ASSESSING AGE AND BREEDING ORIGIN OF WRECKED LITTLE AUKS *ALLE ALLE*: THE USE OF BIOMETRICS AND A VARIABLE UNDERWING PATTERN

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Camphuysen, C.J. 2006. Assessing age and breeding origin of wrecked Little Auks *Alle alle*: the use of biometrics and a variable underwing pattern. Atlantic Seabirds 7(2): 49-70. *Biometrics and plumage characteristics of Little Auks* Alle alle *were evaluated to assess possibilities for the external ageing of individual birds. Age is important when biometrical data are used to assess the subspecific identity or probable breeding origin of the birds. Standard biometrics included bill length (feathers to tip), distance from nostril to tip, bill depth, head, wing (maximum flattened chord), and tarsus length, and body mass. The presence or absence of white or white-tipped feathers was checked in seven feather groups of the (grey) underwing. Bill depth and wing length were the most useful measurements to separate adult and juvenile Little Auks (when combined, classification accuracy 83%). In combination with body mass (only emaciated birds were used), the age was assigned correctly in 88% of the examined birds. White or white-tipped feathers in the lesser primary coverts (LPC) occurred more frequently in juveniles than in adults, while the reverse was true for the greater secondary coverts (GPC). Only 74% of the Little Auks were properly aged on the basis of a combination of LPC and GPC pigmentation. With body mass being a 'difficult' measurement (an assessment of physical condition is required and incomplete corpses cannot be weighed), the combination of bill depth, wing length and white in LPC and GPC was evaluated (87% correctly assigned). A review of biometrics collected in breeding areas indicated that birds wrecked in The Netherlands were of the subspecies* A. alle alle*, with an overall size similar to for example birds of Bjørnøya (Bear Island) in the Barents Sea. It is recommended to use bill depth and wing length for ageing in combination with pigmentation patterns of LPC and GPC in future studies of wrecked birds. For comparisons with breeding populations, bill length and wing length are the most widely available and therefore useful measurements.*

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INTRODUCTION

The smallest of the Atlantic Alcidae, the Little Auk *Alle alle*, is a common offshore winter visitor in the North Sea area (Skov *et al.* 1989; Stone *et al.* 1995). In recent years, influxes and wrecks occurred in all countries around the

North Sea at irregular intervals (Camphuysen & Leopold 1996). The latest wreck on record coincided with a relatively small influx in the SE North Sea in early 2003 (Camphuysen 2003). Substantial flights of Little Auks were seen in Denmark and The Netherlands in autumn 2005 (Van Bemmelen & Wielstra 2005).

Mass-strandings are common in most of the auks and during systematic beached bird surveys it is often tried to obtain an idea of the age-composition of the casualties using external features in the plumage and/or soft parts (beak development in Puffin *Fratercula arctica* and Razorbill *Alca torda*, plumage characteristics in Common Guillemots *Uria aalge*; Kuschert *et al.* 1981; Jones *et al.* 1982; Camphuysen 1995). Information on the age of birds is important when biometrics are used to collect information on subspecies level or on the probable breeding origin of the casualties (cf. Jones 1988). Only for adult birds is sufficient baseline information in breeding areas available.

Ageing auks, or at least separating juveniles from older birds, is fairly easy in most species, but not in Little Auks. Characteristics as "brownish-black" versus "glossy black" upperparts in juveniles and adult respectively (Witherby *et al.* 1941; Glutz von Blotzheim & Bauer 1982; Cramp 1985; Gaston & Jones 1998; Svensson & Grant 2000) are not particularly helpful when examining wet, decomposed and often incomplete carcasses. Even after drying the remains, the results are not consistent between observers. It would therefore be useful if other ageing characteristics could be identified, on the basis of which adults and juveniles could be separated with a high degree of reliability, but without the need to investigate the (internal) gonads and bursa (Jones 1985). Plumage characteristics or biometrics with a potential to correctly 'predict' the age of an individual bird are needed, preferably on the wings and/or head (parts that remain when corpses are heavily scavenged).

In this paper the standard biometrics were compared with autopsy results in order to find measurements that may be of use for ageing Little Auks. The plumage of the birds was the next point of attention. The underwing of Little Auks is described in handbooks and fieldguides as "dark", "grey" or even "blackish-looking". Glutz von Blotzheim & Bauer (1982), however, noted that "*Die im Feld meist dunkel wirkende Flügelunterseite ist im Bereich der Handdecken und des Apikalteils der mittleren Armdecken fleckig oder flächenhaft weiß aufgehellt.*" In fact, the underwing pattern is rather variable, with white feather tips or entirely white feathers occurring in variable amounts in several of the main feather groups of the underwing. Following the useful observations of Kuschert *et al.* (1981), as a result of which we can now easily separate first-year Common Guillemots from older birds on the basis of white tips on the greater secondary underwing coverts, it was hoped that a careful examination and dissection of a sufficiently large sample of Little Auk wings

might provide similar clues. A study of underwing patterns was therefore undertaken using 42 freshly stranded individuals during the 2003 wreck in The Netherlands and this paper reports the results.

A larger sample of wrecked Little Auks, collected in The Netherlands over the last 30 years, were used to elucidate the probable breeding origin of the birds and their subspecific identity. The purpose of this paper is to prioritise certain measurements and plumage observations that are useful for the ageing of Little Auks in the hand. Secondly, the available baseline data are reviewed to find biometrics that are particularly useful when the subspecies or the probable breeding origin are to be assessed.

METHODS

Little Auks were collected opportunistically since 1975. If possible, the following measurements or observations were made: (a) bill length (tip to feathers and tip to nostril), (b) bill depth (at the base, Snh1), (c) head length, (d) wing length (maximum flattened chord), (e) tarsus length, (f) body mass, (g) sex and age by dissection (development and size of gonads, presence and size of bursa *Fabricii*), and (h) physical condition (subcutaneous fat, deposited fat and breast muscle) (see Jones 1985, Camphuysen 1995). Sometimes, probably as a result of severe emaciation, the condition of the gonads and bursa were such that sexing and ageing was difficult. In case of doubt, the birds were left unaged/unsexed.

In February 2003, 42 Little Auks were collected to examine the plumage in more detail. Preferably the right, and otherwise the "best" wing was collected, stretched and dried. The pattern of the underwing was documented by a description (a score) and digital photography. The wings were photographed with a HP scanjet 2200c scanner at 300 dpi and examined at actual pixels level in Photoshop 5.0 in a slideshow presentation on a 17" NEC screen. Feather groups of the underwing were evaluated one at the time and without indications of the age and sex of the birds at hand: greater (GPC), median (MPC) and lesser (LPC) primaries coverts and greater (GSC), median (MSC) and lesser (LSC) secondary or underwing coverts and the axillaries or inner median underwing coverts (Axil; Fig. 1). These seven sets of feathers were categorised and scored using the following criteria:

All grey	score 1
Grey, partly with faint white edges	score 2
Faint white tips	score 3
All or mostly faint white	score 4
Clear white tips	score 5
All or mostly bright white	score 6

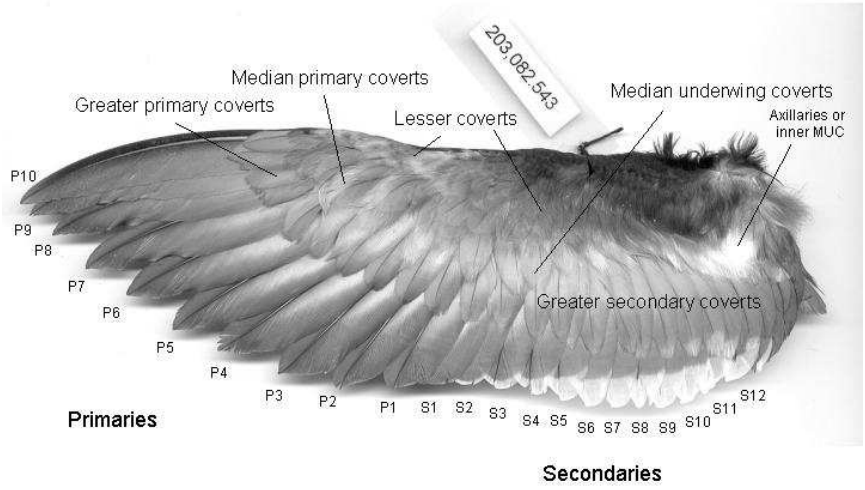

Figure 1. Topography of a Little Auk underwing and terms used in this paper. Note white tips on the inner greater secondary coverts, a bright white patch in the area between axillaries and inner median coverts, and vaguely white fringed lesser primary coverts in this example (coll.# 203082.543).

Figuur 1. Topografie van de ondervleugel van een Kleine Alk, inclusief begrippen die in dit artikel worden gebruikt. Let bij dit voorbeeld (coll.# 203082.543) op de witte toppen op de binnenste grote armpendekveren, de helder witte vlek tussen de okselveren en middelste armpendekveren, en de vage witte randjes op de kleine handpendekveren.

A minimum score of 7 would describe an all grey underwing, whereas a maximum score of 42 would result from an all white set of underwing coverts. The scores were later linked in the database with the dissection results. The birds were aged and sexed on the basis of gonadal development and the presence (and size) or absence of a *bursa Fabricii* (*cf.* Jones *et al.* 1982; Camphuysen 1995). Four categories were the used in the analysis: male and female, adult (no bursa, developed gonads, including immatures; n = 2) and juvenile Little Auks (large bursa, non-developed gonads).

Biometrics were compared with the z-test (Fowler & Cohen 1986), testing between adults (n = 41) and juveniles (n = 50), between unaged males (n = 33) and females (n = 63), between adult males (n = 13) and adult females (n =

28), and between juvenile males (n = 31) and juvenile females (n = 17). Specimens identified as "immature" (birds with a very small bursa and partly developed gonads, n = 6) were excluded from the tests between age classes. Discriminant functions and a jackknife test were calculated to assess the classification accuracy of ageing characteristics (biometrics and plumage) using classical discriminant analysis in SYSTAT 11 (Systat Software Inc. 2006).

RESULTS

Biometrics Mean bill length (± 95% confidence limits), tip to feathers, of all Little Auks measured was 14.3 ± 0.17 (11.7-16.1 mm, n = 104). Adults (14.4 ± 0.26, n = 41) were similar in bill length to juveniles (14.2 ± 0.23, n = 47; z = 0,74, n.s.; Table 1), but unaged males (14.6 ± 0.24, n = 32) were significantly larger than unaged females (14.1 ± 0.24, n = 61; z = 2.57, P< 0.05). When the sexes were split into adults and juveniles, although the tendency of males being larger than females remained the same, the difference was not significant.

The mean distance between nostril and tip of the bill in all Little Auks amounted to 10.9 ± 0.14 (9.5-12.1 mm, n = 82). Neither between sexes nor between ages were significant differences found and the range was so small that the value of this measurement may be questioned (mean ranged between 10.8 and 11.0 mm in any age/sex category).

The mean bill depth measured at the base in all Little Auks amounted to 7.9 ± 0.25 (5.8-13.4 mm, n = 82). Excluding two outliers (13.4 in an adult female and 13.0 in a juvenile male), mean bill depth amounted to 7.8 ± 0.17 (5.8-9.7 mm, n = 80). Excluding outliers, the difference between adults (8.1 ± 0.28, range 6.6-9.7 mm, n = 26) and juveniles (7.6 ± 0.22, range 5.8-9.5 mm, n = 41) was close to significance (z = 2.41, n.s.; Table 1). Otherwise, neither between sexes nor between a combination of age and sex could significant differences be found.

Mean head length of all Little Auks measured was 52.3 ± 0.36 (48-57 mm, n = 95). Adults (52.4 ± 0.56, n = 36) were similar in head length to juveniles (52.1 ± 0.50, n = 45; z = 0.83, n.s.; Table 1), but unaged males (52.7 ± 0.68, n = 30) were significantly larger than unaged females (51.8 ± 0.42, n = 55; z = 2.80, P< 0.01). A difference in head length between the sexes was even more obvious in adult birds (adult males 53.6 ± 1.04, n = 12, adult females 51.8 ± 0.53, n = 24; z = 3.93, P< 0.01), but non-significant in juveniles (juveniles males 52.0 ± 0.90, n = 16, juvenile females 52.1 ± 0.63, n = 27, z = 0.34, n.s.).

The mean tarsus length in all Little Auks amounted to 20.9 ± 0.17 (19-23 mm, n = 87). Neither between sexes nor between ages were significant differences found and the overlap in range was such that the value of this measurement may be questioned.

Table 1. Basic biometrics for Little Auks collected in winter in The Netherlands and Belgium, 1975-2003. Selected individuals were aged during autopsies (presence/absence cloacal bursa and gonadal development).

Tabel 1. Biometrische gegevens van Kleine Alken die 's winters in Nederland en België zijn verzameld, 1975-2003. Geselecteerde individuen werden op leeftijd gebracht bij autopsies (aan/afwezigheid van bursa en ontwikkeling van geslachtsorganen).

	Bill length		Nostril to tip		Bill depth		Head		Tarsus		Wing		Mass	
	Ad	Juv	Ad	Juv	Ad	Juv	Ad	Juv	Ad	Juv	Ad	Juv	Ad	Juv
Mean	14.4	14.2	11.0	10.8	8.1	7.6	52.4	52.1	20.8	21.0	125.5	121.2	117.2	115.7
SD	0.9	0.8	0.6	0.6	0.7	0.7	1.7	1.7	0.8	0.9	4.2	3.5	9.8	11.1
SE	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.3	0.1	0.1	0.6	0.5	2.0	1.9
95% c.i.	0.3	0.2	0.2	0.2	0.3	0.2	0.6	0.5	0.3	0.3	1.3	1.0	3.8	3.6
Min	12.1	12.4	9.9	9.5	6.6	5.8	48	48	19	19	116	114	105	90
Max	15.8	15.9	12.1	12	9.7	9.5	56	55	22	23	135	130	138	135
Sample	41	47	27	42	26	41	36	45	27	43	41	50	25	36

Mean wing length of all Little Auks measured was 123.1 ± 0.76 (114-135 mm, n = 117). Adults (125.5 ± 1.27, n = 41) had significantly longer wings than juveniles (121.2 ± 0.97, n = 50, z = 10.30, P< 0.01; Table 1). Unaged males (123.7 ± 1.38, n = 33) and females (122.9 ± 1.07, n = 63), as well as adult males (125.5 ± 1.82, n = 13) and adult females (125.5 ± 1.68, n = 28) were similar. A difference in wing length between the sexes was found in juveniles (males 122.3 ± 2.03, n = 17; females 120.8 ± 1.04, n = 31; z = 2.53, P< 0.05).

Body mass ranged from 90-150 grams in 71 Little Auks that could be weighed (116.7 ± 2.72, n = 71). Clearly, body mass is influenced by the physical condition of the animal when it died. On a condition index scale ranging from 0-9, two birds scored 4 (some fat remaining) and 6 (moderately fat) respectively, and these birds had a body mass of 147 and 128 grams. The remainder of the sample, all severely emaciated birds (condition index 1.1 ± 0.6 SD), had a body mass of 116.1 ± 2.64 (90-150, n = 69). In these emaciated corpses, adults (117.2 ± 3.84, 105-138, n = 25) were slightly heavier than juveniles (115.7 ± 3.63, 90-135, n = 36; z = 1.78, n.s.; Table 1), males (117.2 ± 5.26, 90-138, n = 21) heavier than females (115.0 ± 2.81, 95-135, n = 46; z = 2.48, n.s.), but the overlap was enormous and the differences were not significant.

Jackknife tests of classification accuracy suggested that approximately between 76% and 88% of the Little Auks used would have been properly aged on the basis of either just bill depth, or a combination of the measurements bill depth, wing length and lean body mass (Table 2).

Table 2. Discriminant functions for Little Auks arranged in order of increasing classification accuracy according to jackknife tests. Measurements of bill depth, wing length and body mass were used of 25 adult and 33 juvenile Little Auks.
Tabel 2. Discriminant functies voor Kleine Alken, gesorteerd op toenemende nauwkeurigheid volgens jackknife-toetsen. Gegevens gebaseerd op snavelhoogte, vleugellengte en lichaamsgewicht van 25 adulte en 33 juveniele Kleine Alken.

Discriminant coefficients				Wilks'			% correct
Bill depth	Wing	Mass	Constant	lambda	*F*	*df*	jackknife
1.665			-12.80	0.77	16.66	1, 56	76
	0.291		-35.76	0.70	24.52	1, 56	78
1.115	0.230		-36.88	0.56	21.74	2, 55	83
4.006	0.117	-0.198	-22.18	0.33	37.14	3, 54	88

Summarised, bill depth (measured at base) and wing length seemingly are the most promising biometrics to separate adults from juveniles. Bill length, head, and wing were most useful to discriminate between the sexes in unaged birds, but only the head produced significant results. Lean body mass was useful for ageing and sexing, but in this case the body condition should be assessed first. Only emaciated individuals were available for the analysis presented here. In the sample examined here, head length was a useful measurement to discriminate between adult males and females, but not juveniles. Wing length was inconclusive to separate the sexes in either adults or juveniles. The material evaluated suggests that on the basis of bill depth and wing length alone, 17% of the birds would not be aged correctly. Adding body mass would improve the accuracy of classifications (88% correct; Table 2), but an internal inspection of the physical condition of the animals is required to make sure that lean body mass is used. During that inspection, a visual check of the presence or absence of a cloacal bursa would give a more definite answer regarding the age of the bird in hand.

Plumage characteristics Of 42 corpses of Little Auks examined for the underwing pattern, 33 could be sexed and 35 were aged during dissection (see Appendix). Age composition was rather even, with 17 adults (or non-juveniles) and 18 juvenile birds, but sexratio was biased towards females (21 females, 12 males). Underwing pattern scores ranged from 7 to 25 out of a theoretical range from 7 to 42 (Appendix 1). Examples of the extremes found are shown in Figure 2 (score 7) and Figure 3 (score 25). Both the greater primary coverts (GPC) and the lesser secondary coverts (LSC) were all grey in all examined specimens (Table 3). Such feather groups may be ignored in future studies. The other feather groups were more variable. Since the birds were examined to investigate

Figure 2. Score 7, not a single white feather in any of the underwing coverts (juvenile female).
Figuur 2. Score 7: geen enkele witte veer op de ondervleugeldekveren (juveniel vrouwtje).

Figure 3. Score 25, white tips or largely white feathers in median and lesser primary coverts, greater and median secondary coverts and a bright white inner secondary coverts/axillaries region (adult female).
Figuur 3. Score 25: witte toppen op of grotendeels witte veren tussen de middelste en kleine handpendekveren, grote en middelste armpendekveren en helder witte okselveren en binnenste dekveren (adult vrouwtje).

*Table 3. Colour scores in seven feather groups on the underwing of aged Little Auks (*n = *35).*
Tabel 3.Kleurscores van zeven onderscheiden veergroepen op de ondervleugel van op leeftijd gebrachte Kleine Alken (n = *35)*

Code	Colour of feathers \ feather group	GPC		MPC		LPC		GSC		MSC		LSC		Axil	
	Age	A	J	A	J	A	J	A	J	A	J	A	J	A	J
1	All grey	17	18	11	9	8	4	11	16	11	11	17	18	3	1
2	Grey, partly with faint white edges			5	8	5	3			2	6			2	5
3	Some faint white tips					2	7	2	2	3	1			1	
4	All or mostly faint white			1	1	1	1			1				7	7
5	Clear white tips					1	2	4							
6	All or mostly white						1							4	5
	Sample	17	18	17	18	17	18	17	18	17	18	17	18	17	18

the possibilities for ageing on the basis of external characteristics, only the successfully aged individuals were used in the analysis (Table 3, Fig. 4). More or less completely white feathers were most frequent in the axillaries (Table 3), but with no difference between adults and juveniles (Fig. 4). The median primary and secondary coverts had highly variable amounts of white, but again, with no difference between the two age categories. White tips of the lesser primary coverts (LPC) and greater secondary coverts (GSC) seemed more promising, with a more frequent occurrence of white-tipped LPC in juveniles and the reverse in GSC in adults (Fig. 2, 3, and 4).

Examples of dull grey or faintly white-tipped GSC are shown in Figure 5, examples of clear-cut white tipped GSC are shown in Figure 6. Note that all examples were collected in February, so that differences in feather wear should theoretically be negligible. All wings were dried prior to inspection and it should be realised that the assessment of white tips and fringes on wet wings may be more difficult.

Mean (± SD) LPC score amounted to 1.9 ± 1.2 (n = 17) in adults and to 2.8 ± 1.4 (n = 18) in juveniles. While white tips on the greater secondary coverts (GSC) occurred in 35% of the mature birds, some 10% of the juveniles had faint white tips. Mean (± SD) GSC score amounted to 2.2 ± 1.7 (n = 17) in adults and 1.2 ± 0.6 (n = 18) in juveniles. A jackknife test of classification accuracy suggested that approximately 74% of the Little Auks used would have been properly aged on the basis of a combination of LPC and GSC pigmentation (Discriminant coefficients LPC = 0.654, GSC = -0.707, constant -0.376, Wilks Lambda 0.705, F = 6.7, df = 2, 32, $P< 0.004$). In the other feather groups, the amount of white observed was similar in both adults and juveniles.

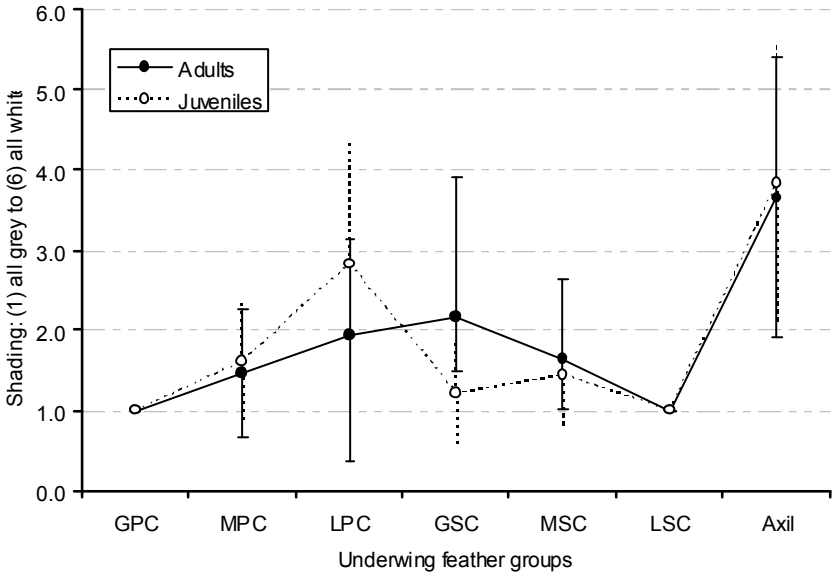

Figure 4. Mean (± SD*) score on the grey-scale for the major feather groups in the underwing of adult (*n = *17) and juvenile (*n = *18) Little Auks.*
Figuur 4. Gemiddelde (± SD*) score op de 'grijsschaal' voor de veergroepen op de ondervleugel van adulte (*n = *17) en juveniele (*n = *18) Kleine Alken.*

DISCUSSION

When studying stranded birds following wrecks and oil incidents, three main questions are put forward: what (sub)species were involved, what was the sexratio and age-composition, and from where did the birds originate? Little Auks are polytypic with the nominate subspecies *alle* nesting in Canada, Greenland, northern Iceland, Jan Mayen and Spitsbergen and with *polaris* nesting on Franz Josef Land (not certainly known which race breeds on Severnaya Zemlya and in the North Pacific; BWP*i* 2004). Breeding populations are very large in more northern areas (many millions) and also the colonies in Franz Josef Land are said to be vast, with some colonies of over 100 000 birds (Norderhaug *et al.* 1977). To allow for a valid comparison of biometrical data (wintering birds and birds in breeding populations or vice versa), adults and immatures should be separated. The first step, therefore is to age the collected birds.

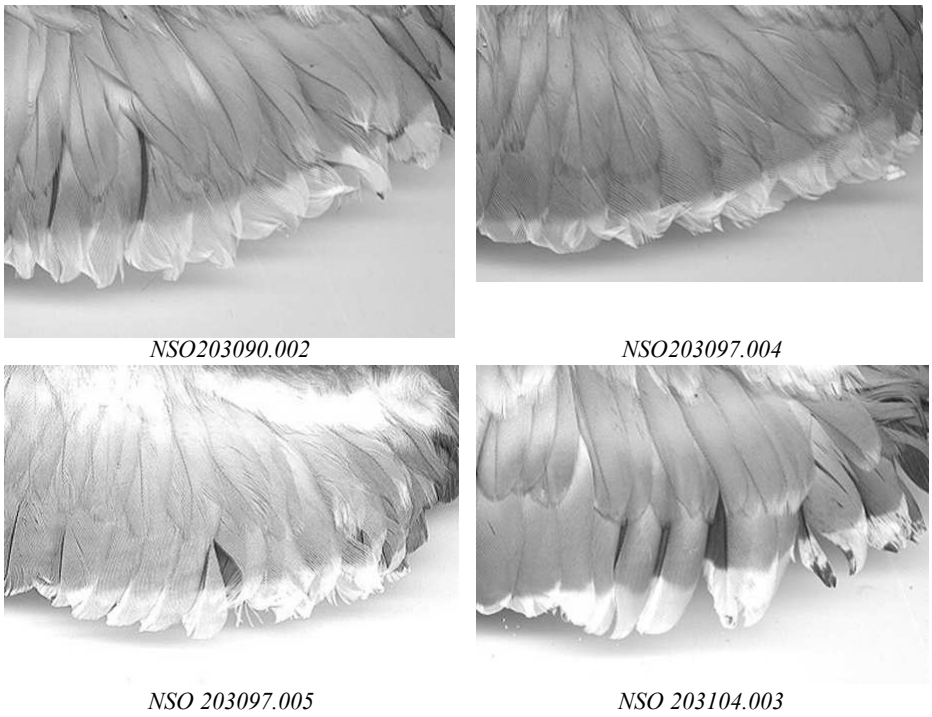

Figure 5. GSC score 3 in two juvenile (top row) and two adult (bottom row) Little Auks.
Figuur 5. GSC-score 3 van twee juveniele (boven) en twee adulte (onder) Kleine Alken.

Ageing Little Auk gonads are small and emaciated birds are sometimes very difficult to sex during a simple visual internal inspection. The presence of a bursa is an important feature, but a small proportion of birds combines a small bursa with partially developed gonads (possibly immatures rather than juveniles). When autopsies can be avoided, much larger samples can be checked. More importantly, when many corpses are partly scavenged, autopsies may not even be an option. From the external ageing characteristics, biometrics are the first to be evaluated. The most promising biometrics for ageing were bill depth and wing length. Body mass was potentially useful, when the condition index was taken into account. Figure 7 reveals a clear split in juveniles and adults on the basis of two measurements, but there is considerable overlap, making individual judgements unreliable (expected accuracy 83%, Table 2).

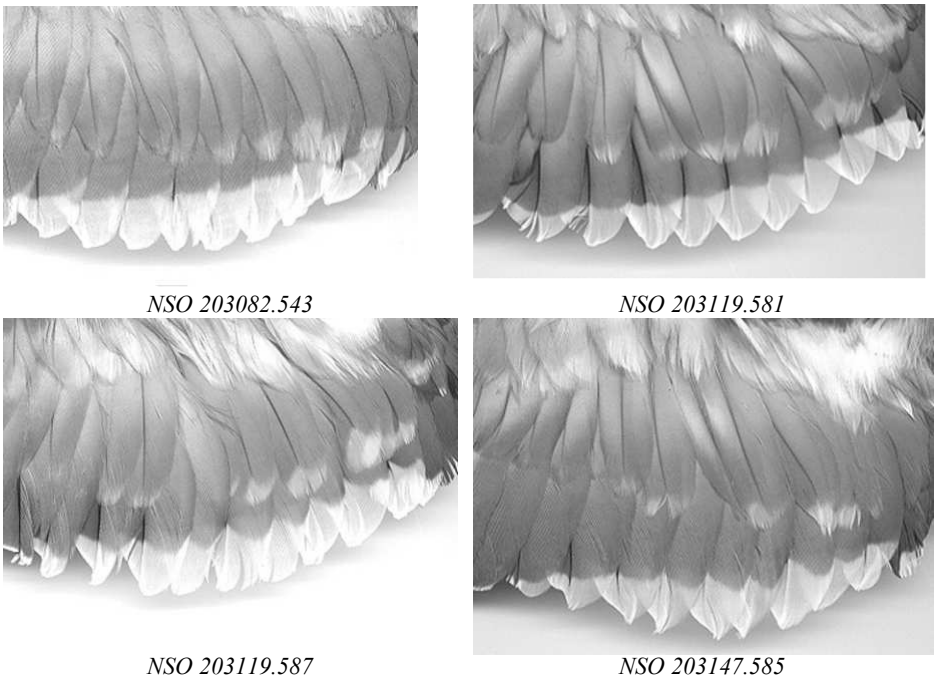

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Figure 6. GSC score 5 in four adult Little Auks.
Figuur 6. GSC-score 5 van vier adulte Kleine Alken.

The prospects for a reliable external judgement of age based on plumage characteristics are not very good either. Despite considerable variation in the amount of white in the underwing feather groups, observed patterns were far from consistent. The most promising feather groups, white-tipped lesser primary coverts (LPC) were indicative of young animals (11 out of 18 birds, 61%), but nearly a quarter of the 17 adults had at least some faint white tips (23%; Table 3). While white tips on the greater secondary coverts (GSC) occurred in 35% of the mature birds, some 10% of the juveniles had faint white tips. The expected accuracy of ageing on the basis of these plumage characteristics was only 74% (jackknife test, see above).

A logical next test was to combine the most promising biometrics (bill depth and wing length) with the most clearly different feather groups (LPC and GSC) in a discriminant analysis. Unfortunately, only 15 aged birds were available for the test (7 adults, 8 juveniles), all the others had at least one of the required parameters missing. A jackknife test of classification accuracy still

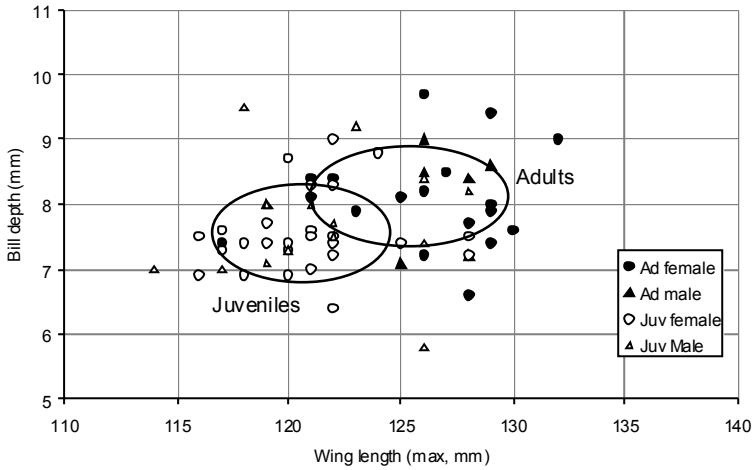

*Figure 7. Wing length (maximum flattened chord) and bill depth relationship in adult and juvenile Little Auks found dead in The Netherlands (*n = *66) The ovals contain mean values and standard deviation ranges.*

*Figuur 7. Relatie tussen vleugellengte (maximum flattened chord) en snavelhoogte bij adulte en juveniele Kleine Alken, die dood in Nederland zijn gevonden (*n = *66). De ovalen bevatten gemiddelden en en standaarddeviaties.*

suggested that approximately 87% of the Little Auks used would have been properly aged on the basis of a combination of LPC and GSC pigmentation, bill depth and wing length (Discriminant coefficients LPC = 0.349, GSC = -0.618, wing length 0.066, bill depth -2.439, constant 11.660, Wilks Lambda 0.150, F = 14.14, df = 4, 10, $P< 0.001$). In the other feather groups, the amount of white observed was similar in both adults and juveniles. It is therefore recommended to keep scoring LPC and GSC in future dissections, to enlarge the sample, and to re-analyse underwing pigmentation as an ageing characteristic in future. Of the basic measurements, wing length and bill depth deserve the highest priority.

Detecting the origin of birds Despite comprehensive research programmes and considerable ringing effort in some colonies (e.g. Norderhaug 1968, Bakken *et al.* 2003), ringed Little Auks are extremely rare in Europe (none in the Dutch beached bird survey since the early 1960s; n = 534 checked corpses). Birds from Spitsbergen were recovered in Iceland and Greenland. Colonies east of Svalbard have received relatively little attention in terms of ringing. Biometrics, if at all

Table 4. Wing length in Little Auks found in winter in the North Sea.
Tabel 4. Vleugellengte van Kleine Alken die 's winters in de Noordzee zijn gevonden.

Sample	Sex and age	mean (mm)	SD (*n*)	Range	Source
Netherlands,	Adults	125.5	4.15 SD (41)	116-135	this study
Winter	Juveniles	121.2	3.51 SD (50)	114-130	
Shetland,					
winter	Ad males	130.2	2.82 SD (13)	124-134	Heubeck &
	Ad females	127.0	3.02 SD (23)	119-131	Suddaby 1991
	All males	129.7	3.06 SD (15)	124-134	
	All females	127.0	3.77 SD (32)	117-134	
Skagerrak,					Anker-
winter	All males	126.4	(65)	117-135	Nilssen
	All females	125.9	(66)	120-132	*et al.* 1988
Britain,					
east coast	Adults	122.7	4.6 SD (71)	112-135	Jones *et al.*
winter	Immatures	120.7	3.0 SD (26)	112-130	1985

different between populations, are therefore the only means of assessing the origin of stranded Little Auks. The main distinguishing feature seems to be the wing length (Anker-Nilssen *et al.* 1988). Heubeck & Suddaby (1991), evaluating the biometrics of Little Auks found in Shetland in December 1990, were able to compare wing length with birds measured live at Jan Mayen colonies (from Camphuysen 1990), measured live at Spitsbergen colonies (Norderhaug 1980, Stempniewicz 1981), and measured as museum skins of adults collected in Franz Josef Land (Vaurie 1965; also prior to assumed shrinkage of 1.5%; Table 4-5). Anker-Nilssen, comparing measurements of Little Auks found dead in an oiling incident in 1981 in the Skagerrak with those from breeding populations, used the same measurements by Vaurie (1965) for Franz Josef Land and Norderhaug (1980) for Spitsbergen (Table 4-5), but also data from museum skins by Vaurie (1965) for Greenlandic specimens. The study of Heubeck & Suddaby (1991) as well as measurements by Anker-Nilssen *et al.* (1988) were representative of the larger end of wing length measurements reported for the form *alle*, but in fact intermediate between birds measured alive in Jan Mayen and Spitsbergen and those measured as skins for the race *polaris* where a shrinkage of 1-2% is likely to have occurred.

Since these studies and overviews, an important new paper was published, reporting fresh measurements of adult birds captured in colonies from Spitsbergen, Bjørnøya, and Franz Josef Land (Stempniewicz *et al.* 1996; Table 5). Birds from Bjørnøya and Franz Josef Land could be separated with

Table 5. Wing length in Little Auks in breeding populations. Note that measurements labelled with an (*) were naturally folded wings rather than maximum flattened chord. Measurements labelled with (†) were dried skins. Norderhaug (1980) did not specify the measuring technique.

Tabel 5. Vleugellengte van Kleine Alken in verschillende broedpopulaties.. NB maten met (*) betroffen natuurlijk gevouwen vleugels in plaats van maximiuaal gestrekte vleugels (maximum flattened chord). Maten met (†) betroffen balgen. Norderhaug (1980) specificeert de gebruikte meetmethode niet.

Sample	Sex and age	mean (mm)	SD (*n*)	range	Source
Franz J. Land	Males †	131.9	(27)	124-138	Vaurie 1965
	Females †	131.6	(7)	129-137	
Franz J. Land	live, unsexed	133.3	3.73 SD (59)	122-141	Stempniewicz *et al.* 1996
Spitsbergen	Adults *	120.5	3.2 SD (97)	114-128	Stempniewicz 1981, 1982
	Fledglings *	97.9	3.6 SD (31)		Stempniewicz 1982
Spitsbergen	live, unsexed	118.5	(185)	106-129	Norderhaug 1980
Spitsbergen	live, unsexed	124.6	2.51 SD (5)	121-127	Stempniewicz *et al.* 1996
Bjørnøya	live, unsexed	124.8	2.64 SD (217)	118-134	Stempniewicz *et al.* 1996
Jan Mayen	live, unsexed	118.4	3.69 SD (20)	112-124	Camphuysen 1990
NW Greenland	Ad males	123.1	2.73 SD (117)	?	Roby *et al.* 1981
	Ad females	122.4	2.95 SD (92)	?	
	first year	117.2	2.20 SD (18)		

confidence on the basis of (combined) body mass and wing length, or bill length and wing length. Multivariate analysis showed that any set of variables measured in the field (mass, wing, tail, bill or tarsus) clearly discriminated the Little Auk populations from Svalbard and Franz Josef Land. An interesting confounding factor, however, was that apparently some of the data sets used previously have included 'naturally folded wing' rather than 'maximum flattened chord'! Stempniewicz in his 1981 paper (data copied in Cramp 1985 and BWP*i* 2004) reports a "flattened wing" according to "Svensson 1975" for Spitsbergen birds: 120.5 ± 3.2, range 114-127.5 (n = 97). Stempniewicz *et al.* (1996), however, report a "naturally folded wing" for Spitsbergen birds of 120.9 ± 3.27, range 114-129 (n = 94), as well as a 'maximum flattened chord' of 124.6 ± 2.51, range 121-127 from only 5 individuals! Their 'second' mean is 4 mm larger than the much larger sample based on naturally folded wings and it is the maximum flattened chord that they use in subsequent analysis and testing. Because most of their 99 Spitsbergen birds were "captured in five expeditions

between 1975 and 1992" there is likely to be overlap between the material published in 1981 and that in the overview paper published in 1996. The earlier comparison with *A.a. alle* from Spitsbergen by Heubeck & Suddaby (1991) based on Stempniewicz's material, suggesting that Shetland's birds are extremely large (Table 4), is therefore misleading. Birds from Shetland are still representative of the larger end of wing length measurements reported for the form *alle*, however.

Stempniewicz (1980) failed to find sexual dimorphism from measurements taken on Little Auks. This is corroborated by most results in this study and in Little Auks measured after a wreck along the British east coast (Jones *et al.* 1985) and during the 1981 oil spill in the Skagerrak (Anker-Nilssen *et al.* 1988). Heubeck & Suddaby (1991), however, tested significant differences between males and females in wing length, gonys bill depth, and bill length. Significant differences in bill length and head length were found between the sexes, if the age of the birds was ignored, in data reported in this study. British east coast birds, as well as birds in the present study, showed significantly different measurements with age in some biometrics, such as wing length. Similar differences were found in studies in breeding areas, for example when adult breeders were compared with first year individuals (Roby *et al.* 1981). Because so few birds measured alive in colonies were sexed, a comparative data set from breeding areas with age and sex of the birds known is difficult to obtain. With age differences being considerably larger than the sexual dimorphy, ageing Little Auks in post-mortems is of higher priority than sexing. The combination of body mass and wing length to separate different populations, as proposed by Stempniewicz *et al.* (1996) is not very useful for studies of wrecked and oiled individuals in winter areas. Such birds are either oiled (and cannot be weighed) or severely emaciated and therefore low in body mass irrespective of structural size.

Adult Little Auks measured live in NE Atlantic colonies (Table 5) can now be compared with measurements of birds collected in the North Sea. Using a combination of wing length (maximum flattened chord!) and bill length, selecting adult birds from the Dutch sample regardless of their sex (n = 41 where both measurements were available), a comparison with individuals classified as *A.a. polaris* from Franz Josef Land and *A.a. alle* from Bjørnøya is shown in Figure 8. The results suggest that winter birds in The Netherlands were consistent with *alle* rather than *polaris*, and that birds from Bjørnøya are similar in size, but with relatively longer beaks. The difference in beak size would call for future attention, but possibly, just as in several of the other auks, are winter beaks in Little Auks smaller than summer beaks.

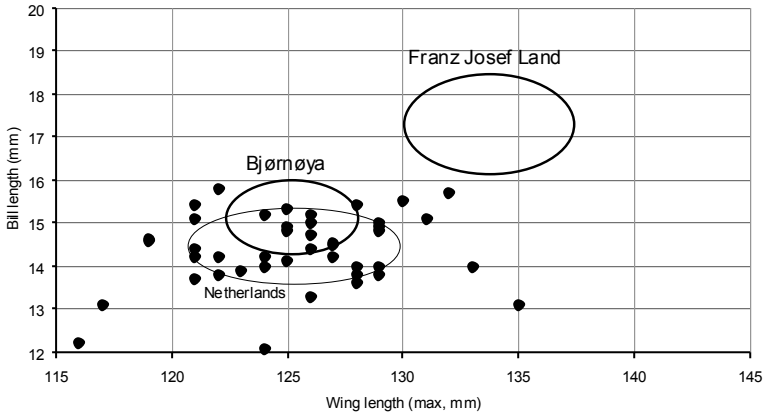

Figure 8. Wing length (maximum flattened chord) and bill length relationship in adult Little Auks found in The Netherlands (black dots and thin oval; n = *41) in comparison with adult birds measured in breeding colonies at Bjørnøya and Franz Josef Land (ovals). Ovals contain mean values and standard deviation ranges.*

Figuur 8. Relatie tussen vleugellengte (maximum flattened chord) en snavelhoogte bij adulte Kleine Alken, die in Nederland gevonden zijn (zwarte stippen en dunne ovaal, n = *41) vergeleken met adulte vogels die gemeten waren in de broedkolonise op Bjørnøya en Franz Josef Land (ovalen). De ovalen bevatten gemiddelden en en standaarddeviaties.*

Body mass The (recent) papers on Little Auk biometrics in breeding areas provide useful information also on body mass of fit, adult individuals. Stempniewicz (1981) reported a mean body mass of 163.1 ± 12.0g (134-193g, *n* = 96) for adult breeding birds in Spitsbergen. Roby *et al.* (1981) reported a body mass of 150.5 ± 8.81g (no range, *n* = 209) for adults from NW Greenland. Stempniewicz *et al.* (1996) reported a mass of 157.8 ± 10.5g (range 133-196g, *n* = 212) for adults from Bjørnøya, and 202.3 ± 12.5g (174-230g, *n* = 56) for *polaris* in Franz Josef Land. With biometrics clearly suggesting the *alle* subspecies (Fig. 8, Table 4-5), the emaciated (adult) birds found in The Netherlands had lost on average a quarter (24.5%) of their body mass (Table 1). This is a very similar result in comparison with other emaciated auks found in the Southern North Sea, where 278 emaciated adult Common Guillemots *U.a. (albionis/aalge)* were 28% below an expected body mass of 975g, 132 adult Razorbills *A.t. islandica* were 25% below an expected body mass of 620g, and 9

adult Atlantic Puffins *Fratercula arctica grabae* were 26% below an expected body mass of 390g (C.J. Camphuysen, unpubl. data).

Future studies From this study, it can be recommended to always include bill depth (measured at base) as a standard measurement. On the other hand, the use of tarsus length and nostril to bill tip length may be omitted. Bill length and wing length are vital parameters when the subspecies or origin of the birds has to be assessed. A follow-up project, studying wing patterns as described in this paper, in combination with the appropriate measurements and dissections to reveal the age from the presence/absence of a bursa is recommended to confirm or even enhance the predictive value of these parameters. Finally, we have no information on underwing patterns in Little Auks in each of the breeding populations and colony workers should therefore be stimulated to study wing patterns during their field work or perhaps studies of skins in museums.

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BEPALING VAN DE LEEFTIJD EN DE HERKOMST VAN GESTRANDE KLEINE ALKEN *ALLE ALLE*: DE BETEKENIS VAN BIOMETRISCHE GEGEVENS EN EEN VARIABEL PATROON OP DE ONDERVLEUGEL

Bij massale strandingen van zeevogels is het een goed gebruik om de achtergronden en de mogelijke oorzaak te onderzoeken. De vogels worden dan gemeten, een indruk wordt opgedaan van de leeftijdsverdeling en de sexratio, en zo mogelijk wordt nagegaan waar de gestrande vogels vandaan zijn gekomen. In het ideale geval zijn alleen uitwendige bepalingen noodzakelijk, liefst aan onderdelen waardoor ook aangevreten, incomplete kadavers nog bruikbaar zijn. Voor de herkomst van vogels zijn ringgegevens het meest betrouwbaar, maar helaas zijn er zelden voldoende geringde exemplaren voorhanden om een uitspraak te kunnen doen. In dergelijke gevallen worden de genomen maten vergeleken met biometrische gegevens uit de broedgebieden. Behalve dat zo een eventuele ondersoort kan worden vastgesteld, geven dergelijke gegevens vaak ook een aanwijzing welk deel van de populatie betrokken was, omdat er binnen een soort vaak regionale verschillen in biometrie bestaan.

Kleine Alken Alle alle *zijn dikwijls betrokken bij massastrandingen en invasies. Helaas zijn bij deze soort de uitwendige verschillen tussen volwassen en juveniele vogels onduidelijk. De invasie van 2003 werd benut om 42 exemplaren nader te onderzoeken. Daarnaast werden de dissecties die gedaan werden aan Kleine Alken die sinds 1975 'opportunistisch' werden verzameld, gebruikt om een wat grootschaligere analyse te kunnen doen. De vogels uit 2003 werden gebruikt*

om de patronen op de ondervleugel in detail te bestuderen, vanwege een vermelding in de handboeken dat hier "variabele hoeveelheden witte veertjes" aanwezig zouden zijn. Alle andere exemplaren werden gemeten en zo mogelijk inwendig onderzocht. Bij dissectie werden leeftijd en geslacht bepaald, waardoor achteraf kon worden uitgerekend in hoeverre de verzamelde biometrische gegevens van nut zouden zijn geweest bij het 'voorspellen' van leeftijd en geslacht.

De standaardmaten die bij Kleine Alken werden genomen waren snavellengte (veerrand tot punt), afstand van neusgat tot snavelpunt, snavelhoogte aan de basis, koplengte, tarsuslengte, vleugellengte en totale massa, inclusief een bepaling van de conditie van de vogels. Bij de analyse van de vogels uit 2003 werden zeven verschillende veergroepen aan de ondervleugel onderzocht en werd de hoeveelheid wit aan de veren gescoord op een schaal van 1 (geheel grijs) - 6 (helderwit). Geheel grijze ondervleugels behaalden zo een score van 7 (7x1); theoretisch zou een score van 42 (7x6) haalbaar moeten zijn. Het bleek dat op grond van een combinatie van de snavelhoogte en de vleugellengte zo'n 83% van de vogels correct op leeftijd zou zijn gebracht. In combinatie met 'vermagerd gewicht' (vrijwel alle onderzochte vogels hadden volkomen uitgeputte vet- en spierreserves) kon de betrouwbaarheid worden opgevoerd tot 88%. Sommige andere maten konden worden gebruikt om de sexen te scheiden. Twee maten, de afstand tussen neusgat en snavelpunt en de tarsuslengte, gaven noch tussen de sexen, noch tussen de leeftijdsklassen verschillen aan en het nut van deze maten wordt daarom betwijfeld.

Witte veertjes, of veertjes met witte toppen, kwamen relatief vaak voor in de kleine handpendekveren (LPC) van juveniele Kleine Alken, het omgekeerde was het geval bij de grote armpendekveren (GPC) van adulte vogels. De gemiddelde LPC score (± SD) bij juveniele Kleine Alken bedroeg 2.8 ± 1.4, bij adulten 1.9 ± 1.2. De gemiddelde GSC score (± SD) van bij juveniele Kleine Alken bedroeg 1.2 ± 0.6, bij adulten 2.2 ± 1.7. De overlap was aanzienlijk en op basis van een combinatie van deze beide veergroepen kon slechts 74% van de Kleine Alken correct op leeftijd gebracht worden.

Omdat het lichaamsgewicht een 'moeizame' maat is, omdat er dan toch ook een dissectie (en een compleet kadaver) nodig is om een uitspraak te kunnen doen over de leeftijd op grond van de afmetingen, werd gezocht naar een combinatie van biometrie en ondervleugelpatronen. Helaas was het monster van vogels waarbij zowel de vleugel was onderzocht, als de juiste maten waren genomen maar klein. Evengoed bleek op grond van een combinatie van snavelhoogte, vleugellengte en de aan-/afwezigheid van witte veertjes op LPC en GSC 87% correct op leeftijd gebracht te kunnen worden.

*Vervolgens werd gekeken, na een nieuwe analyse van de literatuur, welke afmetingen Kleine Alken in de broedgebieden hadden en in hoeverre Nederlandse vogels daarmee overeenkwamen. Over de biometrie in de gebieden van herkomst, in vergelijking met de gegevens die van gestrande vogels in de Noordzee, waren enkele verwarrende analyses gepubliceerd. Uit de literatuur was een groot verschil bekend tussen de broedvogels van Franz Josef Land (*A.a. polaris*) en de broedvogels van Spitsbergen en Groenland (*A.a. alle*). Gestrande vogels op de Britse eilanden hadden maten opgeleverd die feitelijk inzaten tussen de beide populaties, en gespeculeerd werd al over 'nog onontdekte broedgebieden' waar dergelijke vogels zouden kunnen broeden. Uit een vergelijking van drie publicaties van dezelfde auteur over de vogels van Spitsbergen, bleek echter dat de gepubliceerde vleugellengtes niet op een vergelijkbare manier waren gemeten. Na correctie (ongeveer 5% langere maten door de vleugel bij het meten goed te strekken) waren de Noordzeevogels al een stuk minder ongewoon, ofschoon nog steeds relatief groot in vergelijking met de op Spitsbergen gemeten individuen. Nederlandse vogels bleken afmetingen te hebben die prima overeenkwamen met broedvogels van de westelijke Barentszee, zals de broedvogels van Bereneiland of Spitsbergen (Fig. 8, Tabel 5). Met nieuwe gegevens uit de broedplaatsen in de hand kon bovendien preciezer worden ingeschat hoeveel lichaamsgewicht de hier gestrande vogels verloren hadden. Uitgaande van een 'gezond gewicht' van ongeveer 155 gram, hadden de Nederlandse vogels gemiddeld 24.5% van hun lichaamsgewicht verloren.*

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Appendix. Age, sex, colour pattern on underwing feather groups, overall colour score, wing length, bill length, bill depth, and body mass in 42 corpses of Little Auks selected for a plumage analysis in 2003. Bijlage. Leeftijd, geslacht, kleurpatroon op de veergroepen op de ondervleugel, totale kleurscore, vleugellengte, snavellengte, snavelhoogte en lichaamsgewicht van 42 kadavers van Kleine Alken die in 2003 geselecteerd zijn voor een analyse van het verenkleed.

Coll number	Age	Sex	GPC	MPC	LPC	GSC	MSC	LSC	Axil	Score	Wing	Bill	Depth	Mass
203079.596	J		1	1	3	1	1	1	4	12	119	14.1	7.50	
203080.533	J	M	1	2	3	1	1	1	4	13	128	16.1	8.00	
203081.550			1	1	1	1	1	1	1	7	119	13.1	6.70	
203082.542	J	M	1	1	1	1	2	1	6	13	119	14.2	8.00	
203082.543	A	F	1	2	2	5	2	1	6	19	124	15.5	8.30	115
203090.002	J	M	1	1	3	3	2	1	4	15	122	15.2		
203090.003	A	F	1	1	1	1	1	1	1	7	124	14.2		
203090.004	A	M	1	1	1	1	1	1	1	7	122	14.2		
203090.005	J	F	1	1	1	1	1	1	1	7	124	14.3		
203096.569	J	M	1	2	2	1	1	1	6	14	119	13.8	7.10	120
203097.002	A	F	1	1	1	1	1	1	4	10	133	14.0		
203097.004	J	F	1	2	4	3	3	1	4	18	119	13.4		
203097.005	A	F	1	1	2	3	4	1	4	16	116	12.2		
203098.001	A	M	1	1	1	1	1	1	2	8	127	14.2		
203098.002			1	2	4	1	2	1	2	13	119			
203100.572			1	2	3	1	3	1	5	16	129	14.9	7.40	
203100.573	J	F	1	2	3	1	1	1	6	15	122	13.7	6.40	
203100.574			1	2	3	1	1	1	4	13	121	14.4	8.80	
203104.001	A	M	1	2	3	1	1	1	4	13	121	15.4		
203104.003	A	F	1	2	3	3	3	1	6	19	124	15.2		
203105.001	J		1	1	3	1	1	1	2	10	117	14.9		
203105.002	A	F	1	1	1	1	1	1	4	10	121	13.7		
203106.001			1	1	1	1	1	1	2	8	125	15.5		

Coll number	Age	Sex	GPC	MPC	LPC	GSC	MSC	LSC	Axil	Score	Wing	Bill	Depth	Mass
203119.578	J	M	1	2	5	1	1	1	2	13	126	14.7	8.40	130
203119.581	A	F	1	1	1	5	3	1	3	15	124	12.1	8.80	120
203119.587	A	M	1	2	4	5	2	1	6	21	126	13.3	8.50	120
203119.588	J	F	1	2	2	1	1	1	4	12	125	14.3	7.40	125
203119.589	J	F	1	2	3	1	2	1	4	14	122			
203119.590	A	M	1	1	1	1	1	1	4	10	126	15.2	9.00	120
203119.591	J	F	1	4	6	1	2	1	6	21	116	14.6	7.50	120
203119.592	J	M	1	2	5	1	1	1	2	13	126	13.5	7.40	100
203122.001	A	M	1	1	2	1	1	1	2	9	131	15.1		
203144.621			1	2	2	1	1	1	6	14	124			
203146.582	A	F	1	1	1	1	1	1	1	7	121	14.2	8.10	105
203147.579	J	F	1	1	3	1	1	1	4	12	122	13.3	7.20	115
203147.580	A	F	1	1	2	1	1	1	4	11	130	15.5	7.60	
203147.583	J	F	1	1	1	1	2	1	6	13	128	14.3	7.20	115
203147.584	A	F	1	2	2	1	1	1	4	12	129	14.0		
203147.585	A	F	1	4	5	5	3	1	6	25	126	14.7	8.20	120
203147.586	J	F	1	1	2	1	2	1	2	10	117	13.4	7.30	120
203147.618	J	F	1	1	1	1	1	1	2	8	118			
203170.530			1	2	6	1	5	1	6	23	126			
Summarised														
- Sample 21		F	1.0	1.6	2.2	1.9	1.8	1.0	3.9	13.4	123.1	14.0	7.6	117.2
- Sample 12		M	1.0	1.5	2.6	1.5	1.3	1.0	3.6	12.4	124.4	14.6	8.1	118.0
- Sample 17	A		1.0	1.5	1.9	2.2	1.6	1.0	3.6	12.9	125.0	14.3	8.4	116.7
- Sample 18	J		1.0	1.6	2.8	1.2	1.4	1.0	3.8	12.9	121.6	14.2	7.5	118.1

AN INITIAL ESTIMATE OF AGE AT FIRST RETURN AND BREEDING IN MADEIRAN STORM-PETRELS *OCEANODROMA CASTRO*

JOËL BRIED[1*] & MARK BOLTON[1, 2]

Bried J. & Bolton M. 2005. An initial estimate of age at first return and breeding in Madeiran Storm-petrels *Oceanodroma castro*. Atlantic Seabirds 7(2): 71-74.
The Madeiran Storm-petrel Oceanodroma castro *is classified as "Rare" in Europe; however, its population dynamics and its demographic parameters remain unknown. Here, we provide the first estimates of the age at first return to the colony and age at first breeding in this species, using our data from a five-year demographic study conducted in the Azores (subtropical northern Atlantic). On average, Madeiran Storm-petrels return to their birth colony during their third year. They can breed when two years old, and the reproductive performances of first-time breeders are similar to those of experienced individuals.*

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INTRODUCTION

The Madeiran Storm-petrel *Oceanodroma castro* is regarded as a "Species of Conservation Concern" (Category 3) with a status of "Rare" in the Western Palearctic, with a breeding population of less than 10, 000 pairs (Burfield & Van Bommel 2004). Its European population is small (3700 pairs) and apparently declined between 1970 and 1990. Estimating a species' demographic parameters is a prerequisite for biological conservation, but the population dynamics of Madeiran Storm-petrels remain largely unknown. Here, we provide the first estimates of age of first return to the colony and age of first breeding in this species, using the data from a five-year demographic study in the Azores (subtropical northern Atlantic).

METHODS

Field work was conducted on Praia islet (39º03'N, 27º57'W), a 0.12 km^2 islet situated in the Azores archipelago, between 2000 and 2004. Two seasonal

populations of Madeiran Storm-petrels breed on the islet (Monteiro *et al*. 1999; Bolton *et al*. 2004) and use the same nests (authors' unpubl. data). So far, no exchange of individuals has been recorded between these populations (Monteiro & Furness 1998, authors' unpubl. data), whose breeding numbers are quite small: 100 pairs during the hot season (i.e. April-early September) and 200 pairs in the cool season (late August-February; see Monteiro *et al*. 1999, Bolton *et al*. 2004). During each breeding season, we thoroughly inspected potential suitable nesting sites during incubation (mid-June for the hot season population, early December for the cool season population) to check for the presence of adults. Concomitantly, we captured non-breeding prospectors at night, using mist nests. Breeders and prospectors were either ringed or identified from their ring number if ringed earlier. Chicks were ringed before fledging (in late July-early August for the hot season population and in late January-early February for the cool season population).

RESULTS

In the hot season population, 543 breeders and prospectors and 114 chicks have been ringed since 2000. Three two-year old individuals were mist-netted in June 2003. In 2004, four birds of known age were found occupying a nest. The first, found on 13 June, was three years old. Its brood patch was entirely free of down, but the nest contained no egg; during a second visit on 31 July, we found the nest unattended and, again, without egg. Therefore, and also because brood patches do occasionally occur in non-breeding petrels (Warham 1990), this individual was probably a non-breeder. Two other individuals, 4 years old and 2 years old, made their first breeding attempt. The older bird was found incubating on 18 June, but its nest was empty on 31 July. The younger individual had no egg on 14 and 17 June, but it was found incubating in the same nest on 31 July, and a healthy *ca* 5-week old chick (age estimated from 64-mm wing length) was found on 10 September. The fourth individual, which had been ringed as a chick in August 2000, was found incubating on 13 June 2004. A breeding attempt involving the partner of this individual had already been witnessed in the same nest in 2003, but it is unclear if this attempt also involved the four-year old individual. The chick hatched relatively late in the 2003 season, but it fledged successfully. On 10 September 2004, an almost fully grown chick in good condition was found in this nest.

When considering the cool season population, we have ringed 1008 breeders and prospectors and 144 chicks since 2000. On 5 February 2003, we found the remains of a ringed individual preyed on by a vagrant Short-eared Owl *Asio flammeus*. This individual had been ringed as a chick in January 2001,

indicating that it had returned to the colony two years after fledging. Two other two-year old birds were mist-netted on 23 and 25 November 2004, respectively.

We conclude therefore that Madeiran Storm-petrels may commence breeding when 2 years old. Because neither of the breeders had been captured earlier, and excluding the fourth hot season individual which might actually have returned in 2003, we could estimate the age at first return at 2.3 ± 0.7 years ($n = 9$).

DISCUSSION

Our estimated age of first return and age of first breeding are consistent with the fact that petrels are long-lived species (Warham 1990). Similar results were found in other storm-petrel species (Jouventin & Mougin 1981; Schreiber & Burger 2002; G. Hémery pers. comm.). Because of our small sample size, our results must be regarded as preliminary, and they need to be refined by continuing our long-term monitoring. Late breeding by the two-year old bird (and by the last hot season individual if, indeed, it did breed in 2003) is in accordance with the fact that young and/or first-time breeders tend to lay relatively late in the season (see Brooke 1978; Nelson 1978; Haymes & Blokpoel 1980; González-Solís *et al*. 2004). However, the hatching success of these three individuals (66.7%) was similar to that observed in the 58 other nests found occupied by breeders in 2004 (69.0%). This result was somewhat surprising, given that in long-lived species, first-time breeders often have lower reproductive performances than their more experienced and/or older conspecifics (Curio 1983).

ACKNOWLEDGEMENTS

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EERSTE SCHATTING VAN DE LEEFTIJD WAAROP MADEIRASTORMVOGELTJES *OCEANODROMA CASTRO* VOOR HET EERST NAAR DE KOLONIE TERUGKEREN EN BROEDEN

Madeirastormvogeltje Oceanodroma castro *wordt geklassificeerd als "Rare" (zeldzaam) in Europa. De populatiedynamica en demografische parameters van deze soort zijn echter onbekend. Op basis van de gegevens die zijn verzameld tijdens een vijfjarige studie op de Azoren, presenteren we in dit artikel de eerste schattingen van de leeftijd waarop Madeirastormvogeltjes voor het eerst naar de kolonie terugkeren en ze voor het eerst broeden. Madeirastormvogeltjes keren gemiddeld in het derde jaar terug naar de geboortekolonie. Ze kunnen broeden als ze twee jaar oud zijn. Het reproductiesucces van 'nieuwe' broedvogels is gelijk aan dat van ervaren broedvogels.*

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THE ALDERNEY NORTHERN GANNETRIES – PHOTOGRAPHIC COUNTS OF ORTAC AND LES ETACS, CHANNEL ISLANDS IN 2005

JEREMY G. SANDERS[1] & MICHAEL P. HARRIS[2]

Sanders J.G. & Harris M.P. 2005. The Alderney Northern Gannetries – photographic counts of Ortac and Les Etacs, Channel Islands in 2005. Atlantic Seabirds 7(2): 75-82. *Aerial surveys of Northern Gannet* Morus bassanus *colonies on Ortac and Les Etacs, Channel Islands, in July 2005, found 2547 and 4862 Apparently Occupied Sites respectively. The total population increased at an average rate of 3.3% per annum over the last 55 years. There may now only be limited room for expansion on Ortac where the rate of increase has declined substantially in recent years.*

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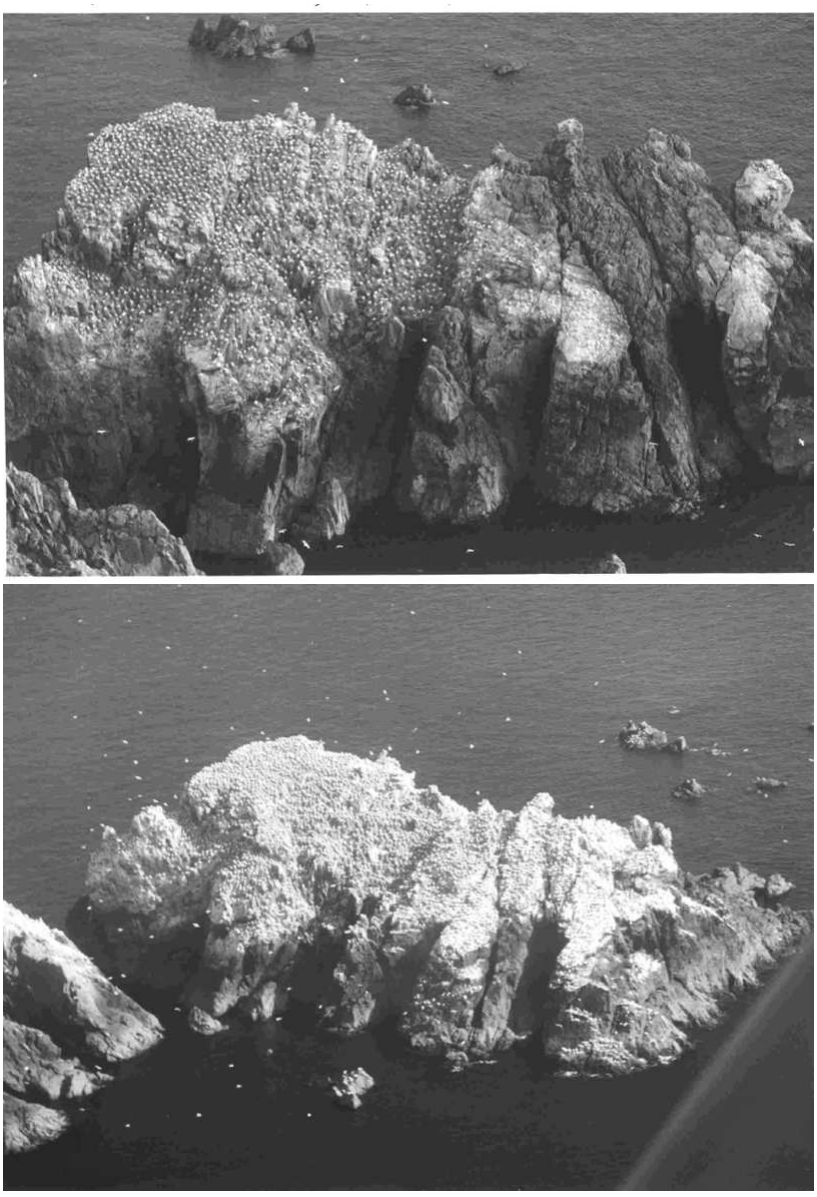
INTRODUCTION

The Channel Islands' Northern Gannet *Morus bassanus* colonies are on the islets of Ortac and Les Etacs, close to Alderney. In June 1940, the entire human population of Alderney, including a small military garrison, was evacuated to the UK. Prior to the evacuation, Major J.A.A. Wallace MC, who was commanding the garrison, and some of his junior officers, visited Ortac to look at a Black-legged Kittiwake *Rissa tridactyla* colony. One of his subalterns reported in great excitement of "a big white bird like an albatross". On climbing to the top of the rock he discovered a Northern Gannet incubating an egg. Local people assured him that it was the first (Lockley 1948), i.e., the first year the species had bred. He also landed on Les Etacs several times, but there were no Northern Gannets. The people of Alderney did not return until the war was over, five years later, hence the origin of Les Etacs colony, and the initial growth of the Ortac and Les Etacs colonies were not documented. However, in 1945 E. Quinain, an Alderney fisherman returning home after his enforced absence, reported that the eastern side of Ortac was covered with Northern Gannets and discovered another colony on Les Etacs, just off the western end of Alderney (Dobson & Lockley 1946). Here, we report on counts derived from an aerial survey undertaken in July 2005, and we also list previous counts.



Les Etacs in 1979 (top) and 2005 (bottom). Les Etacs in 1979 (boven) en in 2005 (onder). (*Mike Hill 1979 & Jeremy Sanders 2005)*

METHODS

Both colonies were photographed between 1800 and 1900 hrs BST on 12 July 2005 using 100 ASA colour film and 35 mm cameras fitted with 28-90 mm lenses. Photographs were taken through the windows of a single-engine, high-wing aircraft flying at about 200 m altitude. The weather was fine and the gannetries were in sunshine. Additional photographs of Les Etacs were taken from the adjacent mainland of Alderney on 20 July 2005, and of Ortac and Les Etacs from a boat on 6 August 2005. Counts for Ortac were made from the aerial photographs but 17% of the final total for Les Etacs came from the later photographs.

Northern Gannets on Les Etacs are used to aircraft, since 20-50 small aircraft using Alderney's airfield pass over daily, and non-breeding or 'club' birds did not take off when the aerial photographs were being taken. Fewer aircraft pass over Ortac and some, but not all, club birds took off. The August boat trip allowed the breeding areas to be delimited.

Three complete counts were made from 30x20 cm colour prints overlaid with tracing paper (first count) or acetate sheet (second and third counts). When counting, natural rock features were used as reference divisions to avoid double counting on different photographs. The count unit used was the Apparently Occupied Site (AOS) defined as one or two Northern Gannets occupying a site, irrespective of whether any nest material was visible. Counts were made by the senior author using a x8 magnifying glass, each AOS being spotted out as it was counted.

Some previous counts have reported on the numbers of club-birds present. We did not do this since it was unclear how many had left due to the aircraft and because there were many birds on the sea and on the Renonquet reef, situated 1.5 km north-east of Ortac and 3.5 km north-west of Les Etacs. Northern Gannets started roosting on Renonquet in 1999. The reef is low-lying, and there has so far been no evidence of Northern Gannets attempting to nest on it.

RESULTS

Ortac Ortac is an isolated rock, approximately 100x70 m rising to 22 m in height, situated 4.5 km west of Alderney; it has very steep sides. In 2005, there were 1865 AOS (range of three counts 1754-1944) on the east side and top, and 682 (567-784) on the west side, giving a total of 2547 (2321-2728) AOS.

Les Etacs The name Les Etacs is no longer in everyday use, although still used on maps and documents, having been replaced by the name the Garden Rocks. Les Etacs consist of two groups of rocks, rising steeply from the sea. The areas

and names of the various rocks are essentially those of Hill (1993). The largest unit, the Main Rock at the western end of the Main Group, is approximately 120 m long x 70 m wide, and rises steeply from the sea to a height of 37 m. The north face of the Main Rock shelves at an angle sufficient to enable Northern Gannets to nest on the greater part of it, and has the major part of the colony. The south face of the Main Rock is sheer, and birds nest only on outcrops. Adjacent to the northeastern end of the Main Rock are two rocks called here North Rock 1 (closest to the Main Rock), and North Rock 2 (which lies to the north of North Rock 1). All three units are joined at very low tide. The East Stacks comprise a unit which is about one third as big as the Main Group, and consist of two stacks, the highest of which is 32 m high.

In 2005, the Main Rock had 3479 AOS (range 3327-3660), North Rock 1 had 423 AOS (including an estimate of 100 nests in hidden areas; range 417-429), North Rock 2 had 266 AOS (254-277), and the East Stacks had 694 ASO (646-739). This gives a total of 4862 AOS (4644-5105).

Table 1. Counts of Northern Gannets on Ortac, 1940-2005.
Tabel 1. Tellingen van Jan-van-genten op Ortac, 1940-2005.

Year	Count	Range	Source
1940	1 nest		Dobson (1952)
1946	250 pairs		Dobson (1952)
1948	>234 nests		Fisher & Vevers (1951)
1949	225 pairs	200-250	Fisher & Vevers (1951)
1950	570 pairs		Fisher & Vevers (1951)
1951	225 pairs		K. Le Cocq (in Hill 1989)
1952	450 pairs	400-500	K. Le Cocq (in Hill 1989)
1960	925 nests		Cramp *et al.* (1974); Anonymous (1961)
1969	1000 AON	800-1200	Cramp *et al.* (1974) Operation Seafarer records
1979	1787 AOS	1719-1871	Hill (1989)
1984	2062 AOS	1964-2142	Hill (1989)
1987	2211 AOS	2138-2284	Hill (1989)
1989	2106 AOS	1967-2194	Hill (1989)
1994	2098 AOS		M.G. Hill (*pers. comm.*)
1999	2500 AOS		J. Hooper (in Wanless *et al.* 2005)
2005	2547 AOS	2321-2728	This study

Previous counts It was not until June 1938 that (two) Northern Gannets were recorded flying past the Casquets group of rocks in summer (Dobson 1952). The single nest with an egg on Ortac in 1940 was almost certainly the first breeding attempt (Dobson 1952), at least in historic times. By the time of the next checks, in 1946, there were c. 250 pairs on Ortac and c. 200 pairs at the

new colony on Les Etacs (Fisher & Vevers 1951). Details of counts known to us are given in Tables 1 and 2. Most of these counts are documented by Hill (1989). The units used in these counts varied - nests, pairs, Apparently Occupied Nests (AON) and Apparently Occupied Sites AOS – so for convenience we follow the normally accepted convention of assuming that these are all equivalent when comparing counts (Wanless et al. 2005). There is some uncertainty regarding the very high count from Les Etacs in 1969 since this is approximately double the counts of 1960 and 1973. Long (1981) reported that numbers at both colonies showed "a steady increase until about 1960 when they reached about 1000 at both sites, since when the totals seem to have remained fairly constant". Wanless (1987) assigned a count of 1120 site-holding individuals and 71 club birds in the Main Colony in 1969 to W.A. Burridge, and Hill (1989) presented a map showing that the extent of the colony increased relatively little between 1960 and 1974. Therefore, it appears likely that the count of 2000 nests in 1969 is erroneous and for plotting population trends (see Figure 1) a figure of 1000 pairs is used (Wanless 1987).

Table 2. Counts of Northern Gannets on Les Etacs, 1940-2005. n.c. = not counted.
Tabel 2. Tellingen van Jan-van-genten op Les Etacs, 1940-2005. n.c. = niet geteld.

Year	Total colony	Main colony	East stack	Source
1940	0	0	0	Dobson (1952)
1946	200 nests	190	10	Dobson (1952)
1948	>200 nests			Fisher & Vevers (1951)
1949	418 pairs	400	18	Fisher & Vevers (1951)
1950	615 pairs	600	15	Fisher & Vevers (1951)
1960	1010 pairs	1000	10	Cramp *et al.* (1974); Unpublished J. Fisher papers, British Museum
1960	1062 nests	1000	62	Anonymous (1961); Unpublished J. Fisher papers, British Museum
1969	[2000 nests]			Cramp *et al.* (1974)
1973	> 1003 AOS	1003	n.c	Hill (1989)
1974	1269 AOS	1019	*c*.50	Wanless (1987)
1975	1627 AOS	1525	102	Wanless (1987)
1979	1978 AOS	1891	87	Hill (1989)
1984	2325 AOS	2207	118	Hill (1989)
1987	2536 AOS	2412	124	Hill (1989)
1989	2810 AOS	2655	155	Hill (1989)
1992	2746 AOS	2535	211	M.G. Hill (*pers. comm.*)
1994	3380 AOS	3008	372	M.G. Hill (*pers. comm.)*
1999	3450 AOS			J. Hooper (in Wanless *et al.* 2005)
2005	4862 AOS	4168	694	This study

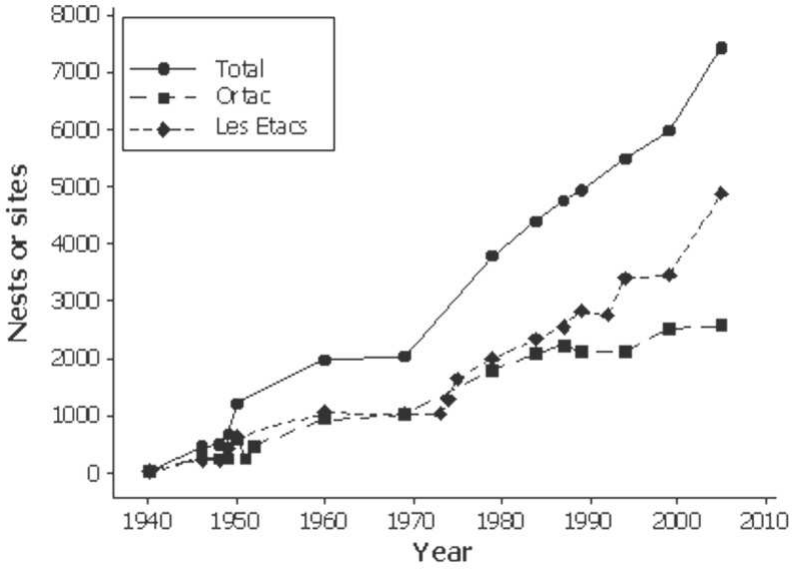


Figure 1 Number of Northern Gannet breeding sites (AON/AOS/nests/pairs) on Ortac and Les Etacs, 1940-2005.

Figuur 1. Aantal broedplaatsen (AON/AOS/nest/paar) van Jan-van-genten op Ortac en Les Etacs, 1940-2005.

DISCUSSION

There must have been massive immigration into these two colonies during and immediately after the war years to allow the increase from 1 to c. 450 nests over a five-year period and to 1185 nests by 1950. The increase has continued, albeit at a slightly reduced rate (Figure 1). Between 1950 and 2005, the rate of increase of the two colonies combined has been remarkably constant at 3.3% per annum (9 counts, $r^2 = 97\%$, $P < 0.001$). However, the rate of increase on Ortac between 1979 and 2005 was only 1.2% p.a., compared with 3.3% on Les Etacs. The literature comprises many accounts of seabird colonies that appeared to have been full, but which have subsequently increased. Dobson & Lockley (1946) speculated that the maximum capacities of Ortac and Les Etacs were 500 and perhaps 1000 pairs respectively. In 2005, there were about five times as many pairs as these predictions. However, the much reduced rate of increase on Ortac does suggest that space may be becoming limited.

The Channel Island colonies were not counted during the British and Irish Northern Gannet survey in 2003/04, and Wanless et al. (2005) assumed a figure of 6500 AOS based on the past rate of increase. This would now appear to have been slightly too low but even so, these two gannetries still hold less than 3% of the total British and Irish population (c. 260,000 occupied AOS; Mitchell et al 2004). However, whereas the average rate of increase of the British and Irish population since the last full survey had declined to 1.2% p.a., that in the Channel Islands had remained high at 2.8% p.a. The rate of increase at the large French colony on Rouzic (135 km from Alderney) has also declined in recent years (Siorat & Bentz 2004) so it will be interesting to see what happens to numbers on Ortac and Les Etacs in the near future.

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JAN-VAN-GENTENKOLONIES OP ALDERNEY, INVENTARISATIE VAN ORTAC EN LES ETACS, KANAALEILANDEN, IN 2005

Een inventarisatie vanuit de lucht van kolonies van Jan-van-gent Morus bassanus *colonies op Ortac en Les Etacs (Kanaaleilanden) in juli 2005, resulteerde in respectievelijk 2547 en 4862 schijnbaar bezette plekken (Apparently Occupied Sites). De totale populatie nam de afgelopen 55 jaar toe met een jaarlijks gemiddelde van 3.3% . Mogelijk is ruimtegebrek op Ortac nu de beperkende factor voor een verdere toename. In deze kolonie is de groeisnelheid de laatste jaren sterk gedaald.*

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COMMON GUILLEMOTS *URIA AALGE* DIFFERENTIATE THEIR NICHE TO COEXIST WITH COLONIZING GREAT CORMORANTS *PHALACROCORAX CARBO*

MÅRTEN B. HJERNQUIST[1], MÅNS HJERNQUIST[2], BJÖRN HJERNQUIST[2] & KATHERINE A. THUMAN HJERNQUIST[1,3]

Hjernquist M.B., Hjernquist, M., Hjernquist B. & Thuman Hjernquist, K.A. 2005. Common Guillemots *Uria aalge* differentiate their niche to coexist with colonizing Great Cormorants *Phalacrocorax carbo*. Atlantic Seabirds 7(2): 83-89. *Colonization of new species into an established community generally results in interspecific competition over resources between the colonist and existing members of the community. Interspecific competition has been suggested to influence extinction rates, population dynamics, community structure, niche differentiation and evolution. In this study, we observe possible interspecific competition over breeding sites resulting in niche differentiation and coexistence of Great Cormorants* Phalacrocorax carbo *and Common Guillemots* Uria aalge *in a seabird cliff community. In Sweden, Great Cormorants have naturally increased and expanded during the last two decades. Here, we show that most Common Guillemots previously bred on cliff ledges with high roof heights before the study-island was colonized by Great Cormorants, but are now mainly found breeding on cliff ledges with lower roof heights. A temporary decline in the Common Guillemot population coincided with the colonization event and we discuss the potential for this decline to be caused by increased nest-site competition combined with high nest-site fidelity.*

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INTRODUCTION

Coexistence of species has interested community biologists for decades and studies of birds have played a major role in understanding inter- and intraspecific competition and how they influence evolution (Lack 1968; Lack 1971; Alatalo *et al*. 1986; Alatalo *et al*. 1987). Interspecific competition over resources has long been argued to influence extinction rates, population

dynamics, community structure, niche differentiation and evolution (Begon *et al.* 1996). Gause's (1934) competitive exclusion principle predicts that competition between two or more species will lead to the extinction of all but one species if competitors do not differentiate their niche. More elaborate versions of Gause's principle suggest a limit to the extent of similarity between species and a limit for the number of species that can utilize a niche within a community (MacArthur & Levins 1967; May 1973).

The availability of nesting sites for seabirds on cliff ledges may not be a limiting resource (Furness & Birkhead 1984; Wittenburger & Hunt 1985; Olsthoorn & Nelson 1990), but because sites vary in quality they should be subject to competition (Ashmole 1962; Porter & Coulson 1987). Interspecific competition over nest sites in seabird cliff communities has previously been shown, as well as potential niche differentiation and competitive exclusion (Kenyon and Phillips 1965; Lack 1968; Maunder & Threlfall 1972; Williams 1974; Squibb & Hunt 1983). Thus, interspecific competition over nest sites is often an important force influencing the habitat used by seabirds. However, there are not always costs associated with coexisting with other species and there might even be fitness benefits associated with interspecific interactions, e.g. increased juvenile survival and number of offspring produced (Forsman *et al* 2002).

Conservation biologists have considered the immigration of new species into communities, both natural and with help from humans, as a cause for concern with respect to existing biodiversity. The Swedish population of Great Cormorant *Phalacrocorax carbo* has naturally expanded and migrated into new areas over the last two decades (Engström 2001). In 1992, the first pairs of Great Cormorants colonized the bird cliffs on the island of Lilla Karlsö (57°19'N, 18°04'E), situated on the west coast of the island of Gotland in the Baltic Sea. Great Cormorants are piscivorous and build nests in the scree-slope, in trees and on cliff ledges. For the first three years after colonization, Great Cormorants bred only on cliff ledges, but more recently they have started to nest on the scree-slopes to a greater extent, with a few nests also in trees; for example, in 2001 approximately 60 % of the Great Cormorants bred on scree-slopes, 35% on cliff ledges, and 5% in trees (unpublished data). The Common Guillemot *Uria aalge*, also a piscivorous seabird, has bred on the cliff ledges on Lilla Karlsö since at least the 18th century (von Linné 1741). Using breeding distribution data of Common Guillemots gathered before and after Great Cormorants colonized the study island, we analysed how nest site niches utilized by Common Guillemots changed in response to cormorant colonization, allowing us to test predictions of competitive exclusion and niche differentiation. Long-term population data for both species were used to assess potential population effects following the colonization.

METHODS

Study site and populations The only seabird cliffs in the Baltic Sea are situated on the island of Lilla Karlsö and on its sister island Stora Karlsö. On Lilla Karlsö, there are two large seabird cliffs where birds nest on cliff ledges, in cavities and on the ground. The cliff ledges on Lilla Karlsö are cavernous, with sufficient width and depth to be suitable breeding places for both Common Guillemots and Great Cormorants. However, they vary in roof height ranging from less than 1m to several metres, or no roof at all. Most Great Cormorants nest on ledges where Common Guillemots also breed. Public access to the breeding colonies (both from land and sea) is prohibited.

Population data For both species, population data from 1988 until 2004 was obtained from an annual nature monitoring report for Lilla Karlsö (Hjernquist 2004).

Cliff ledge data In 1974 (before the Great Cormorant colonized the study island), 1997 and 2001 (after the Great Cormorant colonized the study-island) ledges with auks were surveyed from a boat outside the restricted water-zone. The great majority of auks breeding on cliff ledges on Lilla Karlsö are Common Guillemots, and we therefore assumed all auks to be Common Guillemots. At the same time these ledges were categorised as either having high roof heights (approximately 2 m high and including ledges without a roof) or low roof heights (approximately lower than 2 m) and we used this to categorise the niches utilized by the Common Guillemot before or after the colonization event. Thus, we compared one year of data, gathered 18 years before the colonization event, with two years of data, gathered five and nine years after the colonization. Breeding birds are monitored annually on Lilla Karlsö and no apparent shift in breeding sites was observed until after the Great Cormorants colonized the island (personal observations); the years 1974, 1997 and 2001 are therefore assumed to be representative of the breeding distribution before and after the colonization.

RESULTS

Population data Since 1988, Common Guillemot population size has fluctuated around 1100 pairs (mean = 1072.1). The last major population decrease was between 1992 and 1993, with a decline of about 600 pairs, followed by an immediate and rapid increase between 1995 and 1997 to the earlier levels of about 1100 pairs (Figure 1). The Great Cormorant population size has increased since initial colonization and peaked in 2000 (2268 pairs) followed by a slight decrease (Figure 1).

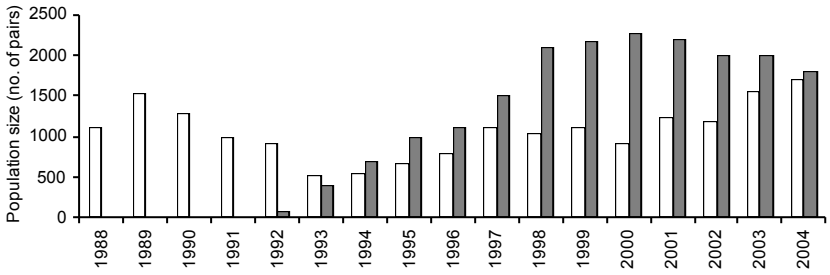

Figure 1. Number of breeding pairs of Great Cormorants (filled bars) and Common Guillemots (open bars) on the island of Lilla Karlsö in the Baltic Sea, 1998-2004 (Hjernquist 2004).

Figure 1. Aantal broedpaar van Aalscholver (grijze staafjes) en Zeekoet (witte staafjes) op het eiland Lilla Karlsö in de Baltische Zee, 1998-2004 (Hjernquist 2004).

Cliff ledge data In 1974, 73% of the 155 cliff ledges with breeding Common Guillemots observed had high roof height. In 1997 and 2001, i.e. after the Great Cormorant colonized the island, 122 and 94 cliff ledges were observed with breeding Common Guillemots, with 31.1% and 29.8% respectively, having high roof heights. This suggests that Common Guillemots shifted from breeding mainly on cliff ledges with high roof heights before Great Cormorants bred on Lilla Karlsö, to breeding on cliff ledges with low roof heights (G-test on merged data, $G_{adj} = 58.0$, $df = 1$, $P < 0.01$; Figure 2). This pattern of change is as evident when analysing the two years after the colonization event separately (1997: $G_{adj} = 44.5$, $df = 1$, $P < 0.01$; and 2001: $G_{adj} = 41.4$, $df = 1$, $P < 0.01$).

DISCUSSION

Our results imply that the Common Guillemot has switched from nesting on cliff ledges with high roof heights to nesting on cliff ledges with lower roof heights after Great Cormorants started to breed on the island. Common Guillemots and Great Cormorants have overlapping niches on the island of Lilla Karslö and the observed pattern of change in the Common Guillemot's realized nest site choice implies that interspecific competition over nest sites occurs between the two species. Thus, Common Guillemots have probably altered their realized niche in order to coexist with the colonizing Great Cormorant, in accordance with the competitive exclusion principle, where species may coexist if they differentiate their realized niche(s).

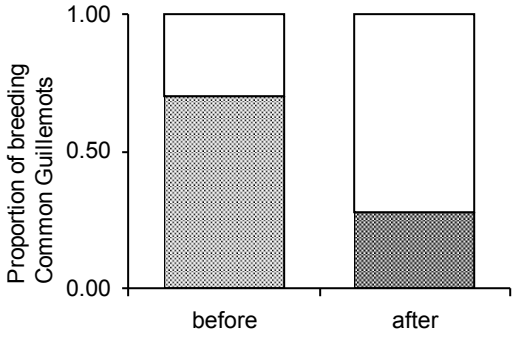

*Figure 2. The proportion of Common Guillemot breeding on cliff ledges with either high (filled area) or low (open area) roof heights before and after colonization by Great Cormorants (*G-*test on merged data,* G_{adj} *= 58.0,* df *= 1,* P *< 0.01).*

*Figuur 2.Het aandeel Zeekoeten dat broedt op klifrichels met een hoog (gearceerd) of laag'dak' voor en na kolonisatie door Aalscholvers (*G-*test op samengevoegde data,* G_{adj} *= 58.0,* df *= 1,* P *< 0.01).*

The large Common Guillemot population decline between 1992 and 1993 could have been caused by, for example, food shortage or intra- or interspecific competition. However, Common Guillemot food resources such as clupeids (herring *Clupea harengus* and sprat *Sprattus sprattus*) increased during this period (Casini 2003). Furthermore, Razorbills *Alca torda* breeding in different sites on Lilla Karlsö, using the same food resources as Common Guillemots, did not decline during this period (Hjernquist 2004), and neither did the Common Guillemot population breeding on the sister island Stor Karslö (S. Hedgren pers. comm.). The temporary decline in the Common Guillemot population coincided with the colonization of Great Cormorants and could possibly be a result of interspecific competition over breeding sites. A recent study of intraspecific nest site competition among Common Guillemots on the Isle of May, Scotland, showed that Common Guillemots exhibited strong nest site fidelity, and if an individual is evicted from its previous nest site it can spend several years as a non-breeder (Kokko *et al.* 2004). However, there was a slight decrease in the Common Guillemots population size before the colonization and it is therefore possible that the decrease was not a response to Great Cormorant colonization. So Great Cormorants might not have evicted Common Guillemots from ledges with high roof heights. Instead, when the Common Guillemot population increased (1995-97) the only available ledges were of low roof heights as Great Cormorants occupied most ledges with high roof heights.

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Thanks to Chris Wiley, Jim Reid, Mats Björklund and two anonymous reviewers for comments. Thor and Jan Veen translated the Samenvatting and figures into Dutch, which is highly appreciated. The authors and the Swedish Society for Nature Conservation (SSNC) funded this research as a part of their nature monitoring of the island of Lilla Karlsö.

NICHE DIFFERENTIATIE VAN ZEEKOETEN *URIA AALGE* ALS AANPASSING AAN KOLONISATIE DOOR AALSCHOLVERS *PHALACROCORAX CARBO*

Kolonisatie door een nieuwe soort resulteert in veel gevallen in competitie om beschikbare bronnen tussen de koloniserende en reeds aanwezige soorten. Competitie tussen soorten wordt gezien als een factor die uitstervingssnelheid, populatiedynamiek, samenstelling van de (broedvogel)gemeenschap, niche differentiatie en evolutie beïnvloedt. We vonden dat competitie tussen Aalscholver Phalacrocorax carbo *en de Zeekoet* Uria aalge *in een zeeklifkolonie om broedplaatsen resulteert in niche differentiatie en coëxistentie. In Zweden is het aantal Aalscholvers de laatste twee decennia op een natuurlijke wijze toegenomen en heeft het verspreidingsgebied zich uitgebreid. We laten zien, dat Zeekoeten voor de expansie van de Aalscholver met name op klifrichels met een hoog 'dak' broedden, en dat hun broedplaatsen zich hebben verplaatst naar richels met een lager 'dak'. De kolonisatie van de Aalscholver valt samen met een tijdelijke afname van het aantal Zeekoeten op de studielocatie. Deze tijdelijke afname zou veroorzaakt kunnen zijn door toegenomen competitie om broedplaatsen in combinatie met en sterke neiging van Zeekoeten om jaarlijks terug te keren naar dezelfde broedplaats.*

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COMMON TERN STERNA HIRUNDO *MATING WITH TWO FEMALES SUCCESSIVELY IN ONE SEASON*

Re-pairing – taking a new mate after failure of the first breeding attempt – within the breeding season is unusual for seabirds (Schreiber & Burger 2002). In the monogamous Common Tern *Sterna hirundo,* mate change may happen between, but not within the season (González-Solís 1999a). For a long-term study on the population ecology of Common Terns, since 1992, all fledged chicks in the Banter See colony in Wilhelmshaven (North-West Germany) have been fitted with transponders (TROVAN ID100, 11 x 2 mm), allowing remote identification of individuals. The transponders are subcutaneously implanted, require no battery and have an unlimited life. Since 1993, all breeders in the colony were checked by placing portable antennas at the nests to identify the marked breeders (see Fig. 1). Around the colony, there is a registration system consisting of 44 resting platforms equipped with antennas to record marked terns whenever they use them (for more details see Wendeln & Becker 1997; Becker *et al.* 2001; Ludwigs & Becker 2005), allowing to gather information on individual arrival.

In 2001, the male "Birk" (transponder ID 0015FE81, ring number 7729576, fledged in 1996) bred with the female "Ronja" (ID 0134EB35, ring 7745054, fledged 1997), just as in the previous year. "Ronja" arrived at the colony on 4th May, and "Birk" on 8th May, and terns were observed on nest number 529 during day and night. The first egg was laid on 20th May. After the clutch was completed (3 eggs), the female was observed incubating for the last time on 30th May, and disappeared during the beginning of June (she probably died). "Birk" incubated the clutch for a few days, but then deserted it. Later in the season, "Birk" was observed incubating a new clutch of nest no. 917 with a new partner (the female "Hanni", ID 01D207AF, ring 7728684, fledged in 1998).

"Hanni" bred for the first time in 2001, arriving at the colony on 6th June in that year. The first egg of her clutch with Birk was laid on 22nd June. Birk and Hanni incubated the clutch, fed the young and one daughter fledged (ID 0604A654, ring 7793500), despite having laid very late in the season. Both terns were recorded at the colony until late August, and returned the following year to breed together again.

This is probably the first documented case of a male which was paired with two females successively within one season in the Laridae. Nisbet et al.

Figure 1. Antenna (black frame) placed around a clutch of a pair of Common Terns within the "Banter See" colony to detect and identify pair mates (the transponder is placed in the breast area of the bird; the part of the body, which is closest to the antenna).

Figuur 1. Antenne (zwart frame) rond een legsel van een paar Visdiefjes in de kolonie "Banter See" om de aanwezigheid en de identiteit van paargenoten vast te stellen (de transponder bevindt zich in de borst, waar het lichaam het nauwst in contact staat met de antenne).

(1978) reported two cases where the females died leaving chicks 7-11 days old and the male successfully reared one young. Males are usually contributing the majority of food to the chicks (Becker & Ludwigs 2004). So, fathers can raise chicks to fledging if the mate dies during the rearing period and the chicks are more than one week old.

It is well known that arriving late at the colony often results in divorce and subsequent loss of breeding status in Common Terns (González-Solis *et al.* 1999b). It is therefore remarkable that the male was able to re-pair so late in the season after an unsuccessful first breeding attempt.

The long-term study of Common Terns in the Banter See is supported by the Deutsche Forschungsgemeinschaft (BE 916/5).

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News and notices

BOOK REVIEWS

BIRDLIFE INTERNATIONAL 2004. *Tracking ocean wanderers: the global distribution of albatrosses and petrels. Results from the Global* Procellariiform *Tracking Workshop, 1-5 September, 2003, Gordon's Bay, South Africa.* BirdLife International, Cambridge, UK. ISBN 0-946888-55-8, softback 100 pp.

Humans are the main threat albatrosses and petrels face at sea; thousands of albatrosses are caught each year as incidental bycatch, particularly in long-line fisheries. With 19 of 21 albatross species globally threatened and the remainder near threatened, albatrosses are recognised as the bird family most threatened with extinction.

In this context in September 2003, all custodians of remote-tracking data of albatrosses and petrels, collected using satellite (PTT) and geolocation (GLS) devices, were invited to a Global *Procellariiform* Tracking Workshop at Gordon's Bay, South Africa. BirdLife International's report, *Tracking Ocean Wanderers: The global distribution of albatrosses and petrels*, along with its associated database containing 90% of extant albatross and petrel tracking data, is the culmination of the workshop.

Drawing on data from 16 species of albatross and three species of petrel, this report presents the first coherent summary of albatross and petrel distributions, generated using kernel density estimator analyses. The authors hope that these data, and other future remote tracking data, will be used in conjunction with at-sea survey data to develop criteria for the selection of Important Bird Areas (IBAs) in the marine environment. Additionally, they could be used in conjunction with other marine taxa and resource use data for the definition of Marine Protected Areas (MPAs). With increased exploitation of the sea's resources, protection of all marine bird species has never been more important. Against a background of such catastrophic mortality of albatrosses and petrels through bycatch, this report provides a crucial information source to aid in the conservation of these species.

Throughout the document, the authors have highlighted caveats and limitations of use of these data, allowing informed interpretation of the results by the reader. The two chapters on the distribution of each species and the regional summaries are an excellent reference for conservationists, marine biologists and marine resource managers alike. The discussion and conclusion develop these essentially data-filled chapters by investigating fisheries interactions and priorities for conservation.

For species that travel such vast distances across the world's oceans, the importance of understanding the spatial overlap between albatross and petrel distributions and fishing effort cannot be understated. One of the most useful and applied aspects of this report is the identification of marine areas that have significant risk of incidental bycatch of albatrosses and petrels. The report identifies and prioritises the 13 Regional Fishery Management Organisations (RFMOs) responsible for these significant risk areas; for example, the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) is the highest priority RFMO. The CCSBT coincides with the ranges of 14 of the 16 albatross species covered in the report, including 70% of the total distribution of breeding albatrosses.

Conservation measures undertaken by RFMOs are listed, and make for worrying, and short, reading; of the five highest priority RFMOs listed, only one, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and the lowest priority of the five, has undertaken comprehensive measures to reduce albatross mortality. CCSBT, the highest priority RFMO, only requires its vessels to use streamers lines. Worryingly, the authors state that fish prices and quotas have led to the expansion of Illegal Unregulated or Unreported (IUU) longline fishing; so, despite any efforts made by RFMOs, illegal fishing is taking place with no mitigation measures employed to conserve birds, exacerbating an already dire problem.

The report also presents a list of those countries whose Exclusive Economic Zones (EEZs), which extend from the coastline to 200 nautical miles offshore, are used most by albatrosses and petrels. New Zealand is the most important because of its high number of endemic albatrosses, with seven species spending 29% of their time during the breeding season within its EEZ. The next four countries, in order of decreasing importance, are France, Australia, the UK (through its Overseas and Dependent Territories, and the USA. Although the RFMOs may perform some regulation in the high seas, the authors state that it is within these territorial waters and EEZs that enforcement of conservation measures is most practical. The main international instrument aimed at global conservation of threatened procelariids is the Agreement on the Conservation of Albatrosses and Petrels (ACAP; http://www.acap.aq/index.php/acap), - "a multilateral agreement which seeks to conserve albatrosses and petrels by co-ordinating international activity to mitigate known threats to albatross and petrel populations". New Zealand, Australia and the UK have ratified ACAP, France is a signatory, and the USA has drafted a National Plan of Action.

The ideological content of this report is excellent and the supporting information is good, but there is a lack of detail in some areas. Data processing is dealt with logically but briefly, with the reader occasionally needing time for reflection to fully understand the processes. Methods are again only briefly

described, with limited description of analytical procedures. This section may have benefited from the inclusion of comprehensive descriptions of the analytical tools used, and also justifications for using them and their associated software applications.

Some of distribution maps contain arrays of colour that are difficult to differentiate, but with so much information to pack into a concise report, this is not surprising. Overall, John Croxall (British Antarctic Survey) and Frances Taylor (BirdLife Seabird Programme) assisted by Janet Silk (BAS), who respectively edited and compiled this report, have ensured that the utilisation distribution maps present the results of complex analyses clearly, and that the text is coherent and flows well. With 28 workshop participants, this is no mean feat!

Although a global effort is required to successfully conserve these wide-ranging species, which may seem eminently aspirational in our present political climate, effective conservation may start at a country level. To date, 11 countries are signatories to ACAP, seven of them having ratified the Agreement (Peru being the latest to do so in May 2005). With the production of this report, and its associated database, showing the at-sea global distributions of 16 species of albatross and three species of petrel, hopefully more countries will become proactive in conserving these charismatic and critically threatened species.

Claire A. McSorley

DAVIS, L.S., & RENNER, M. 2003. *Penguins*. T. & A.D. Poyser, London. ISBN 0-7136-6550-5, 212 pp including 8 colour plates, b/w photos, line illustrations. £35.00.

The contents of this book are so well summarised in the Preface that this is worth quoting in full: 'This work does not pretend to be a complete summary of everything that is known about penguins. Rather it attempts to derive an understanding of the diversity of penguins by examining the most influential factors that affect their lives. In essence, the book has evolved from a thesis put forward by John Croxall and Lloyd Davis as part of a keynote address to the Third International Conference on penguins held in Cape Town in 1996 and subsequently published in Marine Ornithology. That thesis suggested that patterns and apparent paradoxes in penguin biology could be best explained by recognizing the importance of foraging distance on their lifestyles. Penguins must balance living in two worlds – water for feeding, land for breeding – and much of what they do is dictated by how far they must go when at sea; whether

they are inshore foragers or offshore foragers.' This focus immediately explains the seemingly idiosyncratic choice of contents of the book; for instance, there are 20 pages on Taxonomy, 20 pages on Parental Investment and 22 pages on Mate Selection and Courtship but virtually nothing on populations, demography and only one page on the effects of climate change. However, this somewhat novel approach works well, the authors put forward some interesting ideas, and I found myself thinking about some aspects of my own life in a new light.

This relatively short book is well-written and very easy to read. My only criticisms are that it is slightly patronising in places, given the generally well-informed readers of Poyser books, and perhaps a little hard on the interpretations of results made by previous workers. The production is generally good, except for the poor reproduction of the black-and-white photographs in the text. The authors have been ill-served by the writer of the jacket notes – there are no Emperor Penguins at the South Pole and although Little Penguins are indeed smaller than other penguins they can by no stretch of the imagination be described as 'dainty'. A subtitle to the book would have been useful to indicate its focus, but maybe the publishers thought that this would have restricted sales.

I found this book a good, easy and stimulating read. Anyone interested in seabirds will gain substantially by reading this volume and I anticipate seeing it in the bookcases of many marine ornithologists and birdwatchers.

Michael P. Harris