

# SEABIRD 9



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# SEABIRD 9

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# Notes on the eggs and chicks of North Norwegian Shags *Phalacrocorax aristotelis*

Robert T. Barrett, Karl-Birger Strann and Wim Vader

## INTRODUCTION

Shags *Phalacrocorax aristotelis* are common along the coasts of Europe, but relatively little has been published on their breeding biology. Most of the literature (e.g. Snow 1960, 1963, Pearson 1968, Potts 1968, 1969, Coulson *et al.* 1969, Potts *et al.* 1980, Harris 1982, Lloyd 1982 & Furness 1983) concerns southern populations and, except for Belopol'skii's (1957) inclusion of the Shag in his study of the Barents Sea seabird community, nothing is known about its breeding biology in northern waters. This paper presents incidental data collected during a study of the breeding biology of auks and Kittiwakes *Rissa tridactyla* on Hornø, N.E. Norway (70°22'N, 31°10'E) in 1980-1983 (Barrett 1983, Furness & Barrett 1985). Egg and clutch-size data were also collected by KBS from other colonies in N. Norway (Figure 1) during a seabird mapping project of the region in 1981-1984.

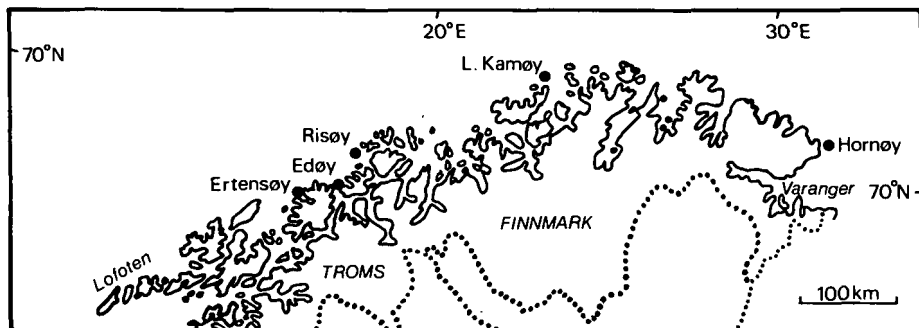


Figure 1. The geographical location of the Norwegian colonies from which Shag data was collected.

## MATERIALS AND METHODS

One hundred and forty-two pairs of Shag nested on Hornø in 1983, this compared to 103 pairs in 1981. Most nests were built on open ledges or on shelves behind large stones, and were scattered throughout a west-facing cliff ca. 500m long, 30m high and 50-100m inland. Other nests were built on open ledges on lower rock faces rising vertically out of the sea. Only 5-10 nests were possibly endangered by rough seas. Other species breeding on the cliffs were Kittiwakes, Common Guillemots *Uria aalge*, Brunnich's Guillemots *U. lomvia*, Razorbills *Alca torda* and Puffins *Fratercula arctica*. The main potential predators were Herring Gulls *Larus argentatus* and Great Black-backed Gulls *L. marinus* which bred in relatively large numbers on the island.

Detailed studies of 22 and 29 nests were made once every three days in 1980 and once every two days in 1981 respectively. Notes on clutch and egg-size on the other colonies were usually made during the late incubation period, but some not until after some of the eggs had

hatched. The maximum length and breadth of eggs were measured to the nearest 0.1mm using vernier calipers and their volumes were calculated using the equation  $v = klb^2$  where  $V$  = volume in ml,  $k = 0.51$  (Coulson *et al.* 1969),  $l$  = length and  $b$  = breadth in cm. Incubation period is defined as the interval between the laying and hatching of individual eggs.

Chicks were weighed every two or three days to the nearest 5g (0-500g), 10g (500-1000g) and 25g (1000-2500g) using spring balances. Adults were weighed to the nearest 25g. Culmen-length (from the edge of the feathers to the tip) was measured to the nearest 0.5mm and wing-length (maximum flattened chord) was measured using a wing rule to the nearest 1mm when naked, 5mm when downy and 1mm after the eruption of the primaries. No attempt was made to weigh or measure chicks immediately prior to fledging because of the danger of premature fledging. Quantitative interpretations of chick growth were made using Ricklefs' (1967) graphical method.

Both adults and chicks sometimes regurgitated food samples when approached or handled. We collected these and considered them as being representative of chick diet.

## RESULTS

The median hatching date on Hornøya was, in 1980, 6 June ( $n = 35$ , range 25 May-23 June). With a mean incubation period of 32.6 (S.D. = 1.7,  $n = 20$ ) d (this study) the median laying date was thus ca. 4 May. In 1981 the median laying date was 19 May ( $n = 66$ , range 28 April-7 June). These approximations exclude clutches which may have been lost before the studies began on 31 May 1980 and 14 May 1981.

TABLE 1. MEASUREMENTS (MEAN  $\pm$  S.D.) OF SHAG EGGS IN 6 REPLACEMENT CLUTCHES ( $N = 13$  EGGS) IN RELATION TO THEIR RESPECTIVE FIRST CLUTCHES ( $N = 17$  EGGS), HORNØY 1981.

	Length mm	Breadth mm	Volume ml
First Clutch	63.4 $\pm$ 4.2	38.6 $\pm$ 1.3	48.3 $\pm$ 5.1
Replacement Clutch	61.8 $\pm$ 3.6	38.1 $\pm$ 2.2	45.9 $\pm$ 6.2

TABLE 2. THE CLUTCH SIZE OF THE SHAG IN N. NORWAY, 1980-1984

Colony	Year	No. of nests with				Mean
		1 egg	2 eggs	3 eggs	4 eggs	
Hornøya	1980 <sup>1</sup>	0	2	22	2	3.0
	1981 <sup>1</sup>	0	4	19	2	2.8
	1982	2	1	24	1	2.9
	1983	3	4	34	1	2.8
L. Kamøy	1983	15	104	283	123	3.0
	1984	30	122	321	141	2.9
Risøy	1981	2	12	48	18	3.0
	1982	19	50	171	60	2.9
Ertensøy	1981	10	33	67	40	2.9
	1982	17	39	110	34	2.8

<sup>1</sup>Not necessarily the same nests as those studied in detail – see Material and Methods.

The mean length, breadth and volume ( $\pm$  S.D.) of 208 eggs laid on Hornøy in 1980-1982 were  $63.8 \pm 3.1$  mm,  $38.5 \pm 1.5$  mm and  $48.4 \pm 5.2$  ml respectively. There was no difference in the volume of eggs laid in 1980, 1981 or 1982 (ANOVA,  $F_{2,205} = 2.8$ , n.s.). Nor were there any differences in the volumes of the first, second or third eggs of 19 3-egg clutches (ANOVA  $F_{2,54} = 0.1$ , n.s.). Although smaller in all measurements the difference in volume of replacement eggs and eggs of their respective first clutches was not significant ( $t = 1.18$ , n.s.) (Table 1). On the other hand there was a marked seasonal decline in the volume of eggs in 1981 (Figure 2) and eggs laid after 21 May were 10% smaller than those laid before 10 May.

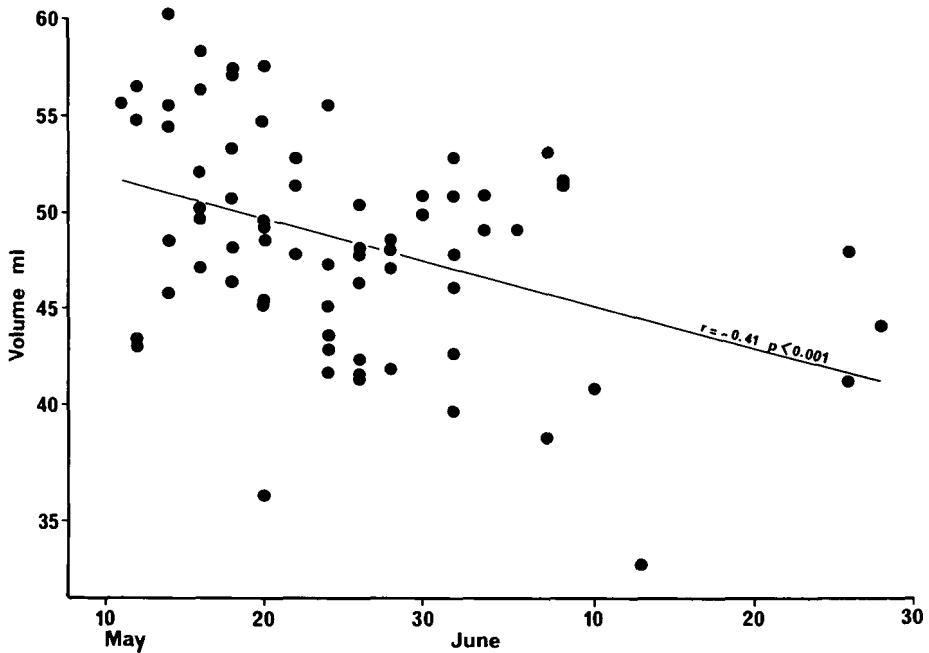


Figure 2. The volume of Shag eggs in relation to laying date, Hornøy 1981.

The mean clutch size was 2.8-3.0 eggs per nest in 1980-1983 (Table 2). There was a significant difference in incubation period of eggs according to the sequence in which they were laid (ANOVA  $F_{3,16} = 3.41$ ,  $p < 0.05$ ) with the third and fourth eggs being incubated ca. 2 d less than the first egg (Table 3). The interval between the hatching of the eggs of a 3-egg clutch was 1.5 (eggs a-b,  $n = 21$ ) - 2.0 (b-c,  $n = 12$ ) d. Of 12 clutches which were lost in 1981, 6 were replaced 4-30 (mean = 15) d after loss. The interval between the laying of the first clutch and the first egg of the replacement clutch ranged from 12-56 d (mean =  $27 \pm 17$  d,  $n = 6$ ). One clutch was apparently replaced ca. 3 weeks after loss even though it was lost 1-3 d after the eggs had hatched.

Hatching success could not be determined as the extent of egg loss through disturbance was unknown. However 33 of 39 (85%) and 23 of 32 (72%) chicks hatched fledged (excluding 2

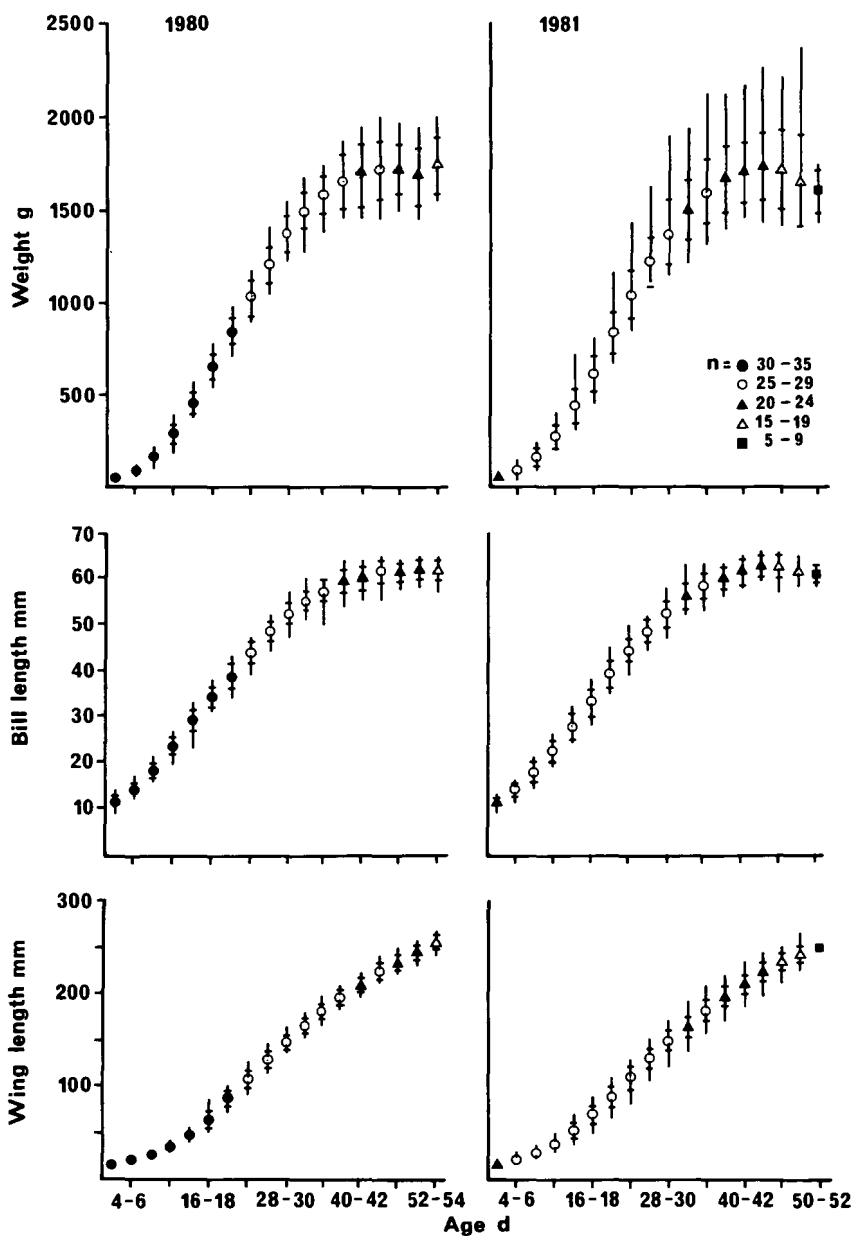


Figure 3. The weight, wing and culmen-length (mean  $\pm$  S.D. & range) of Shag chicks with respect to age, Hornøy 1980 & 1981. (n = sample size).

TABLE 3. THE INCUBATION PERIOD (MEAN  $\pm$  S.D.) OF SHAG EGGS IN RELATION TO LAYING SEQUENCE, HORNØY. (N = SAMPLE SIZE).

	<i>Inc. per.</i> <i>days</i>	<i>n</i>
a-egg	33.9 $\pm$ 1.5	7
b-egg	32.7 $\pm$ 0.8	5
c-egg	31.5 $\pm$ 1.8	6
d-egg	31.5 $\pm$ 1.4	2

nest from which chicks were lost through disturbance in 1981) in 1980 and 1981 respectively. Nests were not disturbed in 1983 and 67 of 120 inspected during early July had an average of 2.1 large chicks (including 8 empty nests) and 33 contained a mean of 2.3 small (<20 d old) chicks or eggs. Assuming a fledging success of 77%, the latter group would have an overall breeding success of maximum 1.8 chicks per nest, giving a total success for 1983 of ca. 2 chicks per nest. Although failed or abandoned attempts would have gone unrecorded, the success of Shags on Hornøy was higher than elsewhere, e.g. on the Farne Islands in N.E. England (ca. 1 fledgling per pair, Potts 1969).

The growth patterns of chicks were very similar in 1980 and 1981 (Figure 3) and weight changes were best fitted by the logistic equation (see Ricklefs 1967). An inverse measurement of growth rate which represented the time to complete growth between 10% and 90% of the asymptote was calculated according to Ricklefs (1967). The maximum instantaneous growth rate (KA/4) was also calculated as it is a better measure of overall growth than the constant k (Hussel 1972). The growth rate of chicks on Hornøy was similar to, if not slightly faster than that of British chicks (Table 4, Figure 4). There was no difference in the growth of siblings of 83-chick broods. Nor was there any difference in growth rates between broods of one (n = 4), two (n = 20) and three (n = 8) chicks (1980 and 1981 data combined).

TABLE 4. GROWTH PARAMETERS OF SHAG CHICKS ON HORNØY AND IN BRITAIN BASED ON DATA FROM THIS STUDY, PEARSON (1968) (FARNE ISLANDS) AND SNOW (1960) (LUNDY). (K = GROWTH CONSTANT, RICKLEFS 1967).

Colony	Asymptote (A) g	Adult wt.		A/W	Growth rate		
		<i>g</i> $\pm$ S.D.	<i>n</i>		<i>K</i> g/d	<i>KA/4</i> d	<i>t</i> <sub>10-90</sub>
Hornøy 1980	1725	1851 $\pm$ 179	53	0.9	0.17	75.4	24.9
1981	1730			0.9	0.18	78.1	24.4
Farne Islands	1640	1785 $\pm$ 44	26	0.9	0.16	66.4	27.4
Lundy	1690	1770		1.0	0.16	75.0	24.7

The mean fledging period was not determined accurately because many chicks were still in their nests at the end of the field seasons. However it was estimated to be ca. 55-60 d.

All 27 food samples collected consisted wholly of Sand Eels *Ammodytes* sp.. The mean weight of samples from adults was 36.0  $\pm$  9.3g (n = 5) and from chicks 17.7  $\pm$  9.2g (n = 4 complete regurgitations). The remaining samples which were found on the nest weighed 23-41g. The lengths of fish were between 60-140mm, mean ca. 120mm.



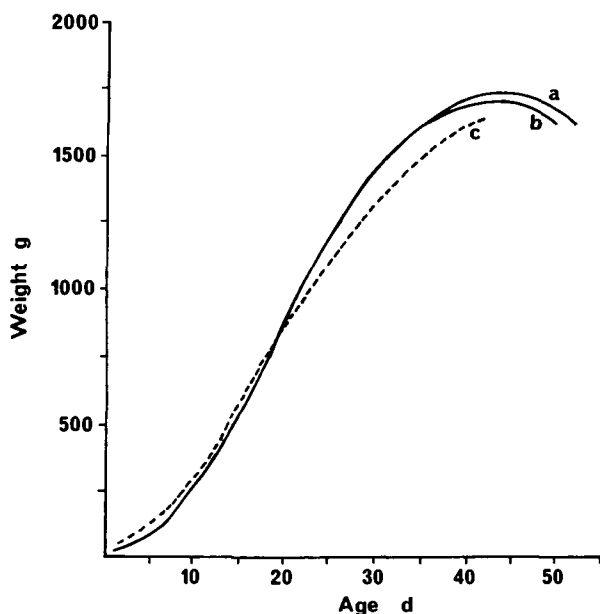


Figure 4. The growth of Shag chicks on Hornø (a) compared with two British colonies, Lundy (b, from Snow 1960) and the Farne Islands (c, from Pearson 1968).

## DISCUSSION

Although there is considerable variation in the timing of the breeding season in Britain (median laying date 6 April-20 May; Snow 1960, Potts 1969), Shags on Hornø laid 2-3 weeks later than in Britain, and at approximately the same time as those on the Murmansk coast (6 May-2 June, Belopol'skii 1957). In 1981 a prolonged period of bad weather and late-lying snow on Hornø delayed the Shag's breeding season and also those of the Kittiwake, Puffin and Razorbill (Barrett 1983, 1984). Similar delays have also been reported by Belopol'skii (1957) and Snow (1960).

Variations in egg size according to laying sequence and date of laying have been found by Snow (1960) and Coulson *et al.* (1969) and, although in some cases statistically insignificant, our results show the same trends. Unfortunately the ages of the Shags breeding on Hornø were unknown so that any age-related differences in e.g. egg or clutch-size could not be accounted for. The clutch sizes of British and Norwegian Shags were also similar. The fact that the third and fourth eggs of the clutch had shorter incubation periods than the two first eggs (see also Coulson *et al.* 1969) and that the hatching intervals between eggs was 1.5-2.0 days as opposed to a laying interval of 3 d (Snow 1960, Coulson *et al.* 1969) suggests that Shags do not incubate their eggs fully until the last eggs have been laid. Both the incubation period and the apparent fledging period on Hornø were similar to those in Britain and the Murman coast (Belopol'skii 1957, Snow 1960, Pearson 1968, Lloyd 1982, Aebischer pers. comm.)

The Shags on Hornøy started breeding 2-3 weeks before the Kittiwakes, Puffins and Razorbills (Barrett 1983, 1984). Although Shags also breed early in Britain (Coulson *et al.* 1969, Potts *et al.* 1980, Lloyd 1982), it is possible that an early start in the Arctic is especially advantageous in that Shags can thus fit a relatively long incubation and brooding period (total >90 d) into the short northern summers. Belopol'skii (1957) suggested that Murman Shags had a much longer brooding period than Shags in central Europe and that the more severe Arctic conditions retarded the development of the nestlings, while Pearson (1968) attributed a slower growth of chicks on the Murman coast to lower temperatures in the north. Our study (Figure 3, Table 4) shows that nestling development is in no way retarded in the north and that chick growth and development is as rapid on Hornøy as it is in the more southerly colonies. Belopol'skii did not take into account that chicks are fed for several weeks after they leave the nest (Snow 1960, Potts 1969) such that although British chicks may leave their nests before their northern counterparts, they are not necessarily independent at an earlier age.

A slower growth of chicks in larger broods of Shag chicks could be due to a difficulty in finding enough food for the larger broods (Furness 1983). No such difference was recorded on Hornøy and the Farne Islands (Pearson 1968) where it is reasoned that food was plentiful. On the contrary, the high growth rate of chicks and the high fledging and breeding success of all seabirds on Hornøy suggest a superabundance of food (Furness & Barrett 1985). Another factor contributing to the success of the Shags on Hornøy was the quality of their nest sites which, using the criteria described by Potts *et al.* (1980), was high. Nearly all nests were built on wide ledges out of reach of rough seas and many were protected from the weather and predators either by adjacent or overhanging rock faces. Nearly all were edge sites with free access to the sea.

A study of the food of the seabirds on Hornøy showed that Capelin *Mallotus villosus* was the most important prey item for the community as a whole but that Sand Eels dominated the food samples of some lesser species (Barrett 1983, Furness & Barrett 1985). That Hornøy Shags seemed to prey entirely on Sand Eels is a situation similar to that on the Farne Islands where Sand Eels made up 81% (by number) and gadids and clupeids only <5% of the Shag diet. Sand Eels were also the dominant prey items of Shags in Cornwall and south-west Scotland (Steven 1933, Lumsden & Haddow 1946). Further details of interspecific differences in the diet of seabirds on Hornøy are given in Furness and Barrett (1985).

## SUMMARY

Incidental data on the breeding biology of Shags collected mainly on Hornøy, but also from 4 other colonies in north Norway in 1980-1984 showed that the egg and clutch-sizes, incubation period, chick growth patterns and fledging period were essentially similar to those of British Shags. A rapid chick growth on Hornøy suggested an abundance of food, while good quality nest sites may have helped towards a high breeding success.

## ACKNOWLEDGEMENTS

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# Razorbill *Alca torda* losses in Portuguese nets

A.M. Teixeira

Large numbers of Razorbills *Alca torda* regularly occur on the Portuguese coast during the winter months. They tend to concentrate at the entrance of estuaries, apparently attracted by good feeding conditions there. The largest assemblies of wintering birds are known from the mouth of the Tagus estuary, where many Razorbills have been falling easy victims to nylon gill-nets floated in the surface layers (Teixeira 1985). The birds die from suffocation underwater, after casually getting entangled in the nets during a dive. The fishermen involved in this mortality make no deliberate attempt to catch the auks and they simply throw away most of the corpses they find in their nets. This situation is markedly different from that Castro (1984) has described from southern Spain, where nets are set around feeding birds.

## METHODS

The numbers of auks killed have been checked in recent years at Fonte da Telha, a small fishing settlement on the shore 15km to the south of Lisbon. Several hundred Razorbill corpses were examined on the beach at this site alone in 1983/84 and 1984/85, from November to April (Table 1). These figures clearly underestimate the true mortality there because many of the drowned birds are discarded at sea and may not wash ashore in the immediate vicinity.

TABLE 1. SEASONAL CHANGES IN THE ABUNDANCE OF RAZORBILL CORPSES ASHORE, AS OBSERVED AT FONTE DA TELHA FOR TWO CONSECUTIVE WINTERS. AGEING BASED ON BILL GROOVES (SEE TEXT).

Date of visits	No. of birds found						totals	% oiled
	1st winter 0+0	immature		adult		age unknown		
		W+0	W+1	W+2	W+3			
27 Nov 83	8	—	—	—	—	—	8	0
17 Dec 83	6	2	—	—	—	16	24	0
27 Dec 83	15	4	5	—	—	—	24	0
28 Jan 84	40	11	9	5	—	23	88	0
4 Feb 84	147	41	13	9	—	33	243	1.9
25 Feb 84	15	8	—	1	1	15	40	20.0
18 Mar 84	3	—	—	1	—	4	8	50.0
24 Mar 84	6	1	1	1	—	1	10	22.2
totals (83/84)	240	67	28	17	1	92	445	3.7
24 Nov 84	40	16	2	—	—	28	86	0
29 Dec 84	20	23	22	8	—	31	104	0
3 Jan 85	4	30	27	16	4	7	88	0
26 Jan 85	8	30	24	16	1	41	120	1.8
23 Feb 85	2	1	1	—	—	8	12	0
2 Apr 85	—	2	—	1	—	9	12	0
totals (84/85)	74	102	76	41	5	124	422	0.3

They also ignore all corpses buried by the tide and those occasionally taken home by some of the fishermen for food or removed by scavenging dogs. On the other hand, the totals may include some birds cast ashore after having died from causes other than the nets. It must be stressed however that the vast majority of the corpses examined obviously was from birds killed in the gill-net fishery. Some of them were handed to us directly by the fishermen when removing their catch from the nets ashore. Others were recovered high up on the beach, clearly beyond tidal reach and usually from piles clustering around the small wooden boats in use at Fonte da Telha. Many corpses did show external signs of lung congestion or physical injuries produced by entanglement in the nets, like wings badly broken or torn apart from the body and missing heads.

## RESULTS

All corpses collected on the shore were examined following standard procedures suggested by Hope Jones *et al.* (1982). Three age classes were distinguished, based on examination of bill grooves (Hope Jones *et al.* 1984): first-winter (no bill grooves, 0 + 0), immature (one white line and one or no black grooves, W + 1 and W + 0) and adults (one white line and two or three black grooves, W + 2 and W + 3). However, we realise that the W + 1 bill category may include some birds which are breeders, as pointed out by De Wijs (1985).

Sixty-eight per cent of all Razorbill corpses examined at Fonte da Telha in 1983/84 were first-winter birds (0 + 0). They far outnumbered all other age-classes in the sample, as anticipated from ringing results (Mead 1974, Lloyd 1974). Few casualties were reported in November and December 1983 but the situation changed drastically in late January 1984 with an exceptional mortality that persisted through early February (Table 1). This coincided with other large-scale seabird wrecks on European shores caused by adverse weather further north (Bourne 1984a) and these storms may have forced more birds into the area, thus increasing their vulnerability to the nets as suggested by Bourne (1984b). The incident was over by late February and few casualties were recorded subsequently at Fonte da Telha.

The composition of the catch in 1984/85 has been quite different from that observed in 1983/84. Many more birds of the older age-classes were found in late December and through January, causing the younger immatures to lose their previous importance in the sample (Table 1). Perhaps this would suggest that many Razorbills have been forced to the south of their normal wintering areas in the NE Atlantic by the exceptionally cold weather that affected most western European countries in January 1985.

Measurements summarized in Table 2 were taken from freshly-killed specimens handled on the shore (sexes combined). The values obtained for winglength (maximum chord) are comparatively low, suggesting that most of the birds involved in the kills originate from the more south easterly Atlantic colonies. Our findings agree well with data published by Hope Jones (1984), based on museum skins examined at Cascais, Portugal.

This view is further borne out by eighteen ringed Razorbills recovered at Fonte da Telha in December, January and February for two consecutive winters (1983/84 and 1984/85). One of the birds was born at Fair Isle in the Orkneys while all the others had been ringed off the west coast of Britain (most of them as chicks), twelve at Great Saltee and one at Skokholm in the Southern Irish sea and the remaining at colonies in Kintyre, the Inner Hebrides and the Shiant Islands, western Scotland.

Analysis of ringing data published by Campos Ferreira (1980) and by Candeias & Castro (1982) also demonstrate that many Razorbills occurring on the Portuguese coast originate in the British Isles, especially from the Irish Sea and northwestern colonies.

TABLE 2. MEASUREMENTS (IN MILLIMETRES) OF FRESHLY-KILLED RAZORBILLS HANDLED AT FONTE DA TELHA, NOVEMBER 1983 TO MARCH 1984. VALUES OBTAINED IN 1984/85 ARE GIVEN IN BRACKETS. AGEING BASED ON BILL GROOVES (SEE TEXT). SEXES APPEAR COMBINED IN THE SAMPLE.

	sample	mean (mm)	range	std. deviation
<i>Winglength</i> (max chord)				
1st winter	227 (56)	190.5 (192.0)	181-200 (183-202)	4.15 (4.56)
immature	94 (122)	197.1 (196.4)	186-209 (184-207)	4.77 (4.18)
adult	15 (34)	198.6 (200.4)	193-208 (193-208)	4.0 (3.16)
<i>Culmen length</i>				
1st winter	234 (51)	31.8 (32.0)	28-36 (29-35)	1.48 (1.52)
immature	95 (133)	32.6 (33.3)	28-37 (30-37)	1.68 (1.54)
adult	17 (35)	32.4 (33.0)	31-34 (30-35)	0.93 (1.36)
<i>Gonys depth</i>				
1st winter	233 (51)	14.9 (15.2)	13-17 (13-17)	0.83 (0.86)
immature	95 (131)	18.1 (18.5)	16-20 (16-21)	1.01 (1.07)
adult	17 (34)	19.2 (19.7)	18-20 (18-21)	0.81 (0.84)

From twenty-one Razorbill corpses obtained at Fonte da Telha in late December 1983 seven proved to be males on dissection, eleven were females and three could not be sexed properly because the gonads were not sufficiently developed.

Ten out of twenty stomachs examined on the same occasion contained remains of sardines *Sardina pilchardus* measuring about seven centimetres long and ingested headfirst. The mean number of fish per stomach was 2.75 (s.d. 4.52,  $n = 20$ , range 0-16). No other food items could be found except for one small anchovy *Engraulis* sp. less than four centimetres long.

The dead birds appeared in good bodily condition apart from congestion of the lungs due to drowning, with visible reserves of both sub-cutaneous and peritoneal fat. On 27 December 1983, a small sample of freshly-killed specimens had a mean weight of 721.7g (s.d. 65.10,  $n = 21$ , range 600-835).

The Razorbills at Fonte da Telha seem to be comparatively unaffected by oil pollution (Table 1). The national beached bird surveys also demonstrate a low incidence of oiling on Razorbill corpses found elsewhere on the Portuguese coast, as had already been pointed out by Lloyd (1974) for ringing recoveries. Dead Razorbills are quite frequently found ashore in winter, but the numbers observed at Fonte da Telha in 1983/84 and 1984/85 accounted respectively for 74.3% and 66.8% of the totals recorded by the national censuses during the corresponding period. These censuses currently include a few dozen sample areas covering most sectors of the Portuguese coast, with a mean 140km of seashore walked monthly five times a year from November to March. All corpses found are removed from the beach or marked with a permanent dye to avoid duplicating the counts. The mortalities observed at Fonte da Telha are therefore considered to be of truly outstanding importance in a national context.

It must be stressed that the gill-net fishery at Fonte da Telha has a much reduced impact on other species. In particular, the Guillemot *Uria aalge* is a rare victim (only six casualties found in 1983/84 and eleven in 1984/85) and the Puffin *Fratercula arctica* is virtually unaffected by the nets, apparently owing to its rather pelagic winter distribution.

The Razorbill has a comparatively small world population of a few hundred thousand pairs (Evans 1984) and the casualties at Fonte da Telha involve birds from the British population, now estimated at only c. 150,000 pairs and not thought to have increased in the south over the last fifteen years (Stowe & Harris 1984). Any measures that could help reduce mortality in the nets should therefore be of interest to seabird conservationists in the British Isles.

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# Sex ratio in a sample of tape-lured Storm Petrels *Hydrobates pelagicus* from Shetland, Scotland

*J.A. Fowler, M.E. Hulbert and G. Smith*

## INTRODUCTION

British Storm Petrels *Hydrobates pelagicus* may be captured by intercepting them as they visit a colony, or by attracting them to tape-recordings of the "purr-call" played on beaches away from colonies. There is now much evidence to suggest that the two methods select samples which are different in composition with respect to Storm Petrel population class. Samples captured at tape-lures away from colonies consist of "wandering pre-breeders" whilst samples captured at colonies (without the use of tape-lures) are heterogeneous, consisting of both "breeders" and "wanderers". The main difference between the wanderer and breeder classes are summarised in Table 1, with references.

TABLE 1. FEATURES WHICH DIFFER IN BREEDING AND WANDERING STORM PETRELS

<i>Breeders</i>	<i>Wanderers</i>	<i>Reference</i>
Arrive at colonies in May and breed	Arrive in inshore waters from the end of June and visit colonies but do not occupy them.	Scott (1970)
Are rarely recaptured at other colonies.	Range widely over the eastern half of the North Atlantic and are often caught in different colonies in the same year.	Mainwood (1976); Fowler & Swinfen (1984)
Are rarely attracted to tape-lures played on beaches away from colonies.	May be attracted in large numbers to tape-lures far away from colonies.	Maguire <i>et al.</i> (1980); Fowler <i>et al.</i> (1982)
May be recaptured at the same colony many years after first ringing.	Recapture rates decline sharply after the first year, rarely recaptured after 2 years.	Fowler <i>et al.</i> (1982)
Have vascularised brood patches.	Have variably feathered brood patches.	Furness and Baillie (1981)
May regurgitate food on handling.	Rarely regurgitate food on handling.	Furness and Baillie (1981)
On average are longer winged and heavier (on St Kilda, W. Isles).	On average are shorter winged and lighter (on St Kilda).	Furness and Baillie (1981)
Are infested with a higher proportion of adults of the feather louse <i>Haliplus pelagicus</i> .	Are infested with a lower proportion of adults of the louse.	Fowler <i>et al.</i> (1984)

Because samples captured in colonies are heterogeneous, simple capture-recapture estimates of colony size are precluded: the presence of the wanderers greatly inflates the estimate (Love 1978). However, Fowler *et al.* (1982) considered that samples of wanderers



captured at tape-lures away from colonies were likely to be homogeneous, and that recapture estimates could be realistically undertaken; they suggested that some 40,000-60,000 birds were available for capture in Shetland waters. Fowler *et al.* (1982) acknowledged that the estimates could be affected by unperceived sampling biases, and noted that differential attraction of the sexes to tape-lures could be a source of bias. This possibility seemed the more likely when James (1984) demonstrated that male Storm Petrels occupying burrows were significantly more likely to respond to a recording of a purr-call than were females.

James (1983) calculated statistical discriminants to distinguish male and female Storm Petrels from the wing, tail and tarsus measurements of 46 breeding birds which had been sexed by cloacal inspection on Skomer, Dyfed. Assuming that the discriminants applied also to wandering birds, he found that the proportion of each sex did not differ between samples captured at a netting site when a tape recording was switched on or off – in both cases there was a slight excess of males. However, the effect of switching on the tape-lure would only have had the effect of changing by an unknown extent the proportion of wanderers in the sample as, within a colony, breeders can still be attracted to a tape-lure (Furness & Baillie 1981). Furthermore, the discriminants calculated by James (1983) would not apply to Storm Petrels in Shetland due to geographical variation in measurements between populations (Furness & Baillie 1981). Moreover, as noted in Table 1, breeders in Scottish waters are significantly larger than wanderers, a difference which James (1983) did not observe on Skomer. A sample of 21 Storm Petrels collected by mist netting without a tape-lure in a "loose colony" on St. Kilda, W. Isles, in 1983 for heavy metal analysis showed, on dissection, to comprise 11 males and 10 females, but the status of the birds is not known. There were no significant differences in the biometrics of the males and females (R.W. Furness, pers. comm.).

Between 5,000 and 10,000 Storm Petrels have been ringed each year since 1976 in Shetland (and other Scottish) waters, the vast majority by attraction to tape-lures. It is clearly desirable to have direct evidence of the sex-ratio in samples so that, for example, appropriate corrections can be applied to capture-recapture estimates of populations. This paper reports the attempts to sex directly samples of tape-lured Storm Petrels by radio-immunological assay of faecal steroid hormones, and by laparoscopy. The feasibility of determining a biometric discriminant function for males and females is considered, and biometric data are presented in support of the view of Furness & Baillie (1981) that geographical variation in measurements exists between samples of Storm Petrels.

## METHODS

Samples of Storm Petrels were captured on Yell, Shetland, in July 1983 and July 1984. Wandering Storm Petrels were captured by attraction to tape-lures played on beaches away from known colonies. Breeding birds were captured in a colony on Copister Broch in Yell Sound, but only recaptured birds which had been ringed there at least three years previously were accepted as breeding. In each case birds were retained arbitrarily during a night's catching. Wing lengths (maximum chord) and tail lengths were measured according to Svensson (1984). Faecal samples were obtained by placing individual birds in a box for 20 min (maximum) and the samples obtained were deep frozen the following morning. They were transported to Leicester in freezer packs. Testosterone and  $\beta$ -estradiol hormones present in the faeces were assayed by radio immunological assay according to the method described by Stavy *et al.* (1979).

### *Laparoscopy*

The usefulness of laparoscopy for the direct examination of internal organs has been

discussed by Wildt *et al.* (1978). Forty nine tape-lured Storm Petrels were retained for laparoscopic inspection of the gonads. Birds were lightly anaesthetised in a veterinary clinic by fluorethane gas, and a 2mm diameter "needle-scope" fibre-optical laparoscope was inserted into the abdomen; the gonads were inspected and sex recorded. Bleeding did not occur, and suturing of the incision was not necessary. The birds came round from the anaesthetic within seconds and were released after a short recovery period.

## RESULTS

The mean wing lengths, with standard deviations, of 62 breeding and 49 wandering Storm Petrels are recorded in Table 2. There was no statistically significant difference between the frequency distributions of the sex hormone ratios in the faeces of 15 breeding and 45 wandering birds. There was no bimodal distribution within either sample, and the ratios obtained were suggestive of males. However, since it is known that breeding males and females visit colonies equally (Scott 1970), it appears that males and females have similar hormonal profiles at this time of year. It was not possible to analyse faecal material from birds of known sex.

TABLE 2. MEASUREMENTS OF BREEDING AND WANDERING STORM PETRELS FROM SHETLAND. SEE TEXT FOR DEFINITION OF BREEDING AND WANDERING CATEGORIES.

	<i>Sample size</i>	<i>Mean (mm)</i>	<i>Standard deviation (mm)</i>
Unsexed Breeders (wing)	62	124.2	2.3
Unsexed Wanderers (wing)	49	123.3	2.63
Male wanderers (wing)	21	122.1	2.59
Male wanderers (tail)	21	55.8	1.72
Female wanderers (wing)	28	124.2	2.32
Female wanderers (tail)	28	56.8	1.78
Foula wanderers (wing - Furness & Baillie, 1981)	108	122.6	2.4
Caithness wanderers (wing - Clark, 1985)	841	122.8	2.53

Laparoscopic inspection of the gonads of 49 birds revealed that 21 were male and 28 were female, a ratio which is not significantly different from unity ( $\chi^2 = 0.74$ ). Gonads were well-developed and would probably have been capable of sexual activity. The mean wing-length and tail-length of each sex in the sample are also recorded in table 2.

The mean wing-length of breeding birds is significantly larger than that of the wanderers ( $t = 1.89$ ,  $p < 0.05$ ), and the mean wing-length of the wandering birds is not significantly different from a sample of 108 wanderers measured by Furness and Baillie (1981) on Foula, Shetland, or from 841 wanderers measured by Clark (1985) in Caithness, Scotland (Table 2).

There is no significant difference between the means of either wing or tail-length of male and female wanderers sexed by laparoscopy ( $t = 1.22$  and  $1.07$ , respectively) and therefore the calculation of a sex discriminant function from these data would be futile.

## DISCUSSION

The failure of faecal steroid hormone assay to distinguish between the sexes of birds is not unprecedented. Stavy *et al.* (1979) assayed faecal samples from some 400 individual birds of sexually monomorphic and dimorphic species representing 12 orders (but not Procelariiformes) and found that in only about 70% of cases could the sexes be distinguished. It appears that the method is unsuitable for distinguishing the sex of Storm Petrels in July, at least.

The laparoscopic examination of the sample of 49 wandering birds establishes beyond reasonable doubt that the sexes occur in similar proportions in captured samples and that no correction factor for sex needs to be applied in capture-recapture estimations. The slight excess of females in the Shetland sample contrasts with a slight excess of males in the Skomer sample (James 1983) but the difference in proportion is not statistically significant ( $\chi^2 = 0.99$ ).

The well-developed state of the gonads came as a surprise because it has always been assumed that birds caught at tape-lures were immature. There is no evidence to suggest that breeding birds ever turn up in samples captured at a tape-lure (Fowler, *et al.* 1982). It is likely that many birds do not return to northern waters in the second year of life (Scott 1970) and the development of the gonads in the third year may well be the stimulus which promotes wandering and prospecting behaviour as the birds seek nest sites. In subsequent years, wandering behaviour (and the susceptibility to attraction to tape-lures) diminishes as presumably birds become established in, and attached to, their colonies.

The mean wing-length and tail-length measurements of males and females sexed by laparoscopy were not significantly different in the sample of 49. Females were nevertheless slightly bigger and there can be little doubt that the differences would become significant in larger samples. However, the substantial degree of overlap in measurements means that a sex-discriminant function based on wing and tail-lengths, whilst mathematically possible, would have no practical value in Shetland. This contrasts with breeding birds on Skomer where James (1983) was able to sex birds "with a reasonable degree of accuracy" using a wing and tail discriminant.

Furness & Baillie (1981) showed that breeding Storm Petrels on St. Kilda were longer winged than were wanderers, an observation which is supported by the data presented in this paper. Furness and Baillie (1981) also present evidence to suggest geographical variation in measurements, indicating in particular that Scottish birds were larger than those from Wales or Ireland. Whilst caution has to be exercised in interpreting differences in measurements made by different observers, the similarity of the wing lengths of the wandering birds from Foula measured by Furness & Baillie (1981), and those of the wanderers in this study suggests that the measurements of these observers may be compared, assuming the samples are derived from the same population. On this basis, the sample of Yell breeders described in this paper represents the longest-winged Storm Petrels yet reported.

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### SUMMARY

Faecal steroid hormone analysis failed to distinguish between the sexes of either breeding or wandering Storm Petrels captured in Shetland in July. In a sample of 49 wanderers examined by laparoscopy, the sex-ratio did not differ significantly from unity. Wing and tail length measurements of both sexes from this sample are so similar that no useful discriminant function can be calculated. However, the measurements support an hypothesis of geographical variation in size, and the breeding Storm Petrels are the largest yet reported in Britain.

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# ***Austromenopon pelagicum* Timmermann, 1963 (Phthiraptera: Menoponidae) from British Storm Petrels *Hydrobates pelagicus* in Shetland, Scotland**

*J.A. Fowler and R.L. Palma*

In their study of non-haematophagous ectoparasite populations of Procellariiform birds in Shetland, Fowler & Miller (1984) reported four species of feather lice on British Storm Petrels *Hydrobates pelagicus*. One of these, *Austromenopon* sp., could not be identified beyond genus because the original description of a species of *Austromenopon* from *Hydrobates pelagicus* was based on a single male, and the four specimens in the 1981 Shetland collection were females. A further 26 specimens were collected in July 1984 which includes males and females. Therefore, it has been possible to identify this species as *Austromenopon pelagicum* Timmermann, 1963. The specimens are retained as slide mounts in the National Museum of New Zealand.

In a revision of the genus *Austromenopon*, Price & Clay (1972) described a new species, *Austromenopon oceanodromae*, based on three females only, each from different *Oceanodroma* species. Female specimens of *Austromenopon pelagicum* fit the description of *A. oceanodromae*. However, to elucidate the status of the latter species, it is necessary to obtain males from its type host, *Oceanodroma hornbyi*, so that a critical comparison of both sexes can be made. Such a comparison may show that *A. oceanodromae* is a junior synonym of *A. pelagicum*; in the meantime both names remain valid.

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# Observations on the role of the sexes in the breeding of the Puffin *Fratercula arctica*

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Although in most seabird species both the male and the female incubate the eggs and brood and feed the chicks (e.g. Fisher & Lockley 1954), there is little documentary evidence for the relative shares taken by the sexes for most species. This note presents data for the Puffin *Fratercula arctica* on the Isle of May, Fife, Scotland.

## METHODS

Data were collected piecemeal 1974-84. Male Puffins have significantly larger bills than females, and the birds were initially sexed by bill measurements (Corkhill 1972, Harris 1979a). Totals of 137 breeding males and 111 breeding females were individually colour-ringed and the sexes of many of these were later checked by observing matings and dissecting birds collected for pesticide residue analysis. Throughout each breeding season 1979-81 and 1984, commencing about 28 March (3-4 weeks before median egg laying date), systematic binocular searches were made for these birds and their occurrence noted. Birds were also caught while incubating eggs, brooding chicks and carrying fish. Fish loads dropped by known sex birds were weighed and the fish measured. Puffins caught in mist-nets on 39 days between 23 March and 21 May 1974 (299 birds) and on 26 days between 19 March and 13 April 1975 (205 birds) were sexed by bill measurement. Although observations were concentrated into the middle and later parts of the day some burrow checks and sightings of colour-ringed birds were made and birds were caught throughout the hours of daylight.

## RESULTS

Puffins returned to the Isle of May during March. I have no details of the sexes of the very earliest birds ashore in a season but neither of the samples of mist-netted birds nor the sightings of colour-ringed birds suggested any sexual difference in colony attendance prior to laying. Both sexes were observed digging the nesting burrow and in lining the nest chamber. Although more males than females were caught in the nest chamber with eggs and young, and more females than males with fish, none of the differences were significant (Table 1). Loads of fish dropped by males were slightly heavier and contained more fish than those dropped by females, but the differences were not significant (Table 2). The individual fish were of similar size.

TABLE 1. NUMBERS OF MALE AND FEMALE PUFFINS CAUGHT WITH AN EGG OR CHICK OR CARRYING FISH.

	Male (n)	Female (n)	X <sup>2</sup>	
With egg	40	25	1.7	n.s.
With chick	75	61	0.7	n.s.
Carrying fish	53	84	3.6	n.s.

Note: X<sup>2</sup> compare observed values with an expected 50:50 sex ratio.

TABLE 2. LOADS OF FISH COLLECTED FROM SEXED PUFFINS.

	No.	Male	No.	Female
		Mean $\pm$ S.E.		Mean $\pm$ S.E.
Weight of load (g)	13	10.5 $\pm$ 1.7	8	7.8 $\pm$ 1.5
No. of fish per load	13	7.2 $\pm$ 0.7	8	5.3 $\pm$ 1.2

Note: The differences between the sexes were not significant (*t*-values 1.0 and 1.6).

There were no differences between the sexes in the dates when successful, unsuccessful, and non-breeding adults were last seen at the colony in 1978 or 1979 (the only years when such information was collected) nor in the number of days they spent at the colony after the chick fledged (Table 3). However, lumping all birds, males left significantly later than did females in 1978 but not in 1979.

TABLE 3. DATES AND DAYS AFTER FLEDGING THAT MALE AND FEMALE PUFFINS WERE LAST SEEN ON THE ISLE OF MAY IN 1978 AND 1979.

		1978			1979	
		No.	Mean $\pm$ S.E. (days)		No.	Mean $\pm$ S.E. (days)
<i>(a) Date last seen</i>						
Successful birds	♂	21	30 July $\pm$ 2		26	9 August $\pm$ 5
	♀	16	27 July $\pm$ 2		13	11 August $\pm$ 4
Unsuccessful birds	♂	24	30 July $\pm$ 2		11	29 July $\pm$ 4
	♀	12	27 July $\pm$ 2		9	1 August $\pm$ 3
Sexually mature but did not breed	♂	33	28 July $\pm$ 1		35	6 August $\pm$ 1
	♀	39	23 July $\pm$ 2		33	5 August $\pm$ 1
Total	♂	78	29 July $\pm$ 1*		72	6 August $\pm$ 1
	♀	67	25 July $\pm$ 1*		55	5 August $\pm$ 1
<i>(b) Days from fledging until last sighting</i>						
	♂	20	14 days $\pm$ 2		25	20 days $\pm$ 2
	♀	13	14 days $\pm$ 3		13	20 days $\pm$ 2

Note: \**t* = 2.7, *P* < 0.01; no other difference between ♂ and ♀ was significant.

Females appeared to spend less time standing around at the colony. Combining all sightings for all years, each female was seen, on average, 4.6 times a year (S.E. = 0.2, *n* = 246), which was significantly less (*t* = 2.18, *P* < 0.05) than the average of 5.3 sightings (S.E. = 0.2, *n* = 360) per year for a male. Ashcroft (1976) also saw colour-ringed male Puffins significantly more frequently than females.

## DISCUSSION

There are few other quantitative data on the role of the sexes in the Puffin, and these are based on very small samples. Bent (1919), Lockley (1953) and Kozlova (1957) all stated that the female incubated more than did the male. Myrberget (1962) recorded 15 males and 22 females on eggs (i.e. not significantly different from equality,  $\chi^2_1 = 1.32$ , *P* > 0.1), and Kaftanovskii (1951) thought that the sexes took equal shares whereas Rosenius (quoted by

Myrberget) noted that in the Faeroes more than half the birds taken off eggs were male. Corkhill (1973) mist-netted 21 males and 28 females carrying fish on Skomer, Dyfed. Combining these with my totals gives a significantly biased sex ratio in favour of females ( $\chi^2_1 = 3.9$ ,  $P < 0.05$ ). In contrast, Corkhill (1973) and Myrberget (1962) watched individually colour-ringed birds entering burrows with fish and recorded 63 feeds by males and 61 by females and I found approximately equal numbers of males and females in burrows with chicks. On Skomer, Ashcroft (1976) found that female Puffins were easier to catch, by a variety of methods, than were males; this probably explains the greater number of females caught while carrying fish.

Differences between the sexes have been detected in many seabird species. Sometimes these are obvious, for example, the male Gannet *Sula bassana* takes the major share of the defence of the nest-site (Nelson 1978), and the female Flightless Cormorant *Nannopterum harrisi* often deserts her mate and young part way through the chick-rearing period and breeds again with a new male (Harris 1979b). However, often the differences are more subtle. Incubation shifts of the male Manx Shearwater *Puffinus puffinus* are significantly longer than those of the female, but the overall difference is less than one day (Brooke 1978). The data collected for Puffins test the null hypothesis that there were no differences between male and female. Although it does appear that there were no gross differences, the observations do not permit the rejection of the hypothesis. There might well be minor differences; perhaps one sex or other tends to incubate at night. More detailed and systematically collected data are needed before we can be sure that male and female Puffins partake equally in breeding.

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## Post-fledging parental care of a Lesser Black-backed Gull *Larus fuscus* brood

Anthony J.F. Holley

Of the 44 species of gulls the length of parental care after fledging has been documented for only 12 (Burger 1980). I present data for another, the Lesser Black-backed Gull *Larus fuscus*. During the breeding seasons 1968 to 1970 I studied the post-fledging stage in the mixed colony then comprising 2400 nesting pairs of Herring Gulls *L. argentatus*, 240 pairs of Lesser Black-backed Gulls and 15 pairs of Great Black-backed Gulls *L. marinus* at Stert Island, Bridgwater Bay, Somerset. Descriptions of the study area and methods and results for the Herring Gull appear in Holley (1982).

In 1968 I made observation on a *fuscus* pair with three fledged young on a territory at the base of the study area nesting bank. On the other three sides were *argentatus* territories. The nearest other *fuscus* families were ten territories away. In this communication only one feed is registered against each parental foraging trip made, irrespective of the number of chicks fed and the number of feeds given.

### RESULTS

The chicks of the study brood were first seen on the nest on 26 June and probably hatched two days earlier. Three chicks fledged (first full flight) on 4 August but continued to be fed by the adults on the territory, as were fledged chicks on other territories along the bank. On 17 August, 54 days after hatching, Carrion Crows *Corvus corone* were seen pecking at a large dead chick just off the territory. It was presumably one of the chicks as thereafter no more than two fledglings were being cared for by only one parent, the sex of which was not known.

The two fledglings accompanied one adult away from the colony at 0800h on 3 September and did not return. During the 24 hours of observation between 1415h on 31 August and 0800h on 3 September the brood was fed nine times averaging a feed every 2h 40mins. For six of the nine feeds both chicks were present on the territory when the adult arrived and on each of these occasions the chicks were fed simultaneously. The indications are that the fledglings were being fed at least four times a day and were entirely food-dependent on the parent. After six of the nine feeds the fledglings immediately flew off, in four instances to areas within sight and earshot of the colony and in the other two they followed the adult away from the colony. During two of the other three feeds some of the food was pirated by other birds, a not infrequent occurrence at this time of the season.

At 0730h on 2 September, immediately after the first feed of the day, the adult called the chicks away (Holley 1982). The parent flew off slowly then turned and circled over the territory long-calling repeatedly. The two fledglings took off, joined the adult and accompanied it to the mainland. The flight of the family party was noticeably slower than that of the other adults travelling in the same direction. The fledglings had returned to the territory within an hour but there was no sign of the parent. The fledglings were again called away at 0800h on the following day, immediately after what looked to be a very sparse feed, and the three birds again flew in close company over to the mainland. Watch was kept on the territory for the remainder of that day and, periodically, during subsequent days but neither the fledglings nor the parent were seen again.

## DISCUSSION

All broods of this species continued to be fed on or near the natal territories for a period of several weeks after fledging. In the case of the study brood that period was four weeks and ended with one of the adults leading the brood away from the colony over to the mainland on two successive days. That the chicks were back on the territory an hour after leaving on the first of these days indicates that they did not travel far. On the second day, however, they left the territory for good in the company of the adult upon which they were still entirely food dependent. Such behaviour may not be unusual. In August of the preceding year a family party of a pair of Lesser Black-backed Gulls with a fledged, frequently food-begging, chick took up occupation on the roof of my house on the seafront at Burnham-on-Sea, 1k from the colony, for a fortnight, scrounging a living in company with the local Herring Gulls from residents and holidaymakers in the area.

## ACKNOWLEDGEMENTS

My thanks to the Regional Officer and staff of the Nature Conservancy for much practical assistance and encouragement, to Drs. R.R. Baker, J. Burger, J.A. Graves and M.P. Harris for helpful comments, to Dr. Harris for improving the manuscript and to Drs. P.J. Greenwood and J.C. Coulson for guidance.

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# The Little Gull *Larus minutus* in Ceredigion, West Wales

A.D. Fox

## INTRODUCTION

In their comprehensive review of the status of the Little Gull *Larus minutus* in Britain and Ireland, Hutchinson & Neath (1978) suggested there had been a considerable increase in numbers seen in the British Isles. Before the early 1950s, Little Gulls were scarce on south and east coasts of England, appearing chiefly in autumn, and even rarer elsewhere, except in Angus and Fife where passage flocks had been regular since the 1940s. However, by 1973, the species was common in many parts of Britain and Ireland in autumn, with a minimum total of 3,700 records in Britain alone during that year, and sightings from all months of the year. Three quarters of all Little Gulls reported in England and Wales were seen during August to November. In Scotland the autumn passage occurs slightly earlier, with about 75% during July to October. A large proportion of the remaining records from all of Britain are from the spring passage during March-May, and winter records remain relatively small, numbering considerably less than 5% of all sightings in most years (Hutchinson & Neath 1978).

In western Britain, the species is similarly a spring and autumn migrant, and in Ceredigion (formerly Cardiganshire) at least, also occurs inshore during the winter in adverse weather conditions. Records from December-February constitute 26% of recent Little Gull records, a remarkably high proportion compared to other parts of Wales (e.g. less than 7% in Gwynedd from Cambrian Ornithological Society Bird Reports). The present paper describes these patterns of occurrence and offers some explanations for these observations.

## Historical Perspective

The first record of Little Gull from the county appears to be that of the Aberystwyth taxidermist Hutchings who obtained a bird in October 1891, with another in 1899 both brought in by storms (from the diaries of Professor J.H. Salter lodged at the National Library of Wales). One was seen by Captain W.W. Cosens at Glandyfi in about 1893 (Forrest 1907, Ingram, Salmon & Condry 1966), followed by another at Borth in 1901 and another at the same place in February 1902.

Elsewhere, the generally winter occurrence of the birds and the association with bad weather was noted by Forrest (1907) in North Wales and the only early record from Pembrokeshire in January 1892 (Mathew 1894) was also associated with strong winds.

Between 1902 and 1964, there were only six more occurrences in Ceredigion, and only two of these in winter. Since 1968, the species has been seen in varying numbers every year except 1971 (Figure 1). The apparent increase in the numbers since 1968 is probably largely due to an increase in the interest in the species, linked to a better understanding of its patterns of occurrence. The following analysis of Little Gull records is based wholly on sightings since 1968, where the occurrence and age of birds seen in the area are well documented.

## METHODS

All records of Little Gull in Ceredigion submitted to Peter Davis, county Bird Recorder, were segregated by age, habitat and date. To assess the meteorological conditions prevailing,

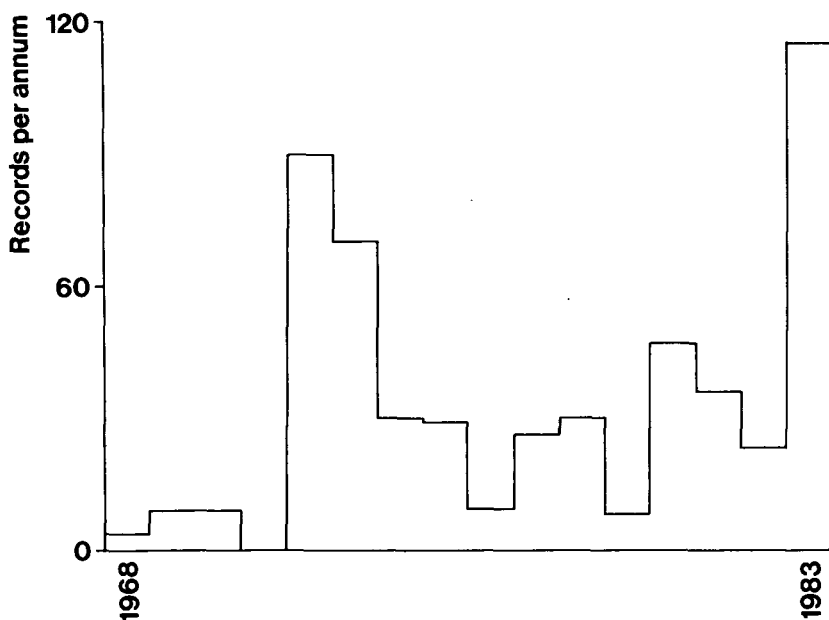


Figure 1. Total annual numbers of records of Little Gull (*Larus minutus*) submitted from Ceredigion for the years 1968-83 inclusive.

wind direction at 09.00 hr GMT and wind run (the distance travelled by the wind during 24 hours) as measured by anemometer at the Welsh Plant Breeding Station, Bow Street, near Aberystwyth were recorded for dates when Little Gulls were seen. To test for differences between these weather patterns and those of typical years, the same information was extracted for all dates (irrespective of whether Little Gulls occurred or not) during the years 1968-83 inclusive.

## RESULTS

### *Seasonal occurrences*

During the years 1968-83, Little Gulls were noted in Ceredigion in every month of the year (Table 1), with maximum numbers in April/May and August/September, few in June/July, but with substantial numbers appearing in winter. Analysis of wind direction and wind strength shows that in Ceredigion, the winter occurrence of the species is almost completely dependent on strong winds from the south and west, in contrast to the prevailing weather conditions during occurrences in the remainder of the year (Figures 2 and 3).

TABLE 1. TOTAL NUMBERS OF LITTLE GULLS SEEN IN EACH MONTH DURING 1968-1983 IN CEREDIGION.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
68	35	19	81	75	3	2	40	92	29	35	29

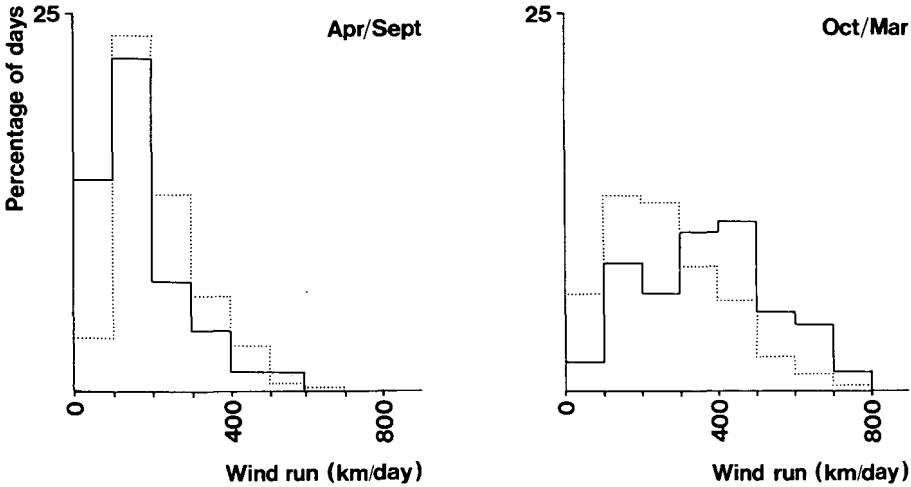


Figure 2. Percentage wind run frequency on days when Little Gulls (*Larus minutus*) were reported in Ceredigion during April to September (upper) and during October to March (lower); for comparison, wind run frequency for all dates during 1968-83 inclusive are shown by dotted lines.

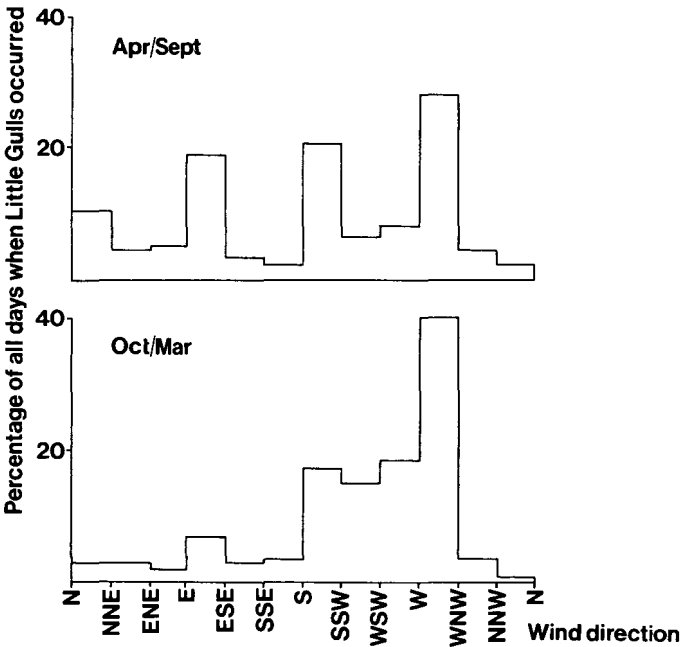


Figure 3. Percentage wind direction frequency on days when Little Gulls (*Larus minutus*) were reported in Ceredigion during April to September (upper) and during October to March (lower).

- (i) *Winter*: comparison of wind strength for days when Little Gulls appeared with all winter dates for the period 1968-1983 shows a significant difference, the gulls occurring more often on days of very strong winds than would be expected by chance ( $\chi^2_{(8)} = 60.25$ ,  $p < 0.001$ , Figure 2). However, it should be stressed that in many winters with strong south-west winds, there are few or no Little Gull records, suggesting birds are not always present offshore.
- (ii) *Spring/Autumn*: by contrast, the appearance of Little Gulls during the period April-September inclusive appears to be a feature of still weather (Figure 2) with gulls appearing on more days of low wind velocity than would be expected by chance ( $\chi^2_{(8)} = 75.67$ ,  $p < 0.001$ ). There does not appear to be such a strong link between wind direction and the pattern of occurrence during this time (Figure 3). Exceptionally, an adult was seen amidst the Black-headed gullery at Cors Caron National Nature Reserve in May 1970, one of several such cases of adults associating with colonies of Kittiwakes *Rissa tridactyla* and Black-headed Gulls *Larus ridibundus* (listed in Hutchinson & Neath 1978).

### Habitat preferences

Hutchinson & Neath (1978) found that winter occurrences of Little Gulls tended to be at beaches, whilst spring and autumn passage sightings come predominantly from brackish water and lagoons near the coast. Ceredigion winter records similarly come largely from steeply-shelving storm-beaches (Figure 4) which are a feature of low-lying stretches of the west Wales coast in Ceredigion. Such beaches occur at Aberaeron, Llansantffraid, Llanrhystud, Tan-y-bwlch (south of Aberystwyth) and Aberystwyth South Beach; Little Gulls have

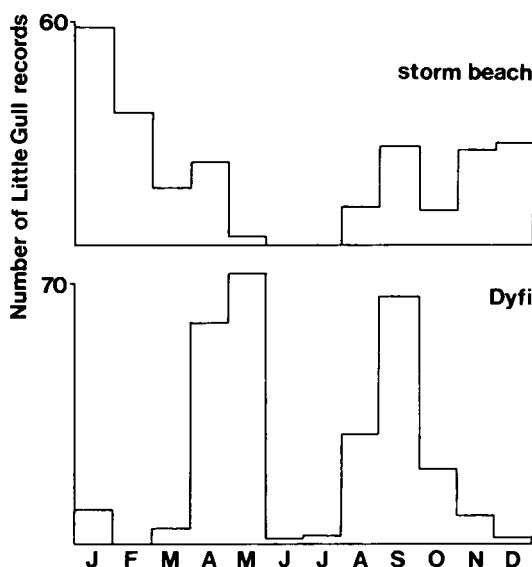


Figure 4. Seasonal distribution of Little Gulls (*Larus minutus*) at steeply-shelving storm-beaches (top) and from Dyfi estuary/Ynyslas area at the northern end of the district (lower) for the years 1968-83.

been recorded from all these sites. Birds appear after severe winds frequently associating with Kittiwakes dip-feeding amongst the white water of waves crashing onto these storm-beaches, but swiftly disappear with ameliorating conditions. Birds may very occasionally appear on storm-beaches in spring and autumn during strong south-west to westerly winds, but records from May-July are very few.

The vast majority of the remaining records come from the well watched Dyfi Estuary National Nature Reserve and surrounding shallow shore. Here, occurrences are almost completely restricted to spring and autumn passage periods, reflecting the general pattern of occurrence at sites elsewhere in Great Britain. The relatively few records from November-March are generally storm driven birds too weak to cope with the strong gales: several come, for example, from the River Leri area where immature birds are blown east in the severest of winds and so are not utilising a habitat type by choice.

### Age Ratios

Hutchinson & Neath (1978) reported immature birds as being three to four times more frequent than adult Little Gulls throughout the whole of the British Isles. However, the ratio of first year birds to adult and sub-adult second-year birds varies throughout the season in Ceredigion, with high proportions of older birds during November-April (Figure 5) from those Little Gulls which were specifically identified as to age. This pattern is presumably a result of adults and immatures both occurring on passage, whilst adults either winter further north or are more likely to be wrecked inshore than the immature birds. Hence only during May to October, when both sectors of the population are moving to and from summer areas, does the ratio of older birds to immatures fall below 25% of the total sightings identified.

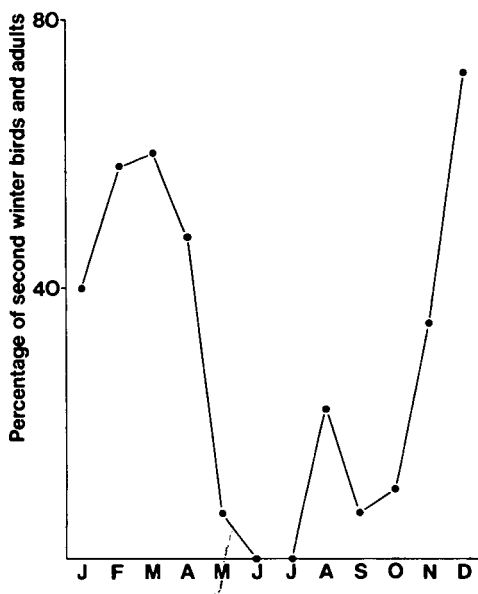


Figure 5. Relative percentage of 2nd year or full adult plumaged Little Gulls (*Larus minutus*) of all birds aged in Ceredigion 1968-83 inclusive.

## DISCUSSION

Little Gulls winter in the Caspian, Black and Mediterranean Seas, as well as in the eastern Atlantic from West Africa as far north as Iceland and Greenland (Cramp & Simmons 1983). Erard (1960) and Hutchinson & Neath (1978) considered that there are two important wintering areas at the east and western ends of the Mediterranean with a second area in the North Sea, English Channel, Western Approaches and the French west coast. It would appear that the latter group is the source of winter storm wrecked birds in the British Isles, and the birds in Ceredigion, judging from the constancy of occurrence during periods of gales, must presumably be wintering not very far out from land. However, in several years, despite suitable weather, gales do not result in wrecks of Little Gulls and it may be that the birds use different areas of the wintering grounds in differing proportions according to season. In the year after the analysis (winter 1984/85), for example, there were no winter wrecks in spite of suitable weather.

The Little Gulls seen in Britain during spring and autumn are seemingly migrants from the western and central European breeding populations. Hutchinson & Neath (1978) considered adults moving from the breeding areas wait back in the Baltic and North Sea areas. Hence in Britain, immatures move through in autumn, but relatively few older birds appear until later, so that in October, most immatures have passed south and west, followed by sudden exodus of adult birds which constitute a high proportion of flocks at this time. The differential passage may be related to the fact that the adults winter further north than immature birds, so that these predominate in storm-driven groups at this time.

## ACKNOWLEDGEMENTS

Thanks must go to all who have supplied records of Little Gulls in Ceredigion, especially to Hywel Roderick and Mrs. M. Chater who have taken particular interest in this species. My gratitude goes to the Cardiganshire bird recorder Peter Davis and to Hywel who collated and supplied me with all documented records. Will Evans at the Welsh Plant Breeding Station kindly permitted access to the meteorological data recorded at the Station. Adrian Fowles provided all extracted records from Professor Salter's diaries. Peter Davis, M de L Brooke and R.A. Hume all read and criticised an earlier manuscript and Pat McIlwraith typed the manuscript. My hearty thanks to them all.

## SUMMARY

Little Gulls have occurred in Ceredigion since the turn of the century, generally as storm-wrecked birds after severe south/south west/westerly gales, but the numbers noted on spring and autumn passage associated with still weather patterns have increased greatly in the last fifteen years. This pattern fits with the general trend of increasing numbers identified in Great Britain although the numbers involved vary considerably from year to year.

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# Monitoring numbers of Kittiwakes *Rissa tridactyla* in Shetland

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## INTRODUCTION

Following the decision to locate a major oil terminal at Sullom Voe in the north Mainland of Shetland, a programme for monitoring numbers of breeding Kittiwakes *Rissa tridactyla* in sample areas was established in 1976 and counts have since been made annually. This paper describes trends observed through the monitoring programme during the period 1976-1985 and compares them with changes recorded by wider surveys made in 1981 and 1985.

## METHODS

### *A. The Monitoring Programme*

Fixed study plots were selected in 5 colonies – Eshaness, Burravoe, Troswick Ness, Sumburgh Head and Noss. The choice of both plots and colonies was determined by logistics (ease of access, visibility, an “adequate” sample of birds etc.) rather than on any random basis. The proportion of each colony included in study plots varied considerably, from ca.98% at Eshaness to ca.4% at Noss. Overall, ca.5% of the total Shetland Kittiwake population was included in the study plots, based upon the 1981 population estimate (Richardson 1985). The aim was to obtain 10 counts of all adult Kittiwakes and nests in each study plot during June. A nest here was defined as a well built structure at which an adult appeared to be either incubating or brooding. Unattended nests containing live young were counted whereas unattended nests containing only eggs or dead young were not. Ten counts were not achieved at all colonies in all years, the number of counts being largely determined by weather. Generally, counts were not made in winds in excess of 20 knots or during rain or fog. At Noss, however, up to 13 counts were made over a more extended period of the breeding season. For all colonies, the figures used in analyses are the means of June counts only.

### *B. The 1981 Surveys*

Two surveys of Kittiwakes were carried out during June 1981. The first was a land based count of nests in several widely scattered colonies to determine whether changes in study plots were reflected generally in study colonies and other colonies around Shetland. Two sets of previous data were available for comparison, the “Operation Seafarer” counts of 1969-1970 (Cramp *et al.* 1974) and counts made in a pilot survey by the Institute of Terrestrial Ecology in 1974 (Harris 1976). To provide comparability, those of the 1974 counts made from the land were repeated. The second was a boat survey of nesting Kittiwakes along most of the Shetland coastline. This provided a relatively accurate, detailed and repeatable set of baseline data (Richardson 1985) as well as allowing some comparisons to be made with those 1974 counts which were conducted from the sea.

### *C. The 1985 Survey*

During June 1985 we counted nests from the sea in part of the area covered in 1981, concentrating particularly on those areas adjacent to the monitored colonies – i.e. the south and south-east Mainland, the north-west Mainland, Fetlar and east Yell. The nests counted

in each of the 1974, 1981 and 1985 surveys were defined less rigorously as well built structures with one or more adults in attendance. On these surveys, only single counts were made on one date as opposed to up to 10 counts on different dates during the monitoring programme. However, the variability in numbers of Kittiwake nests in study plots during June is demonstrably low (Richardson *et al.* 1981; Wanless *et al.* 1982).

Repeating sea-borne counts held several advantages over repeating land counts. First, one largely overcomes the problems of areas not visible from the land and inter-observer differences over which observation points are safely accessible. Counts were made from both the land and sea at 16 colonies during June 1981. At these, a total of 8,600 nests were counted from the sea but only 5,414 (63%) from the land, a difference which was not due to variation in counting date (Pritchard 1981). Second, the data from the 1981 boat survey were recorded in sufficient detail to allow accurate comparisons to be made. Third, offshore islands and skerries could be surveyed, increasing the potential sample size. The main disadvantage of counting from the sea is that movement of the boat and, in some cases, an extreme upward viewing angle makes deciding what constitutes a nest more difficult than from the land. Sometimes this can be overcome by landing the observer on rocks but, in general, the problem can be reduced by simply taking time and care over the counts.

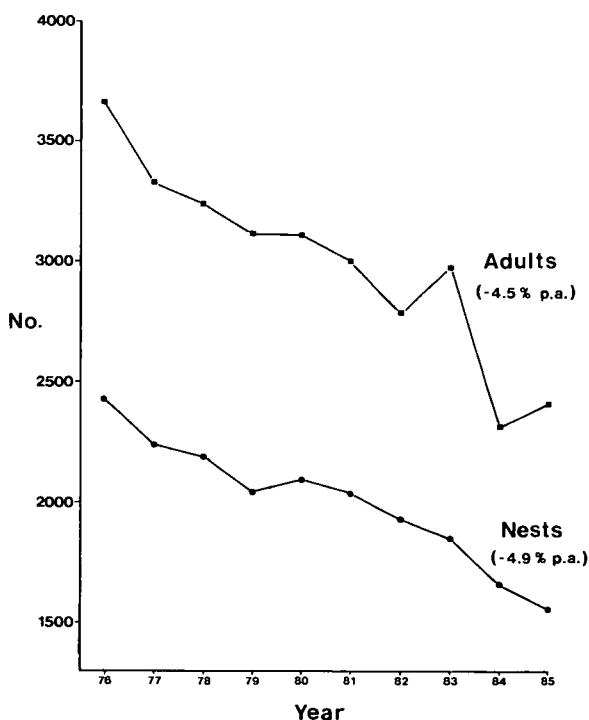


Figure 1. Summed annual mean numbers of adult Kittiwakes and nests in monitoring study plots at 5 Shetland colonies, 1976-1985. Correlation of annual totals with year gives highly significant ( $p < 0.001$ ) relationships for both adults ( $r = -0.936$ ) and nests ( $r = -0.971$ ). The mean annual rates of change are shown in brackets.

## RESULTS

*A. The Monitoring Programme*

Since 1976 there has been a steady decline in the numbers of both adult Kittiwakes and nests in study plots (Figure 1). By 1980, this had resulted in a 13% decline, with data from the N.C.C. monitoring programme in Orkney (Wanless *et al.* 1982) and from Foula on the west side of Shetland (Furness 1983) showing similar decreases (Table 1). These observed declines prompted the 1981 wider-scale surveys. Since 1980, the decrease has continued and by 1985, numbers of adult Kittiwakes and nests in Shetland study plots were only 66% and 64% of their respective 1976 levels, the equivalent figure for nests in Orkney study plots being 66% (Benn & Tasker 1985).

TABLE 1. CHANGES IN MEAN NUMBERS OF ADULT KITTIWAKES AND NESTS IN STUDY PLOTS AT MONITORED COLONIES IN SHETLAND AND ORKNEY, 1976-1980

<i>Shetland (1976-1980)</i>	<i>Adults</i>	<i>Nests</i>
Sumburgh Head	-12%	-4%
Troswick Ness	-18%	-20%
Eshaness	-21%	-22%
Burravoe	-28%	-5%
Noss	+1%	+11%
Foula*		-11%
Overall	-13%	-13%

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<i>Orkney (1976-1980) **</i>	<i>Adults</i>	<i>Nests</i>
Costa Head	-10%	-3%
Row Head	-34%	-25%
Marwick Head	-24%	-22%
Gultack	-34%	-17%
Mull Head	-13%	+10%
Overall	-20%	-12%

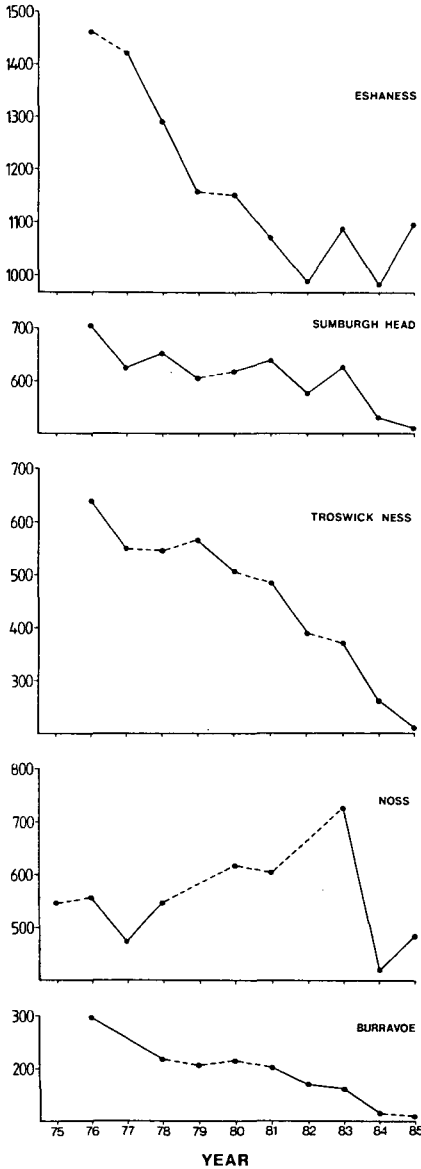
(\*Furness 1983; \*\*Wanless *et al.* 1982)

This decline did not take place uniformly over the monitored colonies in Shetland (Figure 2). Between 1976 and 1985 the mean annual rates of change in numbers of nests varied from -12% per annum at Troswick Ness and Burravoe to +1% at Noss, while the pattern of change over the years has not been consistent. There were also markedly different trends in different study plots within the same colony. For example, between 1976 and 1983 at Troswick Ness two of the four study plots showed mean rates of change of +5% and +34% per annum in numbers of nests while the other two declined at -19% and -13% per annum, all four being adjacent along 200m. of cliff.

*B. The 1981 Surveys*

The data from the 1974 and both the 1981 surveys (Pritchard 1981; Richardson 1985) are summarised in Table 2. This omits counts from Papa Stour where there was uncertainty over the comparability of coverage between the two years. Little change had taken place overall

NUMBER OF  
ADULTS



NUMBER OF  
NESTS

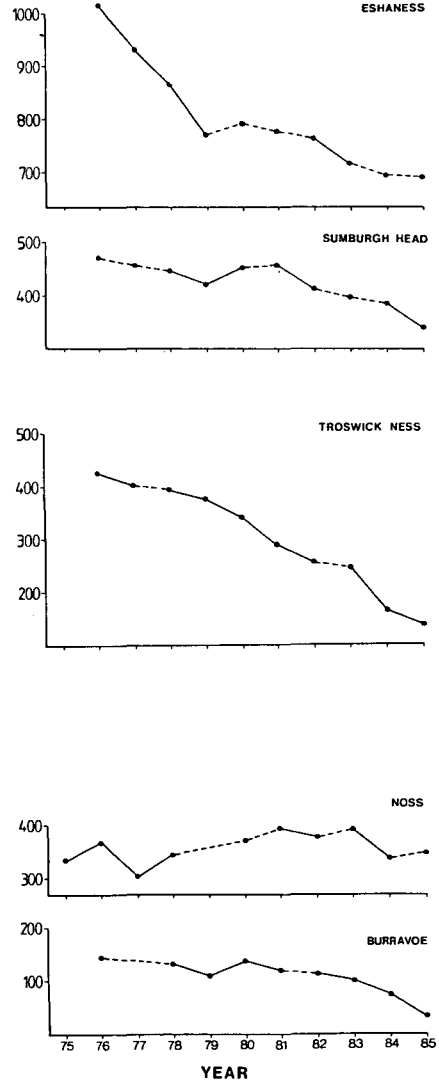


Figure 2. Annual counts (means of combined study plot totals) of adult Kittiwakes and nests of 5 Shetland colonies. Solid lines indicate significant ( $p < 0.05$ ) differences between consecutive years.

with no significant difference between the 1974 and 1981 data sets. The comparison failed to confirm the trend shown by the monitoring data up to 1980 but, rather, indicated that whilst some colonies had decreased in size, others had increased.

TABLE 2. COMPARISON OF TOTAL NUMBERS OF KITTIWAKE NESTS AT SHETLAND COLONIES IN 1974 AND 1981. THERE IS NO SIGNIFICANT DIFFERENCE BETWEEN THE TWO SETS OF DATA (PAIRED SAMPLE *t*-TEST).

<i>Colony</i>	<i>1974</i>	<i>1981</i>	<i>Percentage Change</i>
1. Fitful Head	372	383	+ 3%
2. Westerwick	293	311	+ 6%
3. Vaila	177	295	+67%
4. Wats Ness	60	0	-100%
5. Muckle Roe	50	66	+32%
6. Dore Holm	344*	375*	+ 9%
7. Skerry of Eshaness	1200*	1266*	+ 6%
8. Eshaness Mainland	835	789	- 6%
9. Uyea	397	478	+20%
10. Fetlar	399*	372*	- 7%
11. Birrier	219	111	-49%
12. Burravoe	364	364	0
13. Out Skerries	151*	284*	+88%
14. Noness	887	936	+ 6%
15. Sumburgh/Compass Heads	1798	1624	-10%
Total	7546	7654	+ 1%

\*Indicates a count made from the sea, otherwise all counts were made from the land.

TABLE 3. COMPARISON OF TOTAL NUMBERS OF KITTIWAKE NESTS AT SHETLAND COLONIES IN 1981 AND 1985. THERE IS A SIGNIFICANT DIFFERENCE ( $p < 0.01$ ) BETWEEN THE TWO SETS OF DATA (PAIRED SAMPLE *t*-TEST). ALL COUNTS WERE MADE FROM THE SEA.

<i>Colony</i>	<i>1981</i>	<i>1985</i>	<i>Percentage Change</i>
1. Vaila	249	291	+17%
2. Papa Stour	1059	1087	+ 3%
3. Muckle Roe	152	145	- 5%
4. Dore Holm	375	328	-13%
5. Skerry of Eshaness	1266	1271	< 1%
6. Uyea	731	365	-50%
7. Ramna Stacks	1350	994	-26%
8. Ler Wick, Yell	56	3	-95%
9. Saxavord	141	186	+32%
10. Fetlar	372	221	-41%
11. Birrier	82	11	-87%
12. Burravoe	392	169	-57%
13. Noness	1805	1489	-18%
14. Troswick Ness	716	520	-27%
15. Boddam	254	277	+ 7%
16. Compass Head	464	497	+ 7%
17. Sumburgh Head	2164	2016	- 7%
18. Horse Island	563	516	- 8%
Total	12191	10386	-15%

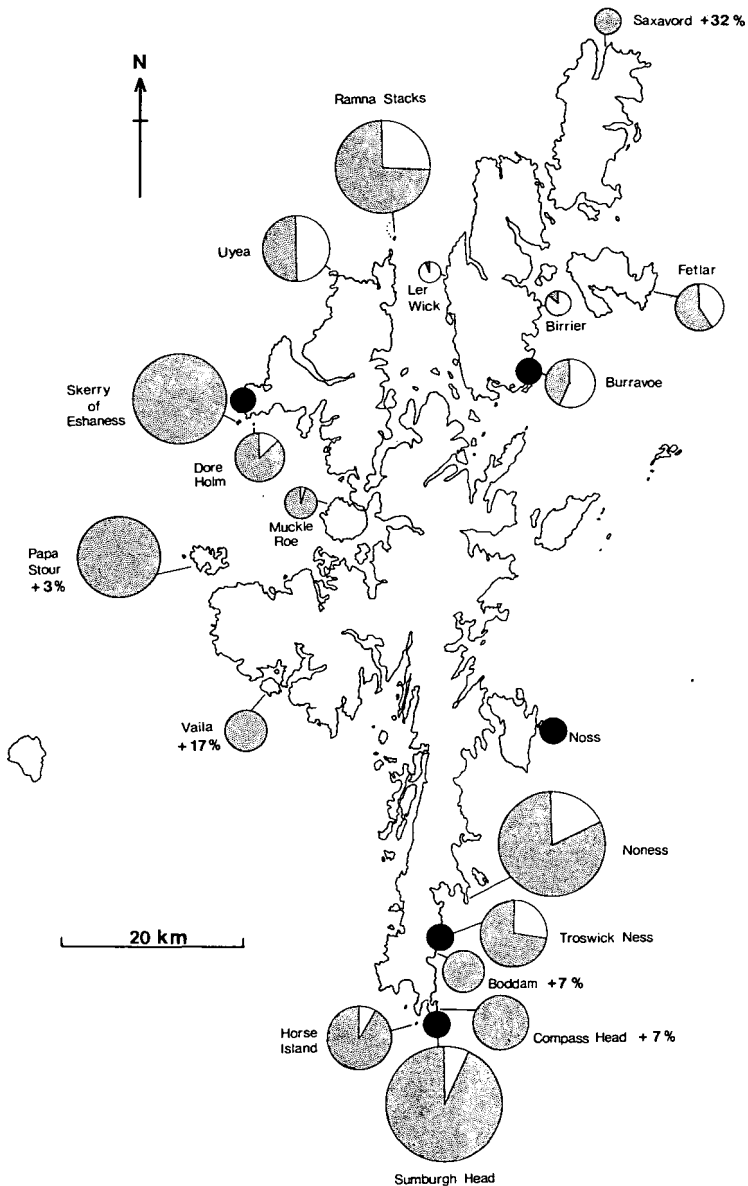


Figure 3. Changes in the total numbers of Kittiwake nests in a sample of 18 colonies between 1981 and 1985. Circle area is proportional to colony size in 1981 (see Table 3); where a decrease occurred, the shaded area represents the 1985 count, increases are indicated numerically. ● = colonies included in the monitoring programme (not to scale).

### C. The 1985 Survey

Comparison between the 1981 and 1985 counts showed a significant ( $p < 0.01$ ) reduction of 15% in numbers of nests (Table 3). However, as in the 1974-1981 comparison, increases had occurred at some colonies. Figure 3 shows the distribution of colonies resurveyed in 1985. Apart from a proportionally large increase at Saxavord, the main decreases appear to have taken place on the north and east coasts of Shetland with the large colonies at Papa Stour and the Skerry of Eshaness having remained fairly stable. In addition, a census of Noss (Shetland's second largest Kittiwake colony) in 1985 revealed a total of 8,643 nests, a decrease of 17.7% on the 10,500 recorded in 1980 (McKay & Crosthwaite 1985). The data from the 1974-1981 and 1981-1985 comparisons are combined in Figure 4. There is a significant ( $p < 0.001$ ) negative correlation between the rate of change and colony size, a relationship which has previously been demonstrated for increases in colony size (Coulson 1983).

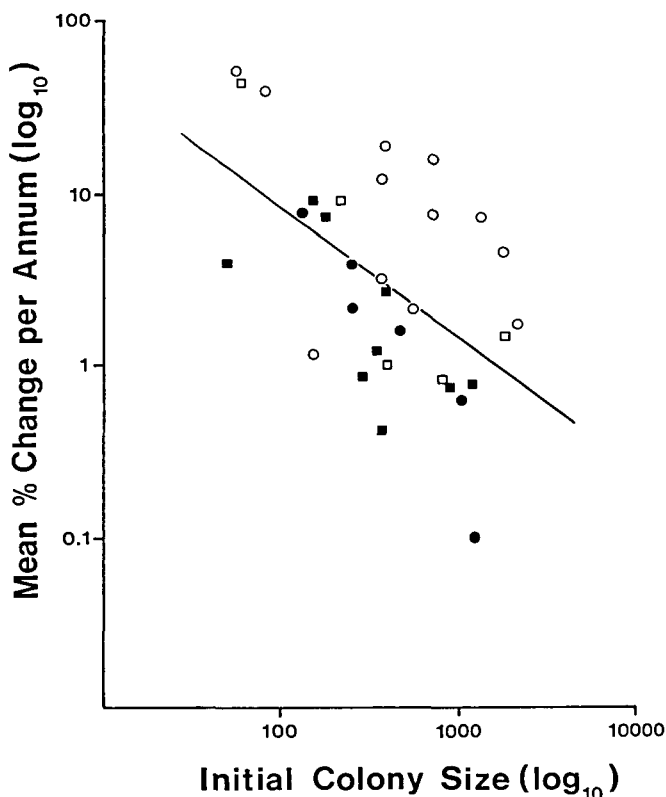


Figure 4. Mean percentage changes per annum in numbers of Kittiwake nests recorded in the 1974-1981 (■) and 1981-1985 (●) comparisons plotted against initial colony size. Open symbols = decreases, Solid symbols = increases. The relationship is significant ( $p < 0.001$ ;  $r = -0.541$ ).

## DISCUSSION

### *Interpreting the Monitoring Counts*

The results of the monitoring programmes in Shetland and Orkney indicate that the numbers of Kittiwakes and their nests in study plots significantly declined between 1976 and 1985. However, this decline was not uniform with some study plots (and colonies) showing either little overall change or even significant increases in numbers.

Comparison of the 1974 and 1981 survey data raised doubts over the representativeness of the selected monitoring sites since it appeared that although declines had taken place at some colonies, increases had occurred at others so that the size of this larger sample of the population had not changed. Harris (1976) arrived at a similar impression when comparing his 1974 counts with those of "Operation Seafarer" (1969-1970), but acknowledged the difficulties of comparing sets of single counts of unknown reliability. Coulson (1983), in a review of the 1969 and 1979 national surveys of Kittiwakes, also came to the conclusion that the "situation in Orkney and Shetland appears to be one of near zero change", although coverage of the two island groups was not extensive. Thus, by 1981 it seemed that the monitoring counts were not reflecting the status of the Kittiwake in Shetland as a whole.

The results of the 1981-1985 comparison went some way towards dispelling these doubts since they did detect a decline. The geographical coverage and sample size were both greater than in the 1974-1981 comparison and the methodology was probably more standardised. Nevertheless, the 15% decrease (mean of  $-3.9\%$  per annum) recorded for the 18 colonies still fell short of the overall 24% decrease recorded in the monitoring study plots over the same period (mean of  $-6.6\%$  per annum). One can therefore interpret all the 1985 data as indicating that the Kittiwake is indeed declining in Shetland but that through chance selection of study plots, the monitoring data are exaggerating that decline.

### *Colony size*

One interesting outcome of the comparisons of the 1974, 1981 and 1985 surveys was the extent to which different colonies (and different parts of the same colony) had undergone changes of varying rate and direction. While some 60% of the Shetland Kittiwake population is concentrated on the three islands of Fair Isle, Foula and Noss, the remaining 40% is scattered among a large number of relatively small colonies (Richardson 1985). Using the definition of Boyd (1960) whereby "colonies" are separated by at least 50m. of unoccupied cliff, Richardson (1985) calculated that this 40% was divided between 249 colonies of which 178 (71%) contained 100 or fewer nests. Even using Coulson's (1963) less restrictive definition of "breeding stations" consisting of colonies or colony groups with less than a mile of unoccupied terrain between them, 57 stations can be identified of which 28 (49%) contain 100 or fewer nests and 35 (61%) contain 250 or fewer.

Given that smaller colonies undergo greater proportional changes than large colonies (Figure 4), it is to be expected that these surveys (which have not included the large colonies of Fair Isle, Foula and Noss) detected considerable variation in trends and rates of change. Although the geographic coverage achieved in the 1985 comparison with 1981 was extensive, the counts still only involved some 22% of the Shetland population and caution should therefore be exercised in extrapolating from the results.

### *Problems of Using Fixed Study Plots*

The pitfalls involved in the subjective choice of monitoring study plots can be illustrated by the 1981 and 1985 counts of Troswick Ness from the sea (Table 4), where three discrete breeding groups or sub-colonies are separated from each other by less than 150m. Group 1



at Troswick Ness itself is largely invisible from the land and so was not chosen for monitoring. Group 2 at Drooping Point Geo can only be viewed from several angles and presents problems in defining areas of overlap so it was not chosen either. Virtually all nests in Group 3 (Brei Geo) can be seen clearly and closely from the clifftop and this was selected as the monitoring site. However, numbers in this particular sub-colony have declined at twice the rate of the colony as a whole (Table 4).

TABLE 4. COUNTS MADE FROM THE SEA OF KITTIWAKE NESTS AT TROSWICK NESS ON 15TH JUNE 1981 AND 21ST JUNE 1985.

<i>Sub-Colony</i>	<i>1981</i>	<i>1985</i>	<i>Percentage Change</i>
1. Troswick Ness	120	166	+38%
2. Drooping Point Geo	242	175	-28%
3. Brei Geo	354	179	-49%*
Total	716	520	-27%

\*This sub-colony includes the monitoring site where numbers decreased by 53% over the same period.

We therefore appear to have a situation where changes in Kittiwake numbers can vary so greatly on both the smallest (adjacent study plots) and largest (e.g. the colonies at Papa Stour and Burravoe) geographic scale that attempting to interpret changes in the population as a whole, whatever that might be, from a small number of subjectively selected fixed study plots is inappropriate and likely to be misleading.

The advantages of using a system of randomly selected study plots have been outlined by Harris *et al.* (1983) for monitoring Guillemot *Uria aalge* numbers on the Isle of May. However, such a method would not be suitable for monitoring the Shetland Kittiwake population. A relatively large number of potential study plots are required in a colony from which to randomly select those to be used for monitoring and many Shetland Kittiwake colonies are either too small or do not have a large enough proportion visible from the land for this to be feasible. Furthermore, if it is the population of Shetland that is being monitored then, logically, some form of random selection of colonies should be made. This would create logistical problems since many colonies are only accessible or visible from a boat while others may be partly visible from the land but are still difficult of access. Finally, basing a monitoring programme on existing colonies means that any future expansion of the population into new breeding sites is likely to go undetected, essentially the same predicament as whether to monitor study plots for a species where that species does not, but might in future, breed.

#### *Towards an Alternative Strategy of Monitoring*

The most appropriate methodology used for monitoring or censusing cliff-nesting seabirds will vary for different species. Study plots and repeated counts are necessary for monitoring Guillemot numbers where the count unit (individual birds) varies considerably both diurnally and between days, the latter variation being largely unpredictable. This does not apply to the Kittiwake since the count unit (nests) does not vary diurnally and the seasonal variation that exists is predictable in direction, if not scale. Furthermore, Kittiwake nests in all but the largest and most densely populated cliffs can be easily and accurately counted from the sea whereas it is generally accepted that Guillemots cannot.

We suggest that a more appropriate method of monitoring Kittiwake populations would

be to make a single count from the sea of delimited sections of coastline (as opposed to "colonies") during the latter half of incubation (when numbers of nests are most stable). Consistency between years could be maintained by:

1. A clear and unambiguous count unit, i.e. well constructed nests (capable of containing eggs) attended by at least one adult.
2. Repeating counts of each section of cliff as a check on accuracy.
3. Recording breeding distribution in as detailed a manner as possible, including photographs.
4. Checking each section of coastline for newly established colonies.
5. Counting from the land any specific areas of cliff where visibility from the sea is poor.

We consider this strategy to be suitable for such a discrete geographical area as Shetland, with its large number of islands and many Kittiwake colonies of varying size. While it may not necessarily be so appropriate for certain other areas, the principle of censusing total breeding numbers rather than extrapolating from arbitrarily selected study plots would appear to be sound.

### *Assessing the Causes of Change*

Although monitoring a breeding population at the level described above may indicate whether or not significant change is occurring, it sheds no light on the possible causes of that change. While the Kittiwake has undergone a dramatic increase over much of its European range this century, recent declines have occurred in Faroes (Cramp & Simmons 1983), central Norway (Barrett & Vader 1984) and south-west Britain (Coulson 1983). Relatively few Kittiwakes are found oiled on Beached Bird Surveys both in Shetland (Heubeck 1985) and nationally (Stowe 1982). Coulson (1985) thought oil pollution to be a relatively unimportant cause of Kittiwake mortality and suggested that the most likely cause of recent declines at British and Irish colonies has been food shortage in the vicinity of the breeding colonies. Lloyd (1982) considered that changes in feeding conditions at sea may be affecting the Kittiwake colony at Great Saltee, Eire while the declines in colony size and low breeding productivity in central Norway have been attributed to the collapse of Herring *Clupea harengus* stocks along that coast (Folkestad 1984). Concern has been expressed over the potential impact of industrial fishing for sandeels (*Ammodytes* spp.) around Shetland, both in terms of implications for the stocks and the fishery (Bailey 1982) and the levels of food resources available to seabirds (Furness 1982). However, no meaningful interpretation of observed changes in population size can be made in the absence of a programme for monitoring breeding performance, diet and feeding requirements of seabird species in Shetland.

### ACKNOWLEDGEMENTS

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# Counts of breeding and nonbreeding Guillemots *Uria aalge* at a colony during the chick rearing period

*M. P. Harris, S. Wanless and P. Rothery*

The number of individual Guillemots *Uria aalge* present at a colony increases as the breeding season progresses due to an influx of immatures and/or breeding adults spending longer at their breeding sites (Lloyd 1975, Birkhead 1978, Slater 1980). Guillemot populations are usually monitored by counting the number of individuals present in carefully defined areas at fixed times of day on 5-10 occasions during the chick-rearing period which in Britain is taken to be June. Although the variations in counts is least at this time (Lloyd 1975) there are still considerable daily fluctuations in numbers. Gaston & Nettleship (1982) showed that in Brunnich's Guillemot *U. lomvia* on Prince Leopold and Digges Islands, Canada, 61% and 31% respectively of the variation in numbers of birds present was explained by varying numbers of non-breeding birds arriving on the cliffs. We present data collected on the Isle of May, Scotland to show that much of the variation in counts of Guillemots was similarly due to the presence of variable numbers of nonbreeding individuals.

## METHODS

Daily observations were made at a completely undisturbed group of 200-250 pairs of Guillemots. All possible breeding sites were numbered on photographs and checked several times a day from before laying. From 1-30 June 1984 and 1-6 and 9-18 June 1985 we counted the number of Guillemots present at about 1100 hr GMT and classified them as follows:—

- i) *Breeders* which were at sites where an egg had been laid that season even if it was subsequently lost. Failed breeders continued to visit and defend their site until the end of the counting period.
- ii) *Site-holders* which were at breeding sites where pairs had been in occupation throughout the season but where no egg had been recorded. Many of these sites had been bred at in previous years and it is conceivable, but we think unlikely given the frequency of nest-checks, that eggs had been laid and very rapidly lost.
- iii) *Non-breeders* which included birds at sites only occupied occasionally and in areas not used for breeding. The study area included an open, broad ledge at the cliff top now being colonised. This was not used at all by Guillemots in 1981 and 1982 but in 1983 nonbreeders visited it occasionally. In 1984 eight eggs were laid but only one survived for more than a few hours and that disappeared overnight. The birds laying here did not defend the sites where eggs were laid and appeared not to visit them after the egg was lost. These birds were not considered to have made a serious breeding attempt so all birds on this ledge were classified as nonbreeders; they would have been classified as such if they had moved into the main part of the colony.

Observations of 73 individually colour-ringed birds in the area showed that breeders and site-holders virtually never landed anywhere in the colony away from their own sites and most if not all, birds recorded away from recognised breeding sites were not breeding that season.

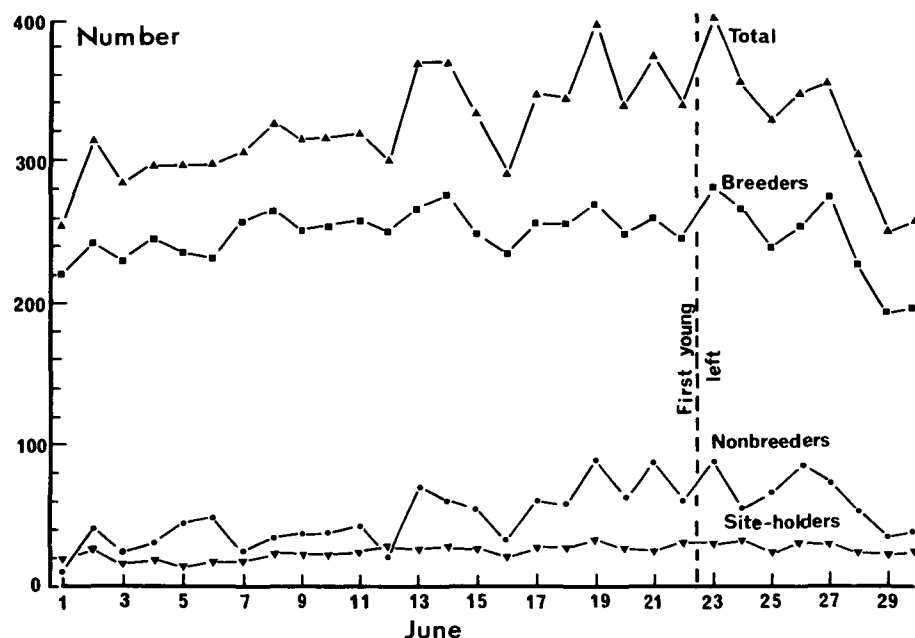


Figure 1. Counts of Guillemots in a study plot on the Isle of May in 1984.

TABLE 1. COUNTS OF GUILLEMOTS OF KNOWN BREEDING STATUS ON THE ISLE OF MAY 1984 AND 1985

Year	Dates	No. of counts	Mean count	Standard deviation	Coefficient of variation (%)
1984	1-30 June				
	Breeders	30	247	21	9
	Site-holders	30	25	5	20
	Non-breeders	30	51	21	41
	Total	30	324	40	12
	1-22 June				
	Breeders	22	250	14	6
	Site-holders	22	25	5	20
	Non-breeders	22	48	21	44
	Total	22	322	34	11
1985	1-18 June				
	Breeders	15	262	14	5
	Site-holders	15	14	3	21
	Non-breeders	15	42	11	26
	Total	15	318	20	6

Note: Totals of 223 and 222 pairs bred in the area in 1984 and 1985 respectively.

## RESULTS

The daily counts for June 1984 are plotted in Figure 1 and summarised in Table 1. All classes of birds showed considerable daily variation in numbers with the counts of nonbreeders having the highest coefficient of variation ( $CV = \text{standard deviation}/\text{mean} \times 100 = 41\%$ ) and counts of breeders the lowest (9%). The CV for all classes combined was 12%. The first young left for the sea on the night 22/23 June. The CVs (but not the overall mean counts) were substantially reduced if only counts made prior to this date were considered. The daily counts of breeders and nonbreeders at the colony tended to go up and down together and the correlation coefficient ( $r$ ) between the two sets of counts was 0.50 ( $n=30$ ,  $P < 0.02$ ). (However, the result should be treated with caution since each day's count may not be independent of the counts on previous and subsequent days which would tend to exaggerate the significance of the finding.)

In 1985 counts were made up to 18 June and the first young left the colony on the night of 18/19 June. Again breeders had a relatively low CV, nonbreeders had a high CV. Overall the counts of total birds were far less variable than were those in 1984. There was no significant correlation between the numbers of breeders and nonbreeders on the same date ( $r=0.18$ ,  $n=15$ , n.s.).

## DISCUSSION

Much of the variation in counts of Guillemots in June was due to the fluctuations in the numbers of nonbreeders visiting the colony. This supports the finding of Gaston & Nettleship (1982) for Brunnich's Guillemot. The large changes in numbers of nonbreeders were very noticeable on the Isle of May, especially in ledges near the top of the cliffs, where nonbreeders tended to gather. The counts of birds on the ledge in the study area being colonised varied from 0 to 47 in 1984 and 0 to 24 in 1985. We have as yet no data on the normal age of first breeding of Guillemots on the Isle of May but elsewhere in Scotland it is 4-5 years, rarely 3 years (Swann & Ramsay 1983). The first return of young birds to the Isle of May appeared to be late in June of their second year when they visited the fringes of the colony and at least some three-year-olds entered the colony earlier in June. This also occurs elsewhere (Swann & Ramsay 1983). Presumably much of the variation in numbers of Guillemots was due to birds in their second and third years of life. Some site-holders were known to have bred previously, others may have been still immature.

What implications do these findings have for those monitoring the numbers of Guillemots? In a review of counts of Guillemots at 27 British and Irish colonies Harris, Wanless & Rothery, (1985) found that the normal CV of counts in June was 10%. The Isle of May counts fitted this norm in 1984 but in 1985 the counts were less variable. Obviously the CV could be reduced substantially by excluding nonbreeders but this is normally impractical and for normal monitoring we shall have to accept the higher level of variation in counts. A more practical way to reduce variation would be to stop counts once the first young leave the colony. One adult, seemingly always the male (Scott 1973) takes the chick to sea so the 'population' being counted changes at this time. The date of first leaving could be recorded directly by observation, or indirectly approximated by seeing very large chicks or hearing the typical penetrating calls given in the evening by chicks near to leaving being heard, or calculated by adding 20 days (the usual chick period) to the date the first young were seen.

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# The possible effect of food availability on incubation and brooding shifts of Brunnich's Guillemot *Uria lomvia* at Digges Island, Northwest Territories

A.J. Gaston and D.G. Noble

Among birds which forage long distances from their breeding site, the time involved in travelling to and fro can be an important constraint on breeding performance. Time devoted to travelling can be reduced by increasing the duration of incubation shifts, hence reducing the frequency of visits to the colony. For seabirds both Lack (1968) and Ashmole (1971) have pointed out that inshore feeders have shorter incubation shifts than offshore feeders, presumably because inshore feeders do not have so far to go to reach their feeding grounds.

Recent comparisons of different measures of reproductive performance among colonies of different size suggest that, for several species of seabirds, large colonies tend to have lower reproductive success and produce lighter fledglings than small colonies (Gaston *et al.* 1983, Birkhead & Furness 1985). This effect has been attributed to local depletion of food supplies around the colony. Evidence concerning the relationship between colony size of Brunnich's Guillemots *Uria lomvia* and rates of feeding and weight increment of chicks has already been presented. Among colonies in the eastern Canadian Arctic, chick growth rates were inversely related to colony size, the lowest being found on Digges Island, Northwest Territories (60° 44'N, 77° 59'W), where 300,000 pairs breed (Gaston *et al.* 1983).

In this paper we compare the duration of incubation shifts at Digges Island with those recorded previously at Prince Leopold Island, Northwest Territories (Gaston & Nettleship, 1981), a colony of 86,000 pairs, where chicks are fed 1.5 to 2 times more often, and normally attain fledging weights approximately 30% higher, than those recorded at Digges Island (Gaston *et al.* 1983, 1985). If birds at the larger colony have to travel further to find food, we might expect incubation shifts to be longer there than at the smaller colony, in order to reduce travelling time.

## METHODS

Estimates of incubation shifts made at Prince Leopold Island were based on the number of exchanges recorded for unmarked pairs observed over 24 hours (Gaston & Nettleship 1981). We repeated the same observations at Digges Island in 1980. This method supplied a mean figure, but did not allow the lengths of individual shifts to be recorded because only the shortest shifts were completed within the duration of the watch. To record the actual length of individual incubation shifts to provide an unbiased estimate of the mean and variance, we marked one member of several pairs of Brunnich's Guillemots at Digges Island in 1982 (see Gaston *et al.* 1985 for a description of the colony) and observed these pairs until they had all completed a pre-selected number of incubation shifts.

Birds were marked with individual colour-ring codes and also with strips of coloured plastic insulating tape c. 1 × 2 cm attached to the crown feathers in different combinations by means of quick drying glue. During the course of the season, 21 birds were marked on plot S1 (see Gaston *et al.* 1985). However, some lost their crown patches and others failed to breed. During four watches carried out between 5 July and 19 August 1982, the number of



marked pairs with eggs or chicks ranged from 7 to 12. Watches were not necessarily continuous, but the presence or absence of marked birds was recorded at least hourly. Total durations of watches were as follows: 71 h, beginning at 0745 h on 5 July (one shift at each site), 73 h from 1130 h on 14 July (two shifts), 68 h from 1200 h on 27 July (two incubation shifts, six for pairs brooding chicks) and 54 h from 1530 h on 16 August (five brooding shifts). Observations were made through a 20 or 25× telescope from a hide situated c. 120m from the study plot.

In addition to recording the presence or absence of marked birds, we also noted the exact time of all change-overs by marked pairs and the presence of eggs or chicks. Results from 1982 are compared with those obtained in 1980 using observations of the rate of exchanges of unmarked pairs during 24-hour watches on 2 July (81 pairs), 7 July (90 pairs) and 15 July (99 pairs) in the early and middle incubation period. These watches were conducted at a different study plot (F1), where the range of observation was 70m.

All times given refer to Canadian Summer Time which, at Digges Island, is one hour ahead of solar time.

## RESULTS

The length of incubation shifts ranged from 23 to 55 h on 5-7 July 1982, when all eggs had been incubated for less than 14 days, and from 3 to 29 h on 14-17 July in the middle of the 32-day incubation period (Table 1). On both watches the most frequent length was about 24 h, but on 5-7 July two of the seven shifts exceeded 48 h. Considering the small sample on 5-7 July, it is likely that the maximum length of incubation shift that Brunnich's Guillemot will undertake exceeds the 55 h maximum that we recorded. No correlation was found between the length of successive shifts at the same site ( $r = 0.06$ ).

TABLE 1. DURATION OF COMPLETE INCUBATION SHIFTS (H) OBSERVED FOR MARKED PAIRS OF BRUNNICH'S GUILLEMOT (1982).

<i>Date of Shift</i>	<i>0-3</i>	<i>3-9</i>	<i>9-15</i>	<i>15-21</i>	<i>21-27</i>	<i>27-33</i>	<i>33-39</i>	<i>39-45</i>	<i>45-51</i>	<i>51-57</i>	<i>n</i>
5 July					3	1	1			2	7
14 July		1	2	6	12	3					24
27 July (eggs)		1	3	2	6						12
27 July (chicks)	4	6	11	4	1						26
16 August (chicks)	9	12	11	4	4						40

By 27-30 July, when some chicks had already hatched and all eggs were close to hatching, incubation shifts were still most commonly about 24 h in length, but the length of brooding shifts clustered around 12 h. On 16-18 August a few chicks had already fledged and the rest were close to fledging age (from 16 days onwards, Gaston & Nettleship 1981). By this time, the length of brooding shifts averaged only 9 h (Table 2).

Comparison of mean durations estimated from the frequency of change-overs with the observed durations of individual shifts shows no serious discrepancy between the two methods (Table 2). Rates of exchange seen in 1982 (mean and s.d. of averages based on change-overs  $22.6 \pm 7.6$  h,  $N=3$ ), were higher than those recorded in 1980 ( $42.3 \pm 12.5$  h,  $N=3$ ), but in both years rates were generally lower than those recorded in two years at Prince Leopold Island (Table 3).

Exchanges of incubation and brooding duty occurred throughout 24 h, including the period when it was too dark for us to make observations, (3-5 h during incubation, depending

on cloud cover), but during incubation they were most frequent from 1400-2200 h and uncommon in the middle of the day (1000-1400, Fig. 1). Exchanges of brooding duty were most frequent just before dark (1800-2200, Fig. 1).

TABLE 2. COMPARISON OF ESTIMATED AND OBSERVED MEAN DURATIONS OF INCUBATION AND BROODING SHIFTS OF BRUNNICH'S GUILLEMOT (1982).

<i>Date of Stint</i>	<i>Sites Observed</i>	<i>Exchanges</i>	<i>Duration (h)</i>	<i>Rate/ 24hrs/site</i>	<i>Estimated <math>\bar{x}</math></i>	<i>Observed <math>\bar{x}</math></i>	<i>s.d.</i>	<i>Maximum</i>	<i>n</i>
5 July	7	16	71	0.77	31.2	35.6	13.1	56	7
14 July	12	45	73	1.23	19.5	20.9	5.7	29	24
27 July (eggs)	6	24	68	1.41	17.0	18.0	7.0	26	12
27 July (chicks)	7	50	68	2.52	9.5	10.4	5.8	25	26 <sup>1</sup>
16 Aug (chicks)	7	38	54	2.41	10.0	9.1	6.7	24	40 <sup>1</sup>

<sup>1</sup>Some exchanges took place during the hours of darkness and hence the length of brooding shifts involved could not be measured exactly. These shifts are omitted from the estimates of the observed mean, but included in the number of exchanges recorded.

TABLE 3. MEAN LENGTHS OF INCUBATION SHIFTS OF BRUNNICH'S GUILLEMOTS AT DIGGES ISLAND AND PRINCE LEOPOLD ISLAND. ESTIMATED FROM RATES OF CHANGE-OVERS.

<i>Days from median date of laying for population</i>	<i>Digges Island</i>		<i>Prince Leopold Island</i> <sup>1</sup>	
	<i>1980</i> <sup>2</sup>	<i>1982</i>	<i>1975</i>	<i>1977</i>
7	48.0 (81) <sup>3</sup>	31.2 (7)	17.1	17.8
12	51.0 (90)			20.0
16		19.5 (12)	12.6	20.0
20	28.0 (99)		20.0	12.0
29		17.0 (6)	12.0	10.9

<sup>1</sup>Data from Fig. 26, Gaston & Nettleship (1981).

<sup>2</sup>Figures have been corrected so that the proportion of exchanges taking place during darkness (2200-0200h) is the same as that observed in 1982 (6%).

<sup>3</sup>Figures in brackets give the number of pairs under observation.

## DISCUSSION

Comparison of our results with those obtained by Gaston & Nettleship (1981: Fig. 26) at Prince Leopold Island suggests that incubation shifts at Digges Island, particularly in 1980, were longer, on average, than those observed in the high arctic. In the former study, mean incubation shifts exceeded 24 h only in the first 2-3 days after laying, perhaps while the female restored energy reserves depleted by egg formation. Subsequently, the mean length of shifts fell between 12 and 20 h, during fourteen 24-hour watches before the median date of hatching. Results at Digges Island in 1980 suggest that, at least up to 7 July, the majority of birds were probably undertaking 48 h incubation shifts. In 1982 shifts of about 24 h remained common throughout incubation.

Although the samples are small, it appears that incubation shifts at Digges Island were generally longer in 1980 than in 1982. Numbers of birds attending the colony, in relation to the number of breeding pairs occupying sites, were lower in 1980 than in 1982 (Gaston *et al.* 1985), indicating that food was probably harder to obtain in 1980 (Gaston & Nettleship

FIGURE 1

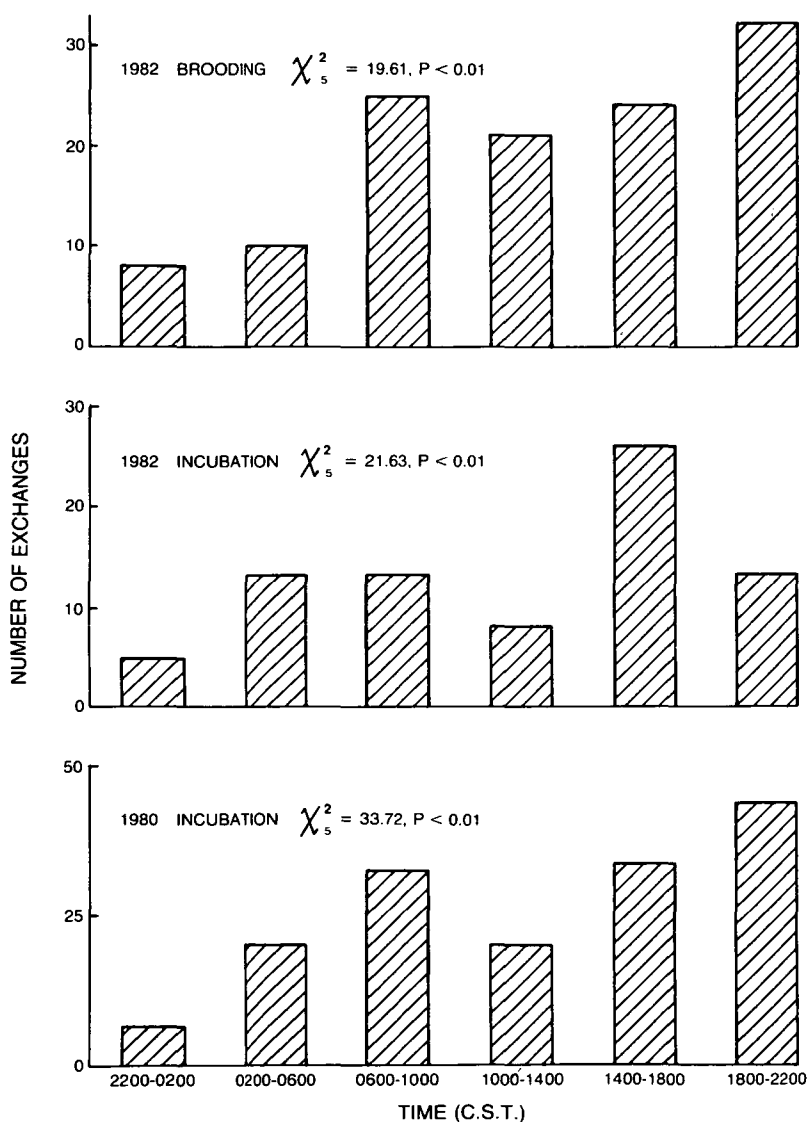


Figure 1. Numbers of exchanges by incubating and brooding pairs of Brunnich's Guillemot in relation to time of day. Chi-square values refer to heterogeneity analyses among time periods (1980, N = 157; 1982 incubation, N = 78; 1982 brooding, N = 117).

1982). This supports the hypothesis that length of incubation shift is related to the availability of food in Brunnich's Guillemots.

Brunnich's Guillemots from Digges Island probably forage about 100 km from the colony during the incubation period (Gaston *et al.* 1985). With a flight speed of  $58 \text{ km.h}^{-1}$  (Bradstreet 1982) this means that each round trip takes 3-4 h. Hence travelling constitutes 7% of the daily time budget if exchanges occur every 48 h and 14% if exchanges are every 24 h.

Gaston (1985) has modelled the probable energy expenditure of Brunnich's Guillemots spending different lengths of time travelling. For a 936 g murre travelling 100 km every 48 h the model predicts that food must be ingested at a rate of  $38.5 \text{ kcal.h}^{-1}$ . This assumes 50% of time is spent incubating and 2 h.day<sup>-1</sup> resting. If the same journey is made every 24 h food must be ingested at  $53.3 \text{ kcal.h}^{-1}$ , 38% higher (for further explanation of the model see Gaston 1985). If food is captured at a rate proportional to its density, then a similar difference in the availability of food would be sufficient to account for the observed difference in incubation shifts between Digges Island and Prince Leopold Island, assuming similar foraging ranges.

#### ACKNOWLEDGEMENTS

We are grateful to Winnifred Cairns, Richard Elliot, John Geale, Ian Jones, Bruce Lyon and Joe Spears for contributing to the prolonged watches. Tony Diamond and Hugh Boyd commented on the manuscript.

#### SUMMARY

Incubation shifts were shorter in 1982 than in 1980, but in both years they were longer than had been observed previously in two seasons at Prince Leopold Island. We think that this difference was due to food being more easily obtained (closer, more abundant or more accessible) at Prince Leopold Island than at Digges Island. Some calculations are presented to illustrate the likely saving in energy obtained by the Digges Island murre through reducing the number of visits made to the colony.

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# The feasibility of using X-rays to monitor digestion in the Guillemot *Uria aalge*

K.E. Partridge

There are a few reports of the rate at which food is digested by seabirds (Blake *et al.* 1985). Firm data on digestive rates are needed for the formulation of energetic models and also would be useful in rehabilitating oiled seabirds. The present study tested the feasibility of following the timing and progression of digestion in the Guillemot *Uria aalge* using X-rays.

## METHODS

Birds used were being rehabilitated at the RSPCA Oiled Seabird Unit at Plymouth. All weighed 750-800g, were feeding well and were apparently physically fit and alert, standing readily and walking on the 'toes'.

To establish an approximate period over which a series of X-ray exposures would be needed, two birds were each fed a meal of 20g of sprat *Sprattus sprattus* containing a gelatin capsule with 0.2ml of the non-toxic dye Methylene Blue. A watch was kept to see when the dye appeared in the faeces, which were collected on clean paper. (Two other birds were fed a similar meal, though with a gelatin capsule containing 0.4ml of dye; they both regurgitated the meal within 15 minutes.) The first bird passed faeces with a very faint blue/green tinge after 110 minutes and faeces with some distinct blue colouration after 140 minutes. The second bird's faeces were a very faint blue/green tinge after 100 minutes and had a more distinct blue colouration after 146 minutes. The faint blue/green tinge might have possibly occurred in the urine content of the faeces.

The X-ray exposures were taken on a 'Heliodor' Hospital Portable Machine. Trial exposures indicated that the best results for detecting a barium meal were at 70Kv at 0.3 secs. and 100 milliamps. Another bird which had access to food throughout the day but had no intake for at least 3 hours prior to this experiment was fed approximately 20gm of sprat, together with a 5ml dose of Microplaque standard Barium, at 2055 hours GMT. Exposures were made after 5 min, 10 min, 15 min, 25 min, 45 min, 65 min and 95 min, i.e. a total of 7 exposures.

## RESULTS

The barium progression was as follows:-

- Feed + 5 min: Barium throughout the stomach, heavy concentration in gizzard end and starting to spread into duodenal loop (Figure 1).
- Feed + 10 min: Less in stomach, heavy concentration in gizzard, and well spread through duodenal loop and into jejunal loop.
- Feed + 15 min: Still a trace in gizzard but heavy concentration in duodenal and jejunal loops, starting to reach axial loop.
- Feed + 25 min: Slight trace left in gizzard, but main concentration in jejunal and axial loops, starting to reach ileal loop.
- Feed + 45 min: Nothing in gizzard or duodenal loop, little in axial loop, main concentration in ileal loop and beginning to reach rectum.
- Feed + 65 min: Nothing in axial loop, slight trace left in ileal loop, heavy concentration in rectum and beginning to reach cloaca.
- Feed + 95 min: Great concentration in rectum and cloaca; no trace elsewhere in gut.

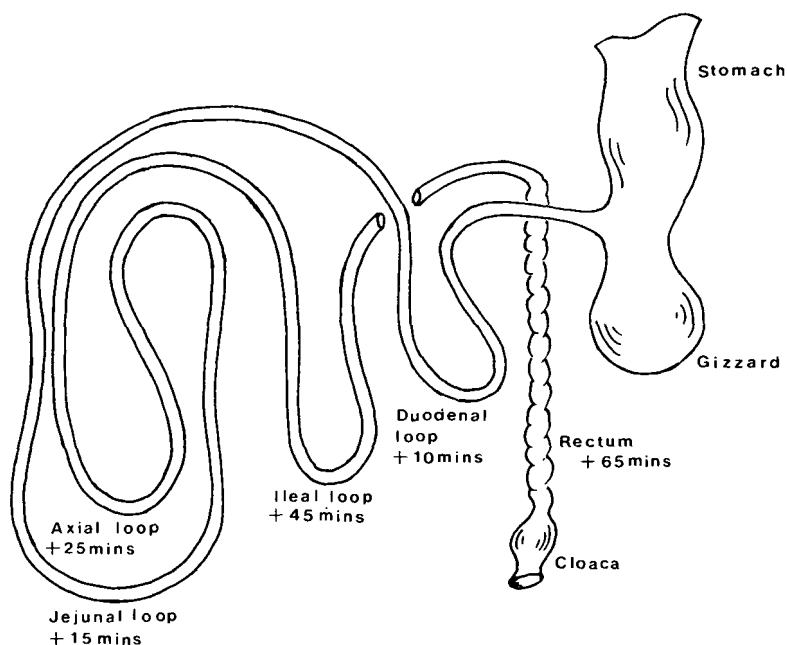


Figure 1. Diagrammatic pattern of intestinal loops for Alcidae as given by King and McClelland (1979).

## DISCUSSION

Henry *et al.* (1933) (quoted by Sturkie 1965) followed the progression of food in hens by X-ray exposures, using barium sulphate mixed with oats. They found the complete disappearance of the feed from the digestive tract within 16 to 25 hours. However, care must be exercised in comparing grain eating species and piscivorous species such as Guillemot. Further use was made of this technique by Furness & Laugsch (1983) on Jackass Penguins *Spheniscus demersus* to determine gastric evacuation rate and gut retention time; they felt the method was unsuitable for such experiments due to the inability of barium sulphate to bind with fish tissue.

It would appear as though fish is passed through the digestive tract of the Guillemot very quickly. This brief experiment supports the views of Ward (1914), quoted by Harris (1965), who estimated that a captive Great Black-backed Gull *Larus marinus* digested fish at a rate of over 100g per hour. Ward also fed a starved Black-headed Gull *L. ridibundus* a 5" sprat, and killed it three hours later finding no remains in the stomach.

My short study indicates the feasibility of using X-rays to follow digestion, a technique preferable to killing birds. Clearly, there is potential for more work along these lines, especially where other factors, e.g. different foods, activities and stresses need to be considered.

## ACKNOWLEDGEMENTS

I would like to acknowledge the very generous help and support given by P.S. Hunt, M.R.C.V.S. of Bower, Hunt & Youngs, Veterinary Hospital, Plymouth, without whom this work could not have been done.

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## BOOK REVIEWS

AINLEY, D.G., LERESCHE, R.E. and SLADEN, W.J.L. 1983. *Breeding Biology of the Adelie Penguin*. University of California Press, Berkeley & Los Angeles, 240pp. Price ?

This book is a major presentation of important original data derived from eleven field seasons of studies (between 1961-62 and 1975-76) of Adelie penguins at the Cape Crozier rookery, situated at 77°S at the base of the Ross Sea, Antarctica.

The title is a slight misnomer. The book, which is produced to a high standard with typographic errors virtually absent, is almost entirely devoted to population biology and dynamics. The absence, even in the general introduction, of information on diet, feeding ecology, moult and interactions with predators is a pity as it would have taken very little extra space to provide readers with a fuller summary of useful background information before tackling the detailed material of the main text. This has a high information content, the six main chapters, totalling 175 pages, containing 90 tables and 30 figures; there are also 15 good plates.

The data analysed depend on the banding of 40,000 chicks, of which 4,485 were subsequently resighted; of these 1,064 birds of known sex form the main data set. Following the introductory and methodological chapters come accounts of the occupation of the breeding colony and the activities of pre-breeders. The first deals with age of return (2 years, mode 3, females on average before males) and arrival dates (older birds earlier; inter-annual variation mainly due to ice-cover). The second examines the progression of juveniles from wandering about, through holding a territory alone, to being paired at a nest site. Fidelity of return to natal area is high, 1% of birds moving to another rookery 1 km away, 23% to another part of the original rookery and 43% to another colony within the same area. Males move more than females. Presented in detail, the results form a useful documentation without being especially illuminating.

The meat of the book is the three chapters (95 pages) dealing with breeding events. The influence of age and previous experience (prior activities as pre-breeders or breeders) on first breeding, time taken to form a pair-bond, laying date, clutch size, incubation routine, duration of incubation shifts and of incubation period, infertility, survival of eggs and chicks, and parental attendance during the brood-guard period are analysed in detail. Age was the only factor significantly affecting lay date, clutch size, fertility and incubation routine; it had no significant influence on incubation period, parental attendance or chick age at fledging. Prior experience essentially affected only the age of first breeding and breeding success.

The influence of environmental and other factors less directly related to age is also considered. Differences in breeding success between central and edge birds are only just detectable and insufficiently strong to induce edge pairs to move to central nests in future years. Partners tend to be of similar age (within one year either way) and this tends to reinforce the poor success of young birds. Unlike many seabirds, pair-bond duration has little influence on breeding success and most pairs change partners between years. This is partly because about 20% of adults die each year, and partly because the importance of breeding early in the short Antarctic summer places a premium on rapid pair-bond formation that apparently outweighs the value of waiting to see if the previous partner will turn up. Consequently the divorce rate is about 50% for all age groups – very high even for penguins. Of 100 pairs intensively studied only six stayed together and bred in three seasons and in the whole study no partnership endured more than 4 years.

The chapter on demography is an important one, mainly because it supplements, and in several areas supersedes, the treatment of the same data by Ainsley and De Master (1980 : *Ecology* 61 : 522-530), especially in correcting survival estimates and evaluating the significant mortality due to banding. The chapter is densely written and not easy to follow, depending on a knowledge of the earlier paper, and needs more explanation of the terms used and of the data deployed in the many tables. The main conclusions are that breeding reduces longevity but that breeding experience promotes greater frequency and success of breeding. In examining the ways in which penguins try to cope with this dilemma it is unfortunate that no data on lifetime reproductive success – surely a major aim of long-term population studies – are presented. This is presumably because a four-year break occurred after the first nine years of the study. However, one might have expected the authors to draw attention to the value of continuous lifetime records in critically examining the outcome of the various reproductive strategies that may be employed by the birds and to the shortsightedness of losing the opportunity to acquire such data by having the study terminated just at the time when such a goal was within reach. That two later seasons funding enabled much valuable data to be salvaged is some consolation.



The brief concluding chapter contains a competent discussion of deferred maturity and breeding and a somewhat inconclusive section on population regulation of seabirds – hardly surprising, as the data in this monograph do not really offer new perspectives or insights into this.

A feature of the book is the generally clear presentation of data and the thoughtful and well balanced interpretation of analyses and results. Apart from a few factual errors (e.g. the species' northern breeding limit is 55°S at Bouvetøya, not 60°S) my only cavil (except for those already raised) is that analysis and interpretation of breeding success data do not distinguish between the brood sizes actually involved. Attempting to rear two chicks rather than one can have rather different consequences in terms of fledging period or chick weight at fledging and chick survival, especially if both siblings survive for an appreciable time. One example illustrates this. The chicks of younger parents enter creches when a few days older than those of older parents. This is interpreted (in the absence of any presentation of supporting evidence) as resulting from their being less well fed and less vigorous. However, because young pairs very rarely have more than one chick surviving to creche age, one might expect that two parents are able to combine provisioning and guarding of their single chick for longer than parents with two chicks, which category will include a disproportionate number of older birds. This latter hypothesis is supported by the fact that Chinstrap penguin chicks are fed more frequently, grow slightly faster and later fledge one week earlier.

While this book offers few revelations in terms of seabird population studies it represents the painstaking compilation and analysis of an immense amount of field data. Although Sladen must be congratulated for initiating and supervising the project in the first nine years and LeResche for carrying out an important interim synthesis, I suspect that the main force behind the comprehensive analyses and presentations in this volume was that of David Ainley. Seabird biologists, all of whom will benefit from reading this book, owe him a great debt for undertaking the task so successfully and for giving us a penguin population study to place beside Richdale's classic work on Yellow-eyed penguins. Would that this might stimulate whoever holds the data from Carrick's long-term study of Royal penguins at Maquarie Island to publish!

J.P. Croxall

CLAPP, R.B., MORGAN-JACOBS, D. and BANKS, R.C. 1983. Marine birds of the Southeastern United States and Gulf of Mexico. Part III: Charadriiformes. Pp. xvi + 853; 25 maps, 84 tables, several black and white photographs. Report No. FWS/OBS-83/30: U.S. Fish and Wildlife Service, Division of Biological Services, Washington, D.C. \$12.00.

This is the third publication in a comprehensive series concerned with the status of seabirds in the south-eastern USA, and their susceptibility to offshore oil developments in the region. Parts I and II, published in 1982, covered respectively Gaviiformes – Pelicaniformes, and Anseriformes.

Part III compiles, from a review of over 1600 world-wide references, information on the seasonal distribution and abundance of 22 Charadriiform species: 2 phalaropes, 6 gulls, 13 terns, and Black Skimmer *Rynchops niger*.

Each species account includes treatment of global distribution, habitat, and diet, along with various life history details for 16 of the key species. This latter section is an excellent synthesis, including breeding biology parameters, breeding success, age at first breeding, longevity, and weights.

This compilation and its predecessors provide much more than just a working manual for field biologists in the USA. Based on an estimated 10,000 references, the series is an invaluable fund of information for all seabird biologists.

Euan Dunn

HALEY, D. (ed.) 1984. *Seabirds of Eastern North Pacific and Arctic Waters*. Pacific Search Press. Pp. 214. \$39.95.

There are just over one hundred species of seabird breeding in the North Pacific, including 21 alcids, 19 gulls and 26 procellariiformes. This glossy, large format book provides an attractively illustrated synopsis of their distribution and biology.

Delphine Haley has written a general introduction, plus short preambles for each of the three orders: procellariiformes, pelecaniformes and charadriiformes. A separate specialist has written each of the family accounts. These are non-technical sketches of the birds' biology, sometimes rather dry, but in other cases written with a personal touch which vividly conjours up all the magic of being among seabirds, either at sea or in a colony (e.g. that on fulmars and shearwaters on p43).

Chapters vary in quality: on p171 the erroneous idea that guillemot eggs spin like tops when knocked, is perpetuated. Even worse, on p172 we are told that Common Guillemot chicks lose weight for the first twelve days after hatching, then gain weight for four days, before losing weight again prior to leaving the colony!

The final very short chapter discusses the conservation of marine birds. We are told, among (a few) other things that Japanese salmon gill nets 'accidentally' catch millions of seabirds, but that the U.S. government is more interested in maintaining good relations with Japan rather than upholding the U.S.-Japan migratory birds treaty!

This book is illustrated with large colour photographs, although with rather fewer than I would have liked (not all species are illustrated). The pictures are, for the most part, excellent (some seas and skies are unbelievably blue), and particularly striking are: (i) the vast flock of shearwaters (p43), the colour phases of the fulmar on the Semidi Islands (p44) and the skimmer skimming (p163).

I doubt whether many British seabird biologists will buy this book, but it would make a nice present.

T.R. Birkhead

CROXALL, J.P., EVANS, P.G.H. and SCHREIBER, R.W. (Eds.) 1984. *Status and conservation of the world's seabirds*. Pp. 778, numerous figures and tables. Cambridge: International Council for Bird Preservation, Technical Publication No. 2. £24.90. ISBN 0-946888-03-5.

Being a seabird is tough. At sea, having skirted a gillnet and surfaced close to an oil slick, the hapless bird must search for food in waters where prey stocks have been diminished by man's activities. On land human exploitation and disturbance maintain the pressure. Even at breeding stations remote from any substantial human population there is a depressingly high probability that introduced predators, notably cats, will abound and make life difficult for seabirds.

What is strikingly apparent from this superlative compendium of information is that these pressures now effect virtually all seabird populations. The chances of a universal return to a 'state of nature' are low. The hope is that, by identifying the major threats, the line can be held, and this book, the best available single-volume documentation of the world's seabirds, can only help. As a source of reference for conservationists or more academically-minded seabird biologists it is totally indispensable.

In their chapter on north-eastern North America Brown and Nettleship correctly identify the need for a much better understanding of the dynamic interactions between human fishing, birds and fish stocks. If seabirds commonly take around 20% of unexploited and if commercial fisheries remove another 60% it does not follow, in a world of complicated biological interactions, that men and birds can together remove 80% without major ecosystem disturbance. In the domain of biological reality one plus one may not always equal two.

Where this book falls down is in the detail of coverage offered in the 39 chapters which together discuss the status of seabirds in nearly all significant corners of the globe. Thus Gallagher's Arabian Gulf chapter gives counts for very modest islands. On the other hand the New Zealand chapter by Robertson and Bell does not give a Wandering Albatross population for the Auckland Islands, the group which is, according to the chapter of Croxall *et al.*, the most important station for this superlative species. The variation in detail is equally reflected in the variation in the length of the chapter reference lists, from half a page to

six pages. Variation is evident too in the quality of the maps. Compare the clarity of the Antarctic peninsula distribution maps with the slightly – but barely discernably – thickened Greenland coastline which indicates a species' presence. All these faults would have been minimised if the editors had followed the good intentions of their Introduction and imposed a slightly more uniform format on their international assemblage of authors.

Typographical errors and outright mistakes are decently scarce. At the time of publication it was overoptimistic to assert (p. 669) that the campaign against Marion Island cats was continuing (although a major onslaught is now planned for the 1986/87 season). *Oceanodroma castro* does breed on the Salvages, *contra* Table 1 of le Grand *et al.*

Despite the threats faced by seabirds – I was staggered to learn that half a million birds are drowned annually in North Pacific gillnets – the knowledge needed to prevent, or at least minimize further damage to their populations is now available. The slow steady recovery of the Torishima Short-tailed Albatrosses and the success of the National Audubon Society in attracting Leach's Petrels to breed on hitherto uncolonised islands are examples to encourage conservationists. But, like their land-based colleagues, seabird conservationists must operate in a world where short-term economic and political 'imperatives' hold undue sway.

M. de L. Brooke

CAUSEY WHITTOW, G. and H. RAHN. 1984. Seabird Energetics. Pp. 328. Plenum, New York.

Books are becoming prohibitively expensive, and this one is no exception. My copy was £55.00 (partly because the exchange rate wasn't very good at the time). Nonetheless, one has certain expectations of a volume costing that amount, and my reaction on opening the book was a mixture of disappointment and interest. The disappointment stemmed from the poor production: the book is phototype set (i.e. it looks like a photocopy of a typed manuscript), made worse by the fact that each author appears to own a different make of typewriter. I started to feel slightly more positive about the book when I received my free review copy, and was able to sell it (very cheaply) to a colleague.

Despite the poor production, this is an extremely useful source book for certain types of seabird biologists. There are fourteen chapters covering various aspects of what the editors call energetics, and what I'd be hard pushed to call anything. As I see it the book can be divided into three sections: the first seven chapters deal with eggs (their formation, incubation, water loss, caloric content and embryonic development). Chapters 8 to 12 cover physiological aspects of energetics (e.g. thermoregulation, energetics of free-ranging penguins). The last two chapters deal with ecology, in particular, the role of seabirds in marine ecosystems. Since the book covers so much ground, spanning as it does, physiology and ecology, most seabird biologists will find something of interest here.

The most useful chapters are those which comprise general reviews, or provide guide lines of 'how to do it'. I found Grau's chapter (1) on egg formation, and that of Rahn *et al.* (Chapter 5), particularly clear and interesting. In the last decade our understanding of the 'ecology' and physiology of seabird eggs has increased dramatically, but as these two chapters show, there is still a great number of unanswered questions, and plenty of scope for seabird biologists looking for interesting projects. Weins' chapter (11), provides a no-nonsense account of how information on seabird physiology and energetics can be incorporated into models which can then be used to make estimates or predictions about food requirements of seabird populations or communities. This is then followed by a case study, by Croxall, Ricketts and Prince of the effects of South Georgia's particularly large and diverse seabird community on krill stocks. Once again, these chapters raise more questions than they answer, but the authors point the way forward and specify the types of data which are now needed to construct more refined models.

Overall, this is a useful book for seabird biologists, but since its production will hardly grace even the poorest of bookshelves, it is probably one you should borrow from the library, rather than sacrifice your holiday savings for.

T.R. Birkhead

## THE SEABIRD GROUP 1986

*The Seabird Group* was founded in 1966 to circulate news of work in progress on seabirds and to promote cooperative research. It is run by an Executive Committee composed of nine elected members and maintains close links with the three major British national ornithological bodies – the British Ornithologists' Union, the British Trust for Ornithology, and the Royal Society for the Protection of Birds. Membership (£5 per annum, £2.50 for students and pensioners) is open to all with an interest in seabirds; for details please contact the Secretary (address below) – payment by banker's order and deed of covenant helps the Group.

*Current Executive Committee* The present Committee comprises: Chairman J.P. Croxall, Secretary E.K. Dunn, Treasurer T.J. Stowe, also A. Blackburn, M.P. Harris, G. Mudge, A. del Nevo (Newsletter Editor), K.E. Partridge, and M.L. Tasker. There are two co-opted members: Ms L. Underwood and, representing the interests of the former Gull Study Group which has now merged with the Seabird Group, K. Taylor.

*Newsletter and Meetings* Three duplicated newsletters are circulated every year to members. They contain all sorts of news including reports on research projects (particularly those with a grant input from the Group – see below), details of meetings, etc. The Newsletter Editor welcomes contributions from members. The usual venue for the Group's annual meeting is the BTO Ringing & Migration Conference at Swanwick, except when the Group holds its own conference, in which case the meeting is combined with that. Our conferences draw on seabird workers from home and abroad to join in a forum of topical interest. In keeping with our desire to promote work in the field, practical manuals and guidelines evolve from the workshop sessions which cater for specialist topics within the conference theme. It is proposed to hold our next conference in spring 1988 on the topic 'Food and Feeding', details of which will emerge in future newsletters.

*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 January annually, and will be considered by the Executive Committee before the end of March for distribution. Certain areas of research may be favoured for grant support from time to time and in 1986 the allocation has reflected our commitment to the Seabird Colony Register (see below). Successful applicants are required to submit a typed report, not exceeding 500 words, by the end of September of the same year for inclusion in the Newsletter. A full typed report (in triplicate) must be submitted by the end of the year.

*Seabird Colony Register* The Seabird Group has always sought to organise and implement national schemes to promote the participation of and harness the energies of its membership, now standing at some 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 is now in full swing with its Seabird Colony Register, begun in 1985 to gather together all existing data on breeding seabird numbers in the British Isles, bring our knowledge of their status up to date by detailed field surveys in 1986 and 1987, and to establish a computerised database which can easily be updated in the future. After a good start to the Register in 1985, when pilot surveys were carried out and regional organisers appointed at the behest of our coordinating sub-committee, 1986 is the critical year in which a formidable amount of fieldwork has been set in motion to achieve a successful coverage. The coastline has been divided into seventeen regions, each organised and coordinated by a local representative. A full appraisal of the current state of the scheme, and future requirements, appeared in Newsletter No. 44 (January 1986). NCC, who have helped fund the

Register this year, have appointed Clare Lloyd to orchestrate the collection and analysis of the data. There will still be opportunities for fieldwork in 1987, and enquiries about help should be addressed to Clare Lloyd, NCC, 17 Rubislaw Terrace, Aberdeen AB1 1XE, Grampian, Scotland.

*Seabird Journal and previous reports* In November 1984 the Group launched its new-look journal *Seabird*, numbered 7 in deference to its pedigree of Seabird Group Reports 1-6. After the production of *Seabird* 8 in 1985, a new format was settled for the present Number 9 and subsequent issues to guarantee a viable annual production schedule for the future at a time of rising costs. Our priority is to maintain a high volume and quality of content at stable cost to the membership, and we trust that recipients of *Seabird* will welcome the modest change of format in pursuit of these standards. The current editor, M. de L. Brooke, welcomes offers of papers (see Notice to Contributors, and address below). Members of the Seabird Group receive *Seabird* free of charge; additional copies to members, and any copies to non-members, are £5 + 50p postage within the British Isles, £5 + £1 postage overseas. Postage overseas must, regrettably, be by surface mail, unless the recipient can make prior provision for air-mail. The subscription to Libraries is £7.50 per copy. To help reduce costs, overseas subscribers are kindly asked to make payment by international money order rather than by cheque. At intervals in the past, the Group published Reports to which *Seabird* is the successor. Copies of 4 of the earlier Reports are available from the Secretary as follows: issues for 1969, 1971 at 50p, 1975-6 (Number 5) at £1, 1977-81 (6) at £2. *Seabird* 7 (1984) is also available at £2, and *Seabird* 8 (1985) at £5. For all these back issues, postage costs are the same as for *Seabird* 9. There are no cost concessions for multiple orders of *Seabird* or previous reports, and postal charges are additive. Copies of the Proceedings of Seabird Group Conferences 1982 and 1985 are also available on receipt of 50p postage, as are copies of the Auk Censusing Manual (1980), though it should be borne in mind that censusing techniques are still advancing.

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

## NOTICE TO CONTRIBUTORS

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

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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 *Ibis* and follow the conventions for section headings, tables, captions, references, quotation marks, abbreviations etc. The Editor may return without consideration any submission that departs from the *Ibis* form of presentation. Spelling should conform with the preferred, i.e. first-cited spelling of the *Shorter Oxford English dictionary*. Hyphenated terms commonly used include: body-weight, breast-band, cross-section, eye-ring, tarsus-length, wing-length, wing-moult, tail-coverts. Details of experimental technique, extensive tabulations of results of computation procedures, etc. are best presented as appendices. A full-length paper must include a summary not exceeding 5% of the total length.

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

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

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

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

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

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

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

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