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Cover vignette of Manx Shearwater by B. Zonfrillo

Hedgehog *Erinaceus europaeus* predation on Arctic Tern *Sterna paradisaea* eggs: the impact on breeding success.

John Uttley, Patricia Monaghan and Jane Blackwood

INTRODUCTION

The majority of seabirds avoids terrestrial predators by nesting either on islands whose natural fauna is lacking in ground predators, or in inaccessible habitats such as cliffs (Lack 1968). Ground nesting species such as gulls and terns which frequently nest on mainland sites rely on communal mobbing as a deterrent, but this is most effective against avian predators. Consequently the presence of ground predators can pose a considerable threat to seabird populations. Feral cats *Felis domesticus* and rats *Rattus sp.* are generally the most destructive and widespread introduced predators but other predators such as mustelids and foxes are known to have had serious effects upon seabird populations (Moors & Atkinson 1984).

The hedgehog *Erinaceus europaeus*, which has been introduced to many offshore islands in Britain in recent times, is now suspected of causing significant damage to seabird populations. On North Ronaldsay in 1986 150 hedgehogs were removed after several species including Arctic Terns *Sterna paradisaea*, Black-headed Gulls *Larus ridibundus*, Skylarks *Alauda arvensis* and Ringed Plovers *Charadrius hiaticula* had suffered decreases in numbers which were attributed to hedgehog predation of eggs and chicks (K. Woodbridge pers. comm.). Arctic Terns at least have since shown improved breeding success, though they have moved from inland habitats to shingle beaches (K. Woodbridge pers. comm.).

Despite the potential threat to island bird populations little is known about the ecology of hedgehogs introduced to islands with large populations of ground nesting birds. Kruuk (1964) performed some experiments in a Black-headed Gull colony at Ravenglass, Cumbria, which showed that a single hedgehog may destroy as many as eight eggs per night if no other food is available. Since Black-headed Gull eggs are twice as large as Arctic Tern eggs one might expect hedgehogs to be capable of taking up to sixteen of the latter's eggs per night although Kruuk (1964) also stated that a diet composed solely of eggs induced diarrhoea in the hedgehogs so that under natural conditions fewer eggs may be taken.

METHODS

In 1987 154 Arctic Tern nests were marked at a breeding colony of ca. 500 pairs at Dalsetter, Shetland, (59° 56' N, 1° 16' W) to monitor breeding performance; 124 clutches were also marked at a nearby, separate colony at Garths Ness (59° 53' N, 1° 23' W) of ca. 400 pairs. Intensive observations from hides of incubating birds were made at Dalsetter between 4 and 13 June and at Garths Ness between 11 and 14 June. The number of nests watched at each site was 35 and 50 respectively. All of these observations were during the daylight hours (0300 to 2100 GMT). On the night of 13/14 June the Dalsetter birds were watched between 2115 and 0130. Attendance patterns of adults were recorded throughout the observation periods, as was clutch disappearance (presumed to be due to predation); clutch desertion (i.e. abandonment of intact clutches) was recorded during the first week of observation at Dalsetter and throughout the observation period at Garths Ness.

RESULTS

A total of 277 eggs produced only 25 chicks from 154 marked clutches at Dalsetter, whereas 124 clutches at Garths Ness, containing a total of 251 eggs resulted in 186 hatched chicks. The mean number of eggs hatched per egg laid at the two colonies was 0.08 (S.E. = 0.02) at Dalsetter and 0.71 (S.E. = 0.33) at Garths Ness ($t = 17.01$, d.f. 276, $p < 0.001$).

No desertion or predation ever occurred during daylight at either colony and incubation behaviour did not suggest that the adults were neglecting their clutches in any way, since nests were left unattended for only 0.035% of daylight observation time at Dalsetter ($n = 1300$ nest-hours) and 0.025% at Garths Ness ($n = 400$ nest-hours). This difference is not significant. Very few clutches were predated or deserted during the observation period at Garths Ness (Table 1). However at the Dalsetter colony overnight disappearance and desertion of clutches and nests occurred in a systematic pattern. All 64 nests in an intensively studied plot failed; at least 25% of failures were a result of nest desertion (Table 1). Freshly deserted clutches were always neighbours of clutches which had disappeared (presumed predated) the previous night, and nests were affected in a well defined geographical sequence, beginning at the inland edge of the study plot and progressing coastwards. Figure 1 shows the temporal pattern of clutch desertion and disappearance.

TABLE 1. THE FATE OF NESTS IN THE STUDY PLOTS AT DALSETTER AND AT GARTHS NESS IN 1987.

	<i>Dalsetter</i>	<i>Garths Ness</i>
No. of clutches observed	64	124
Predated/definitely hedgehogs (n)	48/48*	1/0
Deserted (n)	16†	4
No. where eggs hatched	0	119

* may include some nests deserted after 14 June and subsequently predated before desertion noted.

† minimum figure.

During the night-time observation at Dalsetter two hedgehogs were seen moving through the study plot. Each hedgehog ate two marked clutches and remained in the study plot for 35 and 15 minutes each between 2210 and 2305. An unmarked clutch was also taken by one of the hedgehogs. Disturbances continued to be heard in other areas of the colony until 0045 and it is likely that further predation was occurring. All of the adults incubating eggs within ca. 15 metres of the hedgehogs mobbed the animals as they moved through the colony but this did not obviously deter them. When a nest was found by a hedgehog that adult which had been incubating there continued to mob it whilst all other birds resumed incubating. Mass mobbing only resumed when the hedgehog began searching once more. Nests with eggs which had been deserted previously were generally not depredated and both hedgehogs passed very close to more than five of such nests without being attracted to them.

Nests which had been predated by hedgehogs were easily identifiable. Shell fragments were always left in the nest-scape, whereas avian predators would remove whole eggs from the nest for consumption elsewhere.

DISCUSSION

Although the breeding success of Arctic Terns on Shetland was virtually nil at all colonies in Shetland in 1987, the failure at Dalsetter occurred much earlier in the season than at other

colonies, such as Garths Ness where chicks hatched successfully but died of starvation (Monaghan *et al* 1989). No evidence of the presence of hedgehogs was ever seen at Garths Ness (J.U. & J.B. pers. obs.), and none of the eggs which failed to hatch were predated by hedgehogs (Table 1). Data from 1986 (Coulson 1986) show that failure at Dalsetter occurred at least a week earlier than at other colonies in that year. This suggests that hedgehogs may have been eating Arctic Tern clutches at this colony in 1986 also.

Although in Shetland this problem may be limited to the Arctic Terns at Dalsetter, it is very possible that the problem is more widespread. The distribution and abundance of the hedgehog in Shetland is poorly known. Following introduction to the mainland of Shetland in the mid-nineteenth century they spread into all of the islands in the group with the exception of Unst, Fair Isle and Outer Skerries (Berry & Johnston 1980). The only information on their distribution in Shetland comes from road casualties which are most common around human settlements (Berry & Johnston 1980), and densities in different habitats and in areas away from roads are unknown. Corbet & Southern (1977) state that cover for nesting is an important requirement and so inhabited areas may be expected to be important centres of population. Dry-stone walls, which are common on grazings, also have potential for use as nesting sites. The Arctic Tern colony at Dalsetter is on maritime heathland and unimproved grazing, and several walls lie within the colony. These habitats are very important for Arctic Terns in Shetland, holding approximately 45% of all Shetland colonies in 1980; in the same year all nine colonies of more than 1000 pairs were found in such habitats (Bullock & Gomersall 1981).

Most studies on the ecology of hedgehogs have been performed in rural and suburban areas of the south of England (e.g. Morris 1988). These studies have suggested that 'home-range' and density vary between habitats. On South Uist, Outer Hebrides, hedgehogs were introduced only twelve years ago and have already reached very high densities (D.B. Jackson pers. comm.) but there has been no study made of the effects upon the internationally important concentrations of breeding waders on the Machair.

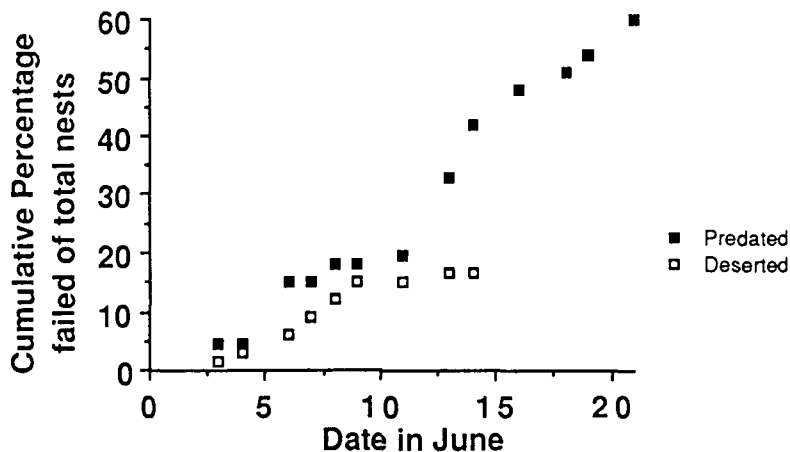


Figure 1. The timing of clutch disappearance and desertion in the study plot at Dalsetter in 1987, showing predated (solid squares) and deserted (open squares) nests ($n=64$ nests). N.B. No desertions could be recorded after intensive observations ceased on 14 June.

Figure 1 shows that during the first week of observation desertion accounted for nearly as many nest failures as did direct predation. The proximity of nests which were deserted and nest which were predated on the same night suggests that hedgehogs caused those nest failures due to desertion in addition to those where they actually ate the eggs. Nocturnal disturbance appears to be an extremely disruptive influence upon breeding terns, and nest failure as an indirect results of nocturnal predation has been noted previously. Nisbet & Welton (1984) documented predation by a Great Horned Owl *Bubo virginianus* on Common Terns *Sterna hirundo* and showed that egg and chick losses due to other causes were enhanced by the owl's activities.

Clearly Arctic Terns are not the only bird species vulnerable to hedgehogs. Imber (1975) has suggested that vulnerability to ground predators is a function of relative body size. Thus Arctic Terns, which weigh only 100-120g compared with hedgehogs which weigh approximately 1000g in the breeding season (Corbet & Southern 1977) may be more at risk than most other seabirds; though burrowing species such as small petrels and shearwaters may also be highly vulnerable. Hedgehogs may also pose a considerable threat to other ground-nesting birds found on islands, such as the waders of the Outer Hebrides. Clearly, where hedgehog predation does occur it can have a dramatic effect on breeding success and there is an urgent need for research into the ecology of hedgehogs introduced to islands with large populations of ground-nesting birds so that the seriousness of the threat posed may be ascertained and appropriate action taken if necessary.

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SUMMARY

There have been few direct observations of hedgehog predation at seabird colonies. This paper reports such an observation and documents the impact of hedgehog predation on the breeding success of a colony of Arctic Terns in Shetland. During incubation nocturnal nest predation and desertion were found to be very high (less than 10% of eggs laid hatched) at one colony where hedgehogs were present and taking tern eggs. The nest failure rate was virtually zero at another colony, where hedgehogs were absent.

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Biometrics of auks at Jan Mayen

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INTRODUCTION

Biometrics of auks caught or collected at breeding colonies are needed to describe a species' geographical variation, and to help to determine the origin of auks found in wintering areas (cf. Anker-Nilssen et al. 1988, Hope Jones 1988). Few data are available from Jan Mayen, Greenland Sea (71°N, 08° 30' W). This paper reports on measurements made in summer 1983.

METHODS

Little Auks *Alle alle* (18), Puffins *Fratercula arctica* (6), Common Guillemots *Uria aalge* (7) and Brunnich's Guillemots *Uria lomvia* (27) were caught on the breeding colonies and measured. Further measurements were taken on corpses of Brunnich's Guillemots (28) and Little Auks (6) found dead at the beach or near the colonies.

Live birds and fresh corpses were weighed to the nearest 5g using a Pesola spring balance. Wing-length was measured to the nearest 1mm by flattening and straightening the feathers to give a maximum value. Further measurements were bill-length, bill-depth (both to the nearest 0.1mm), head-length, and tarsus-length (both to the nearest 1mm), using slightly different methods in each species. In Common Guillemot and Brunnich's Guillemot, bill-length was measured from tip to feathers (method 1) and from tip to nostril (method 2). Bill-depth was measured at the base (1) and gonys (2). In Little Auks, bill-length was measured in a similar way, but bill-depth was measured at the base (maximum depth) only. In Puffins, bill-length was measured from tip to feathers, or the posterior edge of the keratinous cere (1), to the anterior edge of the cere (2), the lower (cutting) edge of the upper mandible from tip to the outer edge of the cere (straight bill length) (3), and from tip to nostril (4). Bill-depth was measured at the base (maximum depth), again excluding the cere. Head-length was the same in all species, measuring from the tip of the bill to the back of the head. Measurements taken of living birds or fresh corpses are presented separately from older corpses, to avoid problems with post-mortem shrinkage (Harris 1980). Measurements of males and females, sexed by dissection, are given separately. Fresh Brunnich's Guillemots' eggs were weighed to the nearest 5g and maximum width and length was measured to the nearest 0.1mm. These eggs came from ledges with both Brunnich's and Common Guillemots. These ledges were later found to hold very low numbers of Guillemots (98% Brunnich's Guillemots, n=299). However, one or two Common Guillemots' eggs may have been included in the sample.

RESULTS

Common Guillemot *Uria aalge*

Guillemots were first observed ashore at Jan Mayen in 1974, and breeding was recorded in 1983 when the population was estimated at 100-1000 pairs (Van Franeker et al. 1986). The proportion of bridled Guillemots was assessed at 28.7% (n=185; Birkhead 1986). Measurements of seven adults with eggs or small chicks are listed in Table 1.

TABLE 1. BIOMETRICS OF ADULT BREEDING GUILLEMOTS CAUGHT AT JAN MAYEN.

	Sample size	Mean	Standard deviation	Range
bill-length (1)	7	45.4mm	±2.03	42.5-47.4
bill-length (2)	7	41.8mm	±1.79	37.1-41.8
bill-depth (1)	6	13.8mm	±0.51	13.8-15.2
bill-depth (2)	7	12.7mm	±0.49	12.7-14.2
head-length	7	113.4mm	±2.60	110-117
wing-length	7	212.1mm	±5.61	203-219
weight	7	1003g	±49	940-1060

TABLE 2. BIOMETRICS OF ADULT BREEDING BRUNNICH'S GUILLEMOTS CAUGHT AT JAN MAYEN (a), OF FRESH CORPSES OF SUMMER PLUMAGE BIRDS (b) AND OF OLD CORPSES OF SUMMER-, WINTER PLUMAGE, AND MOULTING SPECIMENS (c) FOUND DEAD AT JAN MAYEN.

	Sample size	Mean	Standard deviation	Range
bill-length (1) (a)	27	35.7mm	±1.79	32.3-39.5
(b)	13	36.7mm	±2.28	32.6-41.4
(c)	12	34.8mm	±3.77	28.6-39.0
bill-length (2) (a)	27	29.6mm	±1.59	26.8-33.1
(b)	13	30.3mm	±1.85	27.9-34.4
(c)	10	28.2mm	±3.19	23.1-31.4
bill-depth (1) (a)	27	14.6mm	±0.79	13.0-16.3
(b)	13	14.3mm	±0.79	12.8-15.8
(c)	12	13.0mm	±1.74	10.3-15.2
bill-depth (2) (a)	27	13.7mm	±0.75	12.2-14.9
(b)	13	13.5mm	±1.00	12.1-15.3
(c)	12	12.2mm	±2.19	8.4-15.2
head-length (a)	27	102.8mm	±3.10	96-108
(b)	13	103.1mm	±3.33	99-111
(c)	9	101.1mm	±4.40	94-107
wing-length (a)	23	224.5mm	±4.58	214-231
(b)	13	225.6mm	±4.92	216-231
(c)	15	217.8mm	±7.76	206-230
weight (a)	27	1007g	±68	870-1160

Brunnich's Guillemot *Uria lomvia*

The total breeding population was estimated at 107,000 individuals (Van Franeker *et al.* 1986), mainly concentrated on the northern- and southern-most tips of the island (respectively 60,000 and 36,750 individuals). All birds were caught at the colonies near Splittodden (1,550 individuals). Measurements are listed in Table 2 (a). On the tideline 28 corpses were examined including 18 summer plumage, 4 transitional plumage, and 3 winter plumage birds. Measurements of fresh corpses, of which all were summer plumage birds, are listed in Table 2 (b), those of old corpses in Table 2 (c). The winter birds may have included some juveniles which had died at the island in 1982, since decomposition takes its time in the arctic. These birds had the shortest bills recorded (bill-length (1) 28.6-30.7mm) and also short wings (206-211mm). The mean weight of 185 fresh eggs collected in the early breeding season (27-29 May 1983) was 108.4 ± 10.3 g (range 80-135). Length and width of these eggs was 80.3 ± 3.9 mm (range 69.7-89.6, $n=183$) and 50.5 ± 2.9 mm (range 42.5-55.6, $n=185$) respectively.

Puffin Fratercula arctica

Puffins were not particularly numerous at Jan Mayen; a single estimate of breeding numbers suggests 1000-10000 pairs (Van Franeker *et al.* 1986). Highest numbers were recorded at the Splittodden colonies and at Kapp Rudsen. Measurements and weight of adult Puffins (>2 bill grooves) are summarised in Table 3. An immature bird (1½ bill grooves) had bill-length (1) 53.4mm, (2) 50.5, (3) 32.2, (4) 22.7, bill-depth 38.3, head-length 84, tarsus-length 29, wing-length 187, weight 530g.

TABLE 3. BIOMETRICS OF ADULT BREEDING PUFFINS CAUGHT AT JAN MAYEN.

	<i>Sample size</i>	<i>Mean</i>	<i>Standard deviation</i>	<i>Range</i>
bill-length (1)	5	54.8mm	± 2.0	52.7-57.3
bill-length (2)	5	51.9mm	± 1.4	50.1-53.4
bill-length (3)	5	32.7mm	± 0.4	32.1-33.3
bill-length (4)	5	22.0mm	± 1.5	20.2-24.1
bill-depth	5	41.5mm	± 1.2	39.8-42.6
head-length	5	86.0mm	± 1.9	84-89
tarsus-length	5	30.6mm	± 2.1	27-32
wing-length	5	184.2mm	± 6.8	177-195
weight	5	602g	± 37.5	560-650

Little Auk Alle alle

Little Auks are amongst the most numerous breeding seabirds at Jan Mayen, with 10,000-100,000 pairs in 1983 (Van Franeker *et al.* 1986). 18 summer plumage individuals were caught at colonies at Kvalrossen, another 2 were found freshly dead at a colony at Borgsletta. Most of these birds were probably breeding adults. However, a female caught at Kvalrossen definitely was not as it had a thin oviduct. Measurements of all these birds are listed in Table 4. There was no significant difference between males and females in these measurements. Of 4 birds collected on the tideline, all old and dried corpses, only wing-length is available (mean 123.7 ± 5.6 , range 118-131mm).

TABLE 4. BIOMETRICS OF SUMMER PLUMAGE LITTLE AUKS CAUGHT OR COLLECTED AT BREEDING SITES ON JAN MAYEN.

	<i>Sample size</i>	<i>Mean</i>	<i>Standard deviation</i>	<i>Range</i>
bill-length (1)	20	14.1mm	± 0.76	12.4-15.3
bill-length (2)	20	11.2mm	± 0.72	10.1-12.5
bill-depth	20	6.4mm	± 0.55	5.4-7.3
head-length	20	51.5mm	± 1.43	49-54
tarsus-length	20	20.2mm	± 1.01	19-22
wing-length	20	118.4mm	± 3.69	112-124
weight	18	146g	± 13.2	120-175

DISCUSSION

The wing-length of Guillemots breeding at Jan Mayen (mean 212.1mm, Table 1) fits very well with the cline for European Guillemots (Hope Jones 1988), and indicates that a population of rather large birds is found here. Measurements, under-wing spotting and back colour (seen in the field and in the hand), suggest that the breeding sub-species at Jan Mayen may be *U.a.hyperborea*. However, wing-lengths of less than 210mm (found twice) are uncommon in *hyperborea* and our sample is too small to draw a final conclusion.

Schaanning (1933) lists wing- and bill-length of skins and weight of eight breeding Brunnich's Guillemots shot at Jan Mayen. Wing- and bill-length were much smaller than in our data, perhaps as a result of post-mortem shrinkage (wing-length 216.6 ± 3.4 mm, range 211-220, $n=8$, bill-length 33.9 ± 1.9 , 32-37). Remarkably, the weights (mean 1365 ± 61.6 g, range 1300-1470, $n=8$), were on average nearly 20 percent more than our heaviest specimen (see Table 2). Dimensions and weight of 15 eggs measured freshly were quite similar to ours (average 80.7×50.7 mm, weight 99.9 ± 13.6 g, range 77-115).

Measurements of Puffins shot at Jan Mayen have been published previously (Holgersen 1953, Salomonsen 1944, Schaanning 1933). Most authors place the Jan Mayen birds between *F. a. arctica* and *F. a. naumanni*. The average wing-length of 15 skins measured by Salomonsen and nine by Schaanning was 175.1 ± 3.5 mm (range 168-180 mm), and 173.4 ± 3.2 (range 168-177) respectively. Salomonsen also found two dwarf specimens (156 and 162 mm respectively). Holgersen mentions one adult with 177 mm. We have found considerably longer wings (Table 3), and it is doubtful whether post-mortem shrinkage is to blame for a 10 mm difference. Bill-length (method 1, from feathers) was 51.3 ± 2.9 mm (range 45.3-54.2), and 51.2 ± 4.0 mm (range 43-55) respectively. Included are two dwarf specimens (49 and 43 for bill-length, 38 and 35 for bill-depth respectively). Holgersen recorded a bill-length of 51 and depth of 40 mm. In the present study bills were longer, but bill-depth was about the same (54.8 and 41.5 mm respectively). Schaannings weights of Puffins are slightly below our findings (mean 560 ± 41 g, range 490-600). The measurements in this study indicate the presence of *naumanni* rather than of *arctica* on Jan Mayen (cf. Cramp 1985).

Measurements of Little Auks are published by the same three authors from adult birds shot at Jan Mayen earlier this century, and these are similar to the present study.

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SUMMARY

Breeding individuals of Common Guillemot, Brunnich's Guillemot, Puffin and Little Auk were caught and measured at Jan Mayen in summer 1983. Dimensions and weights of 185 eggs of Brunnich's Guillemots were also measured. Compared with previous studies, we found considerably larger Puffins, larger but much less heavy Brunnich's Guillemots and very similar Little Auks. It is concluded that the Common Guillemots belong to the sub-species *Uria aalge hyperborea* and that the Puffins belong to *Fratercula arctica naumanni*.

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A note on the diet of Razorbills *Alca torda* wintering off Portugal

Pedro Rui Beja

INTRODUCTION

The diet of the Razorbill *Alca torda* is fairly well known over much of its breeding range, but far fewer data are available on the winter food (Bradstreet & Brown 1985). Pilchard *Sardina pilchardus* and anchovy *Engraulis encrasicolus* are the only prey species that have been reported from the southern wintering grounds (Witherby *et al.* 1941, Teixeira 1986).

The Razorbill is a common winter visitor to Portugal, and most birds are probably from British and Irish breeding colonies (Mead, 1974, Hope Jones 1984, Teixeira 1986). Each year large numbers drown while diving near floating nylon gill-nets set off the coast for scar *Trachurus trachurus*, mackerel *Scomber* spp., grey mullet (Mugilidae), sea bream (Sparidae), etc. (Bourne 1984, Teixeira 1986). This mortality was studied between 1983 and 1987 at Fonte da Telha, a small fishing settlement 15 km south of Lisbon, where several hundred corpses were found each year from November to March (Teixeira 1986). Here I report on the stomach contents of a few freshly killed specimens.

METHODS

From November 1985 to March 1986, and in January and November 1987, freshly drowned Razorbills were collected at Fonte da Telha. Most birds had been dead for less than 24 hours and none for more than three days, and were caught in nets set within 9 km of land. Corpses were deep-frozen after collection and stomachs removed and stored in 70% alcohol a few weeks later. The soft tissues and bones of prey present in the oesophagus/proventriculus and in the gizzard were identified and counted and their wet weight recorded. Particular care was taken to examine the endothelial folds of the gizzard for small otoliths, invertebrate parts, etc. Each prey item was identified to the lowest possible taxon. Fish identification was achieved from whole bodies and from otoliths and characteristic bones, with the help of a reference collection. Where possible fish length was measured from the tip of the snout to the tip of the hypural fan (standard length).

RESULTS

Of the 26 freshly killed Razorbills examined, 19 (73%) contained identifiable fish prey, 3 (12%) had no remains at all and 4 (15%) had only a very small amount of unidentified fish bones in the gizzard. The samples with identifiable remains averaged 10.8g (n=18; s.d.=13.5g; range 0.9-47.5g), and contained an average of 4.3 items (n=19; s.d.=3.9 items; range 1-17 items). The samples were generally in good condition, since the birds were caught while feeding, so prey identification to species level was usually possible.

The frequency of occurrence of prey species in the stomachs with identifiable remains is shown in Table 1. Four fish families were found, each represented by a single species. Pilchard was by far the most important species, occurring in 15 (79%) of the 19 stomachs with identifiable remains, making up 66% of the 82 prey items found, and being present in all months except December 1985, when the single bird examined had no identified remains.

Standard lengths averaged 6.5cm ($n=11$; s.d. = 1.2cm; range 4.0-8.3cm). These pilchards were certainly immatures less than one year old, as the species attains maturity when c. 13.5-15.5cm long, during the first year of life (Figueiredo & Santos 1988).

The other two important species were anchovy and sandeels. Anchovy occurred in November 1985 and 1987 and was only found when pilchard was also present. The 19 sandeels were present in 3 (16%) stomachs collected in January 1987. The only two identified were *Ammodytes tobianus*. Standard lengths were measured in one anchovy (7.0cm) and in both *Ammodytes tobianus* (10.0cm).

TABLE 1. PREY ITEMS FROM 19 RAZORBILL STOMACHS FROM FONTE DA TELHA, PORTUGAL. (NOVEMBER – MARCH).

Prey	Overall frequency of prey item		Stomachs in which prey item occurred	
	(n)	(%)	(n)	(%)
Clupeidae				
Pilchard <i>Sardina pilchardus</i>	54	66	15	79
Engraulidae				
Anchovy <i>Engraulis encrasicolus</i>	6	7	3	16
Atherinidae				
<i>Atherina presbyter</i>	2	2	1	5
Ammodytidae				
<i>Ammodytes tobianus</i>	2	2	1	5
unidentified Ammodytidae	17	21	3	16
Unidentified fish	1	1	1	5

DISCUSSION

For seabird diet studies care must be taken in drawing conclusions from small sample sizes (Harrison *et al.* 1984). However, these results, together with those from Witherby *et al.* (1941) and Teixeira (1986), indicate the importance of pilchard to Razorbill in its southern wintering grounds. In fact, pilchard is likely to be the main available resource in these areas. Although the relative abundances of fishes in the waters off Portugal are not known, pilchard seem to be the commonest small fish and, as far as is known, the only small epipelagic species that occurs in very large shoals.

Seabird populations interact with fisheries in a complex way but the decrease of several seabird populations has been associated with the overexploitation of some fish stocks (Furness 1984). The Iberian pilchard stock supports a large human fishery which, over the years of 1976 to 1987, took an average of about 24-31% of the total stock each year (ICES 1988). The fishery is based mainly on young fish (ages 0-2), so probably competes with seabirds. Knowledge of the dynamics in availability of pilchard might help explain the very variable annual numbers of Razorbills recorded in the southern wintering areas (Mead 1974, Carboneras 1988).

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The Mallophaga of Manx Shearwaters *Puffinus p. puffinus* from Ynys Enlli, Wales

J.A. Fowler and G.J. Shaw

INTRODUCTION

The Mallophaga of British breeding procellariiform species were described by Fowler and Miller (1984). In that study sufficient data to construct frequency distributions and population structures of infesting lice were obtained only from Storm Petrels *Hydrobates pelagicus* and Fulmars *Fulmarus glacialis*. Subsequent investigations included a comparison of Storm Petrel lice with those of Wilson's Petrel *Oceanites oceanicus* (Fowler & Price 1987), and an analysis of the Mallophaga of Leach's Petrels *Oceanodroma leucorhoa* (Fowler & Hodson 1988).

A study of seabird feather lice may throw light on phylogenetic relationships and geographic origins of birds (e.g. Zonfrillo 1988). Analysis of frequency distributions and population structures of infesting lice can give an insight into the relationship between the ectoparasite and the host (Fowler & Price [1987] review recent work in this field). Fowler & Miller (1984) were able to delouse only four Manx Shearwaters in Shetland, recording two species of Mallophaga. In this paper we report the frequency distributions and population structures of Mallophaga obtained from a very much larger sample of shearwaters from Ynys Enlli, Wales.

METHODS

Adult Manx Shearwaters were captured by hand at night as they came ashore on Ynys Enlli (Bardsey Island), Gwynedd, Wales, during 8-24 August 1987. Birds were not aged or sexed, but unfledged birds were avoided. Shearwaters were deloused at the Bird Observatory in plastic buckets (approx. 13 dm³) for 20 min, as described by Fowler & Cohen (1983). The delousing anaesthetic was ethyl acetate (5 cm³) absorbed on a disc of filter paper cut to fit the floor of the bucket where lice collected. Lice were found by careful scanning with a x10 binocular microscope and removed and preserved in 70% ethanol.

Lice from each bird were identified by comparison with reference specimens verified by R.L. Palma. Age-classes of lice were determined biometrically, using length and width measurements of the chitinated head capsule as explained by Fowler, Miller and Cohen (1984). Population structures and frequency distributions of individual population classes (adults and nymphs) were estimated from random sub-samples.

RESULTS

A total of 12,298 Mallophaga of 8 species was collected from 230 Manx Shearwaters (Table 1). All birds carried lice, and the species frequency distribution was: 1 bird had 1 species; 192 had 2 species; 36 had 3 species; 1 had 4 species. There was no tendency for the most heavily infested birds to have also the most species.

Statistical information relating to frequency distributions is presented in Table 2. The frequency distributions of whole populations of *T. aviator* and *H. diversus* are shown in Figures 1 and 2, and the distributions of adult and nymph population classes are shown separately in Figures 3 and 4. In each case the expected frequencies of a negative binomial

distribution based on estimations from sample data of the exponent k are superimposed (joined closed circles). All distributions are described by the negative binomial model, but that for the whole population of *T. aviator* is only a weak fit (chi-square goodness of fit tests). There is no statistically significant difference between the values of k for adult and nymph classes of either species, or between either population class and its whole population ($z < 1.5$ in all cases).

TABLE 1. INCIDENCE OF MALLOPHAGA ON 230 MANX SHEARWATERS *PUFFINUS P. PUFFINUS* DELOUSED ON YNYS ENLLI DURING AUGUST 1987.

Species	% birds infested	Number of lice collected	Mean (Range in brackets)	Variance s^2
Ischnocera: <i>Trabeculus aviator</i> (Evans, 1912)	99.5	6594	28.7 (0-104)	368.7
Ischnocera: <i>Halipeurus diversus</i> (Kellogg, 1896)	99.5	5572	24.2 (0-102)	316.8
Amblycera: <i>Austromenopon paululum</i> (Kellogg & Chapman, 1899)	13.5	115	0.5 (0-51)	12.96
Ischnocera: <i>Saemundssonina</i> sp.	0.4	7	(0-7)	—
Ischnocera: <i>Naubates harrisoni</i> (Bedford, 1930)	1.7	5	(0-2)	—
Amblycera: <i>Ancistrona</i> sp.	0.8	3	(0-2)	—
Ischnocera: <i>Halipeurus</i> g. <i>gravis</i> (Timmermann, 1961)	0.4	1	(0-1)	—
Ischnocera: <i>Naubates</i> sp.	0.4	1	(0-1)	—

TABLE 2. SAMPLE DATA FOR MALLOPHAGA FROM MANX SHEARWATERS *PUFFINUS P. PUFFINUS* DELOUSED ON YNYS ENLLI DURING AUGUST 1987.

Population category	Number of birds n	Mean number of lice	Variance s^2	$k \pm S.E.$	X^2 (d.f.)	Significance
<i>Trabeculus aviator</i> (all classes)	230	28.7	368.7	2.42 ± 0.291	28.46 (14)	$0.05 > P > 0.01$
<i>T. aviator</i> (adults)	51	15.33	121.15	2.22 ± 0.607	3.16 (5)	NS
<i>T. aviator</i> (nymphs)	51	10.88	82.30	1.66 ± 0.479	10.02 (5)	NS
<i>Halipeurus diversus</i> (all classes)	230	24.2	316.8	2.00 ± 0.247	9.94 (12)	NS
<i>H. diversus</i> (adults)	49	13.71	187.86	1.40 ± 0.410	5.63 (4)	NS
<i>H. diversus</i> (nymphs)	49	11.52	62.68	2.60 ± 0.764	5.75 (4)	NS

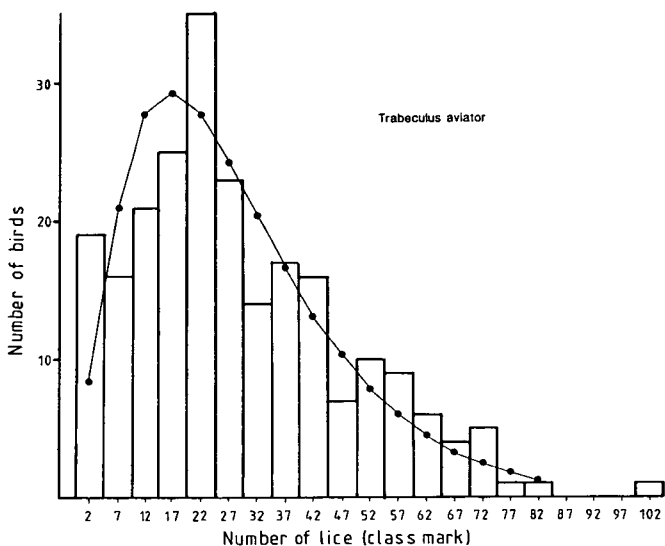


Figure 1. Frequency distribution of *Travebulus aviator* (whole population) on 230 Manx Shearwaters, August 1987. Individual frequencies are grouped into classes of 5. Thus class mark 2 represents individuals with 0-4 lice etc. Joined closed circles are the expected frequencies of a negative binomial distribution.

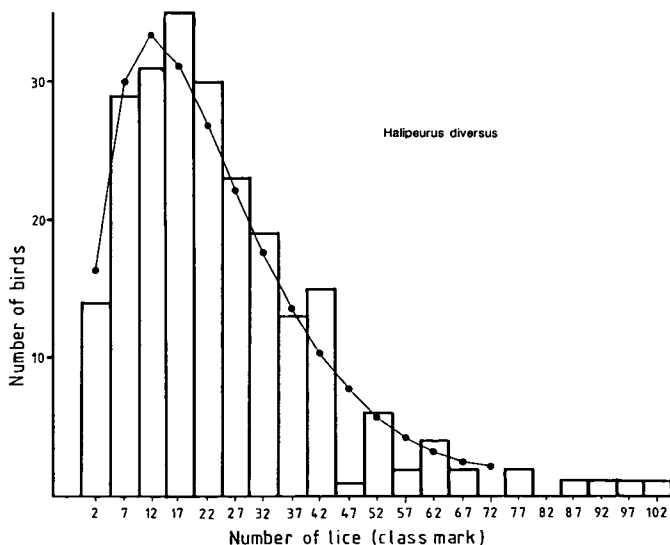


Figure 2. Frequency distribution of *Halipeurus diversus* (whole population) on 230 Manx Shearwaters, August 1987. Individual frequencies are grouped in classes of 5. Joined closed circles are the expected frequencies of a negative binomial distribution.

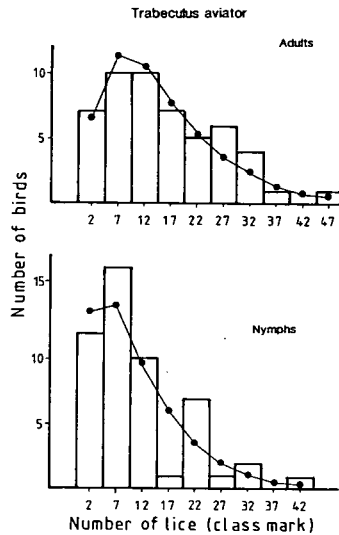


Figure 3. Frequency distribution *Trabeculus aviator* adults (upper) and nymphs (lower) on 51 Manx Shearwaters, August 1987. Individual frequencies are grouped in classes of 5. Joined closed circles are the expected frequencies of a negative binomial distribution.

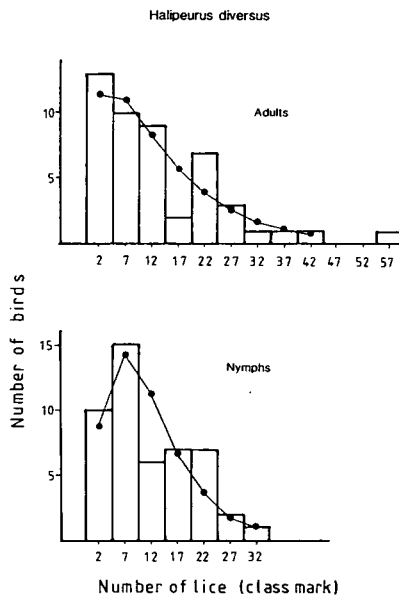


Figure 4. Frequency distribution of *Halipeurus diversus* adults (upper) and nymphs (lower) on 49 Manx Shearwaters, August 1987. Individual frequencies are grouped in classes of 5. Joined closed circles are the expected frequencies of a negative binomial distribution.

Population structures of *Trabeculus aviator* and *Halipeurus diversus* obtained from 30 birds are shown in Figure 5. In both structures the dominant age-class is adult.

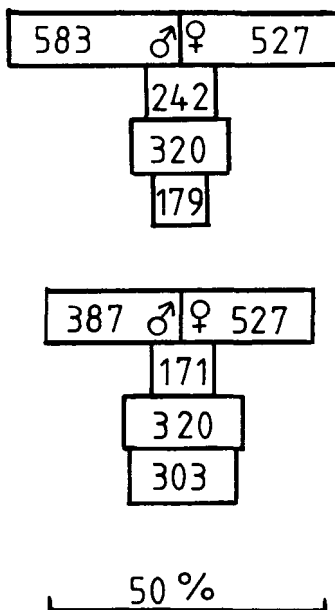


Figure 5. Population structures of Mallophaga from Manx Shearwaters, August 1987. Each "tier" in the structure represents, in ascending order, 1st, 2nd, 3rd instar nymphs, adults. Numbers within the structures are the number of lice obtained from a random sub-set of 30 birds. Upper: *Trabeculus aviator*; Lower: *Halipeurus diversus*.

DISCUSSION

Trabeculus aviator, *Halipeurus diversus* and *Austromenopon paululum* are well known mallophagan ectoparasites of the Manx Shearwater. *Naubates harrisoni* was first reported from Manx Shearwaters by Fowler & Furness (1987) on Rhum. Its presence in a second colony suggests that, despite its low infestation level, it may be widely dispersed among this host. It appears that the three specimens (a female and two nymphs) of *Ancistronea* sp. are the first record for the Manx Shearwater. R.L. Palma (National Museum of New Zealand) communicates:

"*Ancistronea* is widespread on many species of almost all the genera of Procellariidae, and on at least one of the Hydrobatidae. Sampling shows that its abundance and frequency is extremely low, hence its scarcity in collections, and males are even more scarce than females. The earliest name available is *A. vagelli* (J.C. Fabricius, 1787) ex *Fulmarus glacialis*."

Clearly further sampling is required to assess the true status of *Ancistronea* on shearwaters.

The seven *Saemundssonina* sp. were all on a single bird and, since they comprise one female and six nymphs, they evidently represent a "breeding" population. We do not speculate as to

whether the species is a true ectoparasite of the Manx Shearwater, or merely a straggler. However, it is a remarkable coincidence that the species was found on the *only* shearwater that did not carry *T. aviator* which it resembles superficially.

The only known host of *Halipeurus g. gravis* is the Great Shearwater *Puffinus gravis*. The louse was found recently as a straggler on a Sooty Shearwater *P. griseus* by Zonfrillo (1988) who discusses how chance transfers between hosts may arise. The remaining louse, *Naubates* sp., is a straggler of unknown origin.

The agreement of the frequency distributions with a negative binomial model is consistent with a number of seabird ectoparasites (Fowler 1988). The agreement of adult and nymph classes of *T. aviator* is considerably better than that for the whole population but we are unable to explain this observation. Reasons why ectoparasites are dispersed contagiously among birds are given by Fowler & Price (1987).

Population structures of *H. diversus* and *T. aviator* closely resemble those determined for other seabird Mallophaga (e.g. Fowler & Price 1987), which are dominated by adult classes. Although the proportion of each population class in a population at a point in time is a function of its relative longevity, proportions of nymphs increase with reproductive activity (Marshall 1981). The high proportion of adult lice on shearwaters in August suggests that reproductive rates are in decline at that time of year, but collections from other seasons are required to confirm this.

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SUMMARY

A sample of 230 Manx Shearwaters *Puffinus p. puffinus* from Ynys Enlli yielded over 12,000 Mallophaga of 8 species. One, *Ancistronea* sp., is the first record from this host; three other species not previously reported are probably stragglers. Frequency distributions of the two most numerous lice are aggregated and conform with a negative binomial model. Population structures of *Halipeurus diversus* and *Travebulus aviator* are dominated by adult classes.

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Breeding terns in Britain and Ireland 1980-1984

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INTRODUCTION

The RSPB in conjunction with the Seabird Group has continued to monitor the numbers of breeding terns *Sterna* spp. in Britain and Ireland and the results for 1980 to 1984 are presented here. This follows on from previous assessments made by Cramp *et al.* (1974) for 1969/70; Lloyd *et al.* (1975) for 1970 to 1974 and Thomas (1982) for 1975 to 1979.

Some special efforts were made to get data for some poorly covered areas. Bullock & Gomersall (1981) reported on the breeding terns of Orkney and Shetland in 1980; Buxton (1985) on terns in the Western Isles in 1980 and Whilde (1985) on terns in the whole of Ireland for 1984. Reviews of the tern populations of the following areas have also been carried out: Isle of Man (Cullen 1980); Lincolnshire (Bromwich 1982); Rye Harbour (Knight & Haddon 1982); the Solent (Tubbs 1983); and Strangford Lough (Brown & McAvoy 1985).

METHODS

About 90 people contributed to the breeding tern survey during the five year period. The counting method most commonly used was recording the number of occupied nests. Bullock & Gomersall (1981) developed a method of relating the number of Arctic Terns *Sterna paradisaea* counted at a colony to the number of breeding pairs and this was used for estimating the size of the larger Shetland and Orkney colonies.

Coverage of Roseate *Sterna dougalii* and Sandwich Terns *Sterna sandvicensis* is believed to be almost complete each year. Coverage for Common *Sterna hirundo* and Little Terns *Sterna albifrons* is not complete every year. However, we believe that the figures provided give a reasonably accurate picture of what is happening to these breeding populations.

RESULTS

Roseate Tern

The number of breeding pairs is given in Table 1. By 1984 numbers had fallen to 455 recorded pairs which represents an 82% decrease in Britain and Ireland since 1969/70. Breeding numbers in the Scottish and north East England outposts have fallen to very low levels even though there are suitable managed offshore breeding sites with abundant nest space. The four main colonies – holding 376 pairs in 1984 – were all found along the Irish Sea coasts. Anglesey and Swan Island, Co. Down have held consistent numbers between 1980 and 1984 whilst numbers fell at Green Island and Strangford Lough in Co. Down. Green Island is currently only about 0.1 ha in area and continues to be eroded during winter storms. The reduction in size of the island must be the main reason for the fall in the numbers of breeding Common and Sandwich as well as Roseate Terns. The large reduction of Roseate Terns at Lady's Island Lake, Co. Wexford in 1982 was due largely to human disturbance and rat predation on the nesting island. Water levels at the lake have been so low in recent years that the public have been able to walk out onto one of the islands. The increase from 45 to 110 pairs on Rockabill between 1980 and 1984 may be due to colonisation by terns which have left some of the Irish coast sites mentioned above.

TABLE 1. COUNTRY AND MAIN COLONY TOTALS OF PAIRS OF BREEDING ROSEATE TERNS 1969-1984.

Colonies	Average Average			1980	1981	1982	1983	1984
	1969/70	1970-74	1975-79					
Lothian, Inchmickery	46	43	61	21	2	14	6	4
Total, Scotland	126	89	61	21	6	16	7	5
Northumberland, Lindisfarne	25	0	7	‡	5	4	8	4
Farne Islands	60	24	17	22	14	13	3	9
Coquet Island	230	83	33	20	19	29	25	18
Isles of Scilly	20	17	10	8	8	3	9	*
Total, England	338	124	67	52	51	51	47	32
Gwynedd, Anglesey =								
Total, Wales	202	207	179	180	130	170	174	150
Co. Antrim, Swan Island	190	114	59	32	37	59	31	39
Co. Down, Green Island	228	329	174	158	165	59	140	77
Strangford Lough	10	*	119	27	‡	43	15	19
Co. Dublin, Rockabill	60	†100	11	45	30	160	100	110
Co. Wexford, Lady's Island Lake	0	0	117	144	275	10	0	14
Total, Ireland	1851	1285	612	406	509	331	290	268
Total, Britain and Ireland	2517	1705	919	659	696	568	518	455

KEY: * = no information; † = fewer than three years' count; ‡ = present; § = count incomplete

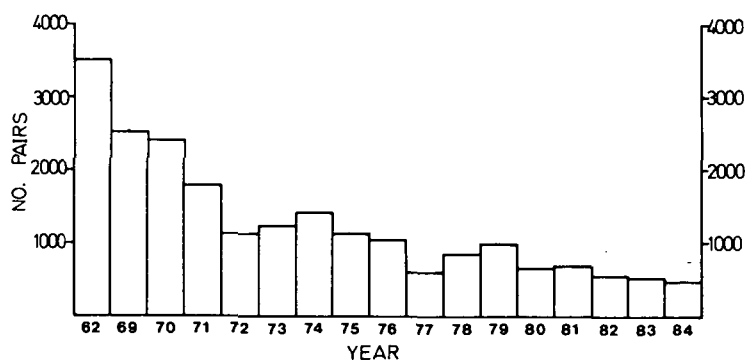


Figure 1. Number of Roseate Terns reported breeding in Britain and Ireland, 1962-1984.

Figure 1 shows the number of Roseate Terns recorded as breeding in Britain and Ireland since 1962. The greatest decline occurred between 1962 and 1972; thereafter the decline continued at a slower rate. It is thought that virtually the entire breeding population has been counted each year since 1969/70.

Sandwich Tern

The number of pairs breeding at the main colonies is given in Table 2. The nine largest colonies held about 82% of the total number of pairs reported.

Numbers at the Sands of Forvie increased from 1,150 pairs in 1980 to 1,670 pairs in 1983 and then dropped to just over 300 pairs in 1984. This drop, caused by disturbance from foxes *Vulpes vulpes*, was partially compensated by the colonisation of nearby Strathbeg by 700 pairs for the first time in 1984. In Norfolk most of the terns nested at Blakeney although an

TABLE 2. COUNTRY AND MAIN COLONY TOTALS OF PAIRS OF BREEDING SANDWICH TERNS 1969-1984.

Colonies	1969/70	Average 1970-74	Average 1975-79	1980	1981	1982	1983	1984
Orkney	290	198	136	119	72	230	13	80
Highlands, Stroma	0	†130	†135	645	368	80	45	4
Rest	1000	99	171	0	0	0	7	0
Grampian, Sands of Forvie	740	1050	1063	1150	1300	1583	1670	331
Loch of Strathbeg	0	0	*	0	0	0	0	700
Lothian, Inchmickery	46	218	568	424	475	478	474	407
Rest	60	109	0	*	7	6	6	6
Strathclyde	*	*	17	0	0	9	0	0
Total, Scotland	2496	1886	1914	2338	2222	2386	2215	1528
Northumberland, Farne Islands	2000	2550	2222	2990	3010	4085	3502	2975
Coquet Island	208	1041	1226	1065	996	1337	1132	1487
Rest	62	26	4	†	4	0	2	2
Norfolk, Scolt Head	3850	3126	3040	1200	300	250	500	1700
Blakeney	0	0	1580	2400	3850	3200	3300	2500
Suffolk, Havergate Island	60	30	202	148	74	53	29	40
Essex, Foulness	17	15	45	0	0	0	42	46
Kent, Dungeness	0	0	4	50	130	180	270	310
Sussex, Chichester Harbour	0	0	56	70	98	42	36	14
Hampshire, Needs Ore Point	179	209	86	0	0	55	85	270
Rest of Solent	44	22	55	*	189	140	6	60
Dorset, Brownsea Island	0	5	65	60	94	57	50	25
Isles of Scilly	0	0	†13	10	15	9	0	*
Channel Isles	0	0	†16	0	0	0	0	0
Cumbria, Foulney	10	38	368	600	500	1400	300	1600
Total, England	7152	9496	9394	8593	9260	10808	9255	11032
Gwynedd, Anglesey =								
Total, Wales	3	96	325	272	183	140	244	165

Co. Antrim, Swan Island	0	3	1	28	40	61	79	149
Co. Down, Green Island/ Greencastle Point	477	834	1015	600	489	441	301	419
Strangford Lough	666	458	710	1075	1171	1134	1367	1540
Co. Fermanagh, Lower Lough Erne	4	69	115	136	129	128	158	78
Co. Wexford, Lady's Island Lake	0	0	115	106	350	120	0	191
Co. Galway, Horse Island	*	*	*	*	*	*	*	150
Duck Island	*	*	*	*	*	*	*	120
Co. Mayo, Carrowmore Lake	25	*	*	*	*	*	223	164
Inishderry	46	*	*	*	*	† 1200	100	114
Co. Donegal, Mulroy Bay	200	*	*	*	*	*	100	180
Total, Ireland	2143	1877	2051	1945	2179	1884	2328	3467
Total, Britain and Ireland	11794	13355	13684	13148	13844	15218	14042	16192

KEY: * = no information; † = fewer than three years' count; ‡ = present; § = count incomplete

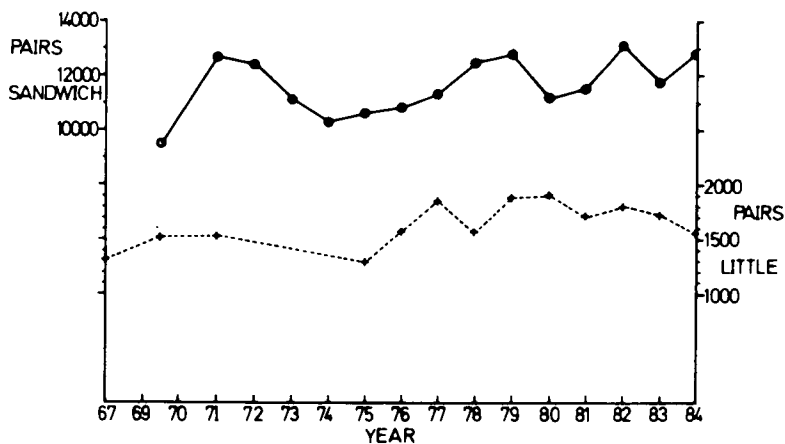


Figure 2. Number of pairs of Sandwich and Little Terns reported nesting in Britain, 1967-1984.

interchange of numbers between here and Scolt Head was evident in 1980 and 1984. Scolt Head was the main Norfolk colony throughout the 1970s. Consistently high numbers nested at Inchmickery, the Farne Islands, Coquet, Green Island and Strangford Lough, Co. Down throughout the five year period.

The breeding numbers at Dungeness have continued to increase from 45 pairs in 1980 to 300 pairs in 1984 as a result of the terns occupying newly-prepared islands in the gravel pits. The increase on Foulney has coincided with a reduction in the number of rats on the island as a result of special control measures. Recolonisations have occurred at several sites in southern England, notably at Foulness and Needs Ore Point.

Figure 2 gives the Sandwich Tern breeding populations reported from 1969 onwards for Britain only; where coverage is believed to have been virtually complete. Whilde (1985) recorded almost 3,500 pairs in the comprehensive survey of Ireland in 1984 which included several small colonies in the west of Ireland that had not been reported on previously. With the benefit of these results the total of 16,192 pairs recorded in Britain and Ireland in 1984 is the best estimate of the breeding population over the last five years.

TABLE 3. COUNTRY AND MAIN COLONY TOTALS OF PAIRS OF BREEDING COMMON TERNS 1969-1984.

Colonies	1969/70	Average 1970-74	Average 1975-79	1980	1981	1982	1983	1984
Orkney, all	285	100+	(190)	231	14+	8+	100	180+
Shetland, all	390	*	*	1014	96	105	87	17+
Grampian, Sands of Forvie	475	351	356	125	100	200	465	152
Loch of Strathbeg	*	*	100	99	87	172	138	186
Lothian, Inchmickery	100	426	599	533	175	415	365	216
Leith Docks (C/A¶)	*	¶29	¶74	65	75	155	170	120
Strathclyde, all	*	*	*	129	280+	181	125	393
Total, Scotland	4680	2194+	1074+	3049	900+	1459+	1807+	1376+
Northumberland, Coquet Island	1200	1240	1159	1094	1176	1094	907	422
Farne Islands	182	116	157	200	282	183	204	205
Norfolk, Blakeney	1200	1600	1290	575	175	260	270	240
Scot Head	500	580	349	280	250	160	161	200
Snettisham	32	38	81	160	65	64	78	120
Suffolk, Minsmere	250	284	105	52	70	40	20	17
Havergate	30	34	34	64	40	85	50	39
Essex, all	66	66	94	187	277	255	273	232
Kent, Dungeness	110	164	208	230	260	350	315	320
Sussex, Rye Harbour	118	*	33	74	91	85	75	73
Chichester Harbour	33	46	61	60	66	51	78	62
Hampshire, Needs Ore Point	120	195	236	150	160	260	320	300
Rest of Solent	125	68	74	41	85	89	65	27
Dorset, Brownsea	74	53	60	68	68	79	83	82
Chesil Beach	80	140	327	45	49	25	8	2
Cornwall, Scilly Isles	150	100+	173	*	*	124	210	*
Channel Isles	100	40	82	68+	173	150	154	153
Lancashire, Colloway Marsh	152	128	200	240	240	228	250	285
Ribble Estuary	420	488	(965)	300	245	225	325	325
Cumbria, Foulney	10	137	169	100	62	120	67	116
Total, England	6224	5568+	5805+	4560	4334	4498	4464	3627
Gwynedd, Cemlyn Bay	21	100	98	100	80	110	80	80
Ynys Fenrig	1	61	37	70	60	100	190	110
Clwyd, Shotton Pools	10	0	152	150	150	150	175	150
Total, Wales	290	161+	414+	341	406	437	476	402
Co. Down, Green Island/								
Greencastle Point	¶523	¶269	¶342	317	455	187	455	254
Strangford Lough	¶562	¶813	¶1063	¶691	¶392	¶520	¶811	519
Co. Antrim, Swan Island	¶380	269	145	160	274	360	185	207
Co. Dublin	70	(40)	(30)	40	40	100	*	132
Co. Wexford, Lady's Island Lake	56	*	110	269	291	65	0	12
Co. Galway, Geabhrog	*	*	*	*	*	*	*	210
Rest	*	*	*	8	*	*	*	444
Co. Mayo	130	*	*	30	*	*	*	211
Co. Donegal	170	*	*	32	*	*	28	228
Total, Ireland	3506	1773+	2064	1763+	1452+	1232+	1479+	2670
Total, Britain and Ireland	14700+	9635+	9357+	9713+	7092+	7626+	8226+	8075+

Includes inland records from coastal counties only.

¶ = C/Arctic Terns; () = site counts; * = no information.

TABLE 4. INLAND COLONIES (BREEDING PAIRS) OF COMMON TERNS 1980-1984.

<i>Colonies</i>	<i>Average 1980-84</i>	<i>1980</i>	<i>1981</i>	<i>1982</i>	<i>1983</i>	<i>1984</i>
Borders	4	5	3	4	2	*
Perthshire	*	*	*	6	*	*
Total, Scotland	4	5	3	10	2	*
Bedfordshire	5	4	6	8	3	*
Buckinghamshire	2	1	2	2	4	*
Cambridgeshire/Huntingdonshire (Fletton BP)	26	28 (13)	4 (10)	1	8+	3+
Cleveland (Billingham Pond)	12	10	*	15	*	*
Derbyshire	9	9	9	9	11	8
Essex Total	48	43	53	55	51	38
(Abberton Reservoir)		(15)	(15)	(30)	(30)	(27)
(Heybridge GP)		(23)	(35)	(20)	(15+)	(5)
Gloucestershire	2	*	1	*	2	2
Hampshire/West Sussex	2	2	1	*	2	1
Hertfordshire	41	41	42+	37	42	44
(Rye Meads)		(37)	(37)	(35+)	(42)	(44)
Leicestershire/Rutland	2	2	3	4	4	2
London area	15	21	13	9	18	*
(King George IV Res)		(8)	(8)	(5)	(5)	(2)
(Wraysbury GP)		(7)	(6)	(5)	(7)	(6)
Manchester area	1	1	1	1	1	*
Norfolk	97	108	86	107	93	89
(Hardley Flood)		(29)	(32)	(39)	(24)	(23)
(Hickling Broad)		(29)	*	(16)	(14)	(13)
(Ranworth Broad)		(38)	(36)	(35)	(32)	(30)
Northamptonshire	4	2	6	5	2	2
Nottinghamshire	36	41	32	40	31	*
Oxfordshire	1	*	*	*	1	*
Surrey	*	*	1	*	*	*
West Midlands	9	8	14	*	15	15
Wiltshire	1	1	2	*	*	*
Yorkshire	2	2	1	*	*	*
Total, England	283	324	297+	293+	288+	212+
Antrim	*	*	*	*	*	41
Armagh (Lough Meagh)	46	60+	53+	57+	15+	44
Tyrone	*	*	*	*	*	32
Fermanagh (Lower Lough Erne)	*	*	*	*	*	13
Cavan	*	*	*	*	*	37
(Lough Oughter)						(32)
Galway	*	*	*	*	¶45	29
Longford (Lough Gowna)	*	*	*	*	*	14
Mayo (Lough Conn)	*	*	*	*	¶34	42
Roscommon	*	*	*	*	*	11
Tipperary	*	*	*	*	*	28
Westmeath	*	*	*	*	*	5
Total, Ireland	112	60+	53+	57+	94+	296
Total, Britain and Ireland	395	389+	353+	360+	384+	508+

¶ = C/Arctic Terns. Only Irish colonies >10km from coast included.

() = site counts; * = no information.

Common Tern

The number of breeding pairs of Common Terns at the main colonies is given in Table 3. Coquet Island was the only colony regularly holding about 1,000 pairs of Common Terns, with Strangford Lough regularly holding more than 500 pairs of Common/Arctic Terns.

Over the five year period 7,092 to 9,713 pairs were reported as breeding in Britain and Ireland. Bullock & Gomersall recorded 1,014 pairs for Shetland in 1980 which meant that the Scottish total for the year was just over 3,000 pairs. Whilde (1985) recorded 2,670 pairs in Ireland in 1984.

The numbers reported in England over the last five years have averaged 4,300 pairs which is over 1,000 pairs lower than the average for the previous ten years. Numerically this can be explained by the fact that Blakeney has only held between 175 to 575 pairs over the five years compared to an average of some 1,400 pairs for the previous ten years. Noticeable decreases have also occurred at Lady's Island Lake, Co. Wexford (see Roseate Terns), Strangford Lough, (Common/Arctic), Chesil Beach and Minsmere. Elsewhere in England over the last five years there have been small but noticeable increases in Essex, at Dungeness, Needs Ore Point, the Channel Islands and Swan Island, Co. Antrim.

Overall, Common Tern numbers reported have fallen after holding up well during the 1970s. The mean number of pairs counted at 23 well-watched British terneries between 1980-1984 was 21% down on the 1969/70 figures. Indeed, the 1984 census indicated a 36% fall in Britain in the population since 1969/70. The 1984 all-Ireland survey revealed an even greater drop in number: a 46% decline in the population since 1970 (Whilde 1985).

Table 4 shows the numbers of Common Terns nesting inland in Ireland (after Whilde 1985) and in Britain (after relevant county bird reports). There appears to be a minimum of 500 to 600 pairs of Common Terns now nesting on freshwater areas in Britain and Ireland. Norfolk, central England and areas around Lough Neagh appear to be the most important inland breeding sites.

We think the great majority of breeding Common Terns are reported each year. Taking the best covered years between 1980 and 1984 the breeding population is estimated to be of the order of 11,000 pairs. (About 3,000 pairs each for Scotland and Ireland and 5,000 pairs in England and Wales).

Arctic Terns

The numbers of breeding pairs at the main colonies (or island groups) in Britain and Ireland are given in Table 5. Bullock & Gomersall (1981) presented a good baseline of numbers nesting in Orkney and Shetland in 1980. Since 1980 there has been much variation in the numbers breeding at the sites for which counts are available; e.g. a large increase was evident at Papa Stour and a large decrease on Foula. Other fluctuations in breeding numbers on these and other islands indicate that a year-by-year redistribution of terns on Orkney and Shetland might be widespread.

Breeding numbers elsewhere in Britain seem to have been reasonably stable over the five years and the British and Irish population is probably still around 77,000 pairs.

Reports of terns not specifically identified as Common or Arctic were few between 1980 and 1984 and are listed for all colonies in Table 6.

Little Tern

The number of breeding Little Terns for each county is given in Table 7. East Anglia is still the main stronghold and about 77% of the breeding population of Britain and Ireland is found along the coast from Lincolnshire to Hampshire. Numbers breeding in Cumbria have increased due to the elimination of rates on at least one reserve. Scotland was best covered in 1980 when Buxton (1985) recorded 103-131 pairs in the Western Isles. Ireland was best

TABLE 5. COUNTRY AND MAIN COLONY TOTALS OF PAIRS OF BREEDING ARCTIC TERNS 1969-1984.

Colonies	Average Average			1980	1981	1982	1983	1984
	1969/70	1970-74	1975-79					
Orkney, Westray	9780	(6446)	(5000)	2282	*	976	510	784
Papa Westray	17865	(8588)	(3300+)	7653	4600	8870	8520	10439
Eday	180	*	450	669	*	238	190	227
Sanday	470	*	(633)	3179	*	*	*	625
Stronsay	640	*	(1025)	2430	*	1176	1450	756
Rousay	624	*	1600	4951	*	2411	2270	2691
Shapinsay	41	*	*	169	*	*	*	53
North Ronaldsay	950	*	(605+)	1537	520	*	*	*
Mainland, etc.	797	*	*	1682	*	1020	180	471
South Ronaldsay	449	*	(2500)	4501	*	4895	715	6017
Hoy and Graemsay	68	*	(500)	1699	*	126	140	40
Walls and Flotta	207	*	*	2317	*	1028	*	133+
Shetland, Unst	739	(800)	(1100)	1393	*	*	320	178
Yell	450	(2019)	(3000)	5354	*	*	1275	273
Fetlar	750	(1292)	2484	2372	1100	*	2274	500
Northmaven	654	*	(775)	1326	*	*	584	495
Delting, etc.	202	*	*	2080	*	*	154+	625
Papa Stour	375	(750)	3000	4394	10000	*	16000	*
Vagaland	60	*	*	1749	*	*	*	214
Whalsay	384	*	*	2377	*	*	*	200
Skerries	780	600	*	1091	*	*	*	*
South Mainland	1127	*	*	5456	*	*	*	1600+
Foula	262	1090	4230	4200	1900	1259	1200	274
Strathclyde, Horse Island	40	135	52	58	174	250	60	60
Tiree	139	*	407	*	*	*	115	*
Western Isles, Monach Isles	*	*	467	110	*	250	*	*
Stornoway	240	(160)	240	430	*	*	*	*
Highland, Stroma	80	(1965)	(1593)	3000	1000	*	1000	*
Grampian, Sands of Forvie	125	92	127	125	100	120	52	50
Total, Scotland	44837	23937+	19067+	70970	20017+	23253+	38284+	27462+
Northumberland, Lindisfarne	80	36	37		45	18	60	36
Farne Islands	3208	2464	1855	3154	4229	4334	4470	3947
Coquet Island	700	610	641	812	707	686	778	495
Cumbria, Foulney	20	137	98	150	83	75	94	84
Total, England	4334	3337	2656	4156+	5116+	5139+	5450	4593
Gwynedd, Anglesey								
Total, Wales	440	250	822	745	756	601	689	718
Co. Down, Green Island/								
Greencastle Point	*	*	*	91	94	17	39	111
Strangford Lough	*	*	*	— see Common Terns —				315
Total, Ireland	1041	*	194+	785+	98+	64+	43+	2288
Total, Britain and Ireland	50652	27524+	22739+	76656+	25987+	29057+	44466+	35061+

¶ = C/Arctic Terns; () = site counts; * = no information.

TABLE 6. COUNTRY AND MAIN COLONY TOTALS OF BREEDING PAIRS OF UNIDENTIFIED COMMON/ARCTIC TERNS 1980-1984.

<i>Colonies</i>	<i>1980</i>	<i>1981</i>	<i>1982</i>	<i>1983</i>	<i>1984</i>
Grampian, Speymouth				100	
Highland,					
Whiteness Head, Inverness	148	50		150	
Inner Moray Firth				100	
Loch Fleet, Sutherland	102			35	
Alness Bay and Point	120				
Talmine Island	120				
Brora	65				
Rest		10		50	
Strathclyde, Gigha		85	40	40	90
Coll					90
Rest					63
Western Isles, Barra	170				
Rest	20			26	
Lothian, Fidra		55	44	40	12
Total, Scotland	745	200	84	541	255
Cumbria, Rockcliffe					
Total, England	138	103	191	135	64
Co. Down, Strangford Lough	— see Common Terns —				83
Co. Cork, Roaringwater Bay					122
Co. Galway, Eashal Island				160	
Lough Corrib	30			50	
Total, Ireland	30			210	339
Total, Britain and Ireland	913	303	275	886	658

covered in 1984 when While (1985) recorded 282 pairs, a figure similar to that of the last comprehensive survey in 1969/70. The British and Irish population is probably around 2,200 pairs and has certainly maintained itself over the last five years. (Figure 2).

Number of Terneries

The number of sites holding the different species of tern between 1980-1984 is given in Table 8. Better coverage especially in Ireland has shown that Little Terns breed at 176 sites (cf. 84 in 1975-79) and Sandwich Terns at 79 sites (58 in 1975-79).

TABLE 7. COUNTRY AND COUNTY TOTALS OF BREEDING PAIRS OF LITTLE TERNS 1967-1984.

<i>Colonies</i>	1967	1969/70	<i>Average</i> 1971 1975-79		1980	1981	1982	1983	1984
Highlands	6	9	15	7	15	4	16	23	*
Grampian	34	74	85	114	62	60	48	40	62
Tayside	30	10	6	31	65	30	35	45	*
Lothian	19	13	35	35	50	68	78	58	26
Strathclyde	49	66	58	14	24	35	64	21+	14
Dumfries and Galloway	2	3	1	*	4	3	*	*	*
Western Isles	25	66	30	59	117	6+	41+	71+	4+
Total, Scotland	172	251	235	254	337	206+	282+	258+	106+
Northumberland	7	15	14	21	20+	35	36+	9	12
Durham	*	*	*	*	*	1	*	*	*
North Humberside	9	4	4	*	*	¶	4	6	¶
Lincolnshire	32	60	131	156	140	117	84	100	146
Norfolk	304	416	390	443	421	313+	409	338	478
Suffolk	71	70	80	33	85	96	137	115	54
Essex	152	130	130	309	421	423+	359+	456	301
Kent	92	55	42	14	33	45	30	41	8+
East Sussex				18	43	59	49	67	66
Sussex (undivided)	102	160	36						
West Sussex				101	44	74	77	26	43
Hampshire	59	80	56	161	188	176	212	156	181
Dorset	200	120	125	57	65	61	45	49	52
Cumbria	41	70	119	55	7	23	25	67	90
Isle of Man	14	20	*	* (43♦)				1+¶(56+♦)	
Total, England	1110	1242	1268+	1293+	1510+	1423+	1467+	1431+	1431+
Gwynedd	22	21	20	38	26	22	18	15	18
Clwyd	13	4	9	33	39	56	39	25	29
Total, Wales	35	25	29	71	65	78	57	40	47
Co. Louth	*	*	*	*	25+	*	*	*	36
Co. Dublin	3	13	55	(12)	*	*	*	*	14
Co. Wicklow	2	50	5	(15)	*	*	*	*	30
Co. Wexford	37	100	78	14+	*	71+	*	*	45
Co. Cork	11	2	2	*	*	*	*	*	2
Co. Kerry	11	11	10	(9)	*	*	*	*	10
Co. Galway	13+	60	4	(10)	40	*	55	70+	45
Co. Mayo	13+	12	4	(10)	29	*	60	17	80
Co. Donegal	*	40	6	(20)	2	*	*	6	18
Co. Derry	20	6	0	*	*	*	*	*	2
Total, Ireland	110+	296+	179+	38+	96+	71+	115+	93+	282
Total, Britain and Ireland	1427+	1814	1711+	1656+	2008+	1778+	1921+	1822+	1866+

♦ = 1979 Figure; ◇ = 1985 Figure; * = no information; () = site count; ¶ = present but no count.

TABLE 8. TOTAL NUMBER OF SITES OCCUPIED BY BREEDING TERNS BETWEEN 1980-84 (figures in brackets indicate inland sites)

	<i>Sandwich</i>	<i>Common</i>	<i>Arctic</i>	<i>'Commic'</i>	<i>Roseate</i>	<i>Little</i>
Scotland	21	201 (4)	730	19	2	42
Ireland	26	103 (29)	92	16 (3)	10	45
Wales	3	7	5	0	1	6
England	19	139 (68)	11	2	6	83
Totals	69	450	838	37	19	176

DISCUSSION

With breeding Roseate numbers continuing to decline the problem of trapping on the West African wintering grounds is being tackled by a new initiative launched recently in Ghana jointly by the RSPB and International Council for Bird Preservation (ICBP) in collaboration with the Ghana Government (Hepburn 1986). Shortage of nesting habitat has been identified as a major factor affecting the North Atlantic Roseate Tern population (Gochfeld 1983) but there are still suitable unoccupied nestsites in Britain e.g. Coquet Island. There may, however, be a case for providing alternative nest sites within the Irish Sea basin where the two main nesting islands of the recent past – Green Island and Tern Island – are being or have been washed away. The Keeragh Islands off Wexford have been identified as a possible alternative site and efforts are being made to attract Roseates to this site (Hillis 1985, Hurley 1986). The Skerries, off Anglesey, is another potential breeding site. They are within 5 km of the existing main Roseate Tern colony on Anglesey.

A probable decline in Common Tern numbers is unexplained but it follows similar trends in North America where increased adult mortality (from 9% to 17% p.a. over a 30 year period) was thought to be due mainly to problems in the winter quarters (Nisbet 1978, Blokpoel *et al*, 1984). After Roseates, Common and Sandwich Terns were the species most commonly trapped in West Africa (Dunn 1981). Habitat loss is also a factor in North America (Shugart & Scharf 1983) but not, apparently, in Britain. As is the case for Arctic Terns the possibilities of food shortages affecting breeding numbers and performance should be investigated.

Little and Sandwich Tern populations continue to hold up well with the main colonies protected on reserves or by wardening schemes. However, such high densities of breeding birds may be at risk from an increase in predator activity.

The RSPB will continue to gather data on breeding tern numbers so that monitoring of population trends can be continued. To facilitate this a computerised database for tern colonies is being established. This will allow for a more detailed analysis of the information on British tern colonies collected through the current scheme.

SUMMARY

The status of the five tern species breeding in Britain and Ireland, Roseate, Sandwich, Common, Arctic, and Little Tern is reviewed for the years 1980-84.

Numbers of Sandwich (c. 16,200 pairs) and Little Terns (c. 2,200 pairs) have remained stable. Common Tern numbers may have fallen from c. 15,000 pairs in 1975-79 to 11,000 pairs in 1980-84. About 500 to 600 pairs now nest beside inland waters. Despite fluctuations in colony size Arctic Tern numbers probably remain at about 77,000 pairs. The decline of the Roseate Tern continued, down from 659 pairs (1980) to 455 pairs (1984). The species has been affected by erosion of nesting islands in the Irish Sea and probably by adverse conditions, especially trapping, at their wintering grounds.

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Occurrence of filoplumes in storm petrels

Adrian R. Plant

Filoplumes occur on the head, neck, upper breast and upper mantle of many Procellariiformes. Imber (1971) reported them from such parts of dark-headed species of *Pterodroma*, *Puffinus*, *Procellaria*, *Pelecyanoides*, *Pachyptila*, *Daption*, *Thalassoica*, *Halobaena* and *Bulweria* but found them lacking in white-headed species of *Fulmarus* and *Pterodroma*. Filoplumes have been noted in the dark plumage of Leach's Storm Petrel *Oceanodroma leucorhoa*, White-faced Storm Petrel *Pelagodroma marina*, Black-bellied Storm Petrel *Fregetta tropica* and Grey-backed Storm Petrel *Garrodia nereis* (Imber 1971) but, surprisingly, have been reported as scarce or absent in the predominately dark-plumaged Harcourt's Storm Petrel *Oceanodroma castro*, British Storm Petrel *Hydrobates pelagicus* (James 1986) and Wilson's Storm Petrel *Oceanites oceanicus* (Imber 1971).

This paper surveys the occurrence of filoplumes in 11 species representing all genera of Storm Petrels and discusses their functional significance.

METHODS

Storm Petrel skins in the British Museum (Natural History), Sub-department of Ornithology, Tring, were examined for the presence of filoplumes. Plumage was examined using a $\times 10$ hand lens and the distribution and number of filoplumes were noted. In many cases, examination of specimens and their data labels did not allow separation of the sexes or of breeding birds from non-breeding or pre-breeding adults attending a colony, so all data for each species (apart from obvious fledglings or first year birds) were pooled.

RESULTS AND DISCUSSION

Filoplumes occurred mainly on the side of the neck, upper breast and the lower and side regions of the nape. They occurred to a lesser extent on the crown, upper nape and upper mantle and in the Sooty Storm Petrel *Oceanodroma tristrami*, between the forehead and eye. Typical storm petrel filoplumes had a relatively long and rigid shaft ending with a "swallow-tail" plume which apparently wears rapidly as in some birds with worn contour feathers, the shaft was virtually all that remained of the filoplume. Filoplumes were generally lighter in colour than the surrounding plumage and in all species except the White-faced Storm Petrel, were confined to dark regions of plumage but it is possible that some filoplumes were overlooked in the white regions of plumage where they would be difficult to see.

The filoplumes of living Grey-backed Storm Petrels and Black-bellied Storm Petrels I have examined at the Chatham Is and Auckland Is were more conspicuous than on the museum specimens. In Black-bellied Storm Petrels, filoplumes are unusually large with shafts as long as 2.0 cm, and in living birds they have a tendency to stand out from the plumage and may give the impression of a poorly developed "ruff" at the side of the neck.

Filoplumes occurred in all genera but the frequency with which they occurred and their abundance were variable (Table 1). In the genus *Oceanodroma*, they were frequent in the Sooty Storm Petrel but uncommon in Leach's Storm Petrel and, although apparently absent in the Galapagos Storm Petrel *O. tethys* and the Least Storm Petrel *O. microsoma*, the

sample size was too small to exclude the possibility of filoplumes occurring. Filoplumes were also seen on the few specimens of Markham's Storm Petrel *O. markhami*, Fork-tailed Storm Petrel *O. furcata* and on the extinct Guadalupe Storm Petrel *O. macrodactyla* in the British Museum collection.

TABLE 1. FILOPLUME FREQUENCY IN CERTAIN STORM PETRELS.

<i>Species</i>	<i>Sample size</i>	<i>Number of birds with filoplumes (percentage in brackets)</i>	<i>Mean number of filoplumes (range in brackets)</i>
<i>Oceanodroma leucorhoa</i>	60	3 (5.0)	2.3 (2-3)
<i>O. tethys</i>	16	0 (0)	0
<i>O. tristrami</i>	7	3 (42.8)	19.3 (1-38)
<i>O. microsoma</i>	11	0 (0)	0
<i>Oceanites oceanicus</i>	35	3 (8.6)	1.3 (1-2)
<i>Fregetta tropica</i>	35	22 (60.0)	14.6 (1-76)
<i>Nesofregetta albigularis</i>	5	1 (20.0)	2.0
<i>Garrodia nereis</i>	38	18 (47.4)	6.1 (1-15)
<i>Hydrobates pelagicus</i>	45	2 (4.4)	1.0
<i>Pelagodroma marina</i>	32	3 (9.4)	2.0 (1-3)

Filoplumes were uncommon and few in number on the Wilson's Storm Petrel, British Storm Petrel and White-faced Storm Petrel but occurred on the White-throated Storm Petrel *Nesofregetta albigularis*. Filoplumes were particularly common in the plumage of Grey-backed Storm Petrel and Black-bellied Storm Petrel. Although a maximum of 15 filoplumes was recorded from Grey-backed Storm Petrel (Table 1), I have counted up to 38 on live, breeding birds at the Chatham Is.

The sample size was too small to assess sexual differences in the occurrence of filoplumes but it was noted that they were often lacking in birds of either sex. Insufficient material was available to assess the age-relatedness of filoplumes but it is interesting to note that although filoplumes occurred on only 4.4% of adult British Storm Petrels, of the four fledglings I examined, one (a male) had two filoplumes and one female had five.

The functional significance of filoplumes in the Procellariiformes has not been satisfactorily explained. In the Grey-faced Petrel *Pterodroma macroptera* (Imber 1971) and Manx Shearwater *Puffinus puffinus* (James 1986), the occurrence of filoplumes is related to sex and age and, although Imber (1971) considered filoplumes as secondary sexual characters important in mate-selection, vocalizations are probably the most important factors in sex and individual recognition (James 1984, James & Robertson 1985).

The long bristle-like shafts of filoplumes can efficiently transmit vibrations along their length to highly innervated sensory regions in the feather follicles (Stettenheim 1976) and probably serve to transmit tactile contact during allopreening. James (1986) doubted that filoplumes would be visible under the low-light conditions of the nesting-burrow where allopreening takes place. However, petrels probably have excellent night vision (Tansley 1964) and the pale colouration of filoplumes contrasts with the surrounding dark plumage and may be visible to partners at the nest. This may be particularly true of surface-nesting species which experience higher light intensities, or of species nesting at high latitudes which experience extended day-length. Filoplumes are particularly frequent and abundant on Grey-backed Storm Petrels which nest at the surface (Plant 1989) and on Black-bellied Storm Petrels which often nest in shallow crevices in scree at high latitudes (Beck & Brown 1971).

The limited data suggest that filoplumes may be common on the Sooty Storm Petrel and White-throated Storm Petrel. The nesting habits of these tropical species are poorly known but both apparently nest in pockets in coral rock shelves, under clumps of overhanging grass or in shallow burrows (Crossin 1974), and their nests presumably experience a higher light intensity than do those of species nesting in deep burrows.

Filoplumes might also serve to transmit indications of air pressure during flying or water pressure during feeding which enable the bird to modify the conformation of its contour feathers in response to external conditions.

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SUMMARY

Filoplumes occurred mostly in the dark regions of plumage in all genera of Storm Petrels but their frequency of occurrence and abundance when present varied between genera and between species of a genus. They were particularly common on the Grey-backed Storm Petrel *Garrodia nereis* and Black-bellied Storm Petrel *Fregetta tropica*. The potential roles of filoplumes in mate-selection, allopreening and modification of the conformation of contour feathers during flying and feeding are discussed.

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The effects of disturbance on the growth of young Common Guillemots *Uria aalge*

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INTRODUCTION

Many studies of seabirds have used comparisons of chick growth rates or fledging weights to investigate variation in food availability, either between colonies or at the same colony through time (e.g. Harris & Wanless 1988, Hatchwell in press). However, the validity of this approach may be questionable if visits to colonies to obtain chick growth data have a significant effect on the development of young, and if standard procedures are not followed in different studies (Gaston 1985).

An effect of disturbance on the fledging weight of Common Guillemots *Uria aalge* has been reported by Birkhead (1976) and Harris & Wanless (1984). Harris & Wanless showed that disturbance caused a reduction in fledging weight and wing-length at fledging compared to less disturbed chicks. These differences could have arisen either through earlier fledging and/or a reduced growth rate. If the differences arose through a reduction in fledging age alone then comparisons of growth rates over earlier stages would be unaffected by variation in disturbance levels. If reduced rate of growth was also responsible for the differences, then comparisons must be treated with greater caution because methodological differences might influence conclusions regarding the relative health of colonies.

In this paper I compare the differences in development of three classes of Guillemot chicks subjected to varying levels of disturbance.

METHODS

On Skomer, Guillemot chicks leave breeding ledges when 21.0 ± 2.03 (sd) days ($n = 451$), weighing about 25% of adult weight, and still dependent on the male parent who accompanies the chick on departure and continues to feed it for a further 70-85 days (Harris & Birkhead 1985, Hatchwell in press). The departure from the breeding site is referred to as fledging.

Chick growth and fledging weights were examined for three groups of chicks in 1985-87:

1. Ringed chicks ($n = 103$ in 1985, 159 in 1986, 149 in 1987). Chicks were weighed and measured once only, causing minimal disturbance. The age of ringed chicks was not known.
2. Fledging chicks ($n = 18$ in 1985, 38 in 1986, 53 in 1987). Chicks were weighed and measured between 2 and 6 times on alternate days from an age of about 14 days to fledging, causing moderate disturbance. The age of these chicks was also unknown.
3. Growth rate chicks ($n = 18$ in 1985, 7 in 1986, 10 in 1987). Chicks were weighed and measured on alternate days from shortly after hatching to fledging, so chick ages were known (day of hatching = day 0). This group suffered the highest level of disturbance.

Chicks were weighed to the nearest g using a Pesola balance, and wing-length was measured from the carpal joint to the tip of the wing coverts. Fledging ages of totally undisturbed chicks in control colonies were recorded by daily observation from a distance of 50-120m (only those ages known to within 24 h are included here).

The areas used to obtain growth rates differed between years. Breeding groups used in 1985 were not used in 1986 or 1987, and although one group was used in 1986 and 1987, an additional one was added in 1987. There were no apparent differences between the groups (unpubl.), although sample sizes were small.

Egg size and the hatching weight of growth rate chicks did not differ significantly between years (Hatchwell in press, Hatchwell & Pellatt 1990) and there was no significant difference in growth rates between years (Hatchwell in press) so data from the three years have been combined in subsequent analyses. The mean fledging weight of fledging chicks did not differ significantly between years (Hatchwell in press) so these data have also been combined.

RESULTS

Fledging age

The mean fledging age of growth rate chicks was 20.14 ± 2.26 days ($n = 36$), significantly younger than chicks fledging from a totally undisturbed control colony (20.77 ± 1.75 days, $n = 306$; $t = 1.99$, 340 df, $p < 0.05$). (There was a seasonal decline in fledging age at control colonies (unpubl.) so only those control chicks fledging over the same time periods (29 June – 4 July 1985, $n = 52$; 6 – 14 July 1986, $n = 139$; 2–13 July 1987, $n = 115$) are included.) It should also be noted that growth rate chicks were visited at 2-day intervals, and the day of absence, rather than the day of last measurement, was used as the fledging age. Chicks in undisturbed control colonies were observed daily, so if departures were randomly distributed between visits, fledging age was likely to have been over-estimated by a mean of 12 hours. Therefore, the difference between the groups was probably greater than indicated.

Growth and fledging weight

Comparisons of fledging weights or wing lengths between the three groups of chicks are not very informative because any differences might be due either to different growth rates, or to different fledging ages. Chick ages were only known for one of the three groups. So, although the mean weight and wing-length of growth rate chicks at last measurement was significantly lower than those of fledging chicks (weight: $t_{142} = 2.85$, $P < 0.001$; wing-length: $t_{142} = 3.03$, $P < 0.001$), interpretation of this difference is impossible without extra information on chick age. However, several studies of alcid chicks have shown wing growth to be relatively independent of nutrition (Razorbill *Alca torda*, Lloyd 1976; Black Guillemot *Cepphus grylle*, Asbirk 1979; Puffin *Fratercula arctica*, Nettleship 1972, Hudson 1979; Brunnich's Guillemot *Uria lomvia*, Gaston & Nettleship 1981) so any differences in the wing-length of chicks at fledging would probably be a consequence of the effect of disturbance on fledging age rather than on wing growth *per se*. An alternative explanation is that growth differences were simply a result of sampling from different parts of a colony, as found by Gaston et al (1983). The use of different groups for obtaining growth rates should have avoided this problem. If it is assumed that wing growth was constant at different disturbance levels, then wing-length can be used as an approximation of age (Birkhead 1976) to examine the effects of disturbance on weight increase.

Fig. 1 illustrates the weight/wing-length relationship of frequently disturbed growth rate chicks, moderately disturbed fledging chicks and minimally disturbed ringed chicks. The different groups were compared by log-transforming the data for wing-lengths of 33–70 mm (a range covered by all three groups), and performing an analysis of covariance on the fitted linear regressions. There was no significant variation in the slopes of the regressions (ANCOVA: $F_{2,866} = 1.89$, ns), but the elevations did vary (ANCOVA: $F_{2,868} = 31.77$, $P < 0.001$), and there were significant differences in all pair-wise comparisons (Tukey's tests: growth-rate v fledging $q = 4.56$, $P < 0.005$; growth-rate v ringed $q = 10.99$, $P < 0.001$; fledging

v ringed $q = 6.15$, $P < 0.001$). Thus, for a given wing-length, chick weight was highest with minimal disturbance, intermediate with moderate disturbance, and lowest with frequent disturbance from hatching.

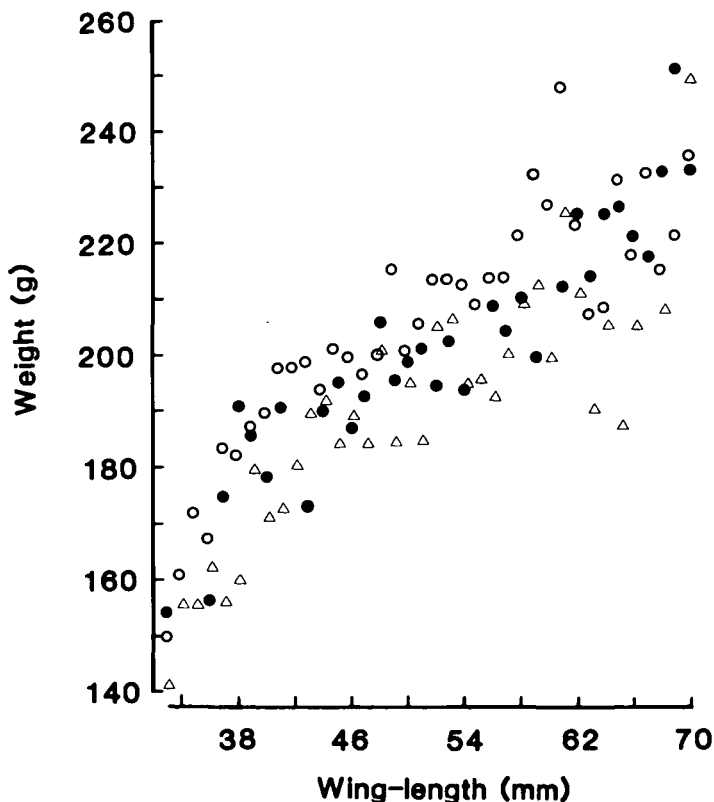


Figure 1. Relationships between chick weights and wing-length for growth rate chicks (Δ), fledging chicks (\bullet) and ringed chicks (\circ). The mean chick weight for a particular wing-length is given for each group of chicks. Sample sizes for each point varied from 1-22, and the total number of measurements in each category were 206 for growth rate chicks, 255 for fledging chicks, and 411 for ringed chicks. Raw data, rather than means, were used for calculations of log-log regressions (see text).

DISCUSSION

This study shows that the effects of disturbance on fledging weight of Guillemots reported elsewhere is not simply a function of fledging age, although this is a contributory factor. If the assumption of constant wing growth at different disturbance levels is valid, then there is a clear effect of disturbance on weight increase as well as fledging age. The cause of this effect

is not clear. When colonies were visited frequently, parents almost invariably left the breeding ledge at my approach, generally after being alerted by gulls. Disturbance of a breeding group lasted up to 2.5 hours, but was generally much shorter (15-45 min). The effect of disturbance on growth might operate through reduced provisioning of chicks by parents, increased energy demands for thermoregulation in the absence of brooding, and/or increased energy expenditure due to the stress of being handled. Harris & Wanless (1984) found that the adverse effect was due to disturbance of adults rather than the stress caused by the handling of chicks. No evidence was collected in this study to differentiate between these possibilities.

On the Isle of May, chicks disturbed daily left the colony weighing less than relatively undisturbed chicks (Harris & Wanless 1984). Birkhead (1976) found a similar effect to that reported here, with chicks suffering moderate disturbance (visited every other day) having a lower weight for a given wing-length than chicks disturbed on a single occasion. On Stora Karlsö, chicks weighed every 3 days had the same fledging weight as chicks weighed on a single occasion as they left the colony (Hedgren 1979, Hedgren & Linnman 1979). These comparisons indicate that visits every day or every two days affect fledging weight, whereas visits every 3 days have no detectable effect. Harris & Wanless (1984) and Gaston (1985) have pointed out that for some purposes the value of chick measurements decreases as the interval between visits increases.

In conclusion, regular disturbance of Guillemot chicks influences fledging weight in two ways: first, by reducing fledging age, and second, by reducing growth rate. The results of this study and comparisons with other studies indicate that these effects can be minimised by less frequent visits to colonies, although this reduces the value of chick measurements. Comparisons of guillemot growth rates and fledging weights should therefore be treated with caution unless disturbance is minimal, or consistent procedures have been followed.

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SUMMARY

The development of three groups of Guillemot chicks suffering different levels of disturbance was compared. Regularly disturbed chicks fledged at an earlier age than totally undisturbed chicks in a control colony. The low fledging weight of regularly disturbed chicks was not only a result of early departure, but also resulted from slower growth.

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Interspecific and age-related differences in the handling time of discarded fish by scavenging seabirds

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INTRODUCTION

Birds differ in their abilities to exploit particular food resources and this leads to differences in foraging niches between species. Age-related differences in foraging efficiency are also well known (Burger 1988) and it has been shown for many species that feeding efficiency increases with age, in groups as diverse as shorebirds (Groves 1978, Burger 1980), passerines (Breitwisch *et al.* 1987, Gochfeld & Burger 1984) and seabirds (Morrison *et al.* 1978). The food intake rates of Herring Gulls *Larus argentatus* feeding at refuse tips increased progressively with age (Greig *et al.* 1983); behind fishing boats, adult Great Black-backed Gulls *Larus marinus* stole more fish than did young gulls and also lost fewer to kleptoparasites (Hudson & Furness 1988).

Mixed-age and species foraging flocks provide a good opportunity to compare the performance of a variety of species and ages of birds exploiting a food resource (Porter & Sealy 1982). However, it is rarely possible to make such studies where the food taken can also be recorded with accuracy. In this paper the handling times of discarded fish, of known species and length, by different age classes and species of seabird are examined and the differences in the efficiency of separate age groups and species discussed. These differences enable predictions to be made regarding the impact of changes in net design and mesh size on multi-species foraging flocks behind whitefish trawlers in Shetland. The contribution of fishery waste to the overall diets and feeding ecology of seabirds in Shetland is covered by Furness & Hislop (1981), Furness *et al.* (1988) and Hudson (1986).

METHODS

During the summers of 1984 (July and August) and 1985 (March to September) the behaviour of scavenging seabirds feeding on discarded fish behind whitefish trawlers in Shetland was observed during normal fishing trips on a variety of boats. Most of the 27 trips were within 10 to 25 km of the west coast of Shetland but some were up to 40 km from land and two were made from the east coast. The boats were small seine or light trawl vessels measuring on average 20 to 25 m in length. Seine boats fish by letting out a net in the form of a semi-circle and pulling the two ends together as the net is towed along the seabed. Light trawling involves the net being trawled along, also on the seabed, with the net mouth held open, usually by otter boards. In Shetland, both methods result in catches of a variety of whitefish species but usually dominated by Haddock *Melanogrammus aeglefinus*, Whiting *Merlangius merlangus* and Cod *Gadus morhua*. Approximately one third of the fish caught are discarded, either because they were too small to sell or the species were unmarketable (Hudson & Furness 1988).

A total of 7605 fish which were sorted by fishermen for discarding were picked out of the discards at random, identified, length measured to the nearest 1 cm, and then discarded. For each fish, the species of seabird and, where plumage allowed, age of the consumer and the handling time were recorded. Handling time was defined as the time taken, to the nearest 0.5s, from when the bird picked up the fish to when it was swallowed (i.e. last visible),

dropped or stolen. Data were recorded onto a miniature tape recorder for convenience. Accuracy of the field recording methods was verified by taking video recordings of several bouts of experimental discarding and analysing the foraging by seabirds using slow play and freeze-frame facilities.

Most discards (71.6%) were Haddock and Whiting, with median lengths of 28cm and 29cm respectively. The mean handling times of Haddock and Whiting were computed for 28cm fish and 95% confidence limits derived. Where these confidence limits did not overlap between handling times by different age groups and species, the differences were significant at at least the 5% level. All differences described later fulfil this criterion.

RESULTS

Nearly half (49%) of the 7605 fish that were discarded experimentally were seen to be swallowed, the vast majority whole but a few were ripped apart. Many others were lost to view in the waves and could have been taken out of sight. Very few fish were seen to sink and large numbers of birds attempted to take the discards. Competition for fish was clearly intense and many birds attempted to steal fish from the individuals that had first lifted them from the water.

Handling times of discards seen to be swallowed

The handling times of Haddock, Whiting and Cod by adult Great Black-backed Gulls all increased with fish length and differed little between fish species (Table 1). Handling times

TABLE 1. REGRESSIONS OF \log_{10} HANDLING TIME ON \log_{10} FISH LENGTH (CM) FOR EXPERIMENTALLY DISCARDED FISH SWALLOWED BEHIND WHITEFISH TRAWLERS IN SHETLAND BY DIFFERENT SPECIES AND AGE-CLASSES OF SCAVENGING SEABIRDS. ALSO GIVEN IS HANDLING TIME (SEC) FOR 28 CM LENGTH FISH.

<i>Bird species</i>	<i>Bird age</i>	<i>Fish species</i>	<i>No. fish</i>	<i>Regression $\log_{10} HT$</i>	<i>r² %</i>	<i>Sig. of slope from zero</i>	<i>HT for 28cm fish (sec)</i>	<i>Log₁₀ HT</i>	<i>95% CL</i>
GBbG	Adult	Haddock	1126	2.58x-3.30	27	***	2.7	.431	±.011
		Whiting	1025	2.83x-3.70	27	***	2.5	.392	±.011
		Cod	48	3.23x-4.22	41	***	2.8	.453	±.059
	3-4 yr	Haddock	96	1.66x-1.87	13	***	3.4	.537	±.039
		Whiting	67	1.22x-1.25	5	*	3.3	.511	±.047
	1-2 yr	Haddock	102	1.83x-2.15	9	***	3.2	.500	±.043
Gannet	Adult	Whiting	110	1.72x-1.94	8	**	3.5	.546	±.039
		Haddock	140	2.25x-2.80	25	***	2.8	.449	±.035
	Adult	Whiting	129	1.64x-1.96	6	**	2.6	.417	±.047
		Haddock	38	3.48x-4.31	38	***	5.3	.726	±.041
H Gull	Adult	Whiting	44	3.12x-3.91	41	***	4.0	.603	±.026
		Haddock	118	3.73x-4.63	43	***	5.7	.756	±.058
G Skua		Whiting	228	3.29x-5.02	38	***	4.5	.652	±.059
		Haddock	40	3.29x-4.74	47	***	8.5	.931	±.058
Fulmar		Whiting	36	2.54x-2.85	38	***	6.7	.824	±.073

GBbG = Great Black-backed Gull; H Gull = Herring Gull; G Skua = Great Skua; HT = Handling time; $x = \log_{10}$ fish length; r^2 = % variation in handling time explained by increase in fish length; CL = confidence limits; *** = $p < 0.001$; ** = $p < 0.01$; * = $p < 0.05$.

of Haddock and Whiting also increased with fish length for Gannets *Sula bassana*, Herring Gulls, Great Skuas *Catharacta skua* and Fulmars *Fulmarus glacialis*. The slopes of the regressions of log handling time on log fish length showed only small differences between seabird species but Great Skuas took proportionately longer to swallow Haddock and Whiting of increasing length than did adult Great Black-backed Gulls ($F_{2,1238} = 5.18, p < 0.05$; $F_{2,1247} = 5.13, p < 0.05$ respectively, testing differences between slopes). The increase in handling time with Whiting length was significantly less for Gannets than for adult Great Black-backed Gulls ($F_{2,1148} = 3.53, p < 0.05$) or for Great Skuas ($F_{2,351} = 6.51, p < 0.05$). Rates of increase of handling time with increasing fish length did not differ between Haddock and Whiting within any one species of seabird.

Both Red Gurnard *Aspitrigla cuculus* and Grey Gurnard *Eutrigla gurnardus* have hard, bony heads with spines and all birds had difficulty in swallowing them. The handling time of gurnards by adult Great Black-backed Gulls was high for all fish lengths (7.8 sec for fish of 28 cm in length) and did not show a significant increase with fish length. Handling time of gurnard by adult Gannets did increase with fish length (handling time $1.98 \times - 2.01$) but, as for Great Black-backed Gulls, was high (7.3 sec for 28 cm length fish).

The average handling times of fish of 28 cm length (mean discard length of Haddock and Whiting, commonest discard species) differed between species and age class of seabird (Table 1). Adult Great Black-backed Gulls swallowed 28 cm fish faster than did immatures of all ages (statistical differences determined from confidence limits, see methods). The handling times of 28 cm fish by Great Black-backed Gulls and Gannets were similar. Both species swallowed 28 cm fish more quickly than did Herring Gulls, Great Skuas or Fulmars and Great Skuas and Herring Gulls swallowed them faster than did Fulmars.

Immature Great Black-backed Gulls rarely attempted to swallow gurnards. They took significantly longer to swallow Haddock and Whiting of any given size than did adults.

In general, the handling times of Haddock were greater than the handling times of Whiting, the differences being significant for adult Great Black-backed Gulls, Herring Gulls and Great Skuas. Haddock have a wider girth than Whiting of the same length (Hudson 1986) and Great Skuas, in particular, experienced difficulty in swallowing them and were seen to chew at the head of Haddock before being able to swallow them.

Handling times of fish seen to be dropped or stolen

Fish length was not correlated with handling time for fish that were not swallowed. No regressions between handling time and fish length for dropped or stolen Haddock and Whiting had slopes significantly different from zero. For Great Skuas, there was a tendency for longer fish to be held for a shorter period of time before being dropped, but this relationship was not significant. For Gannets, Great Black-backed, Lesser Black-backed and Herring Gulls, fish length accounted for less than 3% of the variation in handling time before the fish was lost.

DISCUSSION

For all seabird species in this study, handling time of consumed discarded fish increased with fish length. Similar results were found for prey taken by herons (Quinney *et al.* 1981, Riegner 1982, Smith 1984) and waders (Kushlan 1981). The shape of different species of fish also affects their handling time. Seabirds take longer to swallow flatfish than roundfish (Cook 1978, Hudson 1986). Within roundfish, gurnard were most difficult to swallow and Whiting were easier to swallow than Haddock. The rate of change of handling time with increasing fish length was similar between fish species, although the actual handling times for Haddock and Whiting differed.

Gannets and Great Black-backed Gulls had similar handling times for 28 cm length Haddock and Whiting and each handled them more quickly than did Herring Gulls, Great Skuas or Fulmars. These smaller bird species took more small fish (Hudson & Furness 1988), as fish 28 cm long were difficult for them to handle efficiently. Some bird species select the smallest prey size available to them whereas others take the largest prey (whilst still of manageable size), perhaps to reduce competition, e.g. Pochard *Aythya ferina* (small prey) versus Tufted Duck *A. fuligula* (large prey) (Draulans 1987). It was not feasible to detect such selection behind whitefish trawlers in Shetland as too few small fish were discarded.

Birds swallowed all very small fish and fish length did not affect the time before larger fish were dropped or stolen. However, the proportion of fish that are dropped increases with fish length (Hudson & Furness 1988).

Increasing feeding efficiency with age was demonstrated in two ways in this study. Firstly, adult Great Black-backed Gulls handled Haddock and Whiting more quickly than did immatures and secondly, immatures rarely took gurnard. In addition, adult Great Black-backed Gulls swallow longer fish (Hudson & Furness 1988). Increased foraging efficiency and success were also recorded for adult Herring Gulls over immatures feeding around prawn trawlers in the Clyde (Furness *et al.* 1988). In Mexico, most adult Magnificent Frigatebirds *Fregata magnificens* stealing offal from Laughing Gulls *Larus atricilla* swallowed the food immediately whereas only one third of young birds did so, and adults handled prey much faster than did young birds (Gochfeld & Burger 1981).

The mesh size of nets used to catch whitefish in the North Sea increased from 80 mm to 85 mm in January 1987 and by a further 5 mm in 1990 (J.R.G. Hislop, pers. comm.). This change should have reduced the number of small discards and increased the mean discard length. This in turn would be expected to decrease the availability of discards to Herring Gulls and Great Skuas which might result in increased competition for offal. However, observations from Shetland trawlers showed that large flocks of Fulmars were capable of monopolizing the offal supply and largely excluding other species (Hudson & Furness 1989). Gannets and Great Black-backed Gulls should be relatively unaffected by small-scale changes in discard size and therefore be expected to continue obtaining a large proportion of discarded fish. In practice, no such increase in fish discard length has occurred (unpubl. data; R. W. Furness pers. comm.), partly because the configuration of the codend of the net has been altered with the result that the mesh is pulled tighter, reducing the effective catching mesh size.

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SUMMARY

Random samples of fish that were being discarded from whitefish trawlers in Shetland during the summers of 1984 and 1985 were measured and discarded experimentally. The consuming species of seabird and the handling time for each fish before it was swallowed, dropped or stolen were recorded. Handling times increased with fish length. Gannets and Great Black-backed Gulls swallowed fish more quickly than did Herring Gulls or Great Skuas. Haddock took longer to swallow than Whiting of the same length due to their wider girth. Great Skuas experienced difficulty in swallowing Haddock and all species of scavenging seabird found it difficult to swallow gurnards. Handling of discards by immature gulls was less efficient than by adults.

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The Alderney Gannetries – photographic counts of Ortac and Les Etacs, Channel Islands, 1979-1989

Mike G. Hill

The Channel Islands' Gannet *Sula bassana* colonies on Ortac and Les Etacs are both situated off the northern island of Alderney (Fig. 1). Since their foundation in about 1940 few detailed counts have been made, although the estimates available suggest that the populations have increased substantially. A series of counts was made using aerial photographs taken from 1979 to 1989 with the object of assessing the populations and their rates of growth.

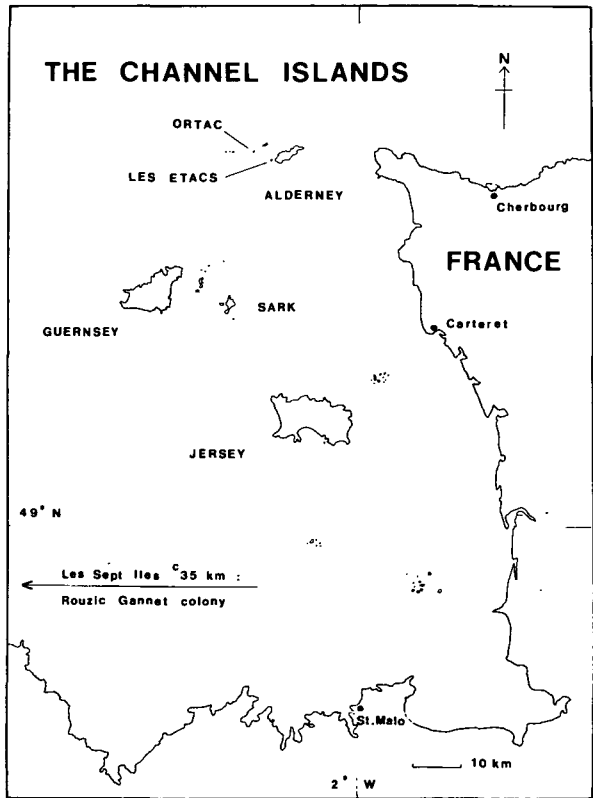


Figure 1. The Channel Islands showing the position of the Ortac and Les Etacs Gannetries.

METHODS

All the monochrome photographs were taken obliquely through the window of a light aircraft flying at about 600 to 700 feet using 35mm reflex cameras fitted with lenses of 90 or 100mm focal length. Photographs taken at other times from land and sea were used to check specific areas in more detail.

The photographs used for counting were selected to show the colonies from similar angles in each year. Geological features were used to align standardised counting zones, which were then drawn on the working prints.

The 5 × 7 inch prints were viewed through a Zeiss 3×/6× magnifying lens and the birds were crossed off directly with a fine drawing pen. Some earlier counts used 10 × 8 inch prints directly, and a few were worked through tracing paper. Some of the 1979 and 1984 pictures were counted again in 1989 using 5 × 7 inch prints as a check on the earlier figures. A few low tracing paper counts were removed from the database.

The count unit used was the occupied site, which is the standard unit generally used for photographic counts of gannetries. The unit is defined as one or two Gannets occupying a site irrespective of whether any nest material is visible.

The survey flights were made on 18 June 1979 at 1800 GMT; 15 June 1984 at 1800 GMT; 11 June 1987 at 1200 and 1800 GMT (1200 data used), and on 8 June 1989 at 1200 GMT.

RESULTS

Ortac – recent counts

The main breeding area on Ortac (Fig. 2) was considered to be in zones one to eight (zone 7 was later combined with 6). The mean counts obtained for these zones are shown in Table 1. The figures for zone 9 are shown separately because the breeding status of birds in this area was difficult to determine accurately.

The figures suggest that Ortac has been more or less stable since 1984 with a mean of the 1984-87-89 totals giving 1905 occupied sites in the main breeding area. Zone 9 contains a few nests and now appears to be more of a fringe area than a club. Although the number of nests built in this zone has increased each year, the area is severely affected by storms due to its low aspect and this may prevent it becoming established as a main breeding area. Six club areas, containing 425 individuals were identified on the 1987 photographs.

TABLE 1. ORTAC – 1979 TO 1989 COUNT RESULTS.

	<i>Mean occupied sites</i>	<i>Number of counts</i>	<i>Range</i>	<i>S.D.</i>	<i>Colony total</i>
1979					
Main colony	1606	5	1546–1669	49.0	
Zone 9	181	4	173– 202	13.5	1787
1984					
Main colony	1862	8	1772–1935	57.3	
Zone 9	200	3	192– 207	6.2	2062
1987					
Main colony	1985	7	1926–2046	38.4	
Zone 9	226	5	212– 238	8.9	2211
1989					
Main colony	1868	7	1740–1950	63.1	
Zone 9	238	7	227– 244	5.2	2106

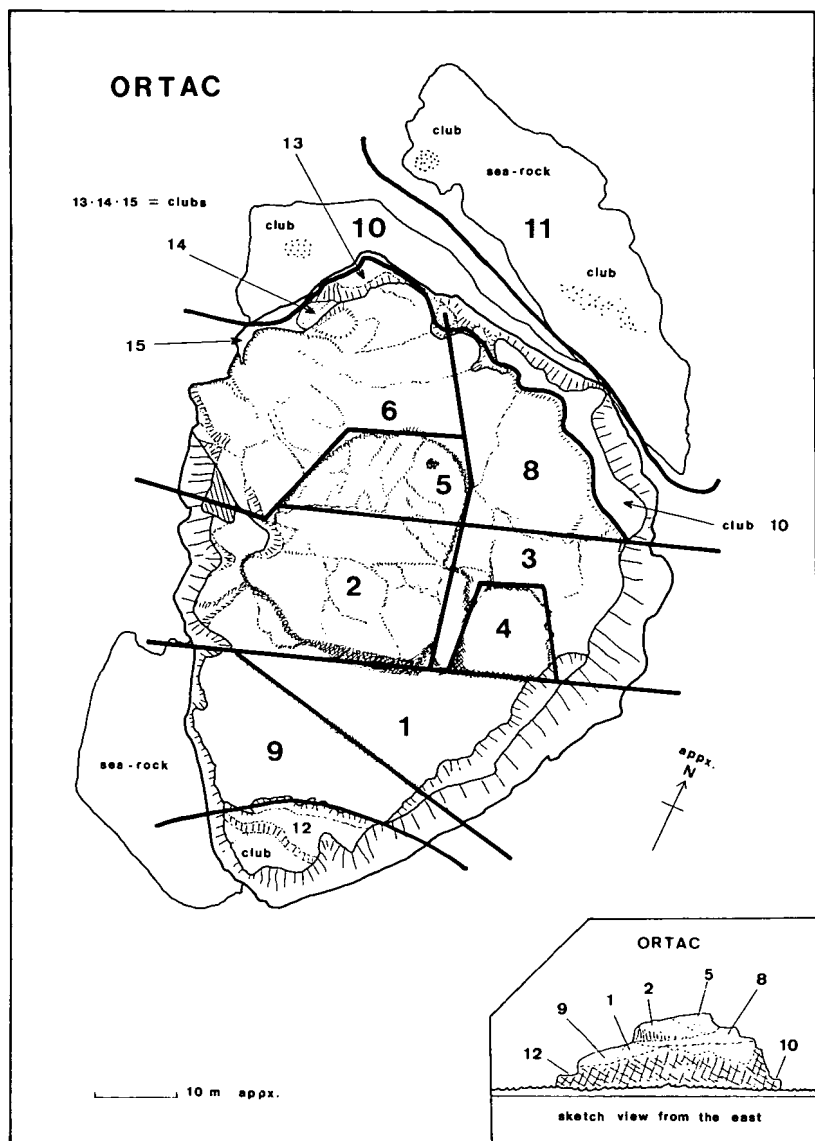


Figure 2. A sketch of Ortac showing the zones used in the gannetry count.

The results show that the 3.1% per annum rate of growth from 1979 to 1984 was not maintained through to 1989. The overall 1979 to 1989 rate of increase was 1.6% p.a., indicating that the main breeding area may now be more or less full with expansion limited to inferior fringe areas. Although space is visible in the colony, it is not clear from the photographs whether this is level enough for nesting.

Ortac – earlier counts

Gannets were regularly seen outside the breeding season in the Alderney area during the 1920's, but it was not until June 1938 that two were recorded flying near Les Casquets (and Ortac) in summer. The single Gannet found in 1940, on nest with egg, was considered to be the first breeding attempt (Dobson 1952). Because of the evacuation of Alderney and subsequent occupation by German forces from 1940 until 1945 there are no counts of the colony prior to 1946. A summary of all the records known to me are shown in Table 2. The estimated annual rates of growth are shown in Table 3.

TABLE 2. ORTAC – EARLY COUNTS AND ESTIMATES.

<i>Year</i>	<i>Count</i>	<i>Range</i>	<i>Source : comments</i>
1940	1 nest	–	Dobson 1952
1946	250 pairs	–	Dobson 1952: boat and air count.
1949	225 pairs	–	Cramp <i>et al</i> 1974: 1949 air photo in Dobson (1952)
1950	570 pairs	–	Dobson 1952
1951	225 pairs	–	K. Le Cocq (in litt.): 90 juveniles ringed.
1952	450 pairs	400–500	K. Le Cocq (in litt.): Fishermen insist far more breeding.
1960	925 (nests)	–	Cramp <i>et al</i> 1974, La Societe Guernesiaise Transactions 1960.
1969	1000 AON	800–1200	Operation Seafarer records.

TABLE 3. ORTAC – ESTIMATED RATES OF INCREASE.

<i>Years</i>	<i>+ Per annum</i>	<i>Figures used</i>
1946–1950	32%	250–570
1950–1960	6.2%	570–925
1960–1969	3.3%	925–1200
1969–1979	3.3%	1200–1606

Les Etacs – recent counts

The main breeding area on Les Etacs was on the largest rock of the group in zones one to five on the north face. There were birds, also, on the south face (Fig. 3). Zone 6 was a club in 1979 but has since developed into a fringe area with a few nests. The zones 7 to 10 remain clubs, although one or two nests were built on the pinnacles in zones 7 and 10 from about 1984. Approximately 30 individuals have been recorded visiting the 'North Rock' since 1987. The 'East Stack' is situated about 100 metres east of the large main rock (Fig. 4), and has a small group established on the western pinnacles. The main breeding areas are in zones 1 and 2; club birds gather below these areas.

The counts show a steady growth of the colony from 1979 to 1989 (Table 4). The nest density within the main breeding area has increased and there now appears to be more activity in the western fringe and southern face areas. The 1989 main breeding area total of

LES ETACS

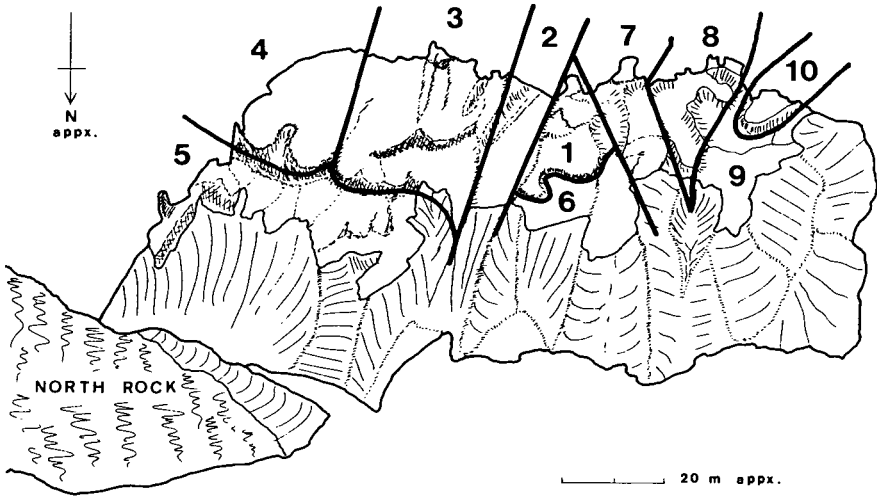


Figure 3. A sketch of Les Etacs (main rock) showing the zones into which the north face was divided during the gannetry count.

LES ETACS

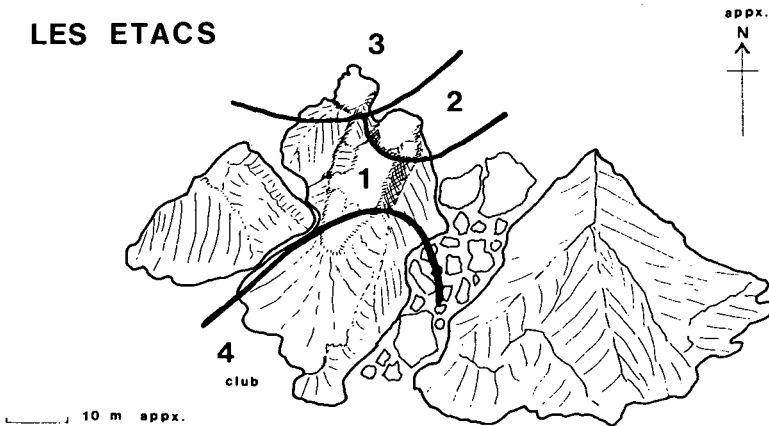


Figure 4. A sketch of Les Étacs (East Stack) showing the zones used in the gannetry count.

2655 occupied sites is an overestimate since it includes some double counting of the ridge between the north and south faces. It was impossible to avoid this and difficult to quantify the overestimate accurately for each year. The true figures were estimated to be approximately 200 fewer occupied sites than shown in the counts, giving 2455 for the main rock and a total colony figure of 2610 for the 1989 counts.

The 1979 to 1989 uncorrected figures indicate a 3.5% per annum rate of growth for the north face area (Table 5). The south face and East Stack areas appear to be increasing at a higher rate. Approximately 500 individuals were present in the club area in 1989 (Table 6).

TABLE 4. LES ETACS – 1979 TO 1989 COUNT RESULTS.

	<i>Mean occupied sites</i>	<i>Number of counts</i>	<i>Range</i>	<i>S.D.</i>	<i>Colony total</i>
1979					
North face	1670	8	1593–1730	51.4	
South face	221	5	207–240	14.5	
East Stack	87	1	–	–	1978
1984					
North face	1925	7	1902–1958	17.2	
South face	282	3	269–291	9.7	
East Stack	118	2	115–126	3.5	2325
1987					
North face	1967	5	1890–2017	45.7	
South face	445	4	405–480	31.0	
East Stack	124	3	122–126	1.6	2536
1989					
North face	2269	5	2126–2373	112.2	
South face	386	3	374–406	12.0	
East Stack	155	3	153–159	2.4	2810

TABLE 5. LES ETACS – COLONY PER CENT PER ANNUM INCREASES.

	<i>North face only</i>	<i>North + South faces</i>	<i>Total colony</i>
1979–1984	3.0%	3.3%	3.5%
1984–1987	0.7%	3.0%	3.0%
1987–1989	7.6%	5.0%	5.4%
1979–1989	3.5%	4.0%	4.2%

TABLE 6. LES ETACS – CLUB AREAS.

	<i>1979</i>	<i>1984</i>	<i>1987</i>	<i>1989</i>	
Zone 6	98	117*	139*	197*	
Zone 7	3	8	34	100	
Zone 8	2	3	20	30	
Zone 9	15	15	161	75	
Zone 10	25	14	51	40	
Totals	143	157	405	442	INDIVIDUALS

* = occupied sites.

Les Etacs – earlier counts

The few published counts from the early years after colonisation are shown in Table 7. Les Etacs was landed on several times in 1940 but no Gannets were seen (Dobson 1952). Colonisation probably took place in the early 1940's but the exact year is not known. The estimated rates of growth are shown in Table 8 and the progressive colonisation of the north face between 1946 and 1987 is shown in Figure 5.

TABLE 7. LES ETACS – EARLY COUNTS AND ESTIMATES.

Year	Total colony	Main colony	East Stack	Source: comments
1940	(0)	0	(0)	Dobson 1952
1946	200 nests	190	10	Dobson 1952: c 130 north and c 60 south faces.
1949	418 pairs	(400)	(18)	Cramp <i>et al</i> 1974
1950	615 pairs	(600)	(15)	Dobson 1952
1960	1010 pairs	(1000)	(10)	Cramp <i>et al</i> 1974: J. Fisher papers.
	1062 nests	(1000)	(62)	La Societe Guernesaise Transactions 1960: J. Fisher.
1969	1800-2200 AON	(1120 ind.)	–	Operation Seafarer records.
1973	1003 OS	803†	–	Wanless 1987
1974	1269 OS	1019†	c50	Wanless 1987
1975	1627 OS	1525*	102	Wanless 1987: sea-air photos.

† Count includes an estimated 200 sites on the south face.

* Count includes an estimated 260 sites on the south face.

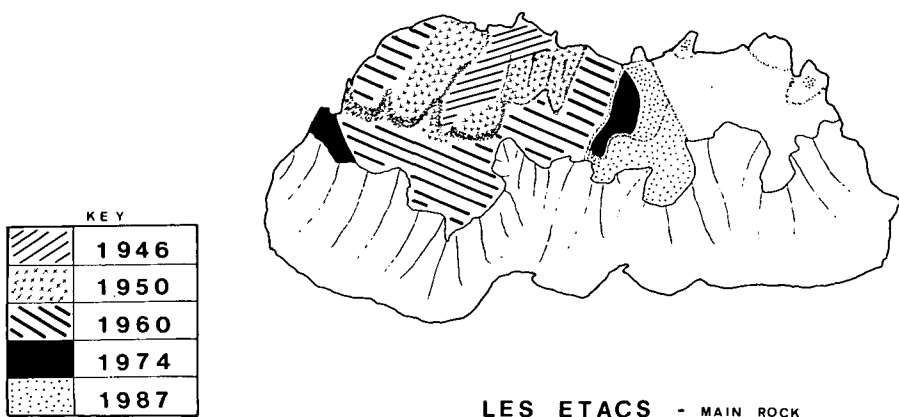


Figure 5. A sketch of Les Etacs (main rock) showing approximately the areas that were progressively colonised by nesting Gannets between 1946 and 1987.

TABLE 8. LES ETACS - ESTIMATED RATES OF INCREASE.

Years	+ Per annum	Figures used
1946-1950	51%	200-615
1950-1960	7.2%	615-1062
1960-1975	3.5%	1062-1627

DISCUSSION

Although Ortac and Les Etacs are reasonably straightforward gannetries to census when compared with some of the larger colonies, there are still problems when interpreting population changes from the counts obtained. Therefore, while the data presented here are likely to reflect the long term trends reasonably accurately, less certainty can be attached to the changes in the shorter periods since the counts are subject to a variety of largely unquantifiable sampling problems such as time of day, tidal conditions, weather and counting errors etc.

Bearing these reservations in mind it seems clear that the rapid increase in numbers of birds at both colonies during the 1940's and 1950's was due to immigration since the rates of change were well in excess of the 3 - 3.5% p.a. which Nelson (1978) calculated was the intrinsic rate of increase for the Gannet. However, from 1960 onwards the growth of the colonies has been consistent with that expected from the colonies' own output.

Future scope for the Ortac population to increase much more seems limited because the main breeding area appears to be full and any further expansion will be restricted to fringe areas. In contrast, Les Etacs appears to have some suitable, but uncolonised, nesting habitat left on the north face.

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SUMMARY

The census of the two Channel Island Gannetries using aerial photographs taken from 1979 to 1989 indicated that both populations had increased in the period, but at different rates. Further expansion on Ortac will probably be limited to fringe areas while Les Etacs appears to be actively expanding. Data from the early years after colonisation suggest an initial rapid expansion due to immigration, the growth rates then reducing to levels more consistent with the colonies' own output from about 1960 onwards. The 1989 census figures indicate the Channel Islands' Gannet population was approximately 4720 occupied sites.

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Inter-colony movement of a Mediterranean Storm Petrel *Hydrobates pelagicus melitensis* in the Western Mediterranean

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Some British authors (Mainwood 1976, Love 1978, Furness & Baillie 1981, Fowler *et al.* 1982, Furness 1983) have reported movements of the British Storm Petrel *Hydrobates pelagicus pelagicus*. Most of their work dealt with immature "wanderers" (Fowler *et al.* 1986) prospecting for breeding sites, or, in a few cases, referred to breeders which were recaptured in a place other than the one where they hatched or had bred previously.

Little information is available about the movements of the Mediterranean Storm Petrel *Hydrobates pelagicus melitensis*. Brichetti (1980) reports the movement of the birds nesting in Italy, Corsica and Maltese islands, where 9800 birds were ringed since 1978. However, none of these birds was recaptured in a colony away from the one where it was ringed. Sultana (*pers. comm.*) obtained the same results for the birds ringed in the islet of Filfla, until the breeding season of 1988.

This note records the first inter-colony movement between two Mediterranean colonies. The storm petrel was captured on 7 September 1985 on the Plana islet (39° 56'N 04° 15' E), in the archipelago of Cabrera, Balearic Islands. It was found behind a stone, had full-grown plumage, and was aged as a bird of more than a year.

On 27 May 1987 the bird was recaptured in the Medas Islands (42° 02'N 03° 13' E) in the Catalan coast, at 241 km NNW. It was mist-netted without tape lure and had well developed brood patches.

Along with the elapsed time, the capture and recapture data raise the possibility that the bird was a breeder when controlled in the Medas Islands, where a small colony has been discovered (Estrada, 1988). But there is no knowing whether the bird was a breeder or just a wanderer visiting the Plana islet colony.

I hope that this first result will stimulate further petrel ringing effort in the Mediterranean, to enhance our knowledge of this storm petrel subspecies.

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Breeding productivity of Kittiwakes *Rissa tridactyla* in southeast Ireland, 1983-88

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INTRODUCTION

Although breeding numbers of Kittiwakes *Rissa tridactyla* increased throughout Britain and Ireland during much of this century (Cramp *et al.* 1974), numbers on the west coast of Britain and east/southeast coast of Ireland decreased during the 1970s (Coulson 1983). Food shortage at or near these colonies was suggested as the most likely explanation (Coulson 1983). However, little information was available on breeding success at colonies outside northeast England, where productivity was high, at 1.0-1.4 young fledged per pair (Cullen 1957, Coulson & White 1958, Coulson & Thomas 1985). More widespread monitoring of breeding output since 1986 has indicated that feeding or other environmental conditions are still more favourable along the east coast, with productivity at west coast and Shetland colonies generally lower and more variable (Heubeck *et al.* 1987, Harris 1988, Harris & Wanless 1989).

The population in east Waterford, southeast Ireland declined by at least 60% between 1974 and 1984 (McGrath & Walsh 1985). Counts at these colonies have continued annually, with complete coverage of other Waterford and south-coast colonies at two- and four-year intervals from 1985 (McGrath & Walsh unpubl.). Recent data on breeding output at Waterford colonies are presented here, as a possible aid to interpretation of population changes and to provide a comparison with British studies.

METHODS

Numbers of chicks fledged were assessed from checks of individually-mapped nests, generally every four to seven days from late May to mid August, at the three Dunmore East colonies: Inner Harbour 1983-88, Outer Harbour and Black Knob in 1984, and Black Knob study plot (D) 1985-88 (Figs. 1 & 2). Chicks were assumed to fledge if, when last seen, they were at least 35 days old or had lost all traces of down. Productivity was expressed as the number of chicks fledged per attended, well-built nest ('nest' hereafter), using the cumulative total of nests recorded each season.

A more general indication of breeding success came from comparison of single counts of nests in June and nests-with-young in July for other colony-years (data for three small colonies, Ardnamult, Foilakippeen and Ballymacaw West, with 7-32 nests each, are not presented). Whole-colony nest counts were made in early-to-mid June, when numbers have usually peaked and are relatively stable, and brood counts generally during 5-15 July, when there are maximum numbers of nests with medium-to-large young at Waterford colonies (O'Meara 1975, pers. obs.). Where young could be clearly seen, brood sizes were recorded and the means were applied to all nests with young, giving maximal estimates of chicks fledged per nest. Although this method is less rigorous than that suggested by Harris (1987), which involves two to four checks of individual nests each season to maximise detection of nests and allow 'late' broods to be followed up, it should provide broadly comparable results.

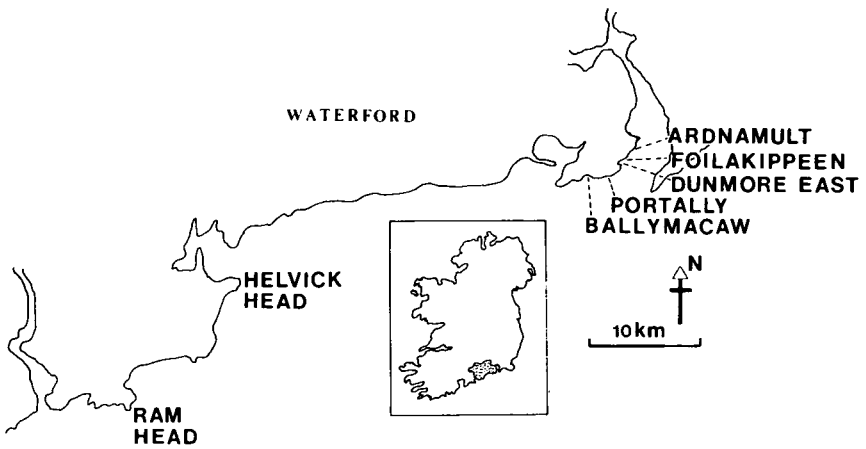


Figure 1. Kittiwake colonies in Co Waterford.

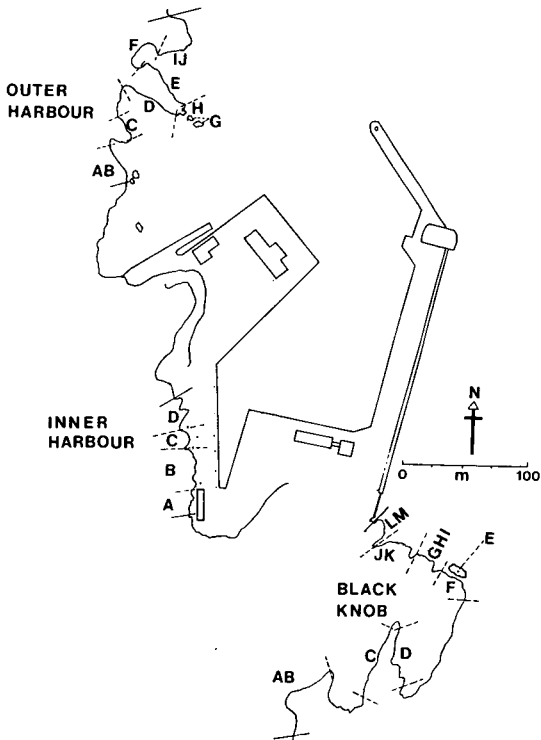


Figure 2. Dunmore East Kittiwake colonies, showing subdivisions used for productivity monitoring.

Statistical comparisons between or within colonies or years were made by χ^2 tests on the proportions of nests fledging or holding different numbers of young: zero v. one or more (percentage nests successful); one v. two or three (brood-size); and zero v. one v. two or three young (chicks per nest).

RESULTS

Detailed monitoring

At the Dunmore East colonies, 43-81% of nests fledged young, with averages of 1.28-1.61 young per brood and 0.56-1.31 young per nest built (Table 1). The three colonies followed in 1984 showed significant inter-colony variation in percentage success of nests ($\chi^2 = 79$, $p < 0.0001$) and in chicks fledged per nest (productivity, $\chi^2 = 84$, $P < 0.0001$) reflecting higher success at Inner Harbour) but not in brood size at fledging ($\chi^2 = 3.34$, n.s.). Productivity and percentage success varied significantly between years at Inner Harbour 91983-88, $P < 0.0001$) but were always higher than the 1984 figures for Outer Harbour and Black Knob. Brood-size also varied significantly between years at Inner Harbour ($\chi^2 = 42.3$, $P < 0.001$).

At Black Knob plot D, significant variation in productivity and percentage success between years ($P < 0.05$) was largely due to total failure in 1986 (Table 1).

Productivity and percentage success varied significantly between subcolonies at Outer Harbour and Black Knob in 1984 and Inner Harbour in 1988, the three instances when success was lowest. In contrast, brood-size did not vary significantly between plots, nor did productivity and percentage success at Inner Harbour in 1983-87.

Single fresh eggs were taken under licence (for pollutant analysis) from 17 nests at Inner Harbour in 1987, 10 in 1988 and 8 at Outer Harbour in 1987. Despite this, 63% of the nests fledged young, 0.77 per nest and 1.23 per brood, possibly after continued laying by some females. Whole-colony figures have not been adjusted, but should be no more than 2% in error.

Low-input monitoring

The percentage of nests occupied in June which held young in early-to-mid July varied greatly (7-74%) as did the mean number of young per nest (0.10-1.26), with significant variation between years and colonies ($P < 0.01$ for all multiple comparisons; Table 2). Productivity estimates were generally highest at Inner Harbour (Table 2), and this held even if productivity at fledging there (Table 1) was used. Brood-size also varied significantly between years at each colony ($P < 0.05$ -0.001), but varied little between colonies in any one year (significant only in 1987, $P < 0.01$; Table 2).

Apart from Inner Harbour, the one-off counts usually indicated significant within-colony variation in productivity and percentage success but rarely in brood-size (Table 2).

As an indication of the likely degree of error in Table 2, Table 3 summarises the influence of July date, and date relative to first fledging, on such one-off estimates of breeding output (based on colony-years studied in detail). As expected, counts early in July usually overestimated productivity, especially in late seasons. If fledging dates are ignored (or assumed unknown), estimates made in mid-July range most evenly about the 'true' figures. Estimates made immediately after first fledging (see footnote to Table 2) are again spread fairly evenly, with maximum overestimation of about 20% (young fledged per nest).

Where detailed assessments were available (Table 1), the one-off counts presented in Table 2 overestimated fledged brood-size by up to 4.5% and productivity by up to 24%, highest at the least productive colonies (Black Knob and Outer Harbour). The degree of overestimation was possibly higher in 1985, when checks at some colonies were made 10-12 days before first fledging (Table 2). Counts in subsequent years were made closer to the onset of fledging.

TABLE 1. DETAILED ASSESSMENTS OF CHICK PRODUCTION FROM WELL-BUILT KITTIWAKE NESTS AT DUNMORE EAST, CO WATERFORD, 1983-88.

COLONY/YEAR	nests	nests fledging young				Young fledged/ brood nest	
		%	1y	2y	3y		
OUTER HARBOUR 1984	578	***43.1	174	75	0	1.30	0.56***
plot AB	8	50.0	2	2	0	1.50	0.75
plot C	28	*** 3.6	1	0	0	1.00	0.04***
plot D	105	***64.8	44	24	0	1.35	0.88***
plot G	9	66.7	5	1	0	1.17	0.78
plot H	39	38.5	11	4	0	1.27	0.49
plot E	271	**34.7	70	24	0	1.26	0.44*
plot F	66	48.5	22	10	0	1.31	0.64
plot IJ	52	55.8	19	10	0	1.34	0.75
INNER HARBOUR 1983	206	81.1	70	92	5	1.61	1.31
plots AB, C, D	62-79	77.2-89.2				1.59-1.64	1.23-1.46
INNER HARBOUR 1984	201	78.1	96	61	0	1.39	1.08
INNER HARBOUR 1985	213	62.9	97	36	1	1.28	0.81
plots AB, C, D	60-83	56.2-70.0				1.24-1.32	0.70-0.93
INNER HARBOUR 1986	213	70.4	74	75	1	1.51	1.07
plots AB, C, D	62-81	62.9-75.7				1.46-1.53	0.92-1.16
INNER HARBOUR 1987	224	70.1	100	57	0	1.36	0.96
plots AB, C, D	62-94	61.8-74.2				1.33-1.39	0.84-1.02
INNER HARBOUR 1988	219	***54.3	53	64	2	1.57	0.85***
plot AB	90	***14.4	8	5	0	1.38	0.20***
plot C	67	***76.0	24	27	0	1.53	1.16***
plot D	62	***88.7	21	32	2	1.65	1.47***
BLACK KNOB 1984	360	***44.2	107	51	1	1.33	0.59***
plot AB	24	*16.7	1	3	0	1.75	0.29*
plot C	54	57.4	19	12	0	1.39	0.80
plot D	54	*61.1	23	9	1	1.33	0.81*
plot E	65	**63.1	29	12	0	1.29	0.82*
plot GHI	26	46.2	9	3	0	1.25	0.58
plot JK	38	***15.8	5	1	0	1.17	0.18**
plot LM	99	*32.3	21	11	0	1.34	0.43*
B.K. plot D 1985	58	53.4	26	5	0	1.16	0.62
B.K. plot D 1986	54	0.0	0	0	0	—	0.00
B.K. plot D 1987	34	55.9	10	8	1	1.52	0.85
B.K. plot D 1988	26	54.8	9	5	0	1.36	0.73

*/**/*** = $p < 0.05/0.01/0.001$ (χ^2 tests for variation within colony, or between observed and 'expected' figures in each plot; see Methods).

Brood-sizes of nestlings colour-ringed at Inner Harbour averaged 1.44 in 1987 ($n = 170$ broods, mainly 6 July) and 1.62 in 1988 ($n = 138$, mainly 29 June), 5.7% and 3.3% higher, respectively, than brood-sizes at fledging.

TABLE 2. COMPARISONS BETWEEN SINGLE COUNTS OF NESTS-WITH-YOUNG IN JULY AND ATTENDED, WELL-BUILT NESTS IN JUNE AT WATERFORD KITTIWAKE COLONIES, 1983-88.

Colony	Jun/Jul dates		nests	nests with young				Young present/ brood nest	
				%	1y	2y	3y		
OUTER HARBOUR	12/11	1984	576	***51.4	165	90	1	1.36	0.70***
	3/ 3	1985	603	***59.4	136	70	0	1.34	0.80**
	10/12	1986	607	***52.9	135	113	2	1.47**	0.78***
	3/11	1987	588	***55.1	111	142	2	1.57	0.87***
	8/ 4	1988	531	***49.3	107	109	3	1.52	0.75***
INNER HARBOUR	20/11	1983	206	82.5	71	75	8	1.59	1.31
	4/15	1984	201	80.6	68	53	0	1.44	1.15
	4/ 5	1985	211	65.4	92	45	0	1.33	0.87
	10/11	1986	212	71.7	78	73	1	1.49	1.07
	8/14	1987	221	72.9	94	65	1	1.42	1.03
	10/ 7	1988	217	***59.4	58	68	3	1.57	0.94***
BLACK KNOB†	14/14	1984	335	***49.0	91	52	1	1.38	0.67***
	4/ 3	1985	357	***53.5	62	29	0	1.32	0.70*
	6/12	1986	372	***32.3	57	34	0	1.37	0.44**
	2/11	1987	314	***63.1	69	72	1	1.52	0.96**
	8/ 4	1988	311	***56.6	79	71	0	1.47	0.83**
PORTALLY	11/15	1984	87	***35.6	23	8	0	1.26	0.44***
	3/21	1985	89	**20.2	-	-	-	-	-
	15/12	1986	94	7.4	4	2	0	1.33	0.10
	3/11	1987	86	74.4	17	30	2	1.69	1.26
	8/ 5	1988	103	**66.0	18	27	0	1.60	1.06*
East Waterford‡		1984	1234	***53.1	349	203	2	1.37	0.72***
		1985	1280	***55.0	290	144	0	1.33	0.73***
		1986	1313	***46.6	276	228	3	1.46	0.68***
		1987	1229	**61.5	291	309	6	1.52**	0.94**
		1988	1231	**54.4	278	282	6	1.51	0.82**
HELVICK HEAD§	1/14	1985	1354	***58.0	441	143	0	1.24	0.72**
RAM HEAD¶	2/14	1985	678	*68.3	293	114	0	1.28	0.87***
West Waterford		1985	2032	***61.4	734	257	0	1.26	0.77***

*/**/** = $P < 0.05/0.01/0.001$ (significant within year variation between subdivisions of a colony or, in the case of east and west Waterford, between colonies: c.f. Table 1).

† Excludes 18-30 nests on 'difficult' face (F).

‡ Includes up to three additional, small colonies (excluded from X^2 tests).

§ Sample 1354 of 1449 nests.

¶ Sample 678 of 1084 nests.

Approximate dates of first fledging (Inner Harbour): 26 June 1983, 24 July 1984 (20 & 24 July, Outer Harbour & Black Knob), 15 July 1985, 8 July 1986, 17 July 1987, 5 July 1988 ($\pm 2-3$ days, usually midpoint of interval before first young seen flying).

TABLE 3. THE INFLUENCE OF (a) DATE AND (b) DATE RELATIVE TO FIRST FLEDGING ON ONE-OFF ESTIMATES OF KITTIWAKE PRODUCTIVITY AT DUNMORE EAST COLONIES, 1983-88. INTERPOLATED FROM DATA FOR EIGHT COLONY-YEARS (ITALICISED LINES IN TABLE 1), WHERE THE NUMBERS OF YOUNG NOTED ON EACH JULY VISIT WERE COMPARED WITH THE PEAK JUNE COUNT OF ATTENDED, WELL-BUILT NESTS (cf. TABLE 2).

Period	<i>Young present/brood as %</i>		<i>Young present/nest as %</i>	
	<i>< or > young fledged/brood</i>		<i>< or > young fledged/nest</i>	
	range	mean	range	mean
<i>(a) Date</i>				
July 1- 5	-2 +29	+12	-1 +55	+19
July 6-10	-2 +17	+5	-1 +40	+13
July 11-15	-8 +7	+1	-16 +25	+6
July 16-20	-16 +3	-2	-37 +17	-3
July 21-25	-22 +2	-6	-56 +10	-14
July 26-31	-29 +2	-10	-80 +7	-27
<i>(b) Relative date</i>				
15-11 d pre-fledge	0 +19	+8	-1 +49	+19
10- 6 d pre-fledge	-1 +16	+5	-1 +44	+15
5- 1 d pre-fledge	-2 +17	+4	-4 +20	+10
first-fledging date	-3 +17	+3	-6 +19	+8
1- 5 d post-fledge	-8 +17	+2	-15 +20	+4
6-10 d post-fledge	-12 +12	-1	-29 +13	-3
11-15 d post-fledge	-19 +5	-6	-52 +6	-17

General patterns

On a colony-by-colony basis, there is no clear evidence of any trends in, or relationship between, productivity and brood-size over the five-year period 1984-88. However, combining east Waterford data, some improvement in productivity is evident between 1984-86 and 1987-88 (Table 2), especially if the timing of brood-counts in relation to fledging is taken into account (cf. Table 3). Both Black Knob and Portally had their least productive year in 1986, but annual variations in productivity were generally far less consistent between colonies than variations in brood-size. Brood-sizes at Dunmore East colonies were lowest in 1985 (1.28-1.34) and also low at Helvick and Ram Heads (1.24-1.28) in that year (median 1.28). Highest brood-sizes at Inner Harbour were in 1983 (1.61) and in east Waterford as a whole in 1987 and 1988 (medians 1.54).

Timing and causes of nest-failure

At Inner Harbour, a high proportion of nests were laid in (at least 93-97%, average 95%, in 1983-88, based on birds incubating on two consecutive visits). This was generally true elsewhere, although 16% of well-built nests at Black Knob in 1984, and 40% at study plot D in 1986, were either not laid in or eggs were quickly lost. At least 77-94% (average 85%) of nests at Inner Harbour hatched young, while 54-81% (average 70%) produced fledged young (Table 1), most total nest-failures here being at the chick stage. However, in 1984 at least, total failures at Outer Harbour and Black Knob were most frequent at the egg or, possibly, early chick stage (21-33% of nests).

At several colonies, cliff-faces particularly exposed to wind and rain produced few fledged young in some years, e.g. Black Knob plot D in 1986 (Table 1) and the main,

southwest-facing cliff at Portally during 1984-88. Some marginal plots, with small numbers of nests, e.g. A and B at both Outer Harbour and Black Knob (Figure 2), had below-average productivities in most years, presumably reflecting a high proportion of 'poor-quality' adults, or inadequate social stimulation (cf. Coulson 1972).

Predation seemed to be a major proximate cause of nest failure at the Dunmore East colonies. Herring Gulls *Larus argentatus*, with up to 110 pairs breeding at or within sight of Dunmore, were probably the most regular predators, followed by Hooded Crows *Corvus corone* and Brown Rats *Rattus norvegicus*, although actual observations were few. Evidence of predation was often indirect, e.g. occasional total failures of adjacent groups of up to 20 nests on broad ledges within a short period. Such severe local predation could be important in particular colony-years, although may not have been typical. Thus, at Outer Harbour, a single juvenile Raven *Corvus corax* destroyed eggs and small chicks in several dozen nests over several days in 1984. In the most extreme case, a Fox *Vulpes vulpes* caused the loss of up to 80 young at Inner Harbour (mainly face B) in 1988; domestic cats *Felix cattus* have also been seen taking young here. Apart from 1988, however, predation levels at Inner Harbour appear to have been low compared to other colonies.

Losses of young through starvation or disease are difficult to establish, and dead young at Dunmore often go unnoticed, as few nests are viewable from above. At Black Knob plot D, a maximum of six corpses in five out of 40 broods were noted in 1984, but nests here are very subject to exposure and water-logging. More conspicuously, up to ten adults or young die annually at Dunmore East through entanglement in fishing-net strands used in nest-construction. In the absence of food-shortage or predation, falls from the nest may be the main cause of chick mortality (Coulson & White 1958), but are difficult to quantify. At Inner Harbour, five to ten dead or injured chicks are found annually on the road at the cliff base, but others are probably lost to scavengers.

Productivity in relation to population status

The east Waterford population declined by 58-76% between 1974 and 1984, apparently reaching a low point in the late 1970s (O'Meara 1975, McGrath & Walsh 1985). This coincided with a drastic reduction in Celtic Sea stocks of Herring *Clupea harengus*, probably an important pre-breeding food (cf. Coulson & Thomas 1985), suggesting an increase in mortality and, perhaps, non-breeding among adult Kittiwakes. However, while Herring stocks had largely recovered by 1984-85 (J. Molloy in McGrath & Walsh 1985), the east Waterford Kittiwake population has shown no sustained increase (6.4% increase 1984-86 but a 7.6% decrease 1986-88: unpubl.).

Preliminary results from colour-ringing at Inner Harbour in 1987-89 suggest 85-90% annual survival of nest-occupying (McGrath, unpublished). If 40-50% of fledglings survive to breed at four years old (cf. Coulson & White 1959, Porter & Coulson 1987), the minimum productivity required for population stability will thus be in the range 0.4-0.75 young fledged per nest (assuming a closed system). Allowing for overestimation in our results (Table 2 v. 3), productivity in east Waterford as a whole averaged ≤ 0.7 fledglings per nests during 1984-88, so may well be insufficient to balance adult and post-fledging mortality. The 1986-88 population decrease was largely confined to the largest colonies, Outer Harbour and Black Knob, where numbers fell by 10% and 16% in 1987 and 1988, respectively (Table 2). Presumably, these colonies failed to attract their 'share' of recruits, although it is possible that some failed breeders changed colony between years (cf. Danchin 1988). Movement of adults almost certainly occurred from some unproductive subcolonies, notably Black Knob plot D where numbers dropped from 53-58 nests in 1984-86 to 34 in 1987 and 25 in 1988 after total breeding failure in 1986. Conversely, Inner Harbour, with a more stable population and

relatively high productivity (Tables 1 & 2), is the only east Waterford colony to have increased since the early 1970s (McGrath & Walsh 1985).

Populations at Helvick Head and Ram Head, in west Waterford, reportedly declined in the 1970s (Coulson 1983), but counts in 1985-87 were 200% higher than in 1969 (McGrath & Walsh unpubl.). Production of fledged young in 1985 was ca. 10% higher than in east Waterford (where the 1985 count was only half that in 1969) but, unless much higher previously, seems unlikely to account, in itself, for the difference in population status. More likely explanations are that previous west Waterford counts were underestimates and that immigration/emigration rates have differed between the two populations.

DISCUSSION

Productivity at Waterford colonies during 1983-88 was generally 0.5-1.1 young fledged per nest, in the mid-range of values recorded for Kittiwakes. On the east coast of Britain, production is generally 1.0-1.5 young per breeding attempt (Cullen 1957, Coulson & Thomas 1985, Harris & Wanless 1990). Breeding success in Shetland was high up to the early 1980s (Furness 1983, Heubeck & Ellis 1986), but from 1985 onwards declined markedly, with total failure at most colonies in 1988 probably due to a reduction in availability of sandeels *Ammodytes marinus* (Heubeck 1988, Harris & Wanless 1990, Heubeck *et al.* 1987). At Irish/Celtic Sea colonies, productivity has also been low in recent years, ranging 0.03-0.98 young per nest in 1986-88, but was variable and frequently low at at least two colonies (Calf of Man and Bardsey) even in the 1960s and 1970s (Harris & Wanless 1990). Productivity in a small study-plot at Great Saltee, Co. Wexford (25 km ESE of Dunmore East) averaged 0.78 young per pair in 1979 (Lloyd 1982).

As noted in Shetland during 1985-87 (Heubeck & Ellis 1986, Heubeck *et al.* 1987, Harris & Wanless 1990), productivity varied considerably both within and between colonies each year. In Waterford, this at least partly reflected localized variations in such factors as predation pressure and exposure. The influence of food supply or feeding conditions on productivity may thus have been obscured, although losses of chicks to predators are more likely to occur if broods are left unattended because of food-shortage (cf. Barrett & Runde 1980).

Brood-size of 'successful' nests in Waterford, while inherently of no use as a measure of overall breeding output, varied more consistently than productivity between years, with little variation between or within colonies. By excluding total losses of nest-contents, in many cases apparently to predators, brood-size may have more directly reflected the influence of feeding conditions on clutch-size or chick survival (cf. Coulson & Thomas 1985, Barrett & Runde 1980, Furness & Barrett 1985). At British colonies, brood-sizes recorded at or near fledging include 1.7 at the Isle of May in 1986 (Harris 1987) and 1.39-1.82 at Shetland colonies in 1976-84 (Furness 1983, Heubeck & Ellis 1986), falling to 1.0-1.2 in 1985 and 1.22-1.53 in 1986 (Heubeck *et al.* 1987). Waterford figures, generally 1.3-1.5, suggest, by comparison, moderately good food availability (with feeding conditions least favourable in 1985). (Brood-size at Great Saltee in 1979 averaged only 1.1 at fledging (Lloyd 1982), lower than in any Waterford plot of comparable size (ca. 30 broods) in 1983-88).

As a low-input method of monitoring Kittiwake productivity, Harris (1987) recommended one or two checks of photographically-plotted nests during incubation, a check at the predicted first-fledging date and, if possible, another visit to check the success of late broods. We found that, if only two main visits to a colony are possible, simple comparison of June nest counts with July brood counts will provide an acceptable result, provided the visits are carefully timed. Some error arises because a single, peak count of occupied nests will usually underestimate the cumulative total (by up to 5-10%). In occasional very late seasons (e.g.

1989 in southeast Ireland), counts at the beginning of June may be too early and up to 30% lower than the eventual peak, so it may be safer to delay the count until mid June. If this is not possible, however, it may be obvious from numbers of empty or poorly-built nests that a count is unreliable.

To minimize overestimation of chick survival, Harris & Wanless (1990) assumed an arbitrary 50% of any small young still present on the last visit would not survive to fledge. Although unable to do so for data presented here (Table 2), we have since adopted this correction factor for downy young. If time allows, dividing older chicks into several broad age-categories can provide a further 'safety-margin' to the productivity estimate.

So little is known of Irish Kittiwakes at present that it is often difficult to establish the occurrence or timing of population changes, let alone the factors involved. Sustained monitoring of both numbers and breeding output at a wider range of colonies, even at a relatively imprecise level, would at least ensure detection of changes and might provide some indication of the environmental conditions responsible.

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SUMMARY

Kittiwake productivity at Waterford colonies during 1983-88 was monitored by a combination of detailed and low-input methods, the latter involving comparison of peak June counts of occupied, well-built nests with July counts of broods. At most colonies 0.5-1.1 young fledged per nest, with pooled productivity ranging <0.6-0.9 between years, possible low enough to limit breeding numbers in east Waterford. Productivity varied greatly both within and between colonies, with no consistent variations between years, apparently because of local variations in predation pressure or exposure to bad weather. Brood-sizes at or near fledging, generally 1.3-1.5 young per productive nest, showed more consistent annual variations, with relatively little variation between or within colonies, and perhaps more directly reflected feeding conditions.

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BOOK REVIEW

KOOYMAN, G.L. 1989. *Diverse Divers. Physiology and Behaviour*. 200pp. DM 178. Spruger-Verlag, Berlin. ISBN 3-540-50274-2.

Not so long ago our knowledge of diving physiology was confined to the responses of animals forcibly submerged. Studies of diving behaviour simply involved timing durations of, and intervals between, successive submergences. Over the last 30 years, the author of this monograph has done more than any other scientist to investigate, using free-living animals, the nature of the anatomical and physiological constraints on diving performance and the ecological and behavioural consequences of this. This book is a personal, avowedly selective, review emphasising field studies, despite the usually substantial difficulties of interpretation. Laboratory investigations, with their risks of artefactuality or unreality are given shorter shrift.

The scope is broad, from reptiles (iguanas, turtles and sea snakes) through birds (chiefly ducks and penguins) to mammals (mainly seals). It covers the full spectrum of physiological responses to diving – tolerance to anoxia, circulation effects, pressure, cardiovascular adaptations, blood and muscle chemistry, metabolism. A separate section considers mechanical (hydrodynamic) influences and the consequences of these for swimming behaviour and speed. The penultimate chapter summarises knowledge of the limits of breath-hold diving and the final chapter briefly reviews some of the main studies that have acquired intermittent or continuous data on diving behaviour.

From the point of view of the average marine ornithologist the weaknesses of this book are that there is little about birds (and even less about seabirds because most early and almost all laboratory work was done on mallards and tufted ducks) and that it is pitched at a fairly sophisticated and specialised level. It strengths are that it is very up-to-date (including new and published data – especially on penguins – from the author's own research), insightful and critical – especially in clearly indicating the problems with techniques, data and interpretation. Partly because over simplification is, rightly, avoided, the message one receives is that the whole field is in a state of flux where, despite the revolution in our knowledge of diving patterns of free-living animals, we still lack much, even most, of the critical data needed to understand the interplay of the constraints and requirements that have produced these patterns. On the physiological front we are particularly ignorant about the metabolic (and hence energetic) correlates of diving, especially to different depths and at different speeds and of the size of functional body oxygen stores – the two key proximate influences on absolute dive duration. In behavioural terms we know nothing of prey capture and encounter rates and thus how these, and the pattern of energy acquisition, affect the voluntary limitation of dive duration. As far as birds are concerned, it is still not understood how they cope with the effect of pressure on deep (e.g. >100m) dives or with the results of apparently exceeding their aerobic dive limit on long (>4 min) dives.

I found the final chapter (Behaviour) a little disappointing in the brevity of its treatment of the ecological information that is emerging from current studies. Specifically, there was little detailed consideration of the nature of the different processes operating in continuous divers which surface only occasionally and in continual divers (e.g. birds) which dive in relatively short bouts interspersed with prolonged periods on the surface or ashore. Within the latter category the important theoretical and practical distinction between benthic and epipelagic foragers is only hinted at.

In short, this is probably a book more for marine scientists wanting a critical review of current ideas on diving physiology and performance than for laymen or general scientists seeking a simple summary of a topic that will undoubtedly become much more complicated before any reliable simplifying syntheses emerge.

It is unfortunate that despite the exorbitant price characteristic of books from this publishing house, most pages (at 25p each) have multiple typographical errors. Collectors of unusual vernacular names will note (p.173) that of the Australian monitor lizard for *Turdus migratorius*!

J.P. Croxall

THE SEABIRD GROUP 1990

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 (£10 per annum, £9 if paid by banker's order, £5 for students) is open to all with an interest in seabirds; for details please contact the Secretary (address below) – payment by banker's order and deed of covenant helps the Group.

Current Executive Committee The present Committee comprises: Chairman T.R. Birkhead, Secretary I. Hepburn, Treasurer R.W. Furness, Membership Secretary S. Russell, M. de L. Brooke (Editor of *Seabird*), also D. Budworth, P. Monaghan, K. Taylor and B. Zonfrillo. The Newsletter is edited by M.L. Tasker.

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

Seabird Group Grants Each year the Group has some money available to help fund research conducted by members. All grant applications should be submitted to the Secretary by the end of February annually, and will be considered by the Executive Committee by the end of March for distribution. Certain areas of research may be favoured for grant support from time to time and from 1986 and 1988 the allocation reflected our commitment to the Seabird Colony Register (see below). Successful applicants are required to submit a typed report, not exceeding 500 words, by the end of October of the same year for inclusion in the Newsletter. A full typed report (in triplicate) must be submitted by the end of the year.

Seabird Colony Register The Seabird Group has always sought to organise and implement national schemes to promote the participation of and harness the energies of its membership, now standing at over 400 members. The Group membership played a major role in the national Operation Seafarer survey whose results were published in 'The Seabirds of Britain and Ireland' (1974). The Group completed its Seabird Colony Register fieldwork in 1988, in conjunction with the Nature Conservancy Council, and the results are published this year in the book: 'The Status of Seabirds in Britain and Ireland'. This register was begun in 1985 to gather together all existing data on breeding seabird numbers in the British Isles, to bring our knowledge of their status up to date by detailed field surveys and to establish a computerised database which can easily be updated in the future. Although this round of survey work is completed it is important to continue monitoring of seabird breeding numbers: anyone eager to conduct counts on a regular basis should contact: Paul Walsh, NCC, 17 Rubislaw Terrace, Aberdeen AB1 1XE, Scotland.

Seabird Journal and previous reports In November 1984 the Group launched its new-look journal *Seabird*, numbered 7 in deference to its pedigree of Seabird Group Reports 1-6. After the production of *Seabird* 8 in 1985, a new format was settled for Number 9 and

subsequent issues to guarantee a viable annual production schedule for the future at a time of rising costs. Our priority is to maintain a high volume and quality of content at stable cost to the membership. The current editor, M. de L. Brooke, welcomes offers of papers (see Notice to Contributors, and address below). Members of the Seabird Group receive *Seabird* free of charge; additional copies to members, and any copies to non-members, are £5 + 50p postage within the British Isles, £5 + £1 postage overseas. Postage overseas must, regrettably, be by surface mail, unless the recipient can make prior provision for airmail. The subscription to Libraries is £15 per copy. To help reduce costs, overseas subscribers are kindly asked to make payment by international money order rather than by cheque. At intervals in the past, the Group published Reports, to which *Seabird* is the successor. Copies of 3 of the earlier Reports are available from the Secretary as follows: issues for 1969 at 50p, 1975-6 (Number 5) at £1, 1977-81 (6) at £2. *Seabird* 7 (1984) is also available, at £2, *Seabird* 8 (1985) at £2, and *Seabird* 9 (1986) and *Seabird* 10 (1987) at £5. For all these back issues, postage costs are as given above. There are no cost concessions for multiple orders of *Seabird* or previous reports, and postal charges are additive. Copies of the Proceedings of the 1982 Seabird Group Conference are available on receipt of 50p postage, as are copies of the Auk Censusing Manual (1980), though it should be borne in mind that censusing techniques are still advancing.

Who to write to As appropriate, contact the Secretary (for general enquiries about the Group, seabird conservation matters, grants, etc.), the Membership Secretary (for membership renewals, applications and enquiries), 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 addressed 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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Seabird contributions should be submitted in the same format as used by *Ibis*, and this is outlined (with slight modifications) below:

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

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

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

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

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

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.