A SURVEY OF MANX SHEARWATERS *PUFFINUS PUFFINUS* ON RUM, INNER HEBRIDES IN 2001

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Murray S., Shewry M.C., Mudge G.P. & Spray S. 2003. A survey of Manx Shearwaters *Puffinus puffinus* on Rum, Inner Hebrides in 2001. Atlantic Seabirds 5(3): 89-100. *A sample survey of breeding numbers of Manx Shearwaters* Puffinus puffinus *was carried out on Rum in 2001, based on 658 circular quadrats randomly positioned throughout the colony. All burrows in the quadrats were checked for occupancy during the late incubation period by playing a tape of a male shearwater call at burrow entrances and recording any response. In order to account for non-responding occupants, the estimate of the total number of responding burrows was multiplied by a correction factor of 2.16, derived from a calibration study carried out in 2003. A total population estimate of 76,310 occupied burrows (61,160 - 95,740, 95% CL) resulted. Burrows were also checked visually for signs of occupancy and this suggested a higher total of 119,950 occupied burrows (106,730 - 133,550, 95% CL). Further study of the response rate at this colony is advisable in order to understand the discrepancy between these findings. The estimate based on visual signs of occupancy is comparable with earlier studies, and little evidence exists to indicate that the colony is decreasing, as was suggested in the 1990s.*

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INTRODUCTION

As a breeding species the nominate form of the Manx Shearwater *Puffinus puffinus* is confined mainly to north-western Europe, from Iceland to the Azores, with very small numbers breeding in Canada and the USA. Prior to recent surveys, the total population was estimated at between 260,000-330,000 pairs, with more than 90% being in Britain and Ireland (Lloyd *et al.* 1991). The largest breeding concentration is on the islands of Skomer, Skokholm and Middleholm in Wales, with a combined estimated total of 151,000 pairs in 1998 (Smith *et al.* 2001).

The island of Rum in the Inner Hebrides has been known as a breeding site of the Manx Shearwater since the 17th century (Martin 1716) but the first attempt to assess the size of the colony was made only in the 1960s (Wormell 1976). In contrast to the low-lying Welsh colonies, shearwaters on Rum breed in mountains, mainly above 457m and as high as 800m. The colonies are often

Figure 1. Main breeding areas of Manx Shearwaters on Rum, Inner Hebrides.
Figuur 1. Belangrijkste broedgebieden van Noordse Pijlstormvogel op Rum, Hebriden.

visually obvious as 'shearwater greens' due to the manuring effect of the birds droppings enriching the surrounding vegetation. The total extent of these greens was estimated by both Wormell (1976) and Earthwatch (in Furness 1990) to be *c*. 30 hectares. Wormell (1976) drew greens on overlays of aerial photographs, transferred the traces to a 1:10560 scale grid and measured their extent with a planimeter; he considered the resulting estimate of colony size to be very approximate. The Earthwatch teams attempted to locate greens by ground survey, but produced only a "crude map of doubtful accuracy" (Furness 1990). Population estimates were made between 1965 and 1969 (Wormell 1976), in 1978-1979 based on Wormell's map of the greens (Thompson & Thompson 1980) and in 1982, also based on Wormell's map (Philips 1982). Furness (1990, 1997) based his surveys on the greens as mapped by Earthwatch.

In 2000, we attempted to re-assess the size of the colony using new maps commissioned by Scottish Natural Heritage. However, once the field study began it became obvious that the maps were inadequate and that any sampling frame based on them would be flawed. Consequently, a different method was used in 2001, with all potentially suitable ground above the 457m contour defined as the colony. This paper reports on the survey work undertaken in 2000, a complete survey in 2001 (which avoided the need to pre-determine green locations) and fieldwork carried out in 2003 to calibrate population estimates based on responses to tape playback.

METHODS

In 2000 and 2001, two methods were used to estimate the numbers of shearwater burrows: visual estimation of 'apparently occupied burrows' (AOBs), and tape playback at burrow entrances.

Although AOBs are usually sufficiently deep to conceal an incubating bird, occupation may be indicated in several ways. There may be signs of recent digging activity, disturbed or recently flattened soil and vegetation, droppings, feathers or the smell of shearwaters. The number of AOBs were counted within circular $20m^2$ quadrats to allow for comparison with previous surveys. In addition, a taped call of a male (Rum) shearwater was played at the entrance of every burrow within the quadrat, whether or not there were signs of occupancy, and any responses noted (Walsh *et al.* 1995). AOBs could not be defined in the few quadrats that were covered with boulders, but the tape was played systematically across the quadrat and again responses noted. We assumed that males always respond to the taped call of another male and females do not (Brooke 1978; Walsh *et al.* 1995).

Herein, the term burrow is used solely for an apparently occupied burrow. There were no other burrowing birds or mammals in the shearwater breeding areas, which prevented misidentification of burrows. Burrows with double entrances are not uncommon, so every burrow entrance within all quadrats was carefully checked to avoid double counting.

Survey work on Rum in 2000 In 2000, a map derived from aerial photography that attempted to differentiate greens and boulder fields was compiled, but it became clear from field survey that these features could not be distinguished accurately. However, data were obtained from 276 quadrats on greens that informed the sampling regime applied in the 2001 survey.

Boulder fields varied widely in area, composition and stability, with only small areas apparently suitable for breeding shearwaters. Typically, shearwater occupancy of these was low compared with greens; of a total of 159 quadrats sampled only 13 responses to the tape were obtained, so most of these areas were excluded from the 2001 survey.

Survey work on Rum in 2001 In 2001, we randomly placed quadrats throughout all ground in the main shearwater breeding areas. Most fieldwork was undertaken from 20 May-12 June, coinciding with the latter half of the incubation period and maximum diurnal burrow occupancy (Thompson 1987).

Quadrats were located using a hand held global positioning system, pre-programmed with 10 figure National Grid references. Over most of the colony, positioning was accurate to within 5 m, but where signals were poor, such as under cliff faces, readings could vary by up to 30 m. Such positional errors are unlikely to be systematically biased.

Previous surveys have indicated the potential for bias if sampling is based only on attempts to map shearwater greens. We used our field experience from the 2000 survey to draw boundaries that encompassed all the main shearwater breeding areas, which were above 457m. On each of the three main peaks Hallival, Askival and Trollaval, the ground within the boundaries was divided into a 'core' area of relatively high density (49.7 ha), surrounded by a 'fringe' area of low density (98.0 ha), a total breeding area of 148 ha. (Fig. 1). The core areas included most of the greens mapped on each mountain in previous studies (Wormell 1976; Furness 1990). Areas where burrow densities were so low that a disproportionate number of quadrats would have been required to obtain sufficient data to allow robust estimates to be calculated were excluded; such areas were Ainshval, Barkeval, west Trollaval, all ground between 366 m and 457 m, and hazardous cliff terraces on Askival and Clough's Crag (Fig. 1).

Data from tape playback in 2000 were used to determine the number of quadrats required to achieve a given level of precision for the 2001 population estimates for each habitat stratum. These data derived from a random sample of the greens mapped in 2000; we assumed, therefore, a similar random sample pertained in 2001.

As no data were available on the area of unsuitable ground within strata, we estimated the proportion of quadrats likely to be on such ground. However, the expected precision of the population estimates is not particularly sensitive to variation in the proportion of unsuitable ground, so we assumed that responses would not be elicited in 50% of quadrats in the core areas or in 80% of the fringe areas. An appropriate number of zero counts was then added to each stratum's 'green' data from 2000 in order to simulate a random sample. This was used to determine the 'optimal' number of quadrats in each strata in order to minimise sampling error for a given sample size. On this basis, 400 quadrats were selected to give an expected coefficient of variation (CV) of 10%. Additional quadrats were generated, giving a total of 658 quadrats with an expected CV of about 8%. A disadvantage of this approach is that only a proportion of the defined area will contain burrows and many quadrats would be located in unsuitable ground; a balance was achieved that minimized the risk of excluding ground that may have contained significant numbers of shearwaters, and at the same time did not include too much unoccupied ground.

The total surface area of each stratum was estimated from a 10 m resolution contour digital terrain model (DTM) in ERDAS Imagine software. The use of surface area was justified as the DTM resolution is of the same order of magnitude as the size of a quadrat (5 m diameter).

Estimates for each stratum were calculated by computing the average number of responses and AOBs/m^2, multiplied by the area of the stratum. Estimates from the six strata were then summed to give an overall population estimate. Confidence intervals for the total number of burrows were calculated using bootstrapping (Efron 1979); 1000 bootstrapped estimates were generated, each estimate being calculated from a different sample of each stratum.

Calibration factor calculation in 2003 Population estimates based on responses to tape playback must be corrected for non-responding birds, mainly females and possibly non-breeders. In 2001, a calibration factor of 1.98 (see Walsh *et al*. 1995) was applied. However, it is advisable that a colony-specific correction factor be applied, ideally derived at the time of the survey (I.P. Mitchell *pers comm.*). We obtained such a correction factor for Rum between 21 and 31 May 2003. This period is late enough to include the peak of egg laying (Thompson 1987), and early enough to exclude most non-breeding birds, some of which may occupy burrows and respond to taped calls (Smith *et al.* 2001). This study was carried out in the core area on Hallival using the 2001 survey criteria for selecting AOBs, chosen as randomly as possible. The tape was played at each burrow entrance, and sufficient burrows were included to obtain a minimum of 30 responses on the first day. The 85 selected burrows were marked with numbered flags, although one burrow later found to have a double entrance reduced the number checked to 84.

The correction factor was calculated as the mean response rate over 10 days for the 84 burrows. Bootstrapped estimates for the response data, from the 2001 survey, were generated in the same way as those for AOBs and then combined with bootstrapped correction factors generated from the 84 burrows to calculate confidence intervals for the corrected estimates.

Table 1. Numbers of quadrats (each 20m²), with Manx Shearwater burrows, and number of burrows from which responses were obtained to tape playback in core and fringe areas on Rum in 2001.
Tebel 1. Aantal plots (elk 20m²), met holen van Noordse Pijlstormvogel en het aantal holen waaruit positief werd gereageerd op het afspelen van de roep in het kerngebied en aan de randen van de kolonie.

Stratum	Site	Area (ha)	Total no. quadrats	No. quadrats with burrows (%)	No. burrows with response (%)
Core	Hallival	26.1	162	94 (58)	64 (40)
	Askival	15.9	70	54 (77)	33 (47)
	Trollaval	7.7	46	29 (63)	21 (46)
	All core	**49.7**	**278**	**177 (64)**	**118 (42)**
Fringe	Hallival	31.1	159	45 (28)	25 (16)
	Askival	36.3	111	35 (32)	21 (19)
	Trollaval	30.6	110	37 (34)	27 (25)
	All fringe	**98.0**	**380**	**117 (31)**	**73 (19)**
	All	**147.7**	**658**	**294 (45)**	**191 (29)**

RESULTS

All 658 quadrats were visited. In the core area, 36% of quadrats held no burrows, but in the fringe area 69% held none (Table 1); average burrow density in the former area was 0.140 AOB/m², and in the latter area 0.051 AOB/m² (Table 2). In the core area, no responses were elicited from 58% of quadrats, and in the fringe area none were elicited from 81%, close to the 50% and 80% predicted values (Table 1).

Table 2. Estimates and confidence limits for the number of apparently occupied burrows in the main Manx Shearwater colonies on Rum in 2001.
Tabel 2. Schattingen en betrouwbaarheidsintervallen van het aantal bezette holen van Noordse Pijlstormvogel in de belangrijskte kolonies op Rum in 2001.

Stratum	Site	Mean AOBs/m²	Estimated no. of AOBs	95% confidence limits
Core	Hallival	0.141	36,760	29,960-44,480
	Askival	0.144	22,980	18,420-27,970
	Trollaval	0.129	9900	7,040-13,320
	All core	**0.140**	**69,640**	**60,070-78,870**
Fringe	Hallival	0.037	11,650	7,930-15,660
	Askival	0.059	21,260	14,400-28,050
	Trollaval	0.057	17,400	11,970-23,950
	All fringe	**0.051**	**50,310**	**40,850-60,420**
	All	**0.081**	**119,950**	**106,730-133,550**

Table 3. Estimates and confidence limits for the number of Manx Shearwater burrows based on responses to taped calls in the main colonies on Rum in 2001.
Tabel 3. Schattingen en betrouwbaarheidsintervallen van het aantal holen van Noordse Pijlstormvogel in de belangrijskte kolonies op Rum in 2001.

Stratum	Site	Mean responses/m²	Estimated no. of burrows	95% confidence limits
Core	Hallival	0.075	21,370	16,230-26,950
	Askival	0.081	14,250	10,190-19,180
	Trollaval	0.079	6,650	4,140-9,470
	All core	**0.077**	**42,270**	**34,690-50,700**
Fringe	Hallival	0.018	6,130	3,600-8,760
	Askival	0.036	13,780	7,770-21,050
	Trollaval	0.042	14,130	8,570-21,030
	All fringe	**0.032**	**34,040**	**25,100-43,690**
	All	**0.048**	**76,310**	**61,160-95,740**

A correction factor of 2.16 (calculated from 2003 data) has been applied to the estimates. Confidence limits take account of uncertainty in the true value of the correction factor.

From the area of each stratum and the respective burrow densities, a total of *c.* 70,000 burrows (60,000-79,000, 95% CL) resulted for the core area, and *c.* 50,000 (41,000-60,000, 95% CL) for the fringe area, a colony total of *c.* 120,000 burrows (107,000-134,000, 95% CL; Table 2). Shearwaters also bred at low density outwith the mapped areas, but no attempt was made to assess numbers. However, based on the approximate area of available habitat elsewhere and applying the density measurement obtained in the fringe area, it is likely that 3,000-6,000 pairs bred elsewhere on Rum.

Population estimates and confidence limits for the number of burrows based on response to tape playback are presented in Table 3. The 2003 calibration study resulted in a correction factor for non-responding occupants of 2.16. The total coefficient of variation for the number of responses was 7.8%, close to the 8% predicted from the 2000 survey data. The estimated total number of burrows where a male responded to the tape was 35,000 (28,000-44,000, 95% CL). Application of the correction factor resulted in an estimate of *c.* 76,000 burrows.

DISCUSSION

Our survey suggested that there were about 120,000 (107,000-134,000, 95% CL) occupied Manx Shearwater burrows on Rum in 2001. However, the total number of burrows based on response rates was 76,000 (61,000-96,000, 95% CL), considerably fewer than the AOB estimate. This difference might be attributable to the presence of non-breeders prospecting burrows and who did not respond to tape playback. However, Smith *et al.* (2001) reported that unoccupied burrows on Skomer were visited only occasionally by responding, presumably non-breeding, birds; only 1% of responses were made by non-breeders. If a similar situation prevailed on Rum, and the survey period predated the expected arrival date of most non-breeders (James 1985), then non-breeders alone cannot account for non-responding burrows.

The colony-specific calibration factor, calculated in 2003, did not greatly reduced the discrepancy between the population estimates resulting from the two different methods; it is also unlikely that the numbers of non-breeders represent as much as 30-40% of the total population. A discrepancy between estimates obtained from responses to tape and the AOB method was also found on St Kilda, where a response was elicited from 36% of apparently occupied burrows (PI Mitchell pers comm.), and on Bardsey (30.5%; Leaper *et al.* in prep.). These figures are very similar to that on Rum (29%).

The reasons for the discrepancies are unknown. It might appear that the two methods measure different population parameters. Perhaps calibration factors vary not only between colonies but also interannually. Furthermore, *View of the breeding areas on Rum.* Uitzicht op de broedgebieden op Rum. *(Steve Geelhoed)* there are several ways in which data from the calibration can be analysed, each resulting in a slightly different value for the correction factor.

Given the uncertainty associated with response rates, we advise that where there are no other burrowing species present, counts of apparently occupied burrows should be undertaken in tandem with a tape playback survey and concurrent calibration study. Possible improvements to the design of the calibration study include ensuring wide spatial coverage, and using an endoscope to determine occupancy.

It is difficult comparing the results of our study with previous surveys given the differences in field methods, sampling strategies and timing in relation to non-breeder activity. However; the core area in 2001 (49.7 ha) broadly coincides with the mapped greens in previous studies (30-33 ha) and here the burrow counts (69,900) are within 12% of Philips (1982) estimate of 79,000 in 1982, and 10% of Furness (1997) estimate of 62,800 in 1995. Wormell's (1976) estimate of 116,000 in 1976 (32-46% higher than the later counts), and Thompson and Thompson's (1980) estimate in 1978-1979 of 124,000-146,000 pairs (at burrow densities 21% higher than in any other study), might appear anomalous. However, the degree to which surveys focus on the most densely populated greens probably greatly affects population estimates. Furness (1990) noted that the large variation in all areas rendered it difficult to demonstrate statistically significant changes over time; however, he considered that there may have been a slow decline in burrow densities from the 1960s through to 1990.

It appears to be widely accepted that the Rum shearwater colony is in slow decline (e.g. Smith *et al.* 2001), but the evidence for this rests mainly on the analysis by Furness (1997) of his fixed quadrat data from 1985, 1990 and 1995. A re-examination of Furness (1997) suggests that population decline between 1985 and 1995 had not been clearly established. Although the decline in used burrows within 105 permanent quadrats, grouped into larger plots in some major greens, was greater than that which could be attributed to observer error, the estimated decline remains subject to sampling error. If we assume that the quadrats, although non-random, are representative of change, then an appropriate statistical test may be used to examine whether the data indicate that actual population change has occurred. A paired t-test was applied by Furness (1997), but this provided no evidence for a statistically significant decline in used burrow density (Furness 1997) and we consider there is no compelling evidence of any substantial change in the size of the Rum shearwater colony since at least the 1980s, if not earlier.

The present population on Rum is somewhere between 61,000 (Table 3) and 134,000 pairs (Table 2), depending on the method used, compared with *c.* 102,000 pairs on Skomer (based on tape playback; Smith *et al.* 2001). Skomer, therefore, is the world's largest single colony of Manx Shearwaters; Rum is certainly of a similar size.

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INVENTARISATIE VAN NOORDSE PIJLSTORMVOGELS OP RUM, HEBRIDEN, IN 2001

Op het eiland Rum werd in 2001 een steekproefsgewijze inventarisatie van broedende Noordse Pijlstormvogels uitgevoerd met behulp van 658 plots die *at random* verdeeld waren over de kolonie. Ieder hol in de plots werd laat in het broedseizoen gecontroleerd op de aanwezigheid van vogels door de roep van een mannetje af te spelen bij de ingang en de reactie te registreren. Om te corrigeren voor niet-roepende vogels werd het geschatte totaal vermenigvuldigd met een correctiefactor van 2,16, die in 2003 was verkregen tijdens een calibratiestudie op Rum. Het resultaat was een populatieschatting van 76.310 (95%-betrouwbaarheidsinterval 61.160-95.740, tabel 3). Een visuele controle van de holen leverde een hogere populatieschatting op, nl. 119.950 (95%: 106.730-133.550, tabel 2) schijnbaar bezette holen (AOB). Verder onderzoek naar de *response rate* in deze kolonie is nodig om het verschil tussen beide schattingen te begrijpen. De visuele schatting is vergelijkbaar met eerder behaalde resultaten. Er zijn geen aanwijzingen voor een afname, zoals in de jaren negentig werd gesuggereerd.

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COUNTS OF ATLANTIC PUFFINS *FRATERCULA ARCTICA* IN THE FIRTH OF FORTH, SOUTH-EAST SCOTLAND IN 2003

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Harris M.P., Wanless S., Murray S., Leitch A. & Wilson. L.J. 2003. Counts of Atlantic Puffins *Fratercula arctica* in the Firth of Forth, south-east Scotland in 2003. Atlantic Seabirds 5(3): 101-110 *The numbers of Atlantic Puffins* Fratercula arctica *breeding at three colonies in the Firth of Forth were estimated in 2003. The Isle of May held 69,300 occupied burrows, making it the largest single colony in Britain and Ireland. This population increased at an average rate of 10.9%* per annum *between 1970 and 2003. Similarly, numbers on Fidra (1466) increased by an average of 9.5%* per annum *over the period 1976-2003. In contrast, the count of occupied burrows on Craigleith (12,100) was less than half of the 1999 estimate. This decline appeared to be due to the rapid spread of an alien plant, the tree mallow* Lavatera arborea. *The geographically distinct population of Atlantic Puffins in east Britain between the Moray Firth and Flamborough Head was estimated at 130,000 occupied burrows in 2003, representing an average rate of increase of 6%* per annum *over the previous 30 years.*

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INTRODUCTION

In Britain, the Atlantic Puffin *Fratercula arctica* has usually been considered a bird of the north and west with the largest colonies on isolated and spectacular islands such as St Kilda, North Rona and Sule Skerry (Cramp *et al*. 1974). However, over the last 40-50 years numbers of Atlantic Puffins nesting on the small, flat islands off the east coast of Scotland and England have increased substantially and several new colonies have established (Smith 1966, 1974; Harris *et al*. 1987). The expansion has been most marked in the Firth of Forth (Fig. 1); this paper reports on counts of burrows made at three colonies in this area (Isle of May, Fidra, Craigleith) in 2003 and assesses the rates of change in numbers in east Britain over the last 30 years.

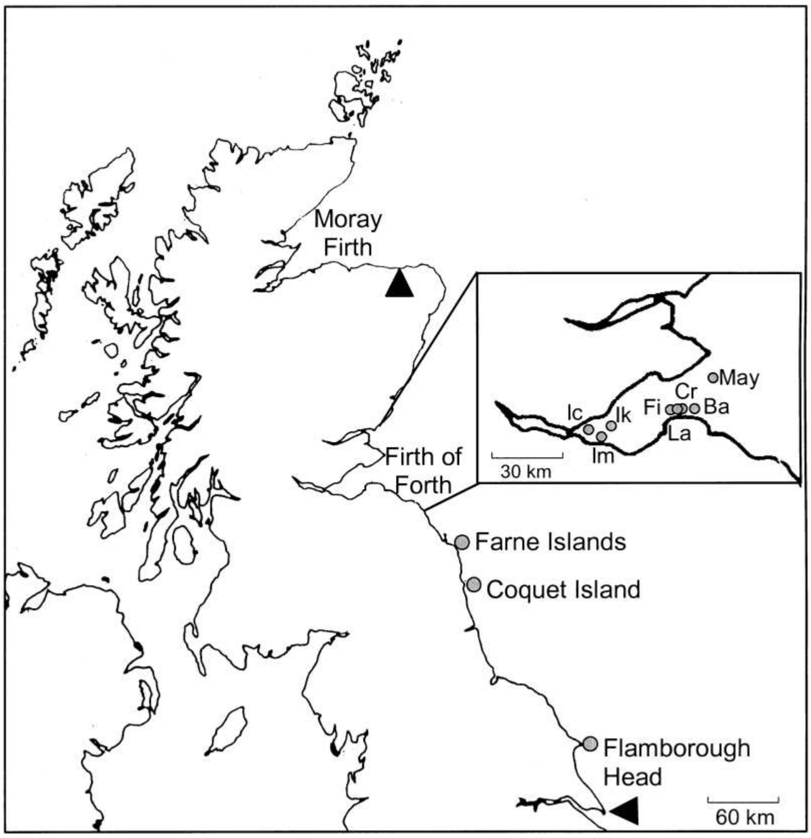

Figure 1. Colonies of Atlantic Puffin in the Firth of Forth, south-east Scotland: Isle of May (May), Craigleith (Cr), Bass Rock (Ba), the Lamb (La), Fidra (Fi), Inchkeith (Ik), Inchmickery (Im) and Inchcolm (Ic). The locations of the large colonies in north-east England and the limits of the local population (triangles) are also shown.

Figuur 1. Papegaaiduikerkolonies in de Firth of Forth, Zuidoost-Schotland: het eiland May (May), Craigleith (Cr), Bass Rock (Ba), the Lamb (La), Fidra (Fi), Inchkeith (Ik), Inchmickery (Im) en Inchcolm (Ic). De ligging van de grote kolonies in Noordoost-Engeland en de grenzen van de lokale populatie (driehoek) zijn eveneens aangegeven.

METHODS

The counting unit employed was the 'apparently occupied burrow', defined as a burrow showing signs of use by Atlantic Puffins such as fresh digging, droppings or regular wear. Where both Atlantic Puffins and rabbits *Oryctolagus cuniculus* occur (as on the Isle of May), there is potential for confusion between the burrows of the two species. However, a rabbit burrow tends to be larger, has more signs of digging, and has characteristic 'pellet' droppings in the entrance. None of the three islands studied has any other species of burrowing bird. For convenience, we use the terms 'burrow' instead of 'occupied puffin burrow'. Additional details of the counts and changes in numbers are given in Wanless *et al*. (2003).

Isle of May Puffins burrow predominantly in the flatter parts of the 55 ha island wherever there is sufficient soil. The count was undertaken by six people between 24 and 27 April 2003 when about half of the burrows contained eggs. The island was divided into 11 areas, each sub-divided into strips 25 m wide with the boundaries marked with bamboo canes. Each observer searched a strip about 5 m wide by zigzagging slowly across and along it. Where there was potential for overlooking burrows or counting them twice, a cane was used to mark the earth in the entrance of each burrow as it was counted.

In order to quantify the detection rate and the classification of burrows a plot *c.* 10x15 m was marked out with string in each of the 11 main counting areas. In five of these plots, the counters marked each burrow with a white plastic tag. In the other six plots, a single counter recorded all burrows he or she found while passing through the plot as part of the main count. Immediately following these counts, MPH, who did not take part in the total count, carried out a detailed examination of each plot, where necessary lying on the ground and feeling to the end of the burrow with a bamboo cane. In each plot, he determined the number of (a) Puffin burrows that had been overlooked (i.e. were unmarked), (b) burrows that belonged to a rabbit rather than a Puffin, (c) entrances that were not true burrows (e.g. were very short), and (d) cases where there were two entrances to a single burrow (i.e. the burrow had been counted twice). Double occupancy of a burrow, where two pairs use a single entrance, is extremely rare so this possibility was discounted.

Censuses of the Isle of May colony have previously been made in late April in 1975, 1984, 1989, 1992 and 1998; similar occupancy checks were made in two of these (Harris & Wanless 1998). In 1992, checks made in four areas suggested that the count had over-estimated the population by 7%, and in 1998, checks suggested an over-estimate of 2%. The probability of overlooking or wrongly classifying a burrow varies from area to area and from year to year due to the state of the vegetation, soil erosion, burrow density, numbers of rabbits, and other factors. For comparison with previous counts – here and on the other islands – we use the uncorrected burrow counts.

Craigleith About 95% of this 11.3 ha island was covered with a dense stand of tree mallow *Lavatera arborea* reaching a height of 2.5 m. Even in early spring the most sheltered parts of the island were under an almost closed canopy that made counting burrows very difficult and time consuming. As far as was practical the methodology followed that on the Isle of May. The count was made on 19 April 2003 by six counters. Checks of the efficiency of counting and classification in 11 plots were made by SM.

Fidra The count of the 7.4 ha island was made by six people on 4 May 2003 using the methodology outlined above. The efficiency of counting and burrow classification was checked by SM in two plots and these figures are used to give an approximate confidence interval for the count.

RESULTS AND COMPARISONS WITH PREVIOUS COUNTS

Isle of May Burrows were recorded virtually everywhere on the island where there appeared to be sufficient soil. The uncorrected count was 74,517 burrows.

Results from the 11 plots used to estimate observer error indicated that a correction factor of 0.93 should be applied to the raw counts (Table 1). This suggested that the overall count was 7% too high, mainly as a consequence of recorded burrows either being too short for breeding or having several entrances. The 95% confidence limits (CL) for this correction factor, ignoring the one plot where there were just two burrows, were 0.891-0.975. Applying this value to the count total (and rounding off to the nearest 100) resulted in a corrected total of 69,300 (66,400-72,700, 95% CL) occupied burrows.

The early history of the Puffin on the Isle of May is fragmentary (Eggeling 1960; Harris 1977; Harris & Wanless 1998). Before 1960, there were generally fewer than 50 pairs, with most occupying fissures in the cliffs rather than burrows in the central, flatter parts of the island. Numbers increased during the 1960s with about 200 pairs in 1963 and about 2000 pairs in 1970. The first systematic census of the colony was made in 1975 (3064 burrows) and counts were subsequently made in 1984 (12,211), 1989 (18,628), 1992 (20,106) and 1998 (41,542). The average rate of increase between 1970 and 2003 was 10.9% per annum (SE = 0.5%; Fig. 2).

Table 1. Checks of burrow counts and classification of Atlantic Puffin burrows on the Isle of May, Craigleith and Fidra, south-east Scotland in 2003.
Tabel 1. Controle van holentellingen en classificatie van papegaaiduikerholen op het eiland May, Craighleith en Fidra, Zuidoost-Schotland, in 2003.

Plot	Field count	Correctly classified	Mistaken classification		Missed	Corrected count	Correction factor
			Too short or used by rabbit	Second entrance to another burrow			
Isle of May							
1	66	59	4	3	8	67	1.02
2	96	84	9	3	2	86	0.90
3	51	44	3	4	1	45	0.88
4	97	85	5	7	8	93	0.96
5	85	79	1	5	8	87	1.02
6	2					3	1.5
7	80					73	0.91
8	52					51	0.91
9	59					46	0.98
10	40					34	0.85
11	21					19	0.90
Total	649					604	0.93
Craigleith							
1	9	9	0	0	3	12	1.33
2	6	6	0	0	2	8	1.33
3	9	9	0	0	0	9	1.00
4	75	68	7	0	31	99	1.32
5	60	54	5	1	10	64	1.07
6	8	8	0	0	12	20	2.50
7	43	43	0	0	11	54	1.26
8	59	53	3	3	2	55	0.93
9	18	17	1	0	1	18	1.00
10	104	90	12	2	7	97	0.93
11	76	70	5	1	11	81	1.07
Total	467	427	33	7	90	517	1.25
Fidra							
1	57	50	7	0	1	51	0.90
2	54	51	3	0	2	53	0.98
Total	111	101	10	0	3	104	0.94

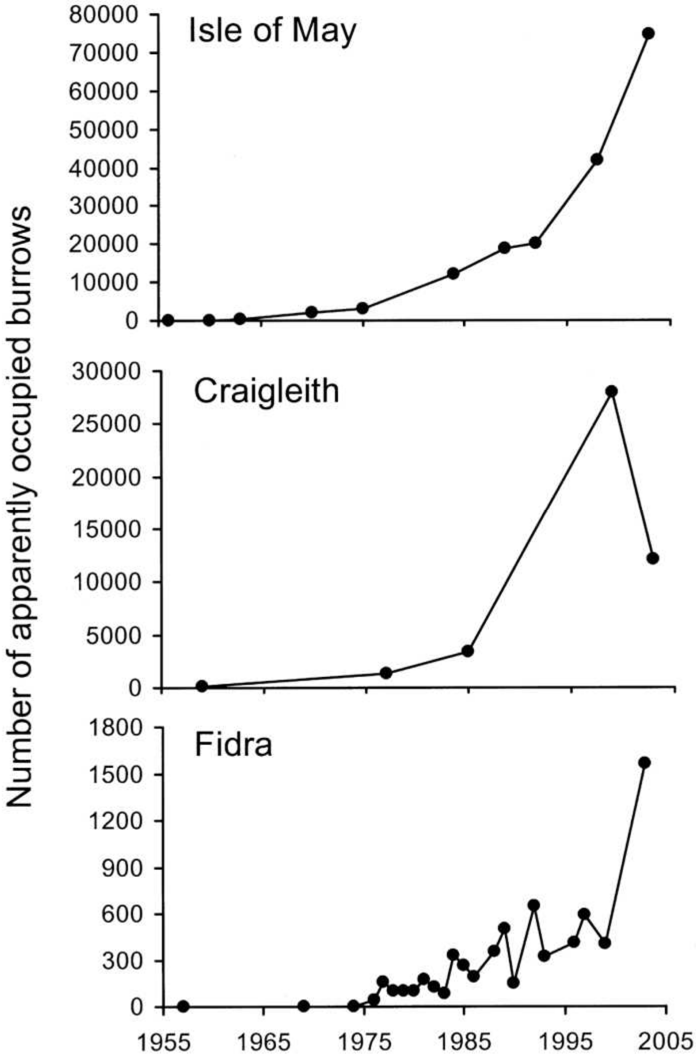

Figure 2. Counts of Atlantic Puffin burrows on the Isle of May, Craigleith and Fidra, south-east Scotland between 1956 and 2003.
Figuur 2. Resultaten van tellingen van papegaaiduikerholen op May, Craigleith en Fidra, Zuidoost-Schotland, tussen 1956 en 2003.

Craigleith The burrow count in 2003 was 9683. Overall, the count appeared to be 25% too low (Table 1), highlighting the problems of counting in tall dense vegetation. The corrected burrow total was 12,100 (9200-15,000, 95% CL).

The only previous estimates of Puffin numbers on Craigleith are 75-100 burrows in 1959, 1325 burrows in 1977, 3361 burrows in 1985, and 28,000 burrows in 1999 (Fairlamb 1998-1999; RWJ Smith *pers. comm.*; Royal Society for the Protection of Birds (RSPB) *pers. comm.*). The 1999 count was based on estimates of burrow density sampled in different habitats and a visual assessment that 55% of the island was covered by tree mallow but no estimate of precision was made. These counts suggest a steady rate of increase of 14.4% per annum (SE = 0.4%) between 1959 and 1999 (Fig. 2). If numbers had continued to increase at this rate, there would have been about 48,000 burrows in 2003 – four times the actual count. We attribute this marked decline to the very obvious recent rapid spread of tree mallow rendering the island much less suitable for breeding Puffins.

Fidra Burrows were dispersed at low density over the island with the exception of the low area to the south-west of the landing, which appeared to be a long defunct rabbit warren with few, if any, Puffin burrows. Tree mallow was present in a localized area near the lighthouse. A total of 1559 occupied burrows was counted. The checks showed that some apparent burrows included in the count were unusable and that the count overestimated the population by 6% (Table 1); the corrected total was 1466 (c. 1388-1528, 95% CL) burrows.

Puffins were first recorded ashore on Fidra in 1966. Four burrows were occupied in 1967 when a single egg was found. Counts have been made in 22 subsequent years (Fig. 2; Andrews 1994-1997; Fairlamb 1998-1999; Jones 2000-2003; RSPB *pers. comm.*). Between 1976 and 2003 the average rate of increase was 9.5% per annum (SE = 1.4%).

DISCUSSION

The 2003 count indicated that the Isle of May was the largest single colony of Atlantic Puffins in Britain and Ireland, with 8% of the Scottish population and 7% of the British and Irish population (Harris & Wanless 2004). Both breeding success and adult survival remain high at this colony (*personal observations*), and in the absence of density dependent effects there is no reason to suppose that the numbers will not continue to increase. At the current rate of increase, the numbers breeding on the Isle of May would double by 2010 and, if the other large colonies in east Britain were to reach carrying capacity (see below), even more birds could be attracted.

The Isle of May had a combined total of 3812 pairs of Herring Gull *Larus argentatus* and Lesser Black-backed Gulls *L. fuscus* in 2003 (Charras & Parkinson 2003). Although there is no evidence that the gulls have a negative impact on Puffin reproductive performance (Finney *et al*. 2001), their presence in areas where Puffins breed at low density reduces the attractiveness to prospecting Puffins (Finney *et al*. 2003). As the density of Puffin burrows increases over most of the Isle of May, gulls may be expected to have less of an effect on recruitment and Puffin numbers might increase at an even faster rate. Given that there are still areas of apparently suitable habitat where the density of burrows is low, there is potential for the colony to increase substantially. Assuming that (a) only 50% of the land surface is suitable for Puffin burrows, (b) none of the already occupied high density areas become unsuitable, and (c) an average density of 1 burrow/m^2, the island could theoretically have a carrying capacity of one quarter of a million burrows.

Within the Firth of Forth the only long established colonies of Puffins are on the Isle of May, Craigleith and the Bass Rock. However, during the last few decades several other islands have been colonised. The numbers of burrows or birds present at these colonies have been counted or estimated in many years (Smith 1966, 1974; Harris *et al*. 1987; Andrews 1994-1997; Fairlamb 1998-1999; Jones 2000-2003; RSPB *pers. comm.*; RWJ Smith *pers. comm.*). Numbers on the Bass Rock have not increased in recent years and there are probably now only about 10 pairs. Puffins were first recorded breeding on Inchkeith in 1965 (three burrows, one egg), although birds were seen ashore in 1961. There was then a rapid increase with 292, 380, 395 and 800-1000 burrows recorded during visits in 1975, 1976, 1978 and 1994, respectively. There are no recent counts of burrows on Inchkeith, but estimates of birds on the sea just off the island suggests that there may currently be more than 2000 pairs at this colony. Colonisation of Inchcolm possibly occurred in 1992 and breeding was proven the following year; in 1995 there were 30 pairs, and in 1997 65 birds. The Lamb was colonised in about 1984 and eight sites (presumably burrows) were recorded in 1985, 56 burrows in 1986 and at least 150 burrows in 1995. Although three Puffins were seen "around" Inchmickery in 1973, there were then few records until three pairs prospected and possibly bred in 1991. In 2003, nine individuals were seen ashore and a further four on the sea. Combining these estimates with our census data suggests that the total population of the Firth of Forth is in the region of 84,000 burrows. This compares with 18,000 burrows in 1985. The cause of this rapid increase is unknown. Many other species of seabirds in the Firth of Forth, with the notable exception of terns *Sterna* spp., have also increased in numbers over the period (Harris *et al*. 1987; Jones 2000-2003). Protection at the colonies may have played a small part but the food supply, perhaps in both the winter and summer, must surely have increased as well.

The two other major Puffin colonies in eastern Britain (both in Northumberland) were also censused in 2003. The Farne Islands held 55,700 burrows (John Walton *pers. comm.*). Coquet Island held 11,300 occupied burrows and an approximately equal number of apparently unoccupied burrows (Paul Morrison *pers. comm.*); the reason for this high proportion of apparently unoccupied burrows in 2003 was unknown but the total burrow count was very similar to those in 2001 and 2002 (RSPB unpublished data). The various Farne Islands and Coquet Island are small and flat with generally shallow soil - conditions that lead to the collapse of burrows and subsequent soil erosion - and appear to have only limited capacity for further increase in numbers of breeding Puffins.

In 1969-1970, Cramp *et al*. (1974) estimated that there were about 29,000 pairs of Puffins in east Britain between the Moray Firth and Flamborough Head in Yorkshire. In 1985-1987, numbers had increased to 55,000 pairs (Lloyd *et al*. 1991). Counts made in 1998-2003 put the number at over 130,000 (Harris & Wanless 2004). These totals suggest an average increase of 6% per annum for the region over the last 30 years. In Britain, the Puffin is usually considered a bird of wild and remote places. However, in 2003 there were more Puffins nesting on the North Sea coasts of Scotland and north-east England, than at the famous seabird colony of St Kilda.

Tree mallow is indigenous to England and Wales but was introduced to Scotland (Cox 2002). Although not very dense or widespread, it is well-established on Fidra, where attempts are currently being made to control it (Dave Jones *pers. comm.*). Unless similar measures are undertaken to control its spread on Craigleith, Puffin numbers there are likely to be reduced further. Tree mallow is intolerant of grazing (Gillham 1953), so consideration might be given to removing some of it and introducing rabbits to Craigleith to restrict its regeneration.

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INVENTARISATIE VAN PAPEGAAIDUIKERS IN DE FIRTH OF FORTH, ZUIDOOST-SCHOTLAND, IN 2003

In drie kolonies in de Firth of Forth werden de broedende Papegaaiduikers in 2003 geïnventariseerd. Op het eiland May werden 69.301 bezette nestholen gevonden, waarmee het eiland de grootste kolonie in Groot-Brittannië en Ierland is. Deze populatie nam van 1970 t/m 2003 toe met een jaarlijkse gemiddelde groei van 10,9%. De aantallen op Fidra (1466 holen) groeide in 1976-2003 met een vergelijkbare snelheid, nl. 9,5% per jaar. Op Craigleith bedroeg het aantal bezette holen in 2003 (12.300) minder dan de helft van het in 1999 geschatte aantal. Deze afname lijkt veroorzaakt door de snelle uitbreiding van een exoot, *Lavatera arborea*. De geografisch te onderscheiden populatie Papegaaiduikers tussen de Moray Firth en Flamborough Head werd in 2003 geschat op 130.000 bezette holen, hetgeen overeenkomt met een jaarlijkse groei van 6% gedurende de afgelopen dertig jaar.

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DEPARTURE OF TERNS IN SPRING 1999 FROM NAMIBIA

Guido O. Keijl

Keijl G.O. 2003. Departure of terns in spring 1999 from Namibia. Atlantic Seabirds 5(3): 111-118. *During a study of terns wintering along the Namibian coast in Feb-Apr 1999, departing terns were recorded. Most terns departed in the evening when other terns went to roosts. Departing flocks consisted only of Sandwich* Sterna sandvicensis, *Common* S. hirundo *and White-winged Black* Chlidonias leucopterus *Terns, of which the first two species originate from north-western European breeding grounds. A major drop in roosting numbers occurred from late February onwards and also a decline in body mass of Common and Sandwich Terns was noted during this period, while departure was observed from early March onwards. Even though the observational data are anecdotal, they suggest that the three tern species migrate not only at night, but also that they may well cross at least part of their route in a straight line. The dominant tern migration strategy remains obscure, but time constraints seem an unlikely cause of jump migration. The jump migration strategy might indicate that the number of suitable stop-over sites is limited.*

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INTRODUCTION

Palearctic terns migrating between the northern hemisphere and the southern part of Africa seemingly face a tight time schedule. Flight feathers are moulted, which takes several months (Stresemann 1963), and they have to complete this moult in the wintering areas or at stop-over sites. Migration of terns as known to most observers takes place along the coast at altitudes up to some tens of metres above sea level (Marr & Porter 1992; Krüger & Garthe 2001). This type of low-level migration may involve thousands of birds per day, both in spring and autumn (Camphuysen & van Dijk 1983; Johansson & Jakobsson 1997). Terns are also known to migrate at night (Grimes 1977; Lambert 1988) and over land (Jellmann & Vauk 1978; Camphuysen 1992), however, but the extent of it remains largely unknown. Alerstam (1985) observed migrating Common *Sterna hirundo* and Arctic Terns *S. paradisaea* leaving Sweden in autumn at great altitude and supposed that terns try to cover large distances in one flight, just as waders (Piersma *et al.* 1990). Little is known about high-altitude migration in terns. Departing Black Terns *Chlidonias niger* and Common Terns from Lake IJsselmeer in autumn ascend to great heights before moving S or SW (Schouten 1982; Lensink *et al.* 2002). High-altitude migration has not been described for terns in spring, and not at all for Sandwich Terns *S. sandvicensis* and White-winged Black Terns *C. leucopterus*. Lambert (1988) mentioned individual terns or tern flocks coming down at night from 'great altitude' to his well-lit observation post at sea in the Gulf of Guinea in spring, indicating that terns pass this area at high altitude at night.

In this contribution, observations from Namibia in spring 1999 are presented, where departing tern flocks were seen to ascend to great altitudes. From a review of available data, it is suggested that this type of high-altitude long-distance migration in terns wintering in Africa could be a common phenomenon.

METHODS

A project on Palaearctic terns was carried out by the Avian Demography Unit (ADU) and Foundation Working Group International Wader and Waterbird Research (WIWO) in Namibia, 1 Februay-2 April 1999 (Arts *et al*. in prep.). Observations were done along the coast between Walvis Bay and a saltpan complex just north of Swakopmund, Namibia. In Swakopmund, terns were ringed. Departing tern flocks were mainly discovered while counting roosting terns. Flight altitudes and flight direction were estimated by eye.

OBSERVATIONS

In March we noticed several tern flocks leaving the study area. Only three tern species of Eurasian breeding origin were involved: Common Tern, Sandwich Tern and White-winged Black Tern. Other terns present in the area were Eurasian Black Tern and the southern African Damara *S. balaenarum*, Swift *S. bergii* and Caspian Terns *S. caspia*. The detailed observations are presented below:

- 4 March – Yacht Club (Walvis Bay), 19:30 hrs, compact flock of four White-winged Black Terns leaving towards the N, discovered when at considerable altitude, continuing to climb until out of sight (estimated at four kilometres distance).
- 6 March – Mile4 Saltworks (Swakopmund), 20:00 hrs, compact flock of approx 50 Sandwich Terns left silently from the roost, flying N and ascending steeply.
- 8 March – Yacht Club, 18:10 hrs, compact flock of 18 White-winged Black Terns discovered overhead at 1000 m by their agitated calls, flying NE. The terns continued to ascend and did not change direction until out of sight.
- 9 March – sewage ponds at Walvis Bay, 19:15 hrs, compact flock of 28 White-winged Black Terns heading NW, flying at great altitude and still ascending.

- 11 March – Langstrand (between Walvis Bay and Swakopmund), 07:30 hrs, 8 Sandwich Terns, calling agitatedly and circling higher and higher until they disappeared in the clouds.
- 11 March – Yacht Club, 18:10 hrs, tight flock of 31 White-winged Black Terns discovered when already at considerable altitude, circling higher and higher and split in two flocks. One flock of 21 individuals left towards the NE, the other flock could not be followed). No calls heard.
- 11 March – Yacht Club, 18:20 hrs, five Sandwich Terns circled higher and higher, calling intensely, disappearing in the mist.
- 15 March – Mile4 Saltworks, 18:20 hrs, compact flock of about 130 Common Terns flew around calling for a while, gradually attaining height until they levelled off at considerable altitude and headed out (direction not noted).
- 16 March – Mile4 Saltworks, *c*. 20:00 hrs, compact flock of 25 Common Terns left the roost just before dark towards the NW.
- 18 March – Walvis Bay Saltworks, 18:00-18:05 hrs, flocks of 4, 3, 2, and 3 Sandwich Terns departed towards the NNW. All birds climbed in tight circles calling continuously and rose to about 200-300m altitude before levelling off. The earliest birds seemingly waited for the later departing birds to join them.
- 18 Mar – Walvis Bay Saltworks, 18:00-18:05 hrs, compact flock of 5 Common Terns ascended steadily and left in NNW direction.

Apparent arrival of terns was observed twice:

- 6 Mar – Mile4 Saltworks, 17:50 hrs, 6 Sandwich Terns, discovered by chance through binoculars, became discernible at an estimated 3 km altitude in a clear blue sky.
- 11 Mar – Walvis Bay, 18:38 hrs, 6 Sandwich Terns appeared from the clouds at probably 1.5 km altitude and quickly descended. They continued low over the water in N direction.

DISCUSSION

As departing terns in Namibia were discovered by chance it is likely that many left unnoticed. Prior to 4 March, departing flocks have probably been overlooked because no attention was paid, even though numbers at the roost in Walvis Bay dropped steeply from 25 February onwards. A drop in body mass of Black, Common and Sandwich Terns was noted, probably indicating that the heaviest individuals had departed (*cf.* Zwarts *et al*. 1990). It is unknown what triggered the terns' departure in spring 1999. They may have left because of changing feeding conditions, for the departure coincided with an influx of warmer water from the north – a phenomenon occurring regularly in the Benguelan system (Shannon *et al*. 1986).

Sandwich and Common Terns from Namibia departed towards the NW or N, White-winged Black Terns towards the NW (one flock), N (one flock) and

NE (two flocks). If birds fly straight N from Walvis Bay they soon find themselves flying over land, to meet the sea again in Central Angola. If terns migrate at night and/or at great altitude there is no need for them to fly over sea. Considering the distance, it is unlikely that terns will cover the entire stretch from Namibia to Europe in one flight (Table 1). The West-African coast, where large numbers of terns occur in winter and spring (Brenninkmeijer *et al.* 2002) is a suitable stop-over site, whereas the Gulf of Guinea seems to be used mainly in autumn (Grimes 1977; Houghton & Mensah 1978; Lambert 1988). On their way from Namibia to the West-African coast the terns would probably cross the Gulf of Guinea quickly.

Table 1. Calculated time needed (h) by terns on their way from Namibia to the African West coast, and from Namibia to West-Europe, assuming a straight line or when following the coastline. Flight speeds from [1]Alerstam (1985) and [2]Gudmundsson et al. *(1992), [3]Brenninkmeijer & Stienen (1994), [4]Stienen & Brenninkmeijer (1994), and [5]Van der Winden & Schobben (2001). 'Commic tern' = Common or Arctic* S. paradisaea *Tern.*
Tabel 1. Berekening van de benodigde vliegtijd (uren) voor sterns van Namibië naar de Afrikaanse westkust en van Namibië naar West-Europa, indien afgelegd in een rechte lijn of langs de kust. Min en max vliegsnelheid van [1]Alerstam (1985), [2]Gudmundsson et al. *(1992), [3]Brenninkmeijer & Stienen (1994), [4]Stienen & Brenninkmeijer (1994) en [5]Van der Winden & Schobben (2001). 'Commic Tern' = Visdief of Noordse Stern.*

	Namibia - Senegal		Namibia – West Europe	
	straight line	along coast	straight line	along coast
	5,500	8,000	8,500	14,000 km
'Commic' Tern[1] 40 km h^{-1}	138	200	213	350
'Commic' Tern[2] 56 km h^{-1}	98	143	152	250
Sandwich Tern[3] 24 km h^{-1}	229	333	354	583
Sandwich Tern[4] 66 km h^{-1}	83	121	129	212
Black Tern[5] 50 km h^{-1}	110	160	170	280

It is very well possible that Sandwich and Common Terns leaving Namibia make use of the predictable SE trade-winds to quickly migrate to West-Africa and skip the Gulf of Guinea. Extra weight is probably not just 'fuel' but also 'insurance' if unfavourable conditions are met with, for instance in rough weather on arrival (*cf.* Dunn 1973, Haney & Stone 1988, Sagar & Sagar 1989).

Ringing results have shown that at least some Sandwich Terns breeding in West-Europe winter in Namibia (Vandewalle 1988; Noble-Rollin & Redfern 2002). Sandwich Terns in The Netherlands arrive at the breeding

Sandwich Terns and Common Terns with two Hartlaub's Gulls, Namibia 1999. Grote Sterns en Visdiefjes met twee Hartlaubsmeeuwen, Namibië 1999. *(Tom van der Have)*

colony from late March onwards, with peaks in arrival mid-April (experienced breeders) and mid-May (inexperienced breeders; Veen 1977; Brenninkmeijer & Stienen 1992). This would give birds leaving Namibia in early March 30-45 days to cover the distance to western Europe and arrive in April, flying on average 190-330 km day^{-1}. One Sandwich Tern, ringed as a chick on Griend, was captured in Namibia on 1 March 1999. Only six weeks later, on 18 April 1999, it was present in its natal colony. These data suggest that Sandwich Terns leaving Namibia in early March are indeed able to arrive in the Dutch colonies within six weeks travelling at 190-330 km day^{-1}.

Several Common Terns captured in Namibia during this study were ringed in Sweden, Finland and Estonia. To reach these areas around early May from southern Africa, terns departing in early March have to fly on average 160-280 km day^{-1}. This is considerably more than the 80-110 km day^{-1} calculated by Kasparek (1982).

Migration strategies of marsh terns *Chlidonias* spp. are even less well known than those of *Sterna* spp.. White-winged Black Terns are known to appear inland in Africa on migration (Bates 1934; Begg 1973; Curry & Sayer 1979; Nikolaus 1987; Goudswaard & Wanink 1993), even over the Sahara (Moreau 1967; Dupuy 1969; Bundy 1971), while they appear to be virtually absent along the western coasts of Africa. White-winged Black Terns are common during spring migration in Sudan (Nikolaus 1987) and these birds may have followed the lake-scattered Rift Valley on their way north from southern Africa. It is not known where White-winged Black Terns are going to after they have left Namibia. The distance between Namibia and the mid-point of the breeding area is over 10,000 km. Most White-winged Black Terns in 1999 left prior to 1 March. To arrive in early May they have to migrate with an average speed of almost 170 km day^{-1}.

The general idea that terns breeding in Europe or Asia migrate in a steady pace along the coast, meanwhile feeding, is probably not true, certainly not for (all) those wintering in southern Africa and possibly not for the entire stretch. Our observations suggest a strategy of jump migration (Piersma, 1987) as is found in several wader species. This could be an indication that the number of suitable stop-over sites is restricted.

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VERTREKKENDE STERNS IN NAMIBIË IN HET VOORJAAR VAN 1999

Ten minste een deel van de in Noordwest-Europa broedende Visdieven Sterna hirundo *en Grote Sterns* S. sandvicensis *overwintert in zuidelijk Afrika. Gedurende een onderzoek in Namibië zijn sterns gevangen en zijn tellingen en andere observaties aan sterns gedaan. Vooral in maart werden tijdens slaapplaatstellingen (figuur 1) wegtrekkende groepjes Grote Sterns, Witvleugelsterns* Chlidonias leucopterus *en Visdieven gezien. Van lokale sternsoorten (Reuzen-* S. caspia, *Damara-* S. balaenarum *en Kuifstern* S. bergii*) en de op het noordelijk halfrond broedende Zwarte Stern* C. niger *is deze wegtrek niet waargenomen. Mogelijke aankomst werd tweemaal waargenomen. Vanaf eind februari nam het aantal overnachtende sterns in het gebied sterk af en bleken ook de gemiddelde gewichten af te nemen. Dit laatste zou echter ook verband kunnen houden met een veranderde voedselsituatie. Vermoedelijk is genoemde periode de gebruikelijke wegtrekperiode van sterns uit dit gebied; de afname van gemiddelde gewichten zou dan verklaard kunnen worden doordat de zwaarste vogels wegtrekken. Na deze periode namen de gemiddelde gewichten weer toe.*

Hoewel het om slechts een handvol waarnemingen gaat wordt duidelijk dat in ieder geval deze drie soorten sterns 's nachts trekken, een weinig bekend fenomeen, maar ook dat het daarmee aannemelijk wordt dat de vogels niet per se de kust volgen om op hun volgende rustplaats te komen. Het is bekend dat er zich aan de West-Afrikaanse kust 's winters en in het vroege voorjaar grote aantallen sterns ophouden. Ondanks de rui in de wintermaanden, die enkele maanden in beslag neemt, lijken ze nauwelijks in tijdnood te komen en hoeven ze zich blijkbaar niet te haasten om in het voorjaar weer tijdig op de kolonies aanwezig te zijn. De 'keuze' voor een sprongstrategie in plaats

van dagelijks een stukje vliegen en onderweg foerageren zou een aanwijzing kunnen zijn dat het aantal voedselrijke rustgebieden onderweg beperkt is.

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A COMPARISON OF TWO METHODS FOR COLLECTING FEATHER LICE FROM DEAD BIRDS

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Jensen J-K. & Olsen B. 2003. A comparison of two methods for collecting feather lice from dead birds. Atlantic Seabirds 5(3): 119-126. *Two procedures for the collection of feather lice from birds are described – a 'dry' method and a 'wet' method. The dry method consists of placing the bird in a plastic bag with chloroform for 30 minutes after which the plumage is brushed and all dislodged lice collected. The wet method consists of thoroughly washing the dead bird in soapy water and straining the water to collect the lice. Eleven Little Auk* Alle alle *corpses were deloused using both methods. Three species of feather louse were recorded using both methods but the wet method consistently resulted in the recording of more lice than the dry method alone. The wet method is especially suitable for collecting lice from dead birds but is impractical for use on live birds.*

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INTRODUCTION

Feather lice can provide valuable information about their bird hosts. A classic example is the work of Hopkins (1942) where he indicated a close relationship between the flamingos (Phoenicopteriformes) and the geese (Anseriformes) in spite of the fact that flamingos superficially more resemble storks than herons (Ciconiiformes). Zonfrillo and Palma (2000) referred to feather lice from the Levantine Shearwater *Puffinus yelkouan* in their discussion of the taxonomic status of shearwaters, and Jensen *et al.* (1999) deduced from the feather lice found on Sooty Shearwaters collected around the Faroe Islands that these birds came from Tristan da Cunha. Several Iceland Gulls *Larus glaucoides* collected in the Faroe Islands were infested with feather lice from Little Auks *Alle alle*, probably as a result of predation by the gulls on the auks in Greenland colonies (Palma & Jensen in prep.). Paterson *et al.* (2000) address the issue of co-evolution of seabirds and feather lice.

Small live birds are usually deloused by suspending them by their head in a glass container filled with chloroform vapours (Williamson 1954; Ontario Bird Banding Association, 1960). Fowler and Cohen (1983) improved this method and considered the statistical validity of the method for a range of host species. Their results suggest that as many as 88% of the lice present on a bird (excluding the head) may be extracted by this method, and that the collected samples appear to be reasonably representative of the species and age classes of the feather lice present. However, they stated that the only method by which the absolute number of ectoparasites present on a bird may be determined is by careful feather-by-feather examination of its plucked plumage.

Clayton & Walther (1997) published a thorough account on the collection of arthropod parasites from both live and dead birds, but most authors do not give details on how they deloused the birds (e.g. Jensen *et al.* 1999; Pilgrim & Palma 1982), so it is difficult to compare results. Systematically delousing a dead bird feather-by-feather is very time consuming, therefore it is feasible only when the sample comprises few birds. A more or less systematic inspection of the feathers to establish presence or absence of feather lice, however, is often the rule. Foster *et al.* (1996) washed birds in soapy water and strained off the lice from the water. They found this method to be very effective and stated that the higher abundance of lice they found on Great Shearwater *Puffinus gravis* compared with a study by Bourgeois & Threlfall (1979) was probably due to different collecting techniques. On birds found dead, the feathers are often wet and dirty but the lice cling to the feathers even after death. Therefore, washing the birds and straining off the lice from the water as carried out by Foster *et al.* (1996) appears to be a good method.

The aim of this study was to compare the efficiency of two sampling methods for collecting feather lice from dead birds. In the first method, we used chloroform to extract the lice, should any have remained alive, and brushed them onto a sheet of white paper. In the second method, the same birds were washed thoroughly in soapy water and the lice strained off in a special strainer following Foster *et al.* (1996).

METHODS

We examined 11 Little Auks found dead on the beach in Nólsoy, Faroe Islands, in December and January 1996-1998. The corpses were stored separately in plastic bags before examination in order to avoid transfer of lice between them. A few of them were stored in a freezer. Prior to delousing, all the birds were air-dried by hanging them indoors for 1 or 2 days until they were completely dry.

Method 1: the 'Dry' Method To delouse the corpses using method 1, each bird was placed in a plastic bag with a cotton wad saturated with concentrated chloroform for 30 mins to ensure that all lice were dead. Each corpse was then held over white paper and the feathers brushed with the fingers and manipulated for a couple of minutes until no more debris or lice fell onto the paper. All dislodged material such as sand, beach debris, feathers, etc. was systematically

Figure. 1. The feather lice strainer is made of a 20 cm PVC waste pipe and a 6 cm high socket made from a pipe coupling, and equipped with a 400 micron plankton net. The internal diameterof the pipe is 10 cm. The pipe coupling has been cut so the wider part is 2 cm high, sawn through below and glued together with the plankton net in between. As the water must flow easily from the strainer the socket has been sawn so that it stands on four legs.
Figuur 1. De veerluisfilter is gemaakt van 20 cm PVC-pijp en een 6 cm hoge pijphouder voorzien van een planktonnet van 400 micron. De interne diameter van de pijp is 10 cm. Het bovenstuk van de pijphouder is 2 cm hoog, van onder doorgezaagd en vastgelijmd met het plankton-net ertussen.Om het water ongestoord te laten vloeien is de standaard uitgezaagd zodat het op vier poten staat.

searched for lice under a dissecting microscope. Lice were collected with a wet needle and immersed in 70% alcohol.

Method 2: the 'Wet' Method In method 2, the same birds that had been deloused using method 1 were washed in order to find more lice. Each corpse was thoroughly washed twice in a plastic bucket with lukewarm water and liquid soap. After each wash, the water was poured through a strainer (Fig. 1). Finally, each corpse was thoroughly rinsed in the bucket with a pressurized water spray and the water again strained off. The lower part of the lice-strainer, which holds the mesh net, was then placed under the dissecting microscope and any additional lice collected were again stored in 70% alcohol. The bucket and the lice strainer were cleaned very thoroughly after processing each bird.

Table 1. The number of feather lice collected from 11 Little Auks using chloroform (method 1 – the Dry Method) and washing the same birds (method 2 – the Wet Method). Values indicated for method 2 include those for method 1.
Tabel 1. Het aantal veerluizen dat verzameld werd van elf dode Kleine Alken met behulp van choloroform ('droge' methode 1) en door dezelfde vogels te wassen ('natte' methode 2). Waarden voor methode 2 zijn inclusief die voor methode 1.

Species	Method	Males	Females	Nymphs
Austromenopon	1. Dry	39	37	88
merguli (T.)	2. Wet	84	99	110
	% increase wet over dry	115	168	25
Quadraceps	1. Dry	142	173	357
klatti (T.)	2. Wet	164	209	382
	% increase wet over dry	15	21	7
Saemundssonia	1. Dry	17	27	38
merguli (D.)	2. Wet	32	48	60
	% increase wet over dry	88	78	58

All lice were identified by comparing them with specimens previously determined by R.L. Palma and slide-mounted following the technique in Palma (1978). A representative part of this insect material is deposited in the Natural History Museum, Tórshavn, Faroe Islands.

In presenting the results for method 2 the lice collected using method 1 were added to those collected using method 2, as we would expect that all lice found with method 1 would also have been found by merely washing the birds after the lice were dead. Freezing the birds before delousing might well have the same effect as the treatment with chloroform, and therefore the treatment of the frozen birds with chloroform could have been omitted.

RESULTS

Three species of feather lice were collected from the 11 Little Auks (Table 1), and all species were found during the first treatment (method 1 – the Dry Method). Washing the birds (method 2 – the Wet Method) did not reveal any new species, although the total number of lice discovered increased by 29% on

Table 2. Feather lice infestation of 11 Little Auks indicated by using chloroform (method 1 – the Dry Method) and by washing the same birds (method 2 – the Wet Method). Values represent numbers of birds, and those indicated for method 2 include those from method 1.
Tabel 2. Aantal met veerluizen besmette Kleine Alken volgens de droge methode 1 en de natte methode 2. De waarden voor methode 2 zijn inclusief die voor methode 1.

Species	Method	Males	Females	Nymphs
Austromenopon	1. Dry	5	6	7
merguli (T.)	2. Wet	7	8	7
	% increase wet over dry	40	33	0
Quadraceps	1. Dry	11	10	9
klatti (T.)	2. Wet	11	10	10
	% increase wet over dry	0	0	11
Saemundssonia	1. Dry	7	9	10
merguli (D.)	2. Wet	9	11	10
	% increase wet over dry	29	22	0

average (Table 1). The wet method was especially effective in collecting adults of *Austromenopon merguli* (a 141% increase) and *Saemundssonia merguli* (an 82% increase), while the number of adult *Quadraceps klatti* increased by only 18%. The increase in number of nymphs was lower - 25%, 58% and 7% respectively.

The observed infestation rate (i.e number of birds hosting the various species and ages of lice) also increased when the birds were washed (Table 2). *Quadraceps klatti* occurred on all the birds with either method, while the infestation rate for adult *Austromenopon merguli* and *Saemundssonia merguli* increased 36% and 25% respectively when the birds were washed. Infestation with nymphs increased by 11 % for *Quadraceps klatti* but no increase in the number of nymphs was found for the other two species.

DISCUSSION

Skinned birds in collections that have been washed with soapy water have few if any feather lice, demonstrating the efficiency of washing away lice with soapy water. Delousing birds using the wet method probably extracts almost all the lice, so in this discussion the cumulative number of lice extracted with methods 1 and 2 are treated as the total number present on the bird. Searching the same birds after delousing failed to reveal any further lice.

The dry method probably dislodges only those lice that are unattached to the feathers and leaves the remainder. *Quadraceps klatti*, the most numerous louse we found on the Little Auks, is most easily extracted both as adult and nymph, as respectively 85% and 93% were extracted using the dry method. For *Saemundsonia merguli*, 55% of the adults and 63% of the nymphs were extracted with the dry method, while for *Austromenopon merguli* the respective proportions were 42% and 80%. As the nymphs were extracted more easily than the adults for all three species, the dry and wet methods also indicate different age distribution of the lice. The infestation rate was also higher after applying the wet method, although, for birds heavily infested there was no difference.

These findings suggest that it is impossible to extract a representative sample of louse species and age classes using a method that fails to extract all lice. This is especially the case with live birds, but on dead birds rough methods can be used and washing the birds as described above (the wet method) after the lice have been killed or are dead, seems to be a reliable method. It is relatively easy, quick and effective, and if the corpses are not required, can be done in the field. However, some lice live within the quills of feathers and will probably be unaffected by either dry or wet methods of collecting. These lice will require special examination by opening feather quills of dead or moulted birds.

The use of chloroform in our dry method might not have had the same effect as in the study of Fowler & Cohen (1983), where the lice on the live birds might have actively left the feathers as they were affected by the chloroform vapour. After the treatment with chloroform, we therefore brushed the birds towards the head against the feathers until apparently all the loose lice were found. The brushing of the feathers in the dry method is unlikely to increase the likelihood of collecting lice subsequently using the wet method. Therefore, we assume that the same total number of lice would have been discovered using the wet method alone, provided that the lice were dead before washing.

Before washing dead birds for delousing, we recommend that the lice are killed by either freezing the birds or by placing them in a plastic bag with chloroform vapour for 30 minutes. We do not know whether lice that die from freezing or from chloroform vapour attach more tightly to the feathers. In any case, birds found dead are often frozen before delousing, so freezing the birds apparently is a good standard method to kill lice on dead birds.

Delousing live birds must be carried out as careful as possible, so washing the birds is excluded. The period should also be as short as is necessary to extract a representative sample of the louse species and age classes (Fowler & Cohen 1983). According to Fowler & Cohen (1983), as many as 88% of the lice present on a Blackbird *Turdus merula* (excluding the head) may be extracted in 30 minutes from the live bird using their method, but there may be large differences between louse species collected. They also state that any method based upon the examination of feathers *in situ* is likely to be strongly biased against the recording of mobile species and the smaller nymphal instars.

Before examination, it is very important that the corpses are stored separately so that transfer of lice between them does not take place. The lice-strainer must also be cleaned and examined very carefully after each session.

In this study we have compared delousing methods for feather lice, but washing the birds in soapy water and straining off the water is also an effective way of extracting feather mites from dead birds, but in this case the net in the strainer has to be 100 micron mesh (Foster et al. 1996) rather than the 400 micron net used here for lice.

Comparing collections of feather lice compiled using different methods may give inaccurate results as the efficiency of extracting the lice depends on the species and their age. Washing a dead bird thoroughly in soapy water as in the wet method extracts almost all the lice from the plumage and so is an effective tool for studying the louse fauna of dead birds. It is an especially suitable method for use on dirty and wet specimens found on the seashore and elsewere.

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EEN VERGELIJKING VAN TWEE METHODEN OM VEERLUIZEN VAN DODE VOGELS TE VERZAMELEN

In dit artikel worden twee methoden voor het verzamelen van veerluizen beschreven: een 'droge' methode en een 'natte' methode. De droge methode houdt in dat een dode vogel 30 minuten in een plastic zak met chloroform wordt gehouden, waarna het verenkleed wordt gekamd en alle luizen die hebben losgelaten, worden verzameld. De natte methode bestaat uit het grondig wassen van een dode vogel met water met zeep, waarna het water wordt gefilterd om de luizen te verzamelen. Elf dode Kleine Alken *Alle alle* werden met beide methoden van luizen ontdaan. Met beide methoden werden drie soorten luizen vastgesteld, maar de 'natte' methode resulteerde steevast in hogere aantallen luizen dan de 'droge' methode. De 'natte' methode is zeer geschikt om luizen van dode vogels te verzamelen, maar is niet praktisch bij levende vogels.

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Notes on seabirds

The international ornithological journal *Ardea*, issued by the Netherlands Ornithologists' Union since 1912, until recently had a rather popular short section called *Notes on seabirds*, edited by Karel H. Voous (Nrs. 1-75, 1963-1988). This seemed to be a useful possibility to obtain an international audience for interesting seabird records that otherwise either would go lost, or were to be published in relatively obscure journals or cruise reports. The editorial board would like to re-introduce the concept for *Atlantic Seabirds* with "Notes on seabirds" numbered in order of appearance. These Notes should have a short title, no abstract, no summary, at most 1 Table or Figure, perhaps a photograph, and crisp text. The relevance of these notes is (for the moment) restricted to Atlantic regions, but notes with global relevance will be considered. These short notes should have five references at most and the contents could be interesting sightings (birds in areas they shouldn't be or in numbers they normally never are), aberrant plumages, wrecks and influxes, strange breeding records (too big clutches, foster parents), interesting/unusual dietary information, very interesting ringing recoveries or exceptional age of seabirds.

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NORTHERN GIANT PETRELS MACRONECTES HALLI *IN BRAZIL*

In Brazil, the Northern Giant Petrel *Macronectes halli* was known from only a single second-year specimen found dead at Ilha Comprida, southern São Paulo state (24°50'S, 47°45'W) on 27 September 1994 (coll. Zool. Mus. Univ. São Paulo #73726; Martuscelli *et al.* 1995). When the bird was fresh, the reddish bill tip was used for identification (biometrics: culmen 105, bill depth at base 46.3, bill width 35.2, tail 157, tarsus 105, wing 510mm). This note reports two additional records: a first-year female captured and kept by fishermen on the beach at Praia do Leste, Iguape (24°40'S, 47°24'W) before 15 October 1999 (sent to Santos Aquarium on 21 October 1999 where it died a few days later, now coll. Zool. Mus. Univ. São Paulo #75483) and another bird found alive on 3 October 2000 near Albardão Lighthouse, southern Rio Grande do Sul state (33°13'S, 52°40'W) that died a few days later in a rehabilitation centre. The skin of this specimen has not been prepared, but photographs of the bird were made where it had been kept (Fig. 1). Both petrels could be identified by the reddish-

Figure 1. Northern Giant Petrels Macronectes halli *stranded in Brazil: a juvenile from São Paulo state (top), and an adult from Rio Grande do Sul state (bottom).*
Figuur 1. In Brazilië Aangespoelde Noordelijke Reuzenstormvogels Macronectes halli: een juveniel uit de provincie São Paulo (boven) en een adult uit de provincie Rio Grande do Sul (onder).

brown bill tip. The first bird was a juvenile with typical blackish plumage (Fig. 1, biometrics: culmen 86.8, bill height at base 44.6, bill width 32.3, tail 225, tarsus 84.0mm), the other individual was an adult with pale eyelids and a strong contrast between under- and upperparts (Fig. 1).

The Northern Giant Petrel has been fairly common in nearby Uruguayan waters in recent years, including seven birds ringed at Macquarie, Crozet and Kerguelen Islands (Olmos 2002). In southern Brazil, the Southern Giant Petrel *M. giganteus* is much more common and birds are recorded regularly north up to Rio de Janeiro. During winter, giant petrels are frequently seen near the coast and Neves (2000) frequently recorded giant petrels during offshore seabird censuses (probably all *giganteus*). The specific identity of eight skins in the collection of the Fundação Universidade Federal do Rio Grande remains to be determined, as these birds have lost their characteristic bill tip coloration, as previously noted by Bourne & Warham (1966).

Bourne W.R.P. & Warham H. 1966. Geographical variation in the Giant Petrels of the Genus *Macronectes*. Ardea 54: 45-67.
Martuscelli P., F. Olmos & R.S. Silva 1995. First record of the Northern Giant Patrel *Macronectes halli* for Brazilian waters. Bull. Brit. Ornith. Cl. 115: 187-188.
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LESSER CRESTED TERNS STERNA BENGALENSIS *ON THE SOUTH AFRICAN ATLANTIC COAST*

Lesser Crested Terns *Sterna bengalensis arabica* from breeding populations in the Middle East migrate south along the eastern coast of Africa. Migrants to southern Africa are largely confined to the northeast of the region from Mozambique (mostly Dec-Apr) to Kwazulu-Natal, South Africa (mostly Jan-Mar; Ryan 1997; Parker 1999). Three records from the Eastern Cape are from February, March and May, respectively.

Lesser Crested Terns have been recorded west of Cape Agulhas on five occasions (Table 1). Four of these records were in March and in addition to these records, Fraser (1993) mentioned an unconfirmed March record from the early 1980s at Buffelsbaai (34°19'S 18°27'E) on the eastern shoreline of the Cape Peninsula. Because the records from the Atlantic Ocean coastline of South Africa are mostly from March, it is possible that these consist of birds that continued to move west along the coast after the bulk of the migration has ceased.

Table 1. Records of Lesser Crested Terns on the South African Atlantic coast.
Tabel 1. Waarnemingen van Bengaalse Sterns langs de Atlantische kust van Zuid-Afrika.

Locality	Date	Source
Lambert's Bay (32°05'S 18°18'E)	1-22 Mar 1999	This note
Strandfontein, Cape Town (34°04'S 18°31'E)	16-dec-95	*Promerops* 231: 7.
Glencairn, Cape Town (34°09'S 18°26'E)	3 Mar 1993	Fraser (1993)
Kogelbaai (34°14'S 18°51'E)	18 Mar 1997	*Promerops* 231: 7
Hermanus (34°25'S 19°15'E)	Mar–Apr 1976	Hockey *et al.* (1989)

Fraser M. 1993. Lesser Crested Tern at Glencairn. Promerops 203: 14.
Hockey P.A.R., Underhill, L.G., Neatherway, M. & Ryan, P.G. 1983. Atlas of the birds of the southwestern Cape. Cape Town: Cape Bird Club.
Ryan P.G. 1997. Lesser Crested Tern Sterna bengalensis. In: Harrison J.A., D.G. Allan, L.G. Underhill, M. Herremans, A.J. Tree, V. Parker & C.J. Brown (eds) The atlas of southern African birds, 1: 474. BirdLife South Africa: Johannesburg.
Parker V. 1999. The atlas of the birds of Sul do Save, southern Mozambique. Avian Demography Unit & Endangered Wildlife Trust, Cape Town & Johannesburg.

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ERRATUM

In: Anker-Nilssen T., Aarvak T. & Bangjord G. 2003. Mass mortality of Atlantic Puffins *Fratercula arctica* off Central Norway, spring 2002: Causes and consequences. Atlantic Seabirds 5(2): 57-72, the symbols for males en females were not converted properly. Line 5 on page 62 should be "(11 ♂♂, 7 ♀♀, Table 1)". The last alinea on page 63 should be: "Thus the beached birds were 63.9% lighter than the birds in that sample. Similarly, the weight of their left breast muscles (7♂♂, 1♀, mean 27.4 g, SE = 0.86) was 63.3% lower than for those collected at sea (15♂♂, 14♀♀, mean 43.3 g, SE = 0.61)."

News and notices

BOOK REVIEWS

MITCHELL, I.P., NEWTON, S.F., RATCLIFFE, N. & DUNN, T.E. 2004. *Seabird Populations of Britain and Ireland*. T. & A.D. Poyser, London., Hardback, ISBN 0-7136-6901-2. 511 pages, 71 figures, 91 tables, numerous photographs and drawings. £35,= (*c*. €46,=)

The first counts of British and Irish seabirds were made in the 19th century, and the first international census, for the Gannet *Morus bassanus*, was published by the greatest British ornithological historian, J.H. Gurney jr, in 1913. This census was repeated and British Fulmars *Fulmarus glacialis* added between the wars, and these censuses for Britain were converted on to a regular basis by James Fisher, and the Kittiwake *Rissa tridactyla* added, afterwards. My contribution was to suggest that this was a waste of observer time, and that all our seabirds should be counted together (*Bird Study* 12: 46-47, 1965). This was accepted enthusiastically by James, so when we formed the Seabird Group the next year we made him Chairman of a Census Committee to organise the first complete British and Irish seabird census in 1969-1970, which he named "Operation Seafarer" after the first Anglo-Saxon list of our seabirds.

This first census was carried out under difficulties not emphasised at the time. It was conducted in haste to provide a baseline against which to measure the impact of imminent petroleum developments, with limited resources. It was directed by James, and organised, and many of the observations made, by its only member of staff, David Saunders. It was largely complete and the resulting book, *The Seabirds of Britain and Ireland*, planned when James was killed in a road accident in 1970, leaving David isolated in west Wales and me in northern Scotland. At this point Stanley Cramp, who had not previously been much involved apart from raising support but had an office in London, stepped in. He was in a hurry since he had other commitments, and behaved rather arbitrarily (for example, my dedication to James explaining his role got left out of the first edition, and was abbreviated in the second), but we were too relieved to get it done by 1974 to complain.

It is noticeable that those involved in organising these censuses do not volunteer to carry out another. The Nature Conservancy Council took over and provided modern data-processing facilities for a permanent Seabird Colony Register (SCR) during the next census in 1985-1987, largely organised by Clare Lloyd. The resulting report, *The Status of Seabirds in Britain and Ireland* (1991), was a bit larger, and the report on the third census, Seabird 2000, which is the main subject of this review, is twice as big, beautifully produced, and the only major howlers I have detected are the promotion of the fairly well-known island of Eynhallow from Orkney to Shetland on p.88, the use of a "less than" symbol at the start of the key to all the maps of changes, and no explanation of the different colours of symbols on the European Storm-petrel *Hydrobates pelagicus* map on p. 87.

It differs from the previous surveys mainly by including inland colonies, and the greater attention given to the nocturnal underground-nesting petrels, counted by plotting their response to recorded calls. It starts with discussions of census methods, current status and trends, causes of change, and the international context, followed by species accounts written by a variety of well-qualified people, with tables of results for counties, maps of distribution and changes, tables of international totals, and finally discussions of causes of seabird population change and the international importance of our seabirds (expressed as confusing possible ranges of population size; this was the place for the nice clear figures in Appendix IV. The counting instructions and recording forms, techniques for counting petrels by playing recorded calls, scientific names and recorded totals are given in appendices.

Among various points, while Fulmars are still increasing in the south-west, there has been a decline in the north, possibly due to long-lining. It is not mentioned that caution is needed over old reports of Manx Shearwaters *Puffinus puffinus* and Atlantic Puffins *Fratercula arctica* which, as suggested by their names, were sometimes confused. There is a great increase in the totals of Leach's Storm-petrels *Oceanodroma leucorhoa* at sites all located near deep water (it is not mentioned that this is not found in North America), and no mention of gull, as well as skua, predation on St Kilda, which was already prominent in 1960. There has been a decrease of northern Great Cormorants *Phalacrocorax carbo*, with an increase to the south and inland, where they have been joined by the inland continental race *sinensis*; this could involve breeding in the winter quarters following protection there.

There has been a decline of Arctic Skuas *Stercorarius parasiticus* possibly due to competition with and predation by the increasing Great Skuas *S. skua*, which have turned on birds following a lack of fish, and a dramatic decline of Herring Gulls *Larus argentatus*, though their numbers are now becoming stabilised, possibly due in part to changed availability of garbage and fish and in part to botulism due to eating rotten food. The Greater Black-backs *L. marinus* have declined less dramatically, whereas the Lesser Black-backs *L. fuscus*, have increased. The Kittiwakes *Rissa tridactyla*, which were still increasing in the 1980s, are down by a quarter, perhaps partly due to a failure of their fishy food-supply, and partly because this has also led to more predation from Great Skuas. Sandwich, Common and Little Terns *Sterna sandvicensis, S.*

hirundo and *S. albifrons* had declined slightly, possibly from a variety of causes including trapping of the first two in the winter.

The Common Guillemots *Uria aalge*, which had been suffering badly from oil pollution among other things, have more than doubled since Operation Seafarer following good breeding seasons, and the Razorbills *Alca torda* have also done well except in the west of Ireland, possibly due to past losses in salmon nets. Better census-methods involving early counts of birds on the sea produced a much larger total for Black Guillemots *Cepphus grylle*, and the total for Atlantic Puffins is also up, especially in the north-east; though their long term decline, possibly due to climatic factors, continues in the south-west.

The discussion of causes of population change omits to consider the past thoroughly. In the early 19th century there was a huge human population on the land in Britain, with a low standard of life, leading to a crisis when the potato crop failed in the west in the "hungry 1840s", and our seabirds were apparently heavily exploited, and have been recovering ever since. We used to speculate in the last century how soon their subsequent increase would reach its ceiling, and presumably we are now seeing this, with fluctuating success from place to place, from year to year and from species to species. The 19th century overkill by "sportsmen" and plumage-collectors also hit some of the weaker populations along the east and south coasts particularly hard, exterminating Great Cormorants and Black Guillemots in the north-east and auks in the inner Channel, for example, and some have still not returned.

Comparatively little attention is also paid throughout the book to another major factor, not just climatic change, but the weather. Storms (and droughts inland) may wipe out a whole season's seabird productivity, and go on to cause serious adult mortality both then and during the subsequent moult and winter (*British Birds* 97, in press). It is obvious that if seabirds live for decades but have fairly stable populations they cannot breed successfully very often, and they evidently also sometimes suffer catastrophic natural mortality of the immatures and/or adults. This may require a different type of investigation, and it is to be hoped that the regular censuses may shed more light on it.

While there is a good deal about predation, one of the more scandalous situations has never received much attention. Those who went on the 1966 Congress Cruise may remember how while the Isle of May was then a sordid gull slum, there was a sort of pink shimmer of Roseate Terns *S. dougallii* over Inchmickery in the central Firth of Forth. Soon afterwards the gulls were poisoned on the May, and for a while the Firth was full of dead bodies, while afterwards the surviving birds descended on all the other islands and roof-tops for miles around, including Inchmickery (photo, p.238), since when the Forth Roseate Terns have been reduced to a remnant on a rock. It seems time

Inchmickery was also cleaned up as well as the Isle of May, and the Roseate Terns tempted back from Ireland again.

There is also little comment on possibly one of the most serious problems, when seabird colonies are targeted by individual predators. The entire season's production of thousands of terns on the Sands of Forvie was once wiped out by two or three pairs of Herring Gulls, and that of a west coast Little Ternery by a pair of Magpies *Pica pica*. It is now accepted practice to exclude Red Foxes *Vulpes vulpes* by electric fences, and Clive Craik has shown that it is easy to control the Mink *Mustela vison* attacking west coast seabird colonies. Yet, when I suggested at the 8th International Seabird Conference that someone should set about the small proportion of the Shetland Great Skuas now devastating their seabird colonies with a 22 rifle, there was a gasp of horror.

In general, this report is a fine production that has involved a vast amount of work, and my main doubt is about cover. During Operation Seafarer, the Census Committee met at regular intervals to review this, while we borrowed RAF Shackleton aircraft afterwards to make sure of it. Since then I get the impression that there has been increasing concern with counting the often uncountable rather than finding everything. For example, while the maps of European Storm-petrel colonies show increasingly large, confident blobs, little seems to have been done about some of the queries, for example around Skye, which seem to have got lost, and the Irish also think they have more birds.

Some of the gull figures also seem doubtful, notably the comparisons with the BTO Atlases (p.208, 219). Are these declines real, or merely a measure of declining thoroughness? There are similar problems with the surveys of roof-nesting gulls, where the largest population, in Aberdeen, was noticed very late in the day, although there is a full-frontal view of a big colony as one walks out of the railway station. Are these figures in turn increasing totals, or merely a measure of increasing thoroughness? And where are the Ring-billed Gulls *L. delawarensis* and Little Gulls *L. minutus*, which seem likely to be breeding somewhere by now?

The real question now is where to go next. This book is already quite big enough, without putting off the young by doubling it every fifteen years with a diminishing amount that is new. The next thing we need to know is what is happening elsewhere, in case for example our Sandwich Terns are periodically taking French Leave in the Netherlands in the same way that British Roseate Terns seem to have found the Irish more hospitable. In fact what we now need to measure is not so much national totals in well-covered countries, as meta-populations throughout their range, doubtless including interesting but poorly-covered places abroad providing scope for exciting expeditions. Maybe the European Union would put up some money for this?

W.R.P. Bourne