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The status of the Northern Gannet in Scotland in 2003-04
Waterfowl counts on the Tay Estuary

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Business Editor: Kate Walshaw, Admin Officer, SOC, The Scottish Birdwatching Resource Centre, Waterston House, Aberlady, East Lothian EH32 0PY.

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Changes in numbers and distribution of waders in the Moray Firth, 1988-2003

BOZENA KALEJTA-SUMMERS

Synchronised counts by about 45 counters were made at high tide in October, December, January and February each winter between 1988/89 and 2002/03. The average winter (December-February) numbers of all waders exceeded 40,000 in all years. Dunlin and Eurasian Oystercatcher were the most abundant waders, with average winter numbers exceeding 10,000 for each species. Sanderling and Red Knot increased significantly over the 15 year period and Purple Sandpiper and Ruddy Turnstone decreased. For Purple Sandpiper, Ruddy Turnstone and Red Knot the trends reflected patterns observed throughout the UK. However, the national index for Sanderling was stable. The seasonal variations in wader abundance were linked to different migration patterns. The Moray Firth supported internationally important numbers of Eurasian Oystercatcher, Ringed Plover, Dunlin, Red Knot, Bar-tailed Godwit, Eurasian Curlew and Common Redshank, whilst numbers of Sanderling, Purple Sandpiper and Ruddy Turnstone were nationally important.

Introduction

The importance of the Moray Firth, northeast Scotland, for wintering and migrating waders has been well documented (Symonds & Langslow 1986, Swann & Mudge 1989). The area is the most northerly group of estuaries in Britain to hold internationally important numbers of waders, with peak midwinter numbers exceeding 36,000 (Symonds & Langslow 1986). It is also an important staging area in autumn and spring (Swann & Mudge 1989, Swann & Etheridge 1996). The value of the Moray Firth has long been recognized and 4 areas have been designated as Special Protection Areas (SPAs), Ramsar sites and Sites of Special Scientific Interest (SSSIs): Dornoch Firth and Loch Fleet, Cromarty Firth, Inner Moray Firth (Munlochy Bay, Beauly Firth, Longman Bay, Castle Stuart Bay and Whiteness Head) and the Nairn coast (Fig 1).

Counts of waders and wildfowl at high tide have been conducted in the Moray Firth since the early 1960s. However, they were initially irregular and rarely covered all the main areas. Annual and complete surveys started only in 1985. These counts were coordinated by the Royal Society for the Protection of Birds (RSBP) and have continued to the present date. The counts are part of the Wetland Bird Survey (WeBS), a joint scheme run by the British Trust for Ornithology, the Wildfowl & Wetland Trust, the RSPB and the Joint Nature Conservation Committee (on behalf of Scottish Natural Heritage, Countryside Council for Wales, English Nature and Department of the Environment Northern Ireland), which coordinate waterbird counts across the UK.

Based on high tide counts, Swann and Mudge (1989) described wader populations in the Moray Firth between 1984 and 1988 and compared them with the counts during 1972-1975. This present paper reviews the current status of waders within the Moray Firth and describes their numbers and distribution between 1988-89 and 2002-03. The

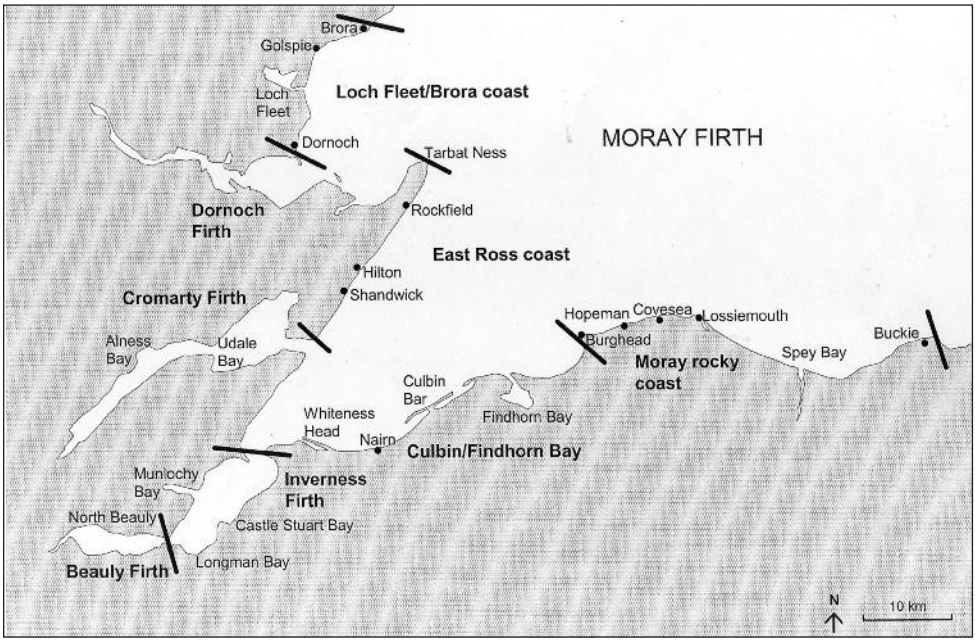

Figure 1. ***The study area in the Moray Firth.***

international and national importance of the Moray Firth for waders is reassessed and comparisons made between the numbers of waders during the last 5 years and the earlier periods (1972-1975 and 1984-1988) as described by Swann and Mudge (1989).

Study area and methods

The study area comprised the firths and adjoining beaches and rocky shores between Brora in the north and Buckie in the east (Fig 1). The area was divided into 8 sections, mainly along natural geographical boundaries: Loch Fleet/Brora coast, Dornoch Firth, East Ross coast (Tarbat Ness to Rockfield and Hilton to Shandwick), Cromarty Firth, Beauly Firth, Inverness Firth, Culbin/Findhorn Bay and Moray rocky coast (Burghead to Hopeman, Covesea to Lossiemouth and Buckie (Fig 1).

Synchronised counts by about 45 counters were made at high tide on selected dates in October, December, January and February each year between 1988 and 2003. The majority of the sections were divided and each counter surveyed one or more subsections. The counts for subsections were summed to provide a total count for the section. Average winter numbers were based on counts in December, January and February.

The East Ross coast section (Fig 1) was included in the surveys only from 1990/91. Therefore, there were no data for the first 2 winters (1988/89 and 1989/90) for this section.

To test for trends in winter, Spearman correlation coefficients were derived for the average winter numbers in the whole of the Moray Firth. To identify trends in specific

areas, correlation coefficients were derived for the average winter numbers for each section. Finally, to test for seasonal trends, correlation coefficients were derived for the total numbers of birds in each month.

To establish the national and international importance of a site for a particular species, the highest count for each winter in the most recent 5 years (1998/99-2002/03) was averaged to give the average maximum count. A site was considered to be of international importance if it regularly supported at least 1% of the western European population or if it regularly supported 20,000 or more of all waterbirds (Wetland International 2002). Similarly, a site was considered to be of national importance if it regularly supported at least 1% of the British population (Rehfisch *et al* 2003a).

A comparison was made between the average winter number of birds in the last 5 years (1998/99-2002/03) and the 3 year periods of the 1972/73-1974/75 and 1985/86-1987/88 as described by Swann & Mudge (1989). In the earlier 2 periods, counts were obtained from 8 sites: the coast between Golspie to Brora, Loch Fleet, Udale Bay, Alness Bay, Munlochy Bay, north Beauly, Longman Bay and Findhorn Bay (Fig 1). To make the results comparable, the same sites were selected for 1998/99 – 2002/03.

Results

Annual and seasonal variations in numbers

Twenty seven species of waders were recorded. Of those, 15 species (Eurasian Dotterel *Charadrius morinellus*, Grey Plover *Pluvialis squatarola*, Curlew Sandpiper *Calidris ferruginea*, Little Stint *Calidris minuta*, Ruff *Philomachus pugnax*, Long-billed Dowitcher *Limnodromus scolopaceus*, Common Snipe *Gallinago gallinago*, Jack Snipe *Lymnocryptes minimus*, Eurasian Woodcock *Scolopax rusticola*, Black-tailed Godwit *Limosa limosa*, Whimbrel *Numenius phaeopus*, Spotted Redshank *Tringa erythropus*, Common Greenshank *Tringa nebularia*, Green Sandpiper *Tringa ochropus* and Common Sandpiper *Actitis hypoleucos*) contributed, on average, less than 0.1% to the total number and were therefore excluded from the analysis.

On average, over 40,000 waders were recorded during winter over the 15-year period. The winter average ranged between 31,600 (in 1989/90) and 48,100 (in 1996-97) (Table 1), with a peak count of 55,200 in February 1997.

Dunlin *Calidris alpina* and Eurasian Oystercatcher *Haematopus ostralegus* were the most abundant species, with average winter numbers exceeding 10,000 and representing, on average, 27% and 26% respectively of the total number of birds (Table 1). They were followed by Common Redshank *Tringa totanus*, Red Knot *Calidris canutus*, Eurasian Curlew *Numenius arquata* and Bar-tailed Godwit *Limosa lapponica* which contributed on average 12%, 11%, 9% and 8% respectively, to the total number of birds.

Statistical analysis of the average winter numbers between 1988-89 and 2002-03 revealed some trends. Sanderling *Calidris alba* and Red Knot increased significantly, whereas Purple Sandpiper *Calidris maritima* and Ruddy Turnstone *Arenaria interpres* declined (Table 1). When their winter averages for the 5 year periods 1988/89-1992/93 and 1998/99-2002/03 were compared, Sanderling and Red Knot increased by 72% and 67% respectively, whereas Purple Sandpiper and Ruddy Turnstone declined by 52% and 35% respectively.

Some species showed very little seasonal variation with Eurasian Oystercatcher, Sanderling, Common Redshank and Ruddy Turnstone maintaining stable numbers between October and February (Fig 2). By contrast,

Table 1. *Average numbers of different species of waders in winter (December-February) between 1988/89 – 2002/03 in the Moray Firth. Standard deviations are given in brackets.*

	Eurasian Oystercatcher	Ringed Plover	European Golden Plover	Northern Lapwing	Dunlin	Red Knot	Sanderling	Purple Sandpiper	Bar-tailed Godwit	Eurasian Curlew	Common Redshank	Ruddy Turnstone	All
1988/89	9,536	479	157	1,168	12,550	2,704	22	379	2,787	3,429	5,365	982	39,612
	(624)	(71)	(70)	(626)	(3,387)	(1,242)	(15)	(101)	(252)	(362)	(695)	(106)	(3,630)
1989/90	9,097	344	301	927	7,565	1,404	30	494	2,591	2,881	5,103	832	31,639
	(754)	(68)	(367)	(501)	(2,250)	(303)	(30)	(53)	(389)	(1,537)	(256)	(130)	(1,240)
1990/91	10,075	599	225	601	12,793	1,457	78	526	3,255	2,489	5,171	985	38,206
	(730)	(218)	(117)	(506)	(868)	(914)	(36)	(139)	(430)	(503)	(710)	(162)	(3,522)
1991/92	10,335	503	449	787	11,631	2,133	61	391	3,290	4,672	5,691	1,148	41,142
	(752)	(18)	(404)	(354)	(2,395)	(840)	(38)	(85)	(446)	(1,765)	(501)	(145)	(2,706)
1992/93	10,446	518	10	899	9,088	1,718	39	353	3,552	3,857	4,966	851	36,310
	(1,052)	(71)	(18)	(763)	(1,184)	(1,271)	(16)	(73)	(1,182)	(1,768)	(216)	(168)	(5,232)
1993/94	9,758	358	63	408	10,784	4,899	59	287	2,814	3,971	3,990	709	38,150
	(1,621)	(100)	(72)	(135)	(2,985)	(2,069)	(10)	(99)	(571)	(1,279)	(742)	(54)	(783)
1994/95	10,271	334	170	779	10,124	4,164	25	183	2,995	4,172	3,922	735	37,931
	(1,354)	(43)	(291)	(386)	(726)	(1,449)	(18)	(149)	(1,222)	(833)	(273)	(41)	(3,435)

1995/96	9,998	411	51	599	11,201	8,506	27	288	4,249	2,907	3,396	672	42,357
	(767)	(155)	(74)	(362)	(4,707)	(1,616)	(5)	(31)	(734)	(844)	(1,019)	(35)	(5,117)
1996/97	11,085	506	2	252	14,940	9,307	36	245	4,385	3,001	3,636	612	48,141
	(482)	(17)	(62)	(101)	(2,657)	(6,107)	(15)	(86)	(1,779)	(943)	(132)	(87)	(10,457)
1997/98	12,790	500	57	1,020	12,941	4,292	108	225	2,440	4,554	4,695	602	44,355
	(1,185)	(23)	(9)	(247)	(891)	(1,711)	(33)	(105)	(1,282)	(779)	(374)	(98)	(3,505)
1998/99	10,589	442	347	845	10,229	5,830	64	281	3,098	4,261	4,785	687	41,518
	(503)	(146)	(95)	(365)	(481)	(1,596)	(38)	(73)	(841)	(707)	(569)	(142)	(1,179)
1999/ 00	10,831	573	112	824	11,633	4,724	146	205	2,363	3,980	4,543	654	40,736
	(84)	(125)	(118)	(217)	(2,467)	(990)	(23)	(15)	(486)	(615)	(205)	(83)	(2,844)
2000/01	11,067	580	338	561	10,872	6,777	191	193	2,556	3,619	5,094	692	42,624
	(444)	(166)	(201)	(409)	(1,513)	(2,780)	(49)	(62)	(444)	(521)	(521)	(160)	(6,286)
2001/02	9,178	576	202	1,371	8,785	5,096	204	210	2,107	3,483	5,095	593	37,015
	(392)	(35)	(129)	(12)	(737)	(988)	(29)	(50)	(1,100)	(706)	(792)	(105)	(2,451)
2002/03	10,212	507	366	747	10,905	6,179	211	144	3,933	3,741	5,331	516	42,898
	(1,178)	(57)	(242)	(494)	(612)	(1,558)	(93)	(49)	(819)	(819)	(331)	(67)	(1,533)
Spearman correlation coefficient	0.4	0.368	0.186	0.111	0.054	0.725	0.746	-0.846	-0.182	0.254	-0.243	-0.861	
	n.s.	n.s.	n.s.	n.s.	n.s.	<0.005	<0.005	<0.001	n.s.	n.s.	n.s.	<0.001	

numbers of Dunlin, Red Knot, Purple Sandpiper and Bar-tailed Godwit were low in October and peaked in January and/or February, whilst Northern Lapwing *Vanellus vanellus* and Ringed Plover *Charadrius hiaticula* reached peaks in abundance in October and the majority were gone by February.

Spatial distribution

Most species occurred in almost all sections of the Moray Firth but their distributions were uneven (Fig 3). Sanderling, for instance, were more numerous in Culbin/Findhorn Bay, Purple Sandpiper and Ruddy Turnstone preferred the Moray rocky coast, whereas Eurasian Oystercatcher and Red Knot occurred in highest numbers in the Cromarty Firth and Culbin/Findhorn Bay. Lapwing preferred the Cromarty Firth, Ringed Plover the Loch Fleet/Brora coast whereas Eurasian Curlew, Common Redshank, Dunlin and Bar-tailed Godwit occurred in high numbers at several localities including the Cromarty Firth, Dornoch Firth, Culbin/Findhorn Bay and/or Inverness Firth (Fig 3).

For species which showed significant trends in average winter numbers in the whole Moray Firth, further significant patterns emerged at particular sections. Sanderling increased at Loch Fleet/Brora coast and Culbin/Findhorn Bay by 63% and 79% respectively, whereas numbers of Red Knot increased in the Dornoch Firth (by 74%), Inverness Firth (by 99%) and Moray rocky coast (by 55%) (Table 2). Ruddy Turnstone and Purple Sandpiper declined in the Dornoch Firth (by 44% and 53%) and along the Moray rocky coast (by 34% and 66%). In addition, Purple Sandpiper also declined by 60% on the East Ross coast and Ruddy Turnstone by 37% in the Inverness Firth.

For species that showed no significant trends in the mean winter numbers for the Moray Firth as a whole, some significant changes occurred at certain sections (Fig 3, Table 2). Numbers of Eurasian Oystercatcher, for instance, increased between 18% and 51% in the Cromarty Firth, Beauly Firth and East Ross coast, but at the same time declined by 25% at Loch Fleet/Brora coast. Similar shifts in distribution were observed for Common Redshank. Their numbers significantly increased by 54% and 71% on the Moray rocky coast and in the Beauly Firth but declined by 24% and 35% in Culbin/Findhorn Bay and the Inverness Firth. Dunlin, on the other hand, declined by 54% in the Beauly Firth as did Bar-tailed Godwit in the Moray and East Ross rocky coasts and Culbin/Findhorn Bay. Ringed Plover decreased by 36% on the Moray rocky coast but, at the same time, increased by 45% in the Dornoch Firth.

International and national importance

The average maximum numbers of 7 species, Eurasian Oystercatcher, Ringed Plover, Dunlin, Red Knot, Bar-tailed Godwit, Eurasian Curlew and Common Redshank, in the Moray Firth exceeded 1% of the international total for those species in the most recent 5 years (1988/89-2002/03) (Table 3). In addition, the Moray Firth supported nationally important numbers of Sanderling, Purple Sandpiper and Ruddy Turnstone. Furthermore, the Moray Firth as a whole supported over 40,000 waders in all years over the 15 year period (Table 1).

When individual sections were considered, internationally important numbers of Common Redshank were found in the Cromarty and Inverness Firths. The Cromarty Firth also supported internationally important numbers of Bar-tailed Godwit and nationally important numbers of Red Knot. Culbin/Findhorn Bay supported nationally important numbers of Eurasian Oystercatcher and Bar-tailed Godwit whereas the Dornoch Firth was nationally important for Bar-tailed Godwit.

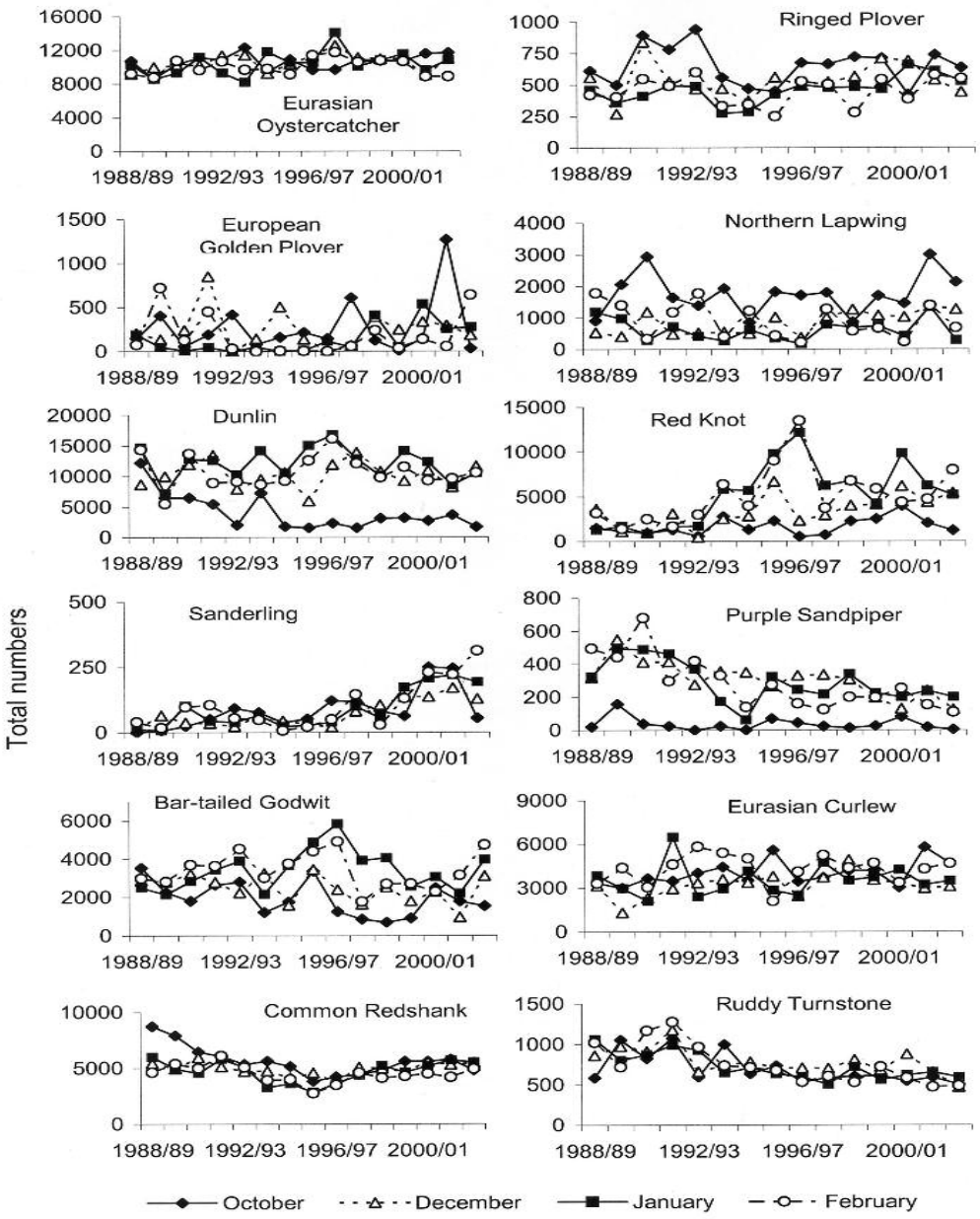

Figure 2. ***Numbers of waders in October, December, January and February in the Moray Firth between 1988/89 and 2002/03.***

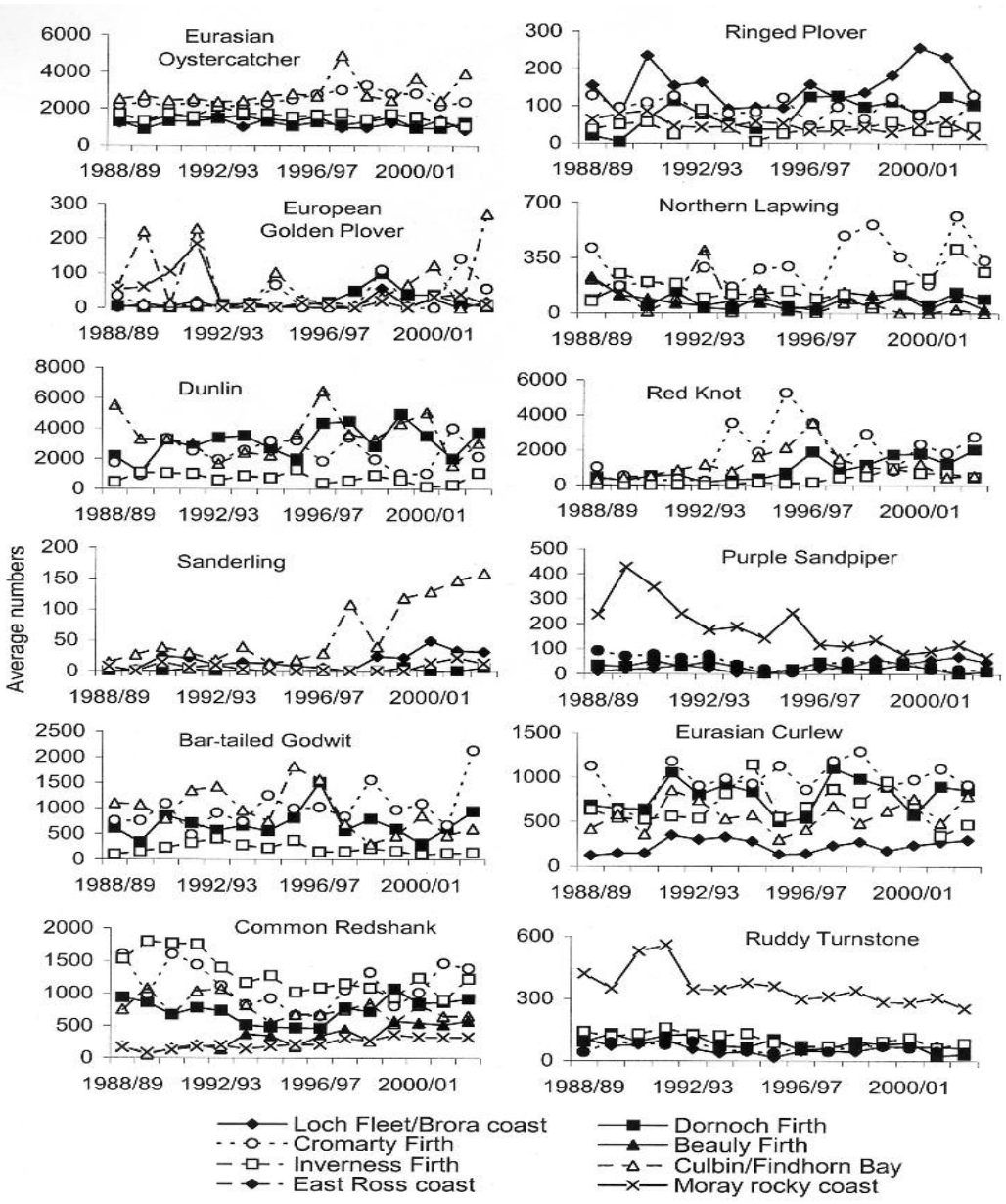

Figure 3. ***Average winter numbers (December-February) of waders in different sections of the Moray Firth between 1988/89 and 2002/03. Only 4 to 5 of the numerically most important sites were selected for each species.***

Table 2. *Spearman correlation coefficients (r_s) and the P-values for different areas within the Moray Firth. P-values are given only for those species which showed significant trends in the average winter numbers between 1988/89 and 2002/03 (see Fig 3).*

	Eurasian Oystercatcher	Ringed Plover	European Golden Plover	Northern Lapwing	Dunlin	Red Knot	Sanderling	Purple Sandpiper	Bar-tailed Godwit	Eurasian Curlew	Common Redshank	Ruddy Turnstone
Loch Fleet/ Brora coast	-0.531 P<0.05						0.588 P<0.05					
Dornoch Firth		0.625 P<0.02	0.589 P<0.05			0.814 P<0.001		-0.543 P<0.05				-0.697 P<0.01
East Ross Coast	0.746 P<0.005							-0.733 P<0.005		0.871 P<0.001		
Cromarty Firth	0.525 P<0.05											
Beauly Firth	0.557 P<0.05				-0.714 P<0.005						0.843 P<0.001	
Inverness Firth						0.912 P<0.001					-0.746 P<0.005	-0.757 P<0.002
Culbin/ Findhorn Bay				-0.606 P<0.02			0.786 P<0.001		-0.579 P<0.05		-0.529 P<0.05	
Moray rocky coast		-0.596 P<0.05				0.595 P<0.05		-0.857 P<0.001	-0.654 P=0.01		0.914 P<0.001	-0.857 P<0.001

Comparisons with previous records

Comparisons between mean winter numbers revealed significant differences between the 1970s, 1980s and 1998 – 2003 for 4 species (Table 4). Between the 1970s and 1980s, numbers of Red Knot and Dunlin declined by 82% and 56%, respectively, (Swann & Mudge 1989). However, since then, they have increased by 80% and 38% (Table 4). Numbers of Ringed Plover increased significantly by 44% in the last 15 years and by 55% between 1970s and 1998 –2003 (Table 4) (Swann & Mudge 1989). Eurasian Oystercatcher, on the other hand, increased significantly by 44% between the 1970s and 1980s and although their numbers dropped by 22% between 1980s and 1998-2003, the increase by 28% between 1970s and 1998-2003 was significant. Numbers of Northern Lapwing decreased significantly by 77% between 1970s and 1980s, but their increase between 1980s and 1998-2003 was not significant. No other species showed significant long term changes in abundance over the last 30 years. Ruddy Turnstone and Purple Sandpiper were not counted in the earlier years so it is not possible to comment on their long term changes in numbers.

Discussion

Annual variations in numbers

This study has revealed significant trends for 4 wader species in the Moray Firth over the 15 year study period. The decrease in numbers of Purple Sandpiper (by 53%) and Ruddy Turnstone (by 35%) (Table 1) reflected trends observed elsewhere in the UK. A survey conducted over 38% of the UK's non estuarine coastline between 1984/85 and 1997/98 showed a decline of 16% for Ruddy Turnstone and 21% for Purple Sandpiper (Rehfisch *et al* 2003c). However, declines of both species in East Lothian, southeast Scotland, between 1970s and 1990s were much higher: 73% for Ruddy Turnstone and 88% for Purple Sandpiper (Dott 1997), indicating spatial variations in these declines. The scale of the decline in the Moray Firth was greater for Purple Sandpiper than for Ruddy Turnstone in line with the other studies. The declines are probably also slightly underestimated because the East Ross rocky shore was not surveyed during the first 2 years of this study.

The increase in numbers of Sanderling in the Moray Firth over the 15 year period did not reflect their national index which is relatively stable (Pollit *et al* 2003). This also contrasts with the estimated UK wintering population on the non estuarine coastline between 1984/85 and 1997/98 which showed a decrease of 20% (Rehfisch *et al* 2003c). For Red Knot, on the other hand, the national index indicates a decline by 15% in the past 30 years but an increase by 4% over the last 10 years (Pollitt *et al* 2003).

The comparison of the counts in the 8 selected areas in the Moray Firth between the 1970s and 1998-2003 indicates that Ringed Plover has continued to increase over the last 30 years (Table 4). This contrasts with the national trend which indicates a decline by more than 25% over the last 25 years (Pollitt *et al* 2003). Similarly, a decrease by 15% has been reported for Ringed Plover on non estuarine coasts between 1984/85 and 1997/98 (Rehfisch *et al* 2003c).

Although there was no significant trend for Dunlin in the Moray Firth over the last 15 years (Table 1), the average winter number in the 8 selected areas over the last 5 years was significantly higher than during 1985-1988 (Table 4). This contrasts with the UK annual index which in the late 1990s was low and similar to that of the mid 1980s (Pollitt *et al* 2003). The average winter numbers of Eurasian Oystercatchers, on the other hand, was higher over the last 5 years than during 1972-1975 (Table 4). This pattern mirrors the national index which increased by 45% over the last 30 years (Pollitt *et al* 2003).

Table 3. ***Average maximum numbers of waders in different sections of the Moray Firth between 1998/99 and 2002/03, and 1% thresholds to qualify sections as internationally (Wetland International 2002) or nationally (Rehfisch et al 2003a) important for those species. Sections of international importance are in bold and underlined whereas sites of national importance are only in bold. Only those sections that held internationally or nationally important numbers of birds are shown.***

	Eurasian Oystercatcher	Ringed Plover	European Golden Plover	Northern Lapwing	Dunlin	Red Knot	Sanderling	Purple Sandpiper	Bar-tailed Godwit	Eurasian Curlew	Common Redshank	Ruddy Turnstone
International threshold	10,200	730	8,000	20,000	13,300	4,500	1,200	750	1,200	4,200	1,300	1,000
National threshold	3,200	330	2,500	20,000	5,600	2,800	210	180	620	1,500	1,200	500
Dornoch Firth	1,504	141	65	154	4,442	2,140	6	35	**997**	1,134	1,012	92
Cromarty Firth	3,153	170	305	897	2,419	**3,327**	0	<1	**1,787**	1,305	**1,732**	49
Inverness Firth	1,669	95	79	607	1,010	1,256	0	2	284	850	**1,425**	116
Culbin/ Findhorn Bay	**4,009**	99	257	59	4,458	1,596	166	3	**855**	998	993	56
Moray Firth	**11,671**	**738**	1,268	3,001	**14,156**	**9,810**	**312**	**339**	**4,739**	**5,767**	**5,795**	**876**

Several factors may be responsible for annual fluctuations and long term trends in numbers. These includes breeding success. Ruddy Turnstones and most Purple Sandpipers wintering in the Moray Firth come from the same breeding grounds, Canada (Nicoll *et al* 1988, Swann & Etheridge 1996), and their declines in the Moray Firth may be due to poor breeding success. For Purple Sandpipers the decline in numbers can be accounted for by the low recruitment in the late 1980s and early 1990s (Summers *et al* 2005).

Climatic changes and increasingly mild winters may cause geographical shifts in the distribution of birds, resulting in local population changes. The increasing mean minimum winter temperature in the UK may partially explain a northward and eastward shift of 6 species of waders between 1984/85 and 1997/98 in their non estuarine coastal distribution, and an eastward shift of 5 species over the last 15 years in their distribution among estuaries (Austin *et al* 2000). The Ringed Plover distribution, for instance, has moved partially from the west to east coast following milder winters (Austin *et al* 2000). It has also been suggested that some waders that used to winter in the UK might now be wintering elsewhere as milder conditions make previously unsuitable areas hospitable (Rehfisch *et al* 2003c). The decline in Ruddy Turnstone and Purple Sandpiper might simply be a result of more birds spending winter closer to the breeding grounds eg Iceland, instead of migrating to Britain. It is also possible that some waders might decide to stay in the Moray Firth for the winter instead of moving further south. More evidence, however, is required to support these ideas.

Severe weather can also affect wader distributions. Prys-Jones *et al* (1994) suggested that the widely fluctuating numbers of Bar-tailed Godwit in Britain between the 1970s and 1990s were due to immigration of birds from the Wadden Sea during severe weather. However, ringing has shown that not many birds come to the Moray Firth from continental Europe in response to severe weather in comparison with wetlands further south in Britain (Swann & Etheridge 1996).

Food supply is another important factor regulating bird numbers. An invertebrate survey in the 1960s in Nigg and Udale Bays indicated that the food supply for waders, although rich in species, was not particularly abundant (Anderson 1970). Lack of large expanses of uniform sediments with optimum amounts of organic nutrients were thought to be responsible for the low density of invertebrates. A later survey, in the early 1980s, showed an increase in species richness (Raffaelli & Boyle 1986). It is unknown, however, if the change was part of a long term natural cycle of invertebrates or were induced by onshore development in the area (Raffaelli & Boyle 1986). The present status of invertebrates in the Moray Firth is unknown.

It has been demonstrated that organic input can have a positive impact on the presence of waders in estuaries and non estuarine coasts (Rehfisch & Austin in press). The discharges from sewage and trade effluents provide organic nutrients for intertidal invertebrates, resulting in an increase in invertebrate abundance and diversity (Pearson & Rosenberg 1978, Kropp *et al* 2000). This is likely to affect the number of waders feeding in the vicinity of outfalls. Although there are 5 distilleries and several sewage outfalls around the Moray Firth, their organic input is now believed to be low because of improvements to sewage treatment in the 1980s (SEPA, pers comm). The most recent (1999) changes involved moving the discharge outfalls from 2 distilleries in the Cromarty and Dornoch Firths into deeper water and away from the shore (SEPA, pers comm). Similarly, the sewage output at Inverness was upgraded in 2000,

Table 4. *Mean winter numbers and standard deviations (in brackets) for waders at 8 selected sites (see methods) in the Moray Firth in 1972-75, 1985-88 and 1998-2003. Mean numbers for the 2 former periods were taken from Swann & Mudge (1989). Ninety five percentage confidence interval of the difference was obtained from* $\pm 1.96 \times \sqrt{(se_1^2 + se_2^2)}$. *Significant differences are in bold.*

				Mean difference (95% confidence interval)	
	1972-1975	1985-1988	1998-2003	1972-1975 and 1998-2003	1985-88 and 1998-2003
Eurasian Oystercatcher	2,504 (423)	4,452 (1127)	3,460 (235)	**956 (407 to1504)**	-992 (-2,296 to 313)
Ringed Plover	83 (35)	103 (40)	185 (49)	**102 (33 to 170)**	**82 (10 to 154)**
Northern Lapwing	615 (420)	141 (105)	245 (123)	-370 (-866 to 126)	104 (-79 to 287)
Red Knot	1,398 (1,234)	255 (294)	1,289 (774)	-109 (-1,759 to 1,541)	**1,034 (96 to 1,972)**
Dunlin	3,137 (1,615)	1,376 (360)	2,218 (599)	-919 (-2,871 to 1,033)	**842 (50 to 1,634)**
Bar-tailed Godwit	705 (324)	521 (385)	504 (336)	-201 (-730 to 328)	-17 (-596 to 562)
Eurasian Curlew	981 (198)	922 (332)	946 (139)	-35 (-309 to 239)	24 (-384 to 432)
Common Redshank	1,703 (330)	1,777 (557)	1,857 (180)	154 (-272 to 580)	80 (-583 to 742)

reducing the amount of nutrients, and moved further east into deeper water. It has been demonstrated that improvements to sewage treatment may result in a decrease in invertebrate abundance as communities return to those more typical of an unenriched environment (Kropp *et al* 2000). On the Clyde estuary, for instance, improvements to 4 sewage treatment works have been linked to a decline in the abundance of *Corophium volutator* and *Nereis diversicolor* (Curtis & Smyth 1982, Thompson *et al* 1986). It is unknown, however, whether the long term changes in wader populations at the Moray Firth have been affected by any changes in invertebrates associated with sewage outfalls.

In the case of Purple Sandpiper and Ruddy Turnstone, both species are rocky shore specialists and are site faithful within and between winters (Atkinson *et al* 1981, Burton & Evans 1997; Rehfisch *et al* 2003b). Their food is less affected by cold weather than that of waders on estuaries but could have been influenced by the changes in sewage outfalls (Eaton 1999).

Seasonal variations in numbers

The seasonal variations in numbers of waders in the Moray Firth can be explained by different migration patterns. The birds that winter in the Moray Firth can be grouped according to their origins. The northwestern group includes Red Knot, Ruddy Turnstone, Purple Sandpiper and Sanderling, which breed in Arctic Canada and northern Greenland. The northeastern group includes Bar-tailed Godwit, Grey Plover and Dunlin that breed in Arctic Russia (Swann & Etheridge 1996, Swann & Insley 1997). The western European group comprises Eurasian Oystercatcher, Common Redshank, Golden Plover, Dunlin, Eurasian Curlew, Purple Sandpiper and Ringed Plover whose breeding grounds include Iceland, Faroe Islands, northern Scotland and Scandinavia. Finally, there is a group of locally breeding birds: Eurasian Oystercatcher, Northern Lapwing, Ringed Plover and Eurasian Curlew (Swann & Etheridge 1996). As a result of the diverse origins of the waders (some of which originate from more than one breeding population), arrivals and departures to and from the Moray Firth occur at different times.

Adult birds of species such as Eurasian Oystercatcher, Common Redshank and Ruddy Turnstone start to return to the Moray Firth in July. Peak numbers for these species occur in late October, when young birds arrive and adults move through on passage (Swann & Mudge 1989). Numbers then remain high and stable throughout the winter (Fig 2). For species such as Dunlin, Red Knot, Purple Sandpiper and Bar-tailed Godwit, the first influx of adults usually occurs in late October and November, and peak numbers are not recorded until the midwinter months (December-January) (Fig 2; Swann & Mudge 1989). For Ringed Plover and Northern Lapwing numbers peak in October, though, the latter species is present in large numbers also in August (McNee 2003). During midwinter, numbers of Ringed Plover decrease (Fig 2) as the larger flocks disperse (Swann & Mudge 1989). Fluctuations in numbers of Golden Plover, Northern Lapwing and Eurasian Curlew throughout the winter (Fig 2) are probably due to severe weather as many of these birds feed locally in the nearby fields and rely more on to the coast when fields become frozen (Swann & Mudge 1989).

The results of this study confirmed the international and national importance of the Moray Firth as a wintering site for waders. However, in comparison with the 1980s, the area no longer supports internationally important numbers of Ruddy Turnstone but it became internationally important for Ringed Plover, Dunlin, Red Knot

and Bar-tailed Godwit (Table 3; Swann & Mudge 1989). In addition, the Moray Firth now supports nationally important numbers of Sanderling and Purple Sandpiper.

The total number of waders in the Moray Firth regularly exceeded 30,000, with 6 species accounting for 93% of the total. This places the Moray Firth as second only to the Solway Firth in importance in Scotland, and twelfth of all the estuaries in Britain (Pollitt *et al* 2003).

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Bozena Kalejta-Summers, Royal Society for the Protection of Birds, Etive House, Beechwood Park, Inverness IV2 3BW.
E-mail: Bozena@waders.fsworld.co.uk

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The status of the Northern Gannet in Scotland in 2003-04

S MURRAY, S WANLESS & M P HARRIS

A census of the Northern Gannet colonies in Britain and Ireland was carried out in 2003-04. Scotland had 14 colonies with a total of 182,511 apparently occupied sites, representing 58% of the east Atlantic population. Numbers were divided unevenly between the colonies with St Kilda, the Bass Rock and Ailsa Craig together holding 74% of the Scottish population and 43% of the east Atlantic population. Two new colonies have been founded since the last major census in 1994-95, at Sule Skerry (2003) and Westray (2003). Comparison of colony totals with previous estimates indicate that numbers at St Kilda and Sule Stack were stable whereas Ailsa Craig and Sula Sgeir had decreased. Rates of increase varied considerably, but in general were highest at the most recently founded and smallest colonies. Although overall numbers continued to increase, the sustained period of population growth throughout the 20th century has slowed over the last 10 years.

Introduction

At the time of the last comprehensive census of the Northern Gannet *Morus bassanus* in 1994-95, there were 12 gannetries in Scotland. The Scottish population was estimated at 167,407 occupied sites which represented 61% of the total for the east Atlantic (Murray & Wanless 1997). Numbers at most colonies were increasing and the Scottish population had increased at an average rate of 2.4% per annum (pa) between 1984-85 and 1994-95. We co-ordinated another survey of British and Irish Gannetries in 2004 and this paper details the counts from all the Scottish colonies in 2003 or 2004 and compares them with the results of the 1994-95 census.

Methods

The locations of the 14 colonies are shown in Figure 1. We carried out aerial surveys of the Bass Rock, Sule Stack, Sula Sgeir, the Flannan Isles, St Kilda, Ailsa Craig and the Scar Rocks in 2004, and counted Sule Skerry from a land photograph. Other observers counted Westray, Foula, Fair Isle and Troup Head in 2004 and Noss and Hermaness in 2003.

The 2003-04 survey was carried out using similar methods to those adopted in 1984-85 and refined in 1994-95, with colonies counted either from field counts made from the land or sea, or from photographs (mainly transparencies) taken from the land, sea or air. The methods and the associated problems are described in Murray & Wanless (1986, 1997). In brief, for counts made from photographs the only practical counting unit was the apparently occupied site (AOS, a site occupied by one or 2 Gannets irrespective of whether nest material was present). In most field counts the unit was the apparently occupied nest (AON, one or 2 birds at a site with nest material present). Sites with a chick but no obvious nest were included in this category. Neither count unit provides an estimate of the number of breeding pairs, nor is it strictly correct to equate occupied sites with pairs, as some sites may be held by a single bird for at least a year (Nelson 1978).

The unavoidable lack of standardisation of count units across colonies makes it impossible to

calculate a grand total for Scotland in terms of a common unit. Our estimate of the Scottish population, and the east Atlantic total, is therefore, a combination of totals of apparently occupied sites at the majority of colonies and a few counts of nests. No correction factors were applied to either unit, and for convenience the grand total is expressed in terms of apparently occupied sites.

Counts were made between 26 May and 26 July, which is within the time period recommended by Nelson (1978). The counts for most colonies are presented in terms of their constituent sections, to facilitate future comparisons of population changes. These boundaries are shown in Murray & Wanless (1997) and Wanless *et al* (2005a). Average rates of change for each colony were calculated using the equation: P2/P1=(1+r)t where r is the rate of population change, P1 is the nest or site count in 1994 or 1995, P2 is the nest or site count in 2003 or 2004 and t is the number of years between the 2 counts. It is inevitable that some of the observed changes in numbers will be due to counting or sampling errors rather than actual changes in abundance. Variations in count methods, dates or times when counts are made and the quality of photographic images, all contribute to counting errors. Even when photographs are of a high standard, there is variation among counts made by each observer and among different observers (Harris & Lloyd 1977). The 2004 results of replicate counts made between 2 observers, indicated that changes associated with observer error were generally between 5-10%, similar to those recorded in the 1984-85 and 1994-95 surveys (Murray & Wanless 1986 & 1997, Wanless 1987, Wanless *et al* 2005a). Therefore, differences in count totals between 1994-95 and 2003-04 of <10%, were interpreted as indicating no overall change and approximately stable numbers. However, for all colonies careful inspections were made to pinpoint any major changes in colony extent or nesting density. Unless otherwise stated, counts from 2003-4 and 1994-5 are directly comparable.

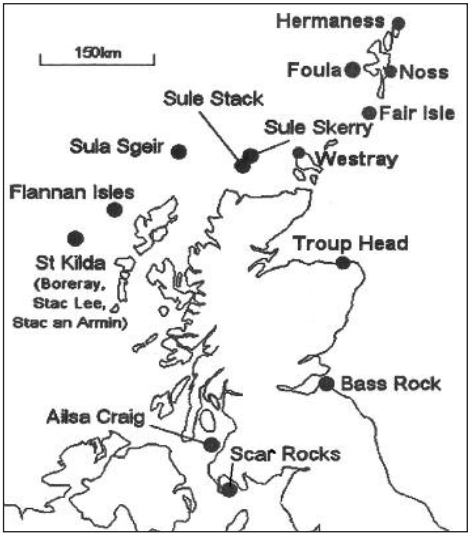


Figure 1. ***The locations of Northern Gannet colonies in Scotland 2004.***

Results

There were 14 active gannetries in Scotland in 2003-04 (Fig 1). Since the 1994-95 survey new gannetries have become established in Orkney, on Sule Skerry and Westray. There has been no recorded nest building on the Shiant Isles since 1986 and no birds or nests were present in May 2004 (pers obs). There have been no reports from Rockall since 1992, when a nest with an egg was found (Belaoussoff 1993). The rock was not visited in 2004. The 2003-04 counts and population trends are summarised below for each of the Scottish gannetries.

Scar (Scare) Rocks

An aerial survey was made on 6 June 2004. Three counts made by 2 observers gave an average total of 2,394 AOS, representing an overall increase of 22.6% since 1995 at an

average rate of increase of 2.3% pa. There was no change in overall density, but small increases in colony extent were apparent at the lower edge of the Plateau section.

Table 1 ***Counts (AOS) of the Scar Rocks Gannetry in 1995 and 2004.***

Count Section	5 August 1995	6 June 2004
West Slope	211	226
West Stack	111	121
North Cliff	28	38
Plateau	1604	2009
Total	1952	2394

Ailsa Craig

An aerial survey was made on 6 June 2004. Three counts made by 2 observers averaged 27,130 AOS, an overall decrease of 16.4% since 1995 at 2% pa. Comparison with the 1995 photographs showed small increases along the upper colony limit of Section 9/10/11, but a decrease in breeding density, leaving a near empty swath through this section (Table 2). In contrast, an increase in breeding density has taken place in Section 21, but without noticeable changes in the colony extent. Elsewhere there appeared to be no changes to colony boundaries, and the small gaps separating Section 6 from Section 7, and also Section 13/14 from adjacent sections, apparent in 1995, were still obvious.

The decrease in the population seemed to be due to an overall decline in breeding density, reflected in both observers results for 2004 (Wanless *et al* 2005a, b & c). Observer 1 counted 25,017 and 26,905 AOS respectively and Observer 2, 28,298 AOS, giving a mean for the 3 counts of 27,130 AOS. The late date of the 1995 count may have contributed to the higher count that year, but that does not explain the large drop in numbers, in for example Section 8 (Table 2). There may have been an element of over counting in 1995, and repeat counts made of some sections support this view. However, even if the 1995 total was too high and is adjusted downward to 30,844 AOS, the lower of the 2 counts, rather than the published average of 32,456 AOS, then the colony has still shown an overall decrease of 13.4%.

Table 2 ***Counts (AOS) of the Ailsa Craig Gannetry in 1995 and 2004.***

Count Section	5 August 1995	6 June 2004
1	946	1009
2	187	85
3	441	245
4 & 5	1877	1222
6	2097	1333
7	954	809
8	4300	2711
9,10 & 11	11959	10338
12	140	157
13 & 14	1994	1411
15 & 16	2263	2279
17	21	38
18	908	711
19	3410	3482
20	531	270
21	250	797
22	0	0
23	177	236
Total	32455	27130

St Kilda (Boreray, Stac Lee and Stac an Armin)

The aerial survey made on 21 June 2004 gave 100% photographic coverage of the stacks and 97.3% coverage of Boreray, the same percentages as in 1994. Two complete counts were done by one observer and sample counts

totalling 38% of the group total by a second observer. The average group total was 59,622 AOS (Table 3), a decrease of 1.3% since 1994 at 0.1% pa. No changes were found in nest densities and colony extent remained largely unchanged, except for small increases in one section on Boreray and 2 on Stac an Armin. The slow but consistent increase that had occurred between 1959 and 1994 (at an average of 0.9% pa Murray & Wanless 1996) had ceased and numbers are probably stable.

Boreray

Because of the complexity of the cliff structure, small areas in some sections are virtually impossible to photograph from the air. These have been identified from past land visits and were counted from the land on 18 August 2003. The aerial survey achieved almost complete coverage of the colony, but the quality of the images was too poor to give a count of sections 3 to 12. Here, 582 AOS were added to the section total, based on these earlier land counts. The figures were included in the final section totals (Table 3).

The combined air and land counts gave an average total of 32,333 AOS (Table 3), an overall decrease of 1.5% since 1994, at 0.1% pa. The land visit in 2003 and comparison with the 1994 photographs failed to detect any changes in colony extent, except for a small increase on the upper east side of section 83 to 88. Given the available information, numbers on Boreray are probably stable.

Stac Lee

The average total was 13,369 AOS (Table 3), a decrease of 8.8% since 1994, at 0.8% pa. Comparison with the 1994 photographs failed to find any obvious changes in the densely packed Top Table or on narrow ledges that comprise breeding sites on other areas of the stack. Areas unoccupied in 1994 that were apparently suitable breeding habitat remained unoccupied, and had not changed in extent. The apparent decrease is within the limits of intra and inter observer variation and suggests that numbers are stable.

Stac an Armin

The average total was 13,920 AOS (Table 3), an increase of 7.5% since 1994, at 0.7% pa. Comparison with the 1994 photographs clearly shows areas of increase, at the foot of the prominent centre gully of the South Summit / East Face section and the lowest corner of the South Centre section. Increases in both these areas were first noted in 1994.

Table 3 ***Counts (AOS) of the St Kilda Gannetry in 1994 and 2004.***

Sub colony	Count Section	15 May 1994	21 June 2004
Boreray	1	21	30
	2	50	58
	3 to 12	1892	1721
	13 to 15	1756	1558
	16 to 41	5815	5506
	42 & 43	1316	1410
	44	89	65
	45	500	593
	46	576	610
	47	784	684
	48	835	854
	49	1063	1044
	50	34	25
	51 to 57	4068	4247
	58 to 63	2447	2408
	64	549	506
	65	455	386
	66	463	450
	67 to 72	1828	1795
	73	426	322
	74 to 78	2622	2371

	79	381	542
	80	382	332
	81 & 82	1341	1587
	83 to 88	2831	2875
	89	294	362
Boreray	**Total**	**32818**	**32333**
Stac Lee	Top Table	7141	7247
	Bothy Face	1525	1273
	Casting Point	2877	2242
	North Face	3117	2607
Stac Lee	**Total**	**14660**	**13369**
Stac an Armin	South Summit / East Face	9089	9830
	Lower East Face	1487	1436
	West Face	1204	1155
	South Centre / Lower South Ledge	1259	1500
Stac an Armin Total		**12950**	**13920**
St Kilda	**Total**	**60428**	**59622**

Flannan Isles

The aerial survey was made on the 26 May 2004. The average total of 3 counts by one observer was 2,760 AOS (Table 4), an increase of 91.9% since 1994 at 6.7% pa.

There were increases in all sections where breeding had occurred in 1994, most notably in the South colony of Roareim, and the offshore islet Sgeir an Eoin. In 1994 breeding was suspected in the East section, but in 2004 this appeared to be used entirely by non breeders, which left the ground on the approach of the aircraft. On the adjacent island, Eilean a Gobha, where displaying pairs were seen on 24 May 1992, there were no birds present in 1994, 1998 or 2004.

A count by M Tasker, G Leaper and S O'Brien, from both land and sea on 3 June 1998 reported 1244 AOS (Wanless & Harris 2004). This was unexpectedly low compared to the aerial survey results obtained in 1994 (1436 AOS) and 2004 (2760 AOS). However, despite the small scale of the colony it is difficult to find a clear viewpoint that adequately covers all the breeding groups, either from the land or the sea, whereas the low lying nature of the islets make them ideal for aerial photography. The most likely explanation for the count fluctuations are the different count methodologies used, and the more complete colony coverage obtained by aerial survey.

Table 4 ***Counts (AOS) of the Flannan Isles Gannetry in 1994 and 2004.***

Count Section	15 July 1994	26 May 2004
West Stac	8	51
Arch Stac	107	145
Sgeir an Eoin	248	625
Main	960	1302
South	113	637
East	0	0
Total	1436	2760

Sula Sgeir

The aerial survey was made on 26 May 2004 and achieved 100% photographic coverage, with good to excellent image quality. Four counts made by 2 observers gave an average total of 9,225 AOS (Table 5), a decline of 11.6% since 1994 at 1.2% pa.

Comparison with the 1994 photographs, particularly those of the summit plateau and around the helipad, revealed no changes in colony extent, either increases or decreases, nor any differences in the limits of sub colony boundaries, however birds appear to be nesting at relatively low densities throughout the colony.

Table 5 ***Counts (AOS) of the Sula Sgeir Gannetry in 1994 and 2004.***

Count Section	15 July 1994	26 May 2004
1	879	546
2	384	337
3	2954	2350
4a	2038	1944
4b	1154	1121
5	0	0
6	1353	1339
7	1680	1589
helipad	0	0
Total	10440	9225

Sule Stack

The first successful aerial survey was made in July 1969 for Operation Seafarer and found 4018 pairs occupying nests (Cramp *et al* 1974). The second aerial survey, on 15 July 1985, was too distant from the rock and the total of 5880 AOS is undoubtedly an overestimate (Murray & Wanless 1997). Subsequent surveys in 1994 and 26 May 2004 (Table 6) have delivered photographs of outstanding coverage and quality. Two whole colony counts made by one observer gave an average total of 4618 AOS, an overall decrease of 5.5% since 1994, at an average rate of 0.6% pa. However, comparisons with the 1994 photographs found no changes in the largest sections, but a small increase in the number of AOS in the South section. This population appears stable, and most probably has been since at least 1969.

Table 6 ***Counts (AOS) of the Sule Stack Gannetry in 1994 and 2004.***

Count Section	15 July 1994	26 May 2004
North	0	0
North West	775	748
North East	632	615
East	357	351
South East]	1296]	569
Centre]	]	633
Top	1755	1581
South	73	121
Total	4888	4618

Sule Skerry

Between 1992 and 2002 Gannets were periodically reported ashore on the west side of the island, (Fig 2) and on the 13 July 2003 15 pairs had sites with either eggs or chicks among nesting Common Guillemots *Uria aalge* (Budworth & Blackburn 2004). To prevent disturbance to this newly established colony, no aerial survey was made. A land count, made by D Budworth on 8 July 2004 gave c40 occupied nests, at least 10 of which had chicks. Counts by the authors from a photograph taken on land that day all suggested 57 AOS. However, there were

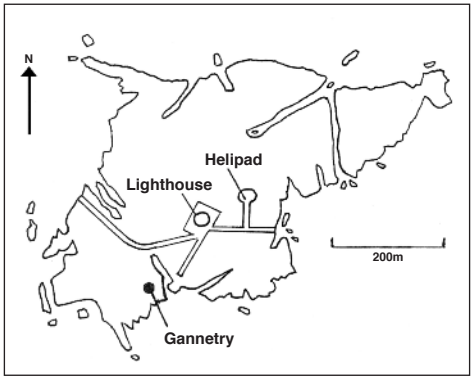


Figure 2. ***The site of the Gannetry on Sule Skerry in 2004.***

slight differences in interpretation of the photograph, so the total was probably between 55-60 AOS (Wanless *et al* 2005a).

Westray

Gannets were first noticed on The Noup, Westray in 2003, when 5 nests were found among breeding Common Guillemots, but only 2 eggs were laid and probably only one chick fledged. A count on 21-22 June 2004 by K Judd (RSPB) found numbers had increased to 14 nests in 3 distinct groups (Wanless *et al* 2005b).

Fair Isle

The 2004 count of 1875 AON was made on 13 June 2004 by C Bailley and D Shaw (Fair Isle Bird Observatory Trust) (Table 7). Counts were made from the land except for Sheep Rock and the outer face of the Inner Stack of Scroo. There had been a 127% overall increase since 1994, at an average rate of 8.6% pa. All the established sub colonies increased, and in 1997 a pair colonised Sheep Rock; only a single bird was present in 1998, but since then an increasing number of pairs has bred each year.

Table 7 ***Counts (AON) of the Fair Isle Gannetry in 1994 and 2004.***

Count Section	13 June 1994	13 June 2004
Outer Stack	219	584
Inner Stack of Scroo	66	205
Yellow Head	34	48
Dronger	77	79
North Felsigeo	285	436
Toor ‘o’ da Ward Hill	82	209
Matchi Stack	30	65
Kame ‘o’ Guidicum	32	226
Sheep Rock	0	23
Total	825	1875

Foula

A total of 879 AOS was counted from the land and sea by S Gear, and a further 40 on the summit of Da Stab stack estimated from the air, giving a total of 919 AOS on 3 July 2004. The 1994 survey on the 2 and 16 July found c600 AOS, thus giving an increase of 130% at an average rate of 8.7% pa over the decade.

Hermaness

The majority of nests were counted from the land on 22 and 23 July 2003 by S E Duffield, J Swale and M Pennington (Duffield 2003), with areas hidden from the land counted from a boat on the 26 June 2003. The total count was 15,633 AON, an increase of 30% since 1994 at 3.0% pa (Table 8). Colony extent also expanded between 1999 and 2003, with birds colonising both the Greing and Flodda Stac. The 2003 total would undoubtedly have been higher had a landslide not destroyed several hundred nests on Saito prior to the survey.

Table 8 ***Counts (AON) of the Hermaness Gannetry in 1994 and 2003.***

Count Section	12 to 18 July & 22 August 1994	26 June & 22 & 23 July 2003
Rumblings East	736	869
Vesta Skerry East	1381	1745
Vesta Skerry West	623	485
Humla Stack North	251	265
Humla Stack West	251	101
Humla Stack Southwest	0	214
Humla Houl North	133	151
Humla Houl South	435	478
Burra Stack East	335	377
Burra Stack West	238	264
Clingra Stack	207	317
Neap North Face	492	1190

Neap - Soorie	3096	3873
Soorie - Saito	1799	2606
Saito	1509	1941
Soorie Stacks	54	60
Neapna Stack	453	550
Flodda Stack	0	38
Greing West	0	109
Total	11993	15633

Noss

Two whole colony counts of nests were made by S Smith, the first between 8-14 June 2003 and another between 9-30 July (Marshall & Thomas 2003). About 90% were counted from the land and those in hidden areas from the sea. The average colony total was 8652 AON, an increase of 18% since 1994 at 1.9% pa (Table 9).

Table 9 ***Counts (AON) of the Noss Gannetry in 1994 and 2003.***

Count Section	18-20 June & 17 July 1994	8-14 June & 9-30 July 2003
Cradleholm	1	4
Holmoless	108	93
Holmoless to Geordies Hole	1569	2008
Geordies Hole	49	70
Rumblewick	223	355
Rumblewick Face	162	320
Cuddacks Geo	0	3
Noup South	2659	2850
Noup East	517	709
Noup North	910	965
The Rump	773	885
Rump North	339	387
Geo Heogatoug	0	3
Total	7310	8652

Figure 3. ***The main features of the Bass Rock and the boundaries of count sections in 2004.***

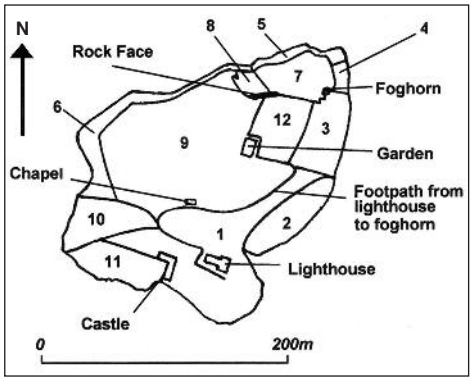
Troup Head

The only gannetry on the Scottish mainland, Troup Head continues to expand, from 530 nests on 31 May 1995 (Wanless *et al* 1996) to 1547 AON on 1 July 2004 (Mavor *et al* 2005). This is the largest percentage increase of any Scottish colony, 200% since 1995 at 20.5% pa.

Bass Rock

The aerial survey was made on 21 June 2004 and covered the entire colony. The rock is now completely sub divided into 12 sections, using natural and man made features as boundaries (Fig 3).Two counts were made by one observer and 24% of the colony total was counted by a second observer, giving a mean count total of 48,065 AOS (Table 10). Although an increase of 20.9% since 1994, at an average rate of 1.9% pa this was a much reduced rate compared with the 5.3% pa increase for the previous decade, although this had been calculated using totals of AONs (Murray & Wanless 1997).

Comparison with the 1994 photographs clearly shows large increases in colony extent, the most obvious being in Section 9 (Table 10). Here, breeding birds have become established up to the summit of the rock, but gauging the extent of



this expansion is complicated by the large numbers of non breeding and club birds around the section edge, which are reluctant to leave the colony at the approach of the aircraft. A land visit had to be made on 17 July 2004, to define both the limits of breeding in this section and in Section 12. Although most of the birds in Section 12 were non breeders, pockets of nesting occurred throughout the section, with particularly high numbers adjacent to Sections 7 and 8. Section 11 had been colonised since 1994 and both here and in Section 12 there is space for future increases. Sections 1,3,7 and 10 all show clear increases in colony extent. Section 8 has no room for expansion and appeared to be full in 1994. Numbers in cliff sections 2, 5, and 6 appeared to have declined, compared with both 1985 and 1994, but the reason for this is unclear. Overall, the population has more than doubled in size since 1985, and despite the reduced growth rate, the large numbers of non breeders attending the colony suggest that the numbers of breeders will continue to increase.

Total numbers in Scotland

The counts documented above were combined to provide an estimate of the total Scottish population in 2003-04. The overall total for colonies counted using AOS was 154,790, the total for those counted using AON was 27,721 (Table 11). Combining these figures, and for convenience expressing the total as the number of AOS, gave a grand total of 182,511 AOS. Numbers were divided very unequally between the 14 colonies, with St Kilda, the Bass Rock and Ailsa Craig together holding 74% of the total. In 1994-95 the Scottish population was estimated at 167,407 AOS (Murray & Wanless 1997). Comparing the 2003-04 total with this value indicates that numbers increased by 6% at an average rate of 0.6% pa, compared with the previous decadal increase of 27% at an average rate of 2.4% pa.

Table 10 ***Counts (AOS) of the Bass Rock Gannetry in 1985, 1994 & 2004.***

Count Section	1 & 11 June 1985	11 July 1994	21 June 2004
1	1227	2737	4087
2	320	645	240
3	3436	6867	7226
4	505	613	349
5	1909	1026	442
6	1560	2119	1066
7	4185	7885	8191
8	2707	3630	3530
9	5371	12651	18855
10	369	1578	2925
11	0	0	157
12	0	0	1000
Total	21589	39751	48065

Table 11 ***Summary of counts of Scottish Gannetries in 2003-04 and changes since the 1994-95 survey.***

Colony	Count AON	Count AOS	% Scottish total	% change overall	% change pa
Scar Rocks		2394	1.3	22.6	2.3
Ailsa Craig		27130	14.9	- 16.4	-2.0
St Kilda		59622	32.7	- 1.3	-0.1
Flannan Isles		2760	1.5	91.9	6.7
Sula Sgeir		9225	5.1	- 11.6	-1.2
Sule Stack		4618	2.5	- 5.5	-0.6
Sule Skerry		57	<0.1	colonised	
Foula		919	0.5	130.0	8.7
Bass Rock		48065	26.3	20.9	1.9
Westray	14		<0.1	colonised	
Hermaness	15633		8.6	23.3	3.0
Noss	8652		4.7	15.6	1.9
Fair Isle	1875		1.0	127.0	8.6
Troup Head	1547		0.8	200.0	20.5
Total	27721	154790			
Grand total	182511			6.0	0.6

Table 12 ***Summary of results from the 2003-04 east Atlantic Northern Gannet survey (Wanless* et al *2005a & b)***

Country	Number of colonies	Year counted	Total AOS/AON	% total east Atlantic
Scotland	14	2003-04	182511	58.0
Ireland	5	2004	36111	11.5
Wales	2	2004	32095	10.2
Channel Islands [1]	2	2005	7409	2.3
England	1	2004	3940	1.3
Iceland [2]	5	1999	28536	9.0
Norway	5	2002-03	4500	1.4
Faeroe Islands	1	1995	2340	0.7
Russia	1	1998	35	0.0
Germany	1	2004	190	0.0
France	1	2004	17000	5.4
Total	38		314667	100.0

Note: [1] Sanders & Atkinson 2006 [2] Gardarsson 2005

Discussion

Although the Northern Gannet population continues to increase in Scotland and 2 new colonies have been founded in Orkney, this steady rise in numbers could be coming to an end, as the overall rate of increase appears to be slowing down.

St Kilda, although still Scotland's largest gannetry, has seen negligible growth since 1994 and is at present stable. By contrast, the Bass Rock, the second largest colony, continued to increase, currently at 1.9% pa, but this is a marked reduction on the 5.3% pa increase recorded up to 1994. Although the Bass Rock could theoretically overtake St Kilda within a decade, it possibly does not have the space to accommodate the 12,000 nests needed to do so. In contrast, Ailsa Craig the third ranking gannetry has experienced a decline of 16.4% since 1995. The losses were not uniform across the colony, and they have not been offset by the small increases in extent and density in some sections.

Sula Sgeir is unique among British and Irish Gannetries in that licensed killing of young birds, 'gugas', by the men of the parish of Ness in Lewis (Beatty 1992) takes place annually and here the colony has declined by 11.6% since 1994. The current licence, issued by the Scottish Executive with advice from SNH, is for 2000 young to be taken. In every year since 1985, except 1999 (1690) and 2004 (1984) the licence returns have been of exactly 2000 birds (Scottish Executive returns). Without more data on colony demography it is not possible to determine the true effect of the guga hunt, but it would appear to be the most likely cause for the lack of growth of the colony (Wanless *et al* 2005a). A clearer picture of the total number of young taken, and the effects of disturbance on non target young would go some way to clarifying the situation.

The gannetry on Sule Stack has also shown little change during the last 20-35 years, but here there appears to be a shortage of space, and that may have resulted in the founding of a new colony on nearby Sule Skerry in 2003. Coincidentally, also in 2003, Gannets bred for the first time on Westray, also in Orkney. The 2 larger Shetland colonies of Hermaness and Noss have also increased since the mid 1990s, and all the 5 smaller colonies, Scar Rocks, Flannan Isles, Foula, Fair Isle and Troup Head, that were extant in 1994-95, showed substantial increases.

In 2003-4 the east Atlantic and total world population of Northern Gannets was estimated at c314,000 and c418,800 AOS (Wanless *et al* 2005b). Scotland remains the species stronghold with 58% and 44% of these populations respectively. In 1995 we wrote 'that all the evidence suggests that conditions are extremely favourable for Gannets'. At that time all the Scottish colonies were expanding, and there seemed no reason to suppose there would be limits to this growth in the near future, as most colonies were not constrained by a shortage of breeding sites or food resources. However, the evidence from this survey shows that the overall growth rate has halved and this suggests that conditions are becoming less favourable. Why this might be happening is unclear, but there is increasing concern that climate change is beginning to affect marine life in the east Atlantic, and the North Sea in particular. How this might affect Gannets is not yet obvious, and while they were one of the few breeding seabirds not to suffer major breeding failure in Scotland in 2004 (Mavor *et al* 2005), it may be only a matter of time before they do so. An analysis of Gannet ringing recoveries for the UK and Ireland has found evidence for an increase in adult mortality over the last 10 years (Wanless *et al* 2006). The reason for this is unknown, but if adult mortality remains high and breeding success falls, we can expect to see a further

Northern Gannets at Sula Sgeir *Arthur Grosset*

decline in the rate of increase, or perhaps even in absolute numbers of the Northern Gannet in Scotland by the time of the next survey.

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Stuart Murray, Easter Craigie Dhu, Cardney, Dunkeld, Perthshire PH8 0EY. e-mail murraysurvey@yahoo.co.uk

Sarah Wanless & Mike Harris, NERC Centre for Ecology and Hydrology, Banchory Research Station, Hill of Brathens, Banchory AB31 4BW. e-mail swanl@ceh.ac.uk

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Waterfowl counts on the Tay Estuary

N ELKINS

Counts of waterfowl populations on the Firth of Tay between 1995 and 2005 are compared to the results from earlier decades, especially the decade 1985-95. Changes have led to a decline in the importance of the estuary to some species and the total number of waders using the estuary has declined significantly. Eurasian Oystercatcher, Dunlin and Common Redshank are the most notable species to have been affected. Disturbance, climate change and roost site configuration are suggested to be possible reasons for the declines.

Introduction

The Firth of Tay is the third largest tidal estuary in eastern Scotland and is a key site for both migrating and wintering waterfowl. Together with the nearby Eden estuary to the south, it is subject to several conservation designations (FERN 2005) on account of internationally important populations of waterfowl. The whole area was declared a Special Area of Conservation (SAC) in 2002, with parts having been a Special Protection Area (SPA) and a Ramsar site since 2000. The area also includes Sites of Special Scientific Interest (SSSI), and both Local and National Nature Reserves (LNR, NNR).

An earlier paper (Elkins & Lynch 1997) described the estuary and its waterfowl, giving a summary of the status of most species resulting from Wetland Bird Survey (WeBS) counts during the period September 1985 to August 1995. During the 10 years since then, ie from September 1995 to August 2005, several changes have occurred, some of them significant.

Methods

Monthly high tide roost counts of Great Cormorants, wildfowl and waders are made throughout the year as part of the Wetlands Bird Survey (WeBS) organized by the British Trust for Ornithology (BTO) in partnership with the RSPB, WWT and JNCC. During winter 1996-97, a series of counts of birds was also made at low tide under contract to Scottish Natural Heritage (SNH), the data from which contributed to the WeBS Low Tide Count scheme (see Musgrove *et al* 2003*)*.

High tide roost counts were made on a specified date each month by a team of observers, usually at spring tides near the middle of the month, although alternative dates were chosen during short winter days when high tide occurred during the hours of darkness. The 4 roost counts are undertaken in the outer Tay at Tentsmuir Point, Tayport and Monifieth to Broughty Ferry and in the inner Tay at Invergowrie and Kingoodie. There were, understandably, some months when one or more of the roosts remained uncounted, mainly due to observer shortage. These missing counts were chiefly in the summer months, with a high degree of coordination otherwise maintained. During the 20 years from 1985-86 to 2004-05, 92% of counts during the priority months between September and March were complete. 66% of all counts were fully coordinated, with the remainder counted within 1-5 days. During April to August, 49% of counts were complete, with 33% fully

coordinated. Wildfowl were less comprehensively counted in the early years and remain poorly covered in the upper reaches of the firth in the vicinity of Mugdrum Island.

Counts made before 1985 (some published in Bird of Estuaries Enquiry (BoEE) annual reports and in Prater (1981)) were very intermittent but a few have been used in comparisons with later counts. Data from the Eden estuary are included where relevant.

Winter counts described below are attributed to the year at the start of the winter. All counts used in calculating means are those resulting from WeBS Core Counts ie counts made on the specified monthly dates. Casual counts on other dates can often be significantly different and, if used here, are only quoted for illustrative purposes. Winter means are calculated using the highest count in the months from December to February.

Results

The mean maximum number of waders (i e excluding wildfowl) roosting on the Tay estuary in midwinter was 7,723 for the period 1995-2004, a decrease of 24% from the previous 10 year mean of 10,130. These figures were derived from summing the highest monthly counts of each species between December and February. They varied from 12,484 in the winter of 1985-86 to 5,918 in 2004-05, coincidentally the first and last winters of the 20 year period (see Fig 1). Monthly totals at other seasons illustrated changes in the number of passage migrants. In September 1996, the total number of waders roosting on the estuary was 13,400, the highest number ever counted in any month during the 20 years. This contrasts with 3,535 in September 2002. Fewest waders were present in June, with a mean of 706, although few comprehensive counts were made during this month (see Fig 2).

There are few published figures of total wader counts before 1985-86. However, those available compare well with the early years of this study, being in the order of 13,000-14,000, although 20,300 were reported in the winter of 1973-74 (BoEE annual reports). If wildfowl are included in the totals for the whole estuary, a decline is still evident. The 5 year mean had dropped from 26,844 in the late 1980s to 22,332 for the period 1999-2003, a fall of 17%.

Species Accounts

Eurasian Oystercatcher *Haematopus ostralegus*
The 5 year winter means show a decrease over the 20 year period (see Fig 3). The midwinter population fell from 2167 in 1985-89 to 1645 in 2000-04, a fall of 24%. Most of this decrease was due to fewer birds roosting in the inner Tay and occurred during the last 5 years. Despite this, the species remains the second most abundant species in midwinter. However, numbers on autumn passage have not changed significantly and have shown a steady increase at Tentsmuir Point at the expense of the Monifieth roost site, mainly in October. This contrasts with the Eden estuary where a marked autumn decrease has occurred from the mid 1990s. The species is now the most abundant autumn wader at Tentsmuir Point in contrast to winter, when only a small percentage of the estuary's total is now found there. There was an increase in spring at Tentsmuir Point during 2001-2005, mainly in March. This suggests a growth in the use of the outer estuary by migrants. Midsummer flocks of immature birds and non breeding adults have remained steady at around 400 birds, by far the commonest roosting wader at this season when the highest proportion occurs in the inner estuary.

As in the earlier years, low tide counts in 1996-97 showed that the winter roosting population was lower than that using the estuary to feed. This has been attributed to movements outwith the estuary.

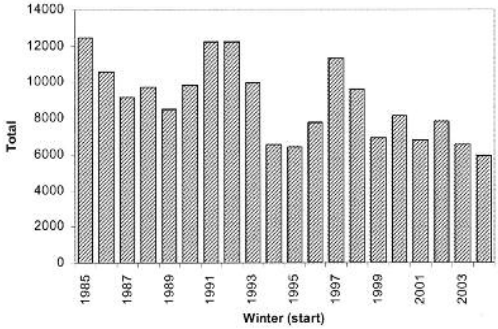

Figure 1. ***Peak wader totals roosting in winter on the Firth of Tay***

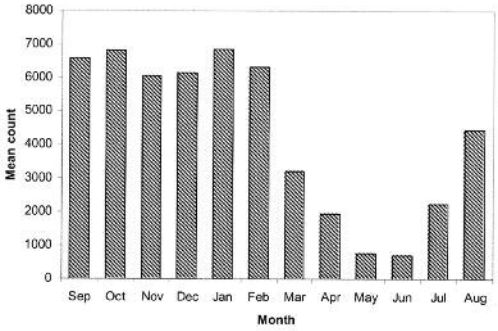

Figure 2. ***Monthly mean number of waders roosting on the Tay, 1985–2005.***

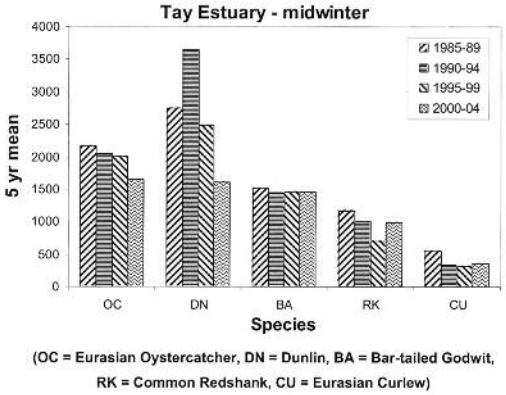

Figure 3. ***5 year means for 5 species of waders wintering on the Tay, 1985–2005.***

Numbers in the early years of this study were similar to those published for 1969-74 (Prater 1981) but the latest data for Great Britain show a decrease from a peak in 1990-91 (Collier *et al* 2005).

Ringed Plover *Charadrius hiaticula*

Minor fluctuations have occurred during winter but with little overall change and a mean of 113 birds; this showed an increase from data published for 1969-74 by Prater (1981). The main roosts remain in the outermost Tay, where a few pairs also breed. There was an increase here during autumn passage, especially at Monifieth in October, with a mean of 273 in the last 5 years representing a sevenfold increase since 1985-89. Estuary totals as a whole in August have increased threefold during the period 1992 to 2005, with a mean of 306 during 2001-2005. Late spring totals, presumed to involve Greenland breeders, reached in peak in 1999, but have declined since. However, the transitory nature of these spring migrants could mean that WeBS count dates may miss the largest flocks on both the Eden and the Tay. For example, the Eden estuary recorded its highest ever casual count of 1030 in May 2002, not reflected in WeBS counts.

Over Great Britain as a whole, the wintering population has declined steadily from a peak in 1988-89 (Collier *et al* 2005).

European Golden Plover *Pluvialis apricaria*

The European Golden Plover remains a very mobile species, with its occurrence on the estuary mainly confined to low tide. Wintering flocks roosting at high tide, often on coastal fields, have declined markedly since the mid 1990s, although autumn migrants show an increase in October. This contrasts with a decrease in November, and may represent earlier migration. Combined totals on the Tay and Eden also show this change. On the nearby Eden

estuary, large flocks also roost and feed at low tide. Here, winter high tide roosts remain substantial with a mean of 200 birds, although a recent decrease has been noted.

Grey Plover *Pluvialis squatarola*
After a peak in the mid 1990s, the wintering population has shown only a slight decline from a mean of 259 in 1995-1999 to 236 in 2000-2005. The species roosts almost entirely at Tentsmuir Point, where the recent decline has been most noticeable in January and February in both 2004 and 2005. On the nearby Eden estuary totals halved during the same months, although a mean of 280 was still present during 2004-05. The Grey Plover population increased markedly during the past few decades but reached a peak in Great Britain in 1996-97 after which a steady decline has been recorded (Collier *et al* 2005; Maclean *et al* 2005). Both spring and autumn passage totals have declined on the Eden and the Tay since 2002.

Northern Lapwing *Vanellus vanellus*
Like the European Golden Plover, Northern Lapwing numbers fluctuate widely, but they are more frequently seen at high tide roosts. They occur earlier than the European Golden Plover on autumn migration, peaking in August and September. The inner estuary holds the largest proportion of Northern Lapwings throughout the year, but there has been a fourfold decline in numbers of roosting birds throughout the winter, perhaps reflecting the high incidence of mild winters when birds are able to feed inland. The Eden estuary has also experienced a decline in wintering birds.

Red Knot *Calidris canutus*
This species, never abundant on the Tay, has decreased in winter. This decline has also occurred on the Eden, although there is still a mean winter population of 400 birds and casual counts still exceed 1000 at times. Red Knot roost mainly at the outer Tay sites, where a decline at Tentsmuir Point has been partially offset by an increase at Monifieth. Marked fluctuations occurred during the early years but the wintering population has stabilised at around 250 birds since the mid 1990s.

Sanderling *Calidris alba*
Sanderling decreased in the earlier decade but the wintering population has stabilised at around 100 birds since 1998. The species remains more abundant during passage periods, especially in autumn when around 150 are present. However, in common with other species, the main passage roost has shifted from Tentsmuir Point to Monifieth, although this is partly dependent on the amount of disturbance. At low tide, feeding birds remain confined to the outer estuary, chiefly on the Buddon beach. There is some evidence that Sanderling roost on uncounted adjacent sandy shores, with increases at counted sites during disturbance elsewhere. This was highlighted in December 2005 when a flock of 560 Sanderling arrived at Tentsmuir Point on high tide. This was the highest count for 18 years.

Dunlin *Calidris alpina*
A major decrease of Dunlin took place after 1999 with a mean midwinter population of just over 1600 birds in the period 2000-04. The roost at Invergowrie contributed to this decline to a large degree, falling significantly between 1990-94 and 2000-04. Some of these birds may have moved to Monifieth, which showed an increase in the winter roost size, but it is believed that the majority of birds displaced from Invergowrie may have moved to the Eden estuary where the midwinter population doubled between 1997 and 2004. However, the proportion of Dunlin to the whole wintering wader population remains at about 30%, accentuating the decline in other species. The large Dunlin passage roosts in the past have also declined, again mostly at Invergowrie with a

small increase at Monifieth partially offsetting this. Overall, autumn passage has declined on both the Tay and Eden.

The low tide counts in the winter of 1996-97 showed a similar distribution to those in 1993-94, although birds were more evenly distributed along the north shore mudflats upriver from Invergowrie.

Bar-tailed Godwit *Limosa lapponica*
Totals show only minor fluctuations over the period; the species has thus increased its proportion of the total wintering wader population from 15% to 21% during the last 2 decades. The main roosts remain at Tentsmuir Point and Monifieth although a significant decline at the former has been offset by a substantial rise at the latter. Indeed few birds were recorded at Tentsmuir Point in the last 2 winters of this study. The species is of international importance on the Tay (i e numbers exceed 1200 birds) with a mean wintering population of 1457 during the decade in question. The winter of 1996-97 held the highest population during the period (2305) coincident with the peak in the Great Britain index. Recent individual months have produced high counts both in autumn (e g 2664 in September 2003) and in winter (e g 1944 in January 2002).

Eurasian Curlew *Numenius arquata*
Few wintering Eurasian Curlews roost at the entrance to the Tay, favouring the more sheltered sites at Lucky Scalp and Invergowrie. The species remains one of the less common waders with a winter mean of around 340, probably due to its habit of feeding inland during high tide. On both the Tay and the Eden, Eurasian Curlews have become more abundant on passage in late summer and early autumn since the mid 1990s. For example, Tentsmuir Point is now used much more during autumn compared to the earlier decade.

Common Redshank *Tringa totanus*
Unlike the earlier decade, wintering numbers of Common Redshank on the Tay do not now reach the criteria for importance either internationally or for Great Britain. The mean midwinter roosting population is now around 700-1000. This is due almost solely to the decline in birds roosting at Invergowrie where numbers have rarely exceeded 500 in recent years. Roosting patterns have also changed at Tayport, where it is the only wader to use the saltmarsh as a roost. Disturbance here often flushes them on to newly created islets on the pond at Tayport.

Autumn passage numbers have also declined, with a peak of 1979 in September 2003, compared to numbers in excess of 3000 prior to 1997. The peak was 5358 in September 1996, of which the majority were at Invergowrie. This decline has also been noted at the Eden estuary. Such decreases are all the more notable since the Common Redshank is relatively site faithful and numbers have been relatively stable in Great Britain as a whole for many years (Collier *et al* 2005).

Ruddy Turnstone *Arenaria interpres*
The small wintering Ruddy Turnstone population favours the rocky outcrops in the outer estuary, mainly on the north shore. Fewer than 100 birds are present and little change has occurred over the period. Rather more pass through in spring, with 170 in March 1998.

Other wader species

Small numbers of other species are recorded on the estuary, mainly during migration. The only other regular wintering species is Common Snipe *Gallinago gallinago*, which favours salt marshes in the inner estuary and at Tayport. Counts appear to have increased in recent years with a peak of 53 in November 2002, but numbers using the saltmarshes are governed by

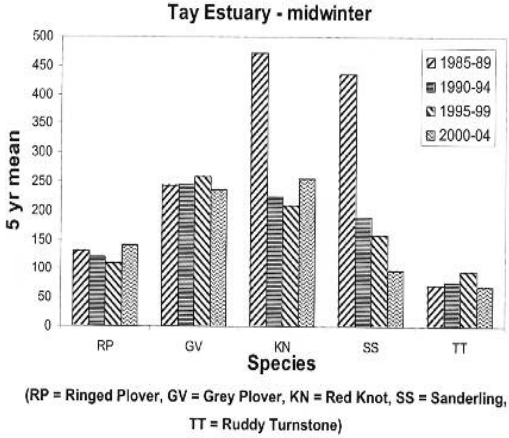

Figure 4. ***5 year means for 5 species of waders wintering on the Tay, 1985–2005.***

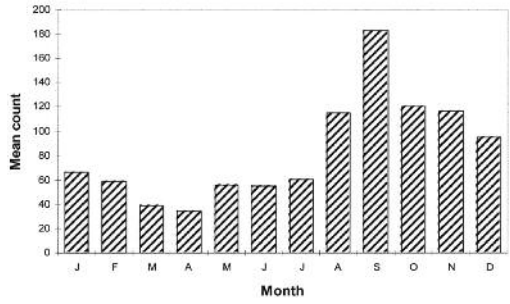

Figure 5. ***Mean monthly count of roosting Great Cormorant on the Firth of Tay, 1995–2005.***

the height of the tide and many of those in the inner estuary remain hidden and uncounted. Black-tailed Godwits *Limosa limosa* are very scarce on the Tay although the Eden estuary wintering population regularly exceeds 200. However, in the winter of 2005-06, after the end of the study period, a small population roosted at Invergowrie, with 50 birds in December 2005. This coincides with the sharp increase in the UK winter population since 1999 (Maclean *et al* 2005). A record count of 615 on the Eden in December 2004 mirrors this.

Great Cormorant and Wildfowl

Great Cormorant *Phalacrocorax carbo*
There are normally Great Cormorant roosts on Lucky Scalp and the Pile platform off Tayport, but the majority uses the old Tay rail bridge columns where most were also recorded during low tide counts. Overall, mean counts begin to increase in August and reach a peak of 183 in September (Fig 5). Thereafter, they decline steadily to a mean of 34 in April. However, individual counts have exceeded 220 between August and October and in December.

Mute Swan *Cygnus olor*
Mute Swans flock on the Tay in considerable numbers between April and September. In recent years, flocks have grown, with a peak of 226 in July 2003. Most of these birds favour the shore at Monifieth, where a small wintering population of around 20 birds is also found. Further parties are found upriver and are not often monitored.

Common Shelduck *Tadorna tadorna*
Common Shelduck numbers have shown little change over the years. A spring build up occurs from February with a peak reached in April when 187 were counted in 1996. Since then, there has been a slight decrease although over 100 are still present at this time. Although a few pairs breed, numbers fall to single figures by August and only a few overwinter. Common Shelduck are distributed throughout the whole estuary and significant numbers near Mugdrum Island are not often counted. For example, 77 were present in this area in February 2003 only a few days prior to a total WeBS count of 41. The Eden estuary holds double the numbers present on the Tay.

Eurasian Wigeon *Anas penelope*
This winter visitor arrives on the estuary in September and departs in March. The peak is reached in early winter, and the mean midwinter population (chiefly in the Tayport area) has increased from 160 in 1985-89 to 319 in 2000-2004. An earlier decline in the mid 20th century (Atkinson-Willes 1963) had not reversed even by 1969-74, when the mean count was only 30 (Prater 1981). The population exceeded 400 in 2 of the 5 latest winters and an exceptionally high number of 824 was present in October 2005, after the period under analysis had ended. This is another species for which flocks of several hundred are often found upriver near Mugdrum Island and remain regularly uncounted. Small numbers of Eurasian Wigeon are present intermittently in summer (normally in single figures) although none has been recorded on July counts.

Eurasian Teal *Anas crecca*
This species declined in the early 1990s (Elkins & Lynch 1997), but has since recovered to previous levels. The decline was first evident during 1990-94, when the mean midwinter count fell to 24 individuals from a mean of 103 during 1985-89. The level remained at a similarly low level until 1997-98 after which numbers rose steadily to a mean of 150 in 2000-04 with a record 302 in January 2002. Although Eurasian Teal are a highly mobile species in winter, this mobility is often linked to unfrozen inland waters. Winters from 1996, however, have been milder than normal, and there is no obvious reason for this recovery in numbers. Most Eurasian Teal counted at high tide are found at Lucky Scalp.

Mallard *Anas platyrhynchos*
Mallard were very abundant in the past but numbers had fallen to a winter mean of 850 during 1969-74 (Prater 1981). Counts of wintering birds reached this number only in 5 winters between 1985 and 2004 (the last being in 1994-95), and there has been a general decline since 1996. The most recent 5 year winter mean has been 350 and individual monthly counts now rarely exceed 400 at any time of the year.

Tufted Duck *Aythya fuligula*
Although Tufted Ducks mainly frequent the inner Tay estuary, counts have been intermittent. However, mean midwinter counts in excess of 200 prior to 1995-96 fell to a mean of only 22 during 2000-2004.

Common Eider *Somateria mollissima*
The Tay Common Eider flock is of international importance but, unfortunately, complete counts are extremely difficult to make. Tides and weather make accurate counts only possible from the south shore under ideal conditions of sunshine, calm sea and within the 2 hours before high tide. Nevertheless, intermittent counts from 1969 show that 5 year means exceeding 10,000 in early years have declined to a mean of 6737 in the period 1999-2004. However, this is probably an underestimate, as there is movement between the estuary and St Andrews Bay; a count in February 2006 within the estuary resulted in 10,000 birds. Dean *et al* (2003) found the largest numbers off Abertay sands and Buddon Ness.

Common Goldeneye *Bucephala clangula*
Common Goldeneye are normally scattered throughout the Tay estuary, although only one large group off Invergowrie is counted by WeBS and has declined during the 2 decades. The peak occurs between January and March and exceeded 200 regularly until 1997. Since then, the mean peak has been around 100. Two other concentrations on the Tay are found outwith the WeBS count area. One is at Newburgh, where peaks of up to 600 can occur in early winter. The decline in this group from December may be the result of some movement upriver to Perth harbour, where numbers often exceed 200 in December and January.

***Goosander** Mergus merganser*
The moulting flock in late summer remains nationally important with the peak occurring between July and September. Most are found on and around Lucky Scalp and exceed 200 in most summers. A few arrive in late May, building to an August peak and mostly leaving by the end of September. All are red heads, with most drakes moving to Norway to moult (Collier *et al* 2005). This moulting flock is a fairly recent phenomenon, not being recorded prior to the mid 1980s.

Other wildfowl species

Other wildfowl not monitored regularly by this study, mainly because they are not present within the count areas at high tide, include geese, mainly Pink-footed Goose *Anser brachyrhynchus* and Greylag Goose *Anser anser*, and sea duck, such as Long-tailed Duck *Clangula hyemalis,* scoter *Melanitta spp* and Red-breasted Merganser *Mergus serrator*. The geese normally roost in the inner estuary and the most recent 5 year means, as counted by the WWT/JNCC National Grey Goose census, are 6014 Pinkfeet and 1224 Greylags (Collier *et al* 2005). The sea duck enter the outer estuary from St Andrews Bay and have been subject to aerial counts by JNCC (Dean *et al* 2003, 2004). Other duck species are rare, a far cry from the flocks of Northern Pintail *Anas acuta*, Common Pochard *Aythya ferina* and Greater Scaup *Aythya marila* present in the 1920s (Berry 1930).

Discussion

The geography and geomorphology of the Firth of Tay in relation to its wetland bird populations was described by Elkins & Lynch (1997). Since that time, little has apparently changed, except that the extensive accreting sand dune systems at the entrance to the firth have changed the shape of the shoreline, particularly at Tentsmuir Point on the south shore. This may be the cause of the shift of roosting birds from the main high tide wader roost at Tentsmuir Point to Monifieth and Barry Buddon on the opposite shore. Declines in birds using the inner estuary roosts at Kingoodie and Invergowrie Bays are thought to be due to disturbance, particularly on the increasingly busy Dundee airport nearby.

More short term fluctuations in the use of the Tay as a feeding and roosting site are occasionally due to the severity of winter weather. The 2 winters of greatest wind chill during the past decade were 1995-96 and 1999-2000, coincident with high mean wind speeds and low mean temperatures. Unlike the previous decade, when no significant local effects on wintering populations were apparent, there was a marked decrease in the number of waders on the estuary during these 2 winters. This was particularly noticeable in 1995-96, when extensive ice covered the mudflats in the inner estuary at times. Conversely, the highest numbers of waders roosting on the estuary was in the winter of 1997-98, coincident with the lowest wind chill (see Fig 1). It is known that wader populations are higher on west coast sites in Britain during cold winters, and that recent milder winters have seen an eastwards shift in wintering populations (Austin & Rehfisch 2005). Thus a significant part of the Tay wader population may have moved to western Scotland in the coldest winters. Climate change may also be responsible for other variations in wintering populations in eastern Scotland, particularly affecting the ability of high latitude waterfowl to winter further north and east during warmer winters.

Total numbers of waterfowl using the Tay estuary have probably declined for several reasons. Some have mirrored national changes, while roost disturbance and changes in roost characteristics all play a part. Considerable movements of some species occurs between the Tay and adjacent waters and shores, where some remain uncounted (cf Sanderling q v).

Acknowledgements

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Norman Elkins
18 Scotstarvit View, Cupar, Fife KY15 5DX

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SHORT NOTES

Secondary nest usage by a pair of Lesser Whitethroats

In Ayrshire, Renfrewshire and Lanarkshire, 9-12 Lesser Whitethroat *Sylvia curruca* territories have been studied regularly since 1983 (T Byars *et al* 1991, *Scottish Birds* 16: 66-76). A Renfrewshire study site contained 2-3 territorial males within a 2 km square south east of Paisley at Brownside Braes (NS 4860). All territories were located in areas of mature Hawthorn *Crataegus monogyna* scrub with a dense mosaic understorey of Bramble *Rubus* sp, Gorse *Ulex europaeus,* Dog Rose *Rosa canina* and Goat Willow *Salix caprea* (T Byars *et al* 1991, *Scottish Birds* 16: 66-76). Breeding Lesser Whitethroats were individually colour ringed, allowing territorial behaviour, site fidelity and interchange to be studied. Sexing Lesser Whitethroats can be difficult as males develop well vascularised brood patches (S C Norman 1992, *Ringing and Migration* 13: 167-174; L Svensson 1992, *Identification Guide to European Passerines,* Stockholm). Research in NE England found that trapped females could be sexed if birds showed distended stomachs and higher body mass through egg carrying, adults can also be sexed on the basis of brood patch size and/or cloacal protuberance (M Boddy 1994, *Ringing and Migration* 15: 65-78). Trapped Lesser Whitethroats at the study site were sexed using a combination of these features.

At Brownside Braes on 8 May 1996, a male Lesser Whitethroat was vociferously holding territory (Territory A). It was mist netted and given an orange colour ring that morning and observed singing throughout the day. The following morning, I discovered a new territory within the study site (Territory B) which was located 800 metres away from Territory A. Although the male was singing infrequently, this second territory did contain a breeding pair (Pair B) and efforts were made to mist net them. Despite various attempts, only the female from pair B was caught and given a green colour ring. Pair B were observed nest building in a gorse bush that afternoon. The female lined and shaped the nest cup, an indication that pair bond establishment had taken place (S Cramp, {ed}, 1992, *Birds of the Western Palaearctic*, Vol 6: 449-450. Oxford University Press, Oxford). Six days later, a new unringed male had taken over Territory A and the orange ringed male had disappeared. On 16 May, the unringed male on Territory B was singing again, suggesting that mate loss had occurred (S Cramp, {ed}, 1992, *Birds of the Western Palaearctic,* Vol 6: 450. Oxford University Press, Oxford). The green ringed female could not be located at Territory B and was never seen again anywhere on the study site. Mist netting at Territory B that morning revealed the orange ringed male, approximately 30 metres away from the now vacant nest site. The following day, the unringed male was still singing on Territory A and the unringed male from Territory B had now moved into a new territory 86 metres away, leaving Territory B vacant.

Returning to Territory B on 7 June to obtain data on the unused nest site, I heard 2 Lesser Whitethroats alarm calling close by. On inspecting the nest in Territory B, I was surprised to find it contained a clutch of 5 Lesser Whitethroat eggs. Both adults became visibly agitated at my presence and immediately started distraction displays which allowed for close observations of this pair. The male was instantly identified by his orange colour ring, while the female was unringed. This new pair had utilised the old nest and successfully raised 4 young, which left the nest on the 17 June. Although rare, this behaviour has been noted in other birds, eg the Wren

Troglodytes troglodytes (J J Sweeney pers comm). This appears to be the first documented account of a pair of Lesser Whitethroats taking on an empty nest.

Tom Byars 81 Sharphill Rd, Saltcoats, KA21 5QU (e-mail:tombyars@btinternet.com)

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Great Skuas feeding on bread

Using scraps of bread to entice ringed birds close enough to a car or hide so that their rings can be read is a well proven method for generating ringing returns, and one which is especially effective with gulls *Laridae*. On 24 June 2004 whilst trying this technique at Scrabster Harbour, Caithness, we were surprised to attract not only the usual handful of Herring Gulls *Larus argentatus* but also 2 Great Skuas *Catharacta skua,* though none of either species was ringed. The latter were quite aggressive and managed to corner most of the bread we provided, but took care not to approach our vehicle closer than about a metre, and for the most part were content to sit on the concrete quay about a metre and a half away. We can find no previous record of Great Skuas taking bread but some have developed the habit of scavenging on Sullom refuse tips with gulls and corvids (see Furness, Monaghan & Sheddon 1981. Exploitation of a new food resource by the Great Skua. *Bird Study* 28:49-52). 2004 was a very difficult season for seabirds in the north of Scotland, and it seems likely that these 2 birds were driven to taking bread due to extreme hunger.

Mark Oksien, 32 Struan Drive, Inverkeithing, Fife KY11 1AR
Robin M Sellers, Crag House, Ellerslie Park, Gosforth, Cumbria CA20 1BL

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Some early records of Northern Gannet movements in the coastal waters off Caithness

Movements of Northern Gannets *Morus bassanus* are regularly observed in coastal waters around much of Britain and Ireland. Such movements can occur at almost any time between March and October, when birds are settled at their breeding colonies and are most numerous in the seas around Britain and Ireland, and may continue for periods extending from hours to several days. Often they involve considerable numbers of birds and are generally orientated in one particular direction. The extent of these movements, now known to be associated with movements between breeding colonies and feeding areas, first became apparent in the 1880's in connection with the enquiry into the movements of birds at coastal lighthouses held under the auspices of the British Association for the Advancement of Science (1880-89) and published in their 'Migration Reports'. Such movements have been described in many parts of Britain and Ireland, the culmination being a detailed study carried out in NE Scotland by Bourne (1982. *Ibis*, 124:81-88; which also contains references to the extensive earlier literature on these movements) who emphasised the important role of wind drift in the phenomenon. It is not generally appreciated that the occurrence of these coastal movements had been reported well before the British Association enquiry in the 1880's. Our purpose here is to draw attention to

3 old records relating to movements of Northern Gannets in the waters off the east coast of Caithness, one from the 18th century, and 2 from the 19th century.

The first published reference to the fact that Northern Gannets were passing through coastal waters off Caithness is contained in Thomas Pennant's *A Tour in Scotland 1769* (1771, J Monk, Chester). He travelled through Caithness *en route* to the John O'Groats area in the north of the county in the late summer of 1769, and as he returned south he: 'saw multitudes of gannets, or soland geese, on their passage northwards they went in small flocks from 5 to 15 in each, and continued passing for hours; it was a stormy day: they kept low and near the shore; but never passed over the land, even when a bay with promontories intervened, but followed (preserving an equal distance from shore) the form of the bay, and then regularly doubled the capes. I saw many parties make a sort of halt for the sake of fishing; they soared to a great height, then darting down headlong into the sea made the water foam and spring up with the violence of their descent; after which they pursued their route'.

Unfortunately he does not say precisely where he saw these birds but from the context it seems to have been somewhere north of Wick, probably between Freswick and Keiss. A few days later he continued his journey south from Wick and between Thrumster and Dunbeath he: 'again saw numbers of flocks of gannets keeping due north, and the weather being very calm they flew high. It has not been observed that they ever return this way in the spring, but seem to make a circuit of the island, till they again arrive at the Bass, their only breeding-place on the east coast'.

He reiterates much of this in his *British Zoology* (1812. *British Zoology Vol II, Class II Birds, Div II Water*. Wilkie & Robinson, London p292).

Some similar observations were reported almost a century later by R I Shearer, who for much of his life lived near Sarclet Head, to the south of Wick, and where he had many opportunities to observe Northern Gannets. Between 1859 and 1867 he published a long series of articles on the birds and mammals of Caithness in the local newspaper, the *John O'Groat Journal* (details in Clark & Sellers 2005. *Birds and Mammals of Caithness - Robert Innes Shearer's Contributions to the Natural History of Caithness, 1859-1867*, Bellfield Publications, Wick), and he mentions the movements of Northern Gannets in 3 of these. The first, published in the edition of 21 July 1859, refers to such movements twice, and begins as follows: 'This bird, though frequently seen at sea, and passing northwards along our coast, is not known to breed in Caithness'.

A little later in the article he returns to this point in the following words: 'There is one thing I have noticed rather strange in regard to those birds, *viz*, that they are occasionally seen through the summer, when I would expect them to be at their breeding stations, flying northwards, but are never seen to return. Whether they be birds migrating, having been unable to procure stations, or from other causes not inclined to stay till the breeding season is over, or belong to fixed breeding stations, I am unable to say. If, however, they belong to a station south of this they must return far out to sea, or perform a journey round our island'.

In a second article published in the issue dated 20 October 1859 and primarily concerned with the Little Auk *Alle alle*, he adds: 'before closing this notice, allow me to mention that solans are still (22nd September) flying northwards in great numbers. The flocks vary in number from two to twenty or thirty. They are very shy and watchful. In the morning of this day the wind blew from the south, and these birds, following a bight or bay opposite Ulbster House, had

either to fly out round Ulbster Head, or to cross over the promontory. They very seldom chose the latter. ... This day the flight of some of these birds was very high, and they were evidently intent on making the most of a favourable wind in their migration.'

The third article appeared on 5 January 1860 and was primarily concerned with the air sacs of the Northern Gannet. He had evidently received some fairly strident criticism for his statement that the Northern Gannets he saw *always* flew northwards, and addresses the final 2 paragraphs of this piece to his critics. The key section of the article reads as follows: 'In some former letters, when writing of the solan, I spoke of its always being seen on the north east coast of Caithness flying northwards in flocks. ... The nearest breeding station south of this is Bass Rock, and the nearest north or north west of this is said to be the Stack of Sule Skerry, an outlying rock, part of the Orkneys; and there are also some stations on the west coast of Scotland. Now, those birds that fly so regularly north on our coast must perform a long migration, whichever of these stations they come from. It is also very strange that this bird is found in Orkney in great abundance, *especially in winter*, while there are few or none of them found at the same season in Britain to the south of this, so far as I know.'

The existence of Shearer's articles in the *John O'Groat Journal* has only recently come to light. They were, however, known to Henry Osborne, a friend of Shearer's and another very capable amateur ornithologist and who also makes reference to the movements of Northern Gannets in the waters off the east coast of Caithness. Osborne prepared a document describing the birds of Caithness, but died before it could be published. The manuscript appears now to be lost, but when Harvie-Brown & Buckley (1887) came to write their *Vertebrate Fauna of Sutherland, Caithness and West Cromarty* in the 1880's they relied to a large extent on Osborne's *Manuscript Notes* for information about Caithness, and quote them extensively. The section on the Northern Gannet reads: 'A common summer visitor to the Caithness coast, but does not breed, appearing merely to follow the shoals of herrings that abound at that season. "A curious feature in their local history is that they are observed invariably to fly in a northward direction; that, while they follow the east coast on their journey northward, their return must be effected by some other route, as the bird is seldom or never seen on the east coast of Caithness to pursue a southward course" (H. Osborne in MSS).'

Recent observations in Caithness confirm what Pennant, Shearer and Osborne reported. On the east coast of the county, northward movements of birds are to be seen regularly March-October, often involving 200-1000 birds per hour, the most intensive movements usually coinciding with periods of strong on shore winds (*Caithness Bird Report* 1976-1999; *Manson* 2002. *A History of Caithness Birds 1769 to 2001*). Very occasionally birds can be seen moving south, but by far the majority pass north. Neither Pennant, Shearer nor Osborne make any comment about movements in the Pentland Firth, but we now know that movements here occur in both directions with approximately equal frequency (based on our analysis of records in the *Caithness Bird Report* 1976-99 and personal observations).

In the 18th and 19th centuries the only gannetries north of Caithness were on Sule Stack, some 60 km west of Orkney, and Sula Sgeir, about the same distance north of Lewis, and the most reasonable interpretation is that the movements seen by Pennant, Shearer and Osborne were birds returning to one or other, or both, of these colonies after fishing excursions into the North Sea. The outward leg of the journey from Sule Stack and/or Sula Sgeir

appears to pass through the Pentland Firth, but we suspect that some birds enter the North Sea to the north of Orkney on occasion.

Pennant, Shearer and Osborne accurately described most of the essential features of these movements a century and a half ago, and both Shearer and Osborne seem to have understood that for the most part they were nothing to do with migration but were much more likely to be connected with feeding movements. What neither Shearer nor Osborne seems to have understood is that they were witnessing the *return* journey, not the outward one, and then only after the birds had drifted or been blown close to the shore by winds from between north and east. Shearer did, however, realise that the other leg was most probably made well out to sea and so went unseen by land based observers. Despite an extensive search through the 19th century ornithological literature we can find no other mention of coastal movements by Northern Gannets published prior to 1880, and conclude that the observations reported by Pennant, Shearer and Osborne are not just the first records of this phenomenon for Caithness but probably for Britain as a whole.

We are indebted to the staff at the Carnegie Library, Wick for their help in locating and copying the material published by Shearer in the *John O'Groat Journal*, and to staff at the Natural History Museum Library, London and Gosforth Public Library, Cumbria for their assistance in locating the other material consulted.

Hugh Clark, 3 Lindsay Place, Wick, Caithness KW1 4PF
(e-mail:hugh@lindsayplace.fsnet.co.uk)

Robin M.Sellers, Crag House, Ellerslie Park, Gosforth, Cumbria CA20 1BL
(e-mail: sellers@craghouse7.freeserve.co.uk)

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Predation of European Storm petrels by Great Black-backed Gulls on the island of Auskerry, Orkney

Auskerry is approximately 1.5 km by 1 km and situated on the eastern side of the Orkney archipelago, 5 km south of the island of Stronsay. It has a rocky coastline with some boulder and shingle beaches and, on the west side, cliffs which reach a height of 18 metres. The vegetation is mainly C*alluna* heath and acidic grassland. There is also some marshy ground and standing water and, in the south of the island, a number of peat banks, the majority of which are no longer worked. The island has long been used for grazing sheep

At least 10 species of seabird breed regularly on Auskerry including Great Black-backed Gull *Larus marinus* and European Storm petrel *Hydrobates pelagicus*. The number of Great Black-backed Gulls increased from 20 pairs in 1969 to 180 pairs in 1976, then declined. It has remained fairly stable since 1983 (Adam R G & Booth C J 1999. The breeding birds of Auskerry, Orkney 1969-1998. *Scottish Birds* 20:1-5) at about 60 pairs. The majority nest on rocks on the east side of the island with 2 to 3 pairs on the west side and a similar number in the centre of the island.

In 1954 Myxomatosis reached Orkney (Booth C & Booth J 1994. *The Mammals of Orkney*, Kirkwall) and, by the early 1960s, the Rabbit *Oryctalagus cuniculus* population on Auskerry

Table 1 ***No of pellets found annually 1997 - 2004.***

1997	1998	1999	2000	2001	2002	2003	2004
57	17	49	59	88	10	36	53

had been wiped out by the disease. Their burrows, however, remain and provide the main nesting sites for storm petrels. These petrels also nest in natural holes in the peat, under stone slabs, in the ruins of ancient stone buildings and amongst stones on the boulder beaches. Surveys have indicated that the number of petrels breeding on the island has declined. In 1995 there were estimated to be 3,613 apparently occupied sites (Wood D 1997. An estimate of the number of Storm petrels *Hydrobates pelagicus* breeding on Auskerry, Orkney, *Seabird* 19: 40-46) but in 2001 only 994 apparently occupied sites were found (Mitchell P I & Newton S F 2004. European Storm petrel in : Mitchell P I, Newton S F, Ratcliffe T & Dunn T E (Eds) *Seabird Populations of Britain and Ireland*, 81-99. T and A D Poyser. London). The greatest decline has occurred in the number of petrels nesting in the old burrows of rabbits. It is thought that overstocking with sheep has led to collapse of burrows and subsequent loss of nesting sites. However, the number of petrels nesting in the ancient ruins and boulder beaches was also found to have decreased.

Since 1970 the authors have made a number of visits to the island to monitor some of the breeding sea birds; these visits have been annual since 1992. In 1984 a ring was noticed in a Great Black-backed Gull pellet (Adam R G & Booth C J 1999. Storm petrel *Hydrobates pelagicus* rings in Great Black-backed Gull *Larus marinus* pellets. *Ringing & Migration* 19, 298) and, on closer examination, it was found that the pellet contained the remains of a whole petrel. The ring was from a petrel that had been ringed on Auskerry in a previous year. This discovery of a ring prompted a more intensive search for pellets with petrel remains, concentrating especially around gull nesting sites. Since 1997 the number of pellets found has been recorded, although effort has varied from year to year depending on time available.

In the period 1997 - 2004 the extreme dates of visits have been 6 July and 17 July, and the number of pellets containing petrel remains found annually is shown in Table 1.

Pellets were found mainly at 3 sites : an area of peat banks close to 2 gull nests in the centre of the island, around a nest on the edge of rocks at the east side and by a nest on the north east side. It appeared that the gulls from these nests may have specialised in catching petrels but this may also be due to the fact that they were probably very close to the main petrel nesting area. No pellets with petrel remains were found at gull nests on the outlying rocks or on the area used by non breeding birds as a daytime roost.

The pellets were all fairly fresh and would have been produced within a few weeks prior to our visits. It can be seen from Table 1 that a total of 369 pellets was found. We could not be certain, because of variation in size, that every pellet would have contained the remains of one petrel. Even so, given the number of pellets, it was thought that at least 300 petrels would have been killed by the gulls in the 8 years between 1997 and 2004. This would be a minimum figure as it does not take into account pellets that were missed and petrels killed during the remainder of the breeding season.

An examination of the pellets revealed 36 storm petrel rings. Five were from birds ringed on Auskerry, 27 were from birds ringed at various localities at distances ranging from 21kms to 77 kms from the island. Two were from birds ringed in Norway and there were single birds from northern England and Portugal. All the petrels had been ringed as full grown birds hatched before the year of ringing.

As the pellets were found before mid July and in the early part of the petrel breeding season, it is probable that some of the petrels killed would have been potential breeding birds. The killing over the years, by the gulls, of these birds could be an additional reason for the decline in the European Storm petrel breeding population of Auskerry. Predation by Great Skuas *Stercorarius skua* is considered to pose a serious threat to the Storm petrel colonies on St.Kilda (Mitchell P I & Newton S F 2004. European Storm petrel, in: Mitchell P I, Newton S F, Ratcliffe T & Dunn T E (Eds) *Seabird Populations of Britain and Ireland*, 81-99. T and A D Poyser. London).

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C J Booth, Ronas, 34 High Street, Kirkwall, Orkney, KW15 1AZ
R G Adam, Northolme, St. Ola, Orkney, KW15 1SB

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Peregrine Falcon catching and killing a bat in daylight

At 1220 hrs on Sunday 20 March 2005, we saw a large bat hawking insects c30-50 m above the Water of Ken near the point where it enters Earlstoun Loch in the Stewartry of Kirkcudbrightshire. It was an overcast and humid day, though the misty cloud was thin in places and it was fairly bright at times. From a distance of c100m we estimated the bat to have a total wingspan of no less than 30 cm. It occasionally showed light brown on the body as it repeatedly turned and dipped to feed; the head appeared owl like. The bat was almost certainly a Noctule *Nyctalus noctula*, a species known to be present in Galloway that behaves in this way (Stewart Pritchard and Peter Norman pers comm).

An immature female Peregrine Falcon *Falco peregrinus* attacked the bat, which detected the falcon and evaded capture by losing height. The Peregrine turned and repeated its attack on the bat, which again evaded capture successfully. Two Carrion Crows then briefly harried the Peregrine, but it was undeterred and turned to capture the bat in level flight at the third attempt. In all, this action lasted some 10–15 seconds. Having secured the struggling prey between its talons, the falcon flew off, briefly slowing twice in mid air to bite and presumably

kill the bat. We lost sight of the Peregrine in the haze about 1-2 km away.

We have watched Peregrines attack a variety of birds over the past thirty years. Usually, when the victim evades capture, it goes to ground or into cover, with the Peregrine characteristically `waiting on' in an agitated and often highly vocal state. Only when the prey is flying high is there normally any chance of multiple attacks in mid air. However, on this occasion the Peregrine pressed home 3 attacks so swiftly that it seemed to know that the bat was unlikely to go to ground, suggesting the falcon had encountered bats before. The bat seemed aware of the danger posed by the Peregrine.

In the UK, Common Kestrels *Falco tinnunculus* have been known to take bats at dusk (Gordon Riddle pers comm; Simms, 1977 Kestrels hunting long eared bats. *British Birds* 70:499-500) and Noctule has been recorded amongst prey items at a Eurasian Hobby's *Falco subbuteo* nest in Hampshire (Insley and Holland, 1975. Hobbies feeding on bats and notes on other prey. *British Birds* 68: 242.). The taking of bats by Peregrines in South America is well known (Albuquerque, 1978. Contribuicao ao conhecimento de Falco peregrinus Tunstall, 1771 na America do Sul. *Revista Brasileira de Biologica* 38:727-737; Pearson & Donohue, 1983. Peregrine Falcon feeding on bats in Suriname, South America. *Am Birds* 37257-259; Sick, 1961. Peregrine Falcon hunting bats while wintering in Brazil. *Auk* 78:646-648), and this behaviour is also reported in the USA (Sprunt, 1951. Aerial feeding of Duck Hawks, Falco peregrinus anatum. *Auk* 68: 372-373; Palmer, 1988. Habits [Peregrine Falcon]. in *Handbook of North American birds* Vol. 5:363-378). Byre (1990. A group of young peregrine falcons prey on migrating bats. *Wilson Bulletin* 102 [4]: 728-730) described how a group of 5 recently released juvenile Peregrines repeatedly watched for and attacked migrating bats flying across lake Michigan on 3 autumn mornings. These Peregrines hunted together and a total of 28 kills were seen over the 3 days, with evidence found of at least another 15.

Ratcliffe (1980. *The Peregrine Falcon*. Poyser, Calton) cited the taking of bats in Texas by Sprunt (no reference), but noted that they had not been recorded as prey in Britain or Ireland. However, John and Geoffrey Kaczanow found Noctule bat remains in pluckings and prey debris at 2 separate Peregrine sites inland in west Devon in 1990 and 1994 respectively. They also found hair of a Pipistelle bat *Pipistrellus sp* in a Peregrine pellet from an eyrie at a third inland site in the same area in 2000 (John Kaczanow pers comm). However, the present report appears to be the first record of a Peregrine being seen to prey on a bat in the UK.

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We are very grateful to Stewart Pritchard and Peter Norman for information on bats in southern Scotland, and to Gordon Riddle and Hugh Insley for information on other falcons taking bats in the UK. One evening on a visit to Galloway in 2005, just 3 weeks before he died, Derek Ratcliffe commented on this record and recalled that the Kaczanow brothers had recently recorded bat parts in Peregrine prey remains in Devon. Next morning, with typical thoroughness, he was able to produce the contact address for these fine naturalists, without whose information this note would have been so incomplete. We are grateful to John and Geoffrey Kaczanow for their information, and to the great man himself for his inspiration and example.

Chris Rollie & George Christie, RSPB Scotland, Old School, Crossmichael, Stewartry of Kirkcudbrightshire, DG7 3AP.

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House Sparrows nesting in sites other than buildings in Scotland

In Britain the great majority of House Sparrows *Passer domesticus* site their nests in holes or cavities in buildings, including some in nest boxes. A small minority construct round, untidy, roofed nests of dry grass or straw with a side entrance, in a tree, hedge or climbing plant, typically a few metres above the ground (Summers-Smith 1988. *The Sparrows*. Poyser, Calton; Cramp and Perrins 1994. *The Birds of the Western Palearctic,* Vol 8. Oxford). There is a presumption that this also applies in Scotland (Thom 1986. *Birds in Scotland*. Poyser, Calton) though little has been published for Scotland except for a few records in *Scottish Bird Reports* and regional bird reports, and some early information in Baxter and Rintoul (1953. *The Birds of Scotland*. Oliver & Boyd, Edinburgh).

To investigate the extent to which House Sparrows nest elsewhere than in buildings in Scotland, I contacted all Scottish Local Recorders in late 2003 and placed a request for information in *Scottish Bird News* (No 71, March 2004). These enquiries asked for any records of House Sparrows nesting in trees, hedges, climbers, other vegetation, or in other unusual sites, with if possible information on place, year(s), how many pairs were involved, whether young were successfully reared, and whether any nesting was associated with Tree Sparrows *Passer montanus* or other birds. The results from this enquiry together with published Scottish records are summarised in Table 1.

Most reports, at over 20 locations, were of nests in vegetation. Nesting in nests of other species and usurping other species' nests were reported from over 12 locations, and nesting in holes in rocks or trees from 9 locations. Of nests in vegetation most were in trees, nearly as many were in hedges, fewer in climbing plants, and only one each in a bush or low plant. Evergreen trees were strongly favoured over deciduous trees. More nests were reported in deciduous than evergreen hedges and more in evergreen than deciduous climbers, though this could have related as much to availability as preference. When nesting in vegetation a single nest was usual, 2 less so, and more than 2 uncommon, though in thick climbers and hedges reporters were not always sure how many nests were involved.

When nest character was mentioned, all those in vegetation were roofed and with a side entrance. The communal nest, reported by G D Joy in Ayrshire, was about 20cm wide and 75cm tall, domed, with separate side entrances for each of the 3 pairs of House Sparrows, and situated in dead interlocking branches of 2 Sitka Spruce trees growing close together and forming part of a line of spruce trees. This appears to be a fairly unique occurrence in Britain, though communal nesting by House Sparrows has been described in Canada (McGillivray 1980. *Journal of Field Ornithology* 51: 371-2).

None of the reports in this survey were from cities or large towns (though the majority of readership of *Scottish Bird News* is from cities and towns); the great majority came from villages and rural locations. A similar number of reports of nests in vegetation came from the Northern and Western Islands as came from the Scottish mainland. Most people replying to the survey believed that young were successfully reared from the nests reported. Predation was reported from one site where several pairs of Sparrows nested in thick ivy on a large tree and Carrion Crows *Corvus corone* were seen to pull a nest apart and take young Sparrows (R N Cinderey *in litt*); perhaps hinting at one important reason why nesting in vegetation is much less common than in cavities in buildings. Climate may also be an influence; Summers-Smith (1988. *The Sparrows*. Poyser, Calton) found House Sparrows nesting away from

Table 1. ***House Sparrows nests in Scotland in sites other than in buildings.*** *SBR =* Scottish Bird Reports, *rbr = regional bird reports, repl = reply to unpublished enquiries (see text), B&R = Baxter and Rintoul 1953, Penn = Pennington* et al *2004.*

Type of nest site	Number of locations	Number of nests per location	Years	Scottish Recording Area	Source
domed nest in tree (spruce)	1	1	2004	Shetland	repl
domed nest in tree	1	1	1999	Outer Isles	SBR
domed nest in tree (spruce & willow)	several	1	several recent	Outer Isles	repl
domed nest in tree (pine)	1	?	1934	Highland	B&R
domed nest in tree (spruce)	1	2	1997-8	Highland	repl
domed nest in tree (*Cupressus*)	1	1	1950s	Borders	repl
communal domed nest in tree (sitka spruce)	1	1 communal nest with 3 pairs birds	2001	Ayrshire	repl
domed nest in bush (hawthorn)	1	1	1996	Orkney	repl
domed nest in hedge	1	7-8	1998	Orkney	rbr
domed nest in hedge (hawthorn)	1	1	1995-6	Orkney	repl
domed nest in hedge (holly)	1	1	1990s	Moray & Nairn	repl
domed nest in hedge (beech-holly)	1	1	recent years	Perth & Kinross	repl
domed nest in hedge (beech-hawthorn)	1	2	2004	Clyde	repl
domed nest in hedge (hawthorn)	1	2-3	c1990-2004	Dumfries & Galloway	repl
domed nest in climber on house (ivy)	1 abandoned	1	2004	Shetland	repl
domed nest in climber on house (ivy)	1	2	2004	Highland	repl
domed nest in climber on house (clematis)	1	1	1990s	Moray & Nairn	repl
domed nest in climber on tree (ivy)	1	several	c1992-2000	Dumfries & Galloway	repl
nest in rhubarb plant	1	1	2000	Orkney	rbr
in hole in tree (ash)	1	1	c1995	Ayrshire	repl
in hole in tree	1	1	2003	Lothian	rbr
in clay pit	1	1	1998-99	Lothian	rbr
in crevices in rocks at coast	3	1	pre-1955, 2002	Shetland	Penn
in crevices in cliff at coast	1	small colony	at least to 1966	Shetland	Penn
in crevices in rock quarry	1	up to 6	1980s-90s	Shetland	repl
in crevices in rock quarry	1	many	early 20th cent	Clyde	B&R
in House Martin nests on cliffs	1	? several	at least to 1974	Angus & Dundee	repl
in House Martin nests on houses	2	? several	2001	Clyde Islands	repl
in Swallow nests on buildings and culverts	several	-	1980s-recent	Orkney	repl
in bases of Rook nests	1	few	1990s	Shetland	repl
in bases of Rook nests	-	-	pre-1924	Dumfriesshire	B&R
in bases of Buzzard nests	several	1-2 per Buzzard nest	1990-recent	Highland	repl
in bases of Grey Heron nests	few	1-2 per Heron nest	1990-recent	Highland	repl
in centre of disused Magpie nest	1	1	2004	Highland	repl

Scientific names of birds in table: House Martin *Delichon urbica*, Barn Swallow *Hirundo rustica*, Rook *Corvus frugilegus*, Common Buzzard *Buteo buteo*, Grey Heron *Ardea cinerea*, Black-billed Magpie *Pica pica*.

buildings to be commoner in southern parts of the Sparrow's Northern Hemisphere range. The proportion of House Sparrows nesting away from buildings in Scotland seems to be extremely small, which the low number of reports received by this enquiry supports, and the proportion may be lower than in southerly parts of UK.

This survey received no reports of House Sparrows nesting in association with Tree Sparrows, though hybrids between the 2 species are known in Scotland, mainly from remote islands (regional bird reports, *Scottish Bird Reports*). In one Ash tree in Ayrshire, 3 holes were occupied in the same year by, from highest to lowest, a pair each of Common Starlings *Sturnus vulgaris*, Tree Sparrows and House Sparrows (A Hogg *in litt*).

Whether there has been any change in the nesting preferences of House Sparrows in Scotland over time is uncertain. Baxter and Rintoul (1953. *The Birds of Scotland*. Oliver & Boyd, Edinburgh) 'often found' House Sparrows' nests in hedges, conifers and 'other evergreens' and cite records of nesting in Ivy covering walls and cliffs. There is no doubt that Sparrows can be adaptable; the same authors mention nests low in Gorse bushes in Skye, and that in the 1880s Sparrows spread over the north part of Lewis 'preferring to nest in holes in rocks rather than in thatched houses'.

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Appendix
Scientific names of plants mentioned in text and table: ash *Fraxinus excelsior*, beech *Fagus sylvatica*, clematis *Clematis* sp, gorse *Ulex sp*, hawthorn *Crataegus monogyna*, holly *Ilex aquifolium*, ivy *Hedera helix*, pine *Pinus sp*, rhubarb *Rheum rhaponticum*, sitka spruce *Picea sitchensis*, willow *Salix sp*.

Harry E M Dott, 8 Mortonhall Park Gardens, Edinburgh, EH17 8SL

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Interaction between Merlins and a Hen Harrier over a nesting area

Relationships between Merlins *Falco columbarius* and Hen Harriers *Circus cyaneus* on their breeding moors are mainly antagonistic. In the spring of 2005 I watched an extension of this behaviour when a pair of Merlins and a male Hen Harrier were involved disputing a nesting area on a heather moor in Galloway. Both Merlins and Hen Harriers breed on this particular moor usually 200-300m apart.

On 29 April a male Hen Harrier hunted near the Merlins' nest. The male harrier returned and directly above the Merlins' nest 'skydanced' 11 times; at the same time the sitting female Merlin flew from her nest and landed about 30m away on a fence post. The male Merlin arrived and the female returned to her nest but was reluctant to settle and flew back to the post. The male Merlin flew up and aggressively attacked the male harrier until he flew away. The male Merlin visited his nest followed by the female which landed just above him. The male flew from the nest and landed a metre away and the female Merlin entered her nest and remained.

On 1 May the male harrier attacked a Carrion Crow *Corvus corone* directly above the Merlins'

nest and he landed in heather 12-15m above; the female Merlin watched the harrier from behind some heather. On 3 May a male Hen Harrier 'skydanced' 91 times above the Merlins' nesting area and then landed in heather 12-15m above the Merlins' nest. The female Merlin rose from a fence post and aggressively attacked the male harrier. The male harrier then began building a 'cock's nest' 12-15m from the Merlins' nest. He gathered nest material 3 times watched by the female Merlin on a fence post.

On 9 May the male harrier landed on the moor above the Merlins' nest whereupon a female Hen Harrier flew from the 'cock's nest' and took small prey from the male on the ground. The female harrier did not remain long and flew away. One hour later the male harrier rose from the heather less than 2-3m from the Merlins' nest but the Merlin remained, apparently incubating. On 12 May a male harrier 'skydanced' 50 times above the Merlins' nest. A female harrier rose from the heather about 250m away and followed the male back to a burnt area 30m above the Merlins' nest. The male 'bowed' to her on 3 occasions but the female flew away, followed by a male, outwith the area.

For a male Hen Harrier to 'skydance', 'bow' to a female and build a 'cock's nest' so close to a Merlins' nest is unusual. Whether the behaviour of the male harrier was to intimidate the Merlins or to attract a female harrier is not known. The pair of Merlins abandoned their nest sometime in May. The Hen Harriers did eventually breed successfully about 250m from the Merlins' nest.

R C Dickson, Lismore, New Luce, Newton Stewart, Dumfries & Galloway DG8 0AJ

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Mean laying dates in the Northern Gannet

Since 1961 the mean laying date (MLD) of Atlantic Gannets *Morus bassanus* on the Bass Rock has consistently fallen within the fourth week of April (Nelson J B 2002. *The Altantic Gannet* second edition. Fenix Books Ltd. Great Yarmouth). This date can be reliably calculated by working back from the age distribution of chicks in July or early August, before any have fledged but after the latest eggs have hatched. The approximate age of chicks is easily assessable, by size and plumage, within the categories 0-3 weeks, 3-6, 6-9 and 9+ (see illustrations in Nelson 2002).

In 2005 I calculated that the MLD was some 3 weeks later than usual. Unlike some Bass seabirds such as Common Guillemots *Uria aalge*, Black-legged Kittiwakes *Rissa tridactyla* and European Shags *Phalacrocorax aristotelis*, whose MLD can vary by several weeks (*pers obs*), Gannets are largely unaffected by weather during the normal laying period (late March to early July). Furthermore, and again unlike other seabirds, Gannet breeding success (young fledged from eggs laid) is consistently high at around 75%. Whilst I have no evidence that breeding success in 2005 was lower than usual, the late laying does seem significant and could potentially be linked to a relative paucity of sand-eels *Ammodytes* spp within the foraging range of Bass Gannets. These fish are an important part of the Gannet's diet prior to egg laying. A reduction in the abundance of sand eels could result from a combination of over fishing and climate change.

J Bryan Nelson, Mine House, Auchencairn DG7 1RL

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Crossbill numbers in old pinewoods on upper Deeside and Speyside in 1944-75

Currently there is renewed interest in Scotland's crossbills (*Loxia* spp), which justifies fuller use of previous data. Here we give a fuller analysis of A Watson's data, which had been published only in summary form, including a brief note on breeding in upper Deeside (1955, *Scottish Naturalist* 67, 121). D Nethersole-Thompson (1975, *Pine Crossbills*, Table 14, Poyser, Berkhamsted, for brevity called DNT below) compared his estimates of numbers in upper Speyside with AW's unpublished estimates in upper Deeside. For this, he and AW used grades such as 'high' and 'peak'. This showed years when the 2 sets of records differed, such as 1950 when few birds were seen on Speyside, yet many on Deeside. He suggested that birds may move between Speyside and Deeside.

Analyses using scores for grades of abundance

Here we present statistical analyses from AW's notes, supplemented by interpretations from MM's experience. Each grade for abundance had a score, 1 for Very Low, 2 for Low, 3 Fair, 4 High, and 5 Peak. Because most data could not be transformed into normal distributions, non-parametric correlations were used. Scores on DNT's area and on AW's area in the same year showed hardly any association (n = 17 years, r_s = –0.19). This also held with proportionate change (the score in year 2 divided by the score in year 1, n = 13, r_s = –0.20). Moreover, although DNT reported cases where estimates on Speyside and Deeside differed, such as 1950, this was not general, and any inverse correlations were extremely weak.

Analyses with a precise index of numbers on upper Deeside

To get a better index of numbers in old Scots pinewood *Pinus sylvestris* near Braemar, AW divided the total of birds seen by the number of days when he was in the woods. This index was more precise than anything attainable with the 5 grades. Nonetheless the indices were strongly correlated with scores for AW's grades in DNT's book (n = 20, r_s = 0.945, P = 0.000). The index was crude, however, because a bird calls more frequently when flying than when not flying, and perhaps more when numbers are high than when low. Also, AW's time in the woods varied from day to day. He was not doing a study of crossbills, and merely passed through the woods on the way to or from high ground. Fluctuations must have been big, however. For instance, he saw no birds in 5 years with considerable effort (6-41 days, mean 17), yet saw many in 1950.

The indices were not associated with scores for DNT's grades on Speyside (n = 29 years, r_s = 0.08), and likewise for proportionate change on Deeside and Speyside (n = 27, r_s = –0.02). Hence analyses using the more precise indices for Deeside birds confirmed that Deeside and Speyside populations did not fluctuate up or down together in the same year, or inversely (one up when the other was down). In short, the evidence goes against the ideas that Deeside and Speyside populations generally fluctuate together or inversely.

Does local movement affect abundance in upper Deeside?

Common Crossbills *Loxia curvirostra* move in summer, but Parrot Crossbills *Loxia pytyopsittacus* and Scottish Crossbills *Loxia scotica* in autumn (M Marquiss 2002, *The Migration Atlas*). To study movement further, AW abstracted his notes by calendar month. Most birds were seen in February-August, and in 1948 none after mid July. The 1949–50 notes are revealing. In 1949, he saw no birds in January–August, but in September 5 in 2 days at Quoich and 25 on each of 2 days at Derry/Luibeg, suggesting that some had immigrated there in September. At

Table 1. ***Crossbill abundance (annual total of birds seen by AW, divided by the number of days when he was in the woods) in old pinewood at Mar Forest and Ballochbuie, and scores for British irruption years (big irruption 2, small 1, none 0).***

Year	Index of abundance	No of days	Irruption score
1944	0.2	19	0
1945	5.7	12	0
1946	3.7	38	0
1947	6.0	38	1
1948	0.6	99	1
1949	0.0	41	0
1950	58.3	25	0
1951	0.5	29	0
1952	1.0	32	0
1953	0.0	10	2
1954	0.03^	32	0
1955	0.3	20	0
1956	0.4	11	2
1957	0.4	12	0
1958	2.0	5	2
1959	0.8	5	2
1960	0.0	6	0
1961	0.8	9	0
1962	3.3	10	2
1963	0.7	13	2
1964	0.7	15	0
1965	0.0	14	0
1966	0.0	12	1
1967	0.7	14	0
1968	0.9	12	2
1969	0.7	12	0
1970	2.0	16	0
1971	1.0	17	0
1972	2.5	16	2
1973	1.7	12	0
1974	3.2	10	0
1975	6.0	15	0

^ Taken to 2 places of decimals to distinguish from 0.0 (none seen).

Derry/Luibeg he saw 15 on 28 October and 9 January, none on 12 other days there in October–January, 20 on a February day, none on 3 other February days, and none on 29 and 30 March there or in Glen Lui and Glen Dee.

On the early morning of 31 March, in contrast, many were at Luibeg and about 120 at nearby Derry, with 'Very large numbers at Luibeg, Carn Crom and Derry, never seen so many' and 'singing everywhere and some displays'. On 6 April 'dozens' were at Derry Lodge and 'everywhere' in lower Glen Derry and Luibeg, and many in old pinewood at Glen Lui. Watson (1955) stated, 'there were hundreds in the woods'. The inference is that many came at the end of March, about the time when Scots pine cones begin to open and provide accessible seed. An influx of Scottish Crossbills occurs into pinewood from February onwards, so the many birds that suddenly appeared at the end of March may have been Scottish Crossbills.

Luibeg stalker Robert Scott and AW saw many flying young from 9 to 29 June, and some newly fledged young being fed on 1 July. Yet 'the majority of the birds remained in large wandering flocks throughout the breeding season' (Watson 1955). AW was in Norway for the rest of July, but RS made notes that fledglings were still being fed until 7 July, and that all birds had gone by mid July. In August and September 1950 he and AW saw none. Although AW stopped noting crossbills in 1975, he has gone through the woods annually and has not seen numbers as high as in 1950.

Do irruptions affect abundance on upper Deeside and Speyside?

Because AW seldom saw flocks closely, the flocks may have consisted of any of the 3 species. Irruptions of continental Common Crossbills occurred in 1927, 29-30, 35. 38-39, 42, and later years shown in Table 1 (Newton 1970, and S Cramp & K E L Simmons (eds), 1994, *BWP*, vol 8, Oxford University Press). Up to 1975, the only big recorded influx of Parrot Crossbills to Britain was in 1962-63 (DNT 1975).

DNT's period included 16 years with irruptions and 26 without. The scores for abundance of Speyside crossbills in the 2 sets were very alike (means 2.87 v 3.00, both medians 3.0). AW's period included 11 years with irruptions and 21 without, Deeside indices in the former being if anything lower (means 1.98 v 4.18, medians 0.95 and 0.70). Correlations between annual scores for irruptions and for abundance of local crossbills were very weak and insignificant (Table 2). This goes against the idea that irruptions affected the abundance of crossbills seen in old pinewoods on upper Deeside and Speyside.

Variation in abundance between woods in the same year

In 1950, the peak year at Derry, Luibeg and Glen Lui, RS and AW saw far fewer in most parts of the Derry and Luibeg woods (ie parts at higher altitudes), none in Glen Dee, Quoich and Ballochbuie, and at Dubh Ghleann only 3 in October. In 1973, AW found more at Ballochbuie than at Mar Lodge and Derry (5 v 1 per day), and in 1974 vice versa (0.5 v 3.1). Abundance in different woods was not in phase.

Dates of fledging

The first fledglings at Derry/Luibeg appeared on 6 June in 1950 and 8 June in 1947. On 9 June 1950, some with fully grown tails were already foraging away from any adults. In 1946, 1947 and 1950 the fledgling peak came in late June, with fewer on 1-10 July.

One nest of small chicks on 19 April 1946 (Watson 1955) was in a young plantation of Scots pine and larch at Knock by Birkhall, a much earlier date than the records in old pinewood at Derry and other sites with old pinewood

Table 2. ***Correlation coefficients (r_s) in comparisons of the 'irruption score' as in Table 1 with a) the numbers score for local crossbills, and b) the proportionate change from year* t-1 *to year* t *in the numbers score.***

Correlation	Yearly comparisons with the irruption score	*n* years	r_s
1	DNT score for upper Spey crossbill numbers^	42	0.003
2	Proportionate change in 1	36	0.09
3	AW score for upper Dee crossbill numbers^	20	–0.06
4	Proportionate change in 3	18	–0.15
5	AW index of crossbill numbers on upper Dee	32	–0.05
6	Proportionate change in AW index*	31	–0.10

^ DNT's book gave 4 grades (note below his Table 11) plus very low. In the book copy sent by DNT to AW, he corrected his 1973 grade as Fair, not Low. *After adding 0.01 to each value, so that proportionate change could be calculated where the earlier year's value was 0.

mentioned above. A few other dates are later than those in old pinewood. The latest note of a fledgling, on 24 July 1945, involved one being fed in old larches at Braemar village. The record in Watson (1955) at Lion's Face involved two young being fed in planted old larches and Norway spruces, as seen by B W Tucker and AW on 21 July 1945. A late observation that is not in Watson (1955) concerned a nest with big young in mature planted Scots pine, larch and Norway spruce at Corndavon Lodge on 15 July 1945. Another was of a fledgling being fed on 10 July 1947 in old planted larches by Invercauld Bridge (BWT & AW).

Scottish or Parrot Crossbills?

All adults in the last paragraph were big billed and thought to be Scottish Crossbills, and the mixed plantations of larch, Norway spruce and Scots pine would fit this (M Marquiss & R Rae, 2002, Ecological differentiation in relation to bill size amongst sympatric genetically undifferntiated crossbills *Loxia* spp. *Ibis* 144: 494–508). Writing of the 1950 birds, Watson (1955) noted that any seen closely at 'less than 12 feet' had heavy bills unlike Common Crossbills that he had seen in Lapland. In his diary he described a pair seen feeding as close as 2.4 m, at the top of Craig Doin in Ballochbuie pinewood on 1 April 1948, where the cock had 'a tremendous pickaxe of a bill'. Having seen Parrot Crossbills with MM and Robert Rae in recent years, he thinks that this cock was a Parrot Crossbill, and likewise cocks seen less than one metre away on a skylight window at Luibeg in April 1949, 1952, 1954 and 1955. DNT had decided from 1966 onwards that the birds in old pinewood were Parrot Crossbills, when he with AW visited the woods in upper Deeside each spring. Because of this, AW called them Parrot Crossbills in April 1969 (discussion after I Newton, 1970, *Animal Populations in relation to their Food Resources*, A Watson (ed), pp. 337–353, Blackwell Scientific Publications, Oxford & Edinburgh) when describing a comparison by DNT and AW of abundance on Speyside and Deeside, and when reporting that DNT 'has done a population study of Scottish parrot crossbills' on upper Speyside. Of old pinewood in the Cairngorms, DNT wrote (in D Nethersole-Thompson & A Watson, 1974, *The Cairngorms*, Collins, London) that he 'and others consider that our resident Scottish Crossbills should be treated as *pytyopsittacus*', and (1975) called them pine or Parrot Crossbills.

Habitat features in the most favoured sites seen on upper Deeside
The most used sites were at lower Glen Derry and at Luibeg, and to a lesser extent near Mar Lodge and on both sides of the river Dee at Ballochbuie. Pines in these places grew at low density, with wide crowns and many cones. This typifies open woodland (H M Steven & A Carlisle 1959, *The Native Pinewoods of Scotland,* Oliver & Boyd, Edinburgh & London), and old conifers (C W Benkman, 1993, *Conservation Biology* 7: 473–479). The pines were old, the Derry/Luibeg ones with a median age of 181 years in a cut sample in 1948 (A Watson, 1983, *Biological Conservation* 25: 289–305).

At all these sites, soils comprised freely drained alluvium with a good crumb structure, at least 20 cm thick. The pines grew in herb-rich, fine-leaved grassland, which was grazed by many Red Deer *Cervus elaphus* and Rabbits *Oryctolagus cuniculus*, and fertilised by their dung and urine at all seasons.

The site in lower Glen Derry included a vegetable plot, and the Luibeg one a field that was partly cultivated before 1940 (Ian Grant, pers. comm., who was brought up there in the early 1900s). In the 1930s–70s, stalkers spread dung and bedding straw on both plots from cattle, horses and poultry, and uneaten hay and other leftover food given to deer in winter would have boosted soil fertility outside the plots (observations by AW after 1942, Donald Macdonald and James Beattie, pers comm for earlier years). Much of the ground in the sites at Ballochbuie and Mar Lodge lay on former arable farmland, as shown on old estate plans cited by A Watson & E Allan (1984, *The Place Names of Upper Deeside*, Aberdeen University Press). Moles *Talpa europea* and molehills of fertile topsoil on all these sites also indicated fertile soil, as did abundant earthworms, especially where stock manure and straw had been added.

Hence, big cone crops per tree in the above favoured sites may be due to trees being isolated, or old, or open to sunshine, or to fertile soil caused by alluvial deposits or cultivation or additions of stock dung and straw, or to 2 or more of these together.

Adam Watson & Mick Marquiss, Centre for Ecology & Hydrology, Banchory, AB31 4BW

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Black Grouse and Western Capercaillie on upper Speyside in 1934–42

In 1988, Desmond Nethersole-Thompson (DNT) sent his notes on Black Grouse *Tetrao tetrix* and Western Capercaillie *Tetrao urogallus* to Adam Watson, following AW's questions. The notes are of considerable interest, because they come from years when both species were abundant, long before the large declines recorded since the 1970s.

In the 1930s, DNT lived at Dorback near Nethy Bridge, and at Whitewell croft on Rothiemurchus from the 1940s till 1961. AW analysed the data and used the Tables to write a summary paragraph on breeding.

Habitat use
In Abernethy and Rothiemurchus, DNT found that Black Grouse were essentially birds of old Scots pinewoods *Pinus sylvestris* and the edges of pine plantations or birchwood *Betula* spp, but many nested in nearby moorland. On Dorback moor he saw them only occasionally more than

one km from woodland, and such birds were usually broodless greyhens. Western Capercaillies seemed more plentiful in the interior of old pinewood. He saw no fighting or threat between the 2 species, but foresters and keepers in the 1930s and 1940s believed that capers were increasing in the interior pinewood, while Black Grouse were declining there.

He noticed that when adult Black Grouse were slightly disturbed, they sometimes did not rise and fly as a flock, but one by one or 2 by 2, and did not always fly in the same direction. His impression was that they did not move in flocks during years with low numbers, whereas several coveys appeared to join when numbers were high, though there were insufficient notes on this to form a sound judgement.

Table 1 ***Features of leks of Black Grouse at Abernethy and Dorback (top 3), and Rothiemurchus (bottom 5).***

	Type of habitat	**Altitude (m)**	**Distance from the nearest woodland (m)**
Loch Garten	bog at edge of mature Scots Pine plantation	250	100
Badenedin	mature Scots Pine plantation	270	inside wood
Lurg	peat bog	250	1500
Whitewell*	permanent grass field	350	300 from mature Scots Pine plantation
Lochan Deo south of Whitewell #	burnt old Scots Pinewood, short Heather and Cowberry	325	150
Allt Dhru towards Lairig Ghru^	permanent grass at disused croft	325	50
West of Loch Morlich**	felled Scots Pinewood, short Heather and Cowberry	370	<50
	peat bog	325	<50

* Existed since at least 1902, not always in the same part of the field. From 1960 it tended to break into several small leks, and in January 1984 was finally deserted.

\# Maybe overflow from Whitewell, very few birds but I once saw a single cock there mating with a hen.

^ A small lek which was in the heart of Western Capercaillie country. On both sides within 50 m were old pinewoods in which Capercaillies had leks and nested.

** Established in late 1950s, abandoned in early 1980s.

Table 2 ***Number of greyhen nests with clutches of 5-13 eggs.***

	5	**6**	**7**	**8**	**13**
1935	0	1	1	0	1
1936	0	0	2	0	0
1937	1	0	0	1	0
1938	0	0	1	0	0
1939	0	0	1	0	0
1940	0	1	0	0	0
1941	0	0	1	0	0
1942	0	0	1	1	0
Total	1	2	7	2	1

Mean 7.3, Standard error 0.5

First egg dates in days after 30 April in the above years starting in 1935 were 8, 13, 16, 17, 17, 19, 21 and 22, mean 17 May.

Woodland clutches were: 3 of 7 eggs, one of 8 and one of 13, and moorland clutches one of 5, 2 of 6, 4 of 7 and one of 8, difference not significant (Wilcoxon rank-sum, $P > 0.1$).

Diet and feeding habits

At the Whitewell lek (Table 1), blackcocks and greyhens fed on birch buds and on pines, and on shoots of Cotton Grass *Eriophorum* spp in a nearby bog. Beside the lek at Loch Garten, blackcocks from February onwards fed and displayed on Larch *Larix europea* treetops where they ate buds, and young shoots later in the spring. In a bog at the edge of the lek, greyhens ate shoots of Cotton Grass, and both sexes likewise in a bog near a lek at Lurg farm on Dorback. As well as their staple diet of Scots Pine needles and buds, Western Capercallies in spring were observed like Black Grouse to be taking Larch at Loch Garten, and cotton grass in bogs at Abernethy and below Whitewell.

In early autumn, flocks of blackcocks with greyhens fed on berries of Cowberry *Vaccinium vitis-idaea* and Blaeberry *V. myrtillus*, and on tips of young Heather *Calluna vulgaris*. During late autumn they often ate loose oats in stubble fields and occasionally on oat stooks. At Whitewell and at Badenedin east of Nethy Bridge, greyhens sometimes joined poultry in spring to eat chicken food, and in 1935 2 greyhens nested in the wood beside Badenedin house. A fairly tame greyhen laid 13 eggs there after feeding frequently with the gamekeeper's poultry on chicken food in the few weeks before and during the egg laying period, and she continued to feed with the poultry daily through her incubation period.

Nesting

Nests of greyhens were well sheltered in tall Heather, apart from 2 sites that were more typical of Western Capercaillies, at the foot of Scots Pines 100 m inside a wood. DNT once found 2 greyhens nesting less than 5 m apart in an old peat cutting; one nest was in a clump of tall Heather surrounded by a Cowberry carpet. Greyhens seldom nested in steep pinewoods such as at Bognacruie in Abernethy, Carn Eilrig in Rothiemurchus, and on Inshriach and Invereshie near Kincraig, in all of which the Capercaillie hens frequently nested. Capercaillies often nested in pinewoods with

Table 3 ***Success of 13 greyhen nests with clutches of 5-13 eggs.***

	5	**6**	**7**	**8**	**13**
n nests	1	2	7	2	1
n nests robbed	0	2	2	1	0
n eggs hatched	2	0	6,7,7,7,7	7	13

Out of 95 eggs, predators took 41%, with Foxes robbing 3 nests and Crows 2. Of the remaining 61

Table 4 ***Brood sizes of Black Grouse at < 2 weeks old and > 2 weeks.***

	< 2 weeks	**> 2 weeks**	**Chicks/hen at > 2 weeks**
1934	4, 5, 5	1	0.33
1935	3, 4	–	–
1936	–	1	1.0
1937	–	2	0.5
1938	2, 3	1	0.33
1939	5	2	0.5
1940	4	1, 2	1.0
1942	5	–	–
Mean	4.0	1.4	0.48

Chicks/hen included hens without young. Breeding success was similar in woodland and moorland. In 2 years when DNT had data for chicks < 2 weeks in both woodland and moorland in the same year, 2 woodland broods had 4 and 2 chicks, and on moorland slightly larger at 2 broods of 5 in the first of these years and one of 3 in the second year. The number of chicks per woodland or moorland hen was 2.0 or 3.3 in the first year, and 3.0 or 0.7 in the second. The proportion of hens without young when chicks were > 2 weeks old was 50% out of 8 hens in woodland, and 86% out of 14 on moorland. The proportion of broodless greyhens varied from 0% in 1936, and 67% in

considerable growth of Juniper *Juniperus communis* bushes, which provided very good cover and shelter.

Greyhens laid their first eggs from 8 May to 22 May, with a mean clutch of 7.3 eggs (Table 2). Red Foxes *Vulpes vulpes* and Crows *Corvus corone* and *C. cornix* took 41% of the eggs, and 92% of the remainder hatched (Table 3). In the 8 nests which were not robbed, the mean number that hatched was 7. There was a mean of 4 chicks in broods less than 2 weeks old, and 1.4 at more than 2 weeks old (Table 4). When broodless hens were included, the mean number of chicks per hen at more than 2 weeks of age was 0.48.

Number of birds

Both species fluctuated in numbers, but showed no obvious overall decline in 1934–42. However, some leks of Black Grouse have been abandoned since 1960 (Table 1). Leks west of Loch Morlich were established when open

ground increased after tree felling at Glen More (Forestry Commission) in 1939–47. The open land was later planted and deer fenced, as was nearby moorland in east Rothiemurchus in 1970–71. When the tree canopy closed over, birds deserted both leks.

The decline of the Whitewell lek coincided with a lack of short vegetation on moorland and open woodland near the lek, following declines of sheep and cattle grazing outside the farm fields, and new deer fences to exclude Red Deer *Cervus elaphus*.

Numbers of gamekeepers and predators
The number of gamekeepers remained fairly similar in 1934–42, but declined after 1950. Foxes and Crows increased during the 1939–45 war, when many keepers were away in the armed services, and then declined as keepers returned and increased their killing. After 1960, the numbers of Foxes and Crows rose above wartime levels, following a decline in the number of keepers, and the many new densely planted woods made keepering more difficult.

Acknowledgement
Des B A Thompson made useful comments.

Adam Watson, Centre for Ecology & Hydrology, Banchory AB31 4BW
The late Desmond Nethersole-Thompson, Culrain, Ardgay IV24 3DW

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Sandwich Tern egg on Common Tern raft

For the last 6 years we have maintained and monitored 3 floating tern rafts on the sea at Avoch, on the Black Isle in Ross and Cromarty. An average of 120 pairs of Common Terns *Sterna hirundo* use the rafts and productivity is over twice that of Common Terns on mainland sites elsewhere in the Moray Firth.

In 2005, a pair of Sandwich Terns *Sterna sandvicensis* were seen around the rafts in May and early June. On 24th June whilst undertaking the first ringing visit, we found a single Sandwich Tern egg on the largest of the 3 rafts. It was cold, as were many of the Common Tern eggs, following a bout of severe weather a couple of weeks earlier. As far as we are aware only Common Terns have been recorded using floating rafts provided by man and this is the first record of Sandwich Terns attempting to breed on a raft. The nearest Sandwich Tern colony is at Morrich Mor, 35 km further north in the Dornoch Firth.

Kenna Chisholm & Brian Etheridge, RSPB North Scotland, Etive House, Beechwood Park, Inverness IV2 3BW.
kenna.chisholm@rspb.org.uk
brian.etheridge@rspb.org.uk

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