SNACKS FROM THE DEPTH: SUMMER AND WINTER DIET OF COMMON GUILLEMOTS *URIA AALGE* AROUND THE ISLAND OF HELGOLAND

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Sonntag, N. & O. Hüppop Snacks from the depth: summer and winter diet of Common Guillemots *Uria aalge* around the Island of Helgoland. Atlantic Seabirds 7(1): 1-14. *Stomach contents from 53 Common Guillemots* Uria aalge *beached at the Island of Helgoland in the southeastern North Sea were examined for prey remains. In winter 2000/2001, the prey spectrum was quite diverse. Remains of species belonging to ten different families of teleost fishes were found, with pipefishes, gobies, sandeels and clupeids being the most abundant prey. Invertebrates contributed only 1% of all prey items. The diversity was considerably smaller in winter 2001/2002, when clupeids and sandeels had the highest numerical abundance and only three other families were found. The number of sandeels and clupeids in the stomachs might be connected with water temperature. When these fish families were present in the stomachs, the water temperature on the day before collecting the dead Guillemots was significantly higher than when these fish were absent in both winter periods. The few samples collected in summer contained mainly sandeels and clupeids, fish species which are also brought to the colony for display and to feed the chicks. However, the fishes found in the stomachs of the adult birds were smaller than fishes carried to the breeding ledges. Additionally, a dragonet and a cephalopod were found in the stomachs, prey that have never been observed in the colony. This confirms our assumption that observations of the fishes brought to the colony are not representative for the diet of adults. Adult Guillemots deliver relatively large fishes of high caloric density to the chicks. During self-feeding, they are much more opportunistic and also consume smaller and leaner prey. This is in accordance with Central Place Foraging Theory. Difficulties in the methods employed and the effect of oiling on diet composition are also discussed in this study. While oiling seemed to have no influence on the total number of prey items found in the stomachs of the dead Guillemots, we found sandeels and gobies more frequently in oiled and pipefishes more often in unoiled birds.*

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INTRODUCTION

Common Guillemots *Uria aalge* have been breeding at Helgoland in the southeastern North Sea (54°11′ N, 7°53′ E) since at least the beginning of the 19th century (Gätke 1900). After a 20-year-increase (Hüppop 1997), the colony is today more or less stable with some 2000 to 2500 breeding pairs (Dierschke et al. 2003). The colony is situated at a considerable distance from other North Sea Guillemot colonies and the prey base may thus be different. There is limited information on prey delivered to chicks or used for display in the breeding season. Leopold *et al.* (1992) and Grunsky-Schöneberg (1998) observed that only sandeels and clupeids, fishes of high energetic value, were brought to the breeding ledges at Helgoland. Similar to the situation around most Guillemot colonies, there is no published account on Guillemot diet around Helgoland in winter. Guillemots are present around the island throughout the year, apart from August (Stone et al. 1995, own observations, German Seabirds at Sea Database, Vers. 3.0), but there is no *a priory* reason to believe that the prey delivered to the chicks represents the diet of the birds during self-feeding, either in the breeding season or at other times of year. According to Central Place Foraging Theory, we assume that a forager increases its fitness by maximizing the rate of delivery of energy e.g. to the breeding place (Orians & Pearson 1979). In a single-prey loader such as the Guillemot, this can be achieved by maximizing the size of the prey brought by the parent to the colony. But why should adult Guillemots not use other, less valuable prey for themselves, especially if it is abundantly available? If fishes need not to be carried off to the breeding ledge, the birds can profitably ingest fish of smaller size or lower caloric density.

Guillemots catch and swallow their prey under water, making direct observations impossible. Examination of stomach contents is an alternative method to study the diet of seabirds (Duffy & Jackson 1986). But, due to ethical reasons, birds should not be killed, which makes obtaining sufficiently large sample sizes difficult. There are various methods to take samples from living birds (for reviews see Duffy & Jackson 1986 and Camphuysen 1990a). However, on Helgoland Guillemots breed on brittle sandstone cliffs where it is neither possible to catch living birds nor to collect faeces. Furthermore, this species does not produce pellets. Therefore, we used beached birds for this study, and dissected their stomachs. This paper presents data on the winter and summer diet of adult Guillemots and discusses the limitations of diet studies using beached birds and the effect of oiling on diet composition.

METHODS

From November 2000 to June 2002 53 carcasses of beached Guillemots were collected at Helgoland. In the 'winter' months (October to March) 49 birds were found, 40 in winter 2000/2001, nine in winter 2001/2002. Four Guillemots were collected in the 'summer' months (April to September), one in summer 2001 and three in summer 2002. 25 of the collected Guillemots were oiled, one bird was caught in fishing gear, one was killed when found with a broken wing, 26 birds died from unknown reasons. The winter sample contained immature and adult birds, the summer sample only adult Guillemots. Birds were aged by feather characteristics (moult of the greater upperwing coverts, white tips on the greater underwing coverts) and the *bursa Fabricii* (presence/absence, size) according to Camphuysen (1995a).

The birds were opened, and their proventriculus and gizzard removed and kept frozen until examination. Fishes were identified from their sagittal otoliths and vertebrae. In addition, the pro-otic bullae of clupeids, the atlas vertebrae of sandeels and the bony plates of pipefishes helped to identify the family. For the identification of otoliths, Härkönen (1986) and Leopold *et al.* (2001) were used. Vertebrae were identified according to Watt *et al.* (1997). The station's reference collection was additionally used for identification. Invertebrates were identified by jaws (polychaetes), claws (crustaceans), horny bills (cephalopods) and shells (molluscs) but not determined to species. Remains of plants were only counted.

For a quantitative interpretation, otoliths and clupeid bullae were counted. Two items of the same size and feature were assumed to represent one fish. The characteristic atlas vertebrae of the family Ammodytidae additionally gave information about the number of sandeels represented in the sample. If only vertebrae of a given fish species were found, it was assumed that the bird had eaten one fish of that species or family. For invertebrates the number of jaws, claws and bills gave reference to the ingested individuals.

From the summer sample, lengths of apparently intact otoliths of sandeels and widths of apparently intact otoliths of clupeids were measured with a digital calliper and corrected for a 5 % wear of the otoliths (see Camphuysen 2001). These measures were used to calculate the fish length according to Härkönen (1986).

Possible effects of oiling on the number and species of food items were investigated in winter 2000/2001, when the beaches were controlled daily and the dead birds did not lie there for more than a day.

RESULTS

Diet composition in the winter 2000/2001 In 40 stomachs, fishes of ten different families comprised 99% of all food items (Table 1). Pipefishes, gobies, clupeids and sandeels were the most common prey. Remains of four hooknoses and three three-spined sticklebacks *Gasterosteus aculectus* occurred in the stomachs. Other species (of the families Carangidae, Gadidae, Pholidae, Pleuronectidae) were found only once. The samples contained five invertebrates (two polychaete worms, a very small gastropod and a very small crab) and ten pieces of plants.

		Winter 2000/2001		**Winter 2001/2002**	
Number of stomachs (with food remains)		40 (37)		9 (8)	
Number of prey items (identified)		374 (355)		47 (44)	
		Frequency of occurrence (%)	Numerical abundance (%)	Frequency of occurrence (%)	Numerical abundance (%)
Fishes					
Agonidae	*Agonus cataphractus* (Hooknose)	4 (10)	4 (1.1)		
Ammodytidae	*Ammodytes* spec. a/o *Hyperoplus spec.* (Sandeel)	14 (35)	44 (11.8)	4 (44.4)	10 (21.3)
Callionymidae	*Callionymus* spec. (Dragonet)			1 (11.1)	1 (2.1)
Carangidae	*Trachurus trachurus* (Horse mackerel)	1(2.5)	1 (0.3)		
Clupeidae	*Clupea harengus* (Herring) / *Sprattus sprattus* (Sprat)	19 (47.5)	27 (7.2)	5 (55.6)	30 (63.8)
Gadidae	*Merlangius merlangus* (Whiting)	1 (2.5)	1 (0.3)		
Gasterosteidae	*Gasterosteus aculeatus* (Three-spined stickleback)	2 (5)	3 (0.8)	1 (11.1)	1 (2.1)
Gobiidae	*Pomatoschistus* spec. (Goby)	12 (30)	124 (33.2)	1 (11.1)	1 (2.1)
Pholidae	*Pholis gunellus* (Gunnel)	1 (2.5)	1 (0.3)		
Pleuronectidae	*Hippoglossoides platessoides* (Long rough dab)	1 (2.5)	1 (0.3)		
Syngnathidae	Pipefishes	19 (47.5)	145 (38.8)		
Unidentified			19 (5.1)		3 (6.4)
Invertebrates					
Polychaeta	Polychaete worms	2 (5)	2 (0.5)		
Crustacea	Crabs	1 (2.5)	1 (0.3)		
Gastropoda	Molluscs	1 (2.5)	1 (0.3)	1 (11.1)	1 (2.1)

Opposite page: Table 1. Stomach contents of Guillemots found in winter. Frequency of occurrence = number of birds in which the respective fish family occurred (in brackets: % of all stomachs). Numerical abundance = total number of items of the respective prey type (in brackets: % of the total number of items).

Tegenoverligende pagina: Tabel 1. Maaginhoud van Zeekoeten die 's winters gevonden zijn. Frequency of occurence = aantal vogels waarin de betreffende visfamilie voorkwam (tussen haakjes % van alle magen). Numerical abundance = totaal aantal items van de betreffende prooi (tussen haakjes % van het totaal aantal items).

Table 2. Stomach contents of Guillemots found in summer. Frequency of occurrence = number of birds in which the respective fish family occurred. Numerical abundance = total number of items of the respective prey type.

Tabel 2. Maaginhoud van Zeekoeten die 's zomers gevonden zijn. Frequency of occurence = aantal vogels waarin de betreffende visfamilie voorkwam. Numerical abundance = totaal aantal items van de betreffende prooi.

Number of stomachs (with food remains)		4 (3)	
Number of prey items (identified)		14 (13)	
		Frequency of occurrence	Numerical abundance
Fishes			
Ammodytidae	*Ammodytes* spec. a/o *Hyperoplus* spec. (Sandeel)	1	6
Clupeidae	*Clupea harengus* (Herring) / *Sprattus sprattus* (Sprat)	2	5
Callionymidae	*Callionymus* spec. (Dragonet)	1	1
Unidentified			1
Invertebrates			
Cephalopoda		1	1

Diet composition in the winter 2001/2002 Remains of five different fish families occurred in the nine stomachs (Table 1). Clupeids and sandeels dominated with a numerical abundance of 64 % and 21 %, respectively. A goby, a three-spined stickleback and a dragonet each were only found once. The samples contained one invertebrate (a tiny gastropod) but no plants.

Diet composition in summer The stomachs contained remains of 13 identifiable prey items, 12 fishes and one cephalopod. Excepting one dragonet *Callionymus* spec., only sandeels and clupeids were found (Table 2). Two stomachs contained plant material. A comparison between the two summer periods was not made because of the small sample size.

Table 3. Fish lengths of sandeels and clupeids in summer. Calculations according to Härkönen (1986).
Tabel 3. Lengte van zandspiering en clupeiden in de zomer. Berekend volgens Härkönen (1986).

	Otolith length (OL) / otolith width (OW) [mm] (corrected for 5 % wear)	Estimated total fish length (TL) [mm]
Sandeel	1.67	96
TL = 8.776 + 51.906 * OL	2.14	120
	1.23	72
	1.90	107
	1.50	86
	0.98	60
Herring	0.91	80
TL = -87.49 + 184.39 * OW	0.99	95
	0.84	67
Sprat	1.05	119
TL = -25.28 + 137.24 * OW		

Fish length in summer Total length (TL) of sandeels ranged from 60 to 120 mm, with a mean of 90 mm. Clupeids averaged 90 mm with minimal and maximal lengths of 67 and 119 mm, respectively (Table 3).

The effect of oiling on diet composition There was no significant difference in the total number of prey found in oiled and unoiled birds from winter 2000/2001 ($G = 3.38$, $P > 0.05$). However, there were some differences between the four main prey families: While clupeids were equally distributed over the stomachs of both categories ($G = 2.41$; $P > 0.10$), sandeels and gobies occurred more frequently in oiled birds ($G = 16.45$ for sandeels, $G = 46.59$ for gobies; $P < 0.001$, respectively). In contrast, there was a higher number of pipefishes in unoiled birds ($G = 117.43$; $P < 0.001$).

DISCUSSION

Limitations on the interpretation of data Studies of stomach contents by dissection of the alimentary tract, especially of birds found dead, are seriously biased towards greater or harder items like otoliths, squid beaks or jaws of polychaete worms (for a review see Duffy & Jackson 1986 and Camphuysen 1990a). Differential digestion and breakdown rates of otoliths from different fish species should be considered (Duffy & Jackson 1986), but adequate data are too scarce (e.g. Cherubini & Mantovani 1997, Leopold & Winter 1997). However, the dominance of rather small otoliths (sandeel, clupeids, gobies) and very small otoliths of pipefishes in this study indicates that this bias was small and the results are likely to be reliable.

Nevertheless, any diet study on dead birds must be considered with caution. Oiled or ill birds might be restricted in, or prevented from feeding and they might take species that are not their preferred prey but are more easy to catch. Blake (1983) found at Hvaler (Norway) that heavily oiled Guillemots took fewer gobies than less oiled birds. By contrast, gadids occurred more frequently in heavily than in lightly oiled birds. In samples from Sweden, however, these differences were not observed. In the present study sandeels and gobies occurred more frequently in oiled birds, but they are a common prey of Guillemots in winter in some areas (Cramp 1985; Blake 1983; Blake 1984) and the high occurrence probably reflects a preference for these fishes rather than a real effect of oiling. Nothing could be said about the high number of pipefishes in unoiled birds and if oiled birds are less capable to capture them. Pipefishes are a very uncommon prey species of Guillemots that has never been published in other diet studies and thus no comparisons are possible. Hence we assume both our samples from oiled and unoiled birds to be representative.

Food spectrum At Helgoland sandeels (Ammodytidae) and clupeids (Clupeidae) are the only fish families known to be brought to the ledges in the breeding season, for display and to feed the chicks (Leopold *et al.* 1992; Grunsky 1994; Grunsky-Schöneberg 1998). The proportions of the two families vary greatly between and even within years. In June 1990 Leopold *et al.* (1992) found 94.6 % clupeids and 5.4 % sandeels brought to the ledges for display and chicks. Between 1991 and 1994 the proportion of sandeels fed to young varied between 21.8 and 68.6 %, and that of clupeids between 78.1 and 31.4 %. During the incubation period sandeels accounted for 32 to 91 %, clupeids for 9 to 68 % of all fishes used for display (1991-1993 only), during chick rearing these proportions were 21 to 73 % and 27 to 79 %, respectively (Grunsky-Schöneberg 1998). Studies in other colonies provide similar results. E. g. on the Isle of May

(Scotland) the chicks are fed with sandeels and clupeids and to a much lesser extent with saithe *Pollachius virens*, mackerel *Scomber scombrus* and gurnards (Triglidae). 99.6 % of display fishes are sandeels and clupeids (Harris & Wanless 1985). Chicks on Skomer Island and Skokholm (Wales) normally get sprats, but sometimes sandeels dominate their diet (Glutz von Blotzheim & Bauer 1982).

Stomach examinations of **adult** Guillemots in summer are scarce. For birds from the Faeroes and the Shetlands sandeels and clupeids are also an important prey for adult birds during the breeding season (Bradstreet & Brown 1985). Adult Guillemots off north and east Scotland mainly eat sandeels in summer (Blake *et al*. 1985). Sandeels (mostly *Ammodytes marinus*), clupeids (*Clupea harengus*, *Sprattus sprattus*) and gadids (*Merlangus merlangius*, *Trisopterus minutus*, *T. esmarkii*, *Gadus morhua*) dominate in the summer diet of adults off western Scotland, with geographical variations between different samples within the study area (Halley *et al*. 1995). The four summer samples collected at Helgoland contained mainly sandeels and clupeids, too. But we also found a dragonet and a cephalopod, prey species that have never been seen taken to the colony. Additionally, the sandeels and clupeids found in the stomachs on average only measured 90 mm and hence were considerably smaller than the prey carried to the breeding ledges. Sandeels taken to the Helgoland colony ranged from 130 to 200 mm and clupeids from 90 to 150 mm with the bulk being 100 to 140 mm (Leopold *et al*. 1992; Grunsky-Schöneberg 1998), similar to those at the Isle of May, where the majority of sandeels and sprats ranged from 130 to 160 and from 120 to 130 mm, respectively (Harris & Wanless 1985). Camphuysen (2001) examined the stomach content of a single adult breeding Guillemot trapped in a pelagic trawl off the Scottish east coast in summer 2001. He found remains of small sandeels *Ammodytes marinus* with a total length of 55-75 mm and remains of Herring and Norway Pout *Trisopterus esmarckii* of similar size. Only one Herring was larger (TL about 110 mm). During the survey where the dead bird was found, Camphuysen observed auks driving balls of sandeels towards the sea surface that also had a TL of 55 to 75 mm, while flying birds carried fishes apparently longer than 100 mm. However, Guillemots also take larger fishes for self-feeding if they are available. Halley *et al*. (1995) found in birds sampled off western Scotland in April and June sandeels with a range from 64 to 228 mm. Fish lengths of sandeels found as predominant prey of Guillemots sampled in April and May in The Netherlands ranged from 60 to 200 mm with the bulk being 140-160 mm (Camphuysen 1990b). These results confirm our assumptions that Guillemots are opportunistic feeders and that the food consumed by adult Guillemots at sea may differ from that provided to the chicks and used for display. Mehlum (2001) observed a difference between the diet of adult Common and Brünnich`s Guillemots *Uria*

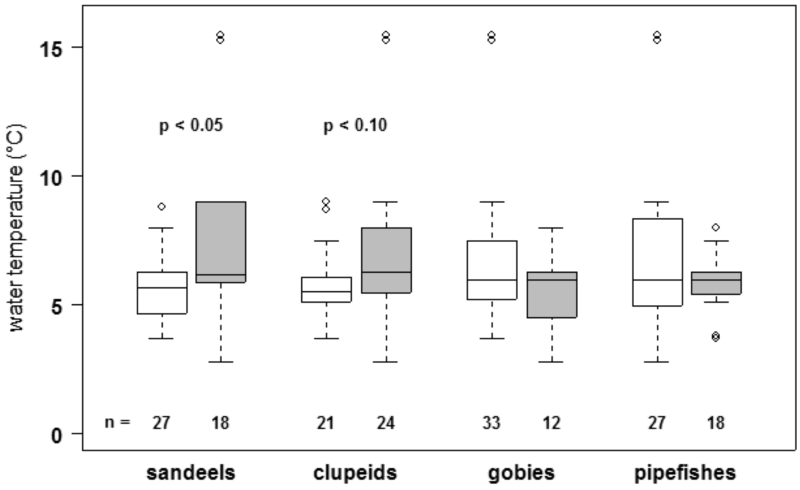

Figure. 1. Water temperatures on the day before sampling of Guillemots containing (grey) and lacking (white) the respective prey groups. (p according to Mann-Whitney-U Test; n = number of birds). Data from both winter periods combined.

Figuur 1. Watertemperatuur op de dag voordat Zeekoeten verzameld werden, met (grijs) en zonder (wit) de respectievelijke prooidiergroepen. (p volgens Mann-Whitney-U Test; n = aantal vogels). Gegevens van beide wnters zijn samengevoegd.

lomvia and chicks in the Barents Sea. While the chicks were fed with fishes the predominant prey of adults were euphausiids. Differences in the diet between adults and chicks are not only found in Guillemots, that can carry only a single fish at high energetic flight costs, but also e.g. in gulls (Ehlert 1971, Spaans 1971, Vermeer 1982, Nogales *et al.* 1995, Dierschke & Hüppop 2003), terns (Glutz von Blotzheim & Bauer 1982) and skuas (Furness 1987), all being much more efficient flyers.

The analysis of the 49 stomachs of both adult and immature birds, found in winter confirmed that the main food of Guillemots around Helgoland is fish. Invertebrates occurred only in very small quantities. With the exception of the Nereid worms they measured only a few millimetres and thus probably originated from the stomachs of prey fish. Blake (1983) found invertebrates, mainly polychaete worms, in only one percent of 425 dissected stomachs of Guillemots from Hvaler (Norway), in none of 153 stomachs from birds found in Bohüslan (Sweden) and in 11 % of 106 stomachs from birds of Aust-Adger (Norway). In the Pacific, however, squid, euphausiids and amphipods comprise a more important part of the Guillemot diet (Gaston & Jones 1998). In the Barents Sea, crustaceans may be an important prey in years when schooling fishes are not abundant (Mehlum 2001).

In winter 2000/2001 a relatively large number of different fish species were taken as prey. Beside sandeels and clupeids, many gobies and pipefishes and some hooknoses and three-spined sticklebacks were identified and in addition singletons of several other fish species. Gobies have been found to become more important in winter in other areas as well: While on Fair Isle (Scotland) only few gobies are taken in summer they play, beside sprat and gadids, an important part in the winter diet (Cramp 1985). Gobies dominated, together with gadids and clupeids, the diet of Guillemots killed during an oil incident in the Skagerrak in January 1981 (Blake 1983) and were also present in birds off north and east Scotland (Blake *et al.* 1985). However, Durinck *et al.* (1991) found only few gobies in the stomachs of Guillemots drowned in the Skagerrak in winter 1988. In that study clupeids were the most important species, followed by gadids. Clupeids, sandeels and gadids were the most common prey species of Guillemots collected during the mass death of auks on the North Sea coasts of England and Scotland in February 1983 (Blake 1984). The diet of birds washed ashore in The Netherlands in November 1990 (Camphuysen and Keijl 1994), in December 1991 (Camphuysen 1995b) and in February 1992 (Leopold & Camphuysen 1992) comprised mainly clupeids, sandeels and gadids with small quantities of other fish species, for example gobies and dragonets. Sprats and few sandeels and gadids were found in stomachs of Guillemots drowned in the Baltic Sea (Lyngs & Durinck 1998). Sticklebacks in the winter diet of Guillemots were recorded from the Danish coast of the Baltic Sea (Glutz von Blotzheim & Bauer 1982) and from birds stranded on the Dutch coast (Leopold, pers. comm.; Camphuysen and Keijl 1994). Although we found a large amount of pipefishes in our samples from Helgoland, there are no published reports on pipefishes in other studies on Guillemot diet. However, they were found as prey of e.g. Common Gulls *Larus canus* (Reijnders & Keijl 1997) and Kittiwakes *Rissa tridactyla* (Vauk & Jokele 1975).

Beside animal remains some components of plants were found in the stomachs but they are not considered to be a part of the Guillemot diet. They might be taken together with prey fishes captured in the seaweed zone, like pipefishes and gobies. At least one of these species was found in 8 out of 10 stomachs that contained plant material. Similarly, in only 2 % of the stomachs of Guillemots from the Murmansk coast plant material was found (Bradstreet & Brown 1985), and Glutz von Blotzheim & Bauer (1982) mention only vestiges of plants in the stomachs of birds from Shetland.

The diversity of fishes was much smaller in winter 2001/2002. Beside the dominating sandeels and clupeids only three other species were found. Although the sample size was much smaller in that year, this might reflect interannual differences in the availability of sandeels and clupeids and the high flexibility of adult Guillemots in reacting to changes in the availability of different prey species (Croll 1990). The abundance of sandeels and clupeids might be related to the water temperature: when sandeels and clupeids occurred in the stomachs water temperatures on the day before collecting the dead Guillemots were significantly higher than in absence of these prey families (U-Test: $P < 0.05$ for sandeels, $P < 0.1$ for clupeids; Figure 1). The mean and minimal water temperatures in winter 2001/2002 were 0.6 and 1.5 °C, respectively, higher than in the winter 2000/2001. (Source: Germany's National Meteorological Service „Deutscher Wetterdienst (DWD)", Station Helgoland). Additionally, most clupeids from the second winter were found in stomachs collected in October and only few samples originate from periods with low water temperatures, which might explain the high abundance of this species. For gobies and pipefishes no relationship was found between their presence in the stomachs and water temperature (U-Test: $P < 0.6$ for gobies, $P > 0.9$ for pipefishes). The stomach examinations carried out by Halley *et al.* (1995) also showed a seasonal variation in the prey spectrum. Sandeels dominated in April and June but were absent in August and November, when prey consisted mainly of various clupeids and gadids. No data are available on the seasonal occurrence of prey fishes around Helgoland and more studies are necessary to examine the effect of season and/or water temperature on the availability of different fish species.

Conclusions The diet of Guillemots around Helgoland is dominated by fish throughout the year. In winter, adult and immature Guillemots use a variable prey spectrum with a high proportion of sandeels, clupeids, pipefishes and gobies, probably depending on the availability of the different species. In summer the prey spectrum is smaller and there appears to be a difference between prey for self-feeding of adult Guillemots and prey provided to mates and offspring. This is consistent with Central Place Foraging Theory which predicts that parents should maximize the delivery rate to the colony, particularly if the distance between feeding ground and colony is large and costs for transport are high (Orians & Pearson 1979). Guillemots are poor flyers that can carry only a single fish at a time. Therefore it is more efficient to deliver only prey items of high energetic value to the colony. Additionally, foraging

Guillemots are exposed to kleptoparasitism from Kittiwakes and larger *Larus* gulls in summer (own observations by O. Hüppop) and should therefore carry only fishes to the colony if their size and calorific value are "worth the risk". For self-feeding, also smaller or lower quality fishes, unacceptable for transport to the colony, are sufficient for the more opportunistic adult Guillemots.

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SNACKS UIT DE DIEPTE: ZOMER- EN WINTERDIEET VAN ZEEKOETEN *URIA AALGE* ROND HELGOLAND

Maaginhouden van 53 aangespoelde Zeekoeten op het eiland Helgoland in de zuidoostelijke Noordzee werden onderzocht op prooiresten. In de winter 2000/2001 was het voedselspectrum divers. Er werden resten gevonden van soorten behorend tot tien verschillende families van beenvissen, met zeenaalden, grondels, zandspieringen en haringachtigen als meest voorkomende prooien. Ongewervelden droegen slechts 1% bij aan alle prooien. De diversiteit was in de winter van 2001/2002 aanzienlijk lager, waarbij haringachtigen en zandspiering kwantitatief de hoogste abundantie hadden, en er slechts drie andere families werden gevonden (tabel 1). De aantallen zandspiering en haringachtigen zijn mogelijk gerelateerd aan de watertemperatuur. Indien deze visfamilies aanwezig waren in de magen, was de watertemperatuur de dag voordat de dode Zeekoeten verzameld waren hoger dan wanneer deze soorten afwezig waren (fig 1). Het geringe aantal monsters dat in de zomer werd verzameld bevatte met name zandspiering en haringachtigen (tabel 2), soorten die ook naar de kolonie worden gebracht voor de balts en voor het voeden van de kuikens. De vissen die in de magen van adulte vogels werden gevonden, waren echter kleiner dan de vissen die naar de broedrichels werden gebracht. Bovendien werden een pitvis en een inktvisachtige in de magen gevonden; prooien die nooit in de kolonie vastgesteld zijn. Dit bevestigt ons vermoeden dat waarnemingen van soorten die naar de kolonie worden gebracht, niet representatief zijn voor het dieet van volwassen vogels. Deze voeden de kuikens met relatief grote vissen met een hoge voedingswaarde. Als ze zelf foerageren, zijn ze opportunistischer en consumeren ze kleinere en magerder prooien. Dit is in overeenstemming met de voedseltheorie.

Tekortkomingen van de gebruikte methoden en het effect van oliebesmeuring worden bediscussieerd. Terwijl olie geen invloed op het totaal aantal prooien in de maag van dode Zeekoeten lijkt te hebben, vonden we in de magen van olievogels vaker zandspieringen en grondels, en vaker zeenaalden in de magen van niet met olie besmeurde vogels.

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FACTORS AFFECTING BREEDING DISTRIBUTION AND SEABIRD RICHNESS WITHIN THE AZORES ARCHIPELAGO

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De León, A., Mínguez, E. & Neves, V.R. 2005. Factors affecting breeding distribution and seabird richness within the Azores archipelago. Atlantic Seabirds 7(1): 15-22. *Seabird populations in the Azores archipelago are currently much smaller and more restricted in distribution than in the past. Important factors in this decline include predation by alien mammals, human exploitation, and habitat loss. We investigated the extent to which the presence of human and introduced predators, and some geographical features of the islands affect distribution and richness of seabirds breeding on this archipelago. Richness of seabird species (five* Procellariiformes, *one gull and two tern species) was higher on the main islands, which possess cliffs. As a result, shearwaters and gulls were more likely to be found on the larger islands that also tended to have rats and cats present. However, Madeiran Storm-petrel* Oceanodroma castro *and Bulwer's Petrel* Bulweria bulwerii *only breed in numbers on a very few rat-free islets. Continued management is needed to avoid human disturbance and alien invasion onto islets with small petrels. We recommend study of the effects of mammals on Little Shearwaters* Puffinus assimilis baroli *and Manx Shearwaters* P. puffinus *in the Azores, as the overlap between the distributions of these two species and rats is surprising.*

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INTRODUCTION

Historical chronicles from the 16th and 17th centuries indicate that the seabird populations of the Azores archipelago suffered remarkable declines following human colonisation of the islands, mainly due to introduction of predators, habitat destruction and direct human exploitation (Monteiro *et al*. 1996). The introduction of predators by itself has been the key factor in the reduction or extinction of more seabird populations in historic times around the world than any other factor (Moors & Atkinson 1984). In the Azores, where a large number of non-native animals have been introduced (Mathias *et al*. 1998), many colonies are now confined to precipitous cliffs and islets, as a result of predation threats by introduced mammals (Monteiro *et al.* 1999). In the case of this archipelago, a factor that may have been crucial in this decline was direct human exploitation of seabirds (Monteiro *et al.* 1996), which still happens occasionally now despite increased legal protection of seabirds.

We investigated the influence of introduced predators, human presence, and geographical features of the islands on the distribution and richness of seabird species breeding on the Azores archipelago.

METHODS

The study included all nine of the main inhabited islands, and 19 of the 26 islets of the Azores archipelago (five in Flores, three in Terceira, three in Santa Maria, three in São Miguel, two in Graciosa, two in Pico and one in São Jorge). The Azores seabird assemblage comprises eight colonial nesting seabird species: five *Procellariiformes*, one gull and two terns. Our analysis included all the breeding seabirds: Madeiran Storm-petrel *Oceanodroma castro,* Bulwer's Petrel *Bulweria bulwerii,* Cory's Shearwater *Calonectris diomedea borealis,* Manx Shearwater *Puffinus puffinus,* Little Shearwater *P. assimilis baroli,* Yellow-legged Gull *Larus* (*cachinnans*) *atlantis,* Roseate Tern *Sterna dougallii*, and Common Tern *S. hirundo.* All these regular breeders, except the Yellow-legged Gull and the Common Tern, are Species of European Conservation Concern with a "Vulnerable" or "Endangered" Conservation Status (Tucker & Heath 1994). Breeding sites were considered as such only if breeding was confirmed. The introduced mammals studied were cats *Felis catus,* rats (Norway Rat *Rattus norvegicus* and Black Rat *R. rattus*), and mustelids (Weasel *Mustela nivalis* and Ferret *M. furo*). Information on the presence or absence of predator and prey species on the islands was extracted from the literature (Mathias *et al.* 1998; Monteiro *et al.* 1996, 1999; Meirinho *et al.* 2003), and interviews with local naturalists, researchers and nature wardens. To complement insufficient information on some islets, fieldwork to record presence or absence of mammals was carried out during August 2003, and consisted of sightings records, collection of excrement, and deployment of "rat sticks". This last technique has been shown to be effective in estimating relative rat abundance (Zonfrillo & Monaghan 1995). It involves the placing along transects of pieces of wood (15 cm x 2 cm), which have been soaked in liquid margarine or butter; the presence of rats is easily detected because they chew the sticks.

For each island, we also recorded the following geographical features that are likely to influence the presence of predator and/or seabird species: number of human inhabitants, the area, maximum altitude (since some seabirds are able to breed at high altitude in Atlantic islands), presence of cliffs, and distance to nearest inhabited island (islands with long distances to the nearest island with human habitation may be less accessible for rats and other alien species associated with humans). All these variables (except the number of inhabitants) were extracted from large scale maps (1:25,000, Instituto Geográfico do Exército, 2002 edition). Number of inhabitants was obtained from the 2001 population census (http://www.ine.pt/). A binary variable named "islet", distinguished between the nine main islands and the 19 offshore islets.

Statistical analysis Relationships between seabirds, geographical features and presence of predators were modelled through generalized linear models (GLM, Crawley, 2002). Programs for model fitting were written in the statistical language S and implemented in R v. 2.0.1. For seabird richness, GLMs were fitted by specifying a Poisson distribution and a logarithmic link function. To explore a simple presence-absence model of each species, GLMs were fitted by specifying binomial distribution and logistic link. Univariate GLMs were first run to assess the importance of each explanatory variable. The main explanatory variable was then selected by an Akaike information criterion (AIC)-based stepwise procedure. This process allowed objective selection between highly correlated explanatory variables.

Table 1. Details of presence of all species on the nine main islands and the 19 islets studied in the Azores archipelago.
Tabel 1. Aanwezigheid van alle soorten op de negen hoofdeilanden en de 19 eilandjes die op de Azoren onderzocht zijn.

	Islands (*n*=9)		Islets (*n*=19)	
	Number	%	Number	%
Cory's Shearwater	9	100	17	89
Manx Shearwater	2	22	0	0
Little Shearwater	8	89	5	26
Madeiran Storm-petrel	1	11	5	26
Bulwer's Petrel	0	0	3	16
Yellow-legged Gull	9	100	8	42
Roseate Tern	7	78	9	47
Common Tern	9	100	12	63
Cat	9	100	1	5
Rat	9	100	4	21
Ferret	5	56	0	0
Weasel	3	33	0	0

*Table 2. Influence of the 10 island descriptors on seabird species composition determined by GLM; NS >0.05, *≤0.05, ** ≤0.01. Trend: '+' positive relationship, ' – ' negative relationship.*

*Tabel 2. Invloed van de tien eilandvariabelen op de soortensamenstelling, volgens GLM; NS >0.05, *≤0.05, ** ≤0.01. Trend: '+' = positief, ' – ' = negatief.*

Variable	% deviance explained	*P*	Trend
Cliffs	28.72	**	+
Islet	22.22	*	-
Distance^2	19.89	*	+ -
Area^2	18.45	*	+ -
Altitude	12.66	*	+
Inhabitants	0.01	NS	+
Inhabitants^2	20.63	NS	+ -
Distance	8.62	NS	+
Altitude^2	17.74	NS	+ -
Area	5.02	NS	+
Cats	12.61	NS	+
Rats	2.10	NS	+
Ferrets	7.13	NS	+
Weasel	1.30	NS	+

RESULTS

Cory's Shearwater was present on all the islands and all but two of the islets, while there were no more than two breeding colonies of Manx Shearwater in the archipelago (Table 1). Madeiran Storm-petrel was present only on six islets, breeding in significant numbers in three small rat-free islets (Vila, Baixo and Praia). Bulwer's Petrel certainly breeds on Vila, and probably also on Baixo and Praia (Table 1). Ferrets and Weasels were found only on some of the nine main islands, but all main islands had cats and rats (Table 1). Rats were especially widespread on main islands, and we also found evidence of the presence of rats in three of the islets (Ilhéus S. Lourenço, da Mina and Vila Franca). Additionally, we observed a cat prospecting at Rosto do Cão islet during low tide, and it is very likely that rats also reach that islet.

Presence of cliffs, type of island (main island or islet), distance to the nearest inhabited island, area and altitude appeared to affect seabird richness (Table 2). The influence of the presence of cliffs seemed relatively strong, as it explained up to 28.7% of the deviance in seabird richness (Table 2). Furthermore, the presence of cliffs was the variable with lower AIC value. Possible models containing the remaining explanatory variables were not adequate, since none of the remaining of the variables reduced the AIC.

Table 3. GLM models of seabird species and influence of the 10 island descriptors on Procellariiformes *species composition. P: NS >0.05, *≤0.05, ** ≤0.01, ***≤0.001. Trend: '+' positive relationship, '–' negative relationship.*

Tabel 3. GLM-modellen van zeevogelsoorten en invloed van de tien eiland-variabelen op Procellariiformes-*soortensamenstelling. P: NS >0.05, *≤0.05, ** ≤0.01, ***≤0.001. Trend: '+' = positef, '–' = negatief.*

Model	Variable	% deviance explained	*P*	Trend
Little Shearwater	Cliff	40.67	***	+
	Islet	27.13	**	-
	Altitude	23.10	*	+
Yellow-legged gull	Distance	50.63	*	+
	Cliff	30.31	**	+
Procellariiformes	Cliffs	23.17	*	+
	Islet	6.47	NS	-
	Area	0.38	NS	+
	Area2	5.39	NS	+ -
	Inhabitants	0.004	NS	+
	Inhabitants2	6.39	NS	+ -
	Distance	3.70	NS	+
	Distance2	11.13	NS	+ -
	Altitude	2.83	NS	+
	Altitude2	5.66	NS	+ -
	Gulls	18.57	NS	+
	Cats	1.87	NS	+
	Rats	0.02	NS	-
	Ferrets	0.72	NS	+
	Weasel	0.13	NS	-

Geographical features used in the models seemed to affect the overall seabird community but not each species′ distribution; the distributions of only two species (Little Shearwater and Yellow-legged Gull) were explained by significant GLM univariate models (Table 3). Little Shearwater distribution seemed to be related to the presence of cliffs and Yellow-legged Gull colonies appeared to be relatively far from the main islands. The presence of cliffs appeared to affect the numbers of *Procellariformes*. However, the other geographic and anthropogenic features were poor predictors of procellariid distribution in the Azores Archipelago (Table 3).

DISCUSSION

The most distinctive features of the seabird assemblage in the Azores are the very large Cory's Shearwater populations, important tern populations, and the small populations of other *Procellariiformes*. Cory's Shearwaters breed in 26 of the 28 sites studied, including all nine main islands. Apart from Cory's and Little Shearwater, *Procellariiformes* breed only in a handful of islands and in relatively small numbers (at present), even though there are many islets apparently free of potential threats. This suggests that other important ecological constraints may exist that limit the distribution and abundance of small petrels in this archipelago. Intra- and inter-specific competition for nest sites is notable among burrowing *Procellariiformes*, and lack of optimal breeding habitat seems important in limiting their populations (Monteiro *et al.* 1996; Bolton *et al.* 2004). In addition, the Azores are the northern limit of the distribution of Bulwer's Petrel and Madeiran Storm-petrel, which might also explain their small populations and small number of colonies.

Seabirds with a widespread distribution in the Azores (Cory's Shearwater, Common Tern and Yellow-legged Gull) are able to breed on the main islands, apparently in coexistence with introduced predators. Furness *et al.* (2000) previously suggested that the strong negative impact of rats at some Cory's Shearwater colonies in the Mediterranean might not occur in the Azores. However, Little Shearwater and Manx Shearwater, species presumably more vulnerable to rats, are also present in islands containing mammalian predators. The latter have been found coexisting with rats and feral cats in some other North Atlantic colonies (Heaney *et al.* 2002). In the Azores, this might occur because of their habit of nesting along inaccessible sea cliffs (Monteiro *et al.* 1999), where they may suffer less severe predation. Nevertheless, we analysed only their presence and coexistence with introduced predators, which does not mean that birds are unaffected, as their breeding success might be severely reduced by predation (Thibault 1995). Indeed, the Manx Shearwater faces extinction in the Azores with an estimated population of just 100 pairs breeding in the islands of Flores and Corvo (Monteiro *et al.* 1999).

Geographical variables such as presence of cliffs, island area and altitude have proven to be very important for seabird diversity, being the key factors influencing species richness on these islands. Collinearity among these variables, however, probably precluded a multivariable GLM model. The distribution of Cory's Shearwater in the Azores archipelago has already been studied in detail by Furness *et al.* (2000), who concluded that the most important habitat for this species was inaccessible cliffs on the large islands. Most seabird colonies were located on large and high islands, and far from human settlements. In the Azores, many colonies are now confined to precipitous cliffs, which form an important part of the archipelago's 790 km of coastline. Most of this coastline consists of inaccessible cliffs, although there are not many islets.

It was not possible to analyse the effects of alien predation on Madeiran Storm-petrel and Bulwer's Petrel distribution because of the small number of islets occupied by these species. Nevertheless, Madeiran Storm-petrel and Bulwer's Petrel breed in significant numbers only on a few small rat-free islets (Vila, Praia and Baixo), and their conservation on this archipelago is dependent on preventing rats from colonising those colonies. The elegant demonstration by Bolton *et al.* (2004) that Madeiran Storm-petrel numbers and breeding success on these islets can be considerably enhanced by provision of nest boxes, suggests that breeding habitat is limiting for this species. Installation of nest boxes has also proved to be an efficient conservation measure for related species (De León & Mínguez 2003). Local investigations of nest-site limitation would be very useful in order to determine conservation strategies. Eradication of rats from islets might also help to increase the amount of natural habitat for small petrel nesting in the Azores. Monitoring the continued absence of introduced predators at these islets is essential to prevent potentially large declines or extinction of these populations in Azores. Given that the small populations of Little and Manx Shearwater occur on islands in the Azores archipelago with rats and cats, a study of the impact of mammals on these shearwaters should be given high priority.

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FACTOREN DIE DE BROEDVOGELVERSPREIDING EN ZEEVOGELRIJKDOM OP DE AZOREN BEPALEN

In vergelijking met vroeger zijn zeevogelpopulaties op de Azoren tegenwoordig veel kleiner en kennen ze een beperktere verspreiding. Belangrijke factoren bij deze achteruitgang zijn ondermeer predatie door ingevoerde zoogdieren, exploitatie door mensen en verlies van habitat. Wij onderzochten in welke mate de aanwezigheid van mensen en geïntroduceerde predatoren, en enkele

geografische eigenschappen van de eilanden invloed hebben op de verspreiding van en de rijkdom aan broedende zeevogels. Soortenrijkdom (vijf *Procellariiformes*, een meeuw en twee soorten sterns) was hoger op de grote eilanden die kliffen hebben. Dientengevolge was de kans om pijlstormvogels en meeuwen te vinden groter op de grotere eilanden die er ook toe neigden dat er katten en ratten aanwezig waren. Grotere aantallen Madeira Stormvogeltje *Oceanodroma castro* en Bulwers Stormvogel *Bulweria bulwerii* broeden echter alleen op een klein aantal ratvrije eilandjes. Voortdurend beheer is noodzakelijk om verstoring door mensen en introductie van predatoren op eilandjes waar stormvogeltjes broeden, te voorkomen. Wij doen een aanbeveling om een studie te verrichten naar de effecten van zoogdieren op Kleine Pijlstormvogel *Puffinus assimilis baroli* en Noordse Pijlstormvogel *P. puffinus*, omdat de overlap in verspreiding van beide soorten en ratten verrassend is.

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RECORDING ARRESTED PRIMARY MOULT IN TERNS, USING BLACK TERNS *CHLIDONIAS NIGER* AS EXAMPLES

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Van der Winden J. 2005. Recording arrested primary moult in terns, using Black Terns *Chlidonias niger* as examples. Atlantic Seabirds 7(1): 23-30. *This paper presents some adaptations to usual primary moult scores in terns. It is proposed to score old 'arrested' moult series separately, to facilitate the analysis of moult in the breeding period more effectively. To do this in a comparable manner, it is proposed to record moult scores for active series (after breeding) as A = new first series, B = new second series and C is new third series. For old (arrested) primaries this can be expanded to: E = old first series, F = old second series and G = old third series. Some examples for Black Tern are presented for the whole annual cycle.*

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INTRODUCTION

In comparison with for example waders, rather few adult terns are captured along the East Atlantic flyway. Present knowledge of (primary) moult patterns in terns is therefore incomplete (Craik 1994; Ward 2000; Walters 1987; Schouten 1982; Van der Winden 2002ab; Zenatello *et al.* 2002). One of the main characteristics of tern moult is that primaries are moulted such that the wing gap is kept to a minimum. Moreover, terns are 'notorious' in starting second and sometimes even third moulting series within their annual cycle (Ginn & Melville 1983; Van der Winden 2002b). This feature is probably a result of evolutionary processes allowing these birds to stay aloft with maximum manoeuvrability, as they are completely dependent on flight for feeding. This paper proposes some adaptations to the usual primary moult scores to facilitate the analysis of moult in terns during the breeding period.

RECORDING WING MOULT

Terns moult primaries descendant, starting from the innermost primary (P1) outwards, during a period of about six months. Before completion of the first series (P1-P10) they start a second series again from P1. Some species, such as Common Tern *Sterna hirundo*, Little Tern *S. albifrons* and Black Tern

Chlidonias niger, may even start a third series at P1 during the final phase of the non-breeding season. A captured tern may thus have as many as three active moult centres (Baker 1993). During the breeding period, primary moult is arrested, but will start again around July, sometimes just before the chicks fledge (Walters 1987; Van der Winden 2002a).

To describe the subsequent moult series in terns, Underhill & Prŷs-Jones (1986) suggested an adjustment of the classic moult score of Ginn & Melville (1983) by separating new primaries in subsequent series. New primaries in the first series were scored as '5' as usual, but new primaries of later series were scored as '6' (2nd series) or '7' (3rd series). However, old primaries were still scored as '0' in their system, even although old primaries from subsequent series can be separated in most cases. I would propose, in addition to Underhill & Prŷs-Jones (1986), to score these old primaries in arrested wings as well. This addition would facilitate studies of previous moult activity in the breeding areas (arrested moult period). A modified recording system is proposed (Table 1), to be able to fully describe tern primary moult within one moult season (in between two breeding seasons) for Palaearctic terns:

Table 1. Proposed primary moult scoring system for Palearctic terns. In this system 5 and 0 are subdivided in three separate age series. It is strongly advised not to use 5 and 0, but in case of difficulties separating series or if time is lacking the classic system still can be used and thus separated from properly treated birds.

Tabel 1. Voorstel voor een systeem om handpenrui bij Palearctische sterns te scoren. In dit systeem zijn 5 en 0 onderverdeeld in drie aparte leeftijdsseries. Het wordt sterk aangeraden om 5 en 0 niet te gebruiken, maar bij problemen om series te onderscheiden of bij tijdgebrek kan het klassieke systeem nog steeds gebruikt worden én kunnen 'klassiek' gescoorde vogels onderscheiden worden van 'goed'gescoorde vogels.

Score	feather scoring system	Source
1	old feather missing or new feather completely in pin	usual definition *cf* Ginn & Melville 1983
2	new feather just emerging from the sheath up to one third grown	usual definition *cf* Ginn & Melville 1983
3	new feather between one and two thirds grown	usual definition *cf* Ginn & Melville 1983
4	new feather more than two-thirds grown and with remains of waxy sheath at its base	usual definition *cf* Ginn & Melville 1983

Table 1 continued. Tabel 1 vervolg.

Score	feather scoring system	Source
A	new fully grown feather developed in the first series (onset in Europe around June-July	*cf* 5 in Underhill & Prŷs - Jones 1986
B	new fully grown feather developed in the second series (onset in Africa around October)	*cf* 6 in Underhill & Prŷs - Jones 1986
C	new fully grown feather developed in the third series (onset in Africa around January)	*Cf* 7 in Underhill & Prŷs - Jones 1986
	Prior to breeding, old feathers	
E	old feather developed in the first series (Europe/Africa)	*this contribution*
F	old feather developed in the second series (Africa)	*this contribution*
G	old feather developed in the third series (Africa)	*this contribution*
(5)	new fully grown feather (series not separated)	usual definition *cf* Ginn & Melville 1983
(0)	old feather; series indistinguishable or not scored	usual definition *cf* Ginn & Melville 1983

In this scheme, scores A, B and C represent feathers developed within the same moult season (between two breeding periods). Note that terns might migrate twice within this period. Codes E, F and G are codes for three arrested series, which can be distinguished within and partly after breeding (if not replaced). This primary moult score specifies the former undefined “0” into different feather age categories and all usual moult patterns in terns anywhere in the world and at any time during the non-breeding season can be properly described. This method also makes it possible to score the arrested ‘moult’ during the breeding period in a systematic way. The advantage is that the progress of primary moult be studied more comprehensively as well in the non-breeding as breeding areas. Subadults may be treated as adults.

Terns with four active/arrested moult series can also be included in the proposed system, by adding D in new series or H in old (arrested) series. However, such individuals are very rare (reported only in Little Tern; A.J. Tree *pers. comm.*). Rarely, and if so mainly in immature birds, one or more primaries are skipped (“forgotten”) during primary moult or arrested for a relative long period (Schouten 1982; Behmann & Persson 2003). Such primaries are older (more worn) than primaries on either side and can be scored as ‘I’ (intermediate; A.J. Tree *pers. comm.*).

BLACK TERN *CHLIDONIAS NIGER*

To exemplify the proposed system, some case studies of Black Tern moult scores are included. Firstly a theoretical moult score is given. Based on captures from breeding as well as stopover and non-breeding areas some data are presented about moult progress based on the extended scoring system.

Breeding season May-June with arrested (not active) wing moult (Fig. 1)
In general 4 to 5 primaries are replaced in the second series resulting in the typical light inner wing. Theoretical standard bird with one arrested series: FFFFFEEEEE. Theoretical standard bird with two arrested series (rare): GFFFFEEEEE. Data from colonies in The Netherlands May-June 1999-2003: Average number of replaced primaries of the second (arrested) series (B): 4.8 *n* = 144. Percentage of terns with a third series (C): 5.0% *n* = 140.

Figure 1. Breeding period May-July (The Netherlands). Arrested primary moult FFFFFEEEEE. (J. van der Winden).

Figuur 1. Broedseizoen mei-juli (Nederland). Onderbroken handpenrui FFFFFEEEEE. (J. van der Winden).

July-September active moult (Fig. 2)
Theoretical standard bird: AA41FFEEEE. In general P1-P3 are replaced in August and one or more growing primaries are visible. Above this, 1 or 2 primaries of the second (arrested) series (F) and the outer dark and worn primaries of the first series (E) are still visible. In such wing patterns it is clear that third series cannot be detected because they are replaced by new ones (A). Data from The Netherlands July-August 1983 (Schouten *unpubl.*). Average number of replaced primaries of the second series (F) for birds still in arrested moult: 4.8 n = 248. Average primary score in July-August: 7.1 with a max of 29 (n = 248). Percentage of terns, which replaced second series (F) completely with new primaries (1 to A): 11.9% (n = 1831).

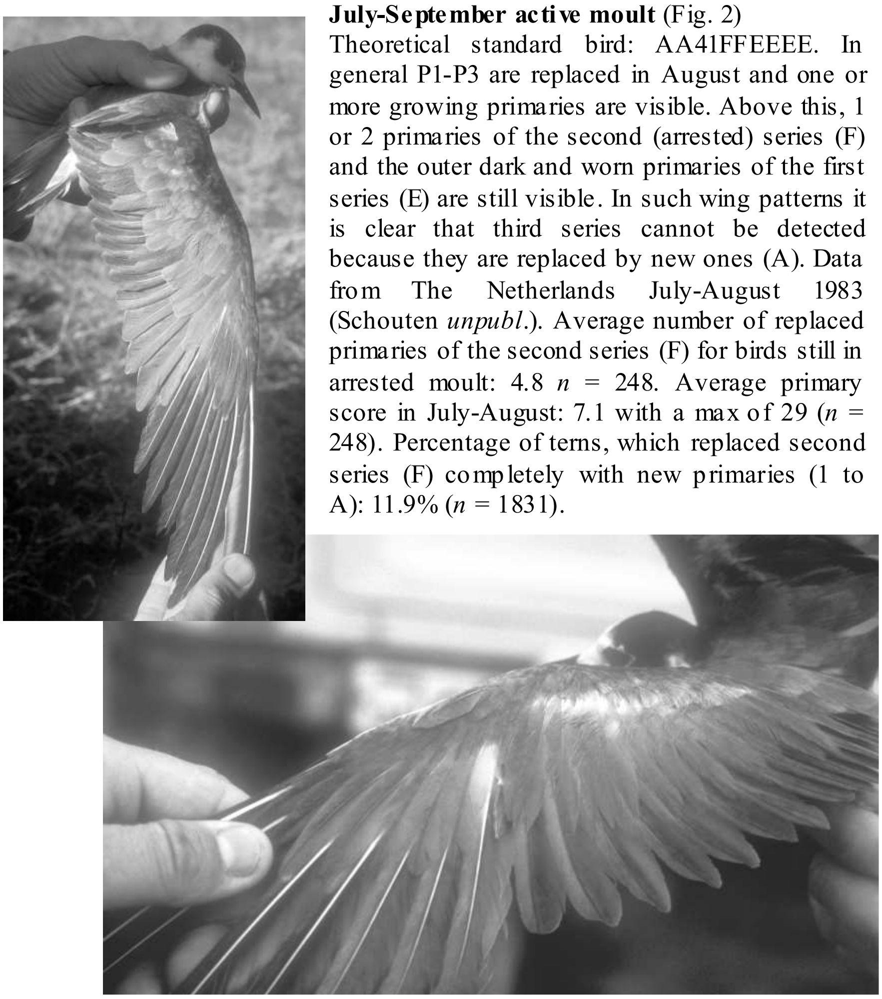

Figure 2. (A, top) July-August (Ukraine, Sivash). Start of primary moult AA43EEEEEE; (B, bottom) July-August (Ukraine, Sivash). Start of primary moult 12FFFEEEEE. Still 3 primaries of second pre breeding series remaining (J. van der Winden).

Figuur 2. (A, boven) Juli-augustus (Oekraïene, Sivash). Begin van handpenrui AA43EEEEEE; (B, onder) Juli-augustus (Oekraïene, Sivash). Begin van handpenrui 12FFFEEEEE. Nog steeds drie handpennen van de tweede pre breeding serie overgebleven (J. van der Winden).

October, Africa active moult (Fig. 3)
Theoretical standard adult: AAAA41EEEE. In general P4 to P6 are replaced in Oct and one or more growing primaries are visible. Sometimes few old primaries of second arrested series remaining (F). All birds in active moult. Data from Ghana early October 2002 (Ghana Wildlife Society, Centre for African Wetlands *unpubl.*) Average primary score early October: 25.7, with min 16 and max 46 (*n* = 53). Percentage of terns, which replaced second series (F) completely with new primaries (1 to 5): 67.9% (*n* = 53).

Figure 3. October (Ghana). One active primary moult series AAAA44EEEE (J van der Winden)

Figuur 3. Oktober (Ghana). Een serie actief ruiende handpennen AAAA44EEEE (J van der Winden)

February-March, Africa active moult (Fig. 4)
Theoretical standard adult: BB4AAAAA3E. In general up to P9 or P10 replaced for the first time (E). Series 2 active or already arrested. Data from Namibia February-March 1999 (WIWO, unpubl.). Average primary score February-March: 43.1, with min 22 and max 50 (n = 270; all with A & B calculated as 5 in order to compare with historical data). Outer primary of series 2 replaced (code 1, 2, 3, 4 or A & B) 3.2, with min = 0 max = 6.

DISCUSSION

In the classic approach, moult scores of 50 are the maximum (Ginn & Melville 1983). In terns this approach can be followed if new feathers with scores A, B or C are all regarded as 5 (new). This provides a general idea of moult progression speed. However, as terns moult ‘new’ feathers again, it is useful to distinguish

Figure 4. February (Namibia). Two active primary moult series B421AAAAA4. Pattern of picture 1 almost completed. (J. van der Winden.)
Figuur 4. Februari (Namibië). Twee handpenseries in actieve rui B421AAAAA4. Het patroon van figuur 1 is vrijwel voltooid (J. van der Winden).

moult progression of each series of primaries separately (Van der Winden 2002b), or more advanced (Underhill, 2003). The maximum for series 1 is always 50 points. The maximum for series 2 and 3 is not the same in all individuals and can be as high as 30 points if transformed to 5 points for each feather (series 2). The recording system proposed here facilitates a more comprehensive description of complicated moult patterns, such as those commonly observed in terns.

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REGISTRATIE VAN ONDERBROKEN HANDPENRUI BIJ STERNS, MET VOORBEELDEN VAN DE ZWARTE STERN *CHLIDONIAS NIGER*

In aanvulling op eerdere methoden om de vleugelrui bij sterns te registreren wordt in dit artikel voorgesteld om zowel oude (onderbroken, 'arrested') als nieuwe ruiseries op een systematische wijze te beschrijven. Het voordeel ten opzichte van eerdere methoden is dat onderbroken series afzonderlijk worden onderscheiden zodat de voortgang van de winterrui achteraf, dus in de broedtijd, beschreven kan worden. Om dit op een vergelijkbare wijze te doen, wordt voorgesteld de registratietechniek voor ruiscores uit te breiden met scores voor nieuwe pennen per serie volgens tabel 1: A = nieuw eerste serie, B = nieuw tweede serie en C = nieuw derde serie. Voor oude pennen kan dit doorgevoerd worden volgens: E = oud eerste serie, F = oud tweede serie en G = oud derde serie. In deze optiek blijven 5 en 0 gereserveerd voor situaties waarin onderscheid niet mogelijk is of wanneer onderzoekers geen onderscheid willen of kunnen maken. In een aantal voorbeelden van ruiscores van zwarte sterns uit de gehele jaarcyclus wordt de voorgestelde score toegepast (fig 1 t/m 4).

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AGEING MANX SHEARWATERS
PUFFINUS PUFFINUS

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Leonard, K. & McKee, N.D. 2005. Ageing Manx Shearwaters *Puffinus puffinus*. Atlantic Seabirds 7(1): 31-38. *There is little published information on ageing criteria for juvenile Manx Shearwaters* Puffinus puffinus. *We detail ageing criteria that have been used at Copeland Bird Observatory, Co. Down, for approximately 30 years. It involves using basic moult techniques and differences in feather colour, shape and pattern to distinguish fully moulted juvenile birds from adults. Juvenile birds have black feathers, a distinctive pointed and hooked primary shape, and pale edgings to their mantle feathers. Adults have brown feathers with rounded, worn primaries and mantle feathers. The shape and colour of the axilliaries have been reported as an ageing criterion and these were found to be useful features. Using these techniques, it is possible to confidently age fully grown down-less Manx Shearwaters caught in the autumn. These characters may also be of use in identifying first year birds found away from the colony in the year after fledging.*

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INTRODUCTION

The Manx Shearwater *Puffinus puffinus* is a common breeding seabird around the British Isles. Researchers have long studied the species as it is easy to catch, tolerant of disturbance and shows a high degree of philopatry. This enables detailed studies of marked birds to be undertaken. Great Britain and Ireland hold approximately 332,000 Apparently Occupied Sites, about 90% of the world total (Mitchell *et al.* 2004). In Northern Ireland, there are three colonies, one at Rathlin Island, Co. Antrim, and two on the Copeland Islands, Co.Down, that lie at the mouth of Belfast Lough. One of these two colonies is on Old Lighthouse Island and this is where Copeland Bird Observatory is located. Manx Shearwaters have been trapped and ringed by members of Copeland Bird Observatory since 1952. The colony has increased steadily over this time from an estimated 250 pairs in the early 1950s, to 2867 Apparently Occupied Sites in 2000 (Stewart 2000; Mitchell *et al.* 2004). This represents approximately 8% of the Irish population. There has been a steady increase in the number of chicks being ringed annually, with a peak of 911 pulli caught in 2002 (Leonard 2002). Manx Shearwater pulli are relatively easy to catch as they fledge from their burrows in late August and September. Young birds spend time on the surface practising wing-flapping and exploring the area around their burrow. Most young are docile and can be quickly ringed and released at the point of capture.

Most young birds (EURING age code 1) are easily identified by having varying amounts of soft, grey down covering their body. Fledgling birds are left with small areas of down on the nape and vent and this is typical of most procellariids (Warham 1990). However, many juvenile birds can be caught that have lost all this down, having completely acquired their first-year plumage. Other criteria are needed to age these fully grown birds (EURING age code 2) and any characters used must be useful under night-time handling conditions. There is little published information on ageing these birds; the available criteria are summarised by Baker (1993), who highlights feather colour and axilliary shape and pattern as the main characters to use. Here we describe the ageing criteria used on Copeland Bird Observatory and summarise our findings on the usefulness of published criteria.

METHODS

All birds examined were trapped by members of Copeland Bird Observatory on Old Lighthouse, Co. Down, Northern Ireland. Manx Shearwaters have been ringed on Copeland since 1952. Since the early 1970s the techniques developed here have been used to age Manx Shearwaters during the time of chick emergence in early September. Since 1970 approximately 13,000 Manx Shearwater pulli have been ringed and any birds without down are aged using a combination of the features discussed in this paper.

In 2004, we also examined the axilliary pattern of Manx Shearwaters to determine this character's usefulness as an ageing criterion. The axilliary patterns of captured birds were compared with the patterns illustrated on page 55 of Baker (1993), reproduced in Figure 4. Juvenile axilliaries are described as pointed in shape with a thick black band across the tip of the feather. Adult axilliaries are rounded with either no or small amounts of black at the tip of the feather. The axilliary shape and pattern was scored as juvenile-type or adult-type. Twenty-five adult birds were trapped between 13 and 17 July 2004 and the axilliary pattern scored. Twenty-five juveniles (pulli with some down) were similarly examined in early September 2004.

Ageing Criteria The main ageing criteria are summarised in Table 1.

Primary Shape The shape of the primaries of juvenile birds differs dramatically from that of adults. In juveniles, the outer two or three primaries are very pointed (Figures 1 and 3a). Primaries 4 to 8 are blunt-ended, the end of the feathers appearing to have been cut off across the shaft. On the inner edge

Table 1. Summary of main ageing characters of juvenile and adult Manx Shearwaters.
Tabel 1. Samenvatting van de belangrijkste kenmerken om de leeftijd van Noordse Pijlstormvogels te bepalen.

	Juvenile	Adult
Outer primary shape	Pointed and fresh	Rounded and worn
Inner primary shape	Blunt-ended with hooked inner edge; fresh	Rounded and worn
Mantle feathers	Black with pale grey edges	Uniform brown and worn
Feather colour	Sooty black	Brown
Axilliaries	Pointed, much black on feather	Rounded, no or small amounts of black

of these primaries there is a distinctive hooked point at 90° to the shaft (Figure 1). All these feathers are sooty black in colour. The edges of the feathers are fresh and unworn; the shafts of the feathers are black. The inner edges of the fresh unused primaries are often 'crumpled' giving them a waved, undulating appearance (Figure 1). In adults, all the old un-moulted primaries are rounded in shape (Figures 1 and 3b). The outer few feathers can be pointed to some degree, but rarely. However, the edges of all the feathers are worn and frayed, often with nicks on the edge. The feather shafts are brown.

Figure 1.Primary shape of adult (left) and fledgling (right) Manx Shearwaters. (Steve Stansfield)
Figuur 1. Vorm van handpen van een adulte (links) en een juveniele (rechts) Noordse Pijlstormvogel.(Steve Stansfield)

Figure 2 .Wear of secondaries and coverts on fledgling (left) and adult (right) Manx Shearwaters. (Steve Stansfield)
Figuur 2. Slijtage van armpennen en vleugeldekveren van een juveniele (links) en een adulte (rechts) Noordse Pijlstormvogel. (Steve Stansfield)

Feather colour The ground colour of the main feather tracts is one of the main differentiating features between adults and juvenile birds. As suggested by Baker (1993), the ground colour of juvenile birds is black. All the major feather tracts are the same sooty black colour, fresh and unworn – remiges, rectrices, scapulars, mantle, nape and head. The moult schedule of Manx Shearwaters is not definitely known but it must occur during the winter (Cramp & Simons 1977). Adults returning in March have fresh black feathers but by early September their feathers are 6-10 months old and are consequently heavily worn (Figure 2). The ground colour of the mantle, scapulars, remiges and rectrices is a dark muddy brown. This contrast with juveniles is usually clear-cut and obvious, often even at a distance in good torch light. On wet nights some caution should be exercised as the wet feathers of adults can at first appear as dark as juveniles and may require closer examination.

Mantle feathers Juvenile mantle and scapular feathers are fresh and sooty black. On closer inspection the mantle feathers typically have a pale grey edge, which produces a scaly effect. This is due to a change in the texture of the feather over about 1.5mm of the margin, rather than a coloured margin. Adult mantle feathers have no pale edge, are rounded and worn, often with nicks at the shaft.

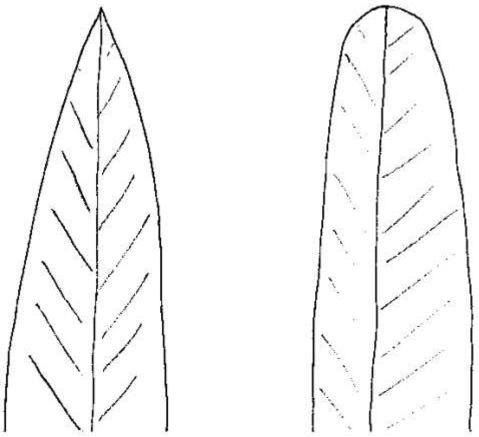

Figure 3.Outer primary shape of juvenile (left) and adult (right) Manx Shearwaters.
Figuur 3. Vorm van buitenste handpen van juveniele (links) en adulte (rechts) Noordse Pijlstormvogels.

Axillaries All 25 adults and juveniles examined had axillaries that fell within the normal range as specified in Baker (1993; Figure 4). Juvenile axilliaries were found to be pointed in shape with large amounts of black across the tip of the feather. Adult axilliaries were rounded with the great majority of birds having white feathers with no black markings. From our small samples it would appear that axilliary pattern is a good indicator of shearwater age.

Plumage texture The fresh plumage of juveniles feels soft to the touch compared with that of adults. On dry nights experienced shearwater ringers can often identify juvenile birds without recourse to other plumage features.

Other features There are some other minor features that can be useful in distinguishing between adults and juveniles. Juvenile birds have fleshy pink legs, whereas the legs of adults are colder and greyer. B. Zonfrillo *(pers comm.)* has accurately pointed out that juvenile birds have a different smell to that of adults. The odour of juveniles is musty, powdery and not unpleasant. This is probably caused by the powdery 'dandruff' from the newly moulted feather sheaths. In contrast to juveniles, adults have no particular smell other than that of an ocean-going seabird. This is a somewhat strange but very useful criterion.

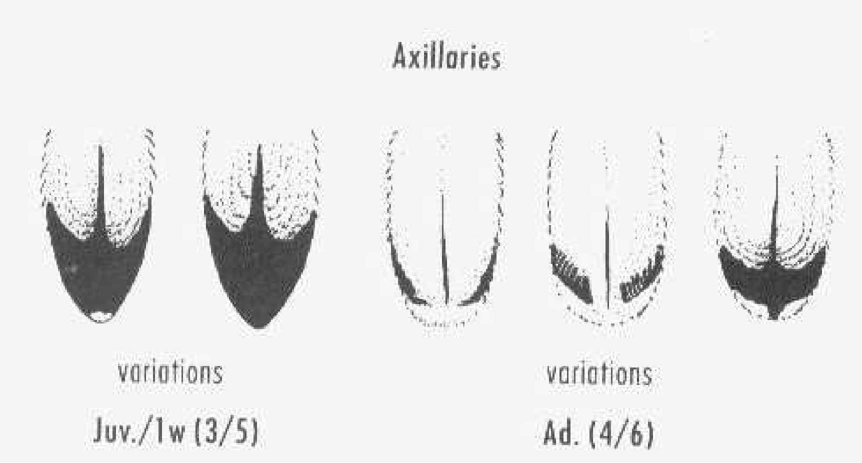

Figure 4. Axilliary patterns of Manx Shearwaters (reproduced with permission from Baker 1993).
Figuur 4.Patroon van de okselveren van Noordse Pijlstormvogels (met toestemming overgenomen uit Baker 1993).

DISCUSSION

The ageing criteria listed herein have been used to age juvenile Manx Shearwaters on Copeland Bird Observatory for nearly 35 years, and with practice it is quite straightforward to age accurately all full-grown birds trapped in the autumn. The main features that are used are feather colour, primary shape and wear, and mantle feather shape and wear. Individuals with sooty black plumage, pointed and hooked primaries and pale-edged mantle feathers are fully moulted pulli (EURING age code 1). Birds with muddy brown feathers, rounded and worn primaries and mantle feathers are adults (EURING age code 4). The ability to accurately age all birds caught at a colony during the fledging period is extremely important and this has greatly enhanced the quality of data gathered on shearwaters at Copeland. Without the use of these criteria many autumn birds would be recorded as of unknown age (EURING age code 2). These specific juvenile ageing characters of Manx Shearwaters fall within the general summary of Warham (1990), juvenile petrels being described as having fresh unabraded plumage, dark feathering and pale edges to the wing coverts, mantle and scapulars.

Primary shape is an important character for ageing shearwaters. The shape of the outer primary feathers has also been recorded as an ageing character in several other petrel species, for example Northern Fulmar *Fulmarus glacialis*, Cory's Shearwater *Calonectris diomedea* and Leach's Storm-petrel

Oceanodroma leucorhoa (Baker 1993). Juvenile birds have pointed outer primaries. Bolton and Thomas (2001) included primary shape and wear to help age European Storm-petrels *Hydrobates pelagicus* in their first year (age code 5); all birds with a pointed tip to the outermost primary were first year birds, whereas most older birds (age code 6) had a relatively blunt outer primary. Primary shape is therefore a common ageing character across several petrel species. The use of primary shape could potentially be combined with moult and wear in other feather groups to age juveniles of other shearwater species.

The degree of ossification of the skull of juvenile birds can be used to distinguish them from adults (Svensson 1992). As far as we are aware, there are no published studies applying this technique to Manx Shearwaters but Sugimori *et al.* (1985) used skull ossification to identify juvenile Short-tailed Shearwaters *Puffinus tenuirostris*. Checking for skull ossification is an intrusive technique and of limited practical use in a shearwater colony at night.

We found axilliary pattern as reported by Baker (1993) to be a useful characteristic with all juvenile and adult birds having feather patterns that fell within the expected range. However, in order to view the axilliaries it is necessary to turn the bird upside-down and fully extend the wing. In our opinion, this increases the likelihood of injury to both ringer and bird, and we accord the technique only secondary importance.

Although the features outlined here have been developed for use in the colony in the autumn they may have wider applications. Little is currently known about the moult of first year Manx Shearwaters. Lee (1995) identified five birds off North Carolina and Georgia as first-year birds. One bird in its first winter and two in the following spring showed only varying degrees of body moult. One bird examined the following August had still not started moult. By mid-December of its first full year another bird had moulted primaries 1-8 (numbered ascendingly). From these birds, the tentative conclusion may be drawn that juvenile shearwaters moult no primaries until at least the following summer, and probably the autumn. Baker (1993) suggested that the axilliary pattern could also be used to age first year birds (Euring age code 5). It is feasible, therefore, that the ageing characters detailed here could be used to identify first-year Manx Shearwaters caught in the northern hemisphere during the northern summer, either at colonies or when tape-lured at coastal headlands. Very few Manx Shearwaters return to their colonies in the first year and there seem to be no published records of this (Brooke 1990), so there would be appear to be little opportunity to test this. However, a few first year Manx Shearwaters have returned to the Copeland colony (Leonard *et al.* in prep.) so the ability to accurately identify first-year birds using plumage characters could help add to our knowledge of the species' post-fledging and pre-breeding movements.

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We acknowledge the many volunteer members from Copeland Bird Observatory who have helped with the trapping of Manx Shearwaters at the observatory over the last 50 years. We thank Jeff Baker for giving us permission to include Figure 4 in this manuscript. Steve Stansfield kindly provided the photographs for Figures 1 and 2. George Henderson, Steve Stansfield and one anonymous referee provided useful comments on earlier drafts of this manuscript. The Environment and Heritage Service Northern Ireland provided funding that helped with the production of this manuscript.

LEEFTIJDSBEPALING VAN NOORDSE PIJLSTORMVOGEL

Er is weinig informatie gepubliceerd over leeftijdskenmerken van juveniele Noordse Pijlstormvogel *Puffinus puffinus*. Wij gaan dieper in op de leeftijdskenmerken die al ongeveer dertig jaar worden gebruikt op Copeland Bird Observatory, Co. Down. Er wordt gebruik gemaakt van standaard ruikenmerken en verschillen in kleur, vorm en patroon van de veren om volledig geruide juvenielen te onderscheiden van adulte vogels (fig 1 t/m 3). Juveniele vogels hebben zwarte veren, kenmerkend gepunte en hoekige handpennen en lichte randen op de mantelveren. Adulte vogels hebben bruine veren met afgeronde, gesleten handpennen en mantelveren. Vorm en kleur van de okselveren worden in de literatuur genoemd als leeftijdskenmerk (fig 4), hetgeen bevestigd kon worden. Door gebruik te maken van de gepresenteerde kenmerken (tabel 1) is het mogelijk om volgroeide, donsloze Noordse Pijlstormvogels die in het najaar zijn gevangen, op leeftijd te brengen. Deze kenmerken kunnen ook nuttig zijn bij herkennen van eerstejaars vogels die het jaar na uitvliegen buiten de kolonie worden gevonden.

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FIRST KNOWN MOVEMENTS BETWEEN TWO COLONIES OF THE MANX SHEARWATER PUFFINUS PUFFINUS *ON THE COPELAND ISLANDS, NORTHERN IRELAND*

The Copelands are a group of three islands located at the mouth of Belfast Lough, Northern Ireland. Copeland Bird Observatory is located on Old Lighthouse Island approximately 3km offshore and has a Manx Shearwater *Puffinus puffinus* colony estimated at 2867 Apparently Occupied Sites (Stewart 2000; Mitchell *et al.* 2004). Shearwaters have been ringed there since 1952. Big Copeland is the largest island in the group and is midway between the mainland and Old Lighthouse Island. Historically, there have been no surveys of Big Copeland for Manx Shearwaters. The population was estimated to be 100+ pairs in the 1970s (Neville McKee *pers. comm.*) but this was a projection based on the work of the adjacent observatory. Big Copeland was surveyed for the first time in 2001 as part of the Seabird 2000 survey and this resulted in a minimum population estimate of 1766 AOS (Stewart 2000; Mitchell *et al.* 2004). With this new information on Manx Shearwater numbers and distribution, members of the observatory visited the Big Copeland colony in the summers of 2002 and 2004 in an attempt to catch adult shearwaters that were originally ringed on Copeland Bird Observatory. In 2003, a visit was made in late August to ring pulli. During these visits, 75 adult shearwaters were handled and five birds originally ringed at the observatory have so far been re-trapped or recovered dead (Table 1).

These birds represent the first recorded movements of shearwaters between the two Copeland colonies. These movements are not unexpected as perhaps one third of fledglings may leave their natal colony and in a similar situation on Skomer and Skokholm in Wales, movements between the two islands have been shown to be frequent (Brooke 1990). These two islands, together with Middleholm island, may be considered a ‘super-colony’. The Copeland colonies total approximately 5000 AOS, which is 13% of the Irish population and renders the islands internationally important for the species (Mitchell *et al.* 2004). The whole island group was designated as an Area of Special Scientific Interest in 2004, the population of Manx Shearwaters being an important part of this designation. Rathlin Island (Co. Antrim) hosts the only other Manx Shearwater colony in Northern Ireland. Formerly thought to hold at least 1000 pairs (Brooke 1990), it seems this colony has been badly affected by introduced ferrets *Mustela furo* (Mitchell *et al.* 2004). Some birds may still be present on inaccessible parts of the cliff but limited surveying as part of Seabird 2000 revealed no shearwaters (Mitchell *et al* 2004).

Table 1. Manx Shearwaters from Copeland Bird Observatory re-trapped on Big Copeland 2002-2004.
Tabel 1. Noordse Pijlstormvogels geringd door Copeland Bird Observatory die zijn teruggevangen op Big Copeland, 2002-2004.

Bird	History at Copeland Bird Observatory	Re-trapping details on Big Copeland
EJ13676	Ringed on 02/09/1981 as a chick. Re-trapped once in 1984 but not since.	Re-trapped 2002
EJ13692	Ringed on 03/09/1981 as a chick. Never re-trapped on the observatory.	Re-trapped 2002
ER32268	Ringed on 19/08/1990 as a chick. Never re-trapped on the observatory.	Re-trapped 2002.
EB53839	Ringed as an adult on 06/08/1978. Never re-trapped on the observatory	Re-trapped 2004
EJ13209	Ringed on 12/09/1980 as a chick. Never re-trapped on the observatory.	Found dead in the colony 2004.

The apparent near demise of the Rathlin colony renders the protection of the Copeland colonies and the understanding of their population dynamics all the more important. Further trapping is required on Big Copeland to ascertain the degree of inter-change between the islands and to compare this with the pattern of movements between sub-colonies on Old Lighthouse Island. If the interchange with Big Copeland is found to be equivalent it would support the treatment of the two islands as one large colony and assist in the conservation of the Manx Shearwater on the Copeland Islands and in Northern Ireland.

I acknowledge the many volunteer members from Copeland Bird Observatory who have helped with trapping Manx Shearwaters on the observatory over the last 50 years. Particular thanks to Neville McKee, Ian McKee, Shane Wolsey, George Henderson and John Stewart for their help trapping on Big Copeland 2002-2004.

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LEACH'S STORM-PETRELS OCEANODROMA LEUCORHOA *LANDING ON A RESEARCH VESSEL AT NIGHT*

During a research cruise on the *RRS Charles Darwin* in deep waters south of Madeira (31°-33°N and 15°-18°W), from 3-20 November 2004, a total of 17 Leach's Storm-petrels *Oceanodroma leucorhoa* were recorded landing on the ships' deck at night. The maximum found on any one night was four on November 6th and 7th (Fig. 1). All but one of the birds was successfully released the following morning after being boxed overnight.

Figure 1. A quartet of Leach's Storm-petrels Oceanodroma leucorhoa *found on the deck of* RRS Charles Darwin *at night. These birds were successfully recuperated and released.*

Figuur 1. Een viertal Vale Stormvogeltjes Oceanodroma leucorhoa *dat 's nachts op het dek van* RRS Charles Darwin *was gevonden. Deze vogels werden met succes opgelapt en vrijgelaten.*

All birds arrived while the ship was stationary and the rear deck was lit with high-power floodlights. In addition to those actually found on deck, small numbers were noted flying around or over the ship. All birds found on deck arrived during calm weather on both clear and cloudy nights, and also at different moon phases; none were picked up on deck during windy nights. Bourne (1992) observed that about half of all records of seabirds picked up on Royal Navy vessels between 1960-1990 related to storm-petrels, with two-thirds of these relating to Leach's Storm-petrels alone.

Both Bourne (1992) and Prendergast (1992) have suggested that birds landing on deck may do so deliberately, in association with social displays. This could explain why none of the recovered birds showed any signs of collision damage, and could occasionally be heard giving the long 'chatter-call' while on deck. Ships operating with high-power floodlights at night in feeding or breeding areas of storm-petrels may have an adverse affect on the birds' behaviour, distracting them from foraging and related activities. In addition, small numbers may perish if they land in enclosed sections of the ship and are not subsequently recovered and released.

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LONGEVITY OF SOOTY TERN STERNA FUSCATA *ON ASCENSION ISLAND*

On 25 June 2002, while carrying out fieldwork on Ascension Island in the South Atlantic (07º 57′ S, 14º 22′ W), we captured a ringed Sooty Tern *Sterna fuscata*. The bird was incubating an egg on Waterside Fair and was captured using a hand net. The number on the American ring was 1013 13651. The following season, on 22 April 2003, we captured another Sooty Tern with an American ring number 1013 13584. The ring was worn rendering the last three digits somewhat illegible and this was our best guess at the ring number. The bird was re-ringed with a British Trust for Ornithology (BTO) ring. In 2005, the original ring was examined in a laboratory and the number confirmed. This bird was incubating an egg on our Mars Bay study site. Both birds were returned to their nest to continue incubating.

Sooty Tern Ascension Island. Bonte Stern Ascension *(B.J. Hughes)*

The Bird Banding Laboratory at Patuxent was contacted and their records revealed that Dr N.B. Gale ringed 200 Sooty Tern pulli on Ascension with this banding sequence during the early part of November 1975. The first tern we captured was therefore 26½ years old and the second was 27½ years old.

Terns are long lived birds and the oldest tern recorded is a Sooty Tern aged 36 years (Schreiber & Burger 2002). The oldest known breeder on the Seychelles is 34 years old, on Dry Tortugas 32 years, and in the Pacific 26½ years (Schreiber *et al.* 2002). The previous longevity records for Sooty Terns on Ascension were 16½ years on 7 July 1942 and 18 years in March 1944 (Thacher Cooke 1945). Our ring recoveries suggest that despite feral cat predation on Ascension, Sooty Terns in the South Atlantic live as long as other Sooty Terns in the Pacific, Indian and North Atlantic Oceans.

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News and notices

BOOK REVIEWS

KLAUS MALLING OLSEN & HANS LARSSON 2003. *Gulls of Europe, Asia and North America.* Helm, London. ISBN 0-7136-7087-8, hardback, 608 pp, 83 plates, 823 photographs. Price £45.

For many of us gulls have become the ultimate avian soap opera. Peter Grant set the scene with *Gulls: a guide to identification* back in 1982 and then added more characters to the plot four years later in a second edition enlarged to include North American species. At this stage, the storyline adhered solely to identification complexities; nobody imagined that the denouement was destined to swirl around challenges to the taxonomic status quo, never mind searching for clues to evolutionary relationships among the DNA of the birds themselves. Gull-watching became addictive in the 1990s. In Ireland, a veil was lifted from previously overlooked American Herring Gulls and Thayer's Gulls, while a succession of pioneering identification papers murmured that big changes were afoot on continental Europe and beyond.

Although just a decade ago, this was an era of portentous smoke signals on the far horizon. Hard news was difficult to come by, unless you could read Swedish or German, never mind comprehending terminology such as 'P10', Kodak Grey Scale, and a proliferation of subspecies names in Latin. I remember feverishly photocopying an English language 'bootleg' translation of Lars Jonsson's 1996 paper in *Var Fagelvarld* on Yellow-legged and Caspian Gulls (subsequently repeated and updated in *Alula* in 1998) and taking out a subscription to *Limicola* to pore over photographs of these 'new gulls' in Detlef Gruber's blitzkrieg articles on field recognition. Since then, perceptive Young Turks have spearheaded advance after advance, at times being derided by a stuffed shirt establishment unwilling to grapple with a changing orthodoxy (warranting the creation of additional species) among, in particular, the 'large white-headed gulls'. Within the last decade, gull identification websites on the internet and periodicals (principally, *Alula*, *Birding World*, and *Dutch Birding*) have been the *modus operandi* by which the growing pool of knowledge has been disseminated. In essence, a quiet but sweeping revolution has taken place. However, one thing has been lacking: an oracle describing, portraying and synthesizing all that has happened.

Klaus Malling Olsen and bird artist Hans Larsson seem to have carved something of a niche for themselves in identification guides. Their two previous books on terns (1995) and skuas (1997) set an acceptable standard, especially by the inclusion of many well-reproduced photographs (more trustworthy than all but the best illustration plates). How did they rise to perhaps their greatest challenge – all the gulls of the northern hemisphere? Presumably, they were aware that, given root-and-branch taxonomic changes coupled with burgeoning identification information, the book was assured a massive audience. The result is a monograph aspiring to cover the gull universe: from straightforward species such as Ivory Gull or Heerman's, to the vexing subtlety of Vega and Heuglin's.

With so many photographs per species, it could be argued that plates were unnecessary. Good photographs have an authenticity that cannot be questioned, whereas artwork relies upon personal interpretation. By any yardstick, Larsson's skills are worth having. His style smacks of a Lars Jonsson wannabe (nothing wrong with that), he has a natural touch with colours, and many of his gulls are fresh, life-like, and not over-egged with the beauty salon treatment of illustrators like Killian Mullarney. Larsson seems to be more comfortable with birds at rest than in flight, although I suspect he is really at his best when he paints a species he knows well. Top among the smaller gulls are his standing Common Gulls and quite the best (at rest) Laughing and Franklin's Gulls I have ever seen. By the shape of his Saunder's Gulls, I suspect he has never seen one (once airborne, the bird has weird, long and sickle-shaped wings). His adult Audouin's Gull is in a familiar rut: I have yet to find a painting that shows the striking grey-washed body of the species. I winced at a range of jarring depictions, from rakish wing-tips on Little Gulls to odd leg colour on second-winter Mediterranean Gull. Furthermore, it is about time that the nearly parallel, 'broken Polo mint', eye markings of breeding plumage Mediterranean Gull were committed to paint. For good measure, flying juvenile Sabine's Gulls are floppier on the wing than adults, which is probably a by-product of their blunter wings and shorter, less deeply forked tails. These Real World differences are yet to catch a bird painter's eye.

As a general theme, the book's artwork follows a stereotyped layout, presumably for easy comparison. Unfortunately, for the large gulls, the birds themselves look stereotyped. I could easily believe that Larsson used the same template for every large gull in the northern hemisphere. After a while, turning page after page of similarly shaped and identically posed subjects (albeit nicely painted) became like counting sheep. German-born Joseph Wolf, one of the greatest bird painters of all time (from the nineteenth century) lived by the artistic mantra 'Life! Life! Life!' Good drawing, he felt, needed to capture personality. I felt that was missing from the larger gulls. Not many of them were wrong, but where was the benign face, guardsman stance, and chopstick legs of Caspian Gull; the mincing strut of Ring-billed; the 'Great Black-backed Gull in sheep's clothing' structure of Yellow-legged Gull; or the inelegant lines of Kumlien's, compared with more shapely Iceland Gull? On a technical level, Larsson seems to think that every time, after first-winter, a large gull moults its coverts and scapulars, it replaces them with a full set of new, homogeneously-chequered 'second winter' feathers. In practice, this is almost never the case. Uniformity of pattern breaks down, and a variable, individualistic patchwork is the norm. Hence, I cannot relate to several of his pristine-plumaged second-winter large gulls. For Caspian Gull, it would have been helpful – and more representative – to depict at least one first-winter with the species' often-characteristic wingbar (formed by dark-based greater coverts), which can be so noticeable at rest.

I was disappointed by Larsson's occasional failure to echo information presented in the accompanying text. In this regard, he does not show the striking, raspberry-coloured legs of adult Thayer's Gull (sometimes also evident in other ages) and none of the Glaucous-winged Gulls in his plate bear a close facial resemblance to the species in the flesh (long lore, pig eye in asymmetric position high on head, peculiar drooping bill). But hold on a minute. Inexplicably, when you scrutinise the four pages of adult gull taxa near the beginning of the book, you find that here he has caught the Glaucous-winged Gull almost to a tee. The paintings of age development on page 15 are useful (although only standing gulls are shown). However, as laid out, the progression from one age group to the next forces the eye to zigzag across the page. Perhaps this is not Larsson's fault, nor perhaps are the several (to my mind sloppy) labelling flaws in the gull topography charts.

In terms of quantity, the text is impressive. It is chock-full of all the paraphernalia of the modern gull-watcher from forensic descriptions of individual feathers (and variation in the pattern) to copious notations of grey plumage tones index-linked to Kodak's patented 'grey scale'. My mind could hardly take it all in. Then I remembered that churning out detail does not necessarily facilitate good communication – that requires lucidity and clear explanation. In a nutshell, there is far too much text in this book. Worse, it is not so much Olympic torch quality, more overblown pedantry. Malling Olsen has thrown in everything that seems to have been written about gulls since Grant, but he is not much good at interpreting it. You cannot fault him for effort. Every species and each age class is discussed under 'Identification' in good detail; then discussed again under 'Description', but this time suffocated with techno-speak and intrusive (and often needless) referencing. Bizarrely, sometimes several references are lumped together inside a single bracket – reducing subsequent literature searches to a game of 'Whodunit'.

I wondered whom the author had in mind when he was writing the text. Anoraks who would be impressed with a nice big red hardback drenched with gull-speak? With other authors, especially Lars Jonsson (even after translation), you get the feeling that layers of confusion are scraped away, that myths and errors are finally consigned to the dustbin, and that a new truthful insight is laid before you. I do not doubt that gulls intrigue Malling Olsen – but his curiosity comes across as unfocused, and obscured by impenetrable text. I am sorry to say that I quibbled and queried my way through many pages, noting down points that I felt were incorrect: from claimed statistical overlap in back colour between *argentatus* Herring Gull and *graellsii* Lesser Black-backed Gull, to gawking at the balderdash written concerning the alleged Mediterranean x Common Gull parentage of a slightly aberrant Black-headed Gull (plate 8). I was regularly frustrated at several presentational quirks. Examples include Malling Olsen's instruction in photo captions to compare the individual depicted in one photograph with numerous others. Yet, he often does not tell the reader which criteria should be compared or, worse, his analysis is muddled or wrong. A spread-winged adult *argentatus* Herring Gull in plate 367 is to be compared with an *argenteus* Herring Gull in plate 365, and, in turn, with an American Herring Gull (full species) in plate 321. A few glib words about *argenteus* having the most black in the wing tip is the gist of what is said. However, waffle follows about alleged P5 differences between American Herring Gull and *argenteus* (not borne out: compare left wing of each species) while a well-shown virtually diagnostic difference (the *thayeri*-pattern on P9 of the American Herring Gull) is not mentioned. Malling Olsen has a habit of saying in his captions what he 'knows' a species shows in life, even if the feature is not shown in the published photograph. In plate 375, side-by-side flying Caspian and Yellow-legged Gulls are compared. It is claimed that the Yellow-legged has (in contrast to the Caspian Gull) 'a broader bill with bulbous tip and well-marked gonys angle'. In the photo, the reverse is true. In plate 379, a first-summer Yellow-legged Gull is supposed to show worn plumage. Actually, its plumage looks remarkably fresh. In plate 314, a flying American Herring Gull shows 'tertials with extensive dark markings'. Once airborne, the lower scapulars overlap the tertials (making them invisible) on all flying gulls.

I could go on – as others already have about gaffes in wing pattern descriptions of Heuglin's Gull (*Birding Scotland* 7(4): 172). However, there is absolutely no doubt that, like many other gull-watchers, I will refer to 'Malling Olsen & Larsson' more than any other reference. It is not all smoke and mirrors! Personally, I think much of the blame for its shortcomings rests with its publisher, Helm, who have presided unprofessionally over an incoherent text and turgid layout – both of which could have been hugely improved. Is *Gulls* a spoiler, a tome that, by virtue of its monopoly status, we will just have to live with? That is my view. Until something better comes along, this book, I believe, is to gull identification what George W. Bush is to Planet Earth.

Anthony McGeehan

CADIOU, B., PONS, J.-M. & YÉSOU, P. (Eds.) 2004. *Les oiseaux marins nicheurs de France métropolitaine (1960-2000)* [Breeding seabirds in metropolitan France 1960-2000). Biotope Publishers. ISBN 2-914817-03-7, hardback, 218 pages.

This book is the first of its kind in presenting a highly detailed analysis of France's marine bird populations. It is based mainly on data collected by several hundred volunteers, both amateur and professional, who contributed to various national bird surveys established from the 1960s. Co-ordinated by GISOM (Groupement d'Intérêt Scientifique Oiseaux Marins), all data are presented to indicate historical changes in seabird populations in France up to 2000. The 27 species and subspecies considered currently total some 240,000 breeding pairs, and occur mainly along the Channel, Atlantic, and Mediterranean coasts; counts of inland breeders, including urban gulls are also presented.

The book presents the reader with a highly researched collection of information with very well written texts. Introductory chapters review the recent history of breeding of seabirds in France, their marine and inland habitats, conservation, population regulation, and survey methods used in assessing the populations. There follows accounts of the 27 species of marine birds that breed regularly in France, with a chapter also on four species that breed irregularly.

The species accounts include a short introduction in English and detailed text (in French) on the past and recent history of breeding in metropolitan France (Corsica is not included), the reasons for population change, and aspects of the conservation of the species. Each species is treated comprehensively and the accounts are well-researched and informed. The text is complemented with detailed tables summarizing historical population data by département and colony, as well as maps and various figures. Each species is illustrated by a black and white vignette, and high quality colour photographs feature in the middle of the book.

This is an impressive book that complements nicely the recent *Seabird Populations of Britain and Ireland* and merits a place on the shelves of all serious seabird ecologists.

Nat Hall