SEABIRD 10

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CONTENTS

Patterns of return to land in a colony of Cory's Shearwater *Calonectris diomedea* on Selvagem Grande

Keith Hamer and Helen Read

INTRODUCTION

Selvagem Grande, the largest island in the Salvage group, lies 290km south of Madeira and 175km north of Tenerife, at 30° 09'N, 15° 52'W. It is a volcanic island of 160 hectares, consisting of alternating layers of volcanic ash, tufa and basalt. These form a plateau surrounded by steep cliffs about 80 metres high. The island is the major breeding site for the East Atlantic race of Cory's Shearwater *Calonectris diomedea borealis*. The breeding season on Selvagem Grande lasts from May until October (Den Hartog *et al.* 1984). The shearwaters nest colonially in a wide range of sites, the most commonly used being caves and smaller crevices on the sides of cliffs.

Until 1967 people were important predators of Cory's Shearwater on Selvagem Grande, culling in excess of 20,000 young along with a smaller number of adults each year (Zino 1985). After 1967, attempts were made to prevent culling. Despite this, huge numbers of young and adults were killed in 1975 and 1976. The island is now protected by wardens, but the population of Cory's Shearwater has been greatly reduced below its previous level, which was probably in excess of 400,000 birds (Den Hartog *et al.* 1984).

In 1984 we visited Selvagem Grande between 7 and 30 August. The chicks were then at the age when flight feathers were beginning to erupt (about 10 weeks). At this stage in the season the adults spend the day at sea and return during the evening to feed the chicks (Cramp and Simmons 1977). They usually return after dark (Lockley 1952; Bannerman 1963; Bannerman and Bannerman 1965), but on Selvagem Grande most adults return before nightfall.

The numbers and behaviour of birds returning to land vary markedly from day to day. In general, they return from feeding at sea in the late afternoon, and form several 'rafts' of up to 2,000 birds about 1,000 metres offshore (Den Hartog *et al.* 1984). After about two hours the rafts start to break up, and birds appear over the island. They circle and swoop around their nests several times before landing. Previous authors (Jouanin & Roux 1966; Mougin & Stahl 1982; Hartog *et al.* 1984) have emphasised the variability in the timing of returns to land. This paper is an investigation into the timing of these returns; in particular, it deals with the return times of breeding versus non-breeding birds, the consistency in the return times of breeding versus non-breeding birds and the relationship between nest spacing and time of return to nests by breeding birds.

METHODS

On 26 August 1984, 85 nests from an area of cliff approximately 2500 metres square were individually numbered using masking tape. The cliff was above Enseada das Cagarras, in the south of the island. Chick weights and tarsal lengths were recorded at 51 nests, along with the distance from each nest to its nearest three neighbours. In the case of nests in caves, this was measured as the distance from the cave entrance, which meant that nests in the same cave were effectively not separated.
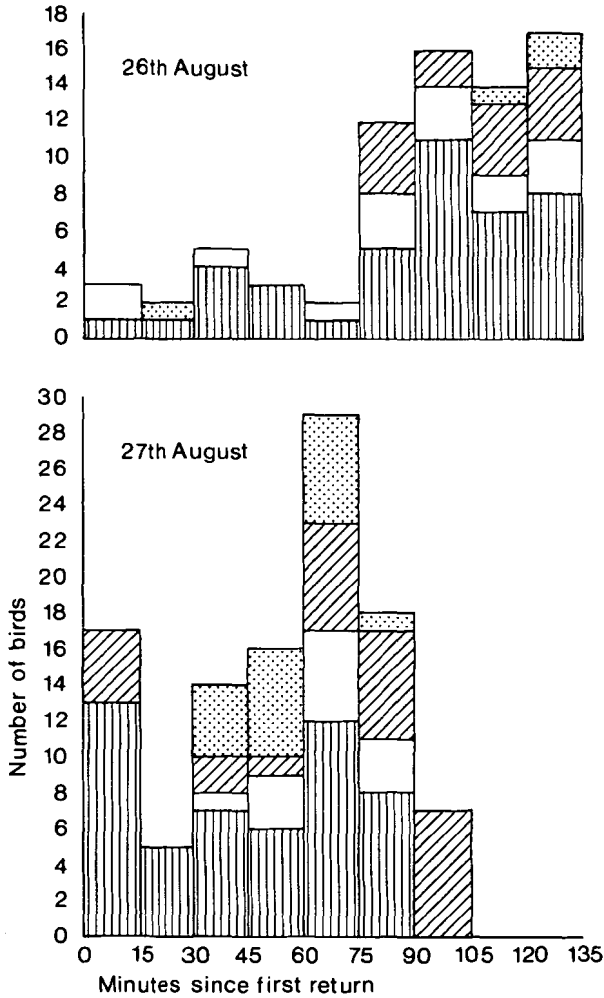
Figure 1. Frequency distribution of return times for four categories of Cory's Shearwater on Selvagem Grande, for each day between 26 and 29 August 1984. Return times were measured relative to the first return each day.

Category 1: first adults returning to nests.

Category 2: non-breeding birds returning to clefts or caves.

Category 3: non-breeding birds returning to paths or ledges.

Category 4: second adults returning to nests.

28th August

29th August

Number of birds

Minutes since first return
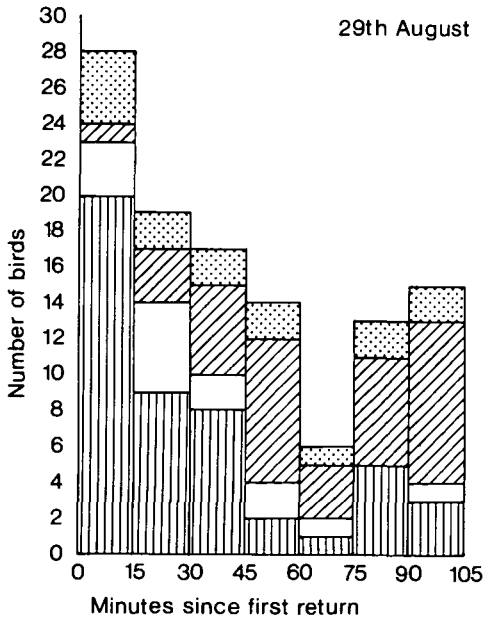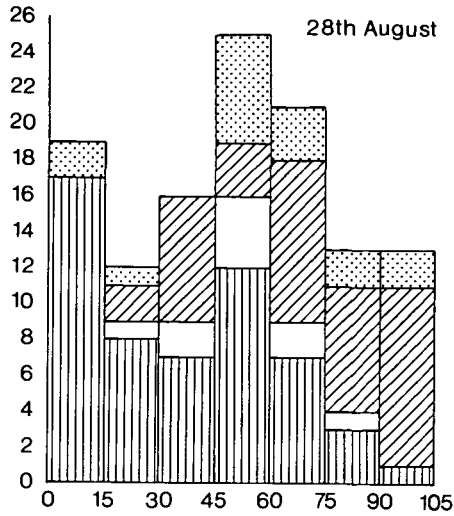
On the evening of 26 August, the area enclosing the marked nests was roughly bisected. On each side a route was marked out between the nests. A total of 71 from the 85 marked were encompassed by the two routes. On this and the three subsequent evenings (26 to 29 August) two workers each completed one circuit on their half of the area every 15 minutes. Recording started when the first birds were seen circling over the cliff, and lasted until approximately one hour after sunset. All the birds which returned during each circuit were noted visually, along with the nest number for marked nests. These returns were placed in one of four categories: category 1, the first parent to return to a nest; category 2, non-breeding birds returning to clefts or caves with no chicks present; category 3, non-breeding birds returning to paths or ledges, where there was little or no shelter; category 4, the second parent to return to a nest (scored only if both parents were present).

On two occasions, birds which had landed at nests flew off at our approach, but both these nests were occupied by an adult on the next circuit. Our presence had no other obvious effect upon the timing of returns. As has been noted previously (Lockley 1952; Den Hartog *et al.* 1984), birds did not move around once they had landed, and breeding birds were very reluctant to move away from their nests. We assumed that birds which did not approach nests were not breeding. It is unlikely that adults remained on the site all day, or returned before recording started, since tours of the study area on the afternoons of the 26 and 29 August failed to reveal any adults present, and we saw no birds flying around the cliff before late afternoon. The two routes were chosen to run between nests, but sites used by non-breeders were evenly scattered among them.

For each night, a table of ranked return times for all four categories was produced, with all the birds returning during a 15 minute period given the same rank. This allowed comparisons to be made between nights, despite differences in first and mean return times. Nests which were not seen to be visited by an adult on a particular night were not given a rank.

Initially, in comparing data sets ranked return times for the four nights were treated separately. This was seen as preferable to using mean ranks over the four nights, since it used more of the data. Nonparametric tests were used, since the data were in the form of ranks (Siegel 1956). Ranked return times to different categories of site were compared using Mann-Whitney U tests. Consistency of ranked return times to each nest over the four nights was tested using a Kruskal Wallace one-way analysis of variance, where a significant probability would indicate that at least one nest had a median rank different from the others. A significant difference would be very unlikely unless a sufficient proportion of nests received consistent ranked return times. The relationship between nest spacing and ranked return time was investigated using Spearman rank correlations. For these and the Mann-Whitney U tests, the probabilities for the four nights were converted to single values by Fisher's combined probability test (Sokal & Rohlf 1969). This gave the probability of obtaining each set of probability values by chance.

RESULTS

Data for the two routes were combined, since their return times did not differ significantly (Table 1). The proportions of nests with returns recorded each night from 26 to 29 August were 58%, 61%, 69% and 62% respectively. These figures are unlikely to represent all returns during a night. However, the error is probably small, since there was a marked decline in activity after dusk, and few Cory's Shearwaters were seen flying or heard calling from the air beyond the first hour after sunset. Moreover, none were caught beyond this period in mist nets placed above the cliff. The proportions of nests visited by adult birds on one, two, three and four occasions were 28%, 18%, 29% and 24% respectively. 28% of chicks spent two nights in succession without being visited during this period, but only one

TABLE 1. MANN-WHITNEY U TESTS BETWEEN RANKED RETURN TIMES TO DIFFERENT CATEGORIES OF SITE

		Categories tested				
		Route 1 vs Route 2	Cat 2 + 3 vs Cat 1	Cat 2 + 3 vs Cat 1 + 4	Cat 3 vs Cat 2	Cat 2 vs Cat 1 + 4
	N	74	70	74	28	59
26 Aug	Z	−0.316	0.970	0.753	0.637	0.112
	P	0.752	0.332	0.444	0.524	0.911
	N	108	87	108	37	82
27 Aug	Z	0.000	3.565	3.636	1.425	2.242
	P	1.000	0.004×10^{-1}	0.003×10^{-1}	0.154	0.025
	N	119	84	119	47	84
28 Aug	Z	0.148	4.049	4.401	2.514	1.466
	P	0.883	0.001×10^{-1}	0.000	0.012	0.143
	N	112	83	112	49	82
29 Aug	Z	1.579	3.304	3.707	4.025	0.587
	P	0.114	0.001	0.002×10^{-1}	0.001×10^{-1}	0.557
Fisher's	χ^2	5.156	60.238	53.302	37.844	12.627
Combined Probability	P	0.742	0.001×10^{-3}	0.002×10^{-3}	0.001×10^{-1}	0.126

All tests were corrected for tied ranks; all probabilities (P) are two-tailed; a positive value for Z indicates higher ranks, and therefore later returns, for the first of each two categories tested; N = sample size. Cat. 1 = first parent to a nest; Cat. 2 = non-breeder to cleft or cave; Cat. 3 = non-breeder to path or ledge; Cat. 4 = second parent to a nest.

chick (1.4%) spent three nights alone in succession. 61% of the returns recorded over the four days were breeding birds. Of these, 21% were returning to nests which already had an adult present.

Figure 1 shows the pattern of returns for each category of bird in each 15 minute interval on each day. Breeding birds (category 1) return significantly earlier than non-breeders (categories 2 and 3) (Table 1). This remains true even if the second adults to return to nests (category 4) are added to the breeding birds (Table 1).

Over the period of study there was some consistency in the ranked return times to individual nests. A Kruskal Wallace one-way analysis of variance was significant (H = 102.01, n = 178 (71 nests times 4 nights minus missing values), P = 0.006). When the test was repeated using only those ten nests with returns recorded on all four nights, there was still consistency in this respect (H = 19.46, n = 40, P = 0.021).

It does not appear that birds return earlier to more closely spaced nests. Spearman rank correlations using ranked return times of first adults to individual nests with various measures of nest spacing (distance to first and third nearest neighbour, plus mean distance to the nearest three neighbours) did not produce any significant relationships when the probabilities for each day were combined (Table 2). However, the closer two nests are, the more similar are the return times to them when both nests are visited by adults. Spearman's correlations between differences in ranked return times of neighbours (first, second or third nearest)

TABLE 2. SPEARMAN RANK CORRELATIONS TO INVESTIGATE THE RELATIONSHIP BETWEEN RETURN TIME OF BREEDING BIRDS TO NESTS AND NEST SPACING

		Data Tested for Correlation				
		Rank vs mean dist.	Rank vs dist. (1)	Rank vs dist. (3)	Diff. vs distance	Rank vs chick tarsus length
	N	21	21	20	20	25
26 Aug	R	−0.035	−0.656	0.409	0.606	−0.007
	P	0.882	0.002	0.074	0.005	0.972
	N	27	29	26	36	37
27 Aug	R	0.024	−0.016	0.191	0.605	0.033
	P	0.908	0.934	0.350	0.001	0.848
	N	33	32	32	45	41
28 Aug	R	0.049	0.284	0.041	0.125	−0.149
	P	0.786	0.115	0.823	0.416	0.352
	N	26	24	25	30	39
29 Aug	R	0.193	0.199	0.142	0.071	0.200
	P	0.345	0.351	0.500	0.710	0.233
Fisher's	X^2	8.119	10.429	9.082	26.851	8.121
Combined Probability	P	0.846	0.474	0.336	0.001	0.846

All tests were corrected for tied ranks; all probabilities (P) are two-tailed; R = Spearman correlation coefficient; N = sample size. Rank = ranked return times; Diff = differences in ranked return times; Mean dist. = mean distances to nearest three neighbours; Dist. (1) = distances to first nearest neighbours; Dist. (3) = distances to third nearest neighbours.

when both returned, and their distances apart showed a significant relationship when the probabilities for each day were combined (Table 2; this combined probability is the probability that the patterns observed on 26 and 27 August occured by chance). This is not to say that neighbouring nests were always visited on the same nights. Over the four days, 65% of nests (200 from 308) were visited on the same nights as one of their nearest three neighbours.

Jones (1986) found a positive relationship between colony density and chick size in Cory's Shearwater. To test for the possibility that ranked return time is a function of chick size (and perhaps age), a Spearman's correlation was performed between ranked return time and chick tarsal length (Table 2). Return time was not correlated with chick size.

DISCUSSION

We have demonstrated relationships between birds in the timing of their daily returns to the colony. This is an aspect of the behaviour of colonial birds which has received very little attention, and there are important implications for their social interactions in the fact that birds appear to be taking account of each other in deciding when, but not whether, to return to land. It would be interesting to see whether these patterns change through the breeding season.

Before returning to the colony each evening, Cory's Shearwater congregate in offshore 'rafts'. Breeding birds return earlier from these rafts each evening than non-breeders (Table 1), and a significant proportion of individuals show some consistency in their ranked return times (see results). Among breeding birds, there is a correlation between the distance apart of nests and the difference in ranked return times to them when both nests are visited by adults (Table 2).

Nelson (1980) suggests that mature seabirds are probably better at finding and catching food than immature birds. However, this is unlikely to be the cause of their earlier returns. Breeding birds need to gather enough food to feed a chick as well as themselves. Moreover, any differences in the time spent feeding and travelling between feeding sites are likely to be masked by the formation of offshore 'rafts'. 64% of non-breeders that landed did so on exposed sites, significantly later than the 36% which landed on sheltered sites (Table 1). Whether a site is sheltered or exposed may be more important to ranked return times than whether a bird which lands there is breeding or not. In this case, the fact that only non-breeding birds returned to exposed sites may be the reason for their returning later overall than breeding birds. On the other hand, non-breeding birds may prefer unoccupied sheltered sites to exposed ones, so that these sheltered sites become filled by non-breeders which return early. However, this might be expected to lead to a pressure upon non-breeders to advance their return times, and hence to earlier return times for non-breeders than for breeding birds, whereas the opposite was found (Table 1). Moreover, there was not a significant difference between the return times of non-breeders landing at sheltered sites and of breeding birds (Table 1).

Common Guillemots *Uria aalge* and Black-headed Gulls *Larus ridibundus* benefit from breeding in dense colonies by an increased awareness of predators and an ability to act in concert against them (Birkhead 1977; Kruuk 1964). The birds nesting at Enseada das Cagarras were all in crevices and caves, with very restricted fields of view covering different aspects of the cliff. In this situation, there may be an advantage to each bird in terms of predator detection in having nests of conspecifics in close proximity. Such advantage will only accrue when neighbouring adults are present on their nests, and a bird on its nest without other adults near it may be more vulnerable to a surprise attack. In this case, a bird may benefit from minimising the time it spends on its nest in the absence of neighbouring adults. This may be particularly important to birds which have recently returned, since their awareness of predators is likely to be low while they are attending to a solicitous chick. Birds do not necessarily return to nests on the same nights as their neighbours, but in any locality a sufficient number are likely to return each night. In fact, a similar proportion of nests were visited by birds on each night of the study.

The population of Cory's Shearwater on Selvagem Grande has been greatly affected by human predation. Before 1967 hunting expeditions killed thousands of young each year for well over a century (Zino 1985). In addition to this, an unknown number of adults were killed each year by fishermen from Madeira and the Canary Islands (Baring & Ogilvie-Grant 1895; Zino 1985). After the advent of motorized fishing boats, increasing numbers of adults were taken each year, culminating in the slaughters of 1975 and 1976 (Zino 1985). Since Cory's Shearwaters do not normally breed until they are seven years old (Jouanin *et al.* 1980) most of the breeding birds in this population are likely to have been survivors from the final cull in 1976. Nevertheless, there are no longer any apparent predators of hatched Cory's Shearwaters on Selvagem Grande, and it is difficult to see how these patterns of return could have been produced solely by predation. There is likely to be an element of social advantage involved, although its nature is as yet unknown.

A significant proportion of birds showed some consistency in their ranked return times from night to night. This may facilitate synchronization of return times between birds and their neighbours, or it may simply reflect differences in foraging ability. The latter is unlikely, since birds spent a number of hours offshore prior to their returns. The circling and swooping around the nests observed by previous authors (Lockley 1952; Den Hartog *et al.* 1984) may be used by breeding birds to assess which of their neighbours have returned. This might explain the observations we made on a number of occasions of birds, which probably included breeders, circling around the cliff several times then heading back out to sea. Calling, both aerial and from the ground, may serve a similar function, although in Manx Shearwaters *Puffinus puffinus* the majority of calling is performed by immature birds (James 1985).

ACKNOWLEDGEMENTS

SUMMARY

On 26 August 1984, 85 nests of Cory's Shearwater on Selvagem Grande were individually numbered, and the distance from each nest to its nearest three neighbours measured. Each evening from the 26 to 29 August, the ranked return times of adults to 71 of these nests were noted, along with the ranks of non-breeding birds. Over this period, breeding birds returned significantly earlier than non-breeders, and a significant proportion of them showed some consistency in their ranked return times. A correlation was found between difference in ranked return time and distance apart of nests. This may be an adaptation to reduce the time each adult spends on the nest in the absence of nearby conspecifics.

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The changing status of Little Gulls *Larus minutus* in north Merseyside, England

Philip H. Smith

INTRODUCTION

During the first half of this century, the Little Gull *Larus minutus* was uncommon in Merseyside. Hardy (1941) describes it as a "regular autumn/winter visitor . . . . . but scarcer in spring", though he gives only twelve autumn/winter and three spring records in the Northwest of England and North Wales. Oakes (1953) refers to only sixteen observations in the old County of Lancashire, which then included north Merseyside. Similarly, between 1954 and 1964, an average of only three individuals a year was seen in Lancashire (Spencer 1973). By the mid-1960s, however, Little Gull numbers began to increase, following a trend noted elsewhere in Britain and Ireland (Hutchinson & Neath 1978). The early part of this change was reviewed by Eades (1982) and by Lassey & Greenhalgh (1969), while Smith (1974) analysed records for the area from 1969 to 1974.

By 1973, north Merseyside was recognised as one of the three most important areas in Britain and Ireland for this species, most birds being seen in the vicinity of the Alt Estuary and at Seaforth Docks (Hutchinson & Neath 1978).

Over the past decade, large flocks of Little Gulls have continued to appear on the north Merseyside coast but the pattern of numbers appears to have changed towards an emphasis on spring passage. This paper describes the current status of the species and presents new information based on an analysis of data collected between 1975 and 1984.

METHODS

From January 1975 to December 1984, frequent visits were made, mainly at weekends, to many coastal localities between Crossens on the south shore of the Ribble Estuary and Seaforth at the mouth of the Mersey Estuary (Figure 1). I did not search specifically for Little Gulls, but the species was recorded when observed. Regular visits throughout all seasons reduced any possible bias towards periods when Little Gulls are particularly numerous.

Second-year Little Gulls can usually be distinguished from adults when in flight but are difficult to separate at roosts. For this reason, these groups were pooled and compared with the easily identified first-years (including birds in juvenile, first-winter and first-summer plumages) for analysis of age composition.

RESULTS

Distribution and roosting behaviour

Little Gulls were most often seen in flocks at three high-tide roosts of gulls, terns and waders, 49% of individuals being counted at Formby Channel, 43% at Seaforth and 5% at Formby Bank on the Alt Estuary. Much smaller numbers were recorded elsewhere; 1% of birds were counted during sea-watches from Formby Point, 1% at a flooded sand-dune slack at Cabin Hill, Formby and 0.1% on reclaimed salt-marsh at Crossens (Fig. 1).

Thus almost all the Little Gulls were confined to a 9 km stretch of coastline between Seaforth and Formby. This highly restricted distribution agrees with Eades' (1982) observations from ships between Point Lynas in Anglesey and Eastham/Garston Docks on the
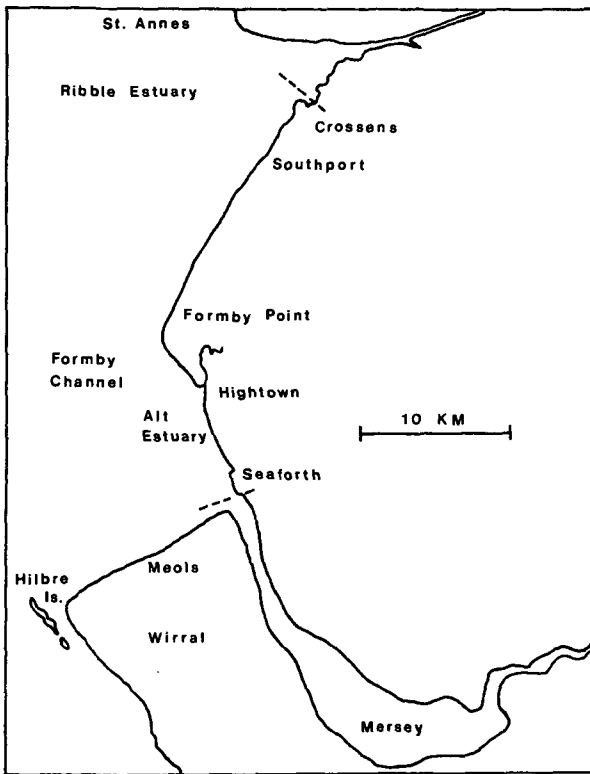
Figure 1. Sketch map of north-west England showing locations mentioned in the text. Hatched lines indicate the limits of the study area.

Mersey. About 77% of his Little Gulls were counted in the Crosby Channel between Seaforth and the Alt Estuary, 18% were seen between the Alt and the Mersey Bar and only 0.3% in the open sea, west of the Bar.

The Formby Channel and Alt Estuary roosts are on sand-banks, parts of which remain exposed, except on the highest spring tides. At Seaforth, roosts formed on a sparsely vegetated area of derelict land between two pools, on the pools themselves or, less often, on the water of a sheltered bay in the adjacent Mersey Estuary. In spring, the largest numbers of Little Gulls usually appeared at roosts during anticyclonic weather, often with mist and light winds between south and east. On autumn passage, the exposed Formby Channel and Alt roosts were mainly used during light winds, while peak numbers at Seaforth were often associated with gales from the west or north-west.

Birds usually began to arrive on the roosts about one to two hours before high-water, preferring to settle in single-species groups or with Common Terns *Sterna hirundo,* rather than with the more numerous larger gulls. Departure from the roosts in small parties usually took place after about two hours ebb and calling was often heard at this time.

TABLE 1. NUMBER AND PROPORTION OF LITTLE GULLS COUNTED IN EACH YEAR OF THE STUDY.

Year	No. Counted	% of total
1975	19	0.6
1976	128	4.4
1977	29	1.0
1978	478	16.3
1979	440	15.0
1980	17	0.6
1981	95	3.2
1982	55	1.9
1983	1086	37.0
1984	587	20.0
Total	2934	

Numbers

During the ten years of the study, 2934 Little Gulls were counted. Annual totals varied greatly, birds being especially numerous in 1978, 1979, 1983 and 1984, particularly 1983 when 37% of the total was recorded (Table 1).

The pooled observations for each week of the study period are shown in Figure 2. Occurrences are sporadic during the first three months of the year. The mid-January peak is entirely due to an influx of 90 birds to Seaforth during the severe north-westerly gale of 13-15 January 1984. Occasional mid-winter flocks have also been noted at Hilbre Island, Wirral (Craggs 1982) and in eastern Ireland (Ruttledge 1974). Presumably these are birds which winter in the Irish Sea (Cramp & Simmons 1983).

A large spring passage occurs throughout April and in early May, 58% of the total appearing in these months. The late April peak includes 330 roosting at Formby Channel on 29 April 1983, the largest flock recorded during the study. I counted only eight Little Gulls in April before 1978. The first sizeable April flock recorded in north Merseyside, though not included in this study, was one of 36 birds at Seaforth on 25 April 1977 (Lancashire Bird Report). There is a steep decline in numbers during mid-May as birds move on towards their breeding areas. Few are then seen until mid-July when autumn passage begins. This contains two marked peaks, the first in late July/early August and a second in late September. My largest autumn count was of 77 Little Gulls at Seaforth during late September gales in 1978.

Numbers fall off rapidly in early October, few Little Gulls being seen after the third week of that month. I had only two November birds and no December records during the study.

Age distribution

Only 21.1% of the Little Gulls counted were in first-year plumage. Following the late July/early August passage which is dominated by adults and second-years (Fig. 2), the first juveniles usually appeared in the second or third week of August. My earliest record of a juvenile was on 31 July 1983. Juveniles, accompanied by birds in first-winter plumage, attain peak numbers in late September coinciding with the second influx of adults (Fig. 2). However, these young birds account for only about 27% of the total numbers counted in September and October.

The majority of Little Gulls seen in the first three months of the year are adults. However, most of the earliest arriving birds on spring passage in the first week of April are first-years.

Thereafter, the April peak is dominated by adults, mostly in breeding plumage. The small numbers of Little Gulls seen in the second half of May and in June are all in first-summer plumage and presumably include birds which do not return to the breeding grounds that year.
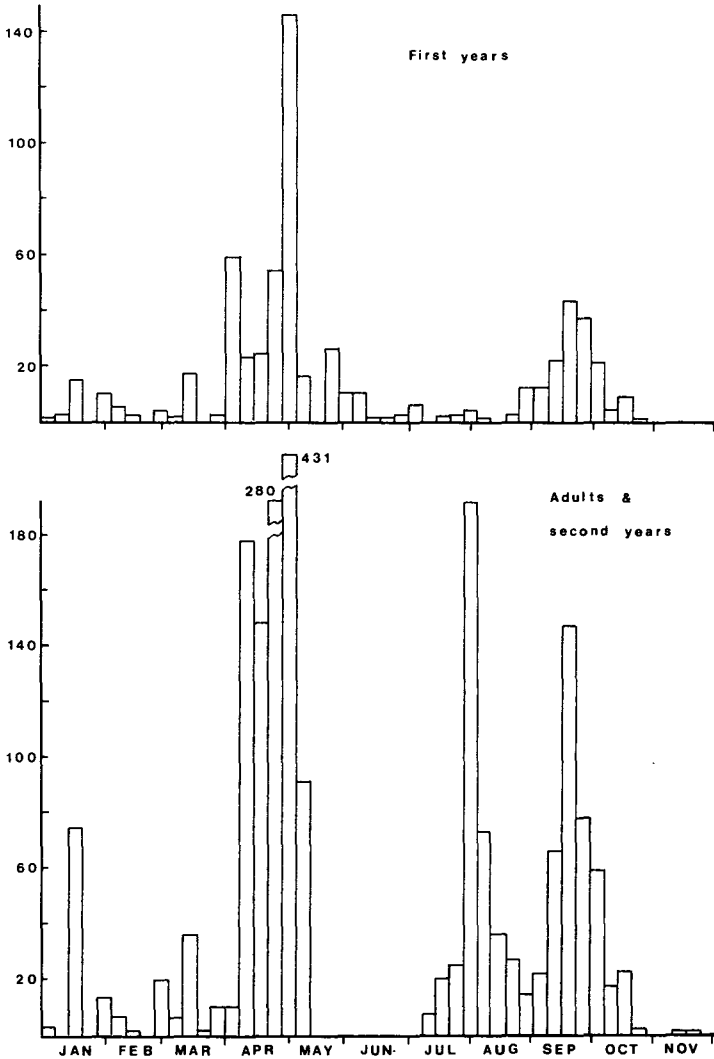

Figure 2. Pooled counts of Little Gulls for each week of the year from January 1975 to December 1984.

DISCUSSION

Regional trends

Since the early 1970s, Little Gulls have continued to gather on the north Merseyside coast in large, but variable, numbers. A clear trend of increasing abundance is not evident from my data but the frequency of large flocks has increased. Thus, parties of 100 or more Little Gulls were recorded on four occasions between 1965 and 1973 (Smith 1974). Fifteen such flocks were recorded during a similar time interval from 1974 to 1982. Furthermore, in the years 1983 to 1985, annual maxima have exceeded 300 (Lancashire Bird Reports; personal observations). As the area was well watched throughout the year before 1974, the difference is unlikely to be due simply to the presence of more observers.

A striking feature of this study has been the size and timing of the spring passage, a large April influx, mainly of adults, being evident since 1977. This contrasts with the results of earlier studies in the region (Table 2). Thus, Lassey & Greenhalgh (1969) describe a double spring passage in 1968. Their peak counts were in February/March and May/June, containing 38% and 23%, respectively, of the total number of birds. Only 1.6% of their Little Gulls were counted in April. The pattern in the early 1970s was similar (Smith 1974), spring peaks being in February and May, with only 1.1% noted during April, compared with 52% during the present study. In both earlier studies, the largest numbers of Little Gulls were seen in misty conditions, often with a light south-east wind.

Eades (1982), recorded few birds in spring between 1963 and 1976, only 5% of his total occurring between February and June. He explains this apparent anomaly by suggesting that the calm, misty weather associated with large counts at shore roosts is unfavourable for seeing birds from ships. A contributory factor is that his study concluded the year before the first April flock appeared. Since then, spring numbers offshore in Liverpool Bay have indeed

TABLE 2. PERCENTAGE OF THE TOTAL NUMBER OF LITTLE GULLS COUNTED IN EACH MONTH DURING FOUR STUDIES IN NORTH MERSEYSIDE.

Month	Period of Study			
	1968 [1]	1969–1974 [2]	1963–1976 [3]	1975–1984 [4]
January	1.6	–	0.1	3.7
February	27.6	8.2	0.1	1.7
March	9.7	1.9	1.4	2.6
April	1.6	1.1	0.2	51.7
May	16.1	14.9	2.8	6.2
June	7.0	1.8	0.1	0.5
July	3.7	10.6	5.5	6.0
August	8.2	36.7	25.8	8.4
September	15.9	22.0	40.8	17.0
October	7.8	2.5	24.1	2.1
November	0.4	0.1	0.2	0.1
December	0.6	–	1.6	–
Total birds counted	515	1138	1879	2934

Sources of data: (1) Lassey & Greenhalgh (1969)
                (2) Smith (1974)
                (3) Eades (1982)
                (4) Present study

increased, culminating in a count of 365, mostly adults, in the outer Mersey on 16 March 1984 (R.A. Eades pers. comm.).

The double autumn passage described here was not detected by Lassey & Greenhalgh (1969) or Eades (1982), both studies reporting September peaks (Table 2). However, Smith's (1974) autumn counts between 1969 and 1974 revealed a large influx in late July (Fig. 3). Numbers remained high throughout August, to be followed by a small but well-marked peak in mid/late September. This pattern is similar to that prevailing from 1975 to 1984, except that the two peaks are now more widely separated (Fig. 2).

North Merseyside's two autumn peaks accord with observations in other parts of Britain and Europe which Hutchinson & Neath (1978) interpret as an initial, limited, movement to suitably sheltered moulting sites, followed by a general dispersal to winter quarters. Liverpool Bay may well be an important moulting area in autumn. Thus, all eighteen Little Gulls trapped at Seaforth on 13 September 1983 were in the late stages of moult (P. Fearon pers. comm.).
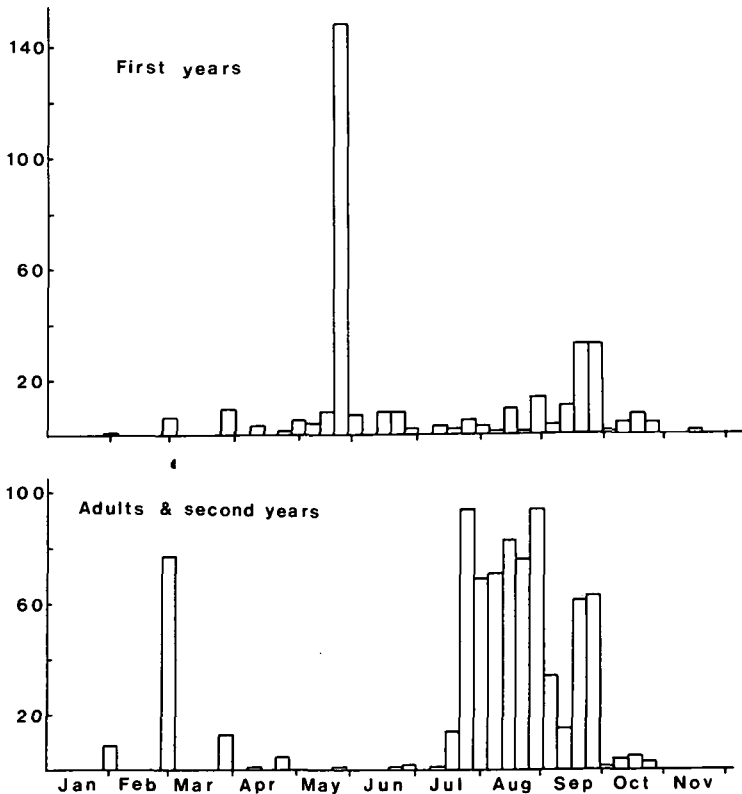

Figure 3. Pooled weekly observations of Little Gulls made between February 1969 and February 1974, redrawn from Smith (1974).

During the period of this study, transient flocks of Little Gulls were seen occasionally from nearby Wirral (Merseyside) and Fylde (Lancashire) coasts, especially in April and September, though no regular roosts were reported. The largest flocks were 215 at St. Annes-on-Sea, Fylde on 17 April 1981 (Lancashire Bird Report) and 205 off Meols, Wirral on 4 April 1982 (Cheshire Bird Report).

National and international trends

Since 1973, numbers of Little Gulls recorded in many parts of Britain and Ireland have continued to increase, although distribution patterns remain similar to those described by Hutchinson & Neath (1978).

(i) Autumn passage

Several areas, especially on the east coast of Britain, report a larger autumn passage since the late 1970s. Thus, in Tayside, autumn peaks have more than doubled, from about 300 in the mid-late 1970s to about 700 in the early 1980s (N.K. Atkinson *in litt.*). Similarly, there has been a three-fold increase in peak counts in north Cleveland during the same period, though part of this may be due to the discovery, in 1980, of a previously unknown roost at Blackhall (B. Unwin *in litt.*). Peak numbers of Little Gulls passing Hartlepool, Cleveland, increased markedly from 1974 to 1978 but, surprisingly, this trend did not continue into the early 1980s (Cleveland Bird Reports). However, autumn passage numbers have recently increased in Northumberland, especially in September and October (M.S. Hodgson *in litt.*). Dunn & Lassey (1985) detail the changing status of this species on the North Yorkshire and North Humberside coasts. Considerable increases were observed during the 1970s; then, in autumn 1982, the largest numbers of Little Gulls ever seen in British waters were recorded. From 24 September to 9 October, 5413 passed Flamborough Head and 1304 occurred at Filey. About 58% of aged birds were adults or second-years. Peak numbers coincided with strong south-easterly winds and heavy rain, suggesting displacement of birds across the North Sea from normal migration routes along the Netherlands coast where up to 11,000 Little Gulls have been counted in autumn (Woutersen 1980). Counts of Little Gulls in Kent show considerable annual variation but there are indications of a continuing increase. Between 1977 and 1982, autumn peaks outnumbered spring maxima by 3.6 to 1 (A.C.B. Henderson *in litt.*).

(ii) Winter occurrences

In winter, both the major Scottish haunts, Tayside and Fife, have recently attracted larger flocks during onshore gales. There have also been occasional January sightings in South Wales since 1978, the maximum flock being 25 (Glamorgan Bird Reports). Fox's (1986) analysis of Little Gull records for Ceredigion, West Wales, from 1968 to 1983 shows that 42% of birds were seen in winter (October to March). There is a significant association between these occurrences and strong winds, especially between south and west. In contrast, from April to September, Little Gulls mainly appeared on days of low wind velocity. Occurrence of winter flocks in eastern Ireland is also associated with onshore gales, with the birds appearing so soon after the onset of suitable winds that their origin is considered to be close to the Irish coast; indeed, in autumn, small flocks of Little Gulls have been reliably reported from fishing boats in the vicinity of sand-banks about 8 km off Wicklow (R.F. Ruttledge *in litt.*).

(iii) Spring passage

Surprisingly few regions report significant increases of Little Gulls in spring since the early 1970s. However, during the early 1980s, flocks of up to 50 birds were seen in eastern Ireland during April and May (R.F. Ruttledge *in litt.*). Spring passage in West Wales from 1968 to 1983 was slightly larger than autumn passage, with 31% of records in April and May compared with 26% in August and September (Fox 1986). Unprecedented numbers appeared in South Wales between 1973 and 1977, with maxima of 50-70 in mid-April. However, from 1978 to 1984, peak spring counts fell back to single figures (Glamorgan and Gwent Bird Reports). It is interesting that this decline occurred at the same time as the spectacular increase in spring numbers in north Merseyside. Although the numbers of Little Gulls seen in Gloucestershire are small, this is one of the few counties in which spring passage is larger than the autumn movement, most records being in May, June and April respectively (Swaine 1982). In complete contrast to its autumn status, few Little Gulls are seen in the early part of the year in the north-east of England. Indeed this species is distinctly scarce in spring at the well-watched Flamborough Head (P.A. Lassey *in litt.*).

Shrubb (1979) reports a considerable increase in April and May records on the Sussex coast from 1973 to 1975. This reflects a well-established easterly passage through the English Channel and southern North Sea which has also been studied on the Netherlands coast. Here, Woutersen (1980) shows that spring migration of Little Gulls between 1974 and 1979 was restricted mainly to the period from mid-April to mid-May, the heaviest passage in any one year being over about ten days. His data reveal no consistent trend of increase, the number of birds recorded per hour varying from 4.4 in 1977 to 30.6 in 1974.

The timing of spring passage in the English Channel and southern North Sea is similar to that seen since 1977 in north Merseyside but the origin and subsequent movements of the latter birds remains unclear. There is, for example, no evidence of an influx through the Western Approaches from wintering areas further south which might be detectable from Cornish coasts. Despite a great increase in sea-watching in Cornwall, the Little Gull is still regarded there as an uncommon passage migrant and winter visitor, numbers having changed little since the early 1970s (Cornwall Bird Reports). Similarly, few Little Gulls are seen in the Isles of Scilly, numbers recorded having actually declined by 60% between 1973/74 and 1983/84 (Isles of Scilly Bird Reports). Nor, apparently, do significant numbers of this species migrate out of, or into, the Irish Sea past western Scotland. During over 400 hours of sea-watching from western Islay, Inner Hebrides, between 1973 and 1977, a total of 174,000 birds of 45 species was recorded but only four of these were Little Gulls (Verrall & Bourne 1982). The same applies to the Outer Hebrides where Cunningham (1983) reports only thirteen sightings of Little Gulls since 1883. Scottish Bird Reports also contain few records of this species for west Scotland.

A possible explanation of these observations is that the spring flocks in north Merseyside represent a growing number of birds which winter in the Irish Sea. Some are blown inshore during winter gales and the majority apparently assemble in Liverpool Bay before departure for European breeding grounds. An overland route across northern England is probable, although evidence is limited to occasional sightings of parties of Little Gulls gaining height and flying inland from Formby and Seaforth.

(iv) Possible origins and breeding expansion

Since 1977, the South West Lancashire Ringing Group has marked 307 Little Gulls, mainly at Seaforth in spring (P. Fearon pers. comm.). Up to October 1985, ten of these birds had

been controlled or recovered in Merseyside. This relatively high recovery rate indicates fidelity of Merseyside Little Gulls to a migration route separate from that through the North Sea used by the majority of the west Europe population. An Irish connection is implied by the recovery of a Seaforth bird at Lough Neagh, while a Durham-ringed Little Gull has been controlled at Seaforth. Other Merseyside birds have been found dead in Finland and in Finistère, France. Only three foreign-ringed Little Gulls have been trapped at Seaforth; all had been marked in Finland on the breeding grounds. Finnish-ringed birds have also been recorded in Fife, Durham and Berkshire. Finally, there have been recoveries on the south and east coasts of England of Little Gulls ringed in Latvia (two), Estonia and Sweden.

Hutchinson and Neath (1978) describe the dramatic increase of Little Gulls in Britain and Ireland up to 1973 as "perplexing" and suggest that an unrecorded expansion of the breeding population was probably responsible. Recent evidence lends support to this idea. Thus, Cramp & Simmons (1983) state that the number of pairs in Finland has apparently increased from about 20 in the 1950s to over 1000. Schütt's (1979) analysis of nearly 10,000 records of Little Gulls on passage in the Trave Valley between Lübeck and the Baltic Sea also indicates that more are breeding the Baltic States. Between 1956 and 1978, the average size of migrating flocks increased by 1.1 birds per annum. The bird's breeding distribution is also spreading westwards. Toft (1983) notes that Little Gulls have recently begun to breed in south-west Norway, while increasing numbers have nested since 1972 in the reclaimed polderlands of the Lauwersee, Netherlands (Veen 1980). This trend is reflected in the unsuccessful breeding attempts in England in 1975 and 1978 (Cramp & Simmons 1983). Eventual colonisation of the British Isles seems likely in view of the continued, albeit localised, increase of the species on passage and in winter.

ACKNOWLEDGEMENTS

SUMMARY

A total of 2934 Little Gulls was counted during the ten years 1975 to 1984, 21% being in first-year plumage. Almost all used three high-tide roosts at Seaforth, Formby Channel and the Alt Estuary on a 9km stretch of sandy coast in north Merseyside Since 1977, there has been a marked increase in numbers during April and early May, consisting mainly of adults in breeding plumage. There are two autumn peaks. The first, in late July and early August is dominated by adults; the second influx in late September includes an increasing proportion of young birds. Sporadic occurrences during winter are associated with onshore gales.

It is suggested that the birds emanate from an increasing number wintering in the Irish Sea. Comparisons are made with previous studies in the region, while recent trends elsewhere in Britain and Western Europe are discussed.

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Origin and mortality of Guillemots *Uria aalge* on the Swedish west coast

Mats Peterz and Bertil Oldén

INTRODUCTION

There were very few recoveries of ringed Guillemots *Uria aalge* from Sweden, up to the end of the 1970's (Mead 1974). However, starting with the severe oiling incident in the Skagerrak in January 1981 (Baillie & Mead 1982), the number of recoveries of British Guillemots in Sweden increased dramatically. Many were among the thousands of auks killed in gill-nets in the southeastern Kattegat (Peterz & Oldén 1984, Oldén, Peterz & Kollberg 1985).

This paper documents recoveries of ringed Guillemots along the Swedish west coast, mainly during the years 1980-1985, and discusses the reason for the sudden increase in number of auks recovered in the Kattegat.

MATERIALS

Data concerning recoveries of ringed Guillemots up to March 1985 were supplied by British Trust for Ornithology, England; Stavanger Museum, Norway; Zoological Museum, Oslo, Norway; Zoological Museum, Copenhagen, Denmark; Museum of Natural History, Reykjavik, Iceland; Swedish Museum of Natural History, Stockholm, Sweden; and Euring data bank, The Netherlands.

The recovery area comprises the Swedish Skagerrak and Kattegat coasts. In addition, four recoveries of West European Guillemots in the Sound and the Baltic have been included.

RESULTS

Time distribution

Since 1933 a total of 105 ringed Guillemots have been recovered (including one control) in the study area. The majority (90 birds) was recovered during the 1980s (Table 1). Before 1980 no birds were recovered in the southeastern Kattegat. Now some west European Guillemots may even reach the Baltic (Fig. 1).

Most birds were recovered during November-February inclusive (Fig. 2). Birds recovered during summer were more often reported as "found dead" than other birds. It is probable that these had been dead for several months at the time of recovery.

The earliest recovery after breeding season (13 August 1982) of a recently dead bird, was a yearling from Fair Isle with incompletely grown primaries. Three Guillemots from Britain, all in their second calendar year found in April, and one bird from the island of Stora Karlsö in the Baltic found in the beginning of May, are the latest recoveries before the breeding

TABLE 1. RECOVERIES OF RINGED GUILLEMOTS ON THE SWEDISH WEST COAST, UP TO MARCH 1985

Recovery are	1930-39	1940-49	1950-59	1960-69	1970-79	1980-85	Total
Skagerrak coast	2	3	1	0	3	41	50
Kattegat coast	0	0	0	3	3	49	55
Totals	2	3	1	3	6	90	105
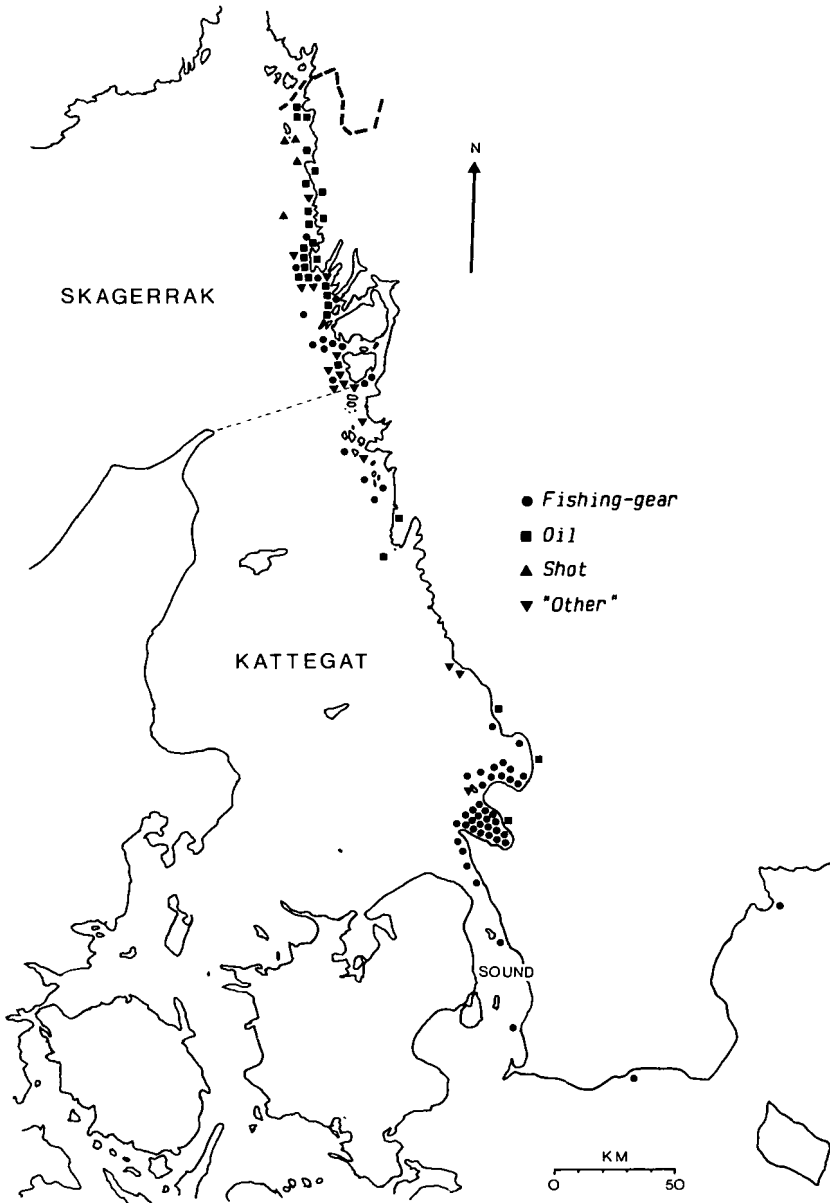
Figure 1. Recoveries of ringed Guillemots *Uria aalge* on the Swedish west coast, from 1933 up to March 1985 (n = 105).
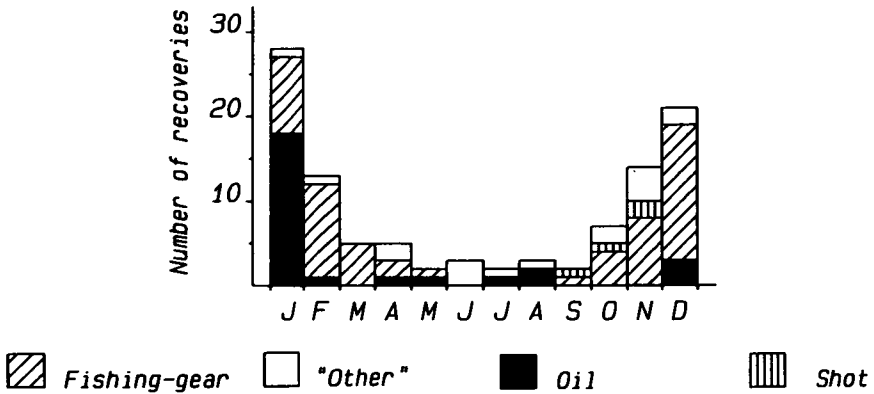
Figure 2. Monthly distribution of Guillemots *Uria aalge* recovered on the Swedish west coast.

season of recently dead birds. None of the birds found during breeding season were recently dead (cf. above).

The only control was one bird ringed at the island of Christiansö in the Baltic which was found breeding in June in its ninth calendar year on the island of Hallands Väderö in the southeastern Kattegat. This is the only breeding site in the Kattegat, established in 1972.

Recovery methods

Nine of those 15 birds found before 1980 were reported as "found dead", the others as oiled (3), netted (2) and shot (1). During the 1980s most birds were drowned in nets. In particular, this situation is pronounced along the Kattegat coast (88%), especially on the southern part, as compared to the Skagerrak coast (31%) (Fig. 1). However, the severe oiling incident in the Skagerrak in 1981, when 15 oiled Guillemots were recovered, has a big influence on this result. It could also be inferred that the study of the fishing net problem in the southeastern Kattegat during the winter 1984/85 (Oldén *et al.* 1985) has increased the number of netted birds reported from this region.

Age

The majority of recovered Guillemots was ringed as chicks (95 birds). Their age distribution during recent years is shown in Table 2; about 70% were birds in their first winter. This is almost exactly the same proportion as was found when examining dead birds from gill-nets in the southeastern Kattegat (Oldén *et al.* 1985). Age distribution has not changed during winters 1980/81 – 1984/85 ($x^2 = 0.67$, p>0.05, df=3).

TABLE 2. RECOVERIES OF RINGED GUILLEMOTS WINTERS 1980–1985 TABULATED BY AGE.

Age	1980/81	1981/82	1982/83	1983/84	1984/85	Total
1st winter	16	2	15	16	13	62
2nd-5th winter	4	0	5	6	5	20
>5th winter	1	2	4	1	0	8

The mean age of birds ringed as chicks was only 1.1 years when recovered. For Guillemots ringed as full-grown it was at least 9.6 years. The oldest bird recovered, ringed as full-grown at Farne Island in May 1962, was at least 23 years old when found in January 1984.

First winter birds comprise 81% of the netted birds compared to only 56% among those killed by oil (Table 3). The difference is statistically significant when comparing frequencies between first-winter and older birds ($x^2 = 6.06$, p>0.025, df=1). This supports the view that younger, inexperienced birds are more vulnerable to fish-nets than are older birds. However, the oiling incident of 1981 exerts a great influence on the age composition among oiled birds. The proportion of first-winter birds at the oiling incident was 73% (n=15), which is almost the same as in fish-nets. Of other oiled birds, only 33% (n=12) were in their first winter.

Origin

The origin of recovered birds is shown in Figure 3. Most birds originated from Scotland, particularly Shetland (48), but a high proportion, relative to the size of the breeding population (2000 pairs, Nettleship & Evans 1985), is from Helgoland (18). Birds have also been ringed in the Faroes (1), Norway (2), Murmansk (1) and the Baltic (6) which show that other populations also winter in the study area.

TABLE 3. METHOD OF RECOVERY OF RINGED GUILLEMOTS TABULATED BY AGE.

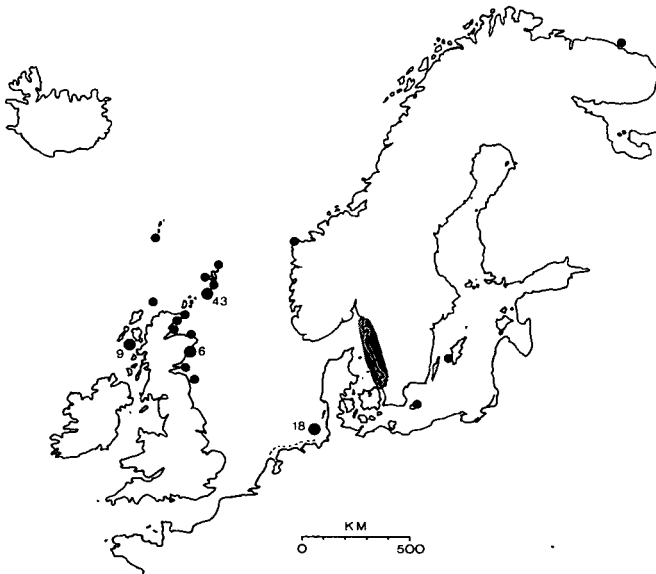| Method of recovery	1st winter	2nd-5th winter	>5th winter	Total
Fishing gear	47	9	2	58
Oil	15	9	3	27

Figure 3. Ringing sites for Guillemots *Uria aalge* recovered on the Swedish west coast (hatched area). Small dots indicates 1-5 recovered birds. Figures next to bigger dots indicates number of recovered birds.

DISCUSSION

Ringing returns suggest that a large proportion of the Guillemots wintering off the Swedish west coast originates in northern parts of Britain. However, this apparent preponderance of British birds could be an artefact induced by the intensive ringing which has taken place in Britain during the late 1970s and the 1980s (Table 4). Birds from the Baltic are rare in the recovery area. Guillemots have been extensively ringed at the island of Stora Karlsö in the Baltic, and the low number of recoveries from this area is certainly real (cf. Cramp 1985, Oldén et al. 1985). It is more difficult to draw conclusions regarding other populations, but it can be assumed that birds from less-intensively ringed, or unringed, populations are more numerous than is shown by ringing recoveries.

TABLE 4. RECENT NUMBERS OF GUILLEMOTS RINGED IN GREAT BRITAIN AND IRELAND (FROM STEPHEN BAILLIE).

Period	Pull	Full grown	Total
1970-74	4533	3418	7951
1975-79	12804	3852	16656
1980-84	31187	8519	39706

The most striking pattern in the data is the sudden increase of Guillemots recovered in Sweden during the last five years (Table 1). Especially the number of auks entangled in nets has risen. This can not be explained by changes in fishing effort or techniques (Oldén et al. 1985). Neither has ringing effort increased compared with the increase in recoveries in Sweden (cf. Tables 1 and 4). Thus it seems obvious that more auks winter in the Kattegat nowadays. This is supported also by field observations which show that the number of auks recorded in the Kattegat has increased during the 1980s (Gärdenfors, Hirshfeld, Holst, Kjellén, Persson & Undeland 1984).

There are also indications that Puffins *Fratercula arctica* from north-east Britain have expanded their winter range during recent years (Harris 1984). Before 1975, these Puffins stayed almost exclusively within the North Sea, but after 1975 recoveries in the English Channel or the Bay of Biscay have increased.

The expanded winter ranges of both Guillemots and Puffins may be a result of limited food resources in the North Sea. During the massive wreck of seabirds in eastern Britain in 1983 (Underwood & Stowe 1984), a great majority of the beached auks was seriously underweight (Jones, Barret, Mudge & Harris 1984). It was concluded that starvation was the proximate cause of death but the ultimate reason for this was not obvious (Blake 1983).

A more possible explanation for higher Guillemot numbers in the Kattegat is changes in prey in this area. In fact, the stocks of small Herrings *Clupea harengus,* which may be a suitable food resource for Guillemots (Blake 1983), have increased in the Kattegat during recent years (Anon. 1986). Examination of Guillemots killed in gill-nets in the southeastern Kattegat showed that they had thick fat deposits (mean weight 1100 g) (Oldén et al. 1985), corroborating that food is abundant in the area.

It must be pointed out that the above-described course of events in the Kattegat coincides with a steady increase in British Guillemot populations, especially in the north-east (Stowe & Harris 1984). Future studies will show if the Kattegat will remain an important wintering area for Guillemots. If this happens, it is even more desirable to try to limit the number of birds killed in gill-nets in order to minimize effects on west European Guillemot populations.

SUMMARY

Analysis of ringing recoveries of Guillemots *Uria aalge* found along the Swedish west coast show a substantial recent increase: before 1980 only 15 ringed Guillemots had been recovered in the area, compared to 90 during the 1980s (up to March 1985). Most ringed Guillemots originate from colonies around the North Sea, especially in the northern parts of Britain.

Field observations support the idea that the increase is due to more Guillemots wintering in the Kattegat. Changes in fishing techniques, fishing effort or ringing effort do not explain the increase. Limited supplies of food in the North Sea, and/or good numbers of small herrings in the Kattegat, may explain why the birds have established new wintering grounds.

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The tern populations of Malaga Bay, Spain.

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INTRODUCTION

During the years 1981, 1982 and 1983, eight species of terns Sternidae were recorded from Malaga Bay, southern Spain, excluding the three species of the *Childonias* group. Of these, only three species, Sandwich Tern *Sterna sandvicensis,* Common Tern *S. hirundo* and Little Tern *S. albifrons* were recorded commonly each year, the remaining five being of scarce or accidental occurrence (Table 1).

There are no breeding colonies of the three common species closer than 180km within the extreme western Mediterranean and all records therefore pertain to wintering, summering or migrant birds.

This note is concerned with the annual and temporal abundance of the three above-named species in relation to known Mediterranean populations. The general status of all species within the extreme western Mediterranean (Sea of Alboran) is described by de Juana & Paterson (1986).

METHOD

Observations totalling 742 hours were made on the western side of Malaga Bay 36° 40″ N, 4° 25″ W, 2-4kms NE of Torremolinos (Fig. 1) on 730 days within the three years 1981, 1982 and 1983, giving an average coverage of 66.6% of all days possible (1981: 216 days, 76.2%; 1982: 236 days, 64.6%; 1983: 216 days, 59.2%).

Observation took place in all months of each year, with an average daily watch length of 61 minutes (1981: 57.1 minutes; 1982: 63.4 minutes; 1983: 63.3 minutes), with an average minimum of 56 minutes (December – February) and an average maximum of 68.3 minutes (June – August).
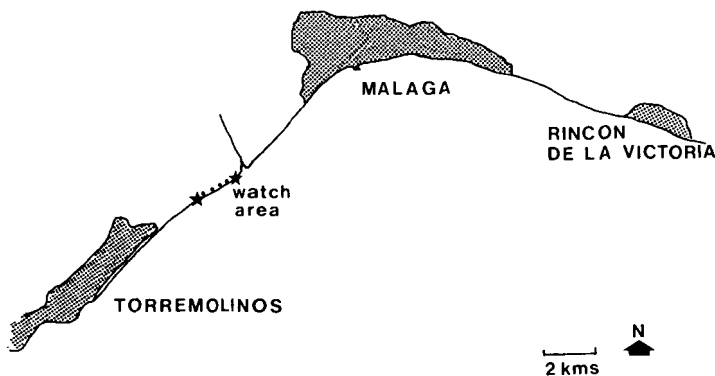

Figure 1. Malaga Bay, showing watch area.

All observations used in this note were made in the three hour period up to sunset, as this period was shown to be best in terms of seabird abundance and also light position for specific identification.

Identification was carried out using 10 × 50 binoculars, supplemented by 20× telescope. The total number of individuals for each species was recorded in each watch period. Only specifically identified birds were recorded. No observations of Arctic Tern *S. paradisaea* were made or suspected, according with its status within the Mediterranean and Strait (de Juana & Paterson 1986).

RESULTS

Table 1 shows the total number of individuals recorded for each species in the three year period. The numerical dominance of the three common species, comprising 99.0% of all records is clearly shown. The most frequently recorded of the three species was Sandwich (70.6%), followed by Little (16.7%) and Common Terns (11.7%).

Table 2 shows the analysis of the records of the three common species in terms of number/hour average for the three years, together with maximum and minimum rates per hour recorded for each period in half monthly units, and also the percentage of the individual species total per half monthly period.

Figure 2 shows the mean rate per hour per species for each half monthly period to illustrate the relative differences in rate and timings.

TABLE 1. SUM OF INDIVIDUALS SEEN PER SPECIES OF STERNIDAE FOR 1981, 1982 AND 1983 IN ORDER OF ABUNDANCE

Tern species	Total	% total
Sandwich	2342	70.54
Little	554	16.68
Common	390	11.74
Gull-billed	25	0.75
Caspian	6	0.18
Royal	1	0.03
Lesser Crested	1	0.03
Roseate	1	0.03
Total	3320	

Sandwich Terns were recorded in all months of the year and normally comprised the total tern population between mid November and February, with the exception of single Common Terns in December and February and six in January in winter 1981-82. During the rest of the year it comprised more than 50% of the total tern population with the exception of the period mid August – mid September, a time when there were normally strong movements of Common and Little Terns. Spring movement was normally noted from early March, with maximum intensity in April (4.26 per hr and 5.34 per hr average per half month), continuing to mid May. The period mid March to mid May accounts for 22.1% of all Sandwich Tern records.

High numbers/hour in the second half of June (7.28 per hr average) and continuing in to July at a lower average rate are accounted for by an immature population of 69.1% of aged birds (n = 291).

TABLE 2. AVERAGE NUMBER PER HOUR FOR EACH HALF MONTHLY PERIOD, TOGETHER WITH MAXIMUM AND MINIMUM NEMBER PER HOUR RECORDED FOR SANDWICH, COMMON AND LITTLE TERNS FOR 1981, 1982 AND 1983; TOGETHER WITH TOTAL RECORDED PER PERIOD AND PERCENTAGE REPRESENTED BY THIS FOR EACH SPECIES.

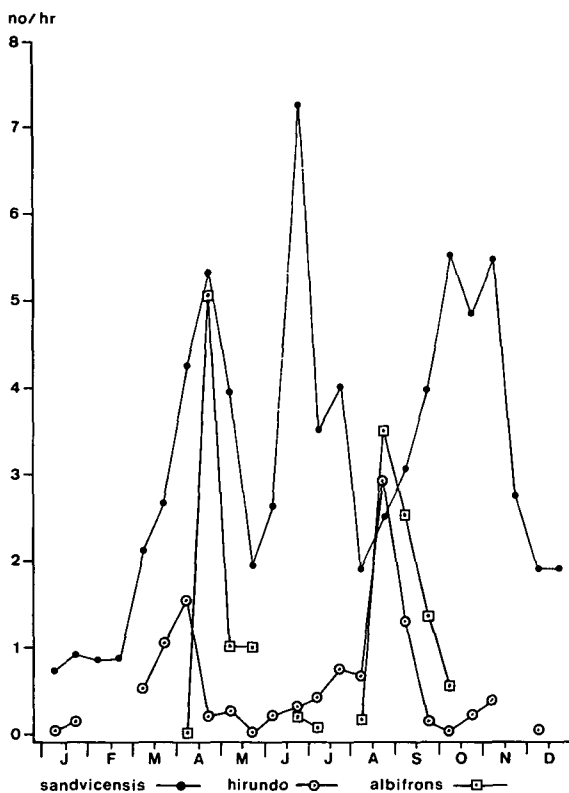|	Sandwich					Common					Little				
			Number/Hour					Number/Hour					Number/Hour		
Period	n	%	Ave	Max	Min	n	%	Ave	Max	Min	n	%	Ave	Max	Min
01-15 Jan	21	0.9	0.75	1.54	0	1	0.26	0.04	0.14	0	–	–	–	–	–
16-31 Jan	28	1.19	0.94	1.58	0.54	5	1.28	0.17	1.58	0	–	–	–	–	–
01-14 Feb	24	1.02	0.85	1.37	0.59	1	0.26	0.04	0.11	0	–	–	–	–	–
15-28 Feb	24	1.02	0.9	1.57	0	–	–	–	–	–	–	–	–	–	–
01-15 Mar	74	3.16	2.14	3.39	0.18	19	4.87	0.55	1.3	0	–	–	–	–	–
16-31 Mar	98	4.18	2.7	4.64	0.31	39	10.00	1.07	1.45	0.72	–	–	–	–	–
01-15 Apr	135	5.76	4.26	6.15	3.18	49	12.56	1.55	3.54	0.21	2	0.36	0.06	0.21	0
16-30 Apr	171	7.3	5.34	7.1	3.39	7	1.79	0.22	0.53	0	163	29.42	5.09	9.6	0.24
01-15 May	113	4.82	3.98	5.45	3.27	8	2.05	0.28	0.48	0	29	5.23	1.02	2.4	0.27
16-31 May	57	2.43	1.96	2.66	0.98	1	0.25	0.03	0.15	0	29	5.23	1.00	2.04	0
01-15 Jun	65	2.78	2.66	6.35	1.47	11	2.82	0.24	0.71	0	–	–	–	–	–
16-30 Jun	136	5.81	7.28	9.57	4.97	6	1.54	0.32	0.86	0	4	0.72	0.21	0.43	0
01-15 Jul	84	3.59	3.52	6.0	0.82	10	2.56	0.42	1.38	0	2	0.36	0.08	0.25	0
16-31 Jul	132	5.64	4.03	10.88	1.11	25	6.41	0.76	2.0	0.2	–	–	–	–	–
01-15 Aug	53	2.26	1.92	4.18	0.62	19	4.87	0.69	1.05	0.44	5	0.9	0.18	0.29	0
16-31 Aug	95	4.06	2.51	5.51	0.64	111	28.46	2.94	7.89	0.71	132	23.83	3.5	6.0	0
01-15 Sep	132	5.64	3.07	3.86	1.54	49	12.56	1.3	2.75	0	109	19.68	2.53	5.31	0
16-30 Sep	177	7.56	4.0	4.52	3.27	7	1.79	0.16	0.28	0.09	59	10.65	1.33	1.73	1.18
01-15 Oct	192	8.2	5.55	9.0	3.55	1	0.26	0.03	0.10	0	20	3.61	0.58	1.25	0
16-31 Oct	175	7.47	4.86	9.79	1.53	8	2.05	0.22	0.59	0	–	–	–	–	–
01-15 Nov	161	6.87	5.5	7.08	3.88	12	3.08	0.41	0.86	0	–	–	–	–	–
16-30 Nov	83	3.54	2.78	3.89	1.9	–	–	–	–	–	–	–	–	–	–
01-15 Dec	52	2.22	1.94	4.0	1.2	1	0.26	0.04	0.08	0	–	–	–	–	–
16-31 Dec	60	2.56	1.94	2.61	1.32	–	–	–	–	–	–	–	–	–	–

Figure 2. Mean rate per hour in half monthly periods for years 1981, 1982, 1983, for Sandwich *S. sandvicensis,* Common *S. hirundo* and Little Terns *S. albifrons,* showing differences in rates per hour and timings of movements.

Autumn movement took place between mid September and mid November, with average half monthly rates falling between 4.0 per hr and 5.55 per hr, comprising 30.1% of all Sandwich Tern records.

Common Terns normally occurred between the first half of March and the end of October, with the exception of the eight birds noted above. Spring movement was at its maximum between mid March and mid April (averages of 1.07 per hr and 1.55 per hr per half month) and comprised 22.6% of all records. Autumn passage was at its greatest in August, reaching a maximum in the second half of the month (2.94 per hr; 22.6% of all records).

Little Terns occurred between early April and mid October, with spring passage concentrated in the second half of April (average 5.09 per hr; 28.5% of all records). Autumn migration took place between mid August and mid September (averages 3.5 per hr and 5.31 per hr per half month) with 43.5% of all records.

Of the remaining five species, Gull-billed Terns *Gelochelidon nilotica* and Caspian Terns *S. caspia* were recorded only occasionally during the study and Royal Tern *S. maxima,* Roseate Tern *S. dougalli* and Lesser Crested Tern *S. bengalensis* once only. The last three are considered to be of accidental occurrence off Spanish Mediterranean coasts (de Juana & Paterson 1986). None of these species occurred in numbers sufficient to justify further analysis.

DISCUSSION

The nearest breeding grounds of any consequence for the three main species are in the Ebro Delta, where the numbers nesting in 1985 were (in pairs): Sandwich Tern – 350; Common Tern – 2,300; Little Tern – 650 (Ferrer & Martinez-Vilalta 1986). The numbers of the latter two seen at Malaga Bay are well within these population levels and it seems possible that the majority derives from these nearest breeding populations. The total Mediterranean populations for Spain, gained by adjusting increases for Mediterranean Spain by Ferrer & Martinez-Vilalta (1986) against those for 1983 and previously, given by James (1984), may be in the order of (in pairs): Sandwich Tern – 1,500; Common Tern – 17,300; Little Tern – 5,600.

Passage movements of both Common and Little Terns are particularly rapid through the Malaga Bay area, particularly in autumn, in direct contrast to the far more prolonged autumn passage of Sandwich Terns. The nearest Sandwich Tern population of any consequence is that of the Black Sea, with about 26,000 pairs (Golovkin 1984). Ardamatskaya (1977) showed that the western Mediterranean is an important wintering area for Black Sea Sandwich Terns with 80% of all ringing recoveries, a further 6% coming from the near Atlantic region.

It seems possible, therefore, that the relatively long autumn passage of Sandwich Terns is due to the involvement of two distinct populations, the smaller Mediterranean population moving through the area in September and early October, with the Black Sea population accounting for the October and early November peak in numbers.

The extreme western Mediterranean is not considered to be an important wintering area for Sandwich Terns (de Juana & Paterson 1986), although considerable numbers winter off Algeria (Jacob 1979) and a small number off SW Iberian coasts (Cramp 1985).

My seawatch data from Malaga Bay indicate that Common and Little Terns depart the vicinity of the breeding colonies much more rapidly than Sandwich Terns and, on the evidence from the Malaga area, move rapidly through towards the Strait of Gibraltar and the wintering grounds off the west coast of Africa. Movement of Sandwich Terns is, particularly in the autumn, much prolonged and it is suggested that this is due to the involvement of two distinct populations, Mediterranean and Black Sea.

RESUMEN

Se discute la composición numérica y abundancia temporal de las *Sternidae* en la Bahía de Málaga. Se muestra que tres especies *Sterna sandvicensis, S. hirundo* y *S. albifrons* compusieron el 99.0% de la población durante los años 1981, 1982 y 1983, las cinco especies restantes son ocasionales. Se discute también las fuentes de población de las tres especies comunes y sus epocas de paso.

SUMMARY

The numerical composition and temporal abundance of the Sternidae from Malaga Bay are discussed. Sandwich, Common and Little Terns comprised 99.0% of the population over the years 1981, 1982 and 1983. The remaining five species (Gull-billed, Caspian, Royal, Roseate and Lesser Crested) were occasional. The population sources of the three main species and the relative timings of their migrations are also discussed.

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Chick production at Kittiwake *Rissa tridactyla* colonies in Shetland, 1986

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Surveys of colonies and counts at monitored study plots have indicated that the Kittiwake *Rissa tridactyla* population in Shetland has declined in recent years (Heubeck, Richardson & Dore 1986). Breeding success was thought to be abnormally low in 1985 (Heubeck & Ellis 1986) and it was decided to examine chick production more closely in 1986. Determining breeding success (the total number of young fledged from the total number of eggs laid) is extremely time-consuming. Instead, the aim was to record the number of nests at which adult birds either were, or appeared to be, incubating during early June, and the number of young which fledged from these nests.
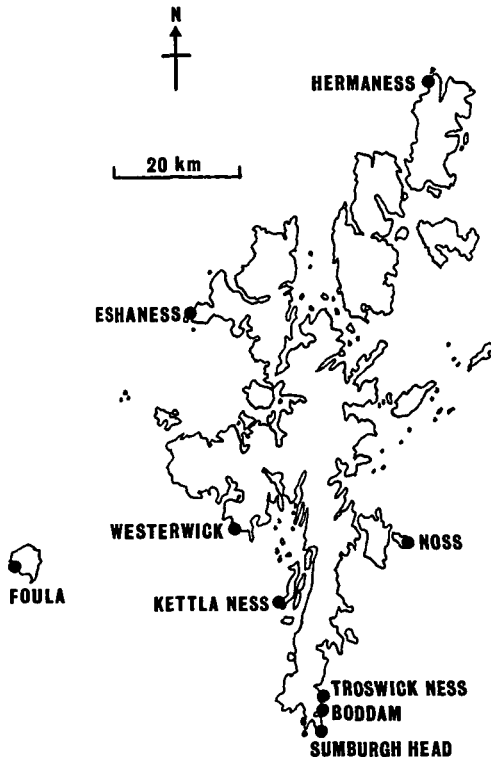

Figure 1. Map of Shetland showing the location of Kittiwake colonies mentioned in the text.

METHODS

Shetland has a large number of Kittiwake colonies of greatly varying size (Richardson 1985) and four were chosen on the basis of convenience and accessibility. Four sections of cliff were delimited as study plots at Sumburgh Head, two at Troswick Ness and one at Noss and Eshaness (Fig. 1). Two of the Sumburgh Head plots were adjacent to each other, as were the two at Troswick Ness. All had been study plots for monitoring since at least 1976 and the changes in numbers of Kittiwakes nesting in them over the past 10 years were known. Information on brood sizes in 1985 existed for some plots.

Photographs of each study plot were overlaid with a transparent acetate sheet and the positions of all nests were marked and numbered on the first visit. On Noss, detailed sketch maps were drawn from a projected photograph of the cliff. Nests were defined as at least traces of nest material attended by one or more adults. No nest material was considered to have remained from the previous year. Nests which appeared after the initial visit were noted by a letter, according to the nearest numbered nest – e.g. 39A. The first visits were made during late May and early June and the last between 3-10th August. Visits were generally made every 4-7 days, although there were fewer during the second half of June due to other commitments. On Noss, visits were made every 2-3 days from 4th June.

Using a telescope, nests were assigned to one of three categories:

a) Active: a substantial nest with a cup capable of holding eggs or young at which an adult appeared to be incubating/brooding, or in which eggs or young could be seen.

b) AON: the above plus those with a cup capable of holding eggs or young. Attended nests in those first two categories correspond to the definition of 'apparently occupied nests' used in previous surveys and the 'Seabird Colony Register'.

c) Nests: the above plus those with some nest material present, but without a cup capable of holding eggs or young.

Nests contents were noted when seen, although the contents of all nests was not known accurately until early July when most chicks were easily visible. If there was doubt about the exact number of eggs or young, a query was marked against the minimum number seen – e.g. 'C1?' indicated that at least one egg was seen, but there may have been more eggs or even small young in the nest. Broken eggshell in an otherwise empty nest was taken as indicating that at least one egg had been laid. Eggs out of the nest cup, clutches not being incubated and dead young in the nest were recorded separately. The size of chicks was estimated as small, medium, large or of fledging size. Birds were assumed to have fledged if they disappeared from the nest when known to be at least 35 days old and/or when all down had been lost and the primaries projected beyond the tail by at least 1 cm (Maunder & Threlfall 1972). Chicks still in the nest at the time of the last visit were all assumed to have fledged subsequently.

RESULTS

The number of 'active nests' is an estimate of the minimum number of breeding attempts made in each study plot because a few breeding attempts may have been made, but failed between visits. The proportion of nests recorded as active varied little between plots, from 75% – 82% of the total (Table 1).

Chick production was expressed as the number of young fledged per active nest (Table 1). Since not all birds seen apparently incubating may have had eggs, especially some of those at nests which were only recorded as 'active' on a single date early in June, this measure of chick production was therefore minimal. Eggs were seen in 65% of the active nests and from these chick production was 0.66, compared to 0.69 for all active nests. There was no significant difference between these two measures of production (paired sample t-test; t = –0.99). At the

TABLE 1. THE NUMBER OF NESTS IN EACH DEFINED CATEGORY, THE NUMBER OF YOUNG ASSUMED TO HAVE FLEDGED AND CHICK PRODUCTION IN EACH OF THE 8 STUDY PLOTS

COLONY Study plot	Nests	AONs	Active nests	% Nests active	Young fledged	Chick production
SUMBURGH HEAD						
Plot A	104	91	81	77.9	56	0.69
Plot B	74	67	61	82.4	50	0.82
Plot C	71	62	58	81.7	31	0.54
Plot D	48	42	36	75.0	13	0.36
TOTAL	297	262	236	79.5	150	0.64
TROSWICK NESS						
Plot A	129	111	104	80.6	115	1.11
Plot B	37	32	30	81.1	34	1.13
TOTAL	166	143	134	80.7	149	1.11
NOSS						
Plot A			139		49	0.35
ESHANESS						
Plot A	123	107	99	80.5	69	0.70
OVERALL TOTAL			608		417	0.69

last visit (3rd-10th August), 120 young still had not fledged. All but four of these were of a size capable of flying and many could perhaps have fledged and returned to the nest. Such happenings explain the increase in number of active nests at one Sumburgh Head plot at the end of July (Fig. 2).

Clutch size was determined for 286 (47%) of the 608 active nests (Table 2). While breeding success (the number of young fledged per egg laid) can therefore be calculated for these nests, the data must be treated with some caution because the sample of nests may not have been representative. Three biases may have produced a lower mean clutch size than would have been the case if the contents of all nests were known:
1. Small clutches were thought to be easier to identify than larger ones as the entire nest cup was not often visible.
2. More visits were made during the first than the second half of June and incomplete clutches may have been recorded, although visits were more regularly spaced on Noss.
3. Inexperienced breeders lay smaller clutches (Coulson & White 1961) and may have incubated less tightly than experienced birds.

The number of active nests recorded on each count, expressed as the percentage of the season's total of active nests for each plot, is shown in Figure 2. Some early breeding attempts failed before clutches were laid in other nests and the peak number of active nests equalled the known total only at Sumburgh Head Plot A, being up to 14% lower at other plots. This emphasised the need for several visits to be made during the period of egg laying, in order to record the total number of breeding attempts most accurately.

The pattern of timing of nest failure differed between plots but no plot showed the stability in numbers throughout June and July described by Richardson et al. (1981). Three of the

TABLE 2. RECORDED CLUTCH SIZES IN STUDY PLOTS AT THE 4 COLONIES. DATA FOR STUDY PLOTS AT SUMBURGH HEAD AND AT TROSWICK NESS HAVE BEEN POOLED. THE PERCENTAGE OF ACTIVE NESTS IN THE STUDY PLOTS WHERE CLUTCH SIZE WAS IDENTIFIED IS INDICATED FOR EACH COLONY WHILE THE NUMBER OF YOUNG FLEDGED PER TOTAL NUMBER OF ACTIVE NESTS IS SHOWN IN BRACKETS

Colony	Nests	Mean Clutch	Fledged Per Egg	Fledged Per Nest
Sumburgh Head (39%)				
C1	39		0.44	0.44
C2	47		0.30	0.60
C3	5		0.40	1.20
Total	91	1.63	0.34	0.56 (0.65)
Troswick Ness (37%)				
C1	7		0.29	0.29
C2	40		0.63	1.25
C3	2		0.67	2.00
Total	49	1.90	0.60	1.14 (1.11)
Noss (67%)				
C1	28		0.21	0.21
C2	65		0.21	0.42
C3	0			
Total	93	1.70	0.21	0.35 (0.35)
Eshaness (54%)				
C1	19		0.37	0.37
C2	34		0.38	0.76
C3	0			
Total	53	1.64	0.38	0.62 (0.70)
Overall (47%)				
C1	93		0.34	0.34
C2	186		0.35	0.70
C3	7		0.48	1.42
Total	286	1.70	0.36	0.64 (0.69)

Sumburgh plots and those at Troswick Ness showed gradual declines in numbers of active nests from early June until the first chicks fledged towards the end of July. A marked decrease in numbers of active nests at the other Sumburgh plot (C) between 4th-10th July coincided with an increase in the rate of breeding failure at Noss, thought to be due to increased predation of chicks by Great Skuas *Catharacta skua*. The failed nests at Sumburgh Plot C were clustered in one section of cliff and predation was also suspected, although not witnessed. In contrast, the steepest rate of nest failure at Eshaness occurred during the second half of June.

Fledging success or chick mortality in the study plots could not be determined accurately (because the precise number of young hatched was not known) but minimum estimates of chick mortality can be compared cautiously between plots (Table 3). Of the 247 chicks known to have died in plots, only 15 were seen dead in the nest. The minimum of 71% chick mortality in the Noss Plot A was thought to be due to persistent predation by Great Skuas

(and to a lesser extent Great Black-backed Gulls *Larus marinus*) which also occurred in 1985 (McKay & Crosthwaite 1985). In some 30 hours observation at the plot 21 predation attempts by skuas and gulls were seen, five of which were successful. Chick mortality (and presumably predation pressure) varied considerably within the plot. In one section, 68 chicks were known to have hatched from 56 nests but only six fledged, a minimum mortality of 91%.

We visited four other Kittiwake colonies prior to first fledging (Fig. 1) and other parts of the Noss and Eshaness colonies and the contents of a sample of nests or all visible nests (at Boddam, Westerwick and Kettla Ness) were recorded. The results were compared with data from single visits to the study plots during the same period and allow an approximate measure
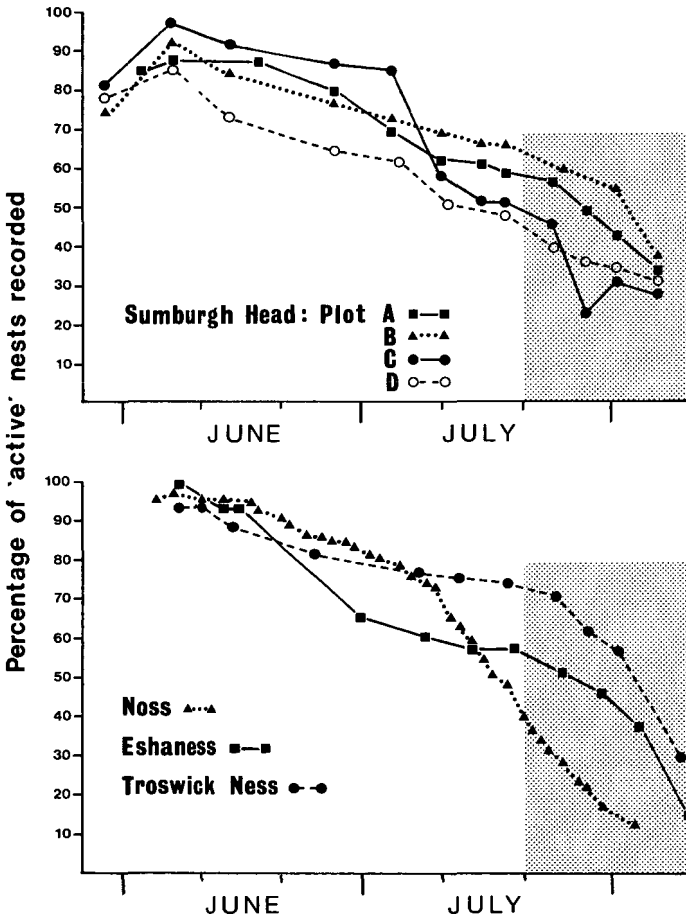
Figure 2. The number of active nests recorded on each visit to study plots, expressed as the percentage of the total for each plot. The two adjacent plots at Troswick Ness showed similar patterns of decline and counts are combined here. Shaded area indicates the fledging period.

TABLE 3. KNOWN CHICK MORTALITY IN THE 8 STUDY PLOTS. BECAUSE THE EXACT NUMBER OF CHICKS HATCHED IS UNKNOWN, THE MORTALITY FIGURE IS AN ABSOLUTE MINIMUM.

	Active nests	Chicks known to have hatched	Chicks assumed to have fledged	Minimum mortality
SUMBURGH HEAD				
Plot A	81	81	56	31%
Plot B	61	64	50	22%
Plot C	58	58	32	45%
Plot D	36	30	13	57%
TROSWICK NESS				
Plot A	104	133	115	14%
Plot B	30	42	34	19%
NOSS				
Plot A	139	167	49	71%
ESHANESS				
Plot A	99	90	69	23%

TABLE 4. NUMBER OF YOUNG RECORDED ON SINGLE PRE-FLEDGING VISITS TO 8 KITTIWAKE COLONIES

Colony and date of visit	Nests	AONs	Nests with Young	x Brood Size	Young /AON	Young /Nest
SUMBURGH HEAD						
Plot A (15/7)	94	69	46	1.28	0.85	0.63
Plot B (15/7)	66	52	38	1.37	1.00	0.79
Plot C (15/7)	64	46	27	1.22	0.72	0.52
Plot D (18/7)	39	23	16	1.25	0.87	0.51
BODDAM (12/7)	146	138	97	1.43	1.01	0.95
TROSWICK NESS						
Plots A & B (12/7)	141	115	101	1.53	1.35	1.10
NOSS						
Plot A (12/7)		117	81	1.17	0.81	
Plot B (12/7)	108	94	72	1.28	0.78	0.67
Plot C (15/7)	115	103	78	1.22	0.92	0.83
ESHANESS						
Plot A (8/7)	109	88	59	1.37	0.92	0.74
Plot B (8/7)	100	89	78	1.38	1.21	1.08
WESTERWICK (14/7)	122	105	36	1.36	0.47	0.40
KETTLA NESS (18/7)		234	111	1.35	0.64	
FOULA						
Plot A (7/7)		74	44	1.48	0.88	

TABLE 5. MEAN BROOD SIZES AND NEST OCCUPANCY RECORDED ON SINGLE, PRE-FLEDGING VISITS TO 6 SHETLAND KITTIWAKE COLONIES, 1985 AND 1986.

Colony	$\bar{x}$ Brood size		% AONs with Young		% Nests with Young	
	1985	1986	1985	1986	1985	1986
SUMBURGH HEAD						
Plot A	1.20	1.28	74.2	66.7		48.9
BODDAM	1.08	1.43	60.2	70.3		66.4
TROSWICK NESS	1.09	1.53	70.6	87.8		71.6
ESHANESS	1.09	1.38	73.8	77.4	68.2	65.6
WESTERWICK	1.06	1.36	42.0	34.3	30.8	29.5
KETTLA NESS	1.08	1.35	63.7	49.1	53.6	46.4
OVERALL	1.10	1.40	63.7	63.6		

of breeding output to be made over a wider geographic spread of colonies (Table 4). The number of chicks per AON (and per nest) in each study plot or colony was very variable, being notably low at Westerwick and Kettla Ness but high at Boddam, Troswick Ness and in Plot B at Eshaness. The number of unfledged young which died subsequent to these visits will also have varied between plots (Fig. 2), e.g. a high rate of nest failure continued at Noss Plot A after 12 July.

The results of single pre-fledging visits to colonies can be compared with data obtained from the same sections of cliff in 1985 (Table 5). The main difference between the two years was an increase in mean brood size in 1986. Brood sizes were low in 1985 with none of three recorded and none of two recorded in the large colony of 8,645 pairs on Noss (McKay & Crosthwaite 1985; Heubeck & Ellis 1986). Production was relatively low in both 1985 and 1986 at Westerwick and Kettla Ness, although it was impossible to know whether this was due to fewer nests being laid or greater loss of eggs or young.

DISCUSSION
Because of the question of representativeness of the sample of nests, it is difficult to compare the 1986 Shetland clutch sizes with data from other colonies or to draw conclusions about the effect of clutch size on chick production. Nevertheless, the Shetland mean of 1.70 was slightly lower than most published values – e.g. 1.85 in Newfoundland (Maunder & Threlfall 1972), 2.03 on Foula (Furness 1979) and 1.95 on Farne Islands (Cullen 1957). Coulson & Thomas (1985) gave values ranging from c.2.27 – c.1.87 over a 30-year period at North Shields although during years of poor feeding conditions in Murmansk, Belopol'skii (1961) recorded mean values of 1.53 and 1.74 and proportions of clutch sizes which closely resemble the 33% of one egg, 65% of two and 3% of three found in Shetland.

Except for Troswick Ness, Kittiwake chick production in Shetland in 1986 (range of 0.35 – 0.82 young per active nest) was considerably lower than values previously published for British colonies, e.g. 1.18 on the Farne Islands between 1953-1955 (Cullen 1957), 1.48 on Foula in 1976 (Furness 1979) and 1.51 on the Isle of May in 1986 (Harris, in press.). For the long-studied colony at North Shields, Coulson & Thomas (1985) give values (5-year running means) of c.1.4 chick fledged per pair in the early 1960's falling to c.1.0 by the early 1980's. In contrast, low production was reported from western Norway in the 1970's (Johansen 1978), at some colonies in southern Ireland in 1984 (McGrath & Walsh 1985) and on Canna in 1986 (Swann 1986). Comparisons with data for 1985 showed that brood sizes in Shetland

were lower in that year and while production at some colonies was low in both years, at others it improved in 1986. Chick production varied considerably over relatively short distances, being high in 1986 at the adjacent colonies of Troswick Ness and Boddam but markedly lower only 10 km to the south at Sumburgh Head.

Barrett and Schei's (1977) Norweigan study appears to be the only instance of chick production being compared between colonies within a discrete geographic area in the same year and so it is difficult to know whether the variation in production found in Shetland colonies is unusual or not. Chick production might be expected to vary between colonies, due to inherent factors such as colony size (Barrett & Schei 1977) or history (Coulson & Thomas 1985) or to environmental factors, such as local feeding conditions. Furthermore, predation pressure appears to vary considerably, both between and within colonies. Within colonies, the number of young fledged can vary according to the density of nests (the 'centre' and 'edge' effect) and two study plots (Plot D at Sumburgh Head and Plot A at Eshaness) were thought to be 'edge' areas, with considerable spacing between small groups of nests.

Predation of Kittiwake chicks by Herring Gulls *Larus argentatus* and Great Black-backed Gulls, both before and immediately after fledging has been reported from Scotland (Evans 1975; Galbraith 1983) and Norway (Burger & Gochfeld 1984; Barrett & Runde 1980), although at other colonies it does not occur (e.g. Cullen 1957). However, additional predation pressure in Shetland comes from Great Skuas. Predation of Kittiwakes – eggs, chicks, fledglings and adults – by Great Skuas has long been known to occur at Hermaness (Lockie 1952; Andersson 1976) and Noss (Perry 1948) although only fledged young and a small number of adults are taken on Foula (Furness 1981). Kittiwake eggshells are normally found in 2-3 Great Skua territories on Hermaness but predation was considered to have been unusually high in 1986, with the remains of up to 250 Kittiwake eggs in one territory and 100 in another. Such heavy predation of Kittiwake eggs by individual skuas has also been recorded in the Faroes (Bayes, Dawson & Potts 1964). The remains of Kittiwake chicks are commonly found in skua pellets on Hermaness, suggesting that predation of young is widespread (A. Martin pers. comm.) Our experience is that Great Skuas tend to concentrate their predation on particular sections of cliff rather than spreading it randomly throughout the colony and so the effects on chick production can be locally severe, as in the Noss study plot.

Low breeding success at colonies in Norway (Johansen 1978; Barrett & Runde 1980), N.E. England (Coulson & Thomas 1985) and western Scotland (Swann 1986) has been attributed to food shortage, and this was likely to have been the case in Shetland in 1985 when unusual numbers of dead young were seen in nests (Heubeck & Ellis 1986). During periods of food shortage, adults must spend more time foraging and are more likely to leave fledglings unattended (Barrett & Runde 1980) and low parental attendance was thought to have encouraged heavy predation of chicks by skuas in 1985 at Noss (McKay & Crosthwaite 1985).

The variability of chick production found in Shetland in 1986, along with the special problems of predation by skuas has important implications for the selection and number of study colonies and plots. Ideally, geographical coverage should be as wide as possible and no colony should contain just one plot.

SUMMARY

Kittiwake chick production was measured at 8 study plots in 4 Shetland colonies. While the 1.11 young fledged per incubating pair at Troswick Ness was comparable to that reported from other British colonies, production at the other 3 colonies (0.35 at Noss, 0.64 at Sumburgh Head and 0.70 at Eshaness) was considerably lower. Single visits prior to fledging were made to four other colonies and counts of chicks emphasised the variability in production between colonies. A mean brood size of 1.40 was recorded on these single visits, compared to 1.10 at the same colonies in 1985. In the Noss study plot, predation of Kittiwake chicks by Great Skuas was thought to be largely responsible for the low production. The consequences for a monitoring strategy of the variation in chick production within and between colonies are discussed.

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A comparative study of the Ischnoceran Mallophaga of Wilson's Petrel *Oceanites oceanicus* and British Storm Petrel *Hydrobates pelagicus*

J.A. Fowler and R.A. Price

Our understanding of host/ectoparasite relationships in birds is limited by the paucity of published data describing infestation levels and the structure and dynamics of mallophagan populations. Moreover, because data for particular hosts have often been collected over prolonged periods only 'average' seasonal patterns are revealed (Marshall 1981). Average values of infestation rates may be misleading because ectoparasites are rarely distributed randomly among their hosts, but rather exhibit a degree of aggregation, or contagiousness, in which most hosts have few parasites and in which large numbers of parasites may be found on a few hosts. It is therefore necessary to obtain parasites from a sufficiently large sample of hosts to describe a complete frequency distribution.

Attempts to describe mammalian ectoparasite frequency distributions mathematically have often resulted in good agreements with the negative binomial (e.g. Randolph 1975). Published descriptions of ectoparasite frequency distributions are more scarce for birds than for mammals, but negative binomial distributions were obtained for feather lice (Mallophaga) and feather mites (Acari) on Storm Petrels *Hydrobates pelagicus* and Mallophaga on Fulmars *Fulmarus glacialis* (Fowler & Miller 1984); Mallophaga and Acari on Reed Buntings *Emberiza schoeniclus* (Fowler & Williams 1985); and Mallophaga on Puffins *Fratercula arctica* (Fowler & Williams 1985, after Eveleigh & Threlfall 1976).

A static picture of a population structure may be obtained by sampling Mallophaga from birds over a period which is short in relation to their life cycles; population dynamics may be investigated by analysing a sequential series of such structures. In this way Fowler & Williams (1985) examined the population dynamics of Mallophaga on Reed Buntings, whilst Fowler *et al.* (1984) compared the population structures of a mallophagan, *Halipeurus pelagicus* Denny 1842, obtained from two population classes of Storm Petrel.

Ectoparasite populations infesting Storm Petrels in Shetland were described by Fowler and Miller (1984) and Fowler & Palma (1986). They found that, in July, two rather similar "elongate" Ischnoceran mallophagan species, *Halipeurus pelagicus* and *Philoceanus robertsi* Clay 1940, inhabited the wings of the host. The former had a relatively high infestation rate ($\bar{x} = 5.7$) and a negative binomial distribution. The mean infestation of *Philoceanus robertsi* was much lower (about 1 louse on one bird in seven) and the frequency distribution was probably Poisson. *Halipeurus pelagicus* was represented by a high proportion (62%) of nymphs, indicating that the population was in a phase of high reproductive rate. Nymphs of *P. robertsi,* on the other hand, accounted for only 17% of its population, suggesting that, at that time of year, the population had a lower reproductive rate, since a low proportion of nymphs is indicative of a declining population (Marshall 1981).

It is possible that the two mallophagan species exist on the host in a state of competition; indeed, wherever two elongate lice are known to co-exist on a petrel species, one of the species is invariably "dominant" in terms of numbers (R.L. Palma, *pers. comm.*). The fact

that two species co-exist at all suggests a degree of niche differentiation, and Fowler & Miller (1984) speculate on the basis of samples collected in July that the apparently asynchronous life cycles of the two species infesting the Storm Petrel could contribute to such differentiation; they suggest that the dynamics of the community could be further investigated by sampling at another time of year. Samples obtained in August and September are described in this paper.

Unlike the Storm Petrel, Wilson's Petrel *Oceanites oceanicus* is host to only one species of elongate mallophaga, namely *Philoceanus robertsi*. The fact that this is the same species as the "subordinate" one on the Storm Petrel offers the opportunity to investigate the frequency distribution and population structure in the absence of the "dominant" *Halipeurus pelagicus*. Furthermore, because samples of the louse can be obtained from Wilson's Petrels during the southern summer, the population structure may be described from this host at a time of year that is impossible for Storm Petrels because they are at sea during the northern winter.

METHODS

Samples of Storm Petrels were captured in mist nets by attraction to tape-lures (Fowler *et al.* 1982) in Shetland, Scotland, on three dates in August and September 1986 for comparison with samples previously obtained in July and described by Fowler *et al.* (1984). Wilson's Petrels were captured in mist nets at Bernsten Point, Signy Island, South Orkney (60° 42′ S, 45° 35′ W) on six dates between 10 January and 6 March 1985 and on three dates between 13 February and 19 March 1986. Birds were deloused in glass vessels saturated with chloroform vapour, exactly as described by Fowler & Cohen (1983). The ectoparasites thus removed were identified and preserved in 70% ethanol.

Specimens of *Philoceanus robertsi* and *Halipeurus pelagicus* were readily sorted, using a ×10 binocular microscope, into 5 distinct size categories. Head widths of a sample of each size class were measured using a calibrated microscope eye-piece graticule and Dyar's law (Teissier 1936) was applied to confirm that each size class corresponded, in increasing size, to first, second and third instar nymphs, adult male and adult female population classes.

RESULTS

Wilson's Petrel

Sixty-one Wilson's Petrels were deloused in 1985, yielding 404 Mallophaga. All but 10 of these were *Philoceanus robertsi*, of which the mean ($\bar{x}$) was 6.5 per bird, the variance (s^2) 29.5 and the median 4.8. The corresponding values for the smaller sample of 41 birds obtained in 1986 are 6.9, 43.6 and 4.6. The differences between the three pairs of statistics are not statistically significantly different ($z = 0.30$; $F_{60, 40} = 1.48$; Mann-Whitney U-test; respectively). The mean infestation over the six sampling dates in 1985 showed no trend ($r_s = 0.314$) and all samples are therefore pooled for the purpose of constructing a frequency distribution of this species.

The remaining Mallophaga comprised *Austromenopon* sp. and *Saemundssonia* sp. but it is not at present possible to identify them specifically because insufficient specimens of each sex were obtained.

The frequency distribution of *Philoceanus robertsi* on Wilson's Petrels is shown in Figure 1. The distribution is clearly an aggregated (contagious) type. An exponent, k, estimated from $k = \bar{x}^2 / (s^2 - \bar{x})$, is 1.56, and may be used to calculate the expected frequencies for a negative binomial distribution based on the sample mean and variance. The expected frequencies are shown in Figure 1, and are in close agreement with the observed frequencies
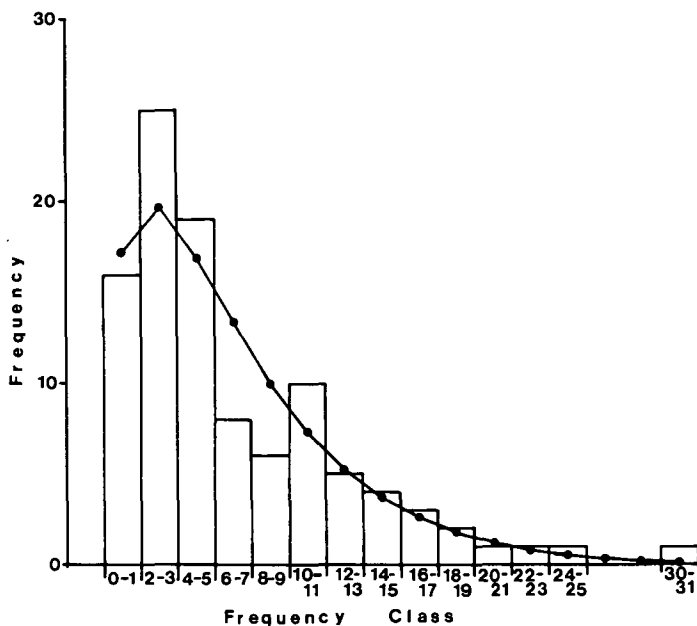
Figure 1. Frequency distribution of *Philoceanus robertsi* on Wilson's Petrels. Joined closed circles are the expected frequencies of a negative binomial distribution estimated from the sample statistics.

($\chi_9^2 = 6.98$, p> 0.50). The value of k is significantly lower than that of 4.27 recorded by Fowler & Miller (1984) for *Halipeurus pelagicus* on the Storm Petrel ($z = 3.24$, p < 0.01).

Mean head widths of each size class of *Philoceanus robertsi* (±95% Confidence Interval, $n = 10$ in each case) were 0.194 ± 0.00759mm, 0.232 ± 0.00826mm, 0.2712 ± 0.008mm, 0.298 ± 0.0051mm and 0.327 ± 0.007mm respectively. The incremental ratio is about 1.2 and a "Dyar plot" of log head width against instar number is linear and confirms that all nymphal instars had indeed been found.

To examine the population structure of *P. robertsi* on the hosts, sufficient numbers of lice were obtained in 1985 to divide the sampling units into three sub-samples corresponding to January, February and March. The number of lice collected, and the proportions of the different population classes in each sub-sample, is shown in Figure 2A. In all three sub-samples, the number of adult female *P. robertsi* exceeds the number of males. Although the sex ratio does not differ significantly from unity in any individual sub-sample, it does when the adults of all three sub-samples are combined ($\female : \male = 1.42:1$; $\chi_1^2 = 5.95$, p < 0.05).

The population structures of the three sub-samples are highly significantly different ($\chi_8^2 = 22.6$, p < 0.01), and reflect a progressive increase in the proportion of adults through the sampling period. In March, first-instar nymphs account for only 7.4% of the sample.

A smaller sample of lice was collected over a shorter time-span in 1986. This is not pooled with the 1985 sample to describe the population structure in case the life cycles of the two
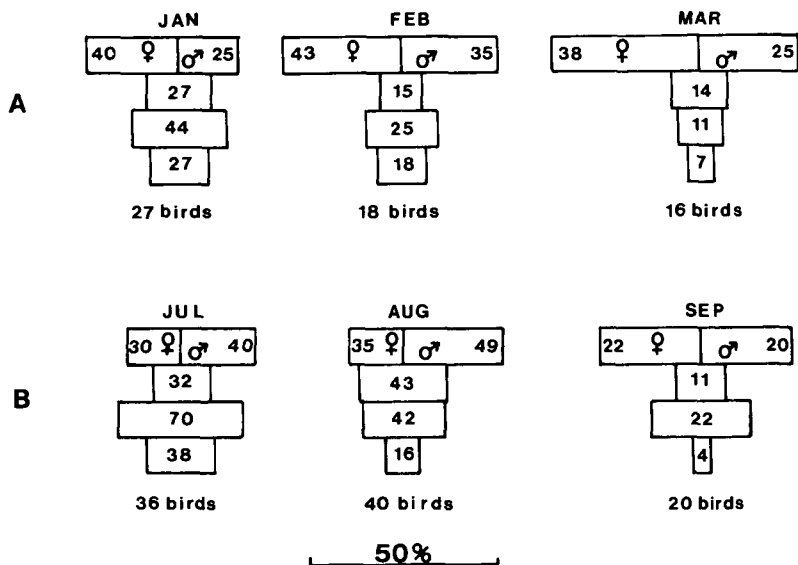
Figure 2. Population structures of elongate Mallophaga species on Wilson's Petrels and Storm Petrels. A: *Philoceanus robertsi* on Wilson's Petrels, January – March; B: *Halipeurus pelagicus* on Storm Petrels, July – September. Each "tier" in the structures represents, in ascending order, 1st, 2nd, 3rd instar nymphs, adults. Numbers within the structures are the numbers of lice obtained.

years are not quite in phase. However, the structure is statistically indistinguishable from the February 1985 sub-sample ($\chi_4^2 = 2.72$) and confirms the trend of a higher proportion of adults later in the season.

Storm Petrel

Sixty Storm Petrels were deloused and the sample of *Halipeurus pelagicus* obtained was divided into two sub-samples corresponding to August and September. The structures of these are shown in Figure 2B and are compared with the July samples described by Fowler *et al.* (1984). The difference between the three structures is statistically highly significant ($\chi_8^2 = 27.9$) and is due to a progressive increase in the proportion of adults in the population over the sampling period; in September first instar nymphs account for only 4% of the sample.

The results (including data presented by Fowler & Miller 1984) are summarised in Table 1.

DISCUSSION

The most conspicuous difference between the ectoparasite complement of the two host species is that the Storm Petrel has two species of elongate Mallophaga whilst Wilson's Petrel has only one. The interesting feature is that the louse species *Philoceanus robertsi* found on the Wilson's Petrel is present also on the Storm Petrel, but is subordinate to its second louse species, *Halipeurus pelagicus* (in this discussion the terms "dominant" and "subordinate" are used to indicate relative numbers only).

TABLE 1. SUMMARY OF POPULATION CHARACTERISTICS OF THE ELONGATE MOLLOPHAGA OF STORM PETRELS. DATA FOR *HALIPEURUS PELAGICUS* IN JULY DESCRIBED BY FOWLER & MILLER (1984) ARE INCLUDED

		Mallophaga species	
		Halipeurus pelagicus	*Philoceanus robertsi*
Storm Petrel	Source	Shetland, July-September	Shetland, July-September
	Mean lice per bird	5.75	0.15
	Variance s^2	13.48	0.18
	Frequency distribution	Negative binomial, $k = 4.27$	Probably Poisson
	Population structure	High reproductive rate with 66% nymphs in July, declining to 45.7% nymphs in September	"Aged" with 14.3% nymphs in July
Wilson's Petrel	Source		Signy Isle, Antarctica January-March
	Mean lice per bird		6.6
	Variance, s^2	(NOT	34.8
	Frequency distribution	PRESENT)	Negative binomial, $k = 1.56$
	Population structure		Actively reproducing with 60% nymphs in January, declining to 34.4% in March

The close agreement of the frequency distribution of *P. robertsi* on the Wilson's Petrel with that of a negative binomial is not unexpected. Reasons why ectoparasites should be contagiously distributed among their hosts have been discussed and reviewed by Crofton (1971), Randolph (1975) and Fowler & Williams (1985), and include such factors as seasonal variation in infestation rates; non-random spatial distribution of hosts in the habitat; resistance to re-infestation by previously infested hosts; and non-random differences in behaviour or physiology (e.g. moult) related to different age classes within the host population. Why the frequency distributions should conform mathematically so well with a negative binomial model, rather than some other model of contagiousness, is not clear, but Anderson & May (1978) postulate that the value of the binomial exponent, *k,* is a measure of the destabilising effect of the parasite on the host population, and is related to the relative reproductive rates of the parasite and host.

The frequency distribution is similar to that of *Halipeurus pelagicus* on the Storm Petrel, but the latter has a more symmetrical distribution with a mode of 3-4 lice which is reflected in the higher value of *k* (as *k* increases, so too does the degree of symmetry of the distribution until eventually the distribution conforms to Poisson). It is not possible to further discuss the biological significance of these sample statistics until more is known about the life histories of the lice, possibly from *in vitro* studies.

Although the mean infestation of Wilson's Petrels by *P. robertsi* did not change during the sampling period, the population structure of the louse altered markedly. The structures illustrated in Figure 1A show a progressive decrease in the proportion of nymphs in the population. The proportion of nymphs peaks when a population is in a vigorously reproducing phase (Marshall 1981). When reproductive rates decline, so does the proportion of nymphs as their more ephemeral stages moult into the longer-lived adults. Crude extrapolation of the observed trend suggests that by June the louse population structure would consist of about 80% adults – similar to the population structure of this species which is found on Storm Petrels in July (Fowler & Miller 1984). It seems likely that the reproductive rate reaches a minimum at about this time, before recovering through the latter part of the calendar year until the cycle is complete and the population structure observed in January is restored. The population structure of *P. robertsi* on Wilson's Petrels in January and February is statistically identical to that of *Halipeurus pelagicus* on Storm Petrels in July, and, as Figure 2B shows, the populations of both louse species undergo a parallel ageing process towards the end of their host's breeding season.

Until such time as large samples of both petrel species can be obtained from their respective wintering grounds for delousing, the complete annual cycles of the mallophagan populations cannot be elucidated with certainty. However, the evidence presented in this paper, when viewed with that of Fowler & Miller (1984), suggests that, on the Storm Petrel, the life cycles of the two louse species are out of phase with each other, possibly the outcome of an adaptive strategy which reduces competition. The observations can further be accounted for within the concepts of "fundamental niche" and "realised niche" described by a number of authors (e.g. Krebs 1985), in which the definition of "niche" includes a multiplicity of biological factors, including density and breeding strategy.

Either of two scenarios seem possible; in both the fundamental niches of *Philoceanus* and *Halipeurus* are taken to be similar to those now occupied on the Wilson's Petrel and Storm Petrel, respectively:

(a) *Philoceanus* is an ancient taxon which infested an extinct precursor of both *Oceanites* and Hydrobates. As the petrel species diverged, *Philoceanus* remained on both and retained a synchronous life cycle on both hosts, even though the hosts' breeding season became asynchronous. *Halipeurus* emerged later and became successful on *Hydrobates*. Competing with *Halipeurus, Philoceanus* assumed a realised niche of greatly reduced density. Bearing in mind Hardin's (1960) axiom "complete competitors cannot coexist", *Philoceanus* maintains a stable, but sub-ordinate, population on *Hydrobates* by virtue of a life cycle which is asynchronous with *Halipeurus*.

Or,

(b) *Philoceanus* and *Halipeurus* evolved separately on *Oceanites* and *Hydrobates*. *Philoceanus* then became established on *Hydrobates* through a secondary infestation brought about by chance encounter of the two petrel species (Fowler & Miller (1984), consider how this might arise). Unable to occupy its fundamental niche on the new host in the presence of *Halipeurus, Philoceanus* occupies a subordinate realised niche by retaining breeding synchrony with the population on its original host.

Detailed investigations of the phylogenetic relationships between the two hosts and those of their lice, supported by comparative studies of other petrels, may eventually suggest which of the alternative scenarios is the more likely.

SUMMARY

The frequency distribution of an elongate feather louse *Philoceanus robertsi* found on the Wilson's Petrel *Oceanites oceanicus* conforms well with a negative binomial model. Its infestation density and frequency distribution are similar to those previously described for another elongate louse *Halipeurus pelagicus* found on the Storm Petrel *Hydrobates pelagicus*. An analysis of the population structures of the lice reveals that both species have highest reproductive rates during the breeding season of the host, but both structures became dominated by adults, suggesting an ageing and declining process, towards the end of the hosts' breeding season. *Philoceanus robertsi* is also found on the Storm Petrel, but at a much lower density. Its reproductive cycle on this host appears to be in synchrony with that of the population on Wilson's Petrels. Explanations in terms of niche differentiation are offered.

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A genus of feather louse new to the Manx Shearwater *Puffinus p. puffinus*

J.A. Fowler and R.W. Furness

It has long been known that the Manx Shearwater *Puffinus p. puffinus* is host to three species of feather lice (Mallophaga): *Halipeurus diversus, Trabeculus aviator* and *Austromenopon paululum* (e.g. Fowler & Miller, 1984). When ectoparasite samples obtained by the method of Fowler & Cohen (1983) from 41 breeding and immature Manx Shearwaters were examined on Rhum, Western Isles, in July 1985, two birds yielded 3 adult females and 1 third instar nymph of a large louse we did not recognise. It was provisionally identified by R.L. Palma (National Museum of New Zealand) as *Naubates harrisoni*. An additional 20 birds deloused at the same site in July 1986 fortunately delivered a single confirmatory male which R.L. Palma has identified as *N. harrisoni* Bedford 1930 *sensu lato* (Mallophaga: Philopteridae). The louse, whose type host is *Puffinus gravis*, is widespread on several shearwater species, but the genus is apparently unreported from any subspecies of *P. puffinus* (R.L. Palma, *pers. comm.*).

Despite the low infestation level (3 birds in 61) it seems surprising that such a large louse should have gone unnoticed for so long. The question of how populations of lice existing at such low densities can maintain homogeneous gene pools intrigues us, especially when it is recalled how infrequently hosts, particularly immatures, encounter each other to provide an opportunity for louse interchange.

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Changes in numbers of cliff-nesting seabirds in Orkney, 1976-1985

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INTRODUCTION

In 1976 a programme to monitor changes in numbers of cliff-nesting seabirds at five colonies on Mainland Orkney was established. Since then counts have been made on an annual basis, and were reported after 5 years (Wanless *et al*. 1982a). This paper reports on the counts over the ten year period, 1976-1985.

METHODS

Between four and seven fixed plots were established at five colonies on Mainland Orkney in 1976 (Fig. 1). Following Wanless *et al*. (1982a) counting was discontinued at several plots, and new plots were added. Plot descriptions and photographs are given in Jones (1978), Wanless *et al*. (1983) and Tasker (1983). The choice of plots and colonies was not random but determined by logistics (visibility of plots, safety of observer, etc.). The count procedure was standardised by Jones (1978) and modified by Wanless *et al*. (1982a). The modified procedure has been followed for the purpose of this analysis and is summarised below. Data collected prior to the modifications have been re-analysed using the modified procedure.

(i) Species counted: counts were made of individual Guillemots *Uria aalge,* Razorbills *Alca torda* and Fulmars *Fulmarus glacialis* and apparently occupied nests of Kittiwake *Rissa*
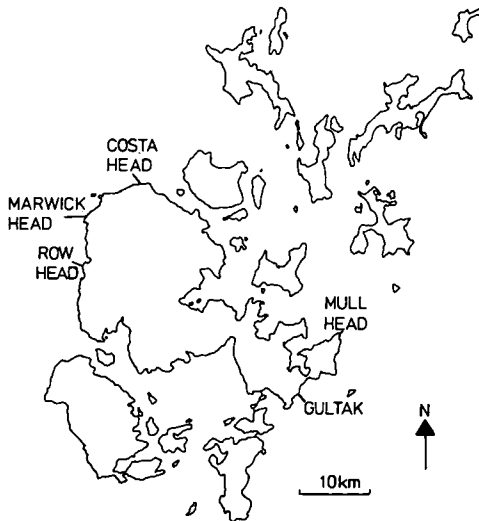
Figure 1. Location of colonies on Mainland Orkney where counts were made.

tridactyla. Nests were defined as a substantial structure capable of holding an egg (whether or not any are present) with one or two adults in attendance.

(ii) Timing: all counts were made in June between 0600 – 1500 GMT. Guillemot and Razorbill counts were discontinued after 22 June as chicks normally start to fledge by this date. Each plot was counted at approximately the same time each day.

(iii) Number of counts: in almost all years between five and ten counts were made at every plot.

(iv) Weather conditions: counts were not made in wind strengths greater than Beaufort Force 4, or in heavy rain or fog; wind and rain may affect seabird attendance (Jones 1978).

Analysis

As the number of plots counted in each colony varied over the 10 year period it was not possible to compare the total number of birds or nests in the plots at each colony directly. A colony average was computed for each year using only data from those days when all plots in a colony were counted. Comparisons between adjacent years were made with t-tests using only those plots common to both years. An index was established, for each species at each colony using 1976 as a baseline. This index has been updated each year using percentage change of all plots within a colony common to adjacent years. An index for Mainland Orkney for each species was calculated using all common plots between years, regardless of colony.

Throughout this paper the term 'significant' is used solely in its statistical sense to indicate differences significant at the 95% level or greater. In some instances changes considered significant in this paper were not considered significant by Wanless *et al.* (1982a) and vice versa. This is because data for Guillemots and Razorbills were treated differently (in their analysis counts after 22 June were included).

Whole colony counts

Counts were made of all Guillemots, Razorbills and Kittiwakes visible from the cliff top at all the study colonies in 1981 and at all but Marwick Head in 1985. Fulmars were counted in 1985 but not 1981. A count of all Kittiwake nests visible from land was made at Marwick Head in 1983, to repeat a count made in 1979 (Planterose 1979). These counts were divided into 36 discrete sub-sections of the colony. All counts were made between 0800 and 1900 GMT.

RESULTS

Guillemot

Guillemot numbers in the plots rose fairly steadily at 7.6% p.a. from 1976-1981 and have decreased slowly since at 3.3% p.a. (Fig. 2). With some variation, this has been the pattern at plots in each of the five colonies (Fig. 3). Counts of total numbers at four colonies indicate a fall of 7.6% in numbers between 1981 and 1985, compared to a 12.5% fall recorded in the index for the four colonies over this period (Table 1).

Razorbill

The changes in Razorbill numbers in the plots closely parallelled those of Guillemots until 1981. Subsequently Razorbills have declined at a faster rate but with some recovery in 1985 (Fig. 2). All the plots at all colonies but Row Head conform roughly to this pattern – the numbers at that colony remained almost unchanged until 1981, but have since declined (Fig.
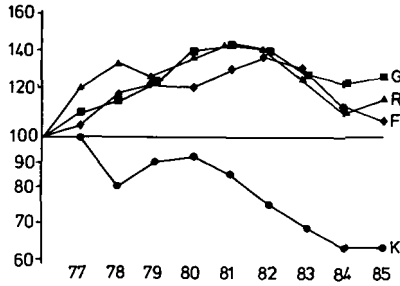
Figure 2. Changes in indices of birds in monitored plots 1976- 1985 (log scale) standardised to 100 in 1976. Guillemot individuals (G), Razorbill individuals (R), Fulmar individuals (F) and Kittiwake nests (K).
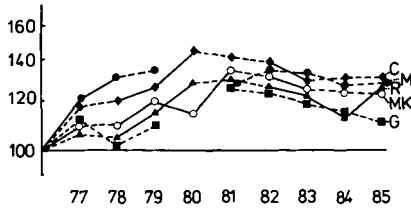

Figure 3. Changes in colony indices of individual Guillemots, 1976-1985 (log scale) standardised to 100 in 1976 at Costa Head (C), Mull Head (M), Row Head (R), Marwick Head (MK) and Gultak (G). Significant annual changes are indicated by a continuous line.
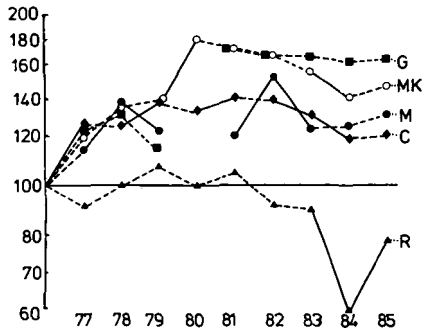

Figure 4. Changes in colony indices of individual Razorbills, 1976-1985 (log scale) standardised to 100 in 1976. Symbols as in Figure 3.

TABLE 1. COUNTS OF GUILLEMOTS, RAZORBILLS AND KITTIWAKES VISIBLE FROM THE CLIFF TOP AT COLONIES ON MAINLAND, ORKNEY IN 1981 AND 1985 WITH PERCENTAGE CHANGE. THE PERCENTAGE CHANGE BETWEEN THE TOTALS DERIVED FROM THE PLOTS IS ALSO GIVEN.

	1981 *Total*	*1985* *Total*	*Percentage change*	*Percentage change in all monitoring plots 1981-1985*
Guillemot (individuals)				
Costa Head	7504	7492	−0.2%	−10.8%
Row Head	6921	6104	−11.8%	−6.0%
Gultak	2105	1799	−14.5%	−16.8%
Mull Head	1390	1171	−15.8%	−3.6%
Total	17920	16566	−7.6%	−12.5%
Razorbill (individuals)				
Costa Head	771	675	−12.4%	−20.0%
Row Head	189	149	−21.2%	−30.0%
Gultak	387	470	+21.4%	−8.8%
Mull Head	84	125	+48.8%	+13.2%
Total	1431	1419	−0.8%	−18.8%
Kittiwake (nests)				
Costa Head	1796	1650	−8.1%	−2.0%
Row Head	2549	2258	−11.4%	−15.2%
Gultak	883	522	−40.9%	−20.0%
Mull Head	1392	1066	−23.4%	−26.0%
Total	6620	5496	−17.0%	−25.9%

4). Counts of total numbers at the four colonies showed a fall of only 0.8% between 1981 and 1985 while the index compiled from the plot counts showed a fall of 18.8% over the same period (Table 1).

Kittiwake

Kittiwakes have declined since the study commenced until by 1985 the colony indices were down to 63% of the 1976 level. Most of this decline has been since 1980 numbers having recovered almost to the 1976 level by then after declines to 1978. The decline from 1980 – 1984 was 9.6% p.a. Numbers remained unchanged from 1984 to 1985 (Fig. 2). The colonies at Row and Marwick Heads and Gultak have changed in a similar way to the general pattern except for the declines in the first two colonies being rather greater. Mull Head increased until 1980 but has since decreased in a similar fashion to Gultak. Numbers at Costa Head have only declined slightly as one of the constituent plots, Ramna Geo, has increased every year since 1976 thus countering to some degree the effect of the other plots which all decreased (Fig. 5). The whole colony counts of Kittiwakes fell by 17% in the four colonies counted in 1981 and 1985, while the colony indices fell by 25.9%. At Marwick Head a count of nests in 1983 was 34.6% lower than a count conducted in 1979; the decrease in the colony index over this period was 32.3%. This, however, hid considerable variation in changes within different sub-sections of the colony. The mean fall in the 36 sub-sections was 32.6% ±14.1%, range −64% to +9%; the 64% drop was in an area where the cliff had fallen; otherwise, the largest decrease was 55% (Tasker 1983).

Figure 5. Changes in colony indices of Kittiwake nests, 1976-1985 (log scale) standardised to 100 in 1976. Symbols as in Figure 3.
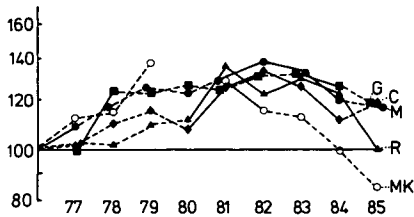

Figure 6. Changes in colony indices of individual Fulmars, 1976-1985 (log scale) standardised to 100 in 1976. Symbols as in Figure 3.

Fulmar

Fulmar numbers increased in the plots at 5.5% p.a. until 1982 but have since decreased at 8.1% p.a. until in 1985 they were almost back to the 1976 level (Fig. 2). The colonies have all behaved in a similar fashion – though those at Row and Marwick Heads are now at or below the 1976 levels (Fig. 6).

DISCUSSION

(i) *Aims and counting methods*

The aim of seabird monitoring is to study a sample of the colonies in order to detect actual changes in overall numbers present both between years and over a number of years. The programme in Orkney has shown changes in numbers of all species in the plots being monitored.

   The Orkney populations of seabirds are nationally important. During Operation Seafarer (1969-70) they held 22% of Britain and Ireland's Guillemots, 6% of Razorbills, 27% of Kittiwakes and 15% of Fulmars (Cramp *et al.* 1974). We suggest that, ideally, monitoring should be able to detect 1% p.a. changes in the British and Irish populations of these species. Thus changes of 5% (Guillemot), 17% (Razorbill), 4% (Kittiwake) and 7% (Fulmar) in the Orkney population would need to be detected for this degree of accuracy to be reached. Wanless *et al.* (1982b) have shown with the current method of ten counts per year significant increases and decreases of 11% and 10% can be detected for Guillemots, 30% and 22%

respectively for Razorbills, 4% and 3% respectively for Kittiwakes and 21% and 17% respectively for Fulmars. The degree of accuracy obtainable with the current method reaches the desired level only for Kittiwakes. A great deal of work has been undertaken on refining monitoring techniques for Guillemots and it would appear that, due to the behaviour of the species, the current level of change detectable may be as good as can be attained. This does not mean that further refinements should not be investigated. One possibility is the photographic surveillance used by Olsen (1985) where numbers of non-breeders could be separated from numbers of breeders, thereby decreasing the variation in counts in a colony. The levels of change detectable in Razorbills and Fulmars are less than that considered acceptable and we suggest that further work needs to be undertaken to develop accurate monitoring techniques for these species. Notwithstanding the above it has been possible to detect trends over several years. These are almost certainly real as the length of the runs is much longer than random expectation would predict.

(ii) *Representativeness of plots*

The five main colonies on Orkney Mainland are currently monitored. At least 7.9% of the Fulmars, 12.2% of the Guillemots, 12.2% of the Razorbills and 12.2% of the Kittiwakes are counted in the plots at each colony (Benn 1985). At Mull Head, virtually the whole colony is censussed. These plots cannot be regarded as statistically representative of the colonies and therefore of the Orkney populations. We consider, however, that complete representativeness of the populations is probably unobtainable on Orkney for a variety of reasons. Harris *et al.* (1983) suggest that random sampling of plots would improve representativeness. However, with random sampling, the observer is still confined to choosing a sample from those plots which may be safely counted from land; in the study by Harris *et al.* (1983) on the Isle of May, plots were only selected from 31% of the island's Guillemot population. The Orkney monitoring programme currently counts around 23% of the five colonies' population of Guillemots (28% of Razorbills, 27% of Kittiwakes and 15% of Fulmars). We are not convinced that an increase in coverage or in the number of plots from which a selection is made could be implemented in Orkney without a decrease in counting accuracy due to factors such as distance from observer. Harris *et al.* (1985) have suggested that plots should be chosen that allow plenty of room for increase. These plots may however behave differently from plots which are already full. This has been shown for Kittiwakes by Coulson (1983) in which small colonies are more attractive to recruits than large ones and thus increase at a greater rate. The same effect has been demonstrated for decreases at colonies (Heubeck *et al.* 1986). Perhaps low density areas should be chosen for plots if we want to detect change but plots of different densities should be chosen if we want to measure change.

Most plots in Orkney were chosen in areas where all four species were present. As each species has different nesting requirements it is impossible to choose plots that have adequate numbers of each species present. Plot size for Guillemots was optimised following recommendations of Wanless *et al.* (1982b), and some single species plots established. We recommend that further research be conducted to establish ideal plot size for the species which are less well represented in the plots and that optimum sized plots be established for these species.

The programme for monitoring numbers of Kittiwakes in Shetland has shown that the scheme there has not followed the actual changes in numbers on the cliffs as a whole (Heubeck *et al.* 1986). The monitoring plots showed a greater decline than the colonies. On Orkney the numbers at the colonies declined at all sites, and with the exception of Gultak, the declines as registered by the whole colony counts and by monitoring plots were in reasonable agreement (Table 1). The difference between the results from Orkney and

Shetland may be due to the fact that Orkney's Kittiwake population is much more concentrated than Shetland's, due to the nature of the coastline. Mainland Orkney has only 7 colonies, compared to a very much larger number of colonies in Shetland. There has been no recent comprehensive survey of Kittiwakes on other islands in Orkney, so that changes elsewhere cannot be examined. However, a complete photographic survey from the sea of the west cliffs of Westray, Rousay and Mainland in 1983 showed that there had been no colonisation of new areas since 1976, when a previous photographic survey had been conducted (Tasker 1983). It would appear that at present the monitoring programme is following changes in numbers in Orkney Mainland relatively well, but we suggest that a wider all-island count be conducted in order that overall changes in Orkney populations may be followed in future.

ACKNOWLEDGEMENTS

SUMMARY

A programme of monitoring numbers of cliff nesting seabirds in Mainland Orkney annually during the years 1976-1985 is described. During this period numbers of Guillemot, Razorbill and Fulmar increased until the early 1980's and have since decreased. Kittiwakes have declined over the period and the number of nests in 1985 was 63% of that recorded in 1976. Counts of whole colonies indicate that in most cases the monitoring scheme is following trends in numbers, although with a tendency to exaggerate their magnitude. There is a need to investigate the causes of these changes.

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Opportunistic feeding of Black Guillemots *Cepphus grylle* at fishing vessels

P.J. Ewins

Throughout most of its range the Black Guillemot *Cepphus grylle* feeds on a wide variety of fish and invertebrates usually caught on or close to the sea bed in shallow inshore waters (Bradstreet & Brown 1985). In Shetland sandeels (*Ammodytidae*) form the bulk of the diet in summer, with a greater dependence on invertebrates during the winter months (Ewins 1986).

Whilst carrying out studies of foraging behaviour around Mousa, Shetland (60° 00'N 1° 10'W) in 1983 and 1984, I noticed that in April and May (but not at other times of year), some of the 300 or so Black Guillemots foraging in the area were exploiting an unusual source of food. From April to September small fishing boats (15-20m in length) caught sandeels by trawling a net over areas of sandy sea bed around Mousa. When they began hauling the net, up to 30 adult Black Guillemots regularly swam or flew into the area aft of the trawler and commenced rapid diving sequences. As the net was hauled in the loose diving flock moved closer to the boat, indicating that the birds were actually diving to the vicinity of the net. Most diving occurred 30-200m from the stern, but a few birds dived as close as 5m from the boat. It was not possible to time the dives due to the numbers of birds involved, but it appeared as though dives became shorter as the net drew closer to the stern of the trawler. On occasions birds surfaced with a large sandeel, estimated to be 12-15cm long. However, some birds appeared to be swallowing as they surfaced and may have ingested smaller fish underwater, as has been noted in other auks (Swennen & Duiven 1977). The fish were probably taken either from the mouth of the net or whilst trapped in the net mesh itself. I saw this feeding method most commonly in the late morning and afternoon, presumably because most adults attended breeding colonies at either end of the day at this time of year (Ewins 1985).

Herring Gulls *Larus argentatus* and Lesser Black-backed Gulls *L. fuscus* invariably attended these net hauls, but surprisingly were never seen to chase Black Guillemots surfacing with sandeels. They concentrated instead on plunge-diving onto the rising net, or pecking sandeels protruding through the mesh as it was winched aboard. Like the Black Guillemots they appeared to respond to the cut in engine speed or change in engine pitch, by flying towards the trawler. On one occasion two Guillemots *Uria aalge* joined the flock diving on the net, but despite large numbers of auks and Shags *Phalacrocorax aristotelis* feeding in the general area this was the only record of other species adopting this feeding method.

A similar opportunistic feeding method was reported by scallop fishermen in Shetland. When dredges were hauled two or three Black Guillemots dived onto the dredges, presumably seeking prey extruded from the rising dredge net, or disturbed on the sea bed by the moving dredge. On one occasion a Black Guillemot regularly fed on discarded invertebrates thrown overboard whilst sorting scallops on the boat (R. Cowie *pers. comm.*).

During studies of seabirds utilising fishery waste in Shetland, Hudson (1986; *pers. comm.*) saw a few Puffins *Fratercula arctica* and Black Guillemots near to whitefish and sandeel trawlers but on no occasion were they thought to be feeding on fishery waste.

DISCUSSION

Although this feeding method has not been noted previously in Black Guillemots, it has been recorded in other auks (though only rarely). Hillis (1971) regarded this as "scavenging

behaviour" and noted up to 20-30 Guillemots and two Razorbills *Alca torda* diving repeatedly as trawls were being hauled in Irish waters. In contrast Watson (1981) recorded small numbers of these species loitering at the periphery of scavenging flocks of gulls at fishing trawlers in the same area, but considered that the auks were independent of the trawlers' activities. Little Auks *Alle alle* have been seen feeding on fishery waste on the Nova Scotian shelf, on the contents of discarded fish stomachs (Rees 1983), but again this is probably an exceptional feeding method for this species. Active association with man's fishing activities appears to be rare amongst auks, although large numbers may be killed incidentally whilst feeding in areas where fixed gear such as monofilament gill-nets is set (Petersen 1981; Evans & Nettleship 1985).

Body condition is crucial for adult birds during the pre-breeding period (Drent & Daan 1980), and I suggest that in April and May adult Black Guillemots were capitalising on this rich supply of food in an attempt to improve their body condition before breeding, at a time when long periods of the day are spent at breeding sites and fish may be less numerous than later in the season. Similarly, in the northern North Sea, Tasker *et al.* (1985) noted that Gannets *Sula bassana* fed at trawlers in the pre-breeding period, when pelagic fish shoals were relatively scarce, but in May there was a shift to feeding on sandeels, away from fishing vessels.

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The marine distribution of Sooty Shearwater, Manx Shearwater, Storm Petrel and Leach's Petrel in the North Sea

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INTRODUCTION

Five members of the order Procellariiformes are seen regularly in the North Sea. The marine distribution of the Fulmar *Fulmarus glacialis* was described by Blake *et al.* (1984) and Tasker *et al.* (1985). Only three of the remaining four species, Manx Shearwater *Puffinus puffinus*, Storm Petrel *Hydrobates pelagicus* and Leach's Petrel *Oceanodroma leucorhoa* breed within the North Sea. Colonies are confined to Orkney and Shetland, where it is likely that several thousand Storm Petrels, several hundred Manx Shearwaters and few Leach's Petrels breed (Cramp *et al.* 1974, Seabird Colony Register). Larger numbers of all three species breed on islands off the west coast of Scotland and in the Faroes.

Manx Shearwaters, Storm Petrels and Leach's Petrels are rare in the North Sea between December and April. The fourth species, Sooty Shearwater *Puffinus griseus*, is a late summer and autumn visitor to the North Sea, from breeding grounds in the southern oceans. Phillips (1963a) showed that Sooty Shaerwaters followed a clockwise circular migration path in the Atlantic Ocean to make optimal use of both prevailing winds and seasonal variation of food stocks. In addition, he suggested that breeding adults were unlikely to follow the migration path further than the Newfoundland Grand Banks in the western North Atlantic, as this would prevent them returning to their breeding sites in time for egg-laying. Consequently the majority of birds that arrive in the eastern North Atlantic in August and September are likely to be non-breeding birds. Around the British Isles, Sooty Shearwaters were commonest over the continental shelf to the north-west (Phillips 1963b). Many have been observed in the North Sea, particulaɪ ly from the coasts of north-eastern Britain (Jones & Tasker 1982). All four species are rare off the continental coasts of the North Sea; occurrence there is normally during periods of onshore wind in September, October and November (Noer & Sorensen 1974, Camphuysen & Dijk 1983, Rasmussen 1985).

This paper reports observations of these four species made in the North Sea by the Nature Conservancy Council's Seabirds at Sea Team between 1979 and 1986. Records made in the Moray Firth, using exactly the same methods, by a team from the Royal Society for the Protection of Birds in 1982 and 1983 are also included.

METHODS

Results reported here were compiled entirely from observations made from ships which enabled broad coverage of the study area. Ships engaged in fishing activities were excluded to avoid bias caused by the attraction of scavenging species (Blake *et al.* 1984).

Counts presented are in the form of numbers of birds seen per unit of distance travelled (or by indicating all records of occurrence for Leach's Petrel which was seen far less frequently than the other species). These counts will suffer from bias caused by movement of flying birds. This is probably irrelevant for comparisons of abundances within a species, but may seriously bias any inter-species comparisons (Tasker *et al.* 1984). Densities obtained from a standard band-transect method (which give more quantified results) are not presented

here as too few birds were seen in the band (Tasker *et al.* 1984). Each month of observations was analysed separately, with all years of observation combined. For mapping, months were amalgamated if the monthly distributions were similar.
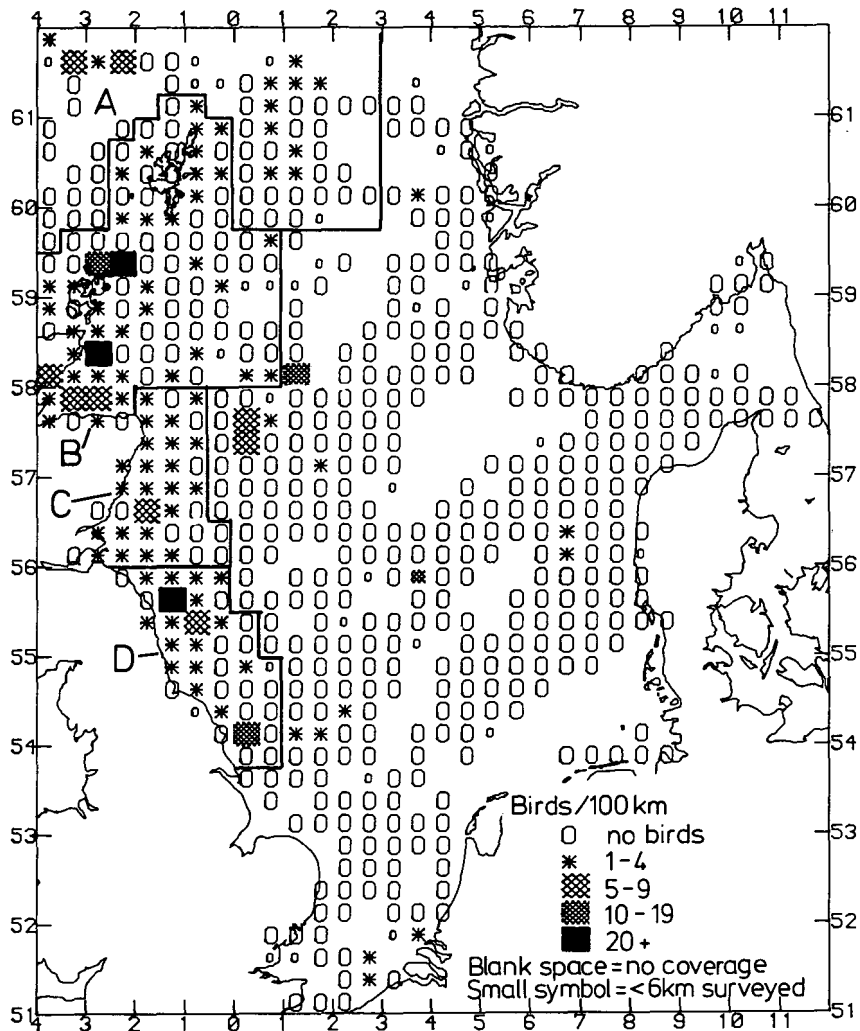

Figure 1. The distribution and average abundance (birds/100km surveyed) of Sooty Shearwaters in the North Sea from July to October. A = northern North Sea, B = northern Scotland, C = eastern Scotland, D = north-eastern England (see Figure 2).
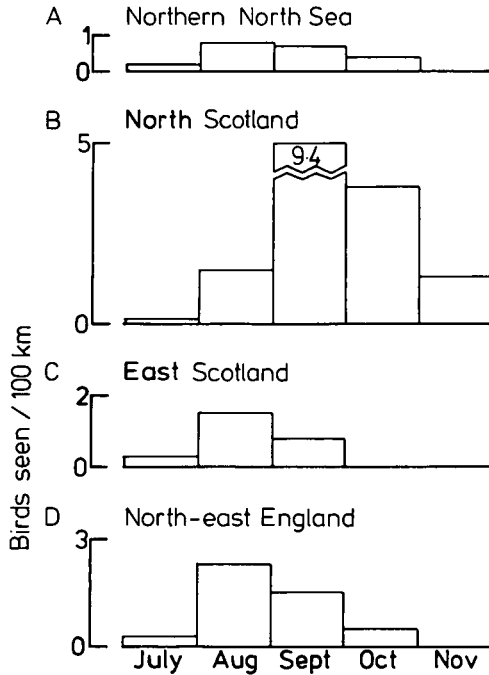
Figure 2. Monthly (July to November) average abundance of Sooty Shearwaters in four zones of the North Sea. See Figure 1 for zone boundaries.

RESULTS

Sooty Shearwater

Sooty Shearwaters were recorded at sea in the North Sea between June and November. Almost all records were from the western North Sea (Figure 1). Four zones were used to show changes in numbers within this area (Figure 2). Highest abundances were recorded in the zone off northern Scotland. These figures do not include one exceptional sighting of a flock of 2500 birds which was made in the Moray Firth in September 1983 (Mudge & Crooke 1986). This is the largest flock ever recorded in North Sea waters. If this flock is included in the analysis, the average number of Sooty Shearwaters/100km rises to 80 in September off north Scotland. Peak abundances in the other three zones occurred in August. The last sightings of Sooty Shearwaters in the year were in the Moray Firth in November.

Manx Shearwater

Manx Shearwaters were observed between May and October in the North Sea. Figures 3 and 4 show numbers of Manx Shearwaters recorded in June/July and August/September respectively. The study area was divided into four zones (Figure 3) for further analysis (Figure 5).
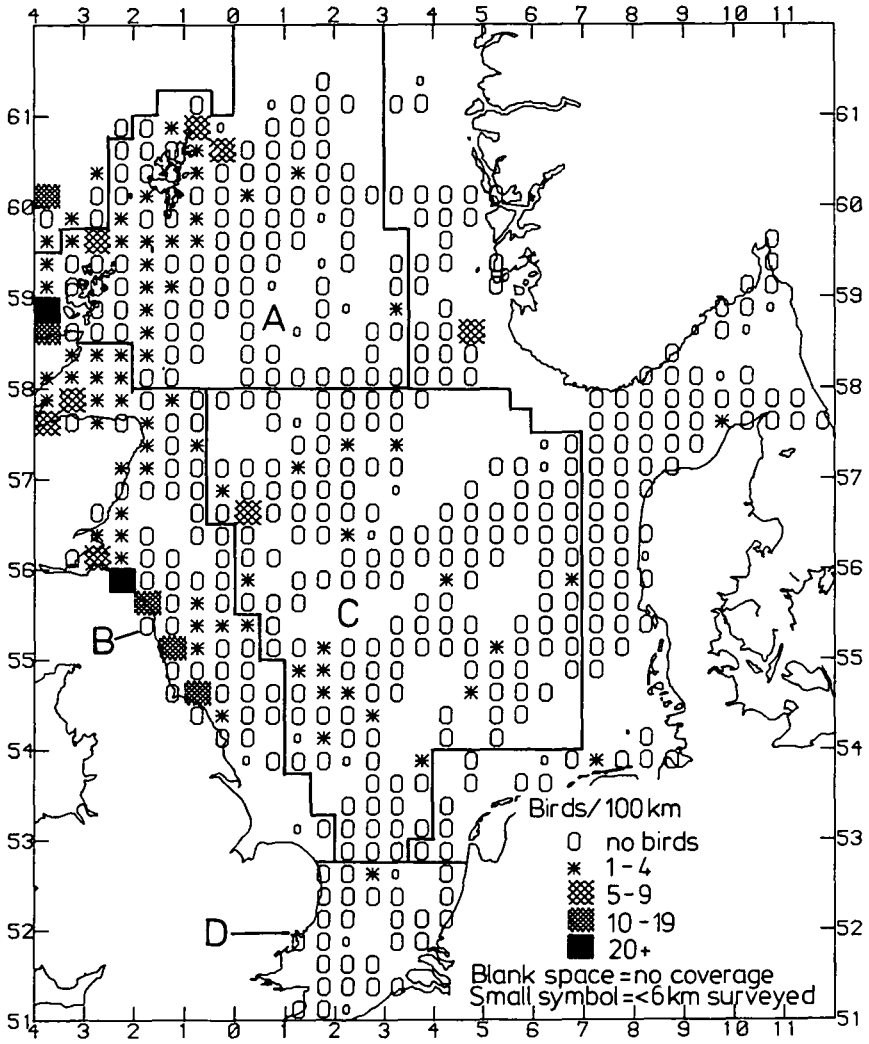
Figure 3. The distribution and average abundance (birds/100km surveyed) of Manx Shearwaters in the North Sea in June and July. A=northern North Sea, B=western North Sea, C=central North Sea, D=southern North Sea (see Figure 5).
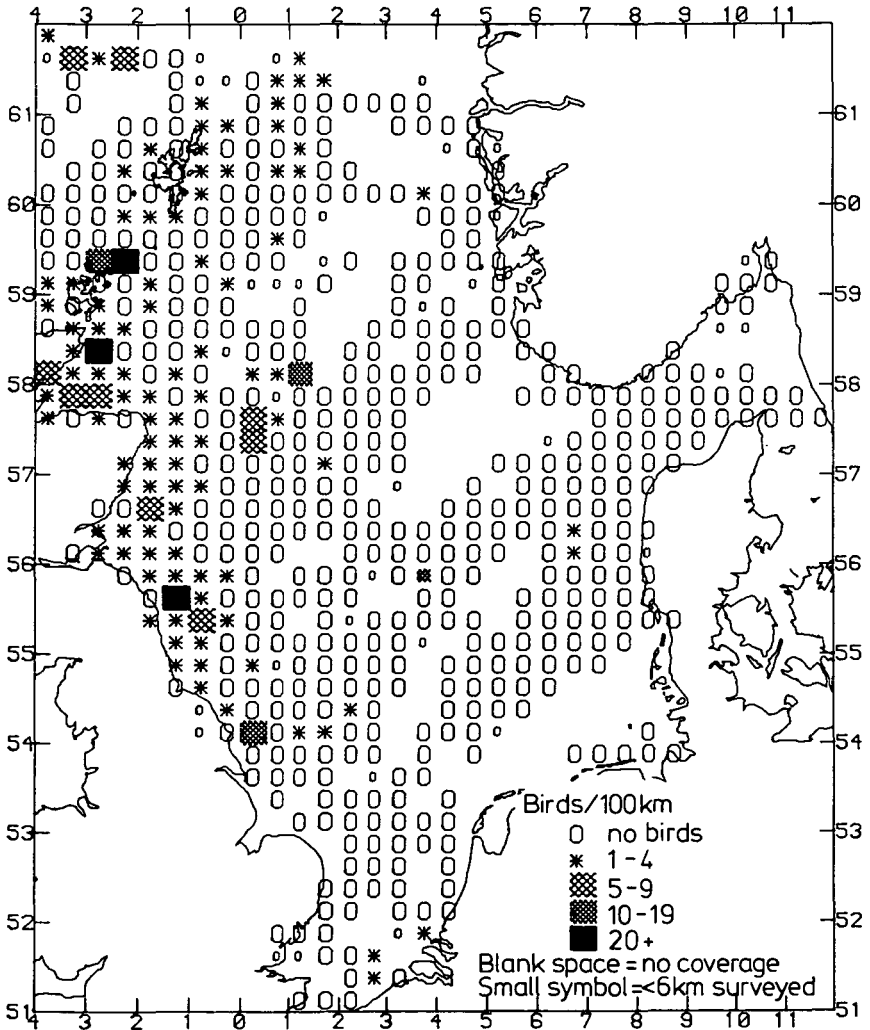
Figure 4. The distribution and average abundance (birds/100km surveyed) of Manx Shearwaters in the North Sea in August and September.
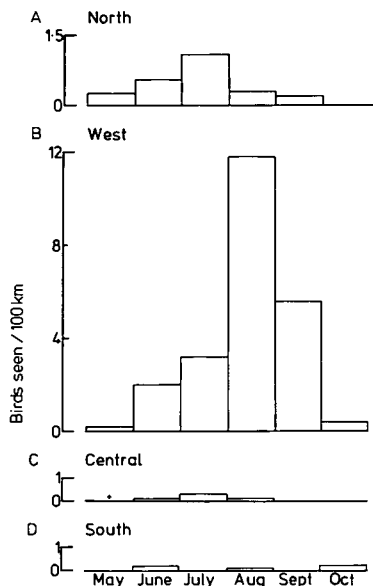
Figure 5. Monthly (May to October) average abundance of Manx Shearwaters in four zones of the North Sea. See Figure 3 for zone boundaries.

In the northern zone, near the breeding colonies, Manx Shearwaters were first recorded in May and reached maximum abundance in July. In the western North Sea, peak abundance occurred in August and relative numbers seen were approximately a factor of ten greater than around the breeding colonies. The inner Moray Firth and areas off north-eastern England were especially important for Manx Shearwaters during August and September (Figure 4). Few Manx Shearwaters were seen in the central and southern North Sea at any time of year.

TABLE 1. AVERAGE ABUNDANCE OF STORM PETRELS (BIRDS SEEN PER 100KM TRAVELLED) BETWEEN MAY AND SEPTEMBER IN FOUR ZONES OF THE NORTH SEA

Zone (see Figure 6)	May	June	July	August	September	October	November
1. North and west of Shetland	0	9	3	16	0	nd	nd
2. East of Orkney and Shetland	0	1	1	5	6	1	0
3. Inshore Orkney and Shetland	2	4	4	3	1	1	0
4. Off north-east Scotland	0	†	†	0	0	0	†

nd = no data   † = present at less than 1 bird per 100km travelled
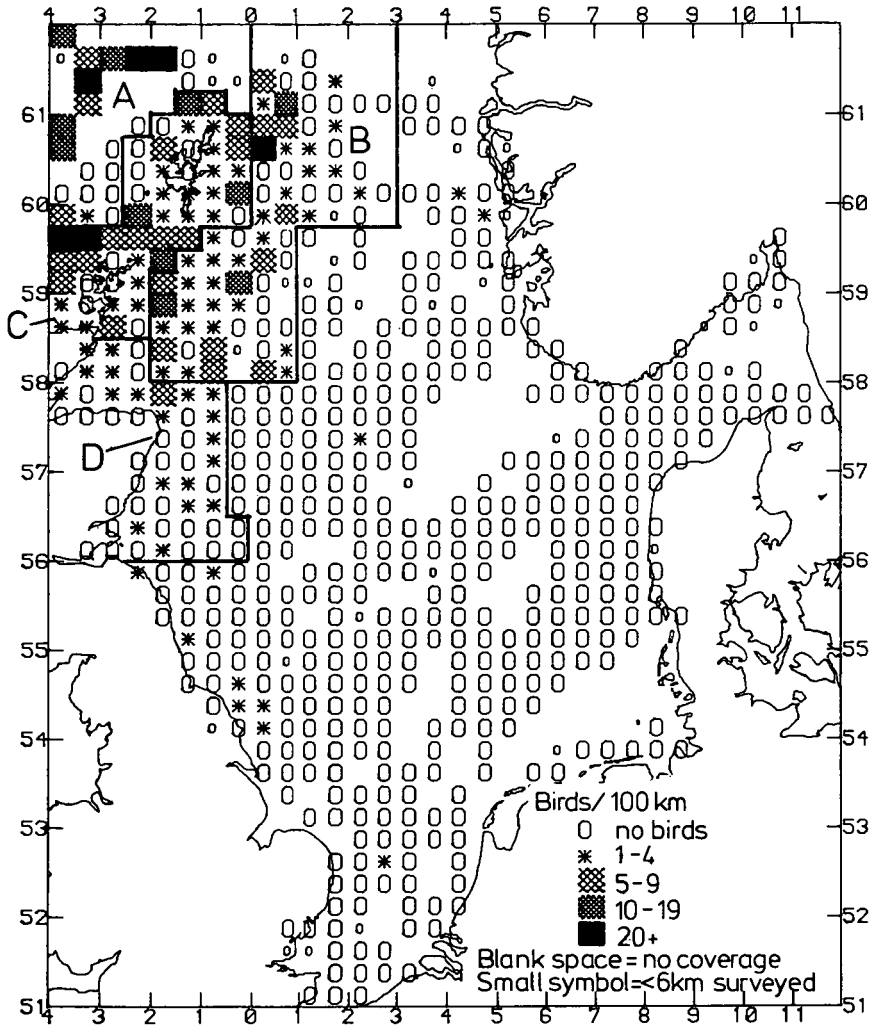
Figure 6. The distribution and average abundance (birds/100km surveyed) of Storm Petrels in the North Sea from June to October. A = north and west of Shetland, B = east of Orkney and Shetland, C = inshore Orkney and Shetland, D = north-east Scotland (see Table 1).
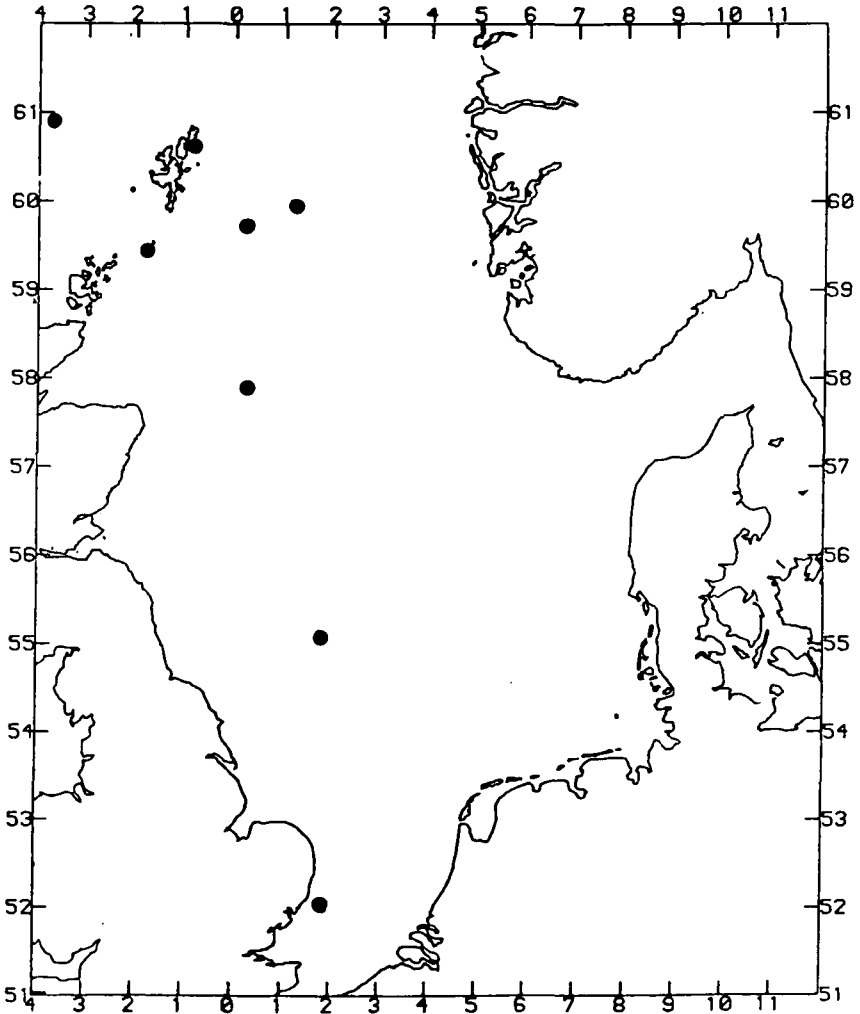
Figure 7. The distribution of sightings of Leach's Petrel in the North Sea.

Storm Petrel

Records of Storm Petrels were most common towards the north-west of the North Sea, in the area surrounding the known breeding colonies (Figure 6). Table 1 shows Storm Petrel abundance by month for four zones within this area.

Earliest sightings were in May, inshore around Orkney and Shetland; numbers in this zone peaked in June and July. Storm Petrels were however most abundant in the zone to the north-west of the breeding colonies, in particular at the continental shelf edge (Figure 6). Numbers in this area peaked in August. Abundance offshore to the east of Orkney and Shetland (Zone 2) peaked in September. The last records of the year in the North Sea were in the zone off eastern and north-eastern Scotland.

Leach's Petrel

Eight records of Leach's Petrel were made at sea between 1979 and 1986. Most of these sightings (Figure 7) were in the northern North Sea. The two southernmost records both occurred in November. The number of sightings was too low for any further conclusions to be drawn.

DISCUSSION

Two main, interrelated factors probably influence the pelagic distribution of seabirds; the location of food resources and of breeding site. The latter factor is only likely to be important when birds are attending their colonies.

Food resources

There have been no studies of the food of these species in the North Sea, however all are known to be planktonivorous or to feed on small fish (Cramp & Simmons 1977). The area over the edge of the continental shelf to the north and west of Shetland held high numbers of Storm Petrels, particularly in August. These high numbers suggest that there was increased prey in the area. This continental shelf edge may cause some upwelling of water as the North Atlantic Drift flows against it. Turbulence, caused by upwelling or mixing, within the water column can enhance nutrient flow to the surface waters, thus increasing plankton production (Pingree *et al.* 1978). Such turbulence may also physically move prey items towards the surface. Both of these processes may enhance the abundance and availability of prey items in surface waters.

Turbulence occurs also along the coast of some areas of the North Sea due to movements of the tides. While our daytime observations indicated that Storm Petrels avoided sea-areas immediately beside land (see close to Orkney and Shetland, Figure 6), it may be that Storm Petrels moved inshore to feed by night. This is supported by the daytime scarcity of Storm Petrels off north-eastern Scotland (where there are no colonies) over many thousand hours of observation from land (M. Innes, pers. comm.). However, luring of these birds using taped calls by night in the same area has resulted in the capture of many hundreds (A. Webb, pers. obs.). Perhaps Storm Petrels avoid sea areas immediately adjacent to land by day to minimise predation. However, at night when plankton tend to move closer to the surface, Storm Petrels may feed closer to land, particularly in areas where water-mixing has enhanced food supply.

Both shearwaters occurred further south in the North Sea in larger numbers than Storm Petrels. Manx Shearwater distribution was very coastal, with highest abundances off certain river outfalls into the North Sea. These outfalls and the coastal zones are areas where there will be considerable tidal mixing of the water column. River outfalls may also bring other

food items from the land. Several other species of seabird were observed scavenging on these outfalls (Tasker *et al.* 1987).

Breeding biology

There have been no studies of Manx Shearwater or Storm Petrel breeding biology in the North Sea. However, on the Welsh island of Skokholm, Manx Shearwaters of breeding age returned to their colonies between late February and early April, with an influx of older immatures from late May onwards (Harris 1966). The breeding season is long and post-breeding departure from the colonies occurred predominantly in September. During the second half of the breeding season however, immatures and failed breeders disperse away from the breeding colonies.

On Skokholm, Storm Petrels returned to the colonies in late April and May, whilst non-breeders arrived about a month later (Davis 1957). Exodus from the same colonies started in the second half of August with failed and non-breeders and continued until the chicks fledged in late September and early October.

Manx Shearwaters and Storm Petrels breed in Orkney and Shetland. Occurrence in the areas around these islands conformed broadly to that expected from the existing information about the timing of the breeding cycle for each species. Elsewhere it seems likely that non-breeders were present, particularly from August onwards. The substantial increases in the abundance of Storm Petrels in the offshore zones to the north-west and east of the Northern Isles and similar increases in Manx Shearwater abundance in the western North Sea suggest that birds from colonies outside the area may have been involved.

The number of Leach's Petrels seen during the seven years of this project was very low. Distribution was generally restricted to the north-west North Sea in summer. Two sightings further south in November are likely to be late migrants.

Sooty Shearwaters, Manx Shearwaters and Storm Petrels all migrate southwards for the northern winter. Sooty Shearwaters and Storm Petrels were both last sighted in November off north-east Scotland. It would appear that the majority of both these species present in the North Sea during the autumn depart from the area by rounding the northern tip of Scotland. Undoubtedly a few birds move south in the North Sea and pass through the English Channel to reach the Atlantic (Oliver 1971). Manx Shearwaters were last sighted in October in the south and west zones of the North Sea. However the numbers seen were very low and the northern approaches are likely to be more important as an exit route from the North Sea than the English Channel.

SUMMARY

Records of Storm Petrel, Leach's Petrel, Sooty Shearwater and Manx Shearwater seen between 1979 and 1986 from ships in the North Sea are presented. Leach's Petrel proved rare. The three other species occurred mainly in the northern and western North Sea. The centre of Storm Petrel distribution was

further north than that of the shearwaters which were very coastal in their distribution. Storm Petrels avoided the waters immediately beside land, at least during daytime. The distributions of all three species were associated with areas where water was more turbulent than elsewhere and possibly prey was more abundant. Occurrence in the North Sea conformed to known breeding schedules for those birds that breed in the area.

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Sandeels *Ammodytes marinus* in the diet of the Fulmar *Fulmarus glacialis* in Shetland, Scotland

J.A. Fowler and A.P. Dye

There is concern that the dramatic increase in annual landings of Sandeels *Ammodytes marinus* caught in the North Sea since the early 1960's (Furness 1982) will result in shortages for Shetland seabirds. Although there is as yet little evidence of this (Furness & Monaghan 1987) it is important to determine the contribution that Sandeels make to the diet of seabirds.

Furness & Hislop (1981) recovered fish otoliths from pellets regurgitated by Great Skuas *Catharacta skua* on Foula, Shetland, and, by regression analysis, determined the size distribution of Sandeels in the diet. Ewins (1985) estimated visually the size distribution of Sandeels fed to Arctic Tern *Sterna paradisaea* chicks on Mousa, Shetland, whilst Furness & Todd (1984) reported that 72% of regurgitates collected from Fulmars *Fulmarus glacialis* on Foula, Shetland, contained Sandeels.

This paper describes the size distribution of Sandeels, calculated from measurements of otoliths recovered from Fulmar regurgitates on Yell, Shetland, and compares it with the size distribution of Sandeels obtained from commercial fishermen in Shetland and with the results of the studies above.

METHODS

Regurgitates from adult and unfledged Fulmars were obtained from 30 sites around the coastline of Yell and its associated islands during July 1984 and 1985. Regurgitates were washed with water to remove oily material and then 'panned' with water in a white plastic dish. Organic material was scooped off and the heavy otoliths were removed from the bottom and stored in 70% ethanol.

In mid-July 1985, fresh Sandeels were obtained from a quay-side factory at Scalloway, Shetland. We do not know in which Shetland waters the Sandeels were caught. Four vats were sampled arbitrarily at different depths until about 2kg of Sandeels were collected. The sample was quartered randomly to provide a working sample of 231 fish. Each was measured to 0.1mm with vernier calipers from the tip of the snout to the ventral lobe of the caudal fin extended backwards. Otoliths were dissected from each fish and, together with those obtained from the regurgitates, were measured with vernier calipers to 0.01mm. The relationship between length of Sandeel and length of otolith was examined by least squares regression, assigning otolith length to the x-variable and assuming negligible error on this axis.

RESULTS

The relationship between Sandeel length and otolith length was:

Sandeel length = (44.01 × otolith length) + 27.92mm.

The coefficient of determination, r^2, was 0.774 and the residual variance, S_r^2, 56.82. The 95% confidence interval for the estimation of a Sandeel length from its otolith length varies between ±14.88mm and 15.43mm over the range of fish obtained.
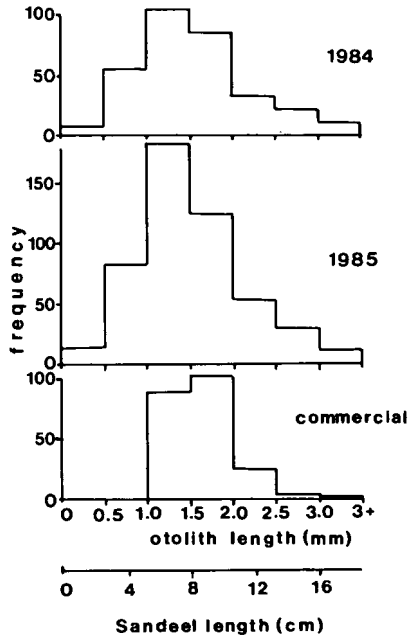
Figure 1. Frequency distribution of size classes of Sandeel otoliths recovered from Fulmar regurgitates on Yell, Shetland in 1984 and 1985, together with that obtained from a 1985 sample of commercially obtained fish. The lower scale is Sandeel length estimated by regression.
Sample sizes: 1984: 299, 1985: 496, Commercial: 231.

A total of 101 regurgitates was obtained (38 in 1984, 63 in 1985) of which 51% contained otoliths. Of these, 92% contained Sandeel otoliths which accounted for 95% of all otoliths present (the remainder were from Norway pout *Trisopterus esmarkii,* Haddock *Melanogrammus aeglefinus,* Saithe *Pollachius virens* and Pollack *P. pollachius*).

Of the regurgitates containing Sandeel otoliths, 84% contained fewer than 25 otoliths, whilst 63% of all otoliths occurred in regurgitates containing more than 25. Figure 1 shows the frequency distribution of otoliths grouped into 0.5mm size-classes obtained from the 1984 and 1985 samples, together with the frequency distribution of Sandeels obtained from the commercial source (the x axis is scaled additionally to show the estimated Sandeel lengths).

The frequency distributions of the 1984 and 1985 samples show a close resemblance and are not statistically significantly different ($\chi_3^2 = 4.78$). In each sample the mean otolith length is 1.52mm and the modal class is 1.0-1.5mm, corresponding to Sandeels of 72-94mm. The mean length of otoliths from commercial Sandeels is 1.62mm and the frequency distribution is significantly different from the regurgitated samples ($\chi_3^2 = 49.72$, p<0.01) with a modal class corresponding to Sandeels of 94-116mm. A striking feature of the commercial sample is the truncation below 1.00mm (corresponding to Sandeels of 72mm). One explanation for this is that Sandeels smaller than this escape capture through the mesh of the net. Nevertheless, even when regurgitated otoliths below 1mm are excluded from the analysis the

size distribution is still significantly different ($\chi_2^2 = 28.63$, p<0.01). There is clearly considerable overlap in the sizes of Sandeels captured by Fulmars and fishermen with a tendency for Fulmars to take the smaller end of the distribution range.

DISCUSSION

The regression equation solved for Sandeels in this study, namely Sandeel length = 44.01 otolith length + 27.92mm, differs from that used by Furness & Hislop (1981), namely Sandeel length = 39.928 otolith length + 40.588. The difference probably reflects either differences in methodology or the possibility that separate Sandeel populations were being sampled. There is no reason to suppose that in both studies reasonably accurate estimates of Sandeel lengths were not obtained. In practice, the difference is rather small for fish near the centre of the distribution: this study predicts that an otolith 2.5mm long came from a fish of 138mm, whilst Furness & Hislop's (1981) equation predicts a length of 140mm, a difference
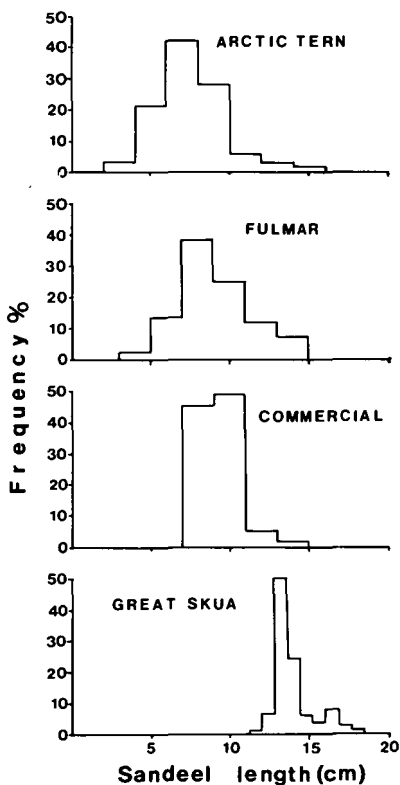

Figure 2. Frequency distribution of Sandeel size classes reported in the diet of three species of Shetland seabird compared with a commercial catch: Arctic Tern, after Ewins (1985); Fulmar, this study; Great Skua, after Furness & Hislop (1981).

of only 1.4% – well within a standard error of the estimate.

A potential source of error is due to dissolution of otoliths to an unknown extent prior to regurgitation. This is likely to be different between adults and chicks, and results in an underestimation of lengths of Sandeel predicted by regression equations.

Furness & Monaghan (1987) state "most Shetland seabirds feed on the one- and two-year old Sandeels, which form the bulk of the diet of Shetland seabird chicks". We can now assemble the size-class frequency distribution of Sandeel prey delivered to three seabird chick species: Arctic Tern (Ewins 1985), Great Skua (Furness & Hislop 1981) and Fulmars (this study). The relationship is summarised in Figure 2. It appears that Arctic Terns, Fulmars, Great Skuas and fishermen are removing Sandeels of a similar size distribution, with Great Skuas taking the larger end of the range and Arctic Terns the smaller. Furness & Hislop (1981) describe the feeding strategies of Great Skuas, pointing out that the main source of Sandeels is direct predation upon dense shoals which rise to the surface. Some of their prey, however, is obtained by kleptoparasitism and this may substantially bias prey selection towards larger items. Arctic Terns probably seek fish at a lower density in shallow water. Furness & Todd (1984) estimate that Shetland Fulmars have a potential feeding range of 120-200km but little is known of how they catch their Sandeel prey. It is possible that a proportion of the Sandeel prey taken by Fulmars is obtained by scavenging behind fishing boats. The exact proportion is not known, but if it is high, it would not be surprising that the size distribution of commercial and Fulmar-caught Sandeels is similar.

Fish stocks in Shetland and other coastal waters are likely to vary from year to year, and changes may have consequences for seabird productivity. This preliminary study provides a baseline for comparison with future changes.

SUMMARY

Otoliths recovered from Fulmar regurgitates in Shetland during 1984 and 1985 were estimated by regression to have come from Sandeels of a size range 60-160mm, with a modal range of 72-94mm. Comparison with other studies shows that Sandeels taken by Fulmars are a little larger than those taken by Arctic Terns, but smaller than those taken by Great Skuas.

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BOOK REVIEWS

BOAG, D. and ALEXANDER, M. 1986. The Atlantic Puffin. Pp. 128, numerous colour photos in text, 1 map. Blandford, Poole. £12.95.

This is the third book to be written on *Fratercula arctica* – the pioneer, rather anthropomorphic and unfortunately out-of-print *Puffins* by Ronald Lockley (Dent, 1953), my own (I like to think slightly more scientific) *The Puffin* in 1985 (Poyser) and now *The Atlantic Puffin*. (To add more confusion there is also the short booklet *The Puffin* by Jim Flegg.) Obviously I have the vested interest in such books but I will try and be objective in my assessment of this one.

The Atlantic Puffin consists of about 70 pages of text and 50 of colour photos taken by the authors. Thus it differs from the two other books in its reliance on colour. The text, written by David Boag on 'basic research' done by Mike Alexander while he was warden on Skomer NNR, will probably take second place to the photographs in attracting buyers. Skomer has previously been the scene of several studies on the Puffin – some of Lockley's work, Ruth Ashcroft did a commendable D.Phil. thesis there, Peter Corkhill studied food, Peter Hudson the survival of immatures and Christopher Perrins' EGI team are continuing to follow adult survival. All the photos appear to have been taken on Skomer and the main new information presented on the bird came from the authors' observations of chicks underground. This was done by placing a 'hide' over an excavated nest-chamber. This technique was first used (on Skomer) by Peter Corkhill and later by several photographers, who obtained pictures of a far lower quality than these presented here. There is a niche for a book on the Skomer Puffin. *The Atlantic Puffin* approaches this as their own observations and narration come from there but many published data are included and it is sometimes not clear to the uninformed reader if these refer to Skomer or elsewhere.

There are some very good and striking pictures, including aspects of puffin-life not often seen – underground, underwater and on the sea. The standard of reproduction is mostly good but in some cases sharpness has suffered, probably due to the printing, and none of those inside the book approach the clarity of the stunning Puffin on the dust-jacket. The text is well written and the book is an easy read. The standard of accuracy is generally good but there are some lapses. For example, flightlessness during wing moult is not typical of all auks as the smaller auklets replace their primaries in an orderly sequence. The statement, that a great many colonies have rabbits, is just not true. Rightly, much is made of the development of the beak taking several years, but an excellent picture of a winter-plumaged adult at the colony is incorrectly labelled a 1-year-old whereas several bill grooves/ridges are clearly visible. The distribution map is inaccurate as it misses out some well known breeding areas such as Jan Mayen, Bear Island, the far north of Greenland but shows a colony at sea to the east of Novaya Zemlya (seemingly because the caption symbol from the map of that area in *The Puffin* is included). The index is too brief to be useful.

The book has plenty of details of puffin biology but is not, and perhaps was never meant to be, truly scientific as no sources are given for the information used. The suggestions for further reading are resticted to just 11 items including an unpublished thesis, a difficult-to-get 1877 French paper and the newsletter of the *Fratercula Fund* (the only non-European reference whose author is Stephen Kress (not Kiess). Both Ruth Ashcroft and I are given handsome credit for our researches, and Ronald Lockley is mentioned in the text but some other workers are forgotten. Richard Perry (who, after all, with Lockley started Puffin study) and several eminent Scandinavian and North Americans could be miffed by lack of acknowledgement, given the title of the book. Kenny Taylor studied the behaviour and standardized terminology. His terms such as Gape, Low Profile Walk, Post-landing Posture, Head Jerk are all here, as is his concluding advice in his chapter in *The Puffin* to watch in the evening, but he again gets no credit. The attention to such details could have raised this from a pleasant and well-illustrated read to a useful book.

M.P. Harris

BURTON, R.1985. Bird Behaviour. Pp. 224. Numerous colour photographs. Granada, London. £10.95 hardback.

At last! A book full of pictures of birds actually doing things, and a clear, concise text which explains what they are doing. Popular bird books come in many forms, but this is easily the best I have seen for a long time. Robert Burton has produced an excellent pictorial overview of the interesting and beautiful behaviour of birds. Although not specifically about seabirds, there are enough seabird examples (e.g. feeding behaviour, pp94-97, colonial life pp142-145), to keep even the most narrow minded seabird specialist happy.

'Bird Behaviour' is divided into ten chapters of varying length, each conveniently broken down into short, readable sections. The chapters cover the following: flight, senses, food finding, diet, communication, social life, courtship and mating, rearing the young and migration. Burton's aim in producing this book has been to extract from the scientific literature important and interesting results from studies of bird behaviour, and to present them in a way that your mum would understand: he has succeeded admirably. The text is clear and informative, and right up to date, and supplemented by numerous outstanding colour photographs. Burton must have gone through Bruce Coleman's entire collection to get the number and range of photographs he has for this book! Although 'Bird Behaviour' is primarily for the bird watcher who wants to understand more about the behaviour he or she sees birds performing, this book is so full of exciting information there is something to interest everyone, whatever their interest in birds.

My only criticism is that there are no references, nor indeed a guide to further reading. To be fair, the inclusion of references would have made the book less readable, and would have doubled its length.

This book is a bargain at £10.95: all (sea) bird watchers and biologists should read and own a copy.

T.R. Birkhead

CROXALL, J.P. (ed.).1987. Seabirds: feeding ecology and role in marine ecosystems. Pp. 408. Cambridge University Press, Cambridge. £30. ISBN 0-521-30178-5.

After reading this multi-author volume I was encouraged to believe that studies of seabird feeding ecology are finally becoming interesting. Even if tedious papers listing squid with the double misfortune of possessing a long Latin name and of cropping up in the vomit of albatrosses are still necessary (and I speak as somebody who has written one such), more interesting questions can now be posed with the prospect of a preliminary answer. For instance is the energetic impact of seabirds on marine ecosystems different in different oceanic zones? But I jump ahead. How does the book, the result of a symposium on 'Seabirds and Nutrient Cycles' at the 1982 International Ornithological Congress, encourage such optimism?

The volume's structure is clear. The first section considers constraints on seabirds. Hunt and Schneider's chapter on oceanographic constraints has the preposterous ratio of 10½ pages of references to 21 pages of text. More entertainingly Colin Pennycuick explores how seabird wings have evolved in various directions from those of a 'standard' seabird, the White-chinned Petrel. For example frigatebirds have increased wing length and maintained a constant aspect ratio which is economical for thermal soaring, but slow. Is this the reason for slow nestling frigatebird growth? In the other direction use of the wings for underwater propulsion has the most dramatic impact. We are told that a Macaroni Penguin could fly, cruising at 40m/s (BMWs watch out), provided it could flap at 50 Hz. This frequency is achieved by smaller hummingbirds but would impose intolerable stresses on a penguin wing. Bob Furness discusses kleptoparasitism and Kooyman and Davis consider seabird diving performance. Penguin field studies are progressing nicely but there is terrific scope for work on the metabolic performance of (captive?) diving birds.

The chapters on the dietary studies of the four most truly marine bird groups, penguins, petrels and albatrosses, Pelecaniiformes and auks are also the most traditional in approach. At times they exemplified what has brought studies of community structure and competition into such ill repute. Thus, if dietary differences occur between sympatric species, ecological segregation is proclaimed. If there is considerable overlap, as in Tony Diamond's study of Aldabran frigatebirds, hands are thrown up and a post-hoc explanation is manufactured. This is another field where there are (almost?) sufficient data to test specific hypotheses about what circumstances might be correlated with more or less overlap.

Six chapters cover ecosystem studies from sub-Antarctic South Georgia through sub-tropical Hawaii to Arctic Bering Sea. It looks as if Hawaiian seabirds may take around 40 percent of the annual production of small surface pelagic fish and squid. Is this a fundamental contrast with cooler more seasonal systems where the seabird take has usually been estimated at 20-30 percent? However the principal message of these ecosystem chapters is that the seabird data now generally superior to data on the population dynamics of the fish, squid and crustacean prey of the birds. Fish, squid and crustacean biologists take note!

This review cannot, I'm afraid, end without a grumble about some of the inconsistencies that are all too often concomitants of a multi-author volume. For instance (p. 58) 'It is still often stated (wrongly) that frigatebirds seldom venture far from land.' Indeed it is, on p. 177. One paragraph in Chapter 16 is so confused it tested my powers of comprehension to the limit, and perhaps beyond. And the potentially

interesting correlations (Chapter 12) between Californian seabird distribution and satellite maps of sea surface temperature are wrecked by lack of figure legends.

The fact that four of the six ecosystem chapters were written by Americans is a reflection of the cost of these studies. If data from aerial bird surveys, satellite imagery and prey sampling are to be integrated usefully, the data must be collected systematically, probably simultaneously and certainly expensively. It would be a shame if NERC's financial distress excluded British workers from playing a full role.

M. de L. Brooke

FURNESS, R.W. and MONAGHAN, P.1987. Seabird Ecology. Blackie, Glasgow & London, Chapman & Hall, New York. Pp. 164. £9.95 (paperback). ISBN 0-216-92088-4.

A synthesis on seabird ecology has been surprisingly slow in emerging, possibly because too many of its investigators are beleaguered on islands or ships for much of the year, and spend the rest decoding guano-spattered notebooks. One of Blackie's Tertiary Level Biology series (which includes Perrins' and Birkhead's *Avian Ecology,* publ. 1983), this timely text is designed to cater for advanced undergraduates, but will also benefit a wider spectrum from interested layman to professional researcher.

The main chapters cover respectively lifestyles, feeding, population regulation, interactions with fisheries, monitoring (mostly pollutants in) marine environments, seabirds as pests, and conservation requirements. Quite a tall order in 147 pages of actual text (plus bibliography), but with a few reservations it is well done and no-one will leave this book without a richer understanding of a most intricate ecosystem and the role of seabirds in it. In the first 2 chapters (30 pages) the authors take for granted a fair degree of knowledge on the reader's part, and while this justifiably creates more space for the subtler relationships explored later on (cf. 46 pages on interactions with fisheries) it needs to be said that seabird 'biology' as such is given crash-course treatment. For example there is no mention of asynchronous hatching or its significance while, more seriously, the factors influencing pelagic distribution of seabirds are treated to a frugal paragraph. A kind of short-hand also sometimes creeps in, so that, e.g., we are told the male (Emperor Penguin) incubates the egg 'with his feet'. The punchy succession of facts and examples nevertheless leaves the reader with nuggets for the memory (manna to the undergraduate!) like why there are no auks in the tropics, and why skimmers can feed at night.

The chapters on population regulation, fishery interactions, and monitoring yield more measured and polemical debate. In the second of these three, a careful grounding in energetics leads to an up-to-the-minute analysis of the subtle links between seabirds and major world fisheries (Peruvian, South African, Antarctic, and North Sea). In so constantly manipulated a system as the North Sea, the modelling approach does much to concentrate the mind, if not yield ready answers. One wonders if the possible scenario (Fig. 5.18) of increased industrial fishing in the 1990's will come about, given the forecast downturn in agricultural production and the fishermen's current trend of returning to lucrative whitefish, resulting in reduced sand-eel (etc.) processing in Scotland (and already the closure of the brand new plant on Barra).

It is at least clear, from graphs of parameters spanning the last hundred years, that seabird biologists have at no time been blessed with a remotely stable ecosystem to study. Techniques and understanding are improving, however, and patterns emerging. Remarkable is it not, for instance, that numbers of terns breeding in the Clyde sea area correlate with the catch per unit effort of herring two years later. Wresting such secrets from the ecosystem is a spur and reassurance to the scientist. The text goes to great trouble to tease out the web of cause and effect, which makes it something of a pity that there are hiccoughs in the visual aids: the three tables are missing from chapter 8, and the captions do not fully explain Figs. 5.6 and 8.1. The running heads on Chapters 3 and 4 are also adrift.

On balance, I feel the authors have been right to focus (especially the undergraduate's) attention on areas of topical importance, not just in academic and economic terms, but also ones which ultimately determine the quality and welfare of our environment and lives. Apart from anything else, this stimulating book demonstrates that in the last twenty years seabird ecology has begun to look hard beyond the cliff ledges and really face up to the conundrum of the sea.

Euan Dunn

GRANT, P.J.1986. Gulls – a guide to identification. Pp. 352, 544 black and white photographs and many black and white drawings. T. and A.D. Poyser Ltd, Staffordshire. £15.00. ISBN 0-85661-044-5.

The first edition of this book, published in 1982, was based upon a series of papers written by the author and published in the monthly journal British Birds (Vols 71-74). It represented the culmination of years of prolonged, detailed and critical observations of gull plumages initiated at Dungeness, Kent, and continued elsewhere in the Western Palaearctic and North America.

The new edition follows the same format as the first. An introductory section deals with general aspects of gull plumage, length of immaturity, age terminology, moult, and how a variety of factors such as wear, fading, posture and light conditions affect appearance. The 31 species covered are then dealt with, not systematically, but sensibly grouped into seven groups; species within each group sharing similar field characters. Thus species most likely to be confused with each other are treated together. Each group is introduced with a page discussing their comparative features and pointers for their separation. Individual species treatments then follow. These are thorough, with all plumages described and illustrated in line drawings on the opposite page.

At the rear of the book is a collection of black and white photographs. These follow the same order as the main body of the book, and were chosen to illustrate identification features. To me these photographs are invaluable as they eliminate any bias that inevitably occurs in any artist's interpretation of field appearances.

Although the major feature of the second edition is the inclusion of the eight species occurring regularly on the west coast of North America, it is far more than just a repeat of the first edition with a new section appended. New information, pertinent to identification and ageing has been included for the majority of the original 23 species covered. Texts of some of the more difficult species (especially Ring Billed and Audouins Gull) have been extensively rewritten. Treatment of the various subspecies of the Herring Gull complex (11 recognised here) has been expanded, while new sections cover the subspecies of Common Gull, and Kumliens Gull (*L. g. kumlieni*), the distinctive subspecies of Iceland Gull now recorded annually in Britain.

Photographs of the original 23 species have been increased from 376 to 465. 207 new photos have been included, many of these are of superior quality to those in the first edition, and result in a more complete representation of identification features. Add the 79 photos of the additional 8 species and the book contains 544 photographs. The general introductory section of the book has been expanded and here more than anywhere else the considerable expertise and experience of the author under a variety of conditions is reflected in his appraisal of how external factors such as light conditions can effect identification.

There are few faults with this book. The species choice seems a touch random, following no logical biogeographical region. Inclusion of a further four species would have covered all the Holarctic gull species. However since all the gulls occurring regularly in North America are now covered this book will be valuable for birders from Europe, Canada and the USA alike. The selection of photographs of the new Group 7 species is limited, only adult Red-legged Kittiwake and first winter and adult Thayers Gull are illustrated, but this presumably reflects the availability of suitable material. Unfortunately two of the references are incomplete.

Peter Grant is now established as the leading expert on identification of west Palaearctic gulls and has only recently stepped down as chairman of the British Birds rarities committee. To criticise any of the identification material would thus be presumptuous. However in my experience far more second winter Iceland and Glaucous Gulls show clear grey feathers on the mantle than Grant has indicated and indeed it is often their lack of uniformity that readily ages them.

Anyone with an interest in identifying and ageing gulls in the field will probably have a copy of the first edition but if not a copy of the second is a must. The book far surpasses any of its competitors, field guides and more expanded treatments, as an aid to identification. The decision to buy this edition if one already has the first is more of a dilemma. Initially I had doubts, unless planning a trip to North West America, but after further reading, the new edition clearly provides so much valuable additional information that it has to be a "must".

Peter Grant is to be congratulated on continuing to push back the frontiers of identification. Let us hope that an identification guide to gulls of the world will follow soon. Only one third (about 16) of the world's species remain to be covered!

Paul Harvey

NELSON, J.B.1986. Living with Seabirds. Edinburgh University Press, Edinburgh. £12.95.

Someone once told me that when Bryan Nelson submitted his PhD thesis his examiners had commented that either the first or the second half would have sufficed! The story may just be apocryphal, but it accurately reflects the depth and breadth of Nelson's studies, which spanned both the behaviour and ecology of the North Atlantic Gannet. This book is a personal account of Nelson's life studying Gannets and other species of seabirds, and is a marvellous blend of biology, anecdotal observations and some philosophical thoughts, all written in a lucid, lively manner. I am hardly unbiased in terms of liking seabirds, but I have rarely enjoyed a wildlife book as much as I did this one. Bryan Nelson is known world-wide for his studies of the Sulidae, and this book provides an interesting insight into the way those studies were conducted. Starting with Gannets on the Bass Rock we travel with him and his (totally indispensable) wife, June, to the Galapágos, to Peru and finally to Christmas Island in the Indian Ocean to study the rare, beautiful and endangered Abbotts's Booby.

At an early stage in his career Nelson decided to undertake a comparative study of the behaviour and ecology of the world's seven species of Gannet and Booby. I doubt if many biologists have set themselves, and achieved such an ambitious target. Not only is this a personal success story, the scientific value of such data collected by the same individual (perhaps I should say couple), is infinitely greater than if each species had been studied by a different biologist. One of the many advantages is that all the results and their interpretation are comparable.

Throughout his studies Bryan Nelson has used the North Atlantic Gannet as his standard – all other species are compared with this, the largest and most robust of all sulids. One wonders whether the Gannet would have assumed such a role had the author started his studies on any of the other species.

For anyone who has conducted research on seabirds, or thinks they might want to, or just simply likes seabirds, read this book. You won't be disappointed.

T.R. Birkhead

NETTLESHIP, D.N. and BIRKHEAD, T.R. (eds.)1985. The Atlantic Alcidae. Pp. 574, numerous tables and figures. Academic Press, London. £33.50.

In the late sixties and early seventies three factors converged to focus attention on the Atlantic Alcidae. The prospect of major oil developments in the Canadian Arctic and the North Sea posed potential threats to the singularly vulnerable auk colonies in these regions. Meanwhile Operation Seafarer was exposing how some auk colonies, particularly Puffin, had plunged in numbers during the century. At the same time it became painfully evident that the census techniques employed by Operation Seafarer were woefully inadequate to monitor future population changes with a useful degree of accuracy. These factors catalysed a flurry of alcid studies in Canada and Great Britain. This multi-author volume is the culmination of these studies.

Can these studies count as a succcess? In terms of narrowing confidence limits on census data, certainly. In terms of providing a clear understanding of the factors which decisively influence the fortunes of auk populations, not really. The slightly qualified negative is deliberate. The book rightly highlights some of the continuing threats to auks – the hundreds of thousands of Brunnich's Guillemots killed by the Greenland fishery, the possibility of a sickening spill close to a major North Sea colony during the fledging period – but these threats are totally obvious, and were equally obvious 20 years ago.

On a more complimentary note, the Atlantic Alcidae does provide a handy synthesis of the nitty-gritty of auk biology. The Nettleship and Evans chapter on distribution and numbers valiantly estimates the Atlantic populations, and certainly succeeds in showing that the estimate is only a guess until Iceland receives better coverage. The Birkhead and Harris chapters on breeding biology are admirably thorough. Sadly there are, as yet, insufficient data to explore variations in recruitment and mortality across species' ranges. How pleased the editors would be if this book maintained the momentum of auk studies so they could tell their grandchildren how, in subtly different ways, Spanish and Bear Island Guillemots balance recruitment and mortality. This task will not be advanced by the Hudson population parameter chapter which includes some peculiar (= wrong!) calculations on the results of halving mortality at various stages in the life cycle.

Despite its value as a compendium the volume is perilously close to the gap between two stools. It provides neither the detailed monographic treatment that has recently been accorded to two of the six Atlantic auks, namely the Puffin by Mike Harris and the Brunnich's Guillemot by Tony Gaston and David Nettleship; nor does it really tease out interspecific trends in a novel way. Perhaps a better plan would have been to wait until sufficient new information on the remaining auks had accrued to merit

monographic treatment, and for a single author to write a much shorter more coherent book that really aimed to synthesize, to explore how auks divided resources and to compare the species' different migratory patterns. Such a treatment could well include Pacific auks, and would be stronger for doing so. Witness Bedard's scene-setting Chapter One on the evolution of the Atlantic Alcidae, a chapter that draws freely on the Pacific auks. Elsewhere authors have been constrained to consider only the six Atlantic species – seven including the poor old Great Auk – and a mere six points can look uninforma-tively forlorn on a graph.

Richard Brown's chapter's on feeding ecology (with Michael Bradstreet) and distribution at sea show that the curtain of ignorance on the auks' activities at sea, where of course they spend most of their time, is being slowly drawn. However I was struck by the contrast between this feeding ecology chapter and what might have been written in a comparable book on landbirds. We really have little idea of what an auk does when it dives, still less what a Guillemot does when it dives during the continuous Arctic night of a North Cape winter. The energetics and physiology of diving might be a fruitful lab-based study in the future. Another unstudied area is the role of diseases in auk population dynamics. A Guillemot colony appears ideal for pathogen transmission and yet, so far as I am aware, there is no evidence that any colonies are regularly afflicted by disease. Why not?

Produced to high Academic Press standards and prices, the Atlantic Alcidae is far from the last word on auk biology. It is more a celebration of the end of the phase of ignorance. Perhaps it will eventually come to herald the phase of knowledge. I hope so.

M. de L. Brooke

THE SEABIRD GROUP 1987

The Seabird Group was founded in 1966 to circulate news of work in progress on seabirds and to promote cooperative research. 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 (£5 per annum, £2.50 for students and pensioners) is open to all with an interest in seabirds; for details please contact the Secretary (address below) – payment by banker's order and deed of covenant helps the Group.

Current Executive Committee The present Committee comprises: Chairman T.R. Birkhead, Secretary P.J. Ewins, Treasurer T.J. Stowe, M. de L. Brooke (Editor of *Seabird*), M.L. Tasker (Newsletter Editor), also I. Hepburn, P. Monaghan and K.E. Partridge. K. Taylor is a co-opted member, representing the interests of the former Gull Study Group which has now merged with the Seabird Group.

Newsletter and Meetings Three duplicated newsletters are circulated every 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), seabird conservation issues, book reviews, details of meetings, etc. The Newsletter Editor welcomes contributions from members. The usual venue for the Group's annual meeting is the BTO Ringing & Migration Conference at Swanwick, except when the Group holds its own conference (as in 1988), in which case the meeting is combined with that. Our conferences draw on seabird workers from home and abroad to join in a forum of topical interest. In keeping with our desire to promote work in the field, practical manuals and guidelines evolve from the workshop sessions which cater for specialist topics within the conference theme. In Spring 1988 the Group will be running its next conference, the theme being 'Seabird Food and Feeding Ecology'. Information and booking forms are available on request, and further details will appear in the autumn Newsletter.

Seabird Group Grants Each year the Group has some money available to help fund research conducted by members. All grant applications should be submitted to the Secretary by the end of February annually, and will be considered by the Executive Committee by the end of March for distribution. Certain areas of research may be favoured for grant support from time to time and in 1986 and 1987 the allocation has reflected our commitment to the Seabird Colony Register (see below). Successful applicants are required to submit a typed report, not exceeding 500 words, by the end of October of the same year for inclusion in the Newsletter. A full typed report (in triplicate) must be submitted by the end of the year.

Seabird Colony Register The Seabird Group has always sought to organise and implement national schemes to promote the participation of and harness the energies of its membership, now standing at some 420 members. The Group membership played a major role in the national Operation Seafarer survey whose results were published in 'The Seabirds of Britain and Ireland' (1974). The Group is now in full swing with its Seabird Colony Register, begun in 1985 to gather together all existing data on breeding seabird numbers in the British Isles, bring our knowledge of their status up to date by detailed field surveys in 1986 and 1987, and to establish a computerised database which can easily be updated in the future. After excellent progress in 1985 and 1986, 1987 is the critical year in which the remaining areas will be covered. The coastline has been divided into seventeen regions, each organised and coordinated by a local representative. A full appraisal of the current state of the scheme, and requirements for 1987 appeared in Newsletter No. 47 (December 1986). NCC, who have

helped fund the Register, have appointed Clare Lloyd to orchestrate the collection and analysis of the data. There may be opportunities for fieldwork in 1988, especially in Ireland, and enquiries about help should be addressed to Clare Lloyd, NCC, 17 Rubislaw Terrace, Aberdeen AB1 1XE, Scotland.

Seabird Journal and previous reports In November 1984 the Group launched its new-look journal *Seabird*, numbered 7 in deference to its pedigree of Seabird Group Reports 1-6. After the production of *Seabird* 8 in 1985, a new format was settled for Number 9 and subsequent issues to guarantee a viable annual production schedule for the future at a time of rising costs. Our priority is to maintain a high volume and quality of content at stable cost to the membership, and we trust that the recipients of *Seabird* welcome the modest change of format in pursuit of these standards. The current editor, M. de L. Brooke, welcomes offers of papers (see Notice to Contributors, and address below). Members of the Seabird Group receive *Seabird* free of charge; additional copies to members, and any copies to non-members, are £5 + 50p postage within the British Isles, £5 + £1 postage overseas. Postage overseas must, regrettably, be by surface mail, unless the recipient can make prior provision for airmail. The subscription to Libraries is £7.50 per copy. To help reduce costs, overseas subscribers are kindly asked to make payment by international money order rather than by cheque. At intervals in the past, the Group published Reports to which *Seabird* is the successor. Copies of 3 of the earlier Reports are available from the Secretary as follows: issues for 1969 at 50p, 1975-6 (Number 5) at £1, 1977-81 (6) at £2. *Seabird 7* (1984) is also available, at £2, *Seabird 8* (1985) at £2, and *Seabird 9* (1986) at £5. For all these back issues, postage costs are the same as for *Seabird 9*. There are no cost concessions for multiple orders of *Seabird* or previous reports, and postal charges are additive. Copies of the Proceedings of the 1982 Seabird Group Conference are available on receipt of 50p postage, as are copies of the Auk Censusing Manual (1980), though it should be borne in mind that censusing techniques are still advancing.

Who to write to As appropriate, contact the Secretary (for general enquiries about the Group and its activities, requests for membership, grants, etc.), the Treasurer (for subscriptions, donations, etc.), Newsletter Editor, or Editor of *Seabird*. All may be contacted through the following address: Seabird Group, c/o RSPB, The Lodge, Sandy, Beds, SG19 2DL, England, UK. Please help the Group by enclosing a stamped envelope for reply.

NOTICE TO CONTRIBUTORS

Seabird publishes original contributions relating to any aspect of seabird ornithology as full-length papers (preferably not exceeding thirty manuscript double-spaced pages) or short notes. Although a portion of the journal will be of particular interest to UK members, contributions are welcomed on aspects of seabird ornithology from any part of the world so long as they are likely to be of general interest.

Copyright is retained by the Seabird Group of UK. Reference to contributions in *Seabird* may be made in other scientific writings but no extensive part of the text, nor any diagram, figure, table or plate may be reproduced without written permission from the Editor. Such permission will not be granted without consultation with the author(s).

Seabird contributions should be submitted in the same format as used by *Ibis,* and this is outlined (with slight modifications) below:

All submissions, of which *three* copies are required, must be typewritten, on one side of the paper, with double spacing and adequate margins. The approximate position of figures and tables should be indicated in the margin. Authors must consult recent copies of *Ibis* and *Seabird* and follow the conventions for section headings, tables, captions, references, quotation marks, abbreviations etc. The Editor may return without consideration any submission that departs from the *Ibis* form of presentation. Spelling should conform with the preferred, i.e. first-cited spelling of the *Shorter Oxford English dictionary.* Hyphenated terms commonly used include: body-weight, breast-band, cross-section, eye-ring, tarsus-length, wing-length, wing-moult, tail-coverts. Details of experimental technique, extensive tabulations of results of computation procedures, etc. are best presented as appendices. A full-length paper must include a summary not exceeding 5% of the total length.

On first mention a bird species should be designated by an English vernacular name drawn from *The status of birds in Britain and Ireland,* or from an authoritative faunistic work treating the appropriate region, followed by the systematic binomial; author and date need be cited only in taxonomic papers. Thereafter only one name should be used, preferably the English one. Capitals should be used for the initial letters of all single words or hyphenated vernacular names (e.g. Great Black-backed Gull, White-eyed Gull) but not in a group name (e.g. gulls, terns). Trinomials should be used only if the identity of specimens has been verified by critical comparison and if the subspecific nomenclature is relevant to the topic under discussion.

Underlining is used for all words of foreign languages, including Latin, other than those which have been adopted into English. Underlining should also be used for phonetic renderings of bird vocalizations. Underlining is not needed for emphasis.

Measurements should be given in SI (International system of units), but if the original measurements were made in non-SI units, the actual values and units should be given, with SI equivalents inserted in parentheses at appropriate points. Measurements may be given in cm.

Figures and diagrams should be drawn in black ink on white board, paper or tracing material, with scales (for maps), and lettering given in Letraset. In designing drawings, authors are asked to note the page-size and shape of *Seabird;* originals should be 1½-2 times final size. Tables should be typewritten and spaced appropriately.

References should be quoted in the text in the format indicated by the following examples: Harris 1980, Cramp & Simmons 1980, Monaghan *et al.* 1980. References at the end of the paper (following acknowledgements) should be given in the following format:

COULSON, J.C. and WOOLER, R.D. 1976. Differential survival rates among breeding Kittiwake Gulls *Rissa tridactyla* (L.). *J. Anim. Ecol.* 45: 205-213.

The author's name should be placed beneath the title of the paper and again at the end, together with the address, after the references.

Twenty-five offprints (40 if more than one author) of each original contribution will be supplied free. Additional copies can be supplied on payment; orders will be required at the time of proof-correction. Reprints of book reviews will only be supplied if a request is submitted with the original copy; in this case the full number will be charged at cost.