amounts of Irish money is not at all worthwhile.

Who to write to. General queries about the Group and its activities. Requests for membership for advice etc. The Secretary: Dr T. R. Birkhead, Zoology Department, The University, Sheffield S10 2TN.

Subscriptions, money etc. The Treasurer: E. D. Ponting, c/o B.T.O., Beech Grove, Tring, Herts HP23 5NR.

This address also works for the Chairman—Chris Mead.

Seabird Report. Offers of papers to Dr. P. G. H. Evans, EGI, Zoology Dept., S. Parks Road, Oxford OX1 3PS or to Dr. T. R. Birkhead (address above).

Newsletter content. Offers of articles (even the articles themselves) to the Newsletter Editor: Dr. R. W. Furness, Zoology Department, Glasgow University, Glasgow G12 8QQ.

Birds at Sea forms, registering Seawatches (land or sea): Peter Hope Jones, N.C.C., 17 Rubislaw Terrace, Aberdeen AB1 1XE.

Newsletter distribution (problems with addresses) and Beached Bird Survey: Tim Stowe, R.S.P.B., The Lodge, Sandy, Bedfordshire SG19 2DL.

Auk corpses of known age (or other seabird species of known age): Peter Morgan, Zoology Department, National Museum of Wales, Cathays Park, Cardiff CF1 3NP.