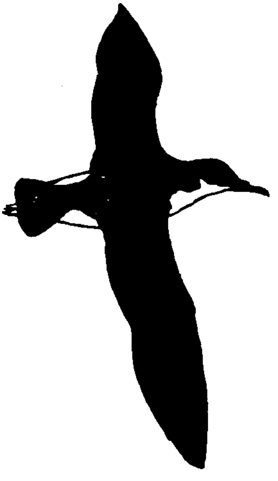
SEABIRD 13



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SEABIRD 13

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Cover vignette of Manx Shearwater by B. Zonfrillo
Additional vignettes by D. Suddaby

Changes in the Shetland Guillemot *Uria aalge* population and the pattern of recoveries of ringed birds, 1959-1990

M. Heubeck, P.V. Harvey and J.D. Okill

INTRODUCTION

Shetland hosts a large breeding population of Guillemots *Uria aalge*, 162,700 individuals in 1985-87 or 14% of the British and Irish population (Lloyd *et al.* 1991). This paper describes changes in Guillemot numbers at Shetland colonies since the mid-1970s. We also examine whether changes in the pattern of recoveries of Guillemots ringed since 1959, at two Shetland colonies, parallel and help explain population trends.

METHODS

Counts at study plots

Study plots (delimited areas of cliff) were established at seven Shetland Guillemot colonies between 1972 and 1977 and standard counts were conducted according to established procedures (Birkhead & Nettleship 1980). The size of these colonies and the proportion of the colony's Guillemots included in plots varied considerably (Table I). Plots were not selected randomly, but by criteria such as visibility, sample size and distance from, and safety of, observer. Counts were made during June, as far as possible at the same time of day and always between 0900-1600 GMT. Until 1984 the aim was to make 10 counts spread throughout June but the number of counts achieved annually at each colony varied. Since 1985 five counts have been made during the middle two weeks of June at all colonies except Fair isle (where 10 counts in the first three weeks of June continued to be carried out) and to ensure maximum comparability earlier, longer data sets were reduced to the five counts from 7th June onwards, avoiding consecutive days where possible. Counts were not conducted in heavy rain, fog or winds stronger than Beaufort Scale Force 4. No allowance was made for tidal variation. Marked photographs at the study plots helped reduce variation caused by changing observers at Fair Isle, Noss and Hermaness. Counts were only used in analyses if all plots in a colony were counted on the same day, in which case the plot totals were summed.

TABLE I. MONITORED GUILLEMOT COLONIES IN SHETLAND: LATEST CENSUS, YEAR OF CENSUS, NUMBER OF STUDY PLOTS IN THE COLONY AND PROPORTION OF THE TOTAL NUMBER OF BIRDS CONTAINED IN THE PLOTS.

Colony	*Latest Census*	*Census Year*	*Plots*	*% included in plots*
Fair Isle	32,321	1989	2	2%
Sumburgh Head	7,724	1990	8	13%
Troswick Ness	558	1988	2	33%
Noss	37,680	1986	3	7%
Eshaness	260	1990	6	100%
Burravoe	126	1990	5	100%
Hermaness	13,200	1990	6	24%

Ringing recoveries

Guillemots were first ringed at Fair Isle in 1959 but only since the mid-1970s have 250+ chicks been ringed annually (Table 2). Apart from a small number of chicks and adults ringed in 1966-67, efforts at Sumburgh Head began in 1977 and 250+ chicks have been ringed annually since 1982. Birds ringed as chicks and reported dead prior to 1st July the following year are referred to as first-year recoveries, prior to 1st July two years later as second-year recoveries and so on. 'Annual' periods referred to therefore extend from July to June, e.g. 1980/81 refers to July 1980 to June 1981 and 1981-89 refers to July 1981 to June 1989. Guillemots ringed when fully-grown are referred to as adults, although their precise age and breeding status at the time of ringing were unknown. By 30th June 1990, 109 Guillemots ringed as adults and 722 ringed as chicks had been reported dead or killed. Of the latter, 73% were first-year, 14% second-, 5% third-, 3% fourth-year and 5% in their fifth-year or older. Details of three first-year recoveries were received too late for inclusion in analyses: one drowned in a fish net in south-west Norway in October 1988 and two in the Norwegian Skagerrak in October 1989, one found dead and one drowned in nets.

TABLE II. THE NUMBER OF GUILLEMOTS RINGED AT FAIR ISLE AND SUMBURGH HEAD.

Period	*Fair Isle Adults*	*Sumburgh Adults*	*Fair Isle Chicks*	*Sumburgh Chicks*
1959-69	576	25	322	108
1970-79	1464	0	3066	99
1980-89	2376	1130	10393	6088
Totals	4416	1155	13781	6295

Recovery rates were expressed as the number of recoveries in an annual period per 100 birds carrying rings on 1st July, i.e. at the start of that annual period. For immatures and adults this was calculated by assuming annual survival rates of 50% for first-year birds, 84% for immature (second- to fifth-year) birds and 94% for adults (sixth-year and older for birds ringed as chicks and all birds ringed as adults) (Baillie & Mead 1982, Hudson & Mead 1984). Guillemots ringed as adults were recovered up to 15 years later, with no significant change in the rate of recovery over time (Spearman Rank Test: rho=0.150, df=13, p=0.30).

Fair Isle and Sumburgh Head are only 40km apart and Guillemots from the two colonies probably experience similar migration and mortality patterns. First-year recovery rates of chicks from the two colonies correlated significantly (Pearson Correlation: $r=0.76$, $df=6$, $p<0.02$; only years when more than 200 chicks were ringed in each colony were included) and data from the two colonies have been pooled in order to increase sample sizes.

RESULTS

Changes in numbers at colonies

Counts at study plots, expressed as annual indices (1978 = 100), showed that Guillemot numbers either increased until the early 1980s (Fair Isle, Sumburgh Head, Troswick Ness, Noss and perhaps Burravoe), or changed little (Eshaness and Hermaness) (Figure 1). Thereafter, numbers fell sharply at all colonies. The mean of annual colony indices indicated peak numbers in 1982 (Figure 2) and trends and rates of change were calculated prior to and since that year (Table III). At four colonies, too few counts were made prior to 1982 to test trends for significance, although increases undoubtedly occurred at Sumburgh Head and Noss. While there was no apparent increase prior to 1982 at Eshaness and Hermaness, numbers are known to have increased at Eshaness between 1969 and 1974 (Harris 1976) and probably also at Hermaness before 1977 (Pennington *et al.* in press). It is difficult to place these changes in historical context because few accurate, comparable data are available from prior to the mid-1970s. However, census counts (i.e. a single count, during June, of all Guillemots on cliff-ledges) at Fair Isle indicated that a rapid increase in numbers occurred during the 1960s and 1970s (Table IV).

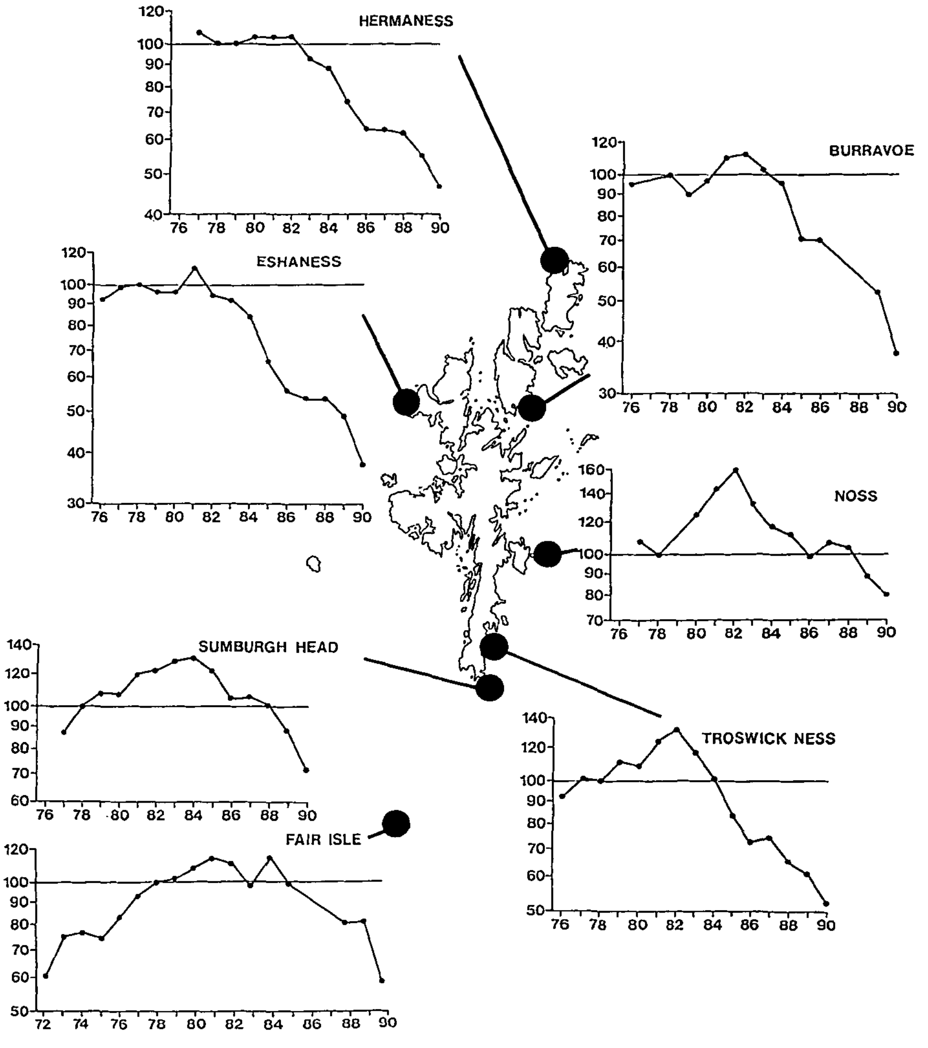


Figure 1. Guillemot population trends at seven Shetland colonies, as recorded by counts at study plots. The mean annual count is given, expressed as a percentage of the 1978 figure and plotted on log scale.

TABLE III. TRENDS AND RATES OF CHANGE IN GUILLEMOT NUMBERS IN STUDY PLOTS AT SEVEN SHETLAND COLONIES PRIOR TO AND SINCE 1982. THE SIGNIFICANCE OF TRENDS WAS TESTED BY SPEARMAN RANK TEST: ? = INADEQUATE SAMPLE, NS = NOT SIGNIFICANT.

	From	*To 1982*	*1982 to 1990*
Fair Isle	1972	+6.2% p.a. $p<0.001$	−7.7% p.a. $p<0.05$
Sumburgh Head	1977	+7.1% p.a. ?	−6.5% p.a. $p<0.001$
Troswick Ness	1976	+6.2% p.a. $p<0.01$	−11.0% p.a. $p<0.001$
Noss	1977	+8.4% p.a. ?	−8.3% p.a. $p<0.001$
Eshaness	1976	−0.3% p.a. NS	−10.9% p.a. $p<0.001$
Burravoe	1976	+2.8% p.a. ?	−12.9% p.a. $p<0.001$
Hermaness	1977	−0.4% p.a. ?	−8.3% p.a. $p<0.001$

The decline in numbers since the early 1980s occurred at all colonies, and at rates exceeding an average of 10% per annum at the three smallest colonies of Troswick Ness, Eshaness and Burravoe. The 1990 indices were lowest for those colonies which showed little or no increase in numbers before 1982 (37.2 at Eshaness, 37.1 at Burravoe and 46.4 at Hermaness) although numbers at all colonies were lower in 1990 than when monitoring began.

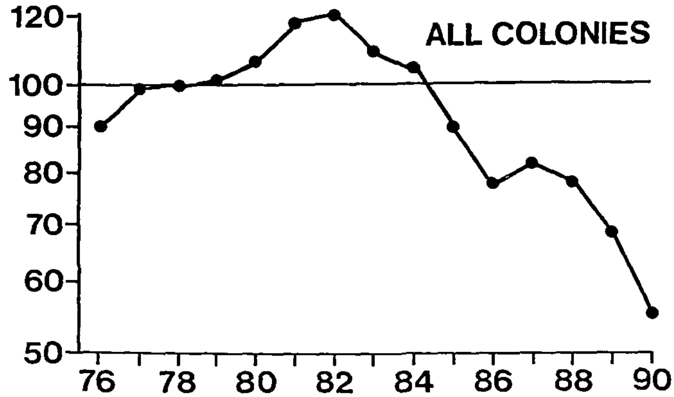


Figure 2. Shetland Guillemot population trend, 1976-1990. The mean of the annual indices at the seven monitored colonies is plotted on log scale.

Monitoring population change through study plots may correctly identify the direction, but underestimate the rate of change in the colony as a whole (Table IV). One factor involved in the non-random selection of study plots was that they contained adequate samples of birds. Sections of cliff with no Guillemots were not chosen, yet mapped censuses of Fair isle and Sumburgh Head have shown that areas of cliff where Guillemots bred in considerable numbers in the early 1980s held no birds a decade or more earlier. At Eshaness, where the whole colony was counted, breeding ceased in some peripheral areas in 1985 but each of the seven sections of the main cliff-face which held Guillemots in 1976 (82% of the 1976 total) were still occupied in 1990, albeit in reduced numbers.

TABLE IV. CENSUS COUNTS OF GUILLEMOTS AND AVERAGE PERCENTAGE CHANGE PER ANNUM AT THREE SHETLAND COLONIES, 1959-90. COUNTS ARE GIVEN ONLY IF THEY WERE MADE IN JUNE AND IF COVERAGE WAS COMPARABLE BETWEEN YEARS. CHANGES IN STUDY PLOTS OVER THE SAME PERIODS ARE INDICATED IN BRACKETS. FAIR ISLE 1975-89: CENSUS = +3.8% P.A.; PLOTS = +0.2% P.A. (NO PLOT COUNTS IN 1986)

Fair Isle			*Sumburgh Head*			*Noss*		
Year	*Birds*	*% p.a.*	*Year*	*Birds*	*% p.a.*	*Year*	*Birds*	*% p.a.*
1959	3,500		1974	4,559		1969	24,155	
1966	11,280	+18.2	1982	13,675	+14.7	1981	65,517	+ 8.7
1969	14,064	+ 7.6	1985	12,911	– 1.9 (– 0.1)	1986	37,680	–10.5 (–7.3)
1975	19,200	+ 5.3 *	1988	10,729	– 6.0 (– 6.1)			
1986	33,596	+ 5.2	1989	9,210	–14.2 (–13.2)			
1989	32,321	– 1.3*	1990	7,724	–16.1 (–18.8)			

Changes in the recovery rates of ringed Guillemots

Most (73%) recoveries of ringed Guillemots were of first-year birds. Relatively few Guillemots were ringed during the 1960s and the first immature and adult recoveries only occurred in March 1964 and January 1967, respectively. Thus, for the early 1960s we could only examine first-year recovery rates which despite the low numbers of chicks ringed, were remarkably high (Figure 3), e.g. four recoveries from the 19 chicks ringed in 1959 and three from the 19 chicks ringed in 1964. These high rates had declined by the early 1970s, remained relatively low throughout that decade but rose again in the early 1980s to a peak of 4.14 per 100 chicks ringed in 1982/83. The annual rate fell below 3.0 from 1985/86 onwards with the low 1986/87 figure of 0.58 (only 13 recoveries from 2,238 chicks ringed in 1986) exerting considerable influence on the pooled data.

The number of ringed immature birds calculated to be alive in any one year did not exceed 500 until 1979/80 and 2,000 until 1984/85 and no trend was apparent in the recovery rate before the mid-1980s, when it began to correspond to the first-year rate. It should be remembered that in calculating immature recovery rates no allowance was made for fluctuations in the first-year mortality rate, which would have a marked effect on the number of ringed birds assumed to be alive. For example, increases of only 10% in first-year and 5% in immature mortality rates would result in our calculated fourth- and sixth-year ringing recovery rates being underestimated by 18% and 22%, respectively.

Mortality rates of adult Guillemots are less likely to fluctuate widely and we can have more confidence in the calculated recovery rates of birds ringed as adults than for those ringed as chicks but reported dead when immature or adult. Recovery rates for adult Guillemots were calculated separately for those a) ringed as adults and recovered within five years (61% of adult recoveries) and b) all birds recovered when adult (Figure 3). Both rates showed similar changes over the 30-year period and broadly followed the pattern for first-year birds, being higher in the late 1960s than in the late 1970s, rising sharply in the early 1980s and declining again in the late 1980s. The main difference between the two adult recovery rates was that the peaks and troughs were greater for those ringed as adults and recovered within five years, suggesting that the effect of not allowing for varying first-year and immature survival rates was to dampen rather than accentuate trends or create spurious changes.

A ringing recovery rate was also calculated for all birds, whether ringed as adults or chicks, which again showed the basic pattern of a decline in the 1960s, relatively low values in the 1970s, a rise in the early 1980s followed by a fall.

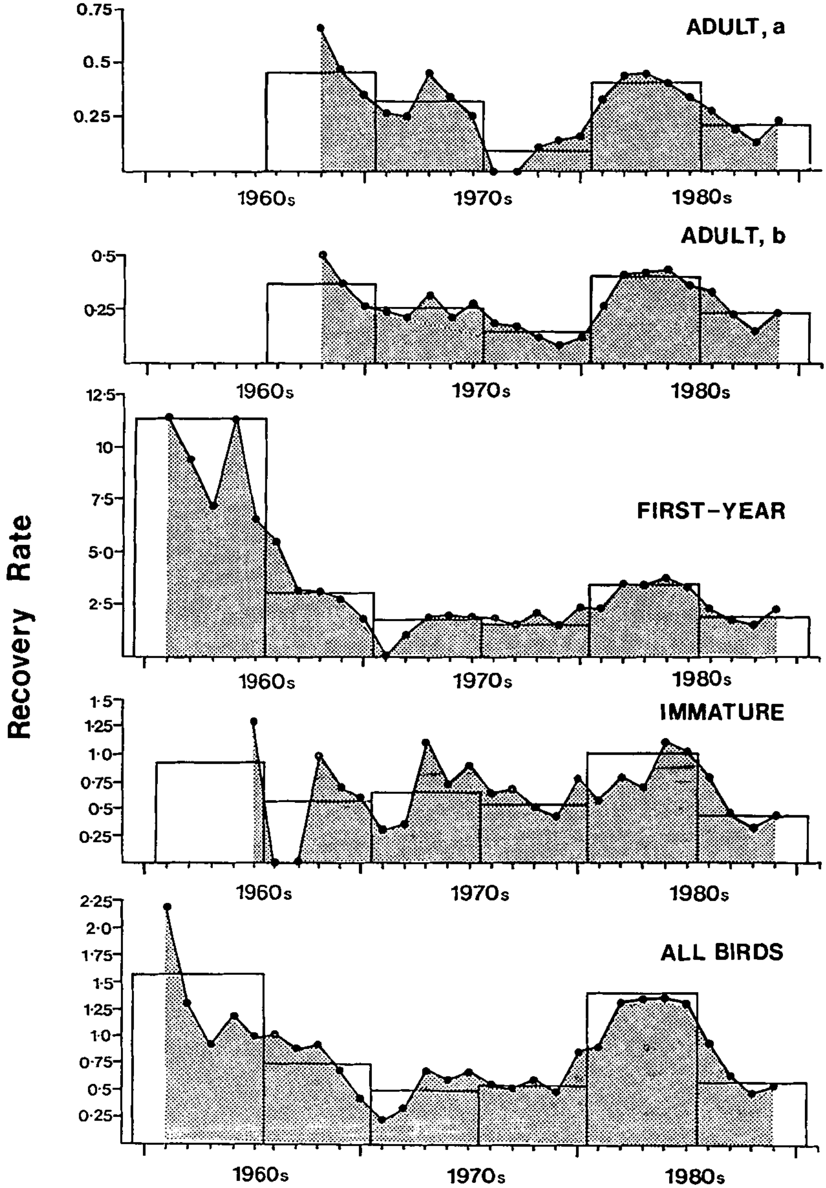


Figure 3. Recovery rates of adult, first-year, immature and all Guillemots ringed at Fair Isle and Sumburgh Head, 1959-89. Adult recovery rates are given for a) birds ringed as adults and recovered within five years and b) all birds recovered when adult. The number of ringed birds alive at the start of each annual period (1st July - 30th June) was calculated assuming survival rates of 50% for first-year birds, 84% for second- to fifth-year birds and 94% for sixth-year birds and older, and for birds ringed as adults. The dotted line represents data pooled into three-year periods and plotted for the middle year, bars represent data pooled into five-year periods.

Changes in the reported cause of death of ringed Guillemots

The reported causes of death fell into five categories: (1) shot or snared by hunters; (2) entangled and drowned in fishing nets; (3) found oiled; (4) found dead/dying but not oiled; (5) no details given. In analyses, oiled birds shot for humanitarian reasons or which became entangled in fishing nets were placed in category 3, while categories 4 and 5 were combined. This latter group is referred to as "found dead". Most reports did not specify the type of fishing gear Guillemots drowned in; those mentioned were nets set for Mackerel *Scomber scombrus* (2), Cod *Gadus morrhua* (9), Salmon *Salmo salar* (3) and Herring *Clupea harengus* (7). There was no means of distinguishing birds reported "found dead" but which had previously been removed from fishing nets and discarded, as some undoubtedly were. There was a significant difference in the reported cause of death of first-year, immature and adult Guillemots ($\chi2=42.04$, df=6, $p<0.001$), between first-year and immatures ($\chi2=19.53$, df=3, $p<0.001$) but not between immatures and adults. Data were therefore compared between first-year birds and immatures and adults combined (Table V).

Recovery rates of birds oiled were high for all ages in the period 1980-85. While 17 (45%) of the 38 oiled first-year recoveries were reported during 1980/81, only 8 (23%) of the 35 immature and adult oiled recoveries occurred that winter. In both age-groups, recovery rates of birds shot fell throughout the period, by 99% for first-year birds and 95% for immatures and adults, especially during the 1960s for first-year birds.

While the number of recoveries was initially small, recovery rates of first-year birds drowned in fishing nets were lower during the 1970s than the 1960s, but then increased markedly in the 1980s. Adult and immature recovery rates during the 1970s and 1980s followed a similar pattern,

TABLE V. THE NUMBER OF RECOVERIES AND RECOVERY RATES OF FIRST-YEAR AND IMMATURE AND ADULT (COMBINED) GUILLEMOTS RINGED AT FAIR ISLE AND SUMBURGH HEAD, 1959-1990, ACCORDING TO THE REPORTED CAUSE OF DEATH: OILED; SHOT OR SNARED DELIBERATELY; ENTANGLED IN FISHING NETS OR GEAR; FOUND DEAD BUT NOT OILED, OR ELSE NO DETAILS GIVEN. ASSUMED SURVIVAL RATES WERE USED TO CALCULATE THE NUMBER OF RINGED IMMATURE AND ADULT GUILLEMOTS ALIVE AT THE START OF EACH ANNUAL PERIOD.

First-Year	*Ringed*	*Oiled*		*Shot*		*Net*		*Dead*	
1959-65	105	1	0.95	7	6.67	2	1.91	2	1.91
1965-70	325	0		6	1.85	2	0.62	2	0.62
1970-75	807	1	0.12	9	1.12	3	0.37	1	0.12
1975-80	2383	3	0.13	17	0.71	9	0.38	8	0.34
1980-85	8411	38	0.45	26	0.31	141	1.68	90	1.07
1985-90	8070	12	0.15	8	0.10	87	1.08	51	0.63
Total and percentage		55	10.5%	73	13.9%	244	46.4%	154	29.3%

Immature and adult	*Ringed*	*Oiled*		*Shot*		*Net*		*Dead*	
1960-65	714	0		0		1	0.14	0	
1965-70	2282	3	0.13	2	0.19	0		5	0.22
1970-75	4332	1	0.02	6	0.14	1	0.02	4	0.09
1975-80	7589	4	0.05	9	0.12	2	0.03	6	0.08
1980-85	20257	35	0.17	5	0.02	48	0.24	51	0.25
1985-90	31258	20	0.06	3	0.01	43	0.14	55	0.18
Total and percentage		63	20.7%	25	8.2%	95	31.3%	121	39.8%

although the situation in the 1960s was unclear. The recovery rate of first-year birds "found dead" followed closely that of birds drowned in nets, i.e. falling in the 1970s, rising sharply in the early 1980s and falling again somewhat in the late 1980s. A similar pattern emerged for adult and immature recoveries although again, the small number of recoveries in the early 1960s hampered interpretation. Possible links between these last two causes of death are discussed below.

Geographic distribution of ringing recoveries

Detecting changes in the geographic distribution of ringing recoveries was hampered by the relatively few recoveries in the 1960s and early 1970s, especially of immature and adult birds. First-year recoveries were divided into three periods: 1959-80, 1980/81 (when an unusually high number of oiled birds were found) and 1981-90. Recoveries of adults were only divided into the periods 1959-81 and 1981-90, as the number of recoveries in 1980/81 was not unusually high. Recoveries of immatures were examined for 1981-90 only, and numbers comprised 82% of the total.

During 1959-80 most (88%) first-year recoveries were from Norway with a concentration in the southern counties bordering the Skagerrak (Figure 4). Only one recovery was from the Kattegat. Half the Norwegian recoveries were of birds reported shot although north of 64° birds were either drowned in fish nets or "found dead". Hunting Guillemots in Norway was banned in 1979, after which reported bag numbers dropped considerably (Barrett & Vader 1984), although the chances that a ringed bird that was shot would be reported may also have been reduced. Elsewhere, birds were drowned in fishing nets in Iceland and the south-eastern North Sea, found oiled in eastern Britain or "found dead" in the latter two regions. Notably, there were no recoveries from Orkney and Shetland.

There was a large increase in recoveries of birds oiled in 1980/81, not only from an oil-spill in the Skagerrak (Anker-Nilssen *et al.* 1988) but also from the coasts of the south-eastern North Sea, English Channel and eastern Britain. There were no recoveries of birds shot in western Norway and while some were shot in the Skagerrak, they may also have been oiled but not reported as such.

Comparison of first-year recoveries in 1981-90 with those from 1959-80 showed that the distribution within Scandinavia and the reported cause of death changed considerably. Rates from Norway north of 64° fell by 38% while those in western Norway fell by 26%, although in the latter region recovery rates of birds drowned in nets and "found dead" increased by ca. 8- and 4-fold respectively. The recovery rate in the Skagerrak/Kattegat region as a whole increased by 12%, while the proportions of recoveries from the Skagerrak, Kattegat and Baltic (waters east of Falsterbo) changed from 96%, 4% and 0% (respectively) to 58%, 39% and 3%, supporting observations that Guillemots were penetrating further into the Kattegat during winter (Peterz & Olden 1987). Recovery rates from the south-eastern North Sea and the English Channel more than doubled, mostly of birds oiled. On the east coast of Britain, the rate increased from 0.14 to 0.38, the respective proportions reported oiled and "found dead" being 60% and 40% in 1959-80 and 15% and 80% in 1981-90. The 1980s also saw the first recoveries of first-year birds in Orkney and Shetland (87% of which were reported in October to March, with 87% "found dead"), the west coasts of the British Isles (86% "found dead") and Faeroes (90% shot).

There were relatively few recoveries of adult birds during 1959-80 but comparison with 1981-90 suggested similar changes to those of first-year birds (Figure 5). Although few were reported shot in Norway during the early period, there were even fewer in the 1980s, when recoveries of birds drowned in nets increased. The geographic spread of recoveries increased in the 1980s, with the first reports from the Skagerrak and Kattegat and more recoveries from the southern North Sea and English Channel (83% oiled) and Orkney and Shetland (87% "found dead"). The pattern of recoveries of immature birds during the 1980s (Figure 6) was broadly similar to that of adults, but more extensive. There were more recoveries along the north Norwegian coast (with one from Varanger Fjord), the Baltic Sea, the Bay of Biscay and the west coasts of the British Isles.

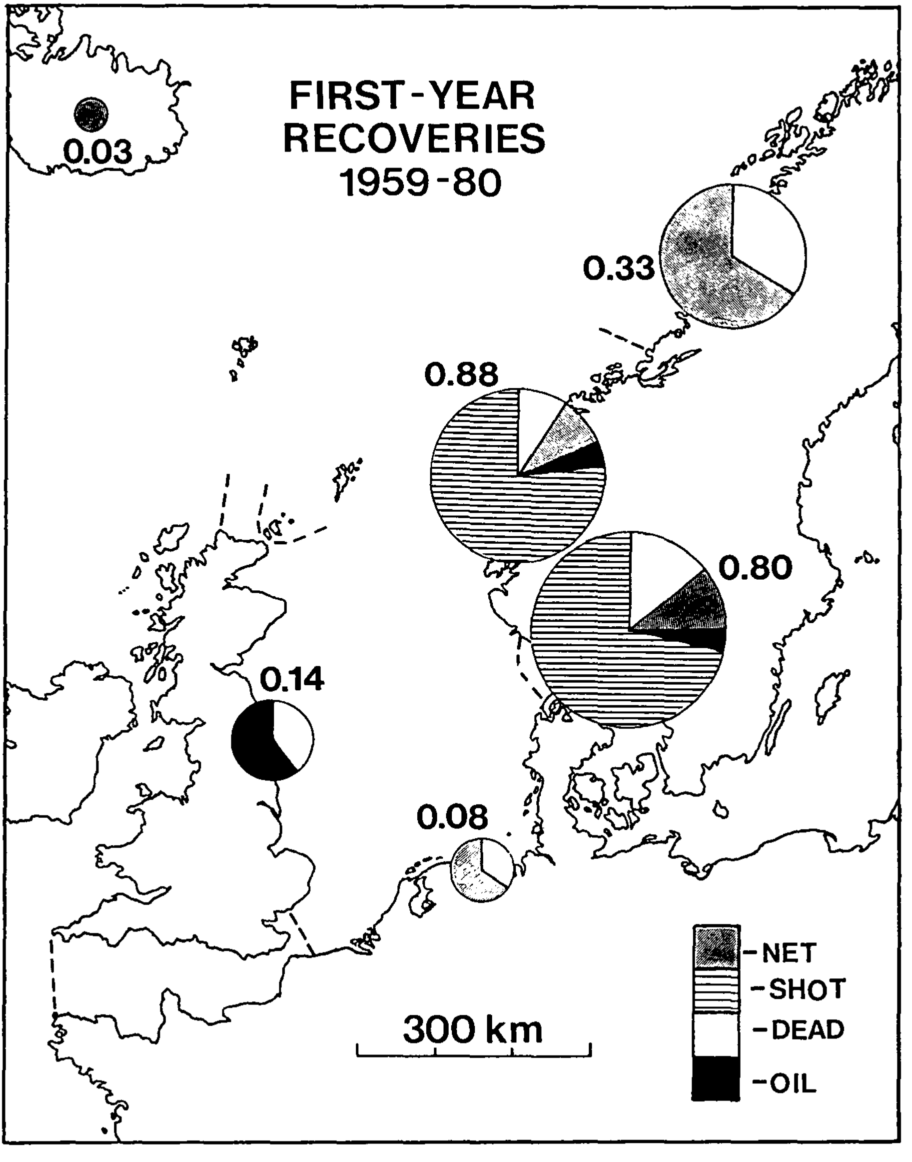
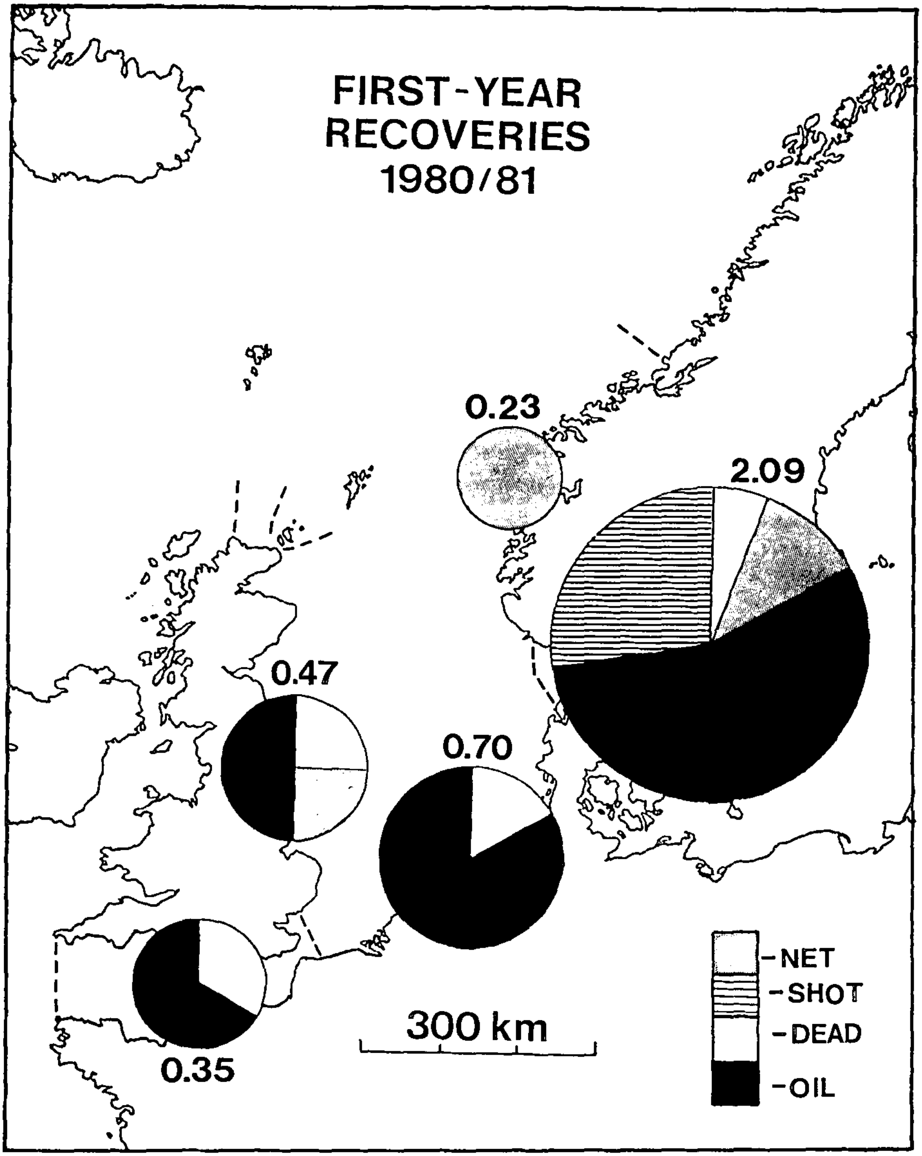


Figure 4. The geographic distribution of ringing recoveries of first-year Guillemots during a) 1959-80, b) 1980/81 and c) 1981-90 in the following regions (boundaries indicated by dashed lines): north Norway; south-west Norway; Skagerrak, Kattegat and west Baltic; south-east North Sea; English Channel; Bay of Biscay; east Britain; west British Isles; Orkney and Shetland; Faeroes; Iceland. Circle area is proportional to recovery rate, which is indicated.


FIRST-YEAR
RECOVERIES
1980/81
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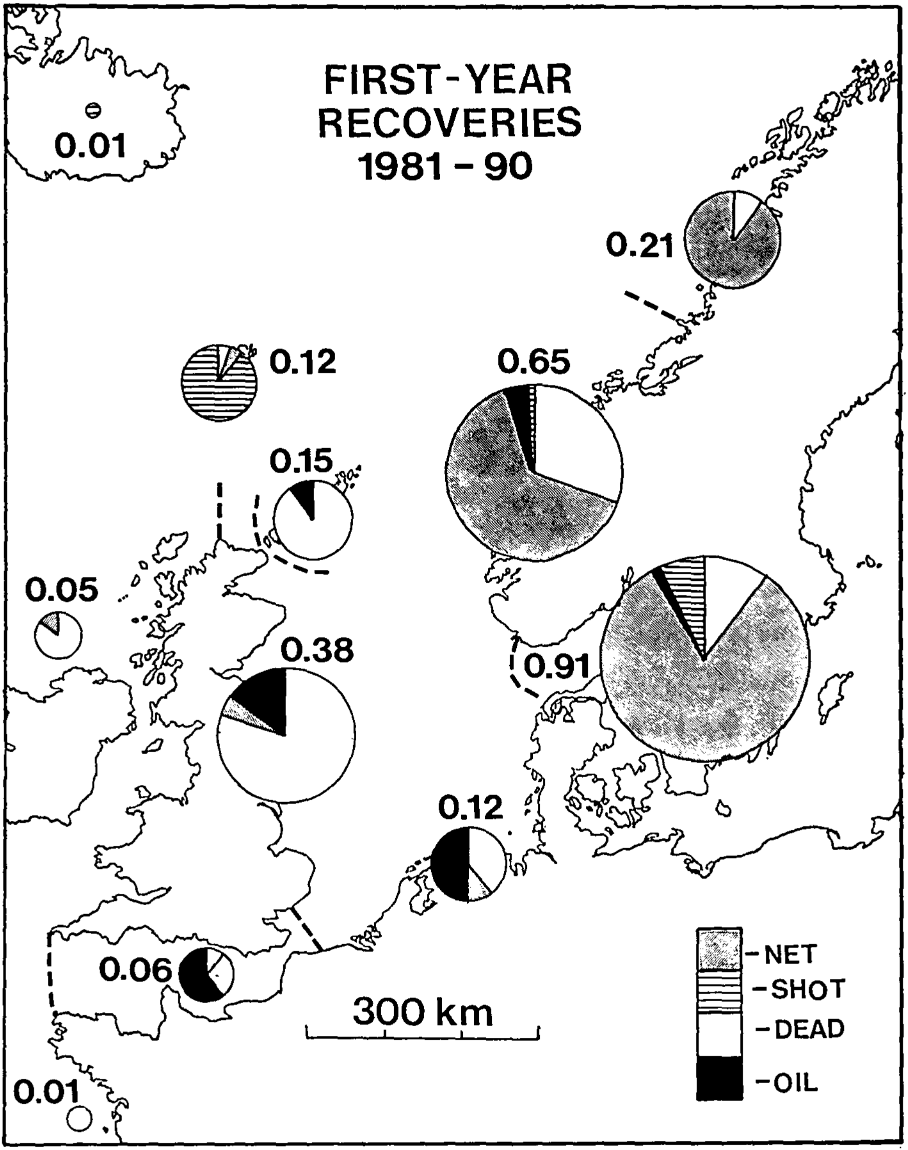
2.09
0.47
0.70
0.35
300 km
-NET
-SHOT
-DEAD
-OIL


FIRST-YEAR
RECOVERIES
1981 - 90
0.01
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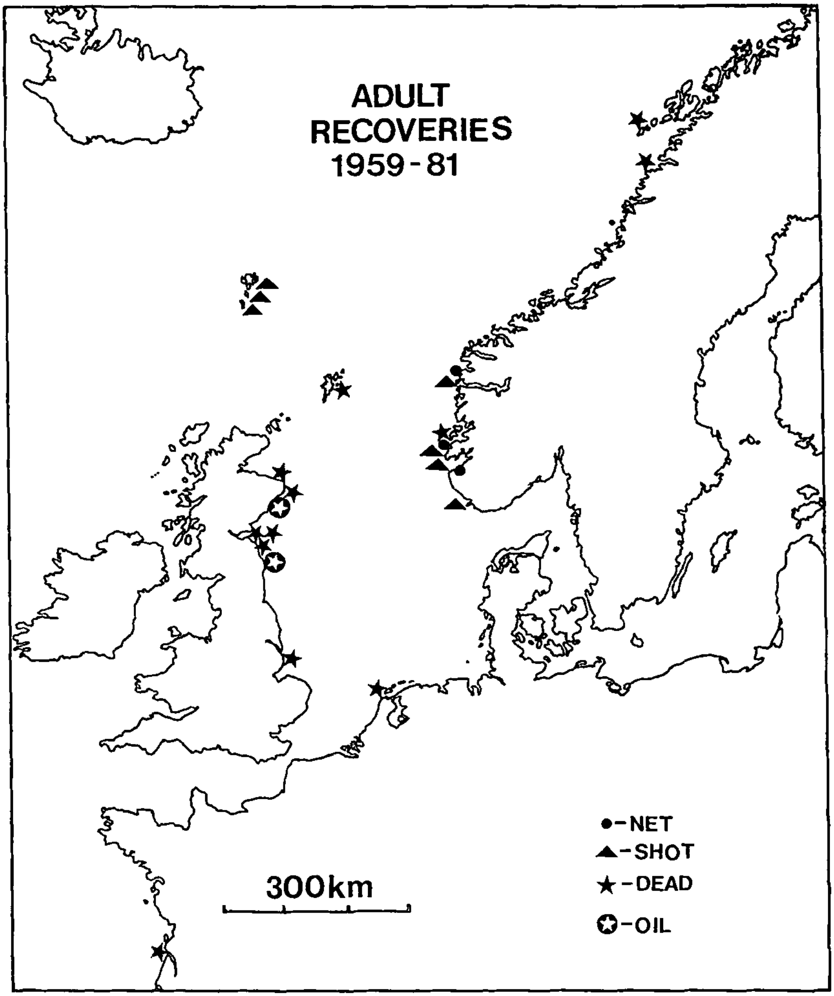
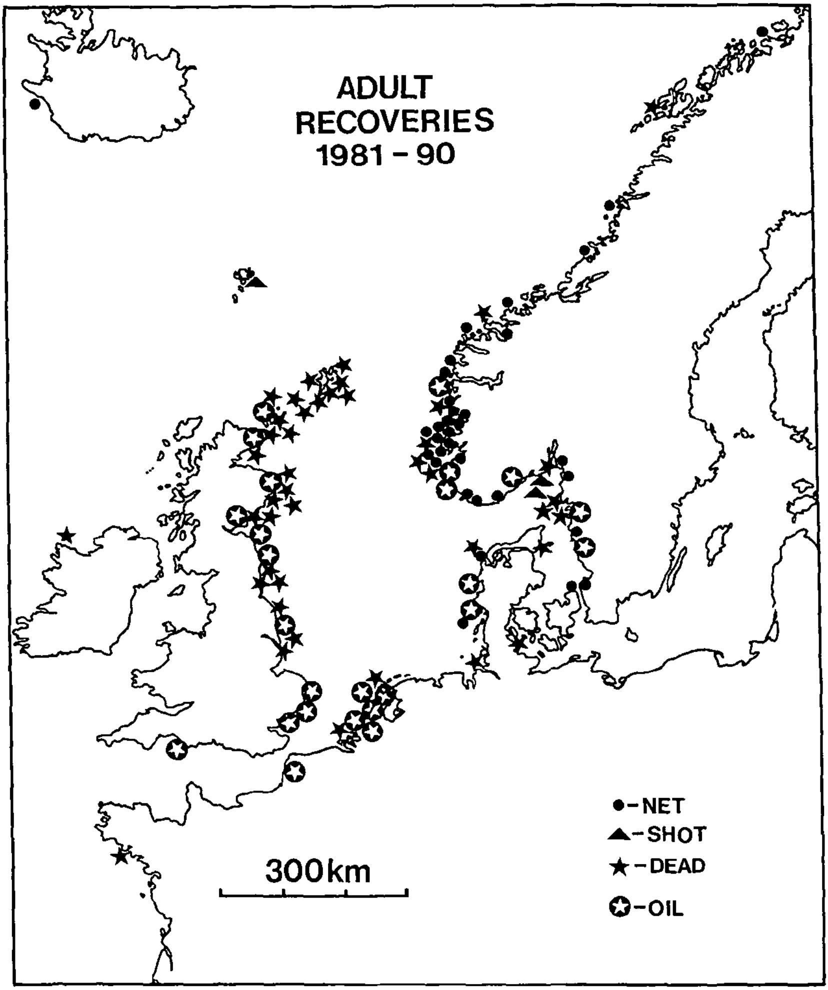


Figure 5. The geographic distribution of ringing recoveries of adult Guillemots (birds ringed as adults and those ringed as chicks recovered in their sixth year or older) during a) 1959-81 and b) 1981-90. One recovery, of a bird found dead in northern Portugal in February 1986, is omitted.


ADULT
RECOVERIES
1981 - 90
300km
●- NET
▲- SHOT
★- DEAD
✪- OIL

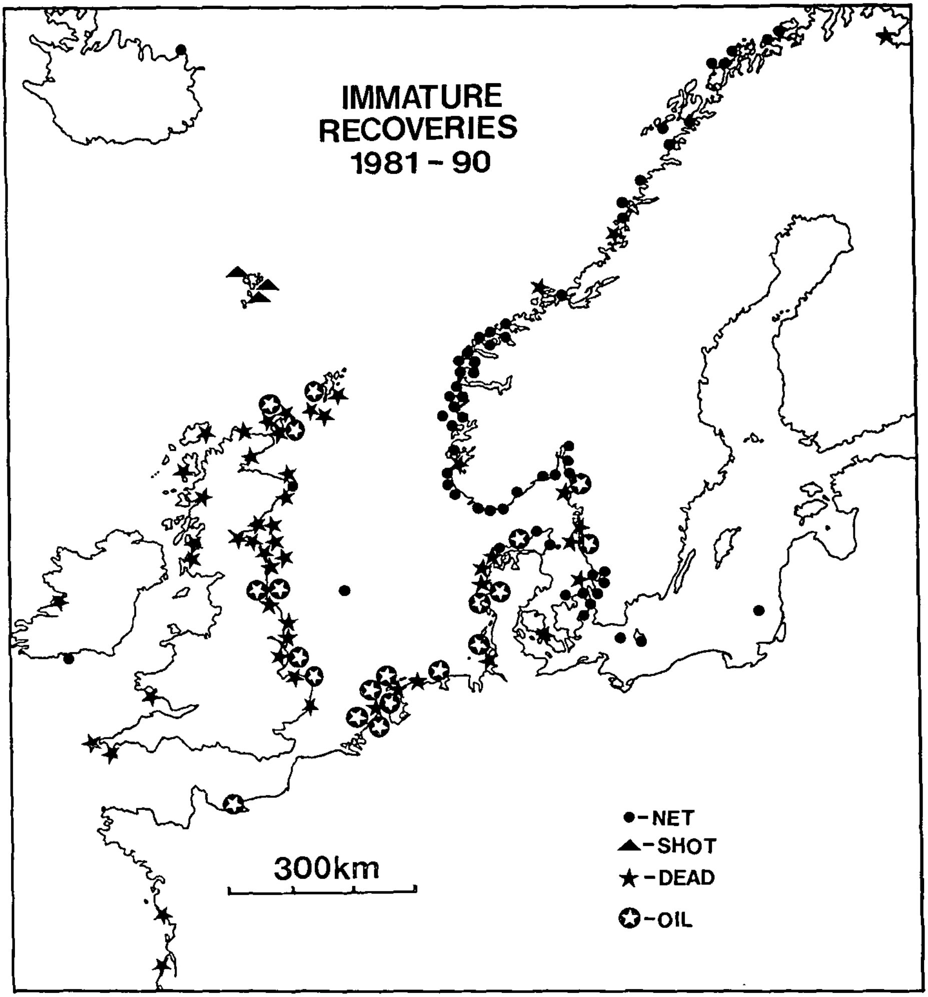


Figure 6. The geographic distribution of ringing recoveries of immature Guillemots, 1981-90.

DISCUSSION

The Shetland Guillemot population increased considerably during the 1960s and 1970s, stabilised in the early 1980s and subsequently declined sharply. This corresponded broadly to changes recorded at colonies elsewhere on the North Sea coast of Scotland (Benn *et al.* 1987; Harris *et al.* 1987; Lloyd & North 1987; Mudge 1986), although recent declines in numbers have not been as pronounced as in Shetland (Walsh *et al.* 1990).

Data from recoveries of ringed birds can provide clues to, but not firm evidence of the causes behind these population changes. Assuming a first-year mortality rate of 50%, 10,038 of the Guillemot chicks ringed at Fair Isle and Sumburgh Head would have died within 12 months of fledging but only 526 first-year recoveries were reported and we should be cautious in assuming that this 5% was representative of the sample as a whole.

Recovery rates are not mortality rates and the place and time of recovery, as well as the reported cause of death are all subject to bias. The chances of a Guillemot which died far out to sea being washed ashore and then found is slight (Bibby 1981; Jones *et al.* 1970) and will be even less on sparsely populated coasts. The chances of a ringed bird being found may rise during well-publicised oil-spills or wrecks, while the changing extent of organised Beached Bird Surveys on North Sea coasts may also have influenced the distribution pattern of recoveries. Birds shot illegally are less likely to be reported, while those drowned in fish nets where the problem is being studied in co-operation with fishermen (Olden *et al.* 1985) are more likely to be reported than those where fishermen are subject to criticism (Bourne 1989; Ewins *et al.* 1988). However, these factors are only likely to blur slightly any gross changes in the pattern of ringing recoveries.

The period of population increase: the 1960s and 1970s

The most striking change in the pattern of ringing recoveries during the 1960s and 1970s was the decline in the reported rate of Guillemots, mainly first-year birds, shot in Scandinavia (Table 5). Recovery rates during 1959-65 were high enough to suggest that the effect of hunting pressure in Norway on the survival of young Shetland Guillemots was considerable and may have limited recruitment to the breeding population.

Hunting seabirds became increasingly popular in Norway after the Second World War, with estimates of an annual kill during the 1970s of 30-40,000 auks, mostly Guillemots (Barrett & Vader 1984), and 45,000 Guillemots (Birkhead 1974). Mortality from hunting was considered to have accelerated the decline of the Norwegian Guillemot population (Brun 1979) and been a "serious mortality factor" for Guillemots from colonies in northern Britain (Mead 1974). Hunting Guillemots was banned in Norway in 1979. The decline during the 1960s and 1970s in the recovery rate of Guillemots shot could thus be explained by a) a decline in the number of birds shot, b) the bag remaining the same but a decrease in the proportion of Shetland birds, or c) increased reluctance by hunters to report ringed birds. We have little evidence to support or refute any of these theories but if either of the first two were the case, then a relaxation of a significant mortality factor for young Guillemots could have improved recruitment to the breeding population and contributed to the increase at Shetland colonies. Interestingly, the recovery rate of first-year birds drowned in fishing nets also declined during the 1960s and early 1970s, although the early values are based on a small sample of recoveries. Six of the seven recoveries during 1959-75 came from Norway and it is possible that birds frequented inshore waters less in the 1970s, reducing the risk from both hunting and fishing nets.

The increases in populations at auk colonies in northern and eastern Britain during the 1970s have been attributed to changes in the marine environment, perhaps oceanographic (Evans & Nettleship 1985) or an indirect result of man's fisheries (Furness 1984), which increased food abundance and promoted high breeding success, survival of young and recruitment to the breeding population. If a plentiful food supply did improve the survival of young Guillemots during this period, one might expect there to have been few recoveries of ringed birds which had not died from oiling, shooting or drowning in fishing nets, and this was indeed the case (Table 5). While again emphasising the small sample, the recovery rate of first-year birds "found dead" decreased to a minimum in the early 1970s.

Population stability and subsequent decline: the 1980s

The halt in the increase of two Guillemot populations in Scotland in the early 1980s has been ascribed to increased immature mortality reducing recruitment to the breeding population (Harris & Wanless 1988; Swann *et al.* 1989). The Shetland ringing recovery data suggest that over-winter mortality of all ages of Guillemots increased during the 1980s and that more than one cause of death was responsible for that increase.

Many Shetland Guillemots died from oil pollution in the winter of 1980/81, both in the Skagerrak (Anker-Nilssen *et al.* 1988) and along the coasts of Denmark, the Netherlands and northern France (Baillie & Mead 1982). Most were first- and second-year birds and it was estimated that their loss would cause a 6-9% reduction in the Orkney and Shetland breeding population between 1980-85, the largest decline (4-6%) occurring between 1984-85 (Baillie & Mead 1982). In the event the declines at Shetland colonies were greater than predicted, suggesting that additional factors became involved. The ringing data showed that oil pollution continued to kill Shetland Guillemots during the rest of the 1980s, most notably in the south-eastern North Sea and the English Channel, but never on a scale approaching that in the winter of 1980/81.

Guillemots from northern Scottish colonies have long been known to be vulnerable to entanglement in fishing gear along the Scandinavian coast (Brun 1979; Mead 1974). Nets of different kinds, set for a variety of species at different times of year have killed birds but the scale of the mortality has been difficult to quantify (Barrett & Vader 1984). Strann *et al.* (1991) estimated that 10-100,000 Common Guillemots drown each year in gill nets set for Cod in northern Norway and detailed one incident in April 1985 in which at least 200,000 birds were caught by forty boats fishing for Cod feeding on spawning Capelin *Mallotus villosus.* On that occasion, fishermen were encouraged to collect ringed birds and two first-year and four immature Shetland-ringed Guillemots were among those reported. Although this fishery is known to have killed large numbers of Guillemots in other years, and probably lesser numbers annually, these were the only spring recoveries of Shetland-ringed Guillemots from northern Norway during the 1970s and 1980s, suggesting that these fishermen do not normally report ringed birds, perhaps deliberately.

Further south in Scandinavia, there is little doubt that as a mortality factor for Shetland Guillemots, drowning in fishing nets increased during the 1980s but the reasons for this are unclear. Increased use of monofilament, rather than woven nets more readily seen by diving seabirds, probably contributed to the problem (Mead 1989), as may the behaviour of the birds themselves. The sudden increase in the early 1980s in the number of Guillemots drowning in nets set for Herring and Cod in the Kattegat was thought not to have been due to changing fishing practices, but an increase in the number of Guillemots wintering in the area, probably in response to a local increase in Herring stocks (Peterz & Olden 1987).

Coincident with the increase in Guillemots drowning in Scandinavian fish nets was an increase in the recovery rate of Guillemots of all ages "found dead", principally on the east coast of Britain and in south-west Norway (Table 5, Figures 4-5). At least 10,000 Guillemots were found dead in eastern Britain in the well-documented wreck of February 1983 (Underwood & Stowe 1984), but this was just one in a series of wrecks of emaciated, but not oiled, Guillemots on the north and east coasts of Britain (Bourne 1990; Heubeck 1990; Kinnear 1990). Similar, coincident wrecks occurred in the Netherlands and West Germany and while most birds there were oiled, this was often secondary and their increased occurrence on beaches could not be accounted for by an increase in chronic oil pollution (Camphuysen 1989; Vauk *et al.* 1987). Instead, it was suggested that the number of Guillemots wintering in the southern North Sea increased during the 1980s, where the risk from chronic oil pollution was relatively high.

Guillemot distribution in the North Sea in winter has been linked to concentrations of Sprat *Sprattus sprattus*, at least where they occur in high densities (Blake *et al.* 1984) and the February 1983 wreck of auks was thought to have been caused by a combination of stormy weather and changing patterns of abundance of North Sea Sprat populations (Blake 1984). The North Sea Sprat stock increased markedly during the 1970s as its distribution shifted abnormally northwards, while a decline in the stock size in the 1980s was accompanied by a southerly reversion in its centre of distribution, changes thought to have been induced by a reduced Atlantic inflow into the North Sea in the 1970s (Corten 1990).

Harris & Bailey (in press) correlated first-year recovery rates of Guillemots ringed on the Isle of May with annual fisheries estimates of the abundance of seven species of suitable fish prey, the number of days of winter gales and December sea temperature. Only the correlation with Sprat abundance was (negatively) significant, and it was suggested that the decrease in the abundance of Sprats in the North Sea may have contributed to increased mortality rates of immature Guillemots.

Although first-year recovery rates of both Isle of May and Shetland-ringed Guillemots increased during the 1980s and there was a significant positive correlation between the annual values (Pearson Correlation: $r=0.72$, $df=13$, $p<0.01$), the decrease in numbers at Shetland colonies has been considerably greater than at colonies further south on the east coast of Britain (Walsh *et al.* 1990). There are several possible explanations for this. Firstly, monitoring counts have been of all birds in study plots and did not distinguish between breeders and non-breeders, nor between incubating or brooding birds and off-duty mates. Any pronounced changes in the frequency and duration of colony attendance by non-breeding and off-duty birds would have influenced the total counts of birds in plots, even when the number of breeding pairs remained stable. The recent decline in the abundance of sandeels around Shetland (Kunzlik 1989) is not thought to have reduced Guillemot breeding success, at least until 1990, but may have influenced the pattern of colony attendance and accentuated the observed decline in numbers. Admittedly, there is little evidence for this although Walsh (1990) recorded mean k values (total number of breeding pairs/ total count of birds) of 0.84 and 0.93 in two plots at Sumburgh Head throughout mid-June 1990, values considerably higher than those given by Harris (1989) for a range of European colonies.

Secondly, our data suggest strongly that the survival rate of adults from Shetland colonies decreased during the early 1980s whereas that of adults from the Isle of May remained high (Harris & Bailey in press). Thirdly, ringing recoveries suggest that Guillemots from Shetland colonies tend to winter further north than birds from colonies further south on the east coast of Scotland, with a greater proportion of recoveries of birds of all ages coming from the Norwegian coast north of the Skagerrak (Rae 1984; Harris & Bailey in press). As stated earlier, the chances of a Guillemot becoming oiled, entangled in fishing gear and even succumbing to a shortage of food will vary between different areas of the North Sea, as will the chances of a ringed bird being first found and then reported.

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SUMMARY

Counts in study plots showed that Guillemot numbers at four Shetland colonies rose by 6-8% per annum during the late 1970s and early 1980s but remained stable at three other colonies. Census counts of whole colonies indicated that increases had occurred throughout the 1960s and 1970s. Since 1982, numbers fell at all colonies by 7-13% per annum. Recoveries of Guillemots ringed during 1959-1989 were analysed in an attempt to explain these population changes. These suggested that hunting in Norway was a significant mortality factor for first-year birds in the early 1960s, but subsequently declined in importance. Recovery rates of birds of all ages were relatively low during the 1970s, but indicated higher mortality of first- and second-year birds from oil pollution in the Skagerrak and southern North Sea in the winter of 1980/81. During the 1980s there was a marked increase in recovery rates of birds of all ages, especially of birds drowned in fish nets in Scandinavia and found dead of unknown causes in eastern Britain and south-west Norway. The occurrence of wrecks of unoiled Guillemots in Britain and oiled birds in the south-east North Sea during the 1980s is discussed in relation to changes in the abundance and distribution of prey fish.

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Auk mortality in fishing nets in north Norway

Karl-Birger Strann, Wim Vader and Rob Barrett

Auks have high adult survival, low clutch size and delayed maturity so that population trends are far less sensitive to incidental breeding failures than to high adult or immature mortality (Hudson 1985). The introduction of monofilament nets and an increasing fishing effort has resulted in large numbers of auks being drowned in fishing nets. This has grown into a major conservation problem in many countries (see e.g. King *et al.* 1979, Ainley *et al.* 1981, King 1984, Piatt *et al.* 1984, Oldén *et al.* 1985, 1986, Atkins & Hereman 1987).

In Norway, the early literature suggested that drowning in fishing nets was a relatively minor source of seabird mortality (Brun 1971, 1979, Myrberget 1980), but Myrberget (1961) found more than 3000 auks drowned in one autumn in two incidents in Helgeland, and Holgersen (1961) recorded the drowning of more than 10000 auks in a single fjord in Finnmark. Although having few hard data Barrett & Vader (1984) suggested an annual toll of tens of thousands of auks and cormorants in Norway in fishing nets.

Since the early 1960's there has been a steady and steep decline in the numbers of Common Guillemots *Uria aalge* breeding on the west coast of North Norway (Brun 1979, Vader *et al.* 1990). Reasons for the decline are uncertain. With the exceptions of the Lofoten Islands since 1970 (Tschanz 1978) and Finnmark during the years of the recent capelin *Mallotus villosus* crash 1985-1987 (Vader *et al.* 1990), breeding success among Guillemots has remained high while Puffins *Fratercula arctica* have had repeated breeding failures (Anker-Nilssen 1987, Barrett *et al.* 1987). The levels of organochlorines and heavy metals found in eggs were well below those that should have adversely effected breeding (Barrett *et al.* 1985). Suspicion has long been directed towards drowning in fishing gear (Brun 1979, Vader & Barrett 1982, Barrett & Vader 1984), but until now no quantitative data were available.

This paper shows that large numbers of auks, particularly Common Guillemots drown in fishing nets in Norway each spring and summer, and that this mortality constitutes a serious threat to the local breeding populations.

MATERIAL AND METHODS

Three types of fisheries caused most auk mortality, winter cod *Gadus morhua* fisheries, spring cod fisheries and salmon *Salmo salar* fisheries. Some auks, particularly Black Guillemots *Cepphus grylle,* drown in gill-net fishery for Lumpsucker *Cyclopterus lumpus* along the coast, but this fishery is a more serious threat to seaducks than to auks (cf. Bustnes & Erikstad 1988).

1. Winter Cod Fisheries

Hundreds of small fishing vessels fish for cod along the coast and in the fjords of North Norway throughout the year. The fishing-gear used changes from season to season, but gill-nets are commonly used. We collected data from seven vessels fishing for cod with gill-nets in a traditionally good cod-fishing area on Mulegga in southern Troms (Fig. 1) from November 1984 to March 1985, including the number of nets used, a list of all birds caught and the depth at which many of the nets were set. We also collected most of the birds themselves.

2. Spring Cod Fisheries

Every late winter/early spring capelin migrate to the coast of North Norway where they spawn in shallow water. These vast schools of fish are followed by many different predators, including predatory fish such as cod and diving seabirds such as auks. Very large numbers of gill-nets are set in the spawning areas of the capelin (which vary in position from year to year, Loeng 1989), sometimes in water no deeper than 10 fathoms. In some of these areas thousands of seabirds aggregate and feed on the spawning capelin and their roe (Gjøsæter et al. 1972, Gjøsæter & Sætre 1974). The combination of large numbers of diving seabirds and the high density of gill-nets represents a great hazard for the birds and a serious nuisance to the fishermen.

In mid April 1985 we registered the numbers of fishing vessels participating in the spring fisheries in the Auvær area, Troms county (Fig. 1), the duration of the fisheries effort, and, from a few boats, the numbers of birds killed during one night. One single boat brought ashore a sample of the by-catch, from which the species composition, their age and morphological data were registered.

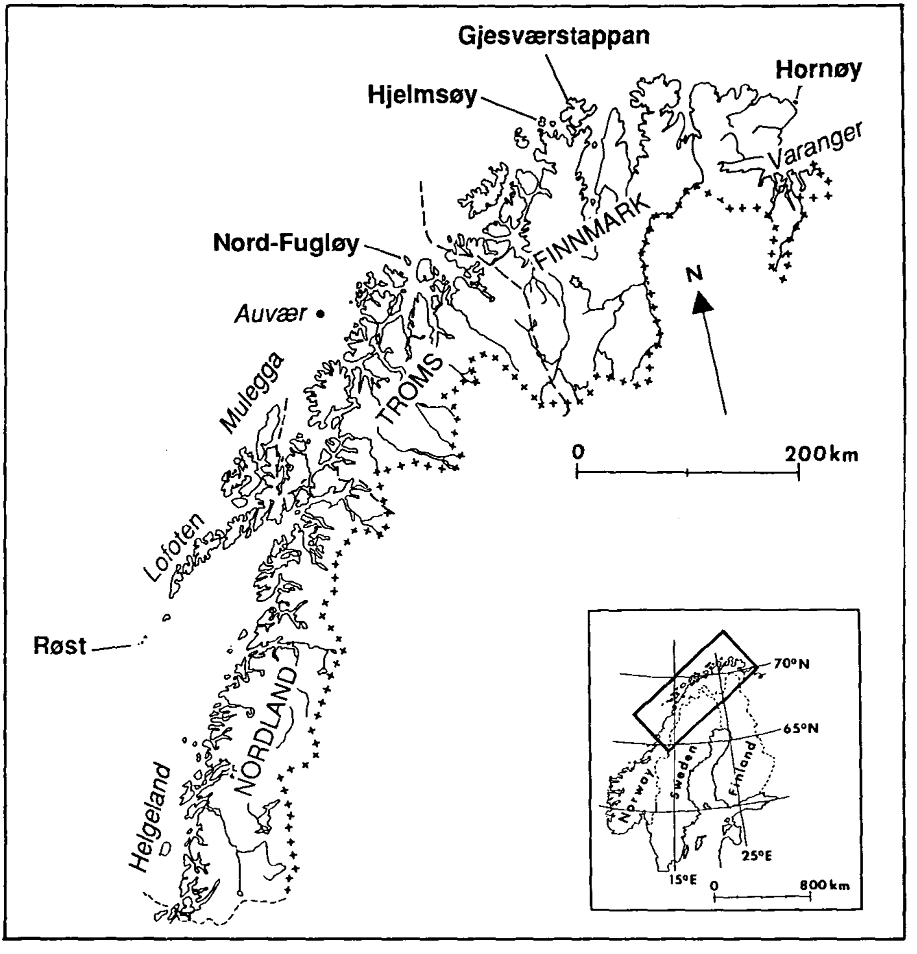

Figure 1. Location of different seabird colonies (bold type) and important fishing areas along the coast of North Norway.

3. Salmon Fisheries
Drift-nets for salmon are set west of North Cape in June-August, and the number of nets used increased tremendously between 1975-1985, especially in Finnmark (Fig. 2). From 1989 this fishery was banned in Norway. Many good fishing areas were close to the seabird-cliffs, often within 4-10 nautical miles. Five salmon-fishermen, each with more than 10 years experience in this fishery, were interviewed and gave us information concerning numbers of seabirds drowned in their drift-nets.

Pound-net fisheries for salmon are another common and well-regulated type of fishery in North Norway, with each authorized fisherman having his own fixed fishing site. Many of these sites, especially those in Troms and Finnmark, are close to major bird-cliffs, and as many as 10-12 pound-nets may be placed along a few km of shore below a single bird-cliff. We interviewed three fishermen about their by-catch of seabirds. Between 1977 and 1984 each of them had been fishing with 5 to 7 pound-nets close to Hjelmsøystauren and Gjesværstappan, two of the most important seabird colonies in western Finnmark (Fig. 1).

All interviews were recorded, and tape-copies were afterwards checked with the fishermen. All three were knowledgeable about the local seabirds, although they did not always distinguish between Common Guillemots and Brünnich's Guillemots *Uria lomvia.*

Samples of Common Guillemots collected during the cod fisheries were aged using the methods descibed by Anker-Nilssen & Røstad (1981), Sandee (1983) and Oldén et al. (1988).

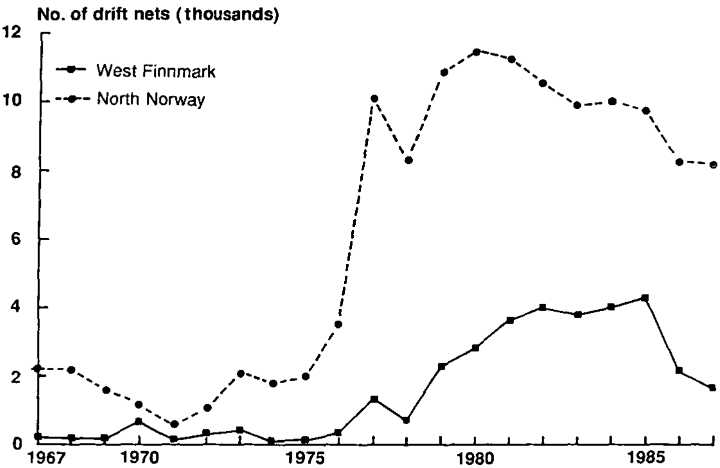

Figure 2. The official number of salmon drift-nets set in North Norway (Nordland, Troms and Finnmark) and in West Finnmark in 1967-1987. (Source: Central Bureau of Statistics in Norway).

RESULTS

Winter Fisheries for Cod
This is a relatively deep water fishery, and the usual depths at which nets were set in our study area in the winter of 1984/1985 were from 25-75 fathoms (40-135 m).

83 Common Guillemots were killed by seven boats during the period of study (Table I). No other seabird species were caught. Most birds were juvenile, but all age classes were represented (Table I).

TABLE I. THE MEAN DEPTHS AT WHICH NETS WERE SET BY SEVEN BOATS AND THE NUMBER AND AGE-COMPOSITION (% IN BRACKETS) OF COMMON GUILLEMOTS (N) CAUGHT ON MULEGGA, NORTH NORWAY IN NOVEMBER 1984 – MARCH 1985. (fth = fathoms)

	Number of days fishing	*Mean depth (fth)*	*Range (fth)*	*Total birds caught*	*First winter*	*First to second winter*	*Adults*
Nov.	10	35	25-65	3	2(67)	1(33)	0
Dec.	8	40	20-70	4	2(50)	1(25)	1(25)
Jan.	14	45	20-70	54	31(57)	17(32)	6(11)
Febr.	7	42	25-65	20	14(70)	4(20)	2(10)
March	8	40	30-65	2	1(50)	1(50)	0

Spring Fisheries for Cod

About 40 fishing vessels were active in the Auvær-area during mid April 1985 using a large number of gill-nets. After one night's fishing, one vessel brought ashore 475 drowned seabirds, which according to the fishermen, was about 10% of the birds taken by that vessel that particular night. All were Common Guillemots, 352 (74%) were first winter birds, 88 (18.5%) were 2-5 year old and 35 (7.5%) were adults.

A few nights later another vessel on which we had an observer caught 2612 birds, of which 2579 were Common Guillemots and 33 Brünnich's Guillemots. A rough check showed that again most of the birds were juveniles and immatures, with only a few adults in breeding plumage seen. Of the Brünnich's Guillemots, 24 were in full breeding plumage and the other 9 were moulting into summer plumage. A comparison of measurements of these birds with our own data from colonies on Iceland, Spitsbergen and North Norway suggests that these birds were from the northern half of their breeding range, i.e. the Barents Sea (Table II).

TABLE II. MEASUREMENTS (MM) OF 33 BRÜNNICH'S GUILLEMOTS CAUGHT IN GILL-NETS IN THE AUVÆR-AREA, NORTH NORWAY IN APRIL 1985.

	Wing	*Culmen*	*Gonys*	*Head+bill*
Mean	222.3	38.49	16.59	107.45
SD	5.55	1.7	0.98	14.10
Min.	208	35.4	14.2	102
Max.	233	43.2	17.8	118

We asked many of the fishermen to collect ringed birds, and 12 ringed birds were all juvenile or immature Common Guillemots from colonies in Britain, Norway and the Soviet Union (Table III).

To estimate the total number of Common Guillemots killed in this incident is not easy. According to the fishermen themselves, "all boats caught thousands of auks every night" for a period of 10-12 days; the 2 boats for which we have better data had c. 4500 and 2600 birds, respectively. Forty boats each catching a conservative 1000 every night each for 10 days will give a total of 400 000 birds. As the number of birds taken per night decreased slowly day by day from the initial peak numbers, according to the fishermen, this estimate may be high, but probably at least 200 000 Guillemots were killed in the Auvær area during the incident.

Driftnet Fisheries for Salmon

The information from the five fishermen we interviewed is consistent. The driftnets were set in long series of from 20-50 nets, giving a total length for each set of 600-1200m. The fishing season

TABLE III. RINGING SITE AND DATE OF 12 COMMON GUILLEMOTS DROWNED IN GILL-NETS IN MID-APRIL 1985 IN TROMS, NORTH NORWAY.

Ringing-Site	*Longitude/Latitude*	*Year of ringing as chick*
Hjelmsøy, Norway	71°09'N 24°44'E	1983
Røst, Norway	67°12'N 12°01'E	1983
Hornøy, Norway	70°23'N 31°09'E	1983
Hornøy, Norway	" "	1983
Fair Isle, Shetland	59°32'N 01°37'E	1981
Fair Isle, Shetland	" "	1983
Fair Isle, Shetland	" "	1984
Fair Isle, Shetland	" "	1983
Sumburgh, Shetland	59°51'N 01°16'E	1984
Kharlov Isl., USSR	68°49'N 37°20'E	1982
Kharlov Isl., USSR	" "	1984
Kharlov Isl., USSR	" "	1984

was in most years restricted to weekdays between 1 June and 5 August. As a rule very few seabirds drown in these nets. But on some few days, in bad light and especially during thick fog, large numbers of auks could be caught, again mostly Common Guillemots. Under such circumstances, it was not unusual to get more than 1000 auks in one single drift (lasting 1-3 hours) and as many as 3000-4000 birds a day.

Such freak catches occurred only once or twice per season, and not always for all boats in the area. Nevertheless, with 10-15 boats fishing in the area off Hjelmsøystauren and Gjesværstappan, and taking into account the odd bird caught every day in each set, it is not unreasonable to suspect that 20 000-50 000 birds, mostly Common Guillemots, may have drowned in driftnets in some seasons. We have not examined birds from these nets, but most were said to be in full breeding plumage and so were probably breeding adults from the local large colonies.

Pound-nets Fisheries for Salmon

Fishermen often claim that pound-nets do not constitute a danger for seabirds. Our interviews and our own observations suggest the converse. According to a local fisherman in Gjesvær, a single pound-net set immediately below the birdcliff Gjesværstappan yearly killed thousands of Puffins. On some days there were so many birds in the nets that two men could not pull the net into the boat, and they had to tow it to a nearby sandy beach for cleaning. He estimated that in one single season he could catch as many as 10 000 Puffins and 1000 "auks" (Common and Brünnich's Guillemots and Razorbills *Alca torda*) in his 5 pound-nets.

TABLE IV. ESTIMATES OF NUMBER OF AUKS CAUGHT IN DIFFERENT SORTS OF FISHING GEAR EACH YEAR ALONG THE COAST OF NORTH NORWAY BEFORE THE REDUCTION IN NUMBERS OF POUND-NETS IN 1984 AND THE PROHIBITION OF DRIFT-NET FISHERY FOR SALMON IN 1989.

Species	*Cod gill-net*	*Salmon pound-net*	*Salmon drift-net*
Common Guillemot	10^4-10^5	10^4	10^4
Brünnich's Guillemot	10^2–10^3	10^2–10^3	10^2–10^3
Razorbill	10^2	10^2	10^3
Puffin	10^2	10^3–10^4	10^3

The information from the other large birdcliff in this area, Hjelmsøystauren, was much the same. The Common Guillemot was the dominant auk both on the cliffs and in the nets. 5 to 7 pound-nets were set below the cliffs in the 1960's and 70's and, according to the local fishermen, caught from 3000 - 10 000 "auks" every year. Again the Common Guillemot (probably including some Brünnich's Guillemots) was the main victim, but Razorbills and Puffins were also caught, although in much smaller numbers (<500). Since their designation as nature reserves in 1984, no pound nets have been set under the colonies on Hjelmsøy and Gjesvær.

Table IV summarizes our estimates for the number of auks drowned in different types of fishing gear in North Norway before the reduction in numbers of pound-nets in 1984 and the closure of the drift-net fishing for salmon in 1989.

DISCUSSION

It is very difficult to collect exact data on the numbers of seabirds drowned in fishing nets. Fishermen are reluctant to provide data, as they fear that these may be used against them either in the ongoing discussion on the economic and ecological merits of different competing fishing methods, or in closing the most favourable fishing areas, which are often close to the bird cliffs.

In the earlier Norwegian literature, it was acknowledged that large numbers of auks occasionally drowned in fishing nets (Holgersen 1961, Myrberget 1961), but this was apparently not considered a major regular mortality factor. Brun (1979) drew attention to the salmon driftnet fisheries, but a subsequent attempt by the Directorate for Wildlife and Fisheries to obtain quantitative data on the numbers of birds involved has not yet succeeded (e.g. Barrett & Vader 1984).

Our data, while admittedly scanty, show quite clearly that we have earlier underestimated the importance of drowning in fishing gear as a mortality factor for auks, and particularly for the deep-diving Common Guillemot. The Auvær-incident may well have been an extreme case, but also in 1974, 1976 and 1986 Tromsø Museum received phone calls reporting that "thousands" of auks had drowned during the cod fishery associated with the spawning of capelin. In all three incidents the reports arrived *post facto* so that we were unable to document them further.

Many other authors have documented Puffins, Razorbills, Common and Brünnich's Guillemots drowning in fishing gear in the Northeast Atlantic (King *et al.* 1979, Piatt *et al.* 1984). The numbers of Puffins and Razorbills breeding in the region are higher than that of Common Guillemots (Strann & Vader 1986). Nevertheless Common Guillemots are by far the most common species found drowned in fishing nets. Oldén *et al.* (1986) also found that Common Guillemot was the most numerous seabird that drowned in gillnets set for cod along the coasts of South Sweden, and that most individuals were immature. They noted a difference between the proportion of immatures drowned in fishing-gear and that of birds killed by oil in the same region and suggested that Guillemots may learn to avoid fishing-gear with age.

The steady decrease in some of the breeding populations of Common Guillemot in North Norway since the early 1960's (cf. Vader *et al.* 1990 and references therein) may well be a result of large numbers drowning in fishing gear. For example the population on Hjelmsøy, in West Finnmark, and Nord-Fugløy in Troms have dropped from 250 000 individuals in 1965 (Brun 1979) to ca. 12 000 individuals in 1989 (Tromsø Museum unpubl. data).

Using a population simulation model (developed by H.M. Iversen, Tromsø Museum) which was based on population parameters initially producing a stable population (from Murphy *et al.* 1986) and assuming no change in these parameters over years, we found that an annual adult mortality of ca. 13 000 adults was required for a reduction in a population of 250 000 breeding individuals to 12 000 individuals over a 25 year period. With an adult mortality of 20 000 individuals each year, the population became extinct within 18 years. How reliable Murphy *et al.*'s population parameters are in a Norwegian context is unknown as no data exists for adult or subadult survival in Norway. However if the reproductive success and adult survival are increased to the maxima found in the litterature (0.82 chicks/pair Hedgren 1980, 0.945 % Birkhead *et al.* 1985, respectively), the model showed that an annual mortality of ca. 25 500 adults was required for the same reduction in population. According to the litterature, such high breeding success and natural adult survival are however unlikely. However crude these simulations may be, they do show that the decline in the Common Guillemot population in Troms and West Finnmark can easily be explained by the drowning of adults in salmon nets alone. How much the bycatch in cod nets contributed to this decline is unknown, as these incidents kill immature birds from a much wider range of the species' distribution. The fact that the breeding population east of North Cape did not show the same decrease and that on Hornøy actually increased (Vader *et al.* 1990) until 1985, may be the result of the prohibition of the use of salmon drift-nets in this area.

The use of salmon drift nets was banned in Norway in 1989 (to protect the salmon stocks, not the seabirds!). How long the ban will be enforced is unknown and whether it will have a positive influence on the numbers of breeding Guillemots in the years to come, remains to be seen.

ACKNOWLEDGEMENTS

We thank Hans Martin Iversen, Tromsø Museum for allowing us to use his seabird population simulation model and Halvar Ludvigsen, Hillesøy for collecting drowned auks from a number of fishermen on Sommarøy. Ellen Beck drew the figures. The study was supported by the Norwegian Institute for Nature Research and Tromsø Museum.

SUMMARY

At least 200 000 Common Guillemots *Uria aalge* (mostly immature) drowned in cod fishing nets in North Norway in April 1985, and tens of thousand of auks are thought to have drowned in salmon fishing nets every year for the last fifteen to twenty years. A steady decline in the Common Guillemot population in Troms and West Finnmark can be explained by the loss of adults in salmon nets alone.

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SEABIRD 13: 30-39

The breeding biology of Cory's Shearwater *Calonectris diomedea borealis* on Berlenga Island, Portugal

Jose Pedro Granadeiro

INTRODUCTION

The Berlengas Islands (39°24'N, 9°30'W) are a small group of granitic islands located off the western coast of Portugal and include the Estelas and Farilhões, both uninhabited, and Berlenga itself where some fishermen live permanently and which many tourist visit in July and August. The island has the only colony of Cory's Shearwater *Calonectris diomedea borealis* reported from the Atlantic coast of Iberia and it also has a small colony of Guillemots *Uria aalge*, on the southernmost limit of the species current breeding range (Cramp 1985). Most of the area was declared a Nature Reserve in 1981.

Following recent census of seabirds (Araujo & Luis 1982, Teixeira 1983, Teixeira & Moore 1983, Teixeira 1984, Vicente 1987), a study of the Cory's Shearwater population was initiated in 1987 to establish baseline information for a subsequent annual monitoring programme. This paper describes the chronology of major events in the breeding cycle, including the growth sequence of nestlings, breeding success and population size. Morphometry of adult birds is also presented and compared with the colony of Selvagem Grande (Madeira).

METHODS

In 1987 the island was visited regularly between February and October. During the breeding season adult birds were counted at sea in late afternoon. After the onset of the reproduction period in March, all nests that could be inspected throughout the entire island were individually mapped. During the laying and hatching periods, all the nest-sites were visited once a day. Eggs were measured to the nearest 0.05 mm with Vernier callipers and weighed using a Pesola spring balance (readable to 2g) if less than three days after laying. After hatching, all chicks of known age were weighed and measured every day for six days, followed by a six days "resting" period. This routine was repeated throughout the breeding season until the young fledged. The following characters were measured on the chicks (in mm): tarsus-length, wing-length (from carpal joint to the tip of the longest feather), head+bill length, culmen-length (from tip of bill to the first head feathers) and bill-height (measured to the foremost head feathering).

One hundred and five adult birds were also caught ashore (mainly before laying), measured, ringed and marked with a three-colour code painted onto the breast feathers, using various combinations of eight different colours, which allowed visual recognition of individual birds, thus avoiding the need for any further handling of the breeding birds in their burrows. When possible birds were sexed according to their vocalization (Cramp & Simmons 1977, Ristow & Wink 1980) or by their position during copulation. Measurements of birds from Selvagem Grande were obtained during a 20 days visit in June/July 1988. All mean values are given ± 1 standard deviation, except where otherwise stated.

RESULTS

Biometrics of adult birds

Comparison of the measurements made on Berlenga and Selvagem Grande colonies showed the existence of differences between all characters studied except wing-length, the birds of Berlenga being significantly smaller than those of Selvagem Grande (Table I). Morphological separation of subspecies have already been reported (Jouanin 1976, Massa & Valvo 1986), but no references were found for such differences within the Atlantic subspecies *C.diomedea borealis.*

TABLE I. ADULT MEASUREMENTS (mm) AND WEIGHT (g) OF CORY'S SHEARWATERS BREEDING AT BERLENGA AND SELVAGEM GRANDE.

	BERLENGA			*SELVAGEM*			*t-TEST*	
	Mean (Range)	*sd*	*N*	*Mean (Range)*	*sd*	*N*	*t Value (d.f.)*	*P*
Weight	813.2 (620-1070)	90.27	194	907.6 (730-1030)	79.33	33	5.65 (225)	<0.001
Wing	365.9 (345-389)	9.02	195	362.2 (346-389)	9.57	33	1.93 (224)	ns
Tarsus	57.93 (53.15-65.35)	1.87	93	60.4 (57.85-63.5)	1.74	33	6.64 (124)	<0.001
Culmen	54.8 (48.10-61.50)	2.49	189	56.3 (51.70-61.70)	2.58	33	3.20 (220)	<0.005
Bill-Height	20.6 (17.80-23.65)	1.36	195	21.7 (19.40-23.65)	1.40	33	4.15 (224)	<0.001
Head+Bill	115.1 (106.95-125.30)	4.05	91	118.1 (110.75-126.55)	3.99	33	3.74 (122)	<0.001

Arrival and laying dates

Cory's Shearwater were first seen on the island and in the surrounding sea area on 5 March, when four birds were observed at sea and two captured ashore at their breeding sites at night. No birds were seen in the area between 21 February and 1 March. Until the laying of the first eggs birds were found ashore only at night, except just prior to laying when they were occasionally found in their burrows during the day. The nests on Berlenga were located mainly in rock crevices and burrows. Some were in holes, on platforms of loose soil on the floor of small caves and in deep rabbit holes, sometimes quite difficult to detect.

The first eggs were found on 26 May (Fig.1), the mean laying date was 1 June, a value showing no statistical differences from the results obtained by Zino *et al.* (1987) for the Selvagem Grande colony in 1984 (see Table III).

No significant correlation was found between laying date and either the weight, length or width of the eggs (r=0.05, r=0.05 and r=0.21 respectively, all n=31, ns). The measurements and weight of the eggs on Berlenga were significantly smaller than those from Selvagem Grande (Table II), although both populations belong to the Atlantic subspecies *C.d.borealis*. Most probably, this merely reflects differences observed in the overall size of the birds from the two colonies. These observations are consistent with the biometrical cline observed in birds from the eastern Mediterranean colonies to the NE Atlantic (Iapichino *et al.* 1983).

Incubation and hatching

The mean incubation period was 55 days, close to the value obtained on Selvagem Grande (Table III). In most cases (68% of total, n=16) the male took the first spell in incubation. Incubation stints of both sexes averaged 4.25 days, calculated from the number of times that a brooding bird was replaced by its mate (Mougin *et al.* 1988). This value is rather low when compared with the 8.4 days obtained by Mougin *et al.* (1988) on Selvagem Grande and it was due to the irregular

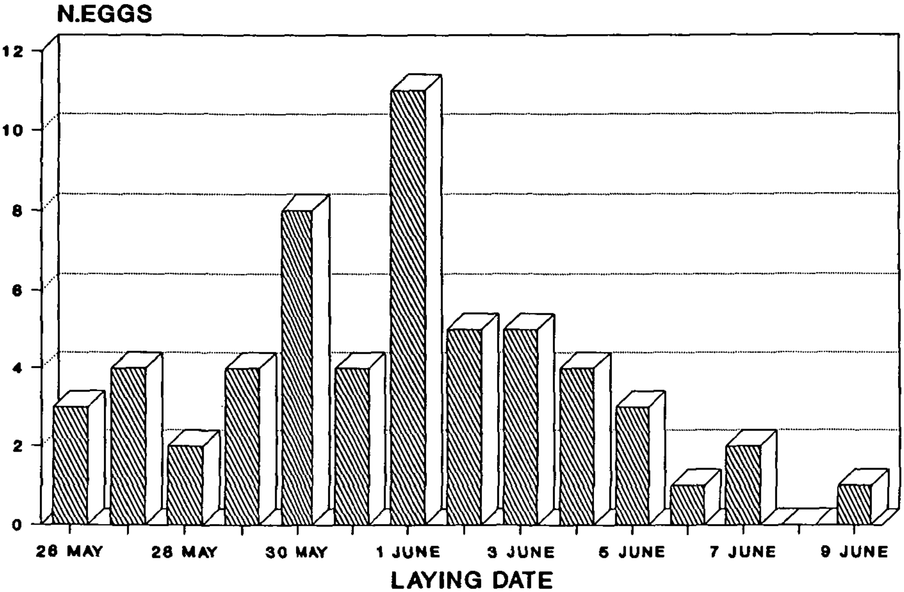


Figure 1. Laying dates of Cory's Shearwater at Berlenga in 1987 (n=57).

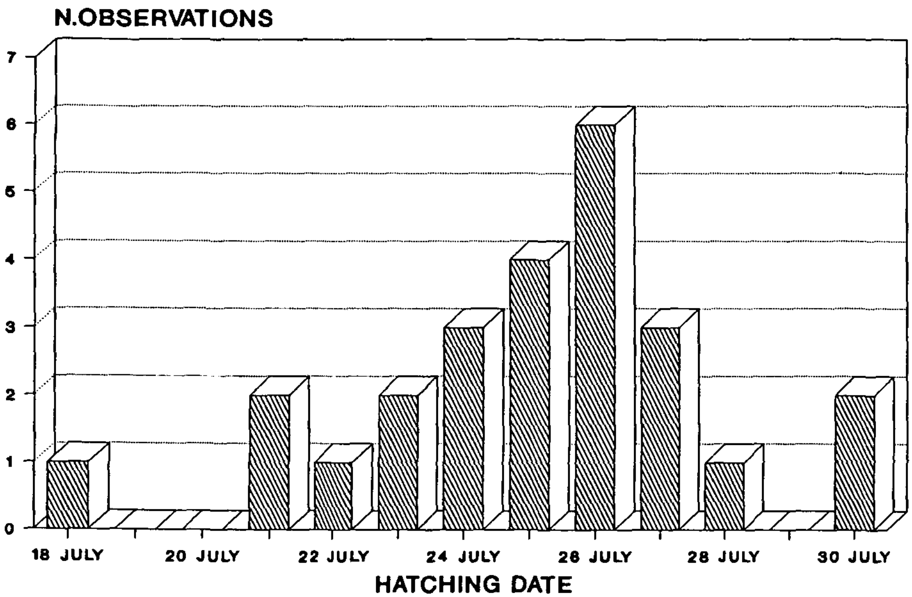


Figure 2. Hatching dates of Cory's Shearwater chicks observed at Berlenga (n=25).

TABLE II. EGG MEASUREMENTS (mm) AND WEIGHT (g) OF CORY'S SHEARWATERS BREEDING AT BERLENGA AND SELVAGEM GRANDE.

	BERLENGA			*SELVAGEM*[1]			*t-TEST*	
	Mean (Range)	*sd*	*N*	*Mean (Range)*	*sd*	*N*	*t Value (d.f.)*	*P*
Length	73.55 (67.25-79.45)	2.99	37	75.3 (70.6-82.3)	2.65	46	2.82 (81)	<0.01
Width	48.41 (45.15-51.45)	1.58	37	52.5 (47.8-54.0)	1.45	46	5.37 (81)	<0.01
Weight	93.5 (82-114)	15.8	31	104.3 (95-115)	5.38	46	3.97[2] (45/36)	<0.01

(1) – data from Zino (1971)

(2) – t-Test for heterogeneous variances (Sokal & Rohlf 1981)

incubation patterns of some breeding pairs at Berlenga, that exhibited periods of highly frequent changes between the brooding individuals. This irregular pattern had marked effects on the reproductive performance of the pairs involved, most of these situations resulting in abandoned eggs.

Most eggs hatched between 21 and 27 July (Fig 2) which was later than the range observed in some colonies of the Mediterranean (e.g. Round & Swann 1977, Ristow & Wink 1980, Thibault 1985, Massa & Valvo 1986). For example, significant differences were found in time of laying between Lavezzi colony, in Corsica (Thibault 1985) and Berlenga (Mann-Whitney U-test: U=234, $n_1 = 59$, $n_2 = 57$, $P<0.001$).

Growth of the chicks

As reported for other colonies, one of the parents usually spent the first few days after hatching with the chick (Zino 1971, Round & Swann 1977, Fernandez 1985, Thibault 1985). At around nine days after hatching the chicks were left alone in the nests (Figure 3), and feeds occurred only during the night. The mean fledging period was 95 days (Table III).

TABLE III. DETAILS OF THE BREEDING BIOLOGY OF CORY'S SHEARWATER OF BERLENGA AND SELVAGEM GRANDE (Test type: MW – Mann-Whitney U-test, t– Student's t-test)

	BERLENGA			*SELVAGEM*[1]			*STAT. TEST*		
	Mean (Range)	*sd*	*N*	*Mean (Range)*	*sd*	*N*	*Test type*	*Value*	*P*
Laying dates	1 June (26 May-9 June)	3.2	57	1 June (26 May-15 June)	3.6	277	MW	U=7227	ns
Incubation (Days)	55.1 (53-60)	1.65	20	54.46 (52-58)	1.12	88	MW	U=707	ns
Fledging period (Days)	94.9 (91-100)	2.96	10	96.76 (91-105)	2.66	78	MW	U=252	ns
Fledging weight (g)	887.0 (790-1010)	74.24	10	854.7 (510-1080)	109.92	68	t	t=0.899	ns

(1) Data from Zino *et al.* (1987)

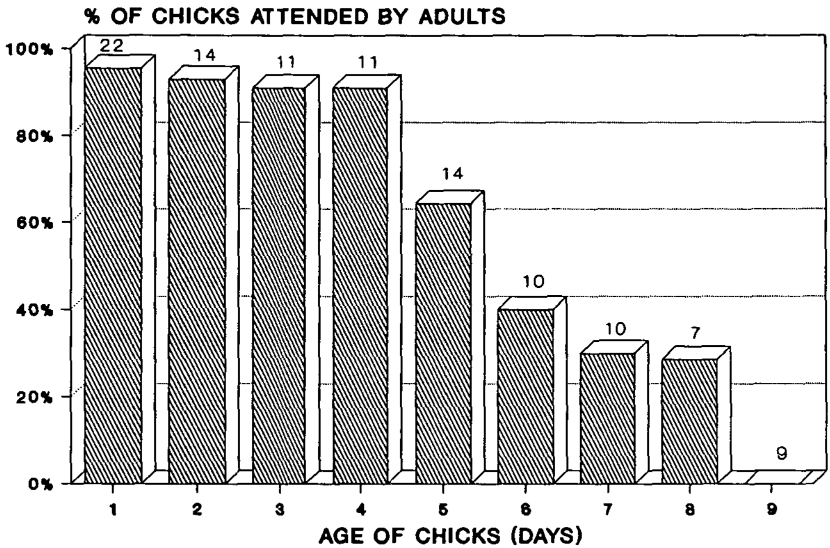


Figure 3. Proportions of chicks of different ages attended by adults. Sample sizes are indicated.

The mean weight of a chick at hatching was 69.2g (sd=8.75g, n=14, range 54-81g). This value probably overestimates the true mean, since some chicks could have been fed between hatching and the first measurements.

The weight growth curve (Fig. 4) was similar to that of other procellariiforms (e.g. Harris 1966, Perrins *et al.* 1973, Round & Swann 1977, Brooke 1990, Cruz & Cruz 1990). The chicks reached mean adult weight about 34 days after hatching and remained above that value for about 45 days. Mean peak weight, calculated from chicks 55 to 79 days old, was 1071.4g (sd=121.9g, n=182, range 790-1330). Body weight began to decrease when the birds were about 80 days old, and then progressively converged to the values recorded for adults. The growth curve for the wing-length (Fig. 5) shows two distinct phases, one from hatching date up to 35-40 days, and another from that age to fledging. The first phase, with a linear growth rate of 2.19mm.day^{-1}, represents the development of the osteological and epidermal structures. The second phase included also the process of feather growth, initiated at c.40 days after hatching, resulting in a linear growth rate of 4.23mm.day^{-1}. Due to the small standard errors and the continuous growth rate throughout the rearing period, the wing-length appears to be the most useful predictor of chick's age.

If the chick growth curves are expressed as a percentage of the corresponding adult values (Figs. 4, 5, 6A and B), it becomes obvious that horny and skeletal structures, like tarsus, culmen, bill and skull are fairly well developed at hatching, reaching up to 40% of the corresponding adult values. While these structures achieve sizes near those of adults rather early, the wing shows a different pattern, with a comparatively slow growth rate, reaching adult length only a few days before fledging (Fig. 5), which suggests an important role in the extension of the dependence period.

The first departure from the colony in 1987 was observed on 23 October and by 27 October 10 more birds had fledged. However, the fledging period could not be fully investigated, since 11 of the 21 chicks controlled were still present at the time of our last visit on 27 October. The mean weight at fledging was 887g (Table III).

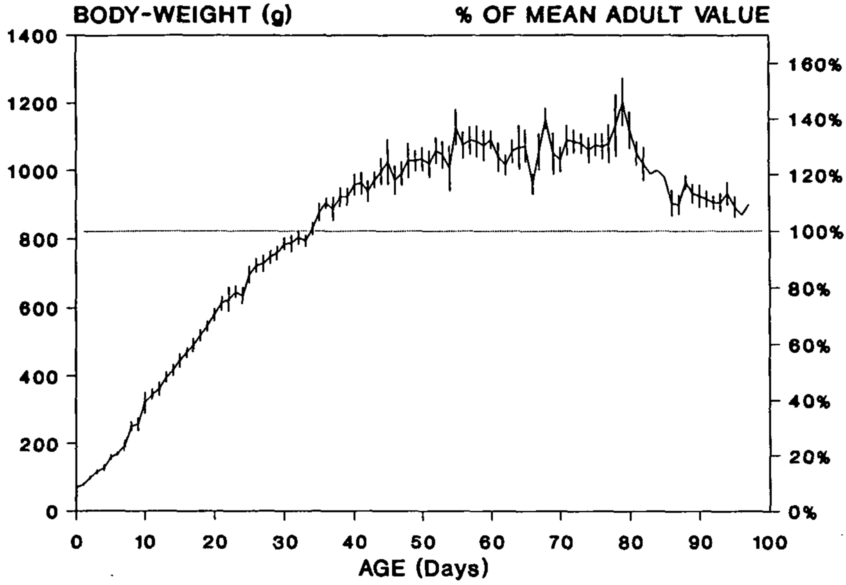


Figure 4. Growth curve for the body of Cory's Shearwater chicks at Berlenga in 1987 (given also as percentage of adult weight - dotted line). Sample size varied between 2 and 18 chicks, according to the day. Points represent mean ± s.e.

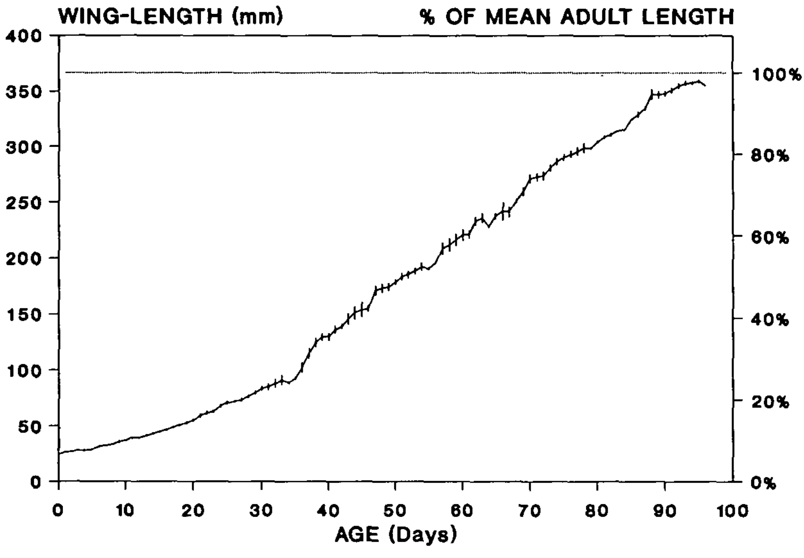
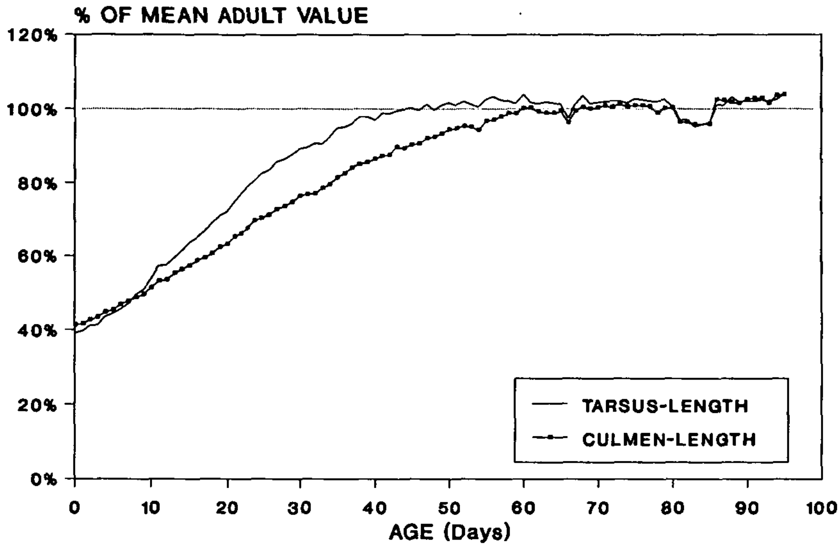


Figure 5. Growth curve for the wing-length of Cory's Shearwater chicks at Berlenga in 1987 (given also as percentage of adult weight – dotted line). Sample size varied between 2 and 18 chicks, according to the day. Points represent mean ± s.e.

a)



b)

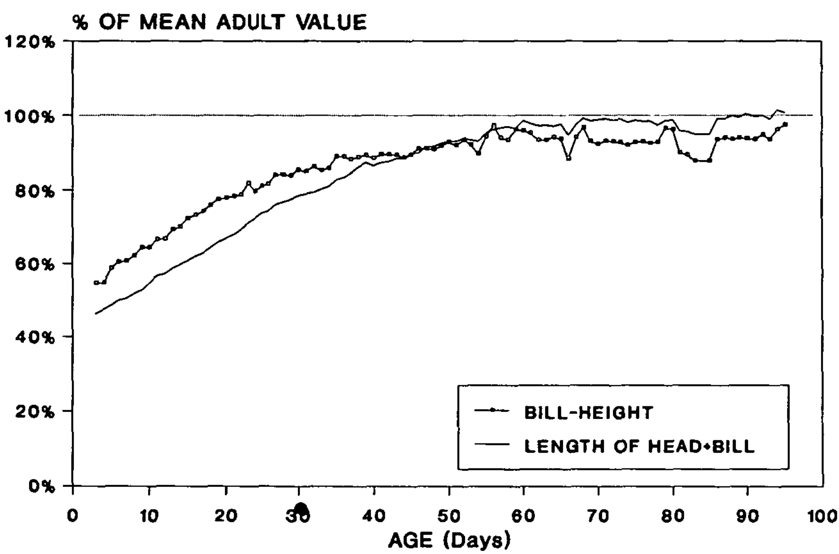


Figure 6. Growth curves of Cory's Shearwater expressed as percentage of mean adult values: (a) – Tarsus and culmen-length; (b) – Height of bill and length of head+bill.

Breeding success

The most striking feature of the breeding parameters in 1987, was the comparatively high number of abandoned eggs in the colony, resulting in a very low overall hatching success. In fact, from 59 individually marked eggs, 34 (57.6%) did not hatch, most of them being deserted in the early stages of the incubation period. This might have been due to our disturbance as some species of shearwaters are rather intolerant to disturbance during incubation (Warham 1990) and we had no control against which to assess our influence. In contrast, only 3 chicks (12%) died after hatching. One was found dead the day after hatching, the second apparently died from starvation at about 20 days old, while the third disappeared from the nest aged 6 days although no signs of predation could be found.

Population size

Census work in 1981, suggested 60-80 breeding pairs of Cory's Shearwater in the whole group (Barcena *et al.* 1984) but further census in 1982 and 1983, increased the estimate to 100-200 breeding pairs (Teixeira 1984). Our study, which included counts at sea and a fairly exhaustive search for suitable nesting habitat all over the island, suggested 100-120 pairs breeding on Berlenga island itself and 80-100 elsewhere.

DISCUSSION

Comparison of the morphometric data collected on adult birds from Berlenga and Selvagem Grande showed that there were significant differences between all characters measured except for the wing-length, although both populations belong to the subspecies *C.diomedea borealis* and these differences are also reflected in the dimensions of the eggs. These findings suggest some sort of reproductive isolation between these colonies which may be explained by the strong mate and nest-site fidelity reported for this species (e.g. Mougin *et al.* 1987, Zammit & Borg 1987). In addition, environmental variables such as food availability could play an important role in maintaining the observed differences.

The details of Cory's Shearwater breeding biology were generally quite similar to those reported from the Atlantic. Minor differences observed probably reflect only different methodological approaches. The differences for the Mediterranean colonies agree with the genetic differences found between subspecies (Randi *et al.* 1989).

The results obtained on the laying and hatching sequences seem to support the currently held ideas about laying synchrony (temporal compression) for this species (Jouanin & Roux 1966, Zino 1971, Zammit & Borg 1987). Furthermore, they seem to reflect also a very high degree of geographical conformity in the breeding behaviour of this species within its range.

The mortality factors affecting this population were difficult to assess. The Black Rat *Rattus rattus* usually described as a predator of seabird eggs and chicks (Moors & Atkinson 1984, Fernandez 1985, Guyot 1985, Thibault 1985, Vidal 1985, Furness & Monaghan 1987) can hardly account for the extent of the egg losses observed at Berlenga. In fact, we had no evidence of predation either of eggs or chicks of Cory's Shearwater, although rats did eat some long-deserted eggs. Similarly, we did not detect any predation of eggs or chicks by the Yellow-legged Herring Gull *Larus argentatus*, despite the recent increases in the population of that species breeding at Berlenga (Vicente 1987, pers.obs.).

The presence of Cory's Shearwater in Berlenga was first recorded by Daveau & Girard (1883) and following a visit to these islands in June 1939, Lockley (1952) estimated the breeding population as 100 pairs. The results obtained in this study suggest a stable condition for this population although it is important to ensure strict control of the most vulnerable breeding areas on the island. In fact, the disturbance by tourists and fishermen at the nest sites during the breeding season seem to play an important role in the overall success of Cory's Shearwater at Berlenga.

Although direct persecution of the birds and their eggs as reported by Lockley (1952) has markedly decreased in recent years, the island now has many summer visitors coming from the mainland and effective protection of some breeding sites is sometimes difficult.

ACKNOWLEDGEMENTS

We thank Direcção de Faróis for all accommodation and transport facilities; the Director of Berlenga Nature Reserve, N. Lecoq, for permission to work on the island. Special thanks are due to A. Teixeira for extensive comments on an early draft of this paper, which improved its contents and readability. M. A. Silva helped with fieldwork and made useful suggestions. Our work benefited from the comments of A. Silva and C.C.Moore. R. Furness and M.P. Harris greatly improved the final standard of this paper.

SUMMARY

In 1987 a biological study of Cory's Shearwater at Berlenga Nature Reserve (Portugal) was initiated in order to establish baseline information for a monitoring scheme for the population. Adult morphometry is presented and compared with data from the colony of Selvagem Grande. The chronology of the major events of the breeding cycle is described and growth of chicks documented. The breeding success in 1987 was very low, mainly because of the high number of abandoned eggs. More work should be carried out to ensure strict control of the most vulnerable sites, avoiding undue disturbance to the breeding birds.

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SEABIRD 13: 40-44

Growth of young Guillemots *Uria aalge* after leaving the colony

M.P. Harris, A. Webb and M. L. Tasker

INTRODUCTION

Guillemots *Uria aalge* have an unusual breeding strategy in which the partly grown, flightless chick is taken to sea when about three weeks old by its male parent which continues to feed it for 2-3 months (Varoujean *et al.* 1979). Young Guillemots have been studied in detail at many colonies in the Atlantic (review in Harris & Birkhead 1985), but apart from a few records of the weights of chicks (eg Anker-Nilssen & Nygård 1987), little has been published on their ecology immediately following their departure to sea. Varoujean *et al.* (1979) reported briefly on the growth of young at sea off Oregon, but gave no details of methods used or sample size. Modelling the patterns of growth of different auks has resulted in intriguing speculations about when the chicks of various species should leave the colony (Ydenberg 1989) but there are few empirical data on chicks immediately after they have gone to sea. The present note combines information collected from young at an east Scottish colony and at sea off northeast Britain within a month of the end of the breeding season.

METHODS

Chicks and adults brooding chicks on the Isle of May, Firth of Forth (56°11'N, 2°33'W), were weighed (nearest g) and had the length of a wing (nearest mm) measured in June 1984 and 1985. Each bird was handled only once. The weights of chicks with wing lengths of more than 60 mm, (by when the rate of weight increase/mm increase in wing length had slowed down, Fig. 1) were taken as an index of the chick's leaving weight (details of study in Harris & Wanless 1988a). Leaving dates (the morning a chick aged 16 or more days old was missing) were those for all chicks produced by c. 600 pairs in five study areas.

Samples of chicks and their accompanying adults, adults without chicks and immatures (identified by having large cloacal bursa; Gower 1939) were shot under licence at sea on 13 August 1984 (off Montrose, 60 km north of the Isle of May (IoM)), 15 August 1984 (at the Wee Bankie, 30 km east of IoM), 22 August 1984 (in Tees Bay, 210 km southeast of IoM), 19 August 1985 (off Fraserburgh 180 km north of IoM) and 29 August 1985 (off Berwick-upon-Tweed, 60 km southeast of IoM) and were weighed (nearest 10 g in 1985, 50g in 1984) and had their wing length (maximum chord) measured. Chicks are easily distinguishable at this time by their small size, behaviour and high-pitched contact call (Jones & Rees 1985). Details of the shot birds and collecting localities are given in Tasker *et al.* (1985, 1986). The origins of these birds were unknown but they presumably came from colonies in the general area because (a) the collecting locations were among the main concentrations of Guillemots off east Britain at the time, (b) there are ringing recoveries of Isle of May chicks in these areas in late summer and autumn, and (c) Guillemots which immigrate into the North Sea in August probably occur further north (Tasker *et al.* 1987).

Wing lengths of young Guillemots at the colony are little influenced by nutrition and are linearly related to age (Gaston 1985). Chicks were therefore aged using the relationship calculated for 73 known-age Isle of May chicks.

$$\text{Wing (mm)} = 21.6 + 2.11 \text{ Age (days)} \quad (R^2 = 78\%, P < 0.001)$$

The daily weight increase over the period of most rapid growth at the colony (4 - 9 days) was calculated by linear regression.

Calculations of weight increases after leaving the colony assume that the birds concerned had left on the mean leaving date and at the mean leaving weight recorded on the Isle of May in each of the two years. Two shot birds from 1984 and one from 1985 were excluded from the calculation of daily weight gain as, although perfectly healthy, they were obviously several weeks younger than the others and probably came from replacement layings. Means are given ± 1 se.

RESULTS

The 1984 season

A total of 241 young were weighed at the colony (Fig. 1). Between the ages of 4 and 9 days chicks gained weight rapidly (15g/day) but the rate of increase then declined and relatively little weight was gained during the days prior to fledging, although wing length continued to increase. The estimated mean leaving weight and mean leaving date were 264 g and 29 June (Table 1). The range of leaving dates was 16 June - 30 July. The mean weight and wing length of 35 adults with chicks were 935 ± 9 g and 201 ± 7 mm, respectively.

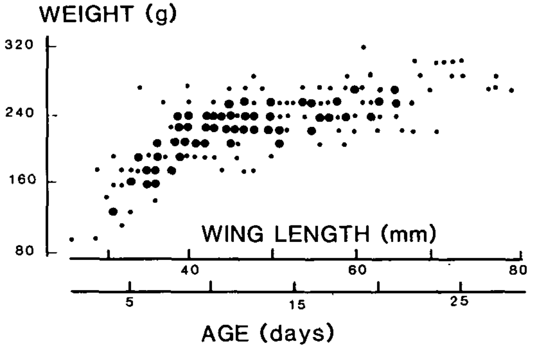

Figure 1. The weights of 241 young Guillemots on the Isle of May in 1984 in relation to wing length and calculated age. Large circles indicate 2-7 records, small circles are single records.

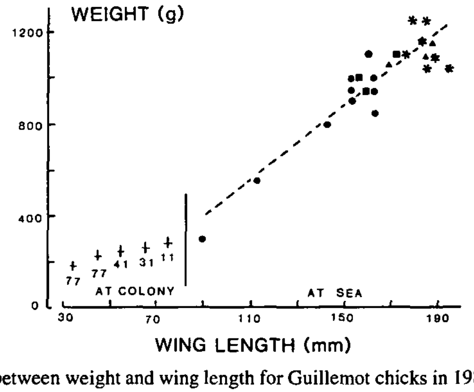

Figure 2. The relationship between weight and wing length for Guillemot chicks in 1984 at the colony on the Isle of May (mean weight and 95% Confidence Interval for each 10 mm group of wing lengths) and at sea on 13 August (circles), 15 August (squares), 22 August (triangles) and 27 August (asterisks). The dotted line is the linear regression for the at sea points (Weight = 7.91 wing length - 305, $R^2 = 85\%$, $P < 0.001$).

Twenty-three chicks were collected at sea. There was a highly significant linear relationship between weight and wing length (Fig. 2), the calculated growth rates between fledging and collection were 8g/mm increase in wing length or 15g/day (Table 1). The heaviest young were presumably close to their asymptotic weights as they were heavier than any adult or immature weighed on the Isle of May (Harris & Wanless 1988b), although adults with chicks on the sea were occasionally heavier.

There was no significant difference between the weights of 12 adults with chicks (1112 ± 52g, maximum 1338), 4 adults without chicks (1050 ± 41g) or 9 immatures (1139 ± 46) (ANOVA $F_{2,22} = 0.5$, n.s.) nor a significant relationship between the weight of an adult and its accompanying chick (n = 11, $R^2 = 18\%$, n.s.). Ten of the adults with young were males, the other was a female and was the only adult with a chick weighing ≥ 1000g.

TABLE 1. DETAILS OF YOUNG AND ADULT GUILLEMOTS ON THE ISLE OF MAY AND AT SEA OFF NORTHERN BRITAIN

		1984		*1985*
	n	*Mean*	*n*	*Mean*
At colony				
Leaving date (95% C.I.)	454	29 June (28-30 June)	561	2 July (1-3 July)
Weight increase of chicks 4-9 days old (R^2 of regression)	73	15.4g/day (47%)	36	13.6 (39%)
Estimated weight at leaving (± SE)	42	264g (± 3.9)	17	260g (± 5.2)
At sea				
Maximum weight recorded	23	1250g	9	1338g
Wing length at maximum weight	23	182mm	9	188g
Rate of weight increase				
(a) g/mm increase in wing (R^2)	23	7.9 (85%)	9	6.5 (63%)
(b) g/day since leaving colony (± SE)	21	14.8 (± 0.4)	8	15.0 (± 0.9)
Weight of adult with chick (± SE)				
(a) at colony in June	35	935g (± 9)	7	924g (± 14)
(b) at sea in August	12	1112g (± 52)	4	1032g (± 88)

The 1985 season

The pattern of chick growth and timing of breeding were similar to 1984 with the mean weight of chicks near leaving and mean date of leaving being 260 g and 2 July, respectively (Table 1). The mean weight of 7 adults with chicks was 924 ± 14 g.

Nine chicks were collected at sea in August and again there was a significant linear relationship between weight and wing length whereby weight increased by 6.5 g/mm increase in wing ($R^2 = 63\%$, P = 0.01). The increase in weight between fledging and collection was 15g/day. The mean weight of 4 adults with chicks was 1035 ± 84g. Three of these adults were males, the other was a female which was one of two adults with a chick so might not have been its parent.

Combining the two years, only 2 out of 7 adults with chicks on 13-19 August were in primary moult (the rest still having a full set of old primaries) whereas on 27-29 August all five adults with chicks were flightless.

DISCUSSION

The daily weight gains of chicks 4-9 days old and after leaving the colony were similar. The temporary slowing of weight gain while wing length continued to increase in the few days prior to leaving the colony is probably associated with the young needing to have an adequate wing surface/weight ratio so as to slow their descent and increase the distance they can "fly" when they jump from the breeding ledges which can be up to 100 m or more above the sea (Birkhead 1977). The calculated regression of weight to wing length after leaving in 1984 predicts that a chick with a wing of 70 mm should have weighed ca. 250 g whereas the mean leaving weight of chicks that year was ca. 264 g; the rate of weight gain appears to have increased very soon after the young reached the sea but there are very few data for chicks of that age.

The daily weight increases of 15 g after leaving were similar to annual values of 12 and 16 g in the Pacific (Varoujean *et al.* 1979). In central Norway three young collected 39-48 days after the peak of leaving at a nearby colony weighed 850-1150 g; no weights at leaving the colony were available but growth must have been rapid, probably in the region of 15-17 g per day (Anker-Nilssen & Nygård 1987). Feeding conditions in these three areas must have been extremely good because (a) one adult could supply enough food for the large chick to gain weight at a similar rate as did very small chicks which were fed by both adults, (b) the adult increased its own weight by 10-20% over the same period, (c) the adult was undergoing a complete moult which takes considerable energy, and (d) the adult can presumably forage only within a few hundred metres of the chick. Oberholzer & Tschanz (1969) recorded that hand-reared chicks 25 days old could catch slow-moving fish, but there is no information on when juveniles in the wild start to catch food for themselves, but it is presumably before they become independent 70-85 days after leaving the colony (Varoujean *et al.* 1977). Nor is there information on when they make their first flights. The only record of fledging age comes from captive birds which first flew in early September when c. 94 days old (Swennen 1977).

Guillemots have a low wing area/body weight ratio and adults and chicks in late August both have such large fat deposits, which presumably act as an insurance against possible food shortage (Tasker *et al.* 1985, 1986, Anker-Nilssen & Nygård 1987) and possible insulation when body feathers are growing that they may be unable to take off even when their primaries are fully grown. Guillemots in their first winter are significantly lighter than adults due to having lighter pectoral muscles (Gaston 1985) so young must lose substantial amounts of weight after independence possibly to allow them to fly.

In some seabirds, eg Manx Shearwater *Puffinus puffinus* and Cape Gannet *Sula capensis*, the weight of a chick at fledging has a significant positive influence on its post-fledging survival (Perrins, Harris & Britton 1973, Jarvis 1974). No such effect has been detected in the Guillemot or in the Razorbill *Alca torda* which has a similar breeding strategy (Hedgren 1981, Lloyd 1979), yet the weight of chicks near to or at the time they leave the colony have been used as a measure of breeding performance (Gaston 1985, Harris & Wanless 1988a). When the young Guillemot leaves the colony it is only 20-25% of the way through its development, and it enters an environment where the daily risk of dying approximately doubles (details and references in Ydenberg 1989). The chance of survival of an individual to breeding age is probably related more to its weight at independence or perhaps the date or age when it reaches a certain weight, rather than to its weight or date when it leaves the colony but there seems little possibility of testing such an hypothesis.

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SUMMARY

Young Guillemots were weighed at a colony and at sea in two years. Growth at sea was as rapid as growth at the colony. By late August, chicks and adults at sea were both much heavier than adults when they were at the colony. The chances of a chick surviving to return to the colony in a subsequent year is likely to be linked with some aspect of its at-sea development rather than to its weight when it leaves the colony.

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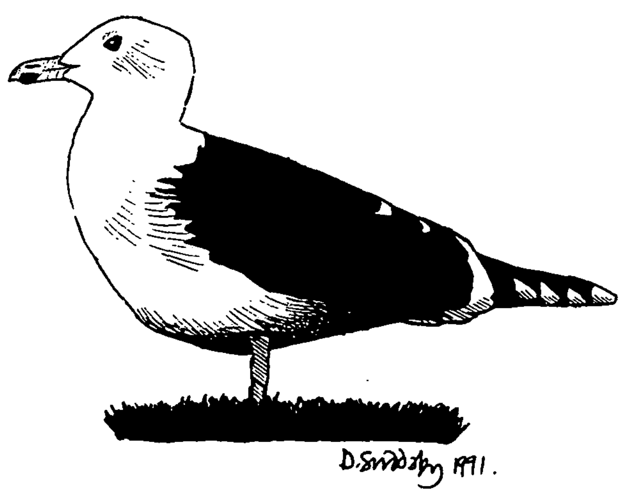

Breeding success of colonial Great Black-backed Gulls *Larus marinus* on the Calf of Man.

D. Walker

The Great Black-backed Gull *Larus marinus* is the least colonial of British breeding gulls (Cramp, Bourne & Saunders 1974). It first bred in the Isle of Man in 1911 and has done so on the Calf since 1914 (Cullen & Jennings 1986). Numbers have increased since then and in the 1980's the population on the Calf has varied between 50 and 140 pairs (Table I). As few studies have been made on colonial nesting Great Black-backed Gulls, I collected data on the breeding success of the birds nesting in 1987 on the Calf.

TABLE I. NUMBER OF PAIRS OF BREEDING GREAT BLACK-BACKED GULLS ON THE CALF OF MAN, 1959-86

Year	*No. of pairs*	*Year*	*No. of pairs*
1959	115	1973	100
1960	115	1974	170
1961	No count	1975	170
1962	140	1976	170
1963	200	1977	160
1964	150	1978	107
1965	200	1979	145
1966	No count	1980	140
1967	120	1981	110
1968	125	1982	80
1969	100	1983	50
1970	110	1984	103
1971	100	1985	116
1972	100	1986	109

From Calf of Man Bird Observatory Annual Reports 1959-1986.
N.B. No details are given as to how estimates of numbers were made.

STUDY AREA AND METHODS

The Calf is a rocky islet of 257 ha off the southern tip of the Isle of Man. It is relatively undisturbed, being inhabited by two wardens between March and November and by lightkeepers throughout the year. The island is open to the public and there are 2-3000 visitors annually. The island consists of large tracts of heathland and derelict pasture bounded by rocky cliffs 25-125m high. It was farmed up to 1959 and some culling of the gull populations probably took place but is undocumented. Great Black-backed Gulls nest all around the coastline with a few pairs among heather on top of the island. The main concentrations are in the south and west of the island, on or close to 1km of coast between Culbery and Burroo. This area consists of mainly low, rocky cliffs backing onto gently sloping ground of maritime turf with frequent rocky outcrops. Most nests here are situated between 15-35m above sea level. This area was chosen as the main study area.

A thorough search of the island throughout the laying period found 135 nests and another 9 pairs which held territories and were probably nesting. The main study area had 90 nests.

The study started on 26th April and ended on 31st July. Nest contents were checked about every other day until all the eggs had either hatched or been lost. Visits were not made in poor weather. When all the eggs had hatched the frequency of visits was reduced.

The location of each nest was plotted on a map and the nest was marked with a small, numbered, plastic peg. The study area was split into five sub-divisions based on nest distribution and geographical features (Fig.1). The length and maximum breadth of each egg in clutches of three eggs was measured to the nearest 0.1mm using vernier calipers. Eggs were weighed to the nearest gram. An index of the volume of each of these eggs was estimated by length x breadth. The indices were summed to give the total volume of each three egg clutch. These eggs were reweighed during incubation and all eggs on the point of hatching were also weighed. Nestlings known to be less than 24 hours old were also weighed. The survival of individual young was often difficult to determine so estimates of survival rely on overall counts of young and known deaths. Chicks two or more weeks old were ringed which allowed the fates of some of the chicks to be followed directly.

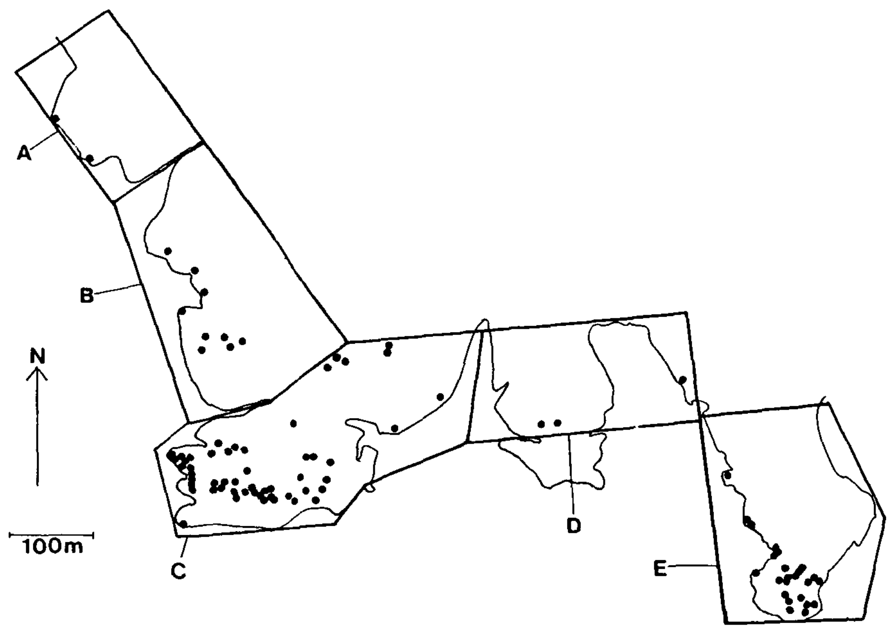

Figure 1. Map of the study area showing locations of Great Black-backed Gull nests and sub-divisions of the colony.

RESULTS AND DISCUSSION

Nests

Nests were often sited next to prominent land features such as rocky outcrops or at the top of a small rise in the ground, but some were on seemingly featureless expanses of ground. The distribution of nests in the study area is shown in Figure 1. The ground base on which 90 nests were sited was noted as follows: bare rock 33 (37%), short vegetation 26 (29%), bare earth 14 (16%) and a mixture of these 17 (19%). There seemed to be no shortage of suitable nest-sites unlike some of the Welsh islands where a lack of suitable nest-sites was thought to encourage colonial nesting (Harris 1964). Nests were constructed from a mixture of coarse grasses and straw whilst in 52 (56%) nests, thrift *Armeria maritima* ripped from the ground was a major component. A few nests had large amounts of additional materials such as: feathers (6 nests), scurvy grass *Cochlearria* sp. (6), dead bracken stems *Pteridium aquilinum* (3), lichen scraps (2) and fish and crab remains (2).

In the two sub-areas with the largest numbers of nests (C & E) the nearest neighbour distance between nests was measured using a tape measure. In 'C' the mean distance between nests was 14.9m (n=50, s.d. 12.7) and in 'E' the mean distance was 13.3m (n=24, s.d. 13.2). The closest distance between nests was 2.1m. but in this, and other particularly close pairs of nests, the incubating birds could not see each other.

Egg-laying

Using nests in which all the eggs laid hatched and where first laying and first hatching date are known, the mean incubating period was 29.7 days (n=38, s.d. 1.04)) and ranged between 28 and 32 days. There will however be some inaccuracy with this figure as visits were only made every two days. Assuming an incubation period of 29 days for nests where the date of laying of the first egg was not known, then all clutches were initiated between 27 April and 25 May (Fig.2). The mean first egg date was 9 May (s.d. 5.6) and the average clutch size was 2.69 with 3 eggs the modal clutch size. Clutch size declined markedly after 16 May (Table II).

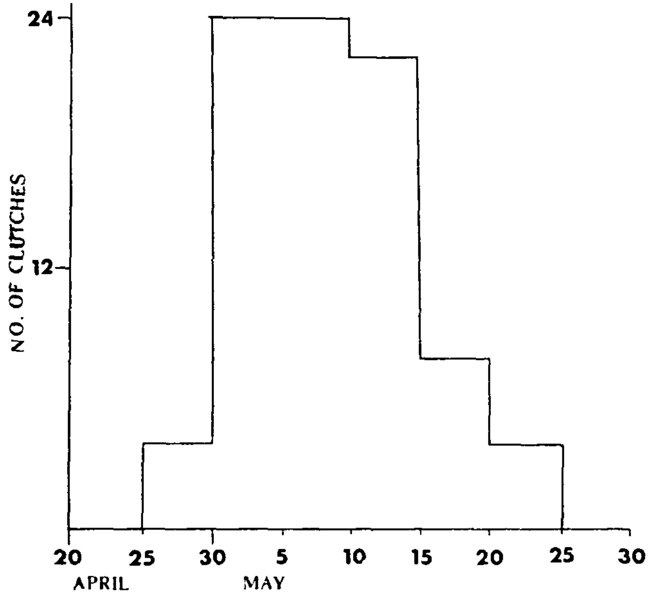

Figure 2. First egg-dates of 86 pairs of Great Black-backed Gulls on the Calf of Man. Data are grouped into 5-day periods.

TABLE II. CLUTCH SIZE AND HATCHING SUCCESS OF GREAT BLACK-BACKED GULL IN RELATION TO LAYING DATE.

Date	*Mean clutch size ±s.d. n=83*	*Mean young hatched/clutch ±s.d. n=88*
April 26-30	2.50 ± 0.57	1.75 ± 0.96
May 1- 5	2.96 ± 0.55	2.25 ± 0.94
May 6-10	2.75 ± 0.44	2.13 ± 1.03
May 11-15	2.83 ± 0.38	2.39 ± 0.89
May 16-20	2.00 ± 0.53	1.13 ± 1.24
May 21-25	1.67 ± 0.58	0.33 ± 0.57

Eggs

The mean size of 138 eggs in 46 clutches of three eggs was 77.8±2.4mm x 54.0±1.3mm. The was no significant decline in the total volume of '3-egg' clutches with laying date ($r=-0.05$, $n=46$). These figures are similar to those given in Cramp & Simmons (1983), but slightly larger than the mean of 74.5 x 51.7mm recorded on Skomer (Harris 1964). Total weighs of 3-egg clutches declined from a mean of 358g when clutch completed to 311g just prior to hatching, a rate of loss of 3.98g/clutch/day ($r=-0.545$, 117df, $P<0.001$; see Fig. 3). All eggs found to be hatching (pipped but not holed) were weighed. The mean weight of 45 such eggs was 106.6g (s.d. 6.9) with a range of 93-121g. Once eggs are holed their weight drops rapidly due to lost of water vapour.

The normal ground colour of the eggs varied from pale buff to olive brown variably marked with blotches of dark brown, grey or black. However, occasionally a paler 'blue' egg was laid which has the ground colour milky- or sky-blue and the usual blotches much reduced or absent. Nine (3.8%) of 237 eggs were of this type. Slinn (1957) gave a figure of 1.11% for the Isle of Man. One of these eggs was the first egg of the clutch, four were the second and four were the third eggs.

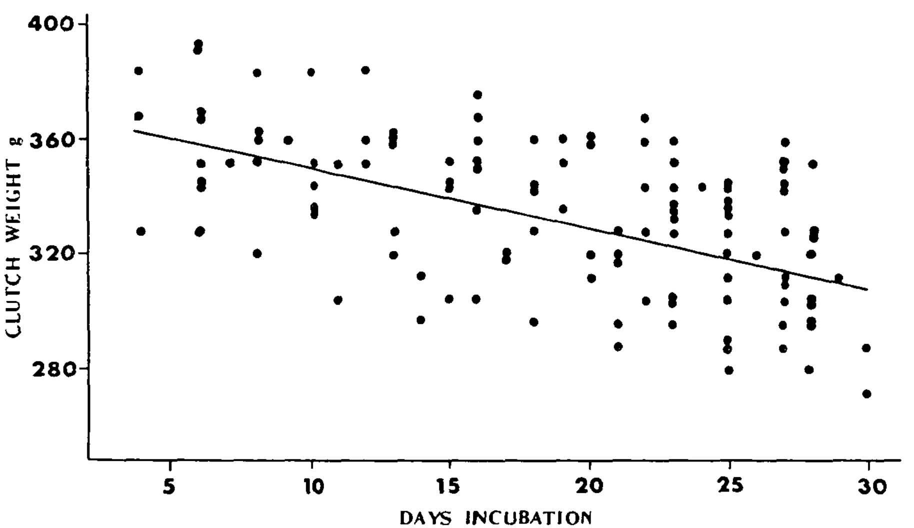

Figure 3. Change in weight of 3-egg clutches of Great Black-backed Gull in relation to number of days incubated.

TABLE III. HATCHING SUCCESS OF GREAT BLACK-BACKED GULL IN RELATION TO CLUTCH SIZE.

No. of eggs laid	*No. of eggs hatched* 0	1	2	3	*Hatching rate %*
1	4				0
2	6	3	13		66
3	5	4	15	36	79
4			2		50

Hatching Success

Of 90 nests, 73 (81%) hatched at least one egg. 177 of 237 (74%) eggs laid were hatched, very similar to the 76% given for Skomer (Harris 1964). The most productive clutch size was three with 79% hatching but success in two egg clutches was still high at 66%, the difference not being significant, (x^2=2.62, 1df; Table III). Six (66%) of nine blue eggs hatched. Eggs laid during the peak laying period had the highest hatching rate (Table II). There was no consistent difference in hatching success in relation to the size of the breeding group (Table III). The causes of failure of 61 eggs were: lost, cause unknown (37), crushed by sheep (6), infertile (5), addled (4), freak eggs (3), damaged in nest (2), dislodged from nest (2), human (1) and Hooded Crow *Corvus corone cornix* (1). Eggs were lost throughout the incubation period but there was a tendency for losses early and late in the incubation period (Table IV). Possible reasons for this may be that eggs lost early are those of inexperienced birds. The increase at the end of incubation may be slightly exaggerated as some eggs may have hatched with the young being predated quickly after hatching. Twelve clutches were lost during incubation, none was replaced but two new nests were built close to the original nests. The mean weight of 23 chicks less than 24 hours old was 84.9g (s.d. 6.0).

TABLE IV. TIMING OF LOSS OF EGGS OF GREAT BLACK-BACKED GULL EXPRESSED AS THE % OF AVAILABLE EGGS LOST AGAINST LENGTH OF INCUBATION.

No. of days incubation	*No. of eggs available*	*No. of eggs lost*	*% of available eggs lost*
0- 7	237	16	6.8
8-14	221	8	3.6
15-21	213	5	2.3
22-	208	18	8.7

Fledging

Young were found in the nest for up to a week after hatching but then became difficult to find when they were sheltering against or underneath rocks. At the end of July when most young were at least six weeks old and could just fly, thorough searches of the colonies found a minimum of 79 young. This was 0.88 young/pair nesting and 1.08 young/pair hatching eggs. Young came from 35 (38%) of nests. Success varied but did not seem to be related to the number of nests in the sub-division of the colony. It was not possible to examine the outcome of nests in relation to laying date. Less detailed observations made in 1984 and 1985 suggest that breeding success was similar in these years. In 1986 unseasonal severe gales in late May and early June destroyed many nests and eggs and later killed many young.

Food

Of 37 regurgitations from chicks, 36 contained fish remains and one Rabbit *Oryctolagus cuniclus* flesh. Elsewhere Great Black-backed Gulls are serious predators on Manx Shearwater *Puffinus puffinus* and Puffin *Fratercula arctica*. Small numbers of these species breed on the Calf but the gulls do not appear to kill many. There are also large numbers of Rabbit which, to judge from pellet remains and observations of gulls killing and carrying off animals, form a significant part of the diet of adult birds. Small numbers of young Shag *Phalacrocorax aristotelis* are also taken (pers. obs.). Food fed to nestlings appears to be mostly fish, a proportion of which is probably taken as waste from fishing boats (pers. obs.).

SUMMARY

A study was made of 90 pairs of Great Black-backed Gull during the 1987 breeding season on the Calf of Man. Nests and their locations are described. The mean first egg date was 9 May. Mean clutch size was 2.69 and the mean incubation period was 29.7 days. Mean total clutch weight declined from 358g to 311g during incubation. 'Blue' eggs formed 3.8% of the eggs laid. 81% of nests hatched eggs and 74% of eggs hatched. The most productive clutch size in terms of hatching was 3. Eggs laid during the main laying period had the highest hatching rate. The size of the breeding group had little influence on breeding success. No replacement clutches were found in the same nests. Fledging success was 0.88 young per pair. Nestlings were fed almost entirely on fish.

ACKNOWLEDGEMENTS

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Post-mortem examination of Little Auks *Alle alle*, Shetland, December 1990

M. Heubeck and D. Suddaby

INTRODUCTION

In late December 1990, following persistent gales many auks came ashore in Shetland and 67 Little Auks *Alle alle* were found on the routine beached bird survey at the end of that month, 1.40 per km. surveyed. None were oiled. Values exceeding 0.30 Little Auks per km. had only been recorded on two previous surveys, December 1979 (0.75/km., 98% oiled) and January 1984 (0.77/km., 38% oiled) and the average December density during 1980-89 was only 0.03/km. A sample of 57 corpses was examined in an attempt to determine their age, sex and possible areas of origin.

METHODS

Procedures followed those recommended by Jones *et al.* (1982). Wing length: maximum flattened chord, measured to the nearest 1mm. Bill dimensions: culmen length and gonys depth, measured to the nearest 0.1mm. Weight: intact, dry birds were weighed to the nearest 5g. Sex: gonads were examined. Age: assumed by the presence (first-winter or immature) or absence (adult) of the cloacal bursa (Rose 1981).

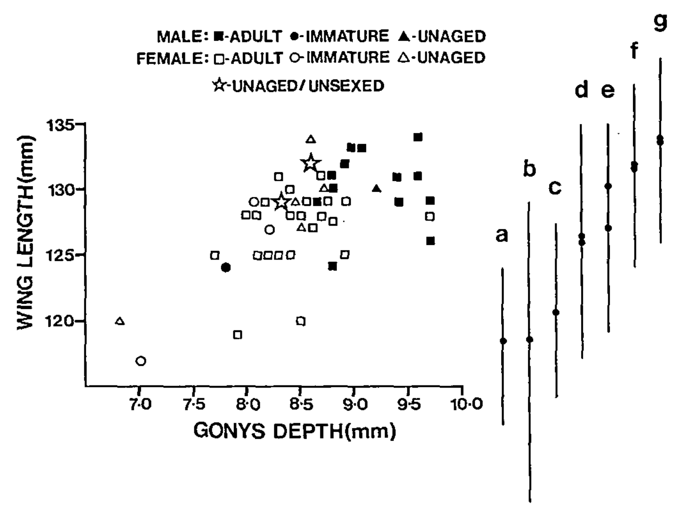

Figure 1. Wing length (mm) plotted against gonys depth (mm) for Little Auks beached in Shetland, December 1990. Vertical lines represent the range of and mean wing lengths (upper = males, lower = females) of birds a) measured live at Jan Mayen colonies, n = 20 (Camphuysen 1989b); b) measured live at Spitzbergen colonies, n = 185 (Norderhaug 1980); c) ditto, n = 97 (Stempniewicz 1981); d) adults freshly dead in the Skagerrak, January 1981, n = 131 (Anker-Nilssen *et al.* 1988); e) adults freshly dead in Shetland, December 1990, n = 27; f) museum skins of adults collected at Franz Joseph Land colonies, n = 34 (Vaurie 1965); g) ditto, prior to assumed shrinkage of 1.5%.

TABLE I. WING AND BILL MEASUREMENTS (MM) OF LITTLE AUKS COLLECTED IN SHETLAND, LATE DECEMBER 1990.

Wing length	*Mean*	*No.*	*S.D.*	*Range*
Adult males	130.2	13	2.82	124-134
Adult females	127.0	23	3.02	119-131
Difference	t = 3.12 p<0.01			
All males	129.7	15	3.06	124-134
All females	127.0	32	3.77	117-134
Difference	t = 2.61 p<0.01			
Gonys depth				
Adult males	9.18	13	0.40	8.6-9.6
Adult females	8.45	23	0.43	7.7-9.7
Difference	t = 5.04 p<0.001			
All males	9.09	15	0.51	7.8-9.6
All females	8.36	31	0.55	6.8-9.7
Difference	t = 4.32 p<0.001			
Culmen length				
Adult males	15.49	13	0.60	14.5-16.1
Adult females	14.65	22	0.66	13.8-16.2
Difference	t = 3.74 p<0.01			
All males	15.47	15	0.68	14.3-16.4
All females	14.57	30	0.78	12.0-16.2
Difference	t = 3.80 p<0.001			

RESULTS

Of 47 birds sexed, 15 (32%) were males and 32 (68%) were females, a biased sex ratio ($\chi 2 = 6.15$, $P < 0.05$). Cloacal bursae were present in 4 birds (1 male, 3 female), absent in 36 and were undeterminable in 17 due to decomposition or scavenging. This suggested that 90% of the sample were adult birds. Body weights ranged from 120–145g. and there was no significant difference ($t = 0.84$, $df = 30$, n.s.) in the weights of male (mean 131.4, SD 7.10, n = 11) and female birds (mean 129.1, SD 7.52, n = 21). Wing and bill measurements are given in Table I. Mean values for males were significantly higher than females for each measurement, both for adults only and for all sexed birds. In order to ascertain the possible identity of unsexed and unaged birds, gonys depth is plotted against wing length in Figure 1.

DISCUSSION

The percentage of adult birds in our sample was rather higher than in samples of Little Auks collected during the February 1983 "wreck" in eastern Britain (73%) (Jones *et al.* 1985), the January 1981 Skagerrak oiling incident (77%) (Anker-Nilssen *et al.* 1988), although not significantly so ($\chi 2 = 4.64$, d.f. = 2, n.s.). In those incidents males and females occurred in equal or almost equal numbers, in contrast to the 68% females in the Shetland sample. Significant differences from parity have been found previously in the sex ratios of samples of Guillemots *Uria aalge* collected following "wrecks", e.g. 59% males (all ages) on Dutch beaches 1982-85 (Camphuysen 1989a), 65% males (immatures) in eastern Britain, February 1983 (Jones *et al.* 1985) and 62% females (adults) in Shetland in February 1986 (Heubeck 1986), but their interpretation is hampered by limited knowledge of the ecology of auks at sea during winter.

The origins of Little Auks wintering in the northern North Sea are unknown. Most birds of the nominate race *alle* from colonies in Spitzbergen are thought to winter along the east and south-west coasts of Greenland while those of the larger race *polaris* from Franz Joseph Land, Novoya Zemla and Severnaya Zemla may winter in either the north-eastern Atlantic or at the edge of the pack ice in the Barent's Sea (Brown 1985). Anker-Nilssen *et al.* (1989) concluded that Little Auks which died in the Skagerrak in January 1981 were representative of the larger end of wing length measurements of the form *alle.* However, mean adult wing lengths in both the Skagerrak and Shetland samples were intermediate between those of live or freshly dead birds measured at Jan Mayen and Spitzbergen colonies and those given by Vaurie (1965) for the race *polaris*, breeding in Franz Joseph Land. The measurements of Franz Joseph Land birds were taken from dried skins and shrinkage of 1-2% is likely to have occurred (Harris 1980; Ewins 1985). Allowing for this, the wing lengths of birds collected in Shetland and the Skagerrak appear to straddle the upper half of the published ranges of *alle* and the lower half of the range of *polaris.* Bedard (1985) located a museum skin of a July-breeding bird from Spitzbergen with a wing length of 134mm (well within the range of *polaris*) and suggested that further examination of birds at colonies in the Russian arctic may reveal a less abrupt size difference between the two races than has been proposed so far.

ACKNOWLEDGEMENTS

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SUMMARY

A sample of 57 corpses of Little Auks, collected from Shetland beaches in December 1990, was examined. Most (88%) birds were adults, based on the absence of cloacal bursa and there were significantly more females than males. Wing and bill measurements of males were significantly larger than females. Adult wing lengths were intermediate between those published for the race *alle*, breeding in Jan Mayen and Spitzbergen and the race *polaris*, breeding in Franz Joseph Land.

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The diet of some young seabirds on Canna, 1981-90

R.L. Swann, M.P. Harris and D.G. Aiton

INTRODUCTION

Recent changes in the numbers and/or breeding success of several species of seabirds in the North Sea are thought to be associated with changes in food availability (Heubeck 1986, 1988, Monaghan *et al.* 1989, Harris & Wanless 1990). The search for possible causes of these changes has highlighted the relative scarcity of data on the diet of British seabirds. As part of a long-term study of the seabirds breeding on the island of Canna (57°03'N, 6°32'W) in the southern Minch, food samples have been collected routinely from Shags *Phalacrocorax aristotelis*, Kittiwakes *Rissa tridactyla*, Guillemots *Uria aalge* and Razorbills *Alca torda* handled for ringing (Swann & Ramsay 1984). Here we summarize information on the diet of these species during chick rearing 1981-90.

METHODS

For Kittiwakes and Shags we collected regurgitations produced by young and by adults feeding chicks, while for Guillemots and Razorbills we collected fish carried by adults feeding young. Samples were obtained from Shags (range of collection dates 21 May-5 August) and Guillemots (28 June-7 July) 1981-90, from Kittiwakes 1987-90 (2 July-2 August) and Razorbills in 1988-89 (1-7 July).

The fish present were identified (using otoliths if necessary) and any intact fish were measured (total length). Scientific names of fish are given in Table II. Samples of intact fish were also weighed in 1983-90. Most regurgitations and multi-prey loads contained fish from a single family – Ammodytidae (sandeels), Clupeidae (herring and sprat) or Gadidae (whiting, haddock, cod, etc.). One sample from a Shag and two from Kittiwakes had fish from two families and the remains of crustacea, and these samples were categorized by the prey which made up the bulk of the sample (but all items are mentioned in the text). Sandeels were classified as small (total fish length 110mm or less) and large (length 111mm or longer, older fish).

Calorific values were determined by bomb calorimetery for 20 fresh and apparently undamaged sprats (mean length 113 ± SE 2.5mm) collected from Guillemots in 1985-86 and frozen soon after collection. Although care was taken to prevent desiccation, the wet weight determinations should be treated with caution as the fish could have become partially dehydrated both during transit from the feeding area and during preservation (Montevecchi & Piatt 1987, Hislop, Harris, & Smith in press).

Means are presented ± 1 standard error.

RESULTS

Shag

There were too few samples in each year to look for annual differences in diet but sandeels were present in 29 (78%) of the 37 regurgitations collected during the study (Table I). In 17 of the 20 samples which contained measurable fish the sandeels were large (n = 18; mean length = 136.2 ± 4.6), one sample had c. 30 sandeels in the range 40-75mm, one had three sandeels c.75-80mm long, and one had three fish all c.90mm long. An additional sample contained three large sandeels and a single unidentifiable gadoid. Seven samples contained only Gadidae including whiting (two fish) and Norway pout (one). Another sample contained unidentifiable Clupeidae.

TABLE I. DIET OF SEABIRDS ON CANNA DURING THE BREEDING SEASON.

Species	*Number of Samples*	*% of samples which contained**			
		Ammodytidae	*Clupeidae*	*Gadidae*	*Other*
Shag	37	78	3	19	0
Kittiwake	36	61	0	36	3
Guillemot	418	38	36	26	0
Razorbill	5	100	0	0	0

* as the main item

Kittiwake

Of the 36 samples, 22 (61%) had sandeels as the commonest item; in 21 samples the sandeels were small (mostly less than 60mm long) and the other had the remains of one large (120mm) sandeel. Thirteen samples contained Gadidae, one of these also had a few small shrimps *Crangon* sp. and another the remains of the large sandeel mentioned above. All identifiable Gadidae were *Trisopterus* spp. and included Norway pout, poor cod and bib *T. luscus*. One regurgitation contained three probable wrasse Labridae. There was a significant increase in the proportion of samples containing sandeels between 1987 and 1988 (only one of 13 samples contained sandeels) and 1989 and 1990 (22/23; Fisher exact test P<0.0001).

Guillemot

Approximately equal numbers of sandeels (38%), Clupeidae (36%; all sprats except for three herring) and Gadidae (26%) were collected (Table 1). There was significant annual variation in the frequency of the three fish families (χ^2 = 94, df = 18, P<0.001) with sandeels predominating in 1982, 1986 and 1988, Clupeidae in 1983-85 and 1987 and Gadidae (mainly whiting and haddock) in 1989 and 1990 (Table II). As the sprats were, on average heavier than the sandeels (below), in biomass terms Clupeidae was the most important prey family.

There were also annual differences in the mean lengths of the main prey species (Table III). Sandeels in 1988 and 1989 were significantly longer than those in 1986 and 1990, while sandeels in 1986 were significantly smaller than those in 1985 and 1987 (t tests, all P<0.05). Sprats in 1986 were significantly longer than those in 1984-85 and 1987-90 and those in 1987 were significantly smaller than those in 1984, 1988 and 1989 (t tests, all P<0.05).

The mean weight of 70 sprats from all years was 11.3 ± 0.3g, which was significantly heavier than that of 91 sandeels (6.5 ± 0.5, t = 7.8, P<0.001) and 46 Gadidae (7.3 ± 0.6, t = 6.4, P<0.001).

The mean calorific density of 20 sprats was 9.5 ± 0.2 kJ/g wet weight and 27.2 ± 0.3 kJ/g dry weight and the mean total calorific value of a sprat was 121 ± 10.5 kJ (range 66-220). Ten of these fish were dissected before analysis and none were sexually active (J.R.G. Hislop pers. comm.).

Razorbill

The five loads all contained 2-7 sandeels all less than 90mm long.

DISCUSSION

The finding that sandeels were overall the most important food of Guillemot, Kittiwake and Shag agrees well with previous studies of the diet of these species in Britain (e.g. Pearson 1968, Furness 1990, Harris & Wanless 1990, Harvey *et al.* 1990). However, the contributions of Gadidae (26, 36 and 19% by number) were much more important than found elsewhere, e.g. 4%, 7% and 4% for Guillemot, Kittiwake and Shag on the Farne Islands, Northumberland in 1961-63, and 0, <1%, 0 and 0, 0, 0 for the Guillemot, Kittiwake and Shag on Fair Isle, and Foula Shetland, respectively (Pearson 1968, Harvey *et al.* 1990, Furness 1989). This could have important consequences for

TABLE II. NUMBERS AND LENGTHS OF FISH BROUGHT ASHORE BY GUILLEMOTS ON CANNA

	Year											*Fish measured*	
	1981	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*Total*	*n*	*Mean length ± SE (mm)*
Ammodytidae													
Sandeel *Ammodytes sp.*	1	15	8	5	8	50	4	31	12	23	157	124	130.2 ± 3.1
Clupeidae													
Sprat *Sprattus sprattus*	2	7	11	21	12	12	16	18	26	22	147	136	113.2 ± 0.8
Herring *Clupea harengus*	0	1	0	0	0	1	0	1	0	0	3	0	
Gadidae													
Whiting *Merlangius merlangus*	0	0	2	0	1	3	2	8	23	20	59	59	93.8 ± 2.0
Haddock *Melanogrammus aeglefinus*	0	0	0	0	0	3	0	0	12	4	19	19	92.7 ± 2.8
Norway pout *Trisopterus esmarkii*	2	0	1	2	1	1	0	4	0	2	13	13	108.0 ± 8.6
Saithe *Pollachius virens*	0	4	0	2	0	2	0	1	1	0	10	7	84.4 ± 6.8
Blue Whiting *Micromesistius poutassou*	0	0	0	2	0	0	0	0	0	0	2	2	103.5 ± 11.5
Cod *Gadus morhua*	0	0	0	0	1	0	0	1	0	0	2	2	91.0 ± 3.0
Poor cod *Trisopterus minutus*	0	0	0	0	1	0	0	0	0	0	1	1	108
Unidentified	0	0	1	2	0	0	0	1	0	1	5	2	68 ± 3.0
Total fish examined	5	27	23	34	24	72	22	65	74	72	418		

Note: Sandeels were separable into two size categories with mean lengths of 90.9 ± 1.1mm (n = 45) and 152.7 ± 2.3 (n = 79).

TABLE III. LENGTHS OF SANDEELS AND SPRATS DROPPED BY GUILLEMOTS ON CANNA.

	Sandeel		*Sprat*	
Year	*No. measured*	*Mean length (mm) ± SE*	*No. measured*	*Mean length (mm) ± SE*
1981	0		2	110 ± 0
1982	15	149 ± ?	7	115 ± ?
1983	6	152 ± 12	10	112 ± 1
1984	4	123 ± 17	21	114 ± 2
1985	7	148 ± 7	11	111 ± 1
1986	48	113 ± 4	12	126 ± 4
1987	4	146 ± 4	16	106 ± 2
1988	20	149 ± 6	16	112 ± 2
1989	12	154 ± 9	26	112 ± 2
1990	23	125 ± 7	22	114 ± 1

Notes: No individual measurements are available for 1982.
There was significant between-year variation in the lengths of sandeels 1983-90 (ANOVA, $F_{7,116} = 5.4$, $P<0.001$) and sprats 1981 and 1983-90 (ANOVA $F_{8,127} = 6.0$, $P<0.001$).

Guillemot chicks as Gadidae of the size taken by Guillemots have, on average, much lower calorific values (c.35 kJ/fish) than the calculated values of sandeels (45 kJ/fish) and large sprats (121 kJ/fish) (Hislop, Harris & Smith in press, unpublished data).

The fish collected from Guillemots suggest that Gadidae had become more important in recent years (maximum 49% by number of prey recovered in 1989) than they had been in the early 1980s (Table 2). This change was not, however, apparent in the Kittiwake samples where virtually all fish recorded in 1989 and 1990 were sandeels. The breeding success of Kittiwake (1986-90) and Shag (1985-90) and the weights of young Guillemots before they 'fledge' (1983-90) were also measured but we failed to detect any clear cut relationship between food and these measures of breeding performance. However, too few food samples were available for Shag or Kittiwake to allow for adequate assessment.

Any ecological conclusions based on data collected on only a few days each breeding season must be tentative as diet of young can change either systematically within a season or erratically from day to day (Hatchwell 1988, Ainley & Boekelheide 1990, personal observations). Although we attempted to standardize data collection by visiting colonies at approximately the same dates there were differences in the timing of breeding from year to year. Despite these obvious drawbacks we consider that we now have some idea of the diet of chicks of these species in the southern Minch. Great concern has been expressed about the possible adverse effects of industrial fishing for sandeels around Shetland (e.g. Heubeck 1989). Such fishing now occurs off northwest Scotland, though not, as yet, around Canna. The changes which we have detected in the diet of Guillemots are therefore likely to reflect natural changes in the availability of different prey species. Conditions for seabirds off west Britain appear to be more variable than in the north and east (Harris & Wanless 1990), so it may be difficult to assign any future changes in diet to the effects of local fisheries or other environmental changes.

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Radio-tracking of a British Storm Petrel *Hydrobates pelagicus* proves a probable new breeding-site in Norway.

Torgeir Nygård and Kjell Einåvik

INTRODUCTION

The breeding distribution of British Storm Petrel *Hydrobates pelagicus* in Norway is poorly known. Breeding was first confirmed in 1961 on the outer Røst islands (ca. 67°30'N 12°00'E) in Lofoten, northern Norway (Helling 1962). Since then breeding has been confirmed at only one additional site (Bleiksøya, 69°16'N 15°52'E, bird sitting on egg), while at a few others there is strong circumstantial evidence (eg Sør-Fugløy, 67°06'N 18°29'E, Barrett & Strann 1987). However, British Storm Petrels have been trapped at several localities along the Norwegian coast during the breeding-season (Nygård *et al.* 1987), but it has not been possible to resolve whether they were immature wanderers or adults on foraging trips or on their way to breeding colonies.

Sklinna (65°13'N 10°58'E) is a group of small islands off the coast of Central Norway. They are uninhabited, except for the two lighthouse keepers. The first record of British Storm Petrels at Sklinna was on 21 August 1984, when two birds were caught at night in a mist-net close to the lighthouse (Nygård *et al.* 1987). Through repeated efforts in 1985-90, we have caught 36 British Storm Petrels and 17 Leach's Storm Petrels *Oceanodroma leucorrhoa*, almost all of them with well-developed brood-patches, many of them well vascularized. Despite much searching, we were not able to find any nests. However, judging from the behaviour of the birds and the apparent suitability of the locality, we had strong reasons to believe that the birds bred there.

Approximately 5000 pairs of Puffins *Fratercula arctica* breed on the islands (authors' data). There are good nesting-sites for storm petrels, such as vacant Puffin burrows, boulder screes, piers and stone-walls (Cramp & Simmons 1977). If the breeding density is low, considerable luck might be necessary to find nesting birds in their burrows. After some years searching in vain, we therefore decided to try radio-tagging. If the birds were local breeders, we expected to track their signals, as the group of islands is no more than 3 km across, within the range of small radio-transmitters.

METHODS

The field work was carried out in August 1989 and in August 1990. The radio-tagging took place 14-17 August 1989. For the catch we used regular small-mesh mist-nets placed at various locations on the main island (Heimøya). A tape lure was used only at one net, especially arranged for the Leach's Storm Petrel, which, unlike the British Storm Petrels at Sklinna, seem to be significantly attracted by taped calls. Of 11 British Storm Petrels and 6 Leach's Storm Petrels caught, two and one respectively were each supplied with a small radio-transmitter, within the 142.0-142.5 MHz frequency range. The radio-transmitters were supplied by Biotrack, Wareham, England, of the type 'SS-1 RM312'. They weighed only 1.5g, and had an expected lifetime of 2-4 weeks. The transmitters were attached to one of the central rectrices using superglue and strong sewing-thread according to the method described by Kenward (1987). We used two receivers of type 'Televilt RX-81', one supplied with an omni-directional mobile-radio antenna, the other with a 'Televilt Y-4' Yagi-type directional antenna (by Televilt AB, Storå, Sweden). The lighthouse (45m above sea-level) provided an ideal place for tracking the signals, owing to the unobstructed view in all directions. On 9-11 August 1990, a recapture effort was carried out.

RESULTS

The first British Storm Petrel was caught at 23:20 on 14 August (the darkest time period is 01:00-01:30). It was equipped with a radio-tag and released at exactly midnight. Tracked by its radio-signal, it was evidently circling around the island a couple of times before it was lost. When the tracking was repeated one hour later it was again circling the island, and at 01:45 it was passing on the south side of the island. The second British Storm Petrel was caught the same night at 02:35. It had a well vascularized brood-patch, and was a large and heavy bird (Table I.) which was ringed and released at dawn (03:30) with a radio-transmitter. It headed directly north for the open sea, and its radio-signal was heard for only about 3-4 minutes. The following evening the signal of this bird was picked up with the omni-directional antenna at 23:15. It soon faded away, but was heard again between 23:57 and 00:15. Subsequent searching with the directional antenna located the signal at the road between the quay and the lighthouse station, on a stretch across a swampy area, where the road is built of large stones. There, in a crevice between the stones, the bird had settled. We could not reach or see the bird, but it was heard vocalizing and moving. The bird was still sitting in its crevice at 04:20, and during repeated checks the following day and evening. It left the site between 00:30 and 03:00 the following night. The signals of the first bird and a Leach's Storm Petrel fitted with a transmitter the following night were not heard again after release.

In 1990, on the evening of 9 August we placed mist-nets in front of the crevice in the road where the bird had been sitting the year before. At 03:30 the following morning a bird was hanging in the net, right in front of the crevice, and the ring revealed its identity to be the bird from the year before. Purr-calls were heard from the same crevice earlier the same night, possibly uttered by the mate. The radio-transmitter was now lost, as was expected, because complete moult takes place in winter (Cramp & Simmons 1977).

TABLE I. MEASUREMENTS OF BRITISH STORM PETRELS FIRST CAUGHT AT SKLINNA (own data, controls not included) AND RØST, LOFOTEN ISLANDS (Myrberget *et al.* 1969).

	Sklinna				*Røst 1966-67*		
	Tagged bird 1989	*Sample 1984-90 Average*	*S.D.*	*n*	*Average*	*S.D.*	*n*
Weight (g)	30.0	24.8	2.10	34	25.9	3.5	235
Wing (mm)	128	121.9	3.91	34	122.7	2.9	231
Tail (mm)	55	53.5	2.20	24	–	–	–
Bill (mm)	12.1	11.5	0.47	34	11.4	0.51	216

The wing is measured as straight (maximum) flattened chord, and the tail length is obtained by inserting a ruler between the central retrices, noting the length of the longest retrice. Bill length is from the feathers' edge at the base of the bill to the tip.

DISCUSSION

All available evidence points to Sklinna as being a new breeding-site for the British Storm Petrel in Norway. The measurements (Table 1.) clearly indicate that the tagged bird was a female. This is implied by the fact that it is one of the largest British Storm Petrels ever caught at Sklinna, and it is also large compared with the data given by Myrberget *et al.* (1969) from Røst. Comparing it with data given by James (1983), it clearly belongs to the female group. The average weight at the peak of the laying period on Skokholm, Pembrokeshire, Wales, was 27.8g (Scott 1970), indicating that our bird was developing an egg. The average egg weight is 7g (Scott 1970), and our bird was more than 5g heavier than an average bird at Sklinna. The fact that the bird stayed in the crevice for 24 hours is strong evidence for breeding. Scott (1970) states that burrows are occupied quite regularly by day during the pre-laying period, most frequently 11-20 days before egg-laying. Thirty-one of 35 British Storm Petrels examined at Sklinna had fully developed brood-patches, and 25 out of 33 were well vascularised. The nearest known breeding colony is 300km to the north (Røst Islands), but ringing recoveries have shown that birds move between Sklinna, Røst and other colonies on the Norwegian coast quite extensively in the breeding-season (Anker-Nilssen, pers. comm). Activity on the ground, however, is solely associated with breeding in Storm Petrels (Cramp & Simmons 1977). The appearance of a bird in the same cavity in two consecutive years, reinforces the contention for breeding beyond reasonable doubt, as does the observation of a bird uttering purr-calls (singing) in the crevice. We believe, however, that the breeding population is small, probably somewhere between 10 and 50 pairs.

British Storm Petrels on the Norwegian coast seem to breed considerably later in the year than in Britain. This is most likely due to its nocturnal habits, and the increasing day-length with higher latitudes in summer. This will inevitably lead to later onset of breeding in the north. On Røst (67°30'N), the peak laying is thought to be in August, and at Bleiksøy (69°16'N) a bird was found brooding an egg 16-17 September (Barrett & Strann 1987). Likewise, there are no really dark clear nights before the 10-15 of August at Sklinna (65°15'N), as its position is only 1°20' south of the Arctic Circle.

The radio-tag represents an extra load to the bird, that could adversely effect its breeding performance or survival. In our case, the transmitter contributed an extra 5% to the bird's weight. Transmitters constituting as little as 1% of the body-mass of diving seabirds (alcids) have affected their behaviour, such as reduced number of feeding trips, shorter foraging-trips and lowered foraging success (Wanless *et al.* 1989). However, small birds are evidently able to fly well with loads up to 10-15% of their weight, while 4-6% is enough for birds weighing above 50g, while the largest birds ought not to carry more than 2-3% (Kenward 1987). The fact that a radio-tagged British Storm Petrel returned after one year to the exact place it was first caught, indicates that this bird was not seriously harmed by the tag. Tail-mounting leads to loss of the transmitter at the subsequent moult, thus minimizing long-term adverse effects. However, a study involving tagged and control birds would be necessary to elucidate possible adverse effects on different breeding parameters. The nocturnal habits of these birds, however, makes such a study difficult to perform.

We feel that this small study points to radio-telemetry as having a large potential when studying birds that have extensive nocturnal behaviour, and for the study of Storm Petrels in particular. Activity patterns at the burrow, and at the breeding colony in general, may well be studied in detail with this method. The range will depend on the transmitter's signal-strength, the quality of the receiving equipment, and the local topography.

SUMMARY

In an attempt to prove breeding of British Storm Petrel at some small islands off Central Norway, radio-tagging was used. Two British Storm Petrels and one Leach's Storm Petrel caught in mist-nets were ringed and supplied with tail-mounted radio-transmitters 14-17 Aug 1989. Of these, one British Storm Petrel was tracked as it returned to the islands after 24 hours, and it was located in a crevice. It stayed there for more than 25 hours, and then left. Inspection of the crevice was not possible. The same bird was recaptured at the same spot in 1990 at the same time of the year, and the transmitter was now lost. Purr-calls were now heard from the crevice, possibly from the mate. It is concluded that radio-tagging seems to have a large potential for the study of birds that have some type of nocturnal behaviour, although one should be careful in assessing adverse effects of the tags.

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Results of an examination of Puffins *Fratercula arctica* washed ashore in Shetland in winter 1990-91

M.P. Harris, M. Heubeck and D. Suddaby

INTRODUCTION

Outside the breeding season the Puffin *Fratercula arctica* lives offshore and is rarely seen from land. There are few ringing recoveries and much of what is known of the winter distribution of various populations comes from comparing the measurements of birds washed ashore during infrequent 'natural' wrecks and oiling incidents, with those birds caught at breeding colonies (Harris 1984a, b, Jones *et al.* 1985). This note gives details of a sample of 98 Puffins collected during a wreck of auks in Shetland in the winter of 1990-91, and makes some comparisons with birds collected during the last major wreck in the northern North Sea which occurred in early 1983 (Underwood & Stowe 1984).

METHODS

Corpses with an intact head and a wing were collected from beaches in Shetland during late December 1990 and early January 1991. Where the state of the body allowed, as many of the following measurements or observations as possible were made: (a) wing length (maximum flattened chord), (b) straight beak length (length of cutting edge of upper mandible), (c) age, based on the number of bill grooves (Petersen 1976, Harris 1984a) as first-winter (no grooves, also primaries very pointed), immature (less than 2 grooves), adult (more than 2 grooves) and intermediate (2 grooves), (d) sex by dissection, and (e) stomach contents. The corpses were not in a good enough condition to weigh.

The expected values for the number of Puffins of the above four age categories alive at the end of a breeding season were calculated using the following assumptions based on data collected on the Isle of May, Firth of Forth, Scotland (Harris 1984a, Harris & Wanless 1991) – (a) a stable population, (b) adult overwinter mortality of 10%, (c) breeding success of 0.80 young per pair, (d) 50% of fledged young surviving to breeding age (4-5 years), (e) a first-winter mortality of 30% and subsequently birds surviving at the same rate as adults and (f) "intermediate" birds were four years old. The comparison between the numbers of birds of different ages found dead and the numbers expected from the above calculation further assumes that the age distribution of birds at risk around Shetland at the time was the same as that of the total population, i.e. that no major mortality of any group occurred during the autumn.

Details of ringed Puffins reported from Shetland and Orkney (added because a similar wreck occurred there at the same time; E. Meek pers. comm.) in December 1990 and January 1991 were supplied by the British Trust for Ornithology.

RESULTS

Fifty (51%) of the 98 birds were adult, 21 (21%) were immature, 17 (17%) were first-winter and 10 (10%) were intermediate. All birds were in full winter plumage, none were in wing moult and, as far as could be judged, all had old primaries. Although no birds were weighed, all were emaciated without even a trace of mesenteric or subcutaneous fat. There were no obvious gross signs of disease or trauma and the birds were not oiled. The most likely cause of death was starvation. Although many more females (42) than males (26) were collected the ratio did not differ from equality (Table I). There were no significant differences between the measurements of males and females in birds of any age-class (t-tests, all ns) so data from the sexes were pooled.

As is usual in Puffins, there were significant differences in both the wing and bill lengths of different aged Puffins (Harris 1979) with both measures in first-winter birds being significantly shorter than those from older birds (Table I).

TABLE I. MEASUREMENTS AND SEXES OF PUFFINS IN SHETLAND IN DECEMBER 1990–JANUARY 1991.

Age	*n*	*Wing length (mm) Mean ± SE*	*n*	*Bill length (mm) Mean ± SE*	*Number of Males*	*Number of Females*
1st Winter	17	154.5 ± 1.7	17	29.8 ± 0.31	3	4
Immature	21	161.4 ± 1.6	21	30.7 ± 0.33	7	10
Intermediate	10	160.7 ± 2.2	9	30.4 ± 0.48	4	4
Adult	50	164.9 ± 0.7	49	31.0 ± 0.22	12	24

Notes: There were significant differences between the age groups in both wing length (ANOVA $F_{3\,97} = 12.7$, P<0.001) and bill length (ANOVA $F_{3\,95} = 2.9$, P<0.05). First-winter birds had signifiantly shorter wings than other groups and their bills were significantly shorter than both immatures and adults (t-tests; all P<0.05). None of the ratios of males to females within an age group were significantly different from equality (X^2 - tests).

Twenty ringed birds were recovered dead in Shetland and Orkney, 12 had been ringed on the Isle of May or other islands in the Firth of Forth, five on the Farne Islands and three in Norway (no ringing details yet available). The lack of recoveries of Puffins ringed in Shetland, or on Sule Skerry (60km west of Orkney) where many thousands have been ringed, suggests that local birds may not have been involved. Of the British ringed birds, three were in their first-year and 14 were aged between five and at least 27 years.

Fish otoliths and polychaete jaws were the only remains of food found, occurring respectively in 15 (23%) and 5 (8%) of the 64 stomachs examined. Of the 18 otoliths recovered, six (two in each of three birds) came from *Trisopterus* sp., four from unidentifiable Gadidae, two from gobies Gobiidae, two from sandeels Ammodytidae and four were too worn for identification.

DISCUSSION

There is a marked latitudinal cline in the wing length of Puffins in the east Atlantic and North Sea with birds at colonies in the south and west of Britain being small (mean wing length 158mm) and those in the high Arctic being large (185mm) (Salomonsen 1944). The distribution of wing lengths in this study suggests that most birds came from colonies on coasts bordering the North Sea, perhaps as far north as Runde (62°N) or possibly Lovunden (66°N) (Fig. 1). Birds from the Faeroe Islands could also have been involved but there is no evidence that these normally winter in the North Sea. Two ringed adults were measured and, surprisingly, the one from the Isle of May, had a substantially longer wing (167mm) than a Norwegian ringed bird (155mm). Two first-winter birds could have come from further north since they had wing lengths of 167 and 169mm respectively, values that exceed those of most adults in south and central Norway. The measurement of wings and beaks of both adults and first-winter birds in 1990-91 were not significantly different from those in the 1983 wreck (t-tests, all ns) when ringing recoveries indicated that most birds came from Britain or southern Norway (Jones *et al.* 1985, Hudson & Mead 1984). The fewer ringing recoveries in the present wreck suggest similar origins for the dead birds.

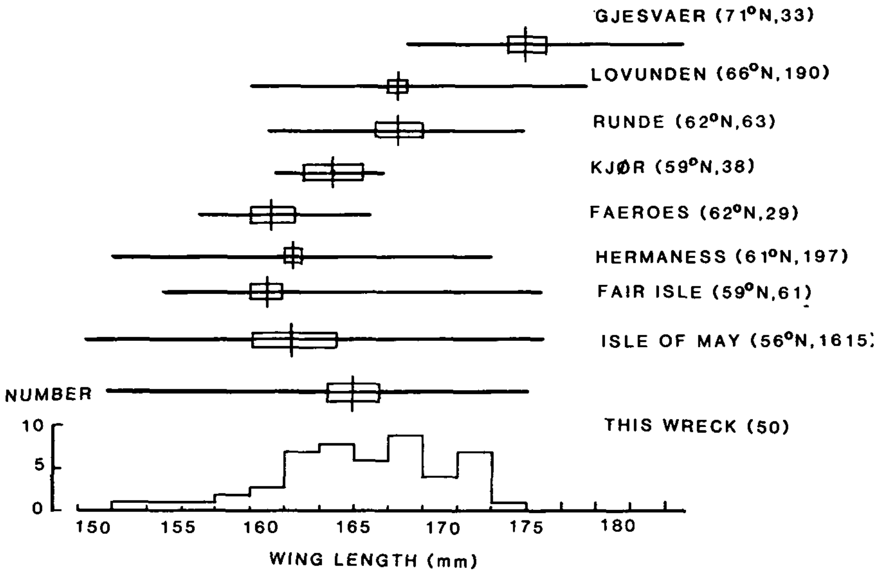

Figure 1. Distributions of wing lengths of adult Puffins collected during the 1990-91 wreck and measured at colonies (from Harris 1984a). The latitude and sample size are given after the colony name. Mean ± 2SE, overall range and sample measured are shown.

Occasionally large numbers of seabirds are washed ashore in wrecks but only rarely are substantial numbers of Puffins involved. Earlier wrecks of Puffins in the northern North Sea occurred in February-March 1916, early 1947, February 1983 and January 1984 (Rintoul & Baxter 1917, Dacker 1948, Underwood & Stowe 1983, pers. obs.). Birds were invariably emaciated and appeared to have died of starvation, presumably following failure of their food supply (Blake 1984). Puffins have their main moult, during which they are flightless, in the late winter (Harris & Yule 1977). This may make them particularly susceptible to adverse conditions and many wrecks (references above) and oiling incidents, (e.g. in northeast Britain in February 1970; Greenwood *et al.* 1971) involving Puffins have occurred between January and March. The 1990-91 wreck was therefore somewhat unusual in its timing.

TABLE II. AGES OF PUFFINS FOUND DEAD IN 1990-91 COMPARED TO THE NUMBERS CALCULATED TO BE ALIVE AT THE END OF THE 1990 BREEDING SEASON.

Age	*Number found dead*	*Number calculated to be alive*
1st Winter	17	18
Immature	21	24
Intermediate	10	10
Adult	50	46

Note: The two distributions were not significantly different ($X^2 = 0.40$, d.f. = 3, n.s.)

Many seabirds have a high annual survival rate and it is often assumed that when conditions become severe, young inexperienced birds suffer a higher mortality than adults (Lack 1954). However, the distribution of ages of the 98 Puffins found dead in this wreck was similar to that calculated for the population as a whole at the end of the breeding season. It appeared as though all age classes had been equally affected (Table 2). There were few ringed birds found in the 1990-91 wreck but the fact that three were first-year birds and ten were ten years or more old suggests that young birds did not suffer a greater mortality than did adults. There was no age bias in the mortality of Isle of May ringed birds in the 1983 wreck (where 20% of the ringing recoveries were of birds old enough to breed) which caused a significant increase in the annual mortality of Puffins and a lower than anticipated number of occupied burrows the next year (Harris & Wanless 1984).

The density of Puffin corpses found during a survey of 48km of beaches in Shetland in December 1990 was 2.51/km which was 70% higher than the previous peak density in January 1984 and 15 times higher than the long-term December-February average (0.17/km) for 1979-1989. Thus this was, by local standards, a large wreck. Many more dead Puffins than normal were also found at this time in Orkney (E. Meek pers. comm.) but the current lack of widespread systematic beached bird surveys in Britain does not allow us to assess the extent of the wreck, to estimate the total number of Puffins which died or to suggest its effect on Puffin numbers.

SUMMARY

Measurements and ringing recoveries of Puffins found dead during a wreck in Shetland in winter 1990-91 suggested that the birds came from colonies bordering the North Sea. There was no age bias in the mortality.

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Duration of winter visits by Black Guillemots *Cepphus grylle* to an Irish breeding site

Julian G. Greenwood

During the winter of 1985/86 it was discovered that Black Guillemots *Cepphus grylle* visited an Irish breeding site at Bangor, Co. Down from late September onwards, and that the arrival times of the birds became earlier in relation to sun-rise as the winter progressed (Greenwood 1987). At that time the length of the visit was not determined; that was the object of this study.

The study area was within the harbour at Bangor, being bounded on the northern side by the North Breakwater, on the eastern side by the shore, and on the southern side by the Central Breakwater; the area of study being approximately 2 ha. The western side provides access to the sea. The main breeding area within the harbour is on the North Breakwater where 15 holes are available for occupation. However the harbour at Bangor is undergoing renovation and during the period of study the Central Breakwater was extended; the extension including the provision of 27 more artificial nest sites for the Black Guillemots (Greenwood *in litt.*).

The attendance patterns of the Black Guillemots at this site differ from other areas. During the breeding season the birds show two periods of peak attendance, one in mid-morning, and another minor one around noon (Greenwood and Marshall 1989), whilst in Shetland for example the second peak occurs in the evening and is higher than the morning one (Ewins 1985). In winter the birds reappear at the colony, often coming ashore at the end of September and beginning of October upon the completion of post-nuptial moult (Greenwood 1987), whilst at other Irish sites birds do not come ashore until March or April (eg Sharrock 1973). In Shetland birds may be present on the sea from October onwards but do not come ashore until early March (Ewins 1985). It is unusual to see Black Guillemots foraging in the study area at any time of the year; most feeding occurring in Belfast Lough. The attendance is clearly associated with breeding.

In order to record the duration of the winter visits by the Black Guillemots I visited the harbour at approximately three-weekly intervals from 1 October 1988 to 26 April 1989, eleven visits being made in all. The number of birds present at the colony was counted at hourly intervals. In addition,

TABLE I. THE NUMBERS OF BLACK GUILLEMOTS PRESENT AT HOURLY INTERVALS DURING THE WINTER (TIMES IN GMT; 0 MEANS NO BIRDS PRESENT, – MEANS NO OBSERVATIONS MADE).

Date	*Time*										
	3	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1 October	–	–	0	19	23	16	13	0	–	–	–
19 October	–	–	–	0	24	13	1	0	–	–	–
9 November	–	–	–	–	0	22	14	0	–	–	–
3 December	–	–	–	–	0	8	7	0	–	–	–
22 December	–	–	–	–	0	1	14	0	–	–	–
13 January	–	–	–	–	0	1	11	7	0	–	–
4 February	–	–	–	–	0	25	2	0	–	–	–
22 February	–	–	–	0	20	21	1	0	–	–	–
18 March	–	–	0	11	30	28	21	1	0	–	–
4 April	–	0	3	29	28	26	22	2	0	–	–
26 April	0	4	24	22	24	21	21	19	14	14	0

TABLE II. THE NUMBERS OF BLACK GUILLEMOTS PRESENT AT THE FOUR AVAILABLE LOCATIONS WITHIN THE HARBOUR DURING THE WINTER (TIMES IN GMT).

Date	*Time*	*Water*	*Boats*	*North Breakwater*	*Nesting holes*
1 October	6.00	19	0	0	0
	7.00	21	0	2	0
	8.00	13	3	0	0
	9.00	13	0	0	0
19 October	7.00	24	0	0	0
	8.00	5	4	0	4
	9.00	1	0	0	0
9 November	7.00	7	7	5	3
	8.00	4	0	10	0
3 December	7.00	8	0	0	0
	8.00	7	0	0	0
22 December	7.00	1	0	0	0
	8.00	11	0	3	0
13 January	7.00	1	0	0	0
	8.00	3	3	5	0
	9.00	7	0	0	0
4 February	7.00	24	0	1	0
	8.00	2	0	0	0
22 February	6.00	20	0	0	0
	7.00	11	5	2	3
	8.00	1	0	0	0
18 March	5.00	10	0	0	1
	6.00	14	4	4	8
	7.00	19	6	0	3
	8.00	16	4	1	0
	9.00	1	0	0	0
4 April	5.00	3	0	0	0
	6.00	23	4	0	2
	7.00	8	7	10	3
	8.00	8	12	2	4
	9.00	5	14	2	1
	10.00	2	0	0	0
26 April	4.00	4	0	0	0
	5.00	15	5	3	1
	6.00	10	4	2	6
	7.00	11	4	3	6
	8.00	0	4	14	3
	9.00	2	9	5	5
	10.00	6	9	3	1
	11.00	1	5	3	5
	12.00	3	6	0	5

the location of the birds within the harbour was recorded; that is whether the birds were on the water, sitting on boats, sitting on the breakwater, or sitting in the entrance of the nesting holes. The birds were clearly visible even in the darkness of early morning as the area is well illuminated by harbour lights. During the study only adult birds were found to be making visits to the harbour.

The results are shown in two tables. Table I is a summary of the attendance pattern and shows two features. Firstly, the arrival times became later from autumn through to mid-winter, from when they became earlier again. This has been shown previously to be correlated to the time of sun-rise (Greenwood 1987). Secondly, the departure times from the colony were much less variable: during October to February, except on 13 January, all birds had gone by 10.00 am, and even in mid-March and early April few stayed as late as that. Table II shows the locations of the birds within the harbour. It can be seen that even in October, whilst most of the birds were on the water, some were making landings onto boats adjacent to the North Breakwater, onto the top of the North Breakwater, and indeed into the nesting holes themselves. This behaviour remained constant throughout the winter until March, when more birds began to make landings including a greater use of the nesting holes. Throughout the entire winter many of the birds were in obvious pairs swimming together on the water and sitting together at the entrance to the nesting holes.

These patterns of attendance are probably governed by two opposing constraints. As has been suggested earlier for Black Guillemots (Greenwood 1987) and for Common Guillemots *Uria aalge* (Harris & Birkhead 1985, see also Greenwood 1972), attendance of the birds during the winter may ensure a breeding site for the forthcoming season. However, opposing this is the requirement for the birds to obtain sufficient energy intake during the winter, when they are undergoing a partial pre-breeding moult and suffering winter weather conditions. The pre-breeding moult period is long lasting from November to February, so daily energy requirements for moult are probably small. The requirements for facing the winter weather are a different matter; indeed, during periods of high wind and extreme cold Black Guillemots do not visit the breeding site at all, remaining at sea in Belfast Lough. The numbers attending the colony in December and January were always less than the number of breeding birds in both 1988 and 1989. The observed attendance pattern is thus a compromise between the need to retain a nest-site and that to obtain food. It is in the spring, with improving weather conditions and longer daylength for foraging, when the attendance patterns change; more time being spent at the colony, with more birds occupying nesting holes. Departure times become later as the breeding season approaches and by egg-laying (late May) the colony may be occupied for over 20 hours a day (Greenwood & Marshall 1989).

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Sandwich Terns *Sterna sandvicensis* feeding juveniles during autumn migration around the NW Iberian Peninsula.

Antonio Fernández-Cordeiro and Rafael Costas

The Sandwich Tern *Sterna sandvicensis* is the tern most frequently observed off the Iberian Atlantic coast, being especially abundant in the Riás Bajas of Galicia (NW Iberian Peninsula), where it winters regularly in small numbers (about 260 individuals; Bermejo *et al.* 1985, 1986). The Riás Bajas are the northern edge of the regular winter range in the Iberian Peninsula (Fernández-Cordeiro & Costas in press).

Autumn migration begins in early August, when first-year birds as well as adults, some of the latter still in summer plumage (pers. obs.) appear. Migration peaks in September, with considerable numbers until the first week of October (Huyskens & Maes 1965, 1971).

Smith (1975) describes the dependence of the young on parental feeding in the breeding areas, when they join together in "créches" in the vicinity of colonies. Such behaviour is maintained up until October in the British Isles.

In this note we describe juvenile dependence on their parents when they are beyond the breeding grounds, and approaching their winter quarters. In late summer 1981, autumn 1987 and 1988 and winter 1990, we recorded 15 cases of adult Sandwich Terns feeding their juveniles at A Ramallosa salt marsh, Riá de Vigo (42°07'N, 8°49'W), as well as in other nearby localities.

Fourteen feeds were observed during August, September and October (8, 5 and 1 respectively), the period coincident with the highest numbers of migrating terns (Huyskens & Maes 1965, 1971). One feed was recorded in December, during the wintering period.

On each occasion juveniles were fed fish c. 5-7cm long. The receiving juvenile was resting on a mudflat in 9 cases, on the water in 5, and was flying in 1. In 12 of the 15 feeds, the juvenile was initially among a resting mixed flock of adults and other juveniles, and left the flock to be fed on hearing the "advertising-call" (Cramp & Simmons 1985) of its approaching parent; in 2 cases the juvenile was already accompanying its fishing parent (once receiving the food in flight and once when the young alighted on the water), and in one case the juvenile was alone.

From our observations, it is clear that adult Sandwich terns continue to feed juveniles during the autumn migration and up until at least December on the wintering grounds. Given that we did not make many observations, we conclude that the behaviour must be relatively common.

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BOOK REVIEWS

BROOKE,M. 1990. The Manx Shearwater. 246pp. £17.00 UK & Europe; $32.50 overseas. T & A D Poyser, London. ISBN 0 85661 057 7.

A species monograph is always welcome, and this is no exception. Mike Brooke has produced a valuable compilation of what is known about the biology of the Manx Shearwater, and has related this to the biology of shearwaters in general. The book covers the usual aspects of breeding biology in considerable detail and describes population numbers and distribution. A chapter is devoted to the intriguing problem of puffinosis which is found only in the colonies on Skomer and Skokholm, and another on the use of Manx Shearwaters in early experiments on bird navigation. There are also chapters on calls, and on the way birds reach their burrows, and notes on ectoparasites. (An intriguing snippet of information, not included in the section on ectoparasites, is that fleas on the Manx Shearwater at their colonies on Rhum are *Ceratophyllus fionnus*, a species recorded nowhere else and from no other host).

The treatment is comprehensive and authoritative, yet I found the book rather difficult to read. The author's laudable intention is to exclude unnecessary technical science and statistics wherever possible, yet in places he seems to fall between the two stools of a scientific treatise and an account designed for the informed naturalist. In the breeding biology chapters especially, the questions to be addressed are minutely, and sometimes inconclusively, dissected with the result that the reader may be diverted from the main issues under consideration. This contrasts with the section on adult survival, where the fact that estimates are based on the improbable model of constant survival throughout life, is hardly discussed at all. Most statistical analyses are straightforward and clear, but there is an occasional lapse such as the legend for Figure 9..2. I was not convinced by the arguments, based on non-significant differences, that the age of first breeding increased in the 1970's compared with the 1960's. This is surely a dangerous way to argue. However, the main messages are clear and this volume is a valuable and worthy addition to the excellent series of Poyser monographs.

The book is very well produced, free from irritating errors and well illustrated with numerous drawings by Dafila Scott, and black and white photographs.

G. M. Dunnet.

RICHARDS, ALAN. 1990. Seabirds of the Northern Hemisphere. 192pp. £19.95. Dragons World, Limpsfield, Surrey. ISBN 1 85028 112 2.

The book's title suggests immediate relevance to Seabird readers, and the rapidly-stated aim in the introduction is to "bring together the finest selection of seabird photographs possible". The author is quite correct that the photographs will "delight and endear the reader", but wisely avoids mentioning that the text is unlikely to. The big format, high-quality paper and a large number of pictures suggest a book to be wallowed in for enjoyment rather than to be consulted for reference. Many photographs are truly splendid; the author has the advantage of having established a wildlife picture agency, but even so has cast his net wide to produce a stunning series. Most photographs show birds near to land; the almost complete absence of pelagic species in the often dramatic environments where they spend most of their life is undoubtedly because it is more difficult to take photographs at sea. The reproduction is of extremely high quality (a very few pictures have small blemishes), and most pictures are well composed, showing plenty of action. A minority are spread across two pages, sometimes annoying when the subject is cleaved in two, and unnecessary as by slightly rearranging layout or by printing at a smaller scale they could have been fitted on single pages. The others are true double-page spreads showing dramatic scenes at colonies or in winter flocks and their added impact from being printed at this size offsets the annoyance of the page-break (especially as for all seven the two halves of the picture are perfectly aligned). As the book is not primarily for identification, the concentration on adults in breeding plumage is an asset not a drawback. Most photographs seem correctly labelled (but I could not find any Caspian Terns *Sterna caspia* on page 128/129; the small red-billed terns are not mentioned in the caption).

The reader may experience disappointments while poring over the pictures, when he looks up lesser-known species of the Northern Hemisphere he would like to see. Divers, grebes, seaducks and phalaropes are all omitted, on the somewhat spurious grounds that they are not colonial breeders. Admittedly, the title is not "All the seabirds of the Northern Hemisphere", but I was disappointed to find many West Pacific or East Palaearctic species omitted from the entire book. American readers are cautioned that occasionally the species order deviates from that of the American Ornithologists' Union, but this is likely to be a minor concern, if they recover from the surprise of seeing most of 'their' western seaboard species relegated to an appendix of irregular or scarce visitors in North America or Europe (note the reduction in area from the book's title). This appendix (from which no species are pictured) is full of surprises: I did not notice that the Bridled Tern *Sterna anaethetus* I saw at Rutland Water in 1984 was (by implication) dead! Each species' short text concentrates on its UK status, but this is sometimes incorrect (there is only one record of Magnificent Frigatebird *Fregeta magnificens* from Britain; the other two were not identified to species). The UK bias reaches its apogee with Thayer's Gull *Larus thayeri,* whose sole occurrence in Europe or North America appears to be in Ireland. The glossary rivals the appendix for errors per column-inch; for example, the tarsus is strictly the tarso-metatarsus (not the metatarsus) and its plural is tarsi (not tarsii).

The main text (after a few introductory sections, the bulk of the book consists of species essays) is of variable quality: parts make excellent reading, bringing to mind the reader's own experiences (how much this is due to seabirds being memorable, rather than skill on the author's part, is debatable). Presentation of measurements in English language units makes reading easy. The lengthy and turgidly written descriptions of the birds appearance and identification should mostly have been omitted (or at least greatly reduced) as they often mislead. The rash assertion that Lesser-backed Gulls *Larus fuscus* have dark trailing edges to the underwing is contested by the portrait on the opposite page. But the author deserves credit for stressing the real possibility of confusing second-year Herring Gulls *L.argentatus* with first-year Ring-billed Gulls *L.delawarensis*. Phraseology is often loose: Arctic Terns *Sterna paradisaea* do not have white underparts (as the author himself owns nine lines later); the dramatic upperwing pattern of Forster's Tern *S.forsteri* is described but as written it could almost equally apply to Common Tern *S.hirundo*. Wingtip position relative to tail is only useful for separating Common and Arctic Terns early in the breeding season, but this feature is presented without caveat. Such slackness is inexcusable when the identification of difficult groups is being considered. Sections about each species's behaviour and ecology are often heavy going, except where the author's enthusiasm for watching birds shines through. Comments on population trends give the book a 'conservation' flavour, and are often up-to-date, though sometimes rather wide of the mark. *Seabird* readers will be aware that the current fundamental problem with Shetland Arctic Terns is not primarily the reduction in breeding numbers, but the catastrophic decline in success. Other purchasers may not know this, although possibly less knowledgeable, yet careful, readers may detect enough inconsistencies within the book's text to make them want to check everything. There are more grammatical than typographical errors and occasional pseudo-scientific terms are annoying (particularly when wrong: e.g. "some other Laridae sp."; why not put gull species?). One cannot avoid feeling that most comments on Nearctic status were added as an afterthought.

Richards has steered a conventional course through the turbulent seas of nomenclature and taxonomy, discarding much modern thinking (Saunders's *S.saundersi* and Least Terns *S.antillarum* are not split from Little Tern *S.minutus*, nor is Yellow-legged Gull *L.cachinnans* from Herring Gull), yet it is of such forms that photographs would have been of particular value for identification (to justify the contention of the dust jacket). The storm-petrels all have the word 'storm' in their name (e.g. Leach's Storm Petrel *Oceanodroma leucorhoa*; I would have preferred a small 'p'), which is good, but of the two references to *Sterna bergii*, one calls it Swift Tern, the other Crested Tern (and only once is the scientific name given), which is bad.

The key to the maps (probably lifted, without acknowledgement, from Harrison's *Seabirds*) is hidden among the publisher's opening formalities and very difficult to find. The maps include breeding vital statistics, although the fledging period is misnamed "fledgling".

In conclusion, the book justifies its existence by the magnificent photographs; it is a pity the text was not severely pruned so that it was merely a commentary to the former. This conclusion has applied to several recently-published 'coffee-table' books; one can only hope that publishers will eventually take notice.

Will Duckworth.

JOHNSON, S.R. and HERTER, D.R. 1989. The Birds of the Beaufort Sea. Pp. 372. BP Exploration (Alaska) Inc., P.O. Box 196612, Anchorage, Alaska, Library of Congress Catalog Number 89-61461.

The aim of this book is to review and summarise relevant knowledge of all bird species that have been reported in the Beaufort Sea region of Canada and Alaska. This is a formidable task because with the development of oil and gas resources in the area, there has been a proliferation of baseline studies, environmental impact statements and monitoring programmes, the findings of which are in many cases, hidden in the 'grey' literature. The incorporation of this information in the species accounts and the bibliography (which contains about 1,600 references, many of them on seabirds) make this book a useful reference work. Would that there were more such reviews of the grey literature!

After a short introduction and description of the vast study area (the marine habitats alone cover nearly 1,000,000 km^2) the bulk of the text is devoted to species accounts which are sub-divided into: distribution and status, winter range and spring migration, breeding biology and fall migration. Eleven species of seabird (three skuas, four gulls, one tern and three auks) breed in the Beaufort Sea area and three more gull species breed on the Mackenzie River delta. Only the Black Guillemot *Cepphus grylle* is present between October and April, spending the winter in open leads and near the ice edge. Between fourteen and seventeen species (depending on whether the questionable records for Black-footed Albatross *Diomedea nigripes*, American White Pelican *Pelecanus erythrorhynchos* and Common Tern *Sterna hirundo* are included or not) are migrants or visitants. The passage of thousands of Ross' Gulls *Rhodostethia rosea* past Point Barrow each autumn must indeed be a spectacular sight.

The book is well produced with four pages of maps and eleven pages of colour plates illustrating some of the species and habitats. BP Exploration (Alaska) Inc. supported the publication of The Birds of the Beaufort Sea and the book can be obtained direct from their Anchorage Office.

Sarah Wanless

BURGER, J. (Ed.) 1988. Seabirds and other marine vertebrates: competition, predation and other interactions. pp 339. $45.00. Columbia University Press, New York. ISBN 0231063628.

As the ambitions of seabird biologists go beyond cliff-based studies, our knowledge of seabird feeding ecology progresses beyond the rudimentary and so major gaps in the seabird literature are filled. Croxall's *Seabirds: feeding ecology and role in marine ecosystems* (Cambridge University Press 1987) celebrated the transition from broadly descriptive studies to syntheses based on energy flux and trophic relationships of foraging seabirds. This volume focuses on an aspect of seabird feeding ecology which remains largely in the descriptive phase.

There are nine chapters, starting with Burger's introduction which summarizes experimental studies of competition, predation and mutualism/commmensalism and the use of marine ecosystems in these studies. The general message is that while descriptive studies abound, rigorous experimental tests are few (although the difficulty of experimentation on marine vertebrate-seabird interaction is acknowledged!). The first section (entitled "Commensalism") includes studies of seabirds and marine mammals in the Northwest Atlantic (Pierotti) and seabird community structure in Australia (Hulsman). Pierotti describes interactions resulting mainly from the attraction of birds and mammals to a common food resource, but evidence for facultative mutualism of gulls and "bubble-netting" humpbacks is presented. Hulsman uses a simple model to consider how various seasonal patterns of resource abundance influence competitive interactions within seabird communities. Commensalism does not figure largely.

The final six chapters are grouped under the title "Competitive and Predation". The chapter by Safina and Burger is long (20% of the volume), detailed and disappointing. Their study of prey fish, predatory bluefish and terns off Long Island must count among the most detailed studies in the field, but sadly the important results and messages are submerged among a profusion of largely unnecessary statistics. Some muddled up figure legends do not assist the clarity of the chapter. Their extensive information on fish dynamics and abundance relative to foraging tern flocks indicate that bluefish are the dominant predator in the system, a major competitor of terns (exploitation and interference competition), and probably responsible for the marked seasonal decline in prey fish numbers. However, the bluefish also acquire increasing importance in making prey available to terns as the season progresses and prey abundance decreases. The chapters on seabird relations with tuna and dolphins (Au & Pitman) and sea lions (Pierotti) conclude that, although the potential for competition exists due to the exploitation of common food resources, the dominant interaction is likely to be either neutral or mutually beneficial. Chapters on the interaction of seabirds and fisheries follow. Furness, Hudson and Ensor present interesting experimental results and calculations suggesting that 75-90% of fishery offal and discards are consumed by seabirds, perhaps supporting up to 2.5 million seabirds around the British Isles. Jones & DeGange provide depressing information on the extent of fisheries' by-catch of seabirds in the North Pacific, but also show how legislation passed to protect seabirds in California can reduce mortality. The final chapter takes a historical perspective, seeking evidence for spatial competition between seabirds and pinnipeds using patterns of abundance from fossil and recent communities.

The standard of chapters varies widely, and they seem to be grouped somewhat arbitrarily. I feel that a concluding chapter, highlighting gaps and common themes, would have been of benefit.

However, most of the studies must have necessitated long hours staring through binoculars in pitching boats, for which the authors gain my fullest admiration. If you are interested in seabird feeding ecology there is much valuable information in this volume on subjects which have previously received scant attention. But it is a book that I would consult from a library shelf rather than my own.

B.J.Hatchwell.

WARHAM, J. 1991. The Petrels: their ecology and breeding systems. Pp. 440. 150 figures, many tables. Academic Press, London. £28.50. ISBN 0-12-735420-4.

The 103 species of petrels (a term used in this book to cover all Procellariiformes, tubenoses and Tubinares) are the most specialized and interesting of birds. They have long attracted attention from biologists and the studies of some species are among the earliest, longest and most detailed of any seabird. Thirty years ago, a review of the group would have been straightforward but since then a plethora of studies have made this a herculean task. The literature quoted here includes more than 1,000 published sources. John Warham has unrivalled field experience of the group and has added to this his encyclopedic knowledge of the literature to produce a first-rate book.

Most of the book falls naturally into two parts. First, there are nine chapters each dealing with one of the main taxanomic groupings (albatrosses, fulmars, gadfly petrels, Blue Petrel and the prions, Bulwer's and Jouanin's Petrels, *Procellaria* spp. and *Calonectris* spp., the true shearwaters, storm petrels, and diving petrels). Each chapter describes the general characteristics, the species in the group, life styles, distribution (with maps of the breeding areas), feeding and food, breeding biology, dispersal and migration, populations and mortality.

Second, there are chapters reviewing and synthesizing what is known of general breeding biology, the pre-egg stage, the egg, incubation and the chick stage. (We are promised a companion volume covering behaviour, physiology, population biology and food.) An appendix lists the species and races (including a few unnamed ones) and their breeding ranges. Any such list will inevitably upset some people, eg the Amsterdam Albatross is demoted to a subspecies, Townsend's and Newell's Shearwaters are combined into a single species, the prions are grouped into five species, but this list is a sensible compromise between extreme views.

During my career I have studied two shearwaters, a gadfly petrel, two storm petrels and an albatross. I wish that I could have presented my results as lucidly and interestingly as John Warham has surveyed the whole family. Books such as this can easily become unbearably detailed but this one is a joy to read. The referencing is exemplary giving credit where credit is due without being intrusive, the diagrams and maps are clear and uncluttered. Most chapters can be browsed, and all readers will benefit from so doing, but by their nature some later sections, eg that on growth, demand more attention. Despite his photographic expertise, the author has wisely restricted the number of photos, presumably in favour of diagrams. This is rather a rave review, but this is an exceptional book, both author and publishers are to be congratulated on the presentation and pricing. All those interested in seabirds even if they never leave British waters should get a copy.

M.P. Harris

THE SEABIRD GROUP 1991

The Seabird Group was founded in 1966 to circulate news of work in progress on seabirds and to promote research. It is run by an elected Executive Committee and maintains close links with the three major British national ornithological bodies – the British Ornithologist's Union, the British Trust for Ornithology, and the Royal Society for the Protection of Birds. Membership (£10 per annum, £9 if paid by banker's order, £5 for students) is open to all with an interest in seabirds; for details please contact the Membership Secretary (address below) – payment by banker's order helps the Group.

Current Executive Committee The present Committee comprises: Chairman K. Taylor, Secretary M. Heubeck, Treasurer R.W. Furness, Membership Secretary S. Russell, Editor of *Seabird* S. Wanless, Newsletter Editor M. Tasker, also M.P. Harris, P. Monaghan, P. Weaver, B. Zonfrillo.

Newsletters and Meetings Three Newsletters are circulated to members each year. They contain all sorts of items including reports on seabird conservation issues and research projects, news from seabird groups in other countries, book reviews, details of meetings, etc. The Newsletter Editor (address below) welcomes contributions from members. The usual venue for the Group's annual meeting is the BTO Ringing and Migration Conference at Swanwick, except when the Group holds its own conference, in which case the meeting is combined with that. Our conferences draw seabird workers from many countries to join in a forum of topical interest. The next conference will be held in Glasgow on 27-29th March 1992, with the theme 'European Seabirds'. 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.

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, and will be considered by the Executive Committee by the end of March. 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 involving the active participation of its membership, now standing at 350 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 completed the Seabird Colony Register fieldwork in 1988, in cooperation with the Nature Conservancy Council, and the results were published earlier this year in the book: 'The Status of Seabirds in Britain and Ireland'. This register was begun in 1985 to gather together all existing data on breeding seabird numbers in the British Isles, to bring our knowledge of their status up to date by detailed field surveys and to establish a computerised database which can be easily updated in the future. Although this round of survey work has been completed, it is important to continue monitoring of seabird breeding numbers: anyone eager to conduct counts on a regular basis should contact Paul Walsh, JNCC, 17 Rubislaw Terrace, Aberdeen AB1 1XE.

Seabird Journal In November 1984 the Group launched its new-look journal *Seabird*, numbered 7 in deference to its pedigree of Seabird Group Reports 1-6. Our priority is to maintain a high volume and quality of content and the current editor, Sarah Wanless, 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 £10 + 50p postage within the British Isles, £10 + £1 postage overseas. Postage overseas is by surface mail, unless the recipient can make prior provision for air mail. The subscription to Libraries is £15 per copy. To help reduce costs, overseas subscribers are kindly asked to make payment by international money order rather than by cheque. Back issues of *Seabird 11* & *12* are available at £5 + 50p per copy. There are no cost concessions for multiple orders of *Seabird* and postal charges are additive.

Who to write to While the Seabird Group maintains an accommodation address (c/o RSPB, The Lodge, Sandy, Bedfordshire SG19 2DL, England, UK), the following can be contacted directly, as appropriate. Please help the Group by enclosing a stamped addressed envelope for reply.

Secretary (general enquiries about the Group, seabird conservation matters, grants, etc.): Martin Heubeck, Mansefield, Dunrossness, Shetland ZE2 9JH, Scotland, UK.

Membership Secretary (membership renewals, applications and enquiries): Sheila Russell, Clober Farm, Milngavie, Glasgow G62 7HW, Scotland, UK.

Treasurer (subscriptions, donations, etc.): Dr Robert Furness, Department of Zoology, University of Glasgow, Glasgow G12 8QQ, Scotland, UK.

Editor of Seabird: Dr Sarah Wanless, c/o Institute of Terrestrial Ecology, Hill of Brathens, Banchory, Kincardineshire AB31 4BY, Scotland, UK.

Newsletter Editor: Mark Tasker, JNCC, 17 Rubislaw Terrace, Aberdeen AB1 1XE, Scotland, UK.

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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.

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 are advised to consult a recent copy of *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 *Seabird* form of presentation. Spelling should conform with the preferred i.e. first-cited spelling of the *Shorter Oxford dictionary.* 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 authorative faunistic work treating the appropriate region, followed by 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 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.