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Distribution and abundance of Twites wintering in Caithness

H CLARK & R M SELLERS

The Twite is one of the commonest small seed eating passerines in Caithness in the non breeding season. Five censuses carried out in the winter months between 1992 and 1994 found between 2,136 and 6,882 birds, typically in flocks of <300 birds, occasionally up to about 1,300 birds. Their wintering range extends over some 615 km^2 of agricultural land mainly between Thurso and Wick. The principal habitats used were weedy Turnip fields, in which Charlock* Sinapis arvensis *was the main foodplant, uncut Rape, especially in 1992 when poor weather prevented the Rape crop being harvested, and Rape stubbles. The results emphasise the importance of Caithness as a wintering area for this British Red Data List species. The conservation aspects of the results are discussed.

Introduction

The Twite *Carduelis flavirostris* is one of only 2 passerines for which the British breeding population is of international importance (Batten et al 1990). Within Britain the species breeds in 2 main areas, the Peak District and southern Pennines in England and in northern and western Scotland from the Mull of Kintyre to the Western Isles and through the Highlands to the Northern Isles (Orford 1973, Sharrock 1976). Small numbers also breed in several other parts of Scotland and in Ireland and a few pairs nest in Wales. Elsewhere in Europe the species' breeding range is restricted to Norway and the Kola peninsula in northern Russia.

The Peak District population winters mainly on the east coast of England from the Humber to Kent and in the Low Countries (Davies 1987, 1988). In Scotland, Twites are virtually absent from high ground in the winter months and appear to be restricted primarily to coastal areas at this time of year (Lack 1986). Despite the obvious conservation interest in the species, many aspects of the Twite's biology remain unknown. We report here on a study of Twites wintering in Caithness, one of the more important wintering areas in Scotland.

Materials and methods

Information on the distribution, flock sizes and habitats used by Twites in Caithness in the winter months was obtained principally through 5 surveys of the area carried out on 14-15 November 1992 (a small area in the extreme south of Caithness was not covered until 16 November), 28-29 December 1992, 4-5 December 1993, 3-4 December 1994 and 29-30 December 1994, together with other observations we have made over the past 15 years and records published in the Caithness Bird Report 1983-94 inclusive. Each of the 5 surveys was carried out over 2 consecutive days, and involved checking fields and other land visible from all public roads in Caithness. Typically one day was devoted to north east Caithness (roughly north of the A882 Thurso-Wick road), and the other to the south west of the area. A number of checks made mainly along the boundary between these 2 areas

showed no evidence of a substantial redistribution of birds between one day and the next and, in the short term at least, Twites appear to return daily to favoured feeding sites. We believe, therefore, that any double counting of birds will have been minimal. Most fieldwork was done by car, but, as necessary, Turnip fields, stubbles and weedy areas were checked by foot. Twites are restless birds and, whilst not easy to locate when feeding, soon take flight revealing their presence. Twites appear to be less active in the afternoon and we found that flocks began to break up in mid afternoon as the birds went to roost. Fieldwork was, therefore, restricted to the period 0900-1400 hr GMT.

It became evident during the first survey that birds were restricted almost exclusively to fields of Turnips *Brassica napa* and Oil Seed Rape *B napus*, so, for the subsequent surveys, we attempted to survey all such fields in Caithness . Most were also covered in the first survey, but a few were undoubtedly missed; the count for the first survey will, therefore, be an underestimate. Information on the distribution of Turnip and Rape fields was kindly supplied by Mr P Miller, who, in the course of his work with the Scottish Office Agriculture and Fisheries Department, visits farms throughout Caithness. The surveys should, in principle, have given a direct estimate of the total number of Twites in Caithness, but no doubt an unknown, but small, percentage will have been missed. Weather for the surveys was generally good.

For all Twite flocks located the number of birds present was estimated and the habitat they used recorded. Twites sometimes occur in mixed flocks with other finches, buntings, etc, and, in these cases, we estimated the number of Twites from the total flock size and the proportion of Twites present.

For ringing purposes birds were caught in single shelf nets set up in Turnip or Rape fields or in 4 shelf nets set by hedges bordering these fields. Birds were attracted to the general trapping area by playing a tape recording of Twite song. The majority of the birds ringed were caught at Bruan, Killimster and Lynegar.

TABLE 1 ***Flock sizes of Twites wintering in Caithness 1992-94.***

Survey date	Mean flock size	Number of flocks of size shown				
		1-30	31-100	101-300	301-1000	>1000
14/15 Nov 92	125	10	4	3	2	0
28/29 Dec 92	344	3	4	7	4	2
4/5 Dec 93	82	12	8	6	0	0
3/4 Dec 94	101	14	9	5	2	0
29/30 Dec 94	151	5	5	8	1	0
All combined	152	44 (39%)	30 (26%)	29 (25%)	9 (8%)	2 (2%)

Results

Formation and size of flocks

Twites occur in Caithness throughout the year. In the breeding season they are well dispersed throughout the area and are rarely to be seen other than in small groups which we take to be family parties. Flocks begin to form as early as July, but it is not until late August that the majority of birds are to be found in flocks. Flocks start to break up in February and few have been recorded in Caithness after March. Flock sizes vary considerably but, in midwinter, typically number no more than about 300 birds. The distribution of flock sizes recorded in our 5 surveys is summarised in Table 1; mean flock sizes varied from 82 to 344 birds with about 40% of flocks containing ≤30 birds, about 65% ≤100 birds and 90% ≤300 birds. Averaged over our 5 surveys, about 5% of the population were in flocks of ≤30 birds, 12% ≤100, 53% ≤300 and the remaining 47% in flocks of >300. The largest flocks recorded in Caithness were 1,280 birds at Alterwall and 1,100 birds at Northfield, both in December 1992 (as part of our surveys), 1,000 birds at Gills in August 1987 (R M Sellers, unpublished observations) and 1,000 at Loch Watten in November 1990 (Caithness Bird Report 1990). The majority of flocks we recorded appeared to consist solely of Twites; the remainder were mixed flocks with Greenfinches *C chloris*, Linnets *C cannabina*, Chaffinches *Fringilla coelebs*, and, less often, Redpoll *C flammea*, Brambling *F montifringilla*, House Sparrows *Passer domesticus*, Reed Buntings *Emberiza schoeniclus* and Yellowhammers *E citrinella*. Twites were generally the single most numerous species in these mixed flocks and were one of the commonest small seed eating passerines in Caithness in the winter months.

Abundance, distribution and habitats

The results of the 5 main surveys are summarised in Table 2. Between 19 and 30 flocks were found per survey, with the total number of birds recorded varying between 2,136 and 6,882 birds. There was a marked increase in the number of birds between the first and second 1992 surveys, which were carried out 6 weeks apart, though the number of flocks increased by only one. We suspect that this increase in the number of birds was a consequence of an influx of birds. By contrast, there was only a small decrease in the number of birds between the 1994 surveys, though the number of flocks decreased by about a third.

TABLE 2 ***Numbers of Twites wintering in Caithness 1992-94.***

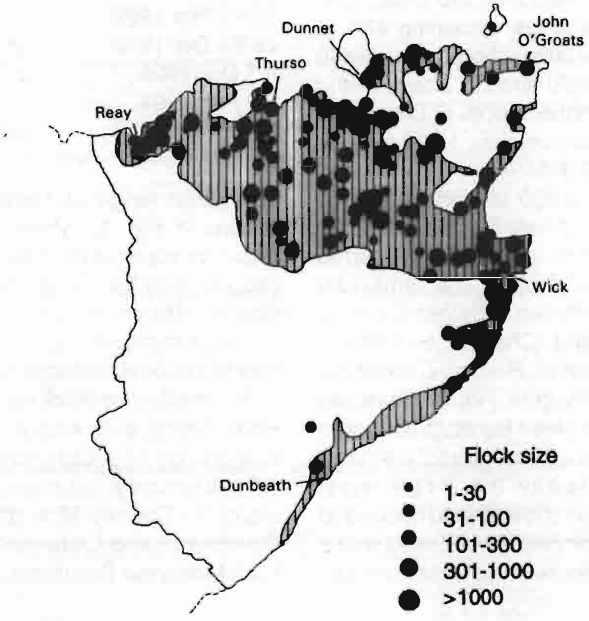
Survey date	Flocks	Birds
14/15 Nov 1992	19	2368
28/29 Dec 1992	20	6882
4/5 Dec 1993	26	2136
3/4 Dec 1994	30	3036
29/30 Dec 1994	19	2873

The winter range of Twites in Caithness is shown in Fig 1, which is based on all observations from our surveys, together with records from the Caithness Bird Report for October-March inclusive. Sightings are confined mostly to land below 200 metres above sea level and occur almost exclusively on the arable and stock rearing land between Reay, Thurso and Wick and Dunbeath. The flow country of south and west Caithness is difficult to survey, but, on the basis of fieldwork along the Causey Mire (the A895 between Georgemas and Latheron), in the vicinity of Loch More, near Broubster, between Camster

and Badlipster, near Houstry, and between Dunbeath and Braemore, we are satisfied that the absence of records from this area represents a genuine absence of birds. On the basis that the winter range coincides with that of agricultural land, as shown in Fig 1, we estimate that the area usually occupied by Twites in Caithness in the winter months is approximately 615 km^2. Only 6 sites (32%) occupied during the 14-15 November 1992 survey still held birds 6 weeks later; for the 3-4 December 1994 survey, 14 sites (48%) still held birds by the time of the next survey 4 weeks later. The majority of the sites vacated held flocks of <30 birds and/or, in the case of the 1994 surveys, were sites where stubbles had been ploughed between the 2 surveys.

The habitats from which Twites were recorded in our surveys are summarised in Table 3. The most important by far were weedy Turnip fields (Charlock *Sinapis arvensis* being the most common weed), Rape stubbles and, in 1992 especially, uncut Rape as wet weather delayed harvesting of the Caithness Rape crop in 1992 and many fields were simply left uncut, or were cut after most seed pods had spilt their contents on the ground. Small numbers of birds were recorded from a number of other habitats, including the sand dune system at Dunnet Links (dominated by Marram Grass *Ammophila arenaria*), weedy

Figure 1 ***Winter range of Twites in Caithness.*** *Shaded area shows agricultural land (after Omand 1972). Largest flock size for each site shown; all records refer to period October-March inclusive; includes data from Caithness Bird Report and special surveys.*



ground (fields, roadside verges etc) and Barley stubbles. Flock sizes were appreciably larger on Rape and Rape stubbles than on Turnips and the other habitats (Table 3). Our fieldwork has shown that Turnip fields, uncut Rape and Marram Grass are also used by some birds for roosting overnight.

We have not systematically collected information on foodstuffs but, during the course of the study, recorded Twites taking seeds of the following plants: Charlock (husked seeds of this plant were visible in the crops of many of the birds we caught), Thistle *Carduus* spp, Dock *Rumex* spp, and Rape. There is also a record from the late summer of 1992 of Twites feeding on the putting greens of Reay Golf Course where they were taking the seeds of Annual Meadow Grass *Poa annua* (J Gunn, *pers comm*).

Ringing recoveries

Despite having ringed 608 Twites in Caithness, about 37% with colour rings, only 4 have been retrapped, recovered or seen again away from where ringed. These involved an adult female ringed at Killimster, Caithness in December and found dead near Poolewe, Wester Ross (165 km WSW) the following May, a first year male ringed at Lynegar, Caithness in November and recovered on Lewis in the Western Isles (180 km W) in July 3.5 years later, a first winter female ringed at Lynegar, Caithness in January and found dead the following April at Dunbeath, Caithness (29 km SSW) and a first year male ringed at Northfield, Caithness in December and found tangled in sheep's wool at Hempriggs, Caithness (2 km SSE) in June 2.5 years later. The third and fourth of these seem to have been birds which bred and wintered in Caithness, whereas the first and second were ones which bred in north west Scotland and wintered in Caithness.

Discussion

Population size

The Twite is one of the most abundant small seed eating passerines which winter in Caithness with a population varying between about 2,000 to 3,000 birds in typical years and up to 7,000 birds in exceptional years in the period 1992-94 according to our surveys. The Winter Atlas (Lack 1986) gives an estimated British and Irish midwinter population of 100,000-150,000 birds (based on a breeding population of 20,000-40,000 pairs and "a net input of 50,000-100,000 birds by December"). Birds wintering in Caithness thus represent roughly 2% in typical years, and up to 5% in exceptional years, of the British wintering population, emphasising the importance of the area for Twites.

The first, third, fourth and fifth of our surveys found roughly the same number of birds (2,000-3,000) and provide a baseline against which future changes can be compared. We found a substantial increase in the number of birds present between the first and second 1992 surveys when food was unusually abundant. We suspect that this was the result of an influx of birds from outside Caithness, or passage birds staying to winter.

Flock of Twites in Caithness typically hold up to 300 birds but, on occasion, numbered over 1,000 birds. These large flocks appear to be amongst the biggest ever recorded in Scotland (Thom 1986), but flocks up to 2,500 strong have been seen on the Wash (Davies 1987, 1988) and up to 3,000 on the Continent (Cramp & Perrins 1994).

Habitats

In Caithness, Twites are confined almost

TABLE 3 ***Habitats used by Twites wintering in Caithness 1992-94.***

Survey date	Habitats											
	Turnips		Uncut Rape		Rape stubble		Weedy ground		Marram		Barley stubble	
No of flocks:												
14/15 Nov 92	10	(53%)	4	(21%)	5	(26%)	0		0		0	
28/29 Dec 92	5	(25%)	15	(75%)	0		0		0		0	
4/5 Dec 93	13	(50%)	0		9	(35%)	2	(8%)	1	(4%)	1	(4%)
3/4 Dec 94	20	(67%)	2	(7%)	5	(17%)	2	(7%)	1	(3%)	0	
29/30 Dec 94	14	(74%)	0		3	(16%)	1	(5%)	1	(5%)	0	
All dates	62	(54%)	21	(18%)	22	(19%)	5	(4%)	3	(3%)	1	(1%)
No of birds:												
14/15 Nov 92	740	(31%)	1185	(50%)	443	(19%)	0		0		0	
28/29 Dec 92	820	(12%)	6062	(88%)	0		0		0		0	
4/5 Dec 93	559	(27%)	0		1179	(57%)	108	(5%)	70	(3%)	150	(7%)
3/4 Dec 94	1034	(34%)	210	(7%)	1684	(55%)	33	(1%)	75	(2%)	0	
29/30 Dec 94	2240	(78%)	0		530	(18%)	100	(3%)	3	(0.1%)	0	
Total	5393	(31%)	7457	(43%)	3836	(22%)	241	(1%)	148	(1%)	150	(1%)
Mean flock size	87		355		174		48		49		150	

exclusively to farmland in the winter months, the important habitats being weedy Turnip fields, Rape stubbles and, mainly in 1992, fields of uncut Rape. Rape is a new crop in Caithness. The birds were exploiting spring sown Rape, which, in 1991, amounted to only 5 ha rising to 491 ha in 1992, the increase apparently being due to a change in agricultural subsidies. Over the same period, winter sown acreage decreased from 234 ha in 1990/91 to 35 ha in 1991/92. We have no figures for seasons before 1991 but understand that the areas sown with Rape were extremely small. As noted above, much of the 1992 spring sown crop was not cut, or was cut late, because of wet weather at harvest time; the abundance of Rape seed in the winter of 1992/93 in Caithness was, therefore, wholly novel, but our observations serve to highlight the ability of Twites to exploit new food sources when they become available. Spring sown Rape appears to be establishing itself as a crop in Caithness with 274 ha in 1993 and 488 ha in 1994, and, even if the crop is successfully harvested, Rape stubbles have the potential to supply a significant part of the species' winter food requirements. Weedy Turnip fields, however, appear to be the traditional wintering habitat and our preliminary observations suggest that they are also important in the Dornoch Firth and Beauly Firth areas. In addition, Twites are recorded as using Turnip and stubble fields in north east Scotland (Buckland, Bell & Picozzi 1990), weedy Turnip fields in Morayshire (Cook 1992) and, on Islay, as using stubbles as well as taking small seeds from farmland weeds and maritime flowers (Elliot 1989).

Origins

Although there are only 4 ringing recoveries available, they suggest that the Caithness wintering population is drawn from both the local breeding population and that of north west Scotland. There is a passage of Twites on Fair Isle in both autumn and spring (Dymond 1991) as well as a number of ringing recoveries showing movements between Shetland and Orkney. We consider it likely that some birds from the Northern Isles also winter in Caithness. There appears to be a small passage across the northern North Sea. Small numbers of Twites are seen each year on North Sea oil rigs (North Sea Bird Club Reports) and it is tempting to see this as evidence that Norwegian birds move into Scotland, though they could be Scottish birds moving to the Continent. This is supported by the recovery of a bird ringed on Fair Isle in July 1953 on a ship off Heligoland the following October. By contrast, an extensive ringing programme in Norway in the 1960s failed to generate a single recovery anywhere in Britain, though there were over 50 along the North Sea coast from Denmark to France (Bernbhoft-Osa 1965). On the evidence currently available, we suggest that the Caithness population is drawn almost entirely from the northern Scottish breeding population.

Conservation

The Red Data Book for birds in Britain (Batten *et al* 1990) stresses the importance of saltmarsh as wintering habitat for the Twite and that among the main threats to the species' survival are loss of habitat and a reduction in the food supply at wintering sites. These comments appear to be based on the English population for which the main foodplants in winter are Marsh Samphire *Salicornia* spp and Sea Aster *Aster tripolium* . The former does not occur in Caithness, nor in several of the other important wintering areas in Scotland, and the latter is relatively scarce in Caithness and is restricted to coastal cliffs (Perring & Walters 1990, Bullard *et al* 1977)

which Twites do not appear to use in the non breeding season. Our results suggest that the weeds of Turnip fields, especially Charlock, are important in Caithness and that this may well be the case in several other parts of Scotland. The acreage of Turnips, and, by implication, that of the associated weed flora, has decreased by a factor of about 8 over the past half century (Table 4), and this trend gives some cause for concern as to future winter food supplies in the area. A similar trend is apparent in Sutherland (Omand 1991). Our results show that Twites can adapt to other foodstuffs if circumstances permit. The abundance of Rape seed in Caithness in 1992 was probably unique, though the continued availability of Rape stubbles may be important. It is clear that the abundance of Turnip fields and Rape stubbles in Caithness needs to be monitored carefully and that further studies are required elsewhere in the main Scottish wintering areas to define the habitats used and the extent to which these are under threat.

Scottish Twites have been described as largely sedentary (eg Batten *et al* 1990, Jardine & Reid 1993), and, whilst this is partly true, evidence is mounting that some do move and that the pattern of these movements may be quite complex. The breeding and winter distributions show a substantial redistribution of birds between the breeding and non breeding seasons (Jardine & Reid 1993, and Lack 1988), and the results of this study are evidence of movements across the north of Scotland between the west coast and Caithness. The conservation of these birds thus depends on protecting both the breeding areas in north west Scotland and wintering grounds in Caithness.

TABLE 4 ***Turnip acreages in Caithness over the past half century .***[a]

Date	Area of Turnips (ha)
1937	3662
1961	2743
1971	1121
1983	707
1991	439[b]

a Data from Scottish Office Agriculture & Fisheries Department

b After 1983 Turnip fields < 2 ha did not have to be reported; this figure thus slightly underestimates the true figure

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Wintering Twite *Mike Ashley*

The status of the Gannet in Scotland in 1994-95

S MURRAY & S WANLESS

A census of all the Gannet colonies in the east Atlantic was carried out in 1994-95. This paper summarises the results from all the Scottish gannetries and compares them with the last major census in 1984-85. Scotland remains the stronghold of the Gannet with 12 colonies and a total population of 167,407 apparently occupied sites representing 61.1% of the east Atlantic population. Numbers were divided very unevenly between the colonies with St Kilda, the Bass Rock and Ailsa Craig together holding 76% of the Scottish population and 47% of the east Atlantic population. Since 1985 Gannets have bred at least once on Rockall (1992) and colonised Scotland's first mainland gannetry at Troup Head (1988). The colony on the Shiant Isles was short lived. The Scottish population increased at an average rate of 2.4% pa between 1984-5 and 1994-95. Sule Stack was the only colony which did not increase over the period. Rates of increase at the other colonies varied considerably but, in general, were highest at recently founded colonies.

Introduction

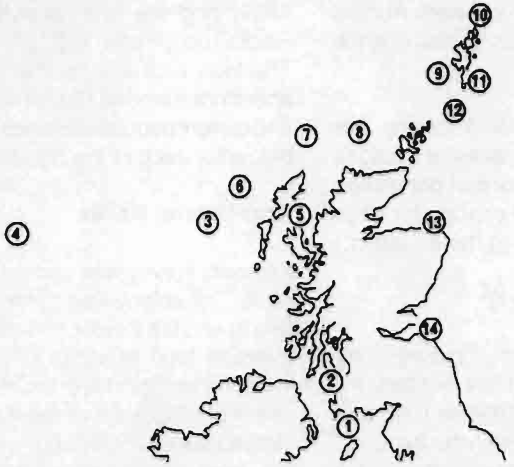
At the time of the last comprehensive census of Gannets *Morus bassanus* in 1984-85, there were 12 gannetries in Scotland. The Scottish population was estimated at 132,100 occupied sites which represented almost 60% of the total for the east Atlantic and about 50% of the world population (Murray & Wanless 1986, Wanless 1987). Numbers at most colonies were increasing and the Scottish population was estimated to have shown an average rate of increase of 2.0% per annum (pa) between 1969 and 1985. We coordinated another complete survey of east Atlantic gannetries in 1994-95 and this paper details the counts from all the Scottish colonies and compares them with the results of the 1984-85 census.

Methods

The locations of the colonies are shown in Figure 1. We carried out aerial surveys of St Kilda, Sule Stack, Sula Sgeir, the Flannan Isles and the Bass Rock in 1994, and Ailsa Craig and the Scar Rocks (also referred to as the Scare Rocks) in 1995. The remaining colonies were counted by other observers who are acknowledged below.

The 1994-95 survey was carried out using similar methods to those adopted in 1984-85 with colonies counted either from field counts made from the land or sea, or from photographs (mainly transparencies rather than prints) taken from the land, sea or air. For a few colonies such as Bass Rock, Hermaness and St Kilda different sections of the colony were counted using different methods. Details of the various techniques

Figure 1 ***The distribution of gannetries in Scotland 1994-95. The colonies are identified by the following numbers: Scar Rocks (1); Ailsa Craig (2); St Kilda (3); Rockall (4, not known if occupied in 1994/95); Shiant Isles (5 abandoned); Flannan Isles (6); Sule Sgeir (7); Sule Stack (8); Foula (9); Hermaness (10); Noss (11); Fair Isle (12); Troup Head (13); and the Bass Rock (14).***



used to count Scottish gannetries, and the problems associated with these methods are given in Murray & Wanless (1986).

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). Sites which were clearly occupied by nonbreeders were excluded whenever possible. In most field counts the unit was the apparently occupied nest (AON, one or 2 birds at a site with some nest material present). Sites with a chick but no obvious nest were included in this category. For both count units we, or other observers, judged that it was always possible to distinguish directly whether a pair or a single bird was present and hence no correction for this effect was necessary for totals of either AOS or AON (cf Nelson 1978). The only exception to this was J B Nelson's count of the Bass Rock for which full details are given in the section dealing with this colony.

We emphasise that 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 also 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.

Nelson (1978) recommended that counts be made in June or July. These guidelines were followed at all colonies, except St Kilda, where the count was carried out in mid May to take advantage of a spell of fine, settled weather, and Ailsa Craig and Scar Rocks where the aerial survey was delayed until early August so as to ensure that there was no disturbance of Guillemots *Uria aalge.*

Where possible, counts for a colony are presented in terms of its constituent sections to facilitate future comparisons of population changes. Average rates of change for each colony were calculated using the equation:

$$P_2/P_1 = (1 + r)^t$$

where r is the rate of population change, P_1 is the nest or site count in 1984 or 1985, P_2 is the nest or site count in 1994 or 1995 and t is the number of years between the 2 counts. Counts made up to 1985 are summarised in Fisher & Vevers (1943, 1944) Nelson (1978) and Murray & Wanless (1986). Only subsequent counts are referenced in this paper.

Results

There were 12 active gannetries in Scotland in 1994-95 (Fig 1). Since the 1984-85 survey, the first colony on mainland Scotland was established at Troup Head (Matthews & North 1989) and the first recorded breeding on Rockall occurred in 1992 (Belaoussoff 1993). The lone nest site on the Shiant Isles was abandoned around 1987. The 1994-95 counts and current population trends are summarised below for each of the Scottish gannetries.

Scar (Scare) Rocks

An aerial survey was carried out on 5 August 1995. The colony was divided into 4 sections (Fig 2) and the 2 independent counts gave an average total of 1952 AOS with observer variation being 7.4% of the mean. The quality of the photographs of the north cliff and the plateau was excellent but only moderate for the west stack and slope. There was a substantial increase in numbers between 1984 and 1995 (Table1). The change from a land based field count of AON in 1984 to an aerial survey of AOS in 1995 will have exaggerated the rate of increase particularly since some areas of the colony are difficult to see from the land (P Collin pers comm). For these reasons, the calculated increase of 154% over 11 years, an annual rate of 8.8% pa, must be regarded as an overestimate.

Figure 2 ***Counting divisions used to census the Scar Rocks in 1995. Counts of the number of AOS in each section are also shown.***

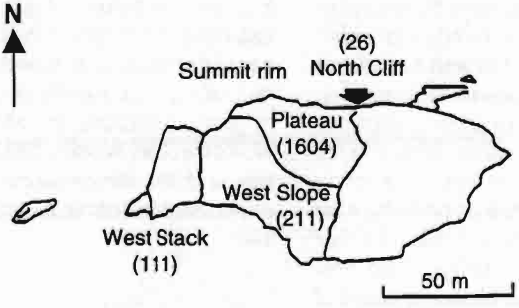


Table 1 ***Counts of the gannetry on the Scar Rocks 1984-1995.***

Year	Field counts (nests)	Aerial survey (occupied sites)	Source
1984	770		Muray & Wanless (1986)
1987	830		Dickson (1992)
1989	700		Nelson in Dickson (1992)
1994		1200+	P N Collin pers comm
1995		1952	This survey

Ailsa Craig

The count was made from aerial photographs taken on 5 August 1995. Weather conditions were ideal and the standard of the resulting slides was excellent. For the count the colony was divided into 19 sections (Fig 3) based on 23 sections originally used by Gibson (1951) and Wanless (1979). A few sections had to be amalgamated, either because increases in adjacent sections made it difficult to distinguish the original boundaries, or because of differences in viewing angle between the previous sea based censuses and the 1995 aerial survey. Two independent counts were made of the colony, the average of which gave a total of 32,455 AOS (Table 2) and observer variation was 5.0% of the mean. This represented an increase of 42% (3.6% pa) over the 1985 count of 22,811 AON. However, although the colony has undoubtedly shown a substantial increase over the period, differences in methodology and count units used in the 2 surveys are likely to have exaggerated the magnitude of the change.

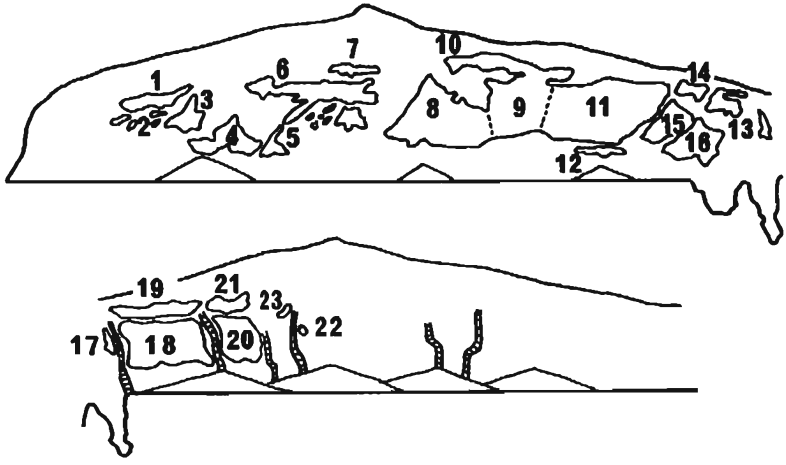
Table 2 ***Counts of the number of occupied Gannet sites on Ailsa Craig on 5 August 1995. Sections are shown in Fig 3 and are based on those used by Gibson (1951) and Wanless (1979).***

Section	Count (AOS)
1	946
2	187
3	441
4,5	1877
6	2097
7	954
8	4300
9,10,11	11959
12	140
13,14	1994
15	993
16	1270
17	21
18	908
19	3410
20	531
21	250
22	0
23	177
Total	32455

St Kilda

Full details of the methodology and results for the St Kilda survey are given in Murray & Wanless (1996) but, in brief, an aerial

Figure 3 ***Counting divisions used to count aerial photographs of Ailsa Craig in 1995.***



photographic survey of the gannetry was carried out on 15 May 1994. Counts of Stac Lee and Stac an Armin were made entirely from aerial photographs; one section on Boreray was counted from a photograph taken from the sea and the remaining sections were counted from aerial photographs. Photographic coverage of the stacs was complete but a few sites on Boreray (c 1.4% of the total) were thought to have been missed and the count was adjusted accordingly.

The overall total for St Kilda was 60,428 AOS with 14,660 AOS (24%) of the total on Stac Lee, 12,950 AOS (21%) on Stac an Armin and 32,818 AOS (54%) on Boreray.

These figures represented overall increases since the last survey in 1985 of 20.7%, 8.4%, 9.3% and 33.0% respectively, equivalent to average annual rates of 2.1% pa, 0.9% pa, 1.0% pa and 3.2% pa. While some, but not all, of the increase on Boreray was thought to be due to differences in count methodology, the increases on the stacs, and some parts of Boreray, were undoubtedly real and we concluded that the St Kilda gannetry had probably shown a sustained increase of c 0.9% pa over the last 35 years.

Rockall

No observations were made in 1994-95 but a single nest containing an egg was found on 19 June 1992 (Belaoussoff 1993). Although Gannets had previously been seen on the rock (review in Bourne 1993) this was the first recorded breeding.

Shiant Isles

No nests were found during a visit to the islands on 3-4 July 1995, but a single bird was seen ashore close to the Garbh Eilean site (J Love pers comm). During the 1985 survey, a single bird was recorded on a nest on Eilean Mhuire and there was another well built nest on Garbh Eilean. Only the Garbh Eilean site was occupied in 1986 and no Gannets were recorded ashore in May 1992 (S Murray pers

obs). It therefore appears that, after a period of occupancy lasting from 1979 to 1986, during which there was no definite breeding record, Gannets have, for the time being at least, given up their attempt to colonise the Shiant Isles.

Flannan Isles

The count was made from aerial photographs taken on 15 July 1994. The colony consists of 6 separate subgroups on the island of Roareim and its islets (Fig 4). The quality of the slides was high and the average of 2 independent counts gave a total of 1,438 AOS with an observer variation of 4.7% of the mean. No birds were recorded ashore on Eilean a Gobha during the 1994 survey, but Gannets were present, but not apparently nesting, on the island's east cliffs during visits in 1988 and 1992 (Table 3).

Previous counts of the colony have all been made from field counts supplemented by land or sea based photographs (Table 3). In 1992, landing was limited to the edge of Sgeir an Eoin resulting in a probable underestimate of this sub colony and the main colony. Although it is clear that the gannetry on the Flannan Isles has increased greatly between 1985 and 1994, the change in count methodology will undoubtedly have resulted in the overall increase and average rate of change, 545% and 23.0% pa respectively, being overestimated.

Sula Sgeir

The count was made from aerial photographs taken on 15 July 1994. Full details of the survey are given in Murray & Wanless (1994). The colony was divided into 8 sections and the standard of the count was considered to be high. The average of 2 independent counts was 10,440 AOS (Table 4) with an observer variation of 0.2% of the mean. Count

Figure 4 ***Locations of sub colonies of Gannets on the Flannan Isles. All the subcolonies except the one on Eilean a Gobha were occupied in the 1994 survey. Counts of the number of AOS in each section are also shown.***

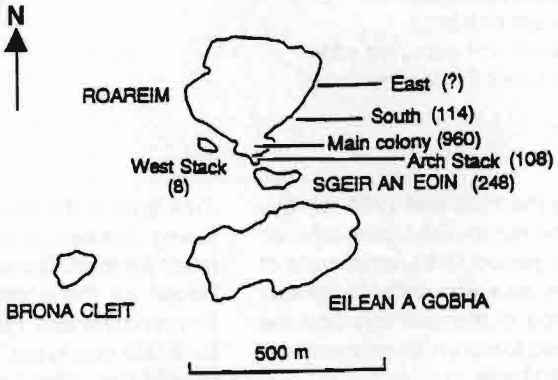


Table 3 ***Counts of the gannetry on the Flannan Isles 1985-94. Locations of the various sections are shown in Fig 4.***

	16 June 1985[1] (nests)	12 June 1988[2] (occupied sites)	24 May 1992[3] (nests)	15 July 1994[4] (occupied sites)
a) Roareim				
East		2	c6	?
South			23	113
Main colony	223	384	539+	960
Arch stack			23	107
Sgeir an Eoin		26	84+	248
West stack		4	4	8
b) Eilean a Gobha				
East		c50[5]	c55[6]	0
Total	223	416	734+[7]	1438

Notes
1. *Counted from photographs taken from the land supplemented by land based field counts*
2. *Counted from photographs taken from the land supplemented by land based field counts (M Tasker & D Rothe, pers comm)*
3. *Land based field counts (S Murray, unpublished)*
4. *Aerial photographs*
5. *Count unit birds*
6. *Count unit occupied sites*
7. *Includes 55 occupied sites*

methodology for the 1985 and 1994 surveys was identical. The number of AOS increased by 14% over the period at an annual rate of 1.5% pa. There was no evidence of any expansion in area of the gannetry and the increase appeared to have occurred mainly in sections 3 and 4 (Table 4).

Sula Sgeir is the only Scottish colony where young Gannets, known as gugas, are still taken for food. The current licence, which is issued by the Scottish Office Agriculture, Environment and Fisheries Department, is for 2,000 young per year but the number of gugas taken is not closely monitored, neither

is there any check on the number of chicks lost during the hunt. Counts of corpses in photographs of gugas prior to off loading from Sula Sgeir (Beatty 1992) suggest that, at least in some years, the number killed may be greater than the licence.

Sule Stack

The count was made from aerial photographs taken on 15 July 1994. Complete coverage of the rock was achieved and the standard of photographs was excellent. The colony was divided into 8 sections (Fig 5) and 2 independent counts gave an average total of 4,888 AOS with an observer variation of 2.8% of the mean. The North Rock remains uncolonised, while the South Rock had only 73 occupied sites but large numbers of non breeders. Although count methodology in 1985 and 1994 was directly comparable, the 1985 photographs were of only moderate standard. The possibility exists that the 17% decrease between 1985-94 was at least partly due to the 1985 total being too high (Table 5), but Sule Stack appears to be the only Scottish gannetry not to have increased in size over the last decade.

Foula

A total of 600 AOS was counted from the land and sea by R W Furness on 2 and 16 July 1994. The colony has increased by 186% over the last 10 years at an average rate of 11.1% pa. Additional counts during the period were 210 AOS/140 AON (1984), 124 AON, 151 AON, 158 AON, 220 AON and 280 AON 1987-1991 respectively (data from Seabird Colony Register).

Hermaness

The numbers of AON were counted from the land by H Towll (SNH) between 12 and 18 July 1994. Hidden areas were photographed

Table 4 ***Counts of the Sula Sgeir gannetry in 1985 and 1994. Count sections are shown in Fig 3 of Murray & Wanless (1986).***

Section	Occupied sites 1985	1994	% Change
1	858	879	2.4
2	584	384	-34.2
3	2394	2954	23.3
4a	*)	2038	.*)
4b	2031)	1154	57.2)
5	136	0	-100.0
6	1532	1353	-11.7
7	1541	1680	9.0
Helipad	68	0	-100.0
Total	9143	10440	14.2

** What was Section 4 in 1985 became 4a and 4b in 1995*

from the sea on 22 August and AOSs counted off the slides. Following Murray (1992), the colony was divided into 18 sections and the figures given in Table 6 are an average of 3 replicate counts by the same observer. A total of 10,640 AON was counted from the land and 1,353 AOS were counted from the photographs (Table 6) which gives an overall total of 11,993 AON/AOS. The 1984 total was originally given as 8,063 AON but this figure was subsequently revised to 8,506 AON (Murray 1992). Thus, over the last 10 years, the colony has increased by 25%, an annual average rate of 3.5% pa.

During the period 1969-84, the Gannet population on Hermaness showed marked fluctuations. As the colony is notoriously difficult to count, it was unclear whether these variations reflected real changes in numbers or were due to counting error. In contrast there has been no evidence of fluctuations over the past 10 years with 9,904 AON recorded in 1986 (S. Wanless & M. Heubeck unpublished) and 10,057 AON in 1991 (Murray 1992). Count methodology was standardised in 1991 (Murray 1992) which suggests that the earlier variability was due mainly to differences in the way that counts were made.

Figure 5 ***Counting divisions used to census the gannetry on Sule Stack in 1994. Counts of the number of AOS in each section are also shown.***

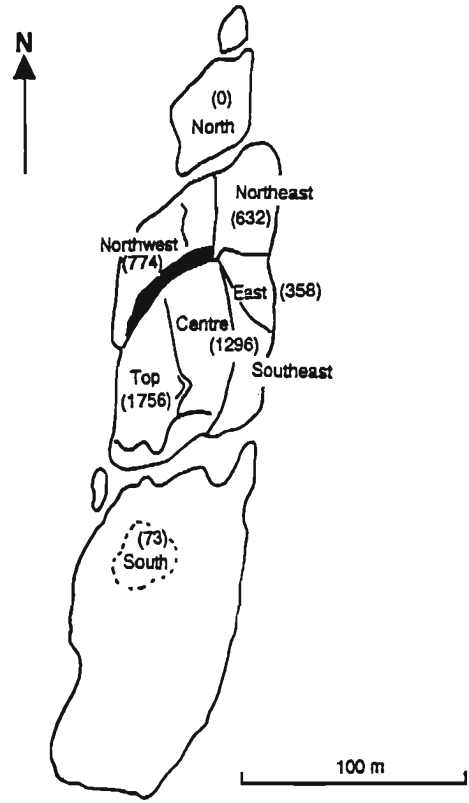


Table 5 ***Comparison of the number of occupied Gannet sites in sections of the Sule Stack gannetry in 1985 and 1994.***

Section	15 July 1985	15 July 1994	% change
North	0	0	0
North west and north east	2240	1406	-37
East, south east, centre and top	3590	3409	-5
South	50	73	46
Total	5880	4888	-17

Table 6 ***Counts of the Hermaness gannetry in 1994. Data supplied by SNH. The sections are shown in Murray (1992).***

Section	Land count (nests)	Sea count (occupied sites)
Rumblings East	736	-
Vesta Skerry East	1381	-
Vesta Skerry West	-	623
Humla Stac North	251	-
Humla Stac West	251	-
Humla Stac Southwest	0	-
Humla Houl North	133	-
Humla Houl South	435	-
Burra Stack East	335	-
Burra Stack West	-	238
Clingra Stack	207	-
Neap North Face	-	492
Neap-Soorie	3096	-
Soorie-Saito	1799	-
Saito	1509	-
Soorie Geo North Stack	19	-
Soorie Geo South Stack	35	-
Neapna Stack	453	-
Total	10640	1353
Overall total	11993	

Noss

In 1994, complete land counts were made on 18-20 June and 17 July respectively and 2 replicate sea counts were carried out on 30 June by S Smith and C Barton (SNH). The methods are described in Murray & Wanless (1992) and, for both land and sea counts, the count unit was apparently occupied nests. The colony was estimated to contain 7,310 AON (Table 7). In 1984 the colony was estimated to contain 5,231 AON. Subsequent counts have been 7,218 AON (1989), 6,730 AON (1991) and 6,856 AON (1992) although the 1989 figure is now thought to be an overestimate due to counting error (Murray & Wanless 1992). Numbers have increased steadily over the last 10 years with the colony showing an increase of 40% at an average annual rate of 3.4% pa.

Fair Isle

The 1994 counts of 825 nests was made on 13 June by G Thompson, Fair Isle Bird Observatory Trust. Most of the colony was

Table 7 ***Counts of the Noss gannetry in 1994. Values for land counts are the averages of 2 surveys carried out 18-20 June and 17 July respectively; values for sea counts are averages of 2 counts carried out on 30 June. Data supplied by SNH.***

Section	Land count (nests)	Sea count (nests)	Total (nests)
Cradleholm	0	1	1
Holmoless	91	17	108
Holmoless to Geordies Hole	1569	-	1569
Geordies Hole	49	-	49
Rumblewick	223	-	223
Rumblewick Face	162	-	162
Cuddacks Geo	-	-	0
Noup South	2659	-	2659
Noup East	-	517	517
Noup North	817	93	910
The Rump	560	213	773
Rump North	297	42	339
Geo Heogatoug	-	-	0
Total			7310

counted from vantage points on the land but part of the Inner Stack of Skroo was counted directly from the sea (Table 8). The number of nests rose from 138 in 1985 to 975 in 1995, an overall increase of 600% and an average annual rate of 21.6%. Nest counts between 1986 and 1993 were 258, 304,488, 676, 643, 687, 781 and 764 respectively (Riddiford 1993, Seabird Colony Register).

Troup Head

The first definite breeding record for Troup Head was in 1988, although the colony could have been established in 1987 (Matthews & North 1989). Full details of changes in numbers, breeding success and breeding chronology for the colony for the period 1988

Table 8 ***Counts of the Fair Isle gannetry in 1994. Dats supplied by Fair Isle Bird Observatory Trust.***

Section	Count (nests)
Outer Stack	219
Inner Stack	66
Yellow Head	34
Dronger	77
North Felsigeo	285
Toor 'o' da Ward Hill	82
Matchi Stack	30
Kame 'o' Guidicum	32
Total	825

to 1995 have been summarised by Wanless *et al* (1996) but, in brief, the number of nests increased by 105% from 5 in 1988 to 530 in 1995, a spectacular rate of increase averaging 64% pa.

Bass Rock

Two counts were made in 1994. One was by J B Nelson on 13 July using the same methods as in 1984, ie mainly from photographs taken from the sea and land with areas which were inadequately covered estimated by eye, using either a comparable area of counted birds or relying upon previous knowledge of the area. Counts were made of the number of birds and these were converted to occupied sites assuming a single bird to pair ratio of 10:1. It was considered possible that the corrected total of 27,293 AOS underestimated the actual total by c 10% and, thus, that the total was around 30,000 AOS. The other survey was made by ourselves from aerial photographs taken on 11 July (Murray & Wanless 1995). The colony was divided into 10 sections (Fig 6). The standard of the slides was so high that, for the majority of the colony, it was possible to separate sites with and without nest material. We, therefore, produced totals in terms of both AOS and AON (Table 9). The average of the 2 counts of AOS indicated a total of 39,751 AOS and an observer variation of 2.1% of the mean, substantially higher than Nelson's total. One reason for this difference is likely to be that we included more non breeding and loafing birds. Typically, non breeders leave a colony during an aerial survey but, during the 1994 census of the Bass Rock, it was clear that, particularly along the landward edge of the colony

Figure 6 ***Counting divisions used to census the gannetry on the Bass Rock in 1994.***

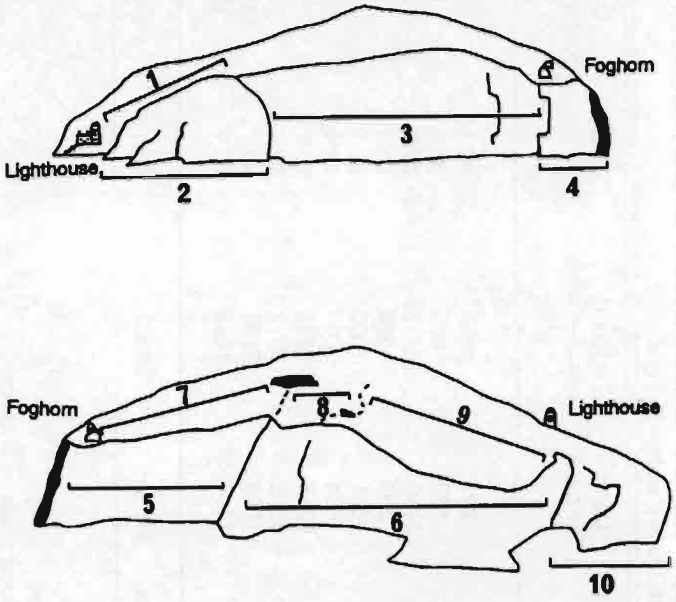


Table 9 ***Counts of numbers of nests and occupied sites on the Bass Rock on 11 July 1994, and 1 and 11 June 1985. Count sections are shown in Fig 6.***

Section	Count[1] (nests)	Count[1] (occupied sites)	% Nests	Count[2] (occupied sites)	Average (occupied sites) 1994	Average (occupied sites) 1985	% change in 1994
1	2677	2888	92.7	2585	2737	1227	123
2	553	652	84.8	637	645	320	102
3	5749	6472	88.8	7261	6867	3436	100
4	538	588	91.4	637	613	505	21
5	671	1000	67.1	1052	1026	1909	-46
6	1594	2009	79.4	2229	2119	1560	36
7	6718	7799	86.1	7972	7885	4185	88
8	3382	3712	91.1	3548	3630	2707	34
9	11068	12197	90.7	13105	12651	5371	136
10	1447	1583	91.4	1573	1578	369	328
Total	34397	38900	88.4	40599	39751	21589	84

Notes
[1]*Counts made by S Murray*
[2]*Counts made by S Wanless*

(sections 7-9), very few birds were disturbed and it was difficult to separate such individuals from true site holders. However, a second reason for the discrepancy could be that the aerial survey provided better coverage of the colony, thus reducing the chances that sections were missed. The nest count indicated a total of 34,397 AON (Table 9). Comparing this figure with the appropriate count of AOS suggested that 88.4% of AOS were in fact AON. This value should be regarded as a maximum because, while there were few problems distinguishing nests in cliff face sections (sections 2-6), it was harder to identify nests in some of the cliff top areas (sections 1, 7-10).

In 1984, Nelson (in Murray & Wanless 1986) estimated that there were 18,162 AOS on the Bass Rock. Comparing this figure with his 1994 total indicates an increase of 50%, an annual rate of 4.2% pa. Bearing in mind that the 1994 total may have been an underestimate (see above) these changes are likely to be minimum values. Comparison of our 1985 aerial survey in which 21,589 AOS were counted, with the 1994 total, indicates an even more spectacular increase of 84%, an average annual rate of 7.0% pa. Inspection of changes in each of the 10 sections indicated that numbers increased in 9 of them, the only exception being section 5 (Fig 6, Table 9) which is an area of steep, clean rock with comparatively few sites. The most obvious and spectacular expansion of the colony occurred on the northwest slope (section 9) but marked increases in colony extent were also apparent in sections 1, 3, 7 and 10. Comparison of the 1994 nest count with the 1985 site count indicated an increase of at least 59% at an average annual rate of 5.3% pa.

Total numbers in Scotland

The counts documented above were combined to provide an estimate of the total Scottish population in 1994-95. Where there were totals for both years such as on Fair Isle and at Troup Head we took the later count. For the Bass Rock, for which there was considerable variation between the 2 independent counts (see above), we used the nest count from the aerial survey as this was considered to have the lowest error associated with it. The overall total for colonies counted using AOS was 113,177, the total for those counted using AON was 54,230 (Table 10). Combining these figures and, for convenience, expressing the total as the number of AOS, gave a grand total of 167,407 AOS. Numbers were divided very unequally between the 12 colonies with St Kilda, the Bass Rock and Ailsa Craig together holding 76% of the total. In 1984/85 the Scottish population was estimated at 132,100 AOS (Murray & Wanless 1986). Comparing the 1994/95 total with this value indicates that numbers increased by 27% at an average rate of 2.4% pa.

Discussion

Compared with many other seabird species, Gannets are relatively straightforward to count, being large and conspicuous, and nesting in well defined but not excessively dense groups. Nevertheless, 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 and variations in count methods, dates or times between the totals being compared can all contribute to counting errors (Nelson 1978). A further source of bias stems from the tendency of individual observers to count consistently high or low (Harris & Lloyd 1977).

Table 10 ***Summary of counts of Scottish gannetries in 1994-95 and changes since the 1984-85 survey. See text for details. The possible colony on Rockall was not checked in either year.***

Colony	Count AON	Count AOS	% Scottish total	% change overall	% change pa
Scar Rocks		1952	1.2	154	8.8
Ailsa Craig		32456	19.4	42	3.6
St Kilda		60428	36.1	21	2.1
Shiant Isles		0	0	abandoned	
Flannan Isles		1438	0.9	545	23.1
Sula Sgeir		10440	6.2	14	1.5
Sule Stack		4888	2.9	-17	-2.1
Foula		600	0.4	186	11.1
Hermaness	10640	1353	7.2	25	3.5
Noss	7310		4.4	40	3.4
Fair Isle	975		0.6	600	21.6
Troup Head	530		0.3	colonised	
Bass Rock	34397		20.5	59	5.3
Total	53852	113555			
Grand total	167407			27	2.4

This effect was highlighted in our replicate counts where SW consistently obtained higher totals than SM, even though the counts were made under identical conditions. The mean (±SD) observer variation was 3.3±2.3% (n = 7 comparisons) However, while these potential errors should be borne in mind, we consider that in many cases the error of any colony counts is likely to be below 5% and, in most cases, below 10%. With an inter census interval of approximately 10 years, small, but consistent, annual changes in numbers of 2-3%, (the rate of increase typical of the Gannet (Nelson 1978)), result in overall numerical changes of the order of 22-34% which is well within the accuracy of counts at individual colonies.

The results of the 1994/95 east Atlantic Gannet survey show that the sustained increases in both abundance and range which have been recorded this century have continued over the last 10 years (Gurney 1913, Fisher & Vevers 1943, 1944, Cramp *et al* 1974, Nelson 1978, Wanless 1987). Numbers increased by 23% from 223,400 AOS in 1984/85 to 273,803 AOS in 1994/95, an average annual rate of 2.0% pa (Wanless

1987, this study). The Gannet's range has extended south with the bizarre record of a pair building a nest on a yacht at Port Frioul in the Mediterranean in 1993 (Fernandez & Bayle 1994) and east into Russia with the establishment of a colony on Kharlov, one of the islands in the Seven Islands Reserve off the Kola Peninsula (Y V Krasnov pers comm). However, Scotland remains the species' stronghold in the east Atlantic, both in terms of the number of active colonies (35% of the total) and population size (61%) (Table 11).

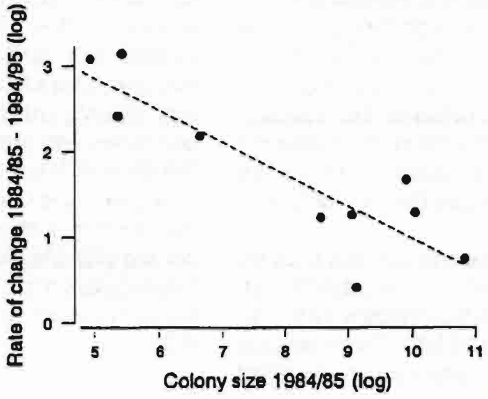
Except for Sule Stack and the nest sites on the Shiant Isles which have been abandoned, counts of every Scottish gannetry were higher in 1994/95 than in 1984/85. There was no evidence that the reduction in Sandeel *Ammodytes marinus* stocks around Shetland during the 1980s (Kunzlik 1989) had any impact on the gannetries there, even though this fish is sometimes an important prey item for Gannets during the breeding season (Martin 1989). There was, however, considerable variation between colonies in average rates of change with values being significantly higher at small colonies compared with large ones (Fig 7). Nelson (1978) calculated that the intrinsic rate of increase for the Gannet on the Bass Rock in the 1960s was about 3% pa. Assuming that current vital rates for the species are similar, this suggests that there is net immigration to colonies containing fewer than about 1,000 AOS.

Table 11 ***Summary of results from the 1994-95 east Atlantic Gannet survey.***

Country	Number of colonies	% total	Total AOS/AON[1]	% total
Scotland	12	35.3	167407	61.1
England	1	2.9	1631	0.6
Wales	1	2.9	26277[2]	9.6
Channel Islands	2	5.9	5478	2.0
Ireland	5	14.7	29948[3]	10.9
France	1	2.9	11628	4.2
Norway	5	14.7	3654	1.3
Faroes	1	2.9	2340	0.9
Iceland	5[4]	14.7	25437	9.3
Russia	1	2.9	3	0.00
Total	34		273803	

Notes: [1] *Data for Norway and Iceland are from Barrett & Folkestad (1996) and Gardarsson (1995) respectively. Counts for other areas were provided by RSPB, M G Hill, O Merne, P G H Evans, F Siorat, B Olsen, Y V Krasnov and ourselves*
[2] *Total considered a minimum due to imcomplete photo coverage*
[3] *No count available for Clare Island. Current status is unknown, but 7 to 9 individuals recorded in 1996(O Merne pers comm)*
[4] *Westmanns considered to be one colony*

Figure 7 ***Relationship between the average annual rate of change in numbers between 1984-85 and 1994-95 and the size of the gannetry in 1984-85. The negative trend indicates that the rates of increase declines with increasing colony size (r = 0.88, n = 10, p<0.001).***



At the beginning of the twentieth century, when Gurney (1913) made his first pioneering census, there were only 5 gannetries in Scotland: Ailsa Craig, St Kilda, Sula Sgeir, Sule Stack and the Bass Rock. The Scottish population was thought to be about 41,300 AOS. As we approach the end of the century, numbers have increased fourfold and there are 12 active colonies. All the evidence suggests that conditions are still extremely favourable for Gannets. However, the species is potentially of conservation concern because of its highly localised breeding distribution with 76% of the Scottish population and almost 50% of the east Atlantic population concentrated in just 3 colonies: St Kilda, the Bass Rock and Ailsa Craig.

Acknowledgements

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Gizzard contents of Pochard, Tufted Duck and Goldeneye from Loch Leven, Kinross, in winter 1994-95

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We examined the gizzard contents of 3 species of diving duck which fed on the benthos of Loch Leven during winter 1994-95. Tufted Ducks and Goldeneye appeared to be mainly carnivorous and Pochard mainly herbivorous. Chironomid larvae appear to be the most important food item overall. The results are discussed in relation to previous studies.

Introduction

Loch Leven National Nature Reserve is internationally important for its wintering wildfowl populations (Owen *et al* 1986) and 3 diving duck species occur there in nationally important numbers - Pochard *Aythya ferina*, Tufted Duck *A fuligula* and Goldeneye *Bucephala clangula* (Waters & Cranswick 1993). The diet of Tufted Duck and Goldeneye is thought to be primarily Chironomid larvae and other invertebrates. Pochard are thought to be mainly herbivorous (Cramp & Simmons 1977) although some studies have shown a predominance of Chironomid larvae in their diet (Winfield & Winfield 1994). The only previous study of diving duck diet at Loch Leven suggested that both Tufted Ducks and Goldeneye fed mainly on Chironomids (Laughlin 1973).

Eutrophication and associated algal blooms have become an important factor in determining aquatic plant growth in Loch Leven. The fluctuating water chemistry has also affected benthic invertebrates (eg Chironomids). Macrophyte and benthic invertebrate communities have been the subject of recent monitoring work on the loch (Murphy & Mulligan 1993, Gunn & Kirika 1994) though their importance to the diving duck populations has not been evaluated since work for the International Biological Programme (IBP) in the 1960s and 1970s.

Methods

Samples from birds' proventriculus and gizzards were collected during winter 1994/95 from freshly shot birds at Loch Leven. After labelling, each was frozen and stored before subsequent analysis. However, many samples refer to gizzard contents only. Consequently, because softer food, such as invertebrates, is often fully digested higher in the gut, analyses of gizzard contents bias estimates towards plant matter and seeds (Swanson & Bartonek 1970). As the resulting small samples are inappropriate for statistical analysis, age and sex classes of the birds have been amalgamated.

Identification and nomenclature for vascular plants follows Clapham, Tutin & Moore (1987), Chironomidae that of Bryce & Hobart (1972) and Bird (undated), Mollusca Macan & Cooper (1977) and other invertebrates Fitter & Manuel (1986).

Two estimates of gizzard contents are presented:

1 The proportion of birds with >5% of each food item in the gizzard (% occurrence).
2 The aggregate percentage dry weight (Swanson *et al* 1974). This is calculated by averaging the proportion of each food item per gizzard in the number of gizzards sampled. This gives equal weight in the analysis to each bird, and thus reduces bias, which may be introduced by individual birds feeding on large amounts of one food item or by variable amounts of total gizzard contents.

Results

Unidentified plant material was found in c80% of Tufted Duck and Goldeneye gizzards, and in all Pochard gizzards (Fig 1). However, Pochard gizzards contained nearly twice the amount of plant matter and a higher proportion of seed than the other 2 duck species (Fig 1, Table 1). *Polygonum*, *Potamogeton* and *Carex* were the dominant seeds found. Tufted Duck and Goldeneye gizzards contained mainly animal matter, mostly Chironomids and unidentified arthropods. Pochard gizzards also contained notable amounts of Chironomids, but Bryozoans were present in much higher quantities than in the other 2 species. Small amounts of leeches were present in all 3 species. Tufted Duck and Goldeneye had both fed on *Trichoptera* larvae while fish were only taken by Goldeneye.

Discussion

Gizzard contents

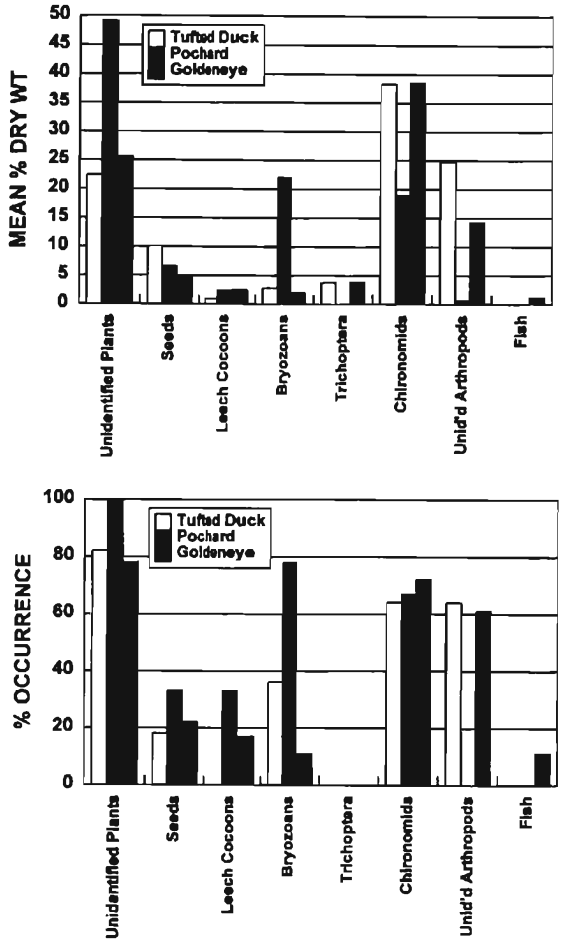
Gizzard analysis of birds shot apparently at random cannot be used to provide a quantitative estimate of diet, due mainly to the time lag between the intake of food and subsequent analysis of contents. This includes pre-mortem factors, such as the time delay between the cessation of feeding activity and shooting, and post-mortem factors, such as the differential digestion of soft versus harder food items. In addition, it does not necessarily follow that birds shot at a site have been feeding there.

A study by Winfield & Winfield (1994) on Lough Neagh showed that only 20% of shot birds had food in the oesophagus or proventriculus, whereas 85% of birds sampled from accidental netting incidents had food there. Swanson & Bartonek (1970) showed that analysis of gizzard contents alone produced a bias toward plant material, with animals such as molluscs, insects and crustaceans almost totally digested after 20 minutes in the gizzard and with digestive juices continuing to digest food for long periods after death. Because gizzard contents in this study were not obtained immediately following a bird's death, only a small amount of the gizzard contents could be identified accurately, especially in the case of Chironomids, which were mostly identified when partially digested or fragmented. Even determining family status proved difficult in many cases.

Pochard

Pochard feed by day and night, preferably at 1m-2.5m depth with dives lasting 13-30 secs. (Owen *et al* 1986, Willi 1970). Winfield & Winfield (1994), however, recorded birds feeding at up to 10m depth in Lough Neagh where Chironomids formed 90% of the diet. In the absence of benthic macrophytes, Pochard have also been found to feed selectively in areas rich in Chironomid larvae (Phillips 1991). These findings contradict other studies which describe the winter diet of Pochard as mainly

Figure 1 ***Gizzard contents of Tufted Duck, Pochard and Goldeneye at Loch Leven, winter 1994-1995.***



plants, chiefly the oospores of stoneworts, *Chara* and *Nitella*, and the seeds of submerged aquatic plants, especially *Potamogeton* (Owen *et al* 1986). Chironomids and other invertebrates are generally reported to comprise less than 15% of the diet (Olney 1968). However, the erroneous belief that Pochard are herbivorous presumably derived from earlier studies which analysed only gizzard samples.

Whilst also based on gizzard analyses, this study suggests that Pochard are omnivorous at Loch Leven, taking significant proportions

of both plant and animal material (mainly Chironomids and Bryozoans). A previous study at Loch Leven analysed one 'stomach' and also found that Chironomid larvae were taken (Laughlin 1973). We do not know whether the high levels of Bryozoans (*Cristatella mucedo* statoblasts) identified in Pochard during our current study were taken on purpose or were consumed inadvertently from benthic vegetation. The relatively higher proportion of plant matter in Pochard gizzards in comparison with the other 2 duck species may suggest the latter possibility.

In areas where Pochard and other species feed primarily on Chironomids, they may compete with a number of fish species, such as Brown Trout *Salmo trutta*, Rainbow Trout *Onchorynchus mykiss* and Perch *Perca fluviatilis* which occur in Loch Leven and Eels *Anguilla anguilla* (Winfield & Winfield 1994) although the latter are thought to be scarce in the loch. Chironomids are eaten by all these species. Thorpe (1973) estimated that Brown Trout consumed no more than 6% of the Chironomid production between June and September. This level is unlikely to have increased because a recent estimate of the fish population (O'Grady *et al* 1993) indicated that the Brown Trout population has declined since Thorpe's study and the Perch population has subsequently decreased dramatically. Annual stocking of Rainbow Trout since 1993 has done little to redress the balance in terms of fish biomass and we assume that fish predation on Chironomids, leading to competition with birds for food, has decreased. The results of this survey indicate that, while Pochard ate fewer Chironomids and more vegetable matter than the other 2 species, Chironomids still formed a large part of their diet.

Tufted Duck

Witherby *et al* (1940), Cramp & Simmons (1977) and Owen *et al* (1986) all describe this species as omnivorous, but emphasise a preference for animal matter, especially molluscs, which usually accounts for over 80% of the diet.

Between 300 and 600 pairs of Tufted Ducks are known to nest annually at Loch Leven (Lauder 1993) and Laughlin (1974) states that Chironomids formed 60% of the diet during this period. Other important items also taken then included caddis larvae and molluscs, especially *Valvata* spp. Thus it appears that Tufted Ducks at Loch Leven mainly eat Chironomid larvae. When looking at the energy flow through the loch, Laughlin found that water depth and depth of food in the substrate were 2 of the major factors affecting the availability of food for Tufted Ducks and that only 20% of the total loch area was suitable for feeding birds.

Laughlin (1974) also suggested that the autumnal peaks of Tufted Ducks at Loch Levren (typically c2,500 birds, but sometimes over 4,000 birds) were correlated with Chironomid production. The high numbers of Tufted Duck present in 1970, coinciding with peak biomass values for *Glyptotendipes* (Maitland & Hudspith 1974), provided evidence for this, but a wide range of other factors clearly affect Chironomid and waterfowl populations.

Goldeneye

Goldeneye are more solitary and usually feed at 3-10m but up to 55m (Cramp & Simmons 1977, Winfield & Winfield 1994) mostly in daylight but sometimes at night (Cramp & Simmons 1977). Goldeneye are known to

Table 1 ***Aggregate percentage dry weights of 9 Pochard, 11 Tufted Duck and 18 Goldeneye gizzards.***

Plant material	Tufted Duck n=11	Pochard n=9	Goldeneye n=18
ALGAE			
Chlorophyta (filamentous)	0.36		0.33
BRYOPHYTA			
Unidentified plant material	22.45	49.11	25.61
ANGIOSPERMOPHYTA			
Dicotyledones			
Unidentified (seed)	4.55	1.67	0.33
Ranunculaceae (seed)		0.33	
Leguminaceae			
Trifolium sp (seed)			0.06
Rosaceae			
Rubus fruiticosus (seed)			
Polygonaceae			
Polygonum sp (seed)	0.55	2.44	1.39
Rumex sp (seed)		0.44	0.11
Betulaceae			
Betula sp (seed)	0.09		
Compositae			
Cirsium sp (seed)	0.09	0.33	
Monocotyledones			
Potamogetonaceae			
Potamogeton sp (seed)	4.27	1.00	1.67
Cyperaceae			
Carex sp (seed)			1.00
Juncaceae			
Juncus sp (seed)	0.09	0.11	
Gramineae (seed)	0.55	0.22	0.11
Anther unidentified		0.22	
TOTAL PLANT MATERIAL	32.64	55.87	30.28
ANIMAL MATERIAL			
PORIFERA			
Spongillidae		0.22	0.56
PLATYHELMINTHES			
Cestoda			0.06
NEMATODA			0.06

ACANTHOCEPHALA	0.18		
ANNELIDA			
Hirudinea			
Erpobdella octoculata	0.91	2.33	2.44
BRYOZOA			
Phylactolaemata (statoblasts)			
Cristatella mucedo	2.82	22.00	1.89
ARTHROPODA			
Arachnida			
Hydracarina			
Arrhenurus caudatus & soft bodied spp	0.36	0.33	0.11
Crustacea			
Ostracoda	0.09		0.06
Isopoda			
Asellus aquaticus			0.28
Insecta			
Odonata			
Anisoptera larvae			0.06
Trichoptera			
Rhyacophilidae larvae	3.78		3.78
Phthiraptera	0.01		
Diptera			
Chironomidae			
Tanypodinae larvae	6.89	1.11	3.22
Chironominae larvae	5.82	15.33	8.61
Chironomid mucus tubes	25.55	2.22	26.61
Unidentified larvae			0.06
Unidentified imago		0.22	
Hymenoptera			
Evaniidae	0.09		
Braconidae		0.11	
Unidentified chitinous fragments	23.73	0.56	14.17
Unidentified ova	1.00	0.11	0.11
MOLLUSCA			
Gastropoda			
Unidentified opercula	0.18		0.06
Valvata sp		0.11	0.72
Planorbis sp	0.09		
Bivalvia			
Pisidium sp	0.09		0.06
VERTEBRATA			
Osteichthyes			
Gasterosteiformes			
Gasterosteus aculeatus	1.11		

feed actively at night at Loch Leven in illuminated water near Kinross. When feeding in flocks, birds may synchronise dives, or dive in succession with dives lasting 30-40 secs.

Our results suggest that Tufted Ducks and Goldeneye at Loch Leven were mainly carnivorous but Pochard were omnivorous. Laughlin (173) obtained similar results for the former 2 species at Loch Leven, but only analysed one Pochard 'stomach'. The range of items consumed appears to be similar for all 3 species with Chironomid larvae appearing as a major resource for each.

The high percentages of plant material recorded in Tufted Ducks and Goldeneye are likely to be a result of the differential periods of digestion outlined by Swanson & Bartonek (1974) and it is possible that most of this material had been ingested incidentally or is residual. This suggestion is supported by previous analyses of diets of Tufted Duck and Goldeneye (Eriksson 1979, Laughlin 1973, Olney & Mills 1963 and Cramp & Simmons 1977), all of which reveal little evidence of plant material as a major dietary component.

Chironomid productivity and diving duck numbers

Laughlin (1974) suggested that winter Chironomid production was a limiting factor for the number of Tufted Duck occurring on the loch. In May 1994, Gunn & Kirika (1994) found similarly high densities of Chironomid larvae. Tanypodinae (*Procladius* spp) were found mainly in muddy substrates, with a mean density of 4,106 m^{-2}, whereas Chironominae were found mainly in sandy substates at the following densities: *Cladotanytarsus* spp 11,086 m^{-2} and *Stictochironomus* spp.2,818 m^{-2}. One genus of Chironominae, *Tanytarsus* spp, was also found in reasonably high densities in mud (1,219 m^{-2}). However, the dominance of the Chironomus group in the gizzards and the frequenty of the cocoons of *Erpobdella octoculata*, a leech typically found on stony or sandy substrates, does suggest that most feeding occurred over sand substrates.

There have been changes in the relative abundance of the constituent genera of the Chironomid community in Loch Leven since the IBP programme in the 1960/70s and producitvity has been variable in what appears to be an unstable system as a result of nutrient enrichment (Gunn & Kirika 1994). Chironomid larvae appear to be the major food resource of diving ducks at Loch Leven and the population levels of benthic feeding waterfowl may well be determined by the productivity of Chironomidae in the loch.

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Waterfowl counts on the Tay Estuary, 1985-1995

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The Tay Estuary is an important site for both migrating and wintering waterfowl. It holds internationally important populations of wintering Eider, Redshank, and Bar-tailed Godwit. The wintering populations of Sanderling and Goldeneye achieve national importance. The estuary is a staging post for migrant waders in spring and autumn, and recent counts of migrant Sanderling, Knot, Ringed Plover and Turnstone have exceeded wintering populations, especially in spring. Mallard, Wigeon and Tufted Duck are all common wildfowl in winter, while Shelduck reach a spring peak. A substantial moulting flock of Goosander is present in late summer. This paper describes the numbers, distribution and changes in waterfowl populations on the estuary between 1985 and 1995, as shown by monthly high tide roost counts and a series of midwinter low tide counts.

Introduction

The Firth of Tay is the third largest tidal estuary in eastern Scotland, after the Moray Firth complex and the Firth of Forth. However, unlike the other firths, little detail has been published on its waterfowl populations. Any accounts available in local reports have concentrated on one area or another but not the whole, probably because the estuary represents the boundaries between Angus, Perthshire and Fife.

With the continuous monitoring carried out over the last decade or so, there is now a clearer picture of the importance of the estuary, and this paper sets out to describe its waterfowl populations, particularly the waders.

The study area

The estuary has an intertidal area of 5,720 ha with a tidal reach of 53km. Its contributing rivers, the Tay and Earn, provide the greatest inflow of fresh water of any British estuary (JNCC 1994).

The maximum width of the inner estuary is 5km, narrowing to 1.5km between Broughty Ferry and Tayport. The constriction is mainly due to the volcanic outliers of the Ochil Hills, which extend all the way along the southern edge of the estuary to cross into Angus at this point. The northern shore of the inner estuary is backed by a coastal plain some 8km wide with the Sidlaw Hills to the north.

The tidal range at Dundee is large, being 5.2m at the highest spring tides, and 1.7m at the minimum. At low tide, the inner estuary is characterised by extensive mudflats on the northern shore, fringed by large salt marshes, with the most extensive continuous stand of *Phragmites* reed swamp in Britain. The inner estuarine substrates consist of coarse sediments in mid estuary and fine mud sediments along the north shore, both of

which, because of their unstable nature and the large tidal range of salinities, support an impoverished variety of invertebrate fauna (JNCC 1994). However, these populations can be enormous and, from the distribution of feeding waders, we suspect that this fauna is more abundant at the eastern end. The outer estuary holds sandier intertidal flats both on the north and south shores, with considerable sublittoral populations of mussels *Mytilus edulis*, and several mussel beds exposed at low tide. On both shores adjacent to the estuary mouth there are extensive accreting sand dune systems. A natural division exists between the inner and outer estuaries where there is a 7km stretch of little or no intertidal flats. The adjacent shores here are mainly urban, where the rail and road bridges span the estuary. In all, the sand and mudflats cover 5,218 ha.

The main high tide wader roosts are situated at Tentsmuir Point and Lucky Scalp on the south shore, and the Monifieth/Barry Buddon shore and Kingoodie/Invergowrie Bays on the north shore (Fig 1). Tentsmuir Point is a sandy promontory where roosting birds use the shoreline. Lucky Scalp is a narrow high tide islet consisting of a sand/pebble stretch covered in rough grassland and marram *Ammophila arenaria*, and surrounded by a pebble shore which is all but covered by the highest tides. It measures 30m in length, and between 5m and 15m in width, and lies 600m from the coastal high water mark. The main roost at Monifieth is usually on the sand spit at the mouth of the Buddon Burn, but occasionally it stretches along the sandy shore towards Buddon Ness. Due to a very busy military live firing range on the Buddon Ness promontory, eastern most roosts have, at times, proved difficult to count with only estimates obtained. There is also a satellite roost near the mouth of the Dighty Water at Barnhill. The only inner estuary roosts are situated at Kingoodie and Invergowrie Bay. Here, a proportion of waders roost at Dundee airport. Subsidiary roosts can also be found on fields, including playing fields, around Tayport and Dundee, where some species feed during high tide.

Methods

As part of the British Trust for Ornithology's (BTO) Wetlands Bird Survey (WeBS) (prior to autumn 1993 this was called the Birds of Estuaries Enquiry (BoEE), monthly counts of roosting waders were carried out every winter. Counts during the remainder of the year were made from 1992. During winter 1993-94, additional regular monthly counts were also made of both roosting and feeding waders at low tide for the BTO's Low Tide counts scheme. This study uses all counts made for WeBS between September 1985 and August 1995.

In addition to waders, wildfowl were also counted on a less regular and comprehensive basis, together with some other estuarine species.

High tide roost counts were made on a specified date each month between September and March inclusive, usually at spring tides near the middle of the month, although during short winter days when high tide occurred during the hours of darkness, alternative dates were chosen. The median date for all complete coordinated counts was the 14th. On some occasions, severe weather or lack of observer(s) disrupted the regularity and simultaneity of counts. From 1992, similar counts were also made from April to August. Monthly low tide counts were made between November 1993 and February 1994 on a chosen date. In February 1994, the date of

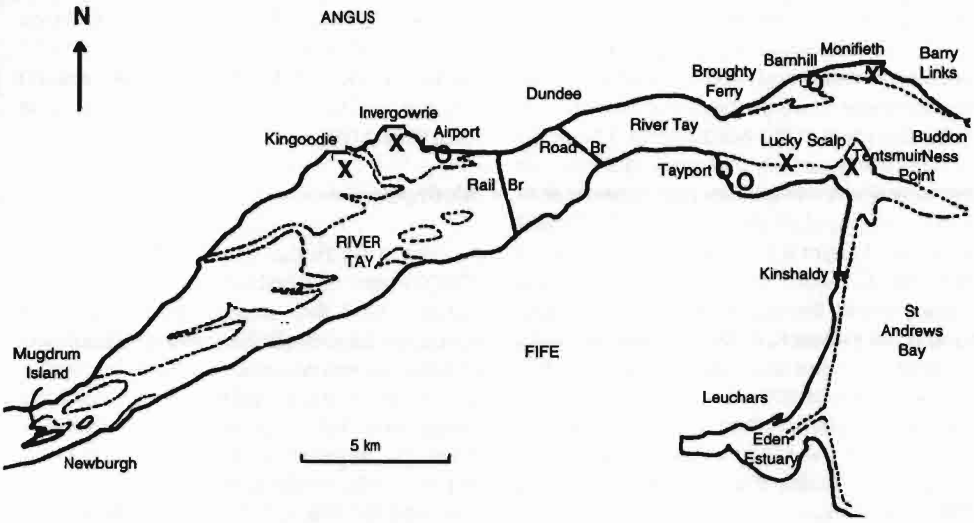

Figure 1 ***Map of the Firth of Tay showing mean low water mark (dotted) Main roosts X Subsidiary roosts O.***

the low tide count fell on the same day as the high tide count, so that a unique direct comparison was available.

With only 4 main high tide roosts, the logistics of providing simultaneous cover were simple. The low tide counts required more organisation; the estuary was divided into a total of 41 sections, with approximately 20 observers involved on each date.

The monthly figures (Table 1) are the 10 year means of all available counts for each roost site. For comparison, casual counts between 1970 and 1985 (for which tidal state was invariably not specified) were extracted from national and local Bird Reports, while BoEE counts were also scrutinised. For the latter, counts of the whole estuary, let alone coordinated counts, were rarely achieved during this earlier period. For this reason, long term trends in population sizes were not possible to detect for many species. Boase (1970) provided useful wildfowl data for the period prior to 1970. A few observations from the 1995-96 winter counts have also been included in cases where the data show new information.

The prevailing wind and weather conditions were noted on each count date. This information was supplemented by weather data from Leuchars, which was used to calculate mean values of temperature and wind speed, the atmospheric parameters assumed to be of most importance to shorebirds. These data were combined to produce a wind chill equivalent temperature for each winter. This is a partly subjective measurement calculated for suitably clothed humans! However, it is considered that the trend of these values may also be meaningful for a healthy bird insulated by plumage.

Results

Between winter 1985-86 and 1994-95, complete and fully coordinated roost counts were made in 48 (69%) of a possible maximum of 70 of the months between September and March inclusive. In the remainder, most counts were carried out within a few days of each other.

The average number of waders roosting on the Tay estuary in midwinter was 10,842. This figure was derived from summing the highest monthly counts of each species between November and February. This wintering population varied from 12,789 in the winter of 1985-6 to 6,797 in 1994-95. The variation between the same months in different years was also marked. For instance, the highest count was made in September 1989, when migrants swelled the population to 13,186, but a year later only 3,960 birds figured in the September count. In winter, Dunlin comprised 30% of the mean total and Oystercatcher 20%, while Bar-tailed Godwit and Redshank accounted for 14% and 13% respectively. Fewest waders were present in May, with a mean of 619.

The 2 winters of greatest wind chill were 1985-86 and 1993-94, coincident with high mean wind speeds and low mean temperatures. It is perhaps indicative of the relatively equable climate during the study period that no significant local effects on wintering populations were noted, although individual counts were affected during easterly gales accompanied by precipitation. Winters outside the study period, namely 1981-82 and 1995-96, have been severe enough at times to allow extensive ice to build up on the mudflats in the inner estuary. What effect this had on wader populations is unclear, although low wader numbers in the latter winter were second only to those of 1994-95.

Species accounts

Oystercatcher *Haematopus ostralegus*

Table 1 shows the rapid increase in the Tay estuary population in July, a steady over wintering population of around 1,700 with a peak in February, and a substantial exodus in March.

Of the total winter roosting population, 30-40% roost in the inner estuary between Dundee airport and Kingoodie. The remainder is found in the 3 outer estuary roosts, with apparent movement between the roosts dependent on tide conditions. The size of the roost on Lucky Scalp is highly correlated with the tidal height, with displaced birds moving to one or other of the outer estuary roosts. At high tide, small numbers sometimes feed on agricultural and sports fields surrounding Tayport, and these are included in the counts.

In the low tide and high tide coordinated counts on 13 February 1994, the roosting population was 20% less than that feeding earlier in the day. This may have been due either to the birds moving out of the estuary completely, or to their movement into uncounted areas such as Buddon Ness. The largest feeding concentration was off Barnhill. Although low tide counts in the other winter months were separated from high tide counts by a week, similar reductions were recorded. Most of these decreases seemed to be confined to the outer estuary.

The low tide counts in winter 1993-94 showed that the majority of birds chose to feed near the low tide mark in the outer estuary, utilising the mussel beds, and that the mean density of such birds was the highest of any of the wader species (Cranswick *et al* 1995). Numbers using the mussel beds varied from 17% to 58% of the total population. Those birds not

Table 1 ***Monthly means of wader roosting populations on the Tay estuary, September 1985 to August 1995.***

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	%	Peak
Oystercatcher	1758	1788	741	319	296	487	1282	1292	1422	1552	1738	1673	33	2153
Ringed Plover	82	84	29	21	24	3	75	102	175	108	98	86	0	125
Golden Plover	131	93	16	0	0	0	0	13	92	56	217	97	43	281
Grey Plover	172	182	169	197	27	6	14	160	200	143	148	161	0	263
Lapwing	379	202	56	24	21	61	91	589	828	270	559	363	88	684
Knot	176	161	113	8	0	0	0	51	128	64	92	138	0	394
Sanderling	170	183	131	80	9	0	1	63	92	124	188	240	0	335
Dunlin	3115	2409	665	147	121	3	20	128	811	1638	1834	1998	71	3230
Bar-tailed Godwit	1032	1074	393	95	32	29	393	474	867	991	809	971	5	1482
Curlew	248	329	320	186	22	69	208	185	375	155	196	191	47	441
Redshank	824	780	929	789	13	51	379	699	1529	1352	1224	810	74	1368
Turnstone	47	44	33	72	1	0	1	18	30	31	38	49	0	76
n	10	10	10	4	4	4	4	4	10	10	10	10		

% = % roosting on inner estuary, September to March
Peak = Mean maximum count, November to February
n = number of years counted.

recorded on mussel beds tended also to favour the lower shore, especially in the inner estuary. As at high tide, small numbers also chose to feed in adjacent fields.

As with all other waders, Oystercatchers do not feed in any great numbers on the extensive mudflats upriver from Kingoodie, where there is a scarcity of food. From mid February, small numbers can be seen upriver towards Newburgh, as they begin to move towards inland breeding sites.

Between May and August, the Oystercatcher is the commonest species on the estuary, comprising up to 60% of all waders in May and June. The midsummer flocks probably consist of immature birds and non breeding adults, while post breeding birds arrive from July onwards (Cramp & Simmons 1983). In late summer, when the population is swollen by migrants, a higher proportion roosts in the inner estuary, possibly because of disturbance by holiday makers along the sandy beaches of the outer estuary (Fig 2).

The peak count during the period occurred on 8 September 1991, when 3,124 birds were present. September is the month in which the species peaks over the whole of Britain (Prater 1981). Of this Tay count, only 19% roosted in the inner estuary, and 64% were present at Tentsmuir Point. Compared to winter months, this appeared to be an abnormal distribution, doubtless caused by the presence of a large number of passage migrants. Such abnormal distributions also occur in winter from time to time, possible due to disturbance, especially when birds roosting on or near the airport are subject to clearance.

There was no evidence of a significant change in the wintering population, although a comparison with figures for the inner estuary (Laing & Taylor 1993) suggests a decrease for this area. Average maximum counts for both autumn passage and winter rose steadily here between the early 1970s and the late 1980s, but the early 1990s showed a downturn of 10-20%. This apparent decrease is supported by the fact that, elsewhere on the estuary, some previous counts far exceeded present numbers. Peak high tide counts prior to 1985 have exceeded 3,000 in all months from August to December, while other counts, at unspecified tidal states (but probably at high tide), have been as high as 7,500 at Tentsmuir Point on 14 October 1973.

The Oystercatcher feeds readily inland, and studies have shown that snow and frost force inland feeders to unfrozen intertidal zones, while flooding due to high rainfall increases the amount of food available in inland fields. The high numbers counted in January and February 1991, and in February 1986, came in months of frequent frosts, while low numbers of roosting birds were counted in the exceptionally wet January of 1993. The low counts in November 1992 and 1993 followed very cold Octobers, suggesting that autumn immigrants may not have stopped but carried on southwards, although numbers recovered later in both winters.

Ringing indicates that most of the wintering Oystercatchers are from the large Norwegian breeding population (Cramp & Simmons 1983, Prater 1981), with some Scottish breeders. Local August ringed birds (probably migrants) have also been recovered in late spring in the Faroes, and in December in France. One bird ringed in February 1988 in Northern Ireland was recovered on the nearby Eden estuary in December 1991. Both winters were exceptionally mild in the Tay area, indicating that the apparent change in wintering site was not as a result of severe weather.

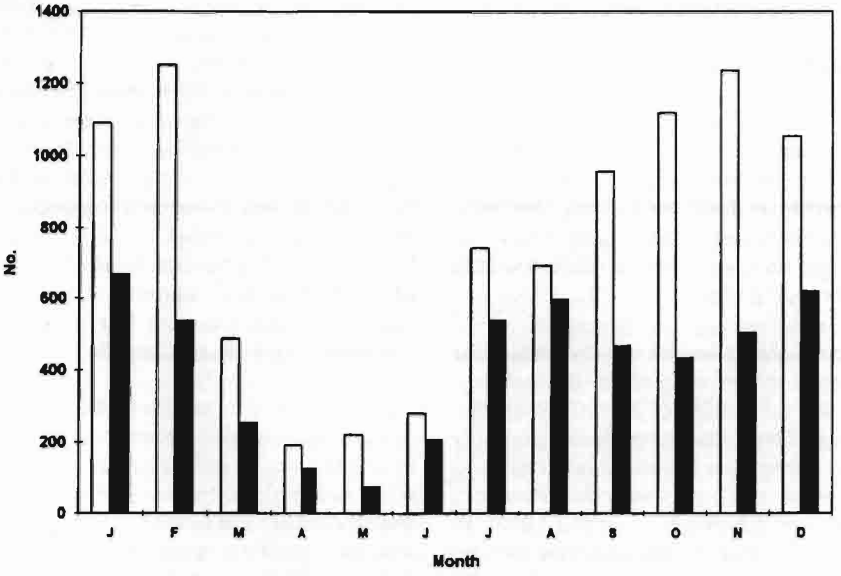

Figure 2 ***Mean monthly high tide roosts counts of Oystercatchers on the Tay estuary 1985-1995 Outer estuary □ Inner estuary ■.***

Ringed Plover *Charadrius hiaticula*

This species is chiefly a passage visitor to the Tay estuary (Table 1). During midwinter, a mean of 80-90 is present, with about 90% roosting in the outer estuary, mostly on the north shore. There is a sudden decrease in March. The maximum midwinter count was 197 on 14 January 1990.

During the 1993-94 low tide counts, the majority of the small population fed in the outer estuary, although small numbers were recorded on the upper shore of Invergowrie Bay. As the numbers roosting invariably exceeded those feeding, it seems that some of the roosting population comes from outwith the estuary, probably from close by on the uncounted beaches of Buddon Ness. Indeed, marked monthly variations suggest such a movement. For example, only 7 were counted at high tide in January 1986, but the following month the roosting flock rose to 164. Both these months were characterised by high wind chill, perhaps making flocks more mobile in search of shelter.

Autumn passage begins in July, reaching a peak in September. The peak high tide count occurred on 11 September 1988, when 315 were present, all on the outer estuary. The small May peak represents those recorded during the regular mid monthly counts. It does not, therefore, include late migrants which

pass through in the last 10 days of May. The rapid movement of such birds means that numbers may temporarily be high and, indeed, flock size on the outer estuary has reached 700. The mean of 8 counts between 1971 and 1989 in the last fortnight of May was 317, with most flocks resting at Tentsmuir Point.

A few pairs of Ringed Plovers breed among the dunes at the outer edge of the estuary.

Ringed Plovers are not abundant in Britain in winter. The population consists primarily of local breeders (Prater 1981) which represent the most northerly wintering population of the species (Cramp & Simmons 1983), and which leave their wintering grounds early. Migrants come chiefly from Iceland and Greenland. Those passing through in May are probably from the latter, since these are the latest to nest. Ringing returns show that migrants passing through east Fife may take both western and eastern coast routes through Britain, although there is some degree of loop migration. An autumn ringed bird was recovered in Dumfries in May, while an autumn bird from Kent passed through the Tay in May. One September ringed bird appeared in western France exactly 3 years later.

Golden Plover *Pluvialis apricaria*

The occurrence of Golden Plovers on the Tay Estuary is very variable. Flocks roost regularly on the intertidal mud at low tide and can be found feeding in adjacent pastures at high tide, although the majority leave the area altogether to feed inland. Studies of Golden Plover wintering behaviour in Scotland (Fuller & Lloyd 1981) have shown that about 60% roost in coastal habitats, mostly on intertidal flats; 70% feed on grassland but very few use this habitat for roosting.

Counts on the estuary, therefore, fluctuate markedly (Table 1), although the highest numbers are normally in November. Peak high tide numbers in this month in 1992 reached 560. No birds roost at Tentsmuir Point, the favoured high tide roosts being in fields at Tayport and in the inner estuary. At low tide, large flocks also roost both at Tayport, where up to 2,300 have been recorded on the intertidal mud in milder winters between October and February, and as far west as Newburgh. Few birds are seen during gales, when inland shelter is sought, and increases are noted when inland fields are frozen, although prolonged freezes usually result in mass emigration. However, there was no significant correlation of numbers on the Tay with weather variables.

Inferences about a species with such mobile behaviour in winter are difficult to draw from estuarine counts. Few are seen in October, when the bulk of the immigrant winter population arrives, but they are present elsewhere in the area in large numbers. It is probable that the wintering population consists of Scottish breeders and continental immigrants, the former departing early for their breeding grounds.

Grey Plover *Pluvialis squatarola*

Grey Plovers are both winter and passage visitors to the Tay. Table 1 shows that a roosting population of around 170 birds is present in winter, but this is subject to considerable variation. The highest count was of 482 in February 1987, in contrast to the 20 birds present at the same time during the following winter. Another peak, of 414, occurred in November 1993. Both these peaks coincided with anticyclonic weather, when mean wind speeds were among the lowest during the study period. This may be

significant for a species that finds it increasingly difficult to feed when winds exceed 11 m/s (Dugan *et al* 1981). Wind chill temperatures were not particularly low in these 2 months; thus the positive physical effects of the light winds were probably more important.

The high and low tide counts in winter 1993-94 showed that the small numbers roosting on the outer north shore equalled those feeding. However, those on the south shore fluctuated markedly, with high tide numbers exceeding those at low tide in November and February, but the reverse in December and January. This suggests that there is considerable movement between the estuary and favoured sites elsewhere in the local area. Counts at the nearby Eden estuary suggest that there is an interchange between the Tay and the Eden and, indeed, flocks have been recorded departing from Tentsmuir Point at high tide, heading south.

The autumn and spring migration periods show an increase in numbers, with arrivals in August and September, and a spring peak in April. A few linger into May, while the return begins in July.

All but a handful of birds roost and feed on the south shore, and the highest recorded count was 676 at Tentsmuir Point in September 1976. This site is the major high tide roost on the estuary, though casual counts reveal an occasional large migrant flock on the north shore.

It has been determined that the species has increased dramatically in Britain over the past few decades (Cranswick *et al* 1995), and this has been mirrored by increases on the Tay.

Lapwing *Vanellus vanellus*

Like the Golden Plover, the Lapwing is a bird of inland habitats in winter, although roosting flocks can be found on exposed intertidal flats where, compared to the plovers, more feed. Thus numbers on the Tay fluctuate considerably.

Peak numbers occur during the autumn migration (Table 1). The bulk of Lapwings (90%) roost on the inner estuary at both high and low tides. The highest count was of 2,000 in September 1987, although up to 4,000 have been recorded in the past on the extensive mudflats at low tide. Small numbers also roost at Newburgh at high tide, but few utilise the outer estuary, although small numbers roost at Tayport at low tide. Most can be found on adjacent grassland.

Continental migrants augment the local populations in winter (Prater 1981)and some effects of severe weather have been noted, similar to those described for Golden Plover.

Knot *Calidris canutus*

The Knot is one of the species which has fluctuated greatly on the Tay. During the study period, numbers peaked in January and February, with 1,200 in 1987 and 770 in 1986 being the highest counts respectively (Table 1). During the 1993-94 winter, the small numbers present fed at low tide on the outer estuary. 90% of the wintering population roosts at Tentsmuir Point.

Autumn migration begins in late July with an upsurge in August and September. During this period a few birds are found on the inner estuary. A sudden drop is apparent in April as migrants depart, and occasional birds occur in summer.

There is ample evidence that the number of Knot wintering on the Tay has decreased in the last 3 decades. Although in a national context it has never been an abundant species, prior to the early 1980s wintering flocks of 1,000-1,500 were not infrequent, but nowadays these numbers are unknown. It is known that Knot suffer from a reduction in food availability during periods of low temperature (Goss-Custard *et al* 1977), but the drop in numbers on the Tay does not appear to be related to the severity of the winters during the study period. In view of the far greater numbers wintering on the nearby Eden estuary, and also on the Montrose Basin, the Tay population can probably be counted as an offshoot of this. Tay Ringing Group data have shown considerable winter movement between sites on the Angus and Fife coasts.

Our birds come from North Greenland and Canada, with a midwinter peak due to birds crossing the North Sea from the Waddensea after moult, returning in late winter to fatten before spring departure (Prater 1981, Tay Ringing Group *in litt*).

Sanderling *Calidris alba*

The Tay Estuary and shores of east Fife hold one of the most important wintering Sanderling populations in mainland Scotland. The regular monthly counts (Table 1) reveal a wintering population on the Tay which reaches a peak in December, with a maximum count of 750 in 1985. The birds are found mainly on the north shore of the outer estuary, though greater numbers roost at Tentsmuir Point in late winter. The counts suggest that the wintering population has declined since a peak in the mid 1980s. In the early 1970s, 1.3% of the west European wintering population occurred on the Tay (Prater 1981). Up to 1991-92, flocks were of national importance in most winters. However, casual counts undertaken outwith the WeBS survey show that flocks of 400-600 still occur, suggesting considerable fluctuation. It may be that the uncounted shores around Buddon Ness and south to Kinshaldy provide the source of these birds, since small flocks are recorded there from time to time during winter. Certainly the species is susceptible to gales, as it feeds at the tide edge (Johnson 1985), and often moves to sandy non estuarine shores in severe weather (Moser & Summers 1987). Numbers of wintering Sanderling in the present study do show a small negative correlation with wind speed.

The low tide counts in 1993-94, when the roosting population was as low as 75, showed that the birds fed in the outer estuary, where they favoured sandier substrates. Very few have been recorded from the inner estuary.

As with Ringed Plover, the passage of Sanderling is not very evident from the regular monthly counts. However, substantial spring and autumn passage movements have been recorded, peaking at 450 in May, while numbers in August and September have reached 250 and 350 respectively. Parties of up to 44 have been seen in July.

A colour ringing study by one of the authors (BML) between 1986 and 1990, during which 158 individuals were marked, showed that our wintering birds probably originate from the NE Greenland population. There have been 25 sightings of Tay ringed birds in May from staging sites in SW Iceland, from where the birds have departed for Greenland by 25 May (Gudmundsson 1992). The ringing study also suggests that spring migrants may stage through the Waddensee as well as Iceland, and that, in autumn, some birds route via the Baltic Sea coasts. Some colour ringed birds have returned to the Tay as early as July, with

the wintering birds having left by late March.

Dunlin *Calidris alpina*

This species is the most numerous wintering wader on the Tay where the peak is reach in January (Table 1). The maximum high tide roost count was 4,657 in January 1994; 70% of the population roosts in the inner estuary. In midwinter, small flocks of up to 250 have been recorded feeding on fields at high tide as far west as Newburgh, suggesting that roost counts may not encompass the whole population. Between October and February, Dunlin comprise between 35% and 50% of the total wader population on the Tay.

The low tide counts in 1993-94 show that the bulk of Dunlin also use the inner estuary for feeding, mainly off Invergowrie and Kingoodie. On 13 February 1994, the number of birds counted there increased by 25% between low tide and high tide, while a large increase was also noted in the smaller flock on the south shore of the outer estuary, suggesting an influx of birds from outwith the counting area. Counts at the Eden Estuary do indeed suggest that there is an interchange between the 2 estuaries. It is known that the density of feeding birds is related to the amount of mud substrate present, thus accounting for the high percentage feeding in the inner estuary. There was no evidence of any weather related fluctuations during the study period.

Few Dunlin are recorded in summer, but the highest numbers are present during autumn migration. 5,292 was the highest count, in October 1988, but, in October 1973, a count topped 10,000 in the inner estuary. From ringing, it is evident that our birds are of the immigrant race *alpina* from northern Scandinavia and Russia (Tay Ringing Group *in litt*). These normally arrive in late October via the moulting grounds on the Waddensea (Prater 1981). The sizeable roost at Tentsmuir Point in October and November may be related to this arrival. Some longer distance passage birds also stage through the area, as locally ringed birds in July and August have been recovered in Portugal and Senegal.

As with the other common wader species on the Tay, a marked reduction in the Dunlin wintering population was recorded in 1994-95, when the highest monthly count in winter was only 57% of the long term mean.

Bar-tailed Godwit *Limosa lapponica*

This species is one of 2 (the other being Redshank) which reaches numbers of international importance on the Tay, with maximum roost counts exceeding 1,500 in most winters. More than 1% of the west European wintering population roosts on the Tay (Prater 1981). The peak occurs in February (Table 1), with the highest count in 1992, when 2,296 birds were present. Most of the wintering and migrant populations roost on the outer estuary, divided between Monifieth and Tentsmuir Point, although the proportion at each site seems to vary according to wind strength and tidal height.

Low tide counts in 1993-94 showed that the inner estuary and the shore off Broughty Ferry are both important feeding areas, although the latter held the highest density of feeding birds (Cranswick *et al* 1995). All feeding birds leave the inner estuary as high tide approaches, as do most of the Broughty Ferry birds, flighting to the outer estuary to roost. The Bar-tailed Godwit is one of the more mobile species on the estuary. As the tide turns, the roosting flocks are among the first to return to feeding sites, typically landing on the flats to feed before the water has receded. At Tentsmuir Point, flocks have been noted arriving from the south before high tide.

If disturbed at roost, some return south. The probability that there is some interchange between the Eden and Tay estuaries is supported by the consistent shortfall of feeding birds compared to roosting birds in the 1993-94 winter.

Bar-tailed Godwits begin to arrive in July, with a minor peak in autumn. The main arrivals on the east coast estuaries occur from November when moulted birds flight in from the Waddensee (Prater 1981). Increases are also noted in Britain when severe winters occur in that area (Cranswick *et al* 1995). They return rapidly in March to fatten before departure for the breeding grounds. Birds ringed in November in east Fife have been recovered one month later in Portugal, indicating onward passage down the east Atlantic flyway, and in April in northern Russia, giving a clue to their origin.

No long term trends can be detected, although Boase (1970) recorded an increase after 1960 to up to 300 wintering in Invergowrie Bay. However, the winter of 1994-95 saw a marked reduction in the wintering population, with the highest monthly count being only 36% of the long term mean. Counts from the 1995-96 winter indicated a return to normal.

Curlew *Numenius arquata*

The Curlew is another species which is very catholic in its habitat requirements, being found on inland fields when unfrozen, as well as intertidal flats and rocky shores.

Winter roosts on the Tay can be substantial, with up to 500-600 having been counted in the inner estuary in midwinter (Table 1). During the low tide counts of 1993-94, small numbers were distributed throughout the inner and outer estuaries, but feeding predominantly at Invergowrie and Tayport.

The roosting population is at its maximum in late winter and early spring, building up in July with an autumn peak in September. This is similar to the pattern on other North Sea estuaries (Prater 1981), and suggests that the local population is augmented by migrants. The decrease in October is thought to be due to autumn flocks moving inland.

No long term trends could be detected in this species, although there was a slow decline over the study period.

Redshank *Tringa totanus*

Like the Bar-tailed Godwit, numbers of Redshank also reach international importance on the Tay, but only in some winters.

The average midwinter roosting population is between 800 and 1,000, but occasionally exceeds 1,500. Over 70% roost in the inner estuary, with the remainder divided among the outer estuary roosts. Low tide counts in 1993-94 revealed that the vast majority feed near their roosts off Kingoodie and Invergowrie, although the highest density of feeding birds occurred near low water mark off Monifieth (Cranswick *et al* 1995). On 13 February 1994, the inner estuary flock increased by nearly 50% between low tide and high tide. Small parties also feed on adjacent pastures at high tide but, unlike Curlew, Lapwing and Golden Plover, this represents only a tiny proportion of the total wintering population.

Peak numbers occur during the autumn migration, when over 1,500 are present (Table 1). The highest count was in September 1989, when 4,713 birds were counted, although casual counts have peaked at 6,900 in October, and rarely 2,500 in April. The Redshank is the most abundant wader species

(around 40% of the total) on the Tay during the migration months of March, April and September. Only small numbers are present from May, with arrivals from July, when British breeders move to the coasts.

Icelandic birds have been caught locally in October, while birds ringed locally have been recovered in Iceland in summer, indicating the origin of most wintering birds (Tay Ringing Group *in litt*). A September ringed bird from the Eden estuary was also recovered in Nigeria in January, showing that staging of Scandinavian migrants, which have the longest migration, occurs.

Boase (1970) recorded similar numbers on the inner estuary at migration periods, but no long term trends were detected. The marked reduction in 1994-95 in the wintering population of the more abundant species was also reflected in Redshank numbers, with the highest winter monthly count being only 40% of the long term mean (Fig 3).

Turnstone *Arenaria interpres*

Although primarily a non estuarine species, which has a substantial wintering population on the open Angus and Fife coasts, small numbers do frequent the Tay estuary. The

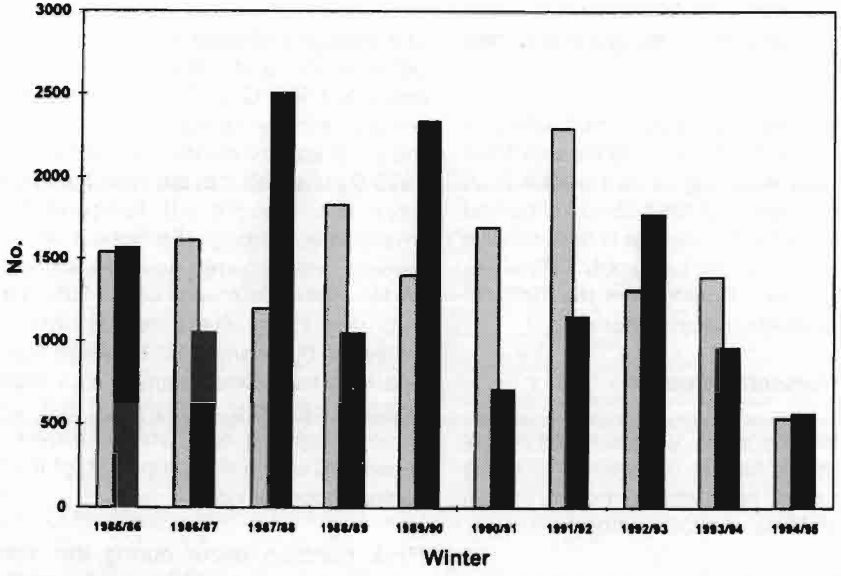

Figure 3 ***Peak winter counts of Bar-tailed Godwit and Redshank roosting on the Tay estuary, 1985-1995, Bar-tailed Godwit*** ☐ ***Redshank*** ■.

wintering population is small, with up to 50 birds (Table 1). The majority are found where mussel beds provide feeding, notably off Monifieth and, to a lesser extent, off Tayport. The highest count was 142 in December 1991.

However, the highest mean (72) occurs in April, and, like Ringed Plover and Sanderling, there may be a considerable turnover of migrants at that time, with peaks occurring outwith the regular monthly counts.

The Turnstone population wintering in the UK originates in Greenland and the Canadian Arctic, while autumn migrants include Scandinavian breeders (Prater 1981). One bird ringed in September 1985 on the Angus coast was recovered on Ellesmere Island in the following June.

Other wader species

Small numbers of other species are recorded on the estuary, mainly during migration. Of these, the only regular wintering species is the Snipe *Gallinago gallinago*, which occupies salt marshes in the inner estuary, and the smaller salt marsh by Tayport. Due to its secretive behaviour, total numbers are unknown. Maximum numbers occur in October, November and January, with a peak count of 30.

Wildfowl

Wildfowl figured less comprehensively in the counts, but sufficient data were obtained to enable an assessment to be made of numbers and distribution of several species.

Mute Swan *Cygnus olor*

Mute Swans frequent the estuary throughout the year and a few pairs breed. Marking with unique Darvic rings has proved that the Tay Mute Swans, in common with others in eastern Scotland, make considerable movements up and down the east coast during the year, although many individuals are fairly sedentary (L Brown pers comm).

A herd of up to 65 is present in the outer Tay between September and February, chiefly at Tayport in autumn but in the Monifieth/ Broughty Ferry area from January. A herd of up to 80 also winters upriver near Mugdrum Island or at the mouth of the River Earn, but these do not figure in the WeBS counts. Birds disperse to breeding sites in early spring, but a flock of non breeders then congregates near Broughty Ferry, to be joined by failed breeders to form a pre moult herd of 30-60 birds between April and July. In 1991, this herd apparently moved up to Mugdrum in June. Such early summer flocks are also noted on the Eden estuary and at Musselburgh on the Forth; all such flocks diminish considerably in August as birds move elsewhere to moult. From May to July in 1995, over 100 were present on the north shore of the outer Tay, mostly at Monifieth. Many of these birds may have originated from the River Earn herd, which departs at the end of April.

In winter and on migration, the Mute Swan herds are occasionally joined by a few Whooper Swans *Cygnus cygnus*.

Shelduck *Tadorna tadorna*

This species can be seen in all months, although spring is the period during which it is most common. A few pairs breed. On average of fewer than 10 birds over winter, feeding mainly in the inner estuary, with a rapid build up occurring from February. The peak is reached in April, with over 100 birds present at times between March and June, the

maximum being 186 in March 1991. This influx probably consists of birds en route from wintering grounds to breeding areas.

In most months, the species frequents the south shore near Tayport, where small parties roost on Lucky Scalp, and the inner estuary, where the majority of the spring influx is found. A few can be located as far west as Newburgh, and, in summer, a number of broods swell the ranks. These keep to the hidden areas of the inner estuary, and may not be monitored on the WeBS counts. A rapid decrease then occurs as the birds depart for their moulting grounds. Boase (1970) recorded numbers in the 1960s of up to 300 off Kingoodie in spring, so there appears to have been a decrease on the Tay since then.

Wigeon *Anas penelope*

This is essentially a winter visitor to the estuary, arriving in September and departing in March. The peak is reached in November, with a mean of 155, but over 200 are frequently recorded between October and January. This represents a recovery in numbers since an earlier decline in mid century (Atkinson-Willes 1963). The maximum occurred in November 1994, when 262 were present. The majority feed and roost around Lucky Scalp, but small numbers also feed at low tide on the foreshore between Monifieth and Broughty Ferry. Casual counts also reveal a significant feeding flock west towards Newburgh (526 in November 1995). No Wigeon are seen between May and August. Boase (1970) recorded the species as being only 'casual' off Kingoodie.

Teal *Anas crecca*

The Teal is a highly mobile species in winter, dependent upon unfrozen inland waters. Nevertheless, it has shown a marked decline during the period. Prior to 1990, numbers wintering on the Tay regularly exceeded 50 birds, with over 100 recorded in January and February, while higher counts have been made in the past (Atkinson-Willes 1963). The peak count was 190 in January 1986. Since 1990, none has been seen in some months, and parties have not exceeded 45 in number. However, although at high tide they are mainly to be found around Lucky Scalp, the reedbeds of the inner estuary may also be frequented and thus they are difficult to locate. Substantial low tide feeding flocks eg 130 in November 1995, have been recorded towards Newburgh, on a par with counts given at that site by Boase (1970) in the 1960s. Any decline may be linked to the greater frequency of mild winters, when birds are able to remain inland.

Mallard *Anas platyrhynchos*

Mallard are the commonest freshwater ducks on the Tay estuary, peaking in January with a mean of 626, but with a minor peak in September, probably due to migrants. Historically, the species was very abundant (Atkinson-Willes 1963, Boase 1970), but numbers have fallen since then, with the maximum count being 1,419 in September 1986, although 1,150 were present in midwinter 1991-92 and 1992-93, and other counts have exceeded 2,000. There is a marked exodus in March and April, with an early upsurge in August. Flocks frequent Lucky Scalp at high tide, but feeding birds keep mainly to the foreshores off Invergowrie and Broughty Ferry and upriver.

Tufted Duck *Aythya fuligula*

This is a species which is found almost entirely in the inner estuary, where counts have been sporadic. Nevertheless, enough data are available to show that the peak is in January, when as many as 720 have been present (1987), and the mean is over 300. Few have

been recorded between March and August. This inner estuary flock was also present in the 1960s (Boase 1970) but at the same time there used also to be hundreds off Dundee and Monifieth in winter, where now there are few.

Eider *Somateria mollissima*

With peak numbers over 20,000 between autumn and spring, the Tay Eiders are of international importance. However, regular counts are not undertaken, as many feeding rafts are often out of sight beyond Tentsmuir Point, and tide dependent feeding movements present great difficulties to counters (Pounder 1971, Cranswick *et al* 1995). Several hundred roost on Lucky Scalp at high tide. Winter 1995-96 saw a concerted effort by local counters and staff of the Wildfowl and Wetlands Trust to determine numbers. Accurate counts are only possible under ideal conditions. This was highlighted in November 1995, when a count on the flood tide in bright sunshine and a moderate westerly wind revealed around 11,500 birds. Only 3 hours later, at high tide with the sun obscured, a freshening wind, and a redistribution of many birds into the choppier waters of mid channel, only 6,500 were located.

Goldeneye *Bucephala clangula*

This species winters in nationally important numbers throughout the estuary, but mainly west of the Tay bridges. Apart from a few early individuals, birds arrive in October and November, building to a peak in January, although a secondary peak in March suggests passage. The highest counts were of 344 in January 1992, and 351 in March 1987. Irregular counts at Newburgh have revealed flocks of up to 200, so that the monthly counts lower down the estuary monitor only part of the population. Small numbers are still present in April, but the majority have left by the end of the month. Boase (1970) recorded several hundreds wintering in the early 1960s, off Invergowrie and also Dundee and Monifieth.

Goosander *Mergus merganser*

There is evidence that the large moulting flock found in late summer is a relatively recent occurrence. Previous to this study, small parties were noted both in spring and in late summer (Boase 1970), but there is also the possibility that there may have been confusion between Goosanders and Red-breasted Mergansers *Mergus serrator*, as all the former are redheads while moulting. The flock begins to build up in June, reaching nationally important numbers in July and August. The peak count was of 277 in August 1995. Most of the birds depart rapidly in mid September, although there were still 225 in the third week of September 1987. Occasional small parties are recorded into November, with some frequenting the upper reaches near Newburgh in winter. At high tide, most roost on Lucky Scalp, but at low tide they disperse both up and down river in smaller parties. The origin and destination of these birds is at present unknown. It is thought that the large breeding population in northern England and the Borders may be the source, although a bird from the increasing Welsh population was recovered on the Eden estuary in August 1992.

Other wildfowl species not monitored regularly by this study include geese, mainly Pink-footed *Anser brachyrhynchus* and Greylag *Anser anser*, which roost in large numbers (exceeding 5,000 and 1,500 respectively) from time to time on the inner estuary, and also feed in adjacent fields. Sea duck, such as Long-tailed Duck *Clangula hyemalis* and Red-breasted Merganser, can be found in small numbers in the outer estuary but more

importantly on the sea to the south.

Discussion

An understanding of the changes in waterfowl populations on the Tay estuary cannot be achieved in isolation from other coasts and it has been noted that there is probably a large degree of movement of some species between the Tay and the Eden, and doubtless also between the Tay and Angus shores. There is also movement between the high tide roosts on the Tay. Laing & Taylor (1993) gave some trends for the inner estuary, but there is considerable evidence that for some species this cannot be meaningful in isolation from the outer estuary.

Changes in species numbers have been described under the species accounts. A number of factors are probably responsible for these fluctuations: breeding success, changing winter mortality and weather probably being the most important. Local climatic fluctuations have already been described. Further afield, NW Europe, where many species stage in autumn and early winter, experienced similar temperature anomalies in most early winters to those that affect the Tay. The exceptions were in 1988-89, when temperatures in November and December exceeded the long term mean to a much greater degree locally, and 1991-92, when the reverse was true.

Overall, the wintering wader population varied between 10,000 and 13,000 over the period. However, the winter of 1994-95 saw a dramatic drop in the number of birds using the estuary, when the number fell to 6,800 (60% of the 10 year average). The 4 most common wintering species were all affected, but Bar-tailed Godwit and Redshank both fell to 40% of their average (Fig 3). As the 4 species have rather different migration strategies, the reason for this decrease is unclear, although both breeding success and climatic conditions on the near continent may have played a part. Counts in the winter of 1995-96 showed that Bar-tailed Godwit numbers recovered, but populations of Dunlin and Redshank remained relatively low.

Any statutory protection afforded to the estuary such as the proposed Special Protection Area (SPA) must take into account the movements between sites within and without the estuary. At present the bulk of the estuary is covered by Sites of Special Scientific Interest (SSSIs), made up of the inner estuary (5,400 ha, including the subtidal area), Monifieth Bay (213 ha), Barry Links (1,041 ha, including the sand dune system) and most of the Tayport-Tentsmuir coast (1,044 ha). A part of the latter is also a National Nature Reserve.

Disturbance to waterfowl varies, but is generally at what seems to be an acceptable level. All roosts except Lucky Scalp are subject to disturbance by walkers, especially in fine weather. Roosting at Dundee airport can be interrupted by aircraft and bird control activities, often to the extent that the roost is completely displaced. Speedboats in the outer estuary disturb wildfowl on the water but the problem is small in winter. At low tide, there is a limited amount of bait digging, but this is thought to cause only minor damage. Any future increase, for instance large scale commercial exploitation, would create a far greater problem. Natural disturbance is confined to the highest tides, especially when onshore winds enhance tidal heights, and normal roosts are covered. Many birds then vacate the area and move to unknown destinations, although this is rare, with only 3 counts undertaken when these conditions prevailed. There was no apparent correlation between tidal height and the total roosting population. However, increased tidal heights

have been shown to be detrimental elsewhere at low tide by covering feeding sites (Pienkowski & Prokosch 1982).

Regular monitoring of water quality has been carried out by the Tay River Purification Board (now the Scottish Environment Protection Agency). The Tay Estuary generally has a good water quality, despite the discharge of sewerage products, mainly in the Dundee area; some untreated discharges give locally poorer quality water, but progress to improve these is in hand. Over the period of study, it is not known if changes have had any effect on the bird populations. Sewage outfalls in the Invergowrie/Kingoodie section may indeed be the reason for the large number of feeding waders along this stretch of mudflats, (Pounder 1976) and it remains to be seen whether cleaning up discharges will result in any redistribution of waterfowl.

The Tay Estuary is an important link in the chain of estuaries along the east coast of Scotland. If the wildfowl, including sea duck, are taken into account, the wintering waterfowl populations of the Tay, Eden and St Andrews Bay exceeds 50,000, of which half are waders, with 3 species reaching international importance, and another 13 (7 waders and 6 ducks) being of national importance. Other waders reach national importance by virtue of their migrant populations.

Acknowledgements

A great debt is due to all those who put in the effort to obtain the data and who continue to count. Apart from the authors, the bulk of the counting was carried out by Dave Bell, Dave Ferguson, the late Steve Fulford, Sylvia Laing, Wendy Mattingley and Donald Stewart.

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Roosting Ringed Plover *David Mitchell*

SHORT NOTES

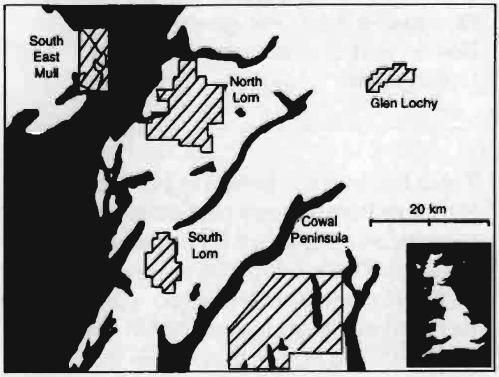
Nest site selection by Buzzards in mid Argyll

Buzzard nests are sometimes sizeable and conspicuous structures. The birds are known to use a wide variety of tree and crag sites (Picozzi & Weir 1974, *British Birds* 67:199-210; Fryer 1986, *British Birds* 79:18-28; Maguire 1979 *Western Naturalist* 8:3-13; Dare 1989, *The Naturalist* (Leeds) 114:3-31, Holdsworth 1971, *British Birds* 64:412-420). Ground nesting behaviour was recorded by Maguire in Kintyre, and occurs infrequently in Argyll (*pers obs*), but has not been recorded in any of the detailed Buzzard studies made in the south of England (Tubbs, 1974, *The Buzzard* David & Charles; Dare 1961, *Ecological observations on a breeding population of the Common Buzzard, Buteo buteo,* PhD thesis, Exeter University). The location of nests on the ground might be thought to make the nest particularly vulnerable to predators. As part of an investigation of Buzzard breeding distribution in Argyll, we considered whether there may be a shortage of suitable nest sites which led to ground nesting, and which might also limit the distribution of these birds. In this note we consider the selection of nest sites by Buzzards and their breeding success in different sites.

Field work was carried out in 3 main areas of Argyll (Figure 1): north Lorn (including Glens Lonan, Feochan and Euchar to the east and south east of Oban), south Lorn (to the north of Lochgilphead) and Glen Lochy (between Tyndrum and the Lochy and Orchy rivers). Attempts were made to locate every nest within these study areas in 1989 and 1990. Each nest was usually visited a number of times each season, to obtain information on clutch size, laying dates, brood size and fledging success. The laying date was usually estimated from direct observation of the date of hatching, or from measurements of the stage of growth of the chick from which its hatching date could be extrapolated. Nests were described as on crag sites where they were located on open rock faces. Bank sites were situated on vegetated ground, usually on steep banks alongside gullies, but with no exposed rock.

A total of 34 nests was located in 1989 and 39 in 1990. Many occupied nest sites had those from previous years in close proximity. 68%

Figure 1 ***Study areas. The areas for which complete coverage was obtained were: South east Mull 50 km^2, North Lorn 140 km^2, Glen Lochy 35 km^2, South Lorn 43 km^2, Nest sites on the Cowal Peninsula included in the analysis with the kind permission of Steve Petty and David Anderson.***



of nests were in trees and Table 1 shows that there was a clear preference for larger trees. Birch was undoubtedly the commonest tree species in North and South Lorn, yet was rarely used if larger trees were available. The crags used for nesting were from 5 to 50 m high, and the nesting ledge invariably had a vertical rock face immediately below the nest, although this was often only a few metes high. The nests were usually readily accessible on foot, although they were hidden by vegetation when viewed from below. There was no evidence that bank nesting was used because of a shortage of suitable trees. In all cases, bank nests were sited in woodland or wooded gullies, with apparently suitable tree sites in close proximity, often containing nests from previous years.

Table 1 ***Numbers of nest sites occurring in trees of different species used by tree nesting Buzzards in mid Argyll.***

Tree species	Number of nests
Oak *Quercus spp*	19
Spruce *Picea spp*	12
Birch *Betula spp*	4
Scots Pine *Pinus sylvestris*	4
Ash *Fraxinus spp*	3
Larch *Larix decidua*	2
Cypress *Chamaecyparis spp*	2
Douglas Fir *Pseudotsuga menziesii*	2
Rowan *Sorbus aucuparia*	1
Beech *Fagus sylvatica*	1

Table 2 shows the breeding performance of Buzzards from different nest sites. There was a significant difference in laying dates between the sites (Kruskall-Wallis one way ANOVA = 11.63, $P < 0.009$) and multiple comparison tests showed that clutches laid in bank nest sites were laid significantly earlier than those laid in the other nest sites. There was no significant difference in clutch size or brood size, but there was a significant difference in fledging success ($K = 8.94$, $P < 0.03$) and multiple comparison tests showed that significantly fewer young fledged from crag sites than from tree or ground sites.

There was no evidence that Buzzards nesting on the ground experienced a higher level of predation than birds using tree or crag sites. Crag sites actually had a higher proportion of nest failures, although the causes could not be determined. It is reasonable to assume that nests on the ground would be exposed to a greater range of predators than those in trees or crags. There is, presumably, some advantage to ground nesting which compensates for this. Buzzard nests are conspicuous, and the first birds to lay will do so before trees are in leaf. If egg predation by corvids and other avian predators is an important cause of breeding failure, it may be that ground nests are less conspicuous at the start of the season. In addition, ground sites may be more protected from wind and rain; this would be particularly important early in the season when leafless trees provide little shelter. This may be why females which are going to breed early in the season are more likely to choose a ground nest site. By doing so they can take advantage of an early start to the breeding season without incurring the higher energy costs that are probably associated with incubation in exposed sites in unfavourable weather conditions. This may explain why ground nesting has not been reported from areas such as the south of England, where the weather is less severe early in the breeding season, and where trees are in leaf earlier in the year.

We are very grateful to David Anderson, David Jardine, Mike Madders, Steve Petty,

Table 2 ***Breeding performance of Buzzards in mid Argyll in relation to nest site situation. Laying date is given with reference to 1 April (day one). Brood quality rank is based on 1=brood consisting principally of nestlings of low weight for age, 2=brood consisting principally of nestlings all of expected weight for age and 3=brood consisting principally of nestlings of high weight for age.***

	Nest site situation			
Breeding parameter	Bank (n=14)	Coniferous trees (n=20)	Deciduous trees (n=30)	Crag (n=9)
Laying date (Median and range)	9 (5-37)	16 (5-30)	14 (2-27)	16 (9-26)
Clutch size (Average and range)	2.59 (2-4)	2.01 (1-3)	2.21 (1-3)	2.17 (2-3)
Initial brood size (Average and range)	2.29 (0-4)	1.90 (0.3)	2.19 (0-3)	2.00 (0-2)
Number fledged (Average and range)	2.13 (0-4)	1.84 (0-3)	2.11 (0-3)	1.25 (0-2)
Brood quality (Mean rank and SE)	2.06 (0.25)	1.53 (0.16)	2.07 (0.14)	1.80 (0.16)

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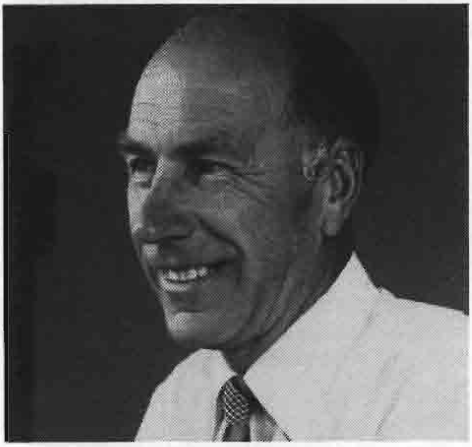
OBITUARIES



MALCOLM CASTLE
1923-1996

The death of Malcolm Castle not only means the loss of a friend, but also the end of an era for the Ayr Branch - Malcolm was the last of the founder members still coming to our meetings. Throughout this period he always maintained close links, from being the first Branch Secretary, through his chairmanship in the 1970s and, latterly, as President. His enthusiasm for birdwatching was always apparent from his questions at meetings and he was a regular on our outings, especially the longer trips.

He was always keen to help with survey work. This was never clearer than in his role as the Ayrshire organiser during the 5 years of field work for the first BTO Breeding Bird Atlas. However, for many, his name will always be linked with rookeries. He first organised a survey of the county in 1966, inspired by the pioneering work of Robert Walls 10 years earlier, and then kept up the counts each decade, sometimes linking with BTO surveys, until the year of his death. It is only a matter of months since he last sent us out with our maps and clipboards. His loyalty to Rooks combined his love of birds and his professional interest in agriculture, in a species that acts as an excellent indicator of the general health of the countryside.

As a scientist, his many years of research at Shinfield and then at the Hannah Dairy Research Institute made him a leading expert on grassland management and silage production. This was recognised in his period as President of the British Grassland Society. His combination of practical agricultural knowledge and concern for wildlife again came to the fore when he played a major role in the formation of the Ayrshire Farming and Wildlife Advisory Group.

Away from work - and birds - Malcolm was a man of many parts. When he came to Scotland he discovered curling, an enthusiasm which remained with him for the rest of his life. After many years of breeding Jack Russell terriers, Malcolm and Betty decided that when they moved to their retiral home at Tobergill they had room for something bigger. It was not long before their little herd of Belted Galloway cattle started to make an impact at the local shows! He also took pride in his skills as a handyman and, after visiting St Kilda with a National Trust workparty, he liked to tell people that he had added stone masonry to his repertoire.

However, the overriding memory of Malcolm for most of us will always be of a good friend, whose infectious enthusiasm for life brightened any day. Whether we remember his comments in meetings or his jokes in the minibus in Islay or Holland, we shall all miss him.

Roger Hissett

ROBERT "BOBBY" JOHN TULLOCH, MBE 1929-96

He was a rare character, one of the kind remembered with a smile. Always known as Bobby, he could amuse and inform without seeming to in his beautiful, soft Shetland accent. At the premiere of the RSPB film on Shetland *Land of the Simmer Dim* in a packed Usher Hall, Bobby walked onto the stage. There was complete silence as he looked around the vast hall and then slowly said "I think there are more people here than in the whole of Shetland". The 2,000 people responded hugely and warmly.

Born in North Aywick, his upbringing was at one with his natural surroundings. At primary school, all the children had "pets" - gulls, crows or waders - all taken as chicks, carefully nurtured for weeks until they could fly. There could be problems, as when his mother found young Bobby tucked up in bed with a young Raven under the covers! Bobby was remarkably surefooted and this stemmed from when he and his school chums ran races along boulder beaches, jumping from stone to stone at breakneck speed - "more interesting than a sandy beach" he told me.

One of the characteristics of Shetlanders is the love of doing something new and the dislike of repetitive work. Bobby, a baker by trade, started up a travelling shop. He bought an old van and spent a long time carefully painting one side with his name and pictures of his products. However, he only did one side; "too routine", he told me, to do the other.

During the 50's and early 60's, all his spare time was spent studying the wildlife around him and increasingly the RSPB used his results and expertise. In 1964, the late George Waterston made him an offer he could not refuse; to be Shetland representative for the Society. For 21 years his achievements for conservation and public relations were truly outstanding. He built up a data base of birds, developed several important nature reserves and stimulated local people to take a pride in their islands. Undoubtedly the first breeding of Snowy Owls on Fetlar (1967) was the highlight of his career. For 4 years he threw himself into organising the protection and viewing of the famous pair and he developed enormously during this time, gaining a confidence which never left him.

Bobby was a remarkably talented man. He was an accomplished musician on guitar, fiddle and accordian, much in demand at any social gathering, and a self taught photographer of outstanding quality. He often processed his own film, both print and slide, and I remember being in his little dark room and seeing a lot of slides in the waste bin. "Oh, they're not good enough" he declared. These rejects I used for many years of lecturing! Bobby's own talks were legendary. Photographically superb, he blended these together with anecdotes and observations which were classic examples of pure entertainment and education. At SOC Conferences he was the centre of a rollicking crowd at the bar, always with laughter as Bobby was a great raconteur. On Saturday evenings the call would go out and soon he was on a chair with his squeeze-box surrounded by happy dancers. Great weekends!

In 1969, Bobby started the Shetland Bird Report and 4 years later he and Dennis Coutts established the Shetland Bird Club. He was elected the Club's President and remaind so until his death. After retiring from the RSPB, Bobby had the freedom to travel. He regularly lectured on National Trust for

Scotland cruises and led tours throughout the world, from the Arctic to Antarctica.

Bobby enjoyed writing but his early publications were also important for bird conservation and showing his fellow Shetlanders just how vital their islands really were. Many people considered his *Bobby Tulloch's Shetland* to be his finest book, giving an insight into how he viewed the natural world, illustrated with his expressive photographs. This book also reflected his deep, alround knowledge of Shetland's natural history, particularly of Otters and seals. Several TV films would never have been possible without his intimate local knowledge.

Other examples of his breadth of interest were his photographs of flowering plants and ferns, while for his own interest he built up a considerable list of fungi for the islands - all of which, he assured me, he had eaten.

After an illness, Bobby died peacefully in Lerwick. His wife, Betty, had died some years previously. Everyone who had ever spoken to him and, I reckon, had even heard him speak, considered him a friend. We all miss him and we are grateful he shared his world with us.

Frank Hamilton

VERO COPNER WYNNE-EDWARDS CBE FRS FRSE 1906-1997

1946 was a year of new beginnings. The world was recovering from the trauma of war and hundreds of thousands of men and women were returning home optimistically to face the future. In that dawn there was a fresh sense of freedom which brought with it a rediscovery of nature and a new ideology called "conservation". Millions who had forgotten the sights, sounds and scents of their native land, had a new found value of all things natural and from their ranks came champions in the name of natural science. One of these was Vero Wynne-Edwards, a man of great intellectual and physical energy, a pioneer of modern marine ornithology, an explorer of the Canadian Arctic and a fundamental thinker.

That year, Wynne-Edwards was appointed to succeed Alistair Hardy to the Regius Chair of Natural History in Aberdeen University. Wynne, as he was widely and affectionately known, was 40 years of age. Like other students of zoology of his time, at Oxford he did the long march through the Animal Kingdom and graduated with First Class Honours in 1927. Unlike most postgraduates, who became specialists in a narrow field, he chose a broad canvas of biological experience and scholarship, and this determined the wonderful personality he was to become. His first venture was in marine research when he worked on Herring, Cod and small crustacea, with a side interest in the behaviour of wintering flocks of Starlings. In 1929 he became a lecturer at Bristol University and married Jeannie Morris. About this time he was studying Lapwings in a large meadow when, from his hide, he was horrified to see a squadron of cavalry trooping through the gate. Rushing forward he addressed the Colonel at the head of the column. "Sir, this field is alive with nesting Lapwings and their chicks... could you please return in a month's time?" So instantly convincing was Wynne's plea that, to the consternation of the troopers, the Colonel turned his charger and led the squadron back through the gate.

In 1930 he became an Assistant Lecturer at McGill University, Canada. He became interested in Atlantic ornithology and produced the hypothesis that seabirds were not randomly distributed across the trackless face of the ocean. His interest in alpine flora, which he had had from his childhood in his native Yorkshire Dales, blossomed in Canada with published papers on the patchy distribution of rare flora. For these works he was twice awarded the Walker Prize of the Boston Natural History Society and the Fellowship of the Royal Society of Canada. During the war, he organised a course in electronic physics for radar mechanics in the Royal Canadian Air Force and was sent to assess the fisheries of the Yukon and Mackenzie rivers.

After 15 years of happy and exciting life at McGill, Canada was in the blood of the Wynne-Edwards family. Their daughter Janet and son Hugh were both born in Canada and returned there to settle in later life. One of the attractions of the Aberdeen job was the fact that it provided 5 months home based skiing in most years! In 1950 Wynne returned to Canada as the zoologist on the Baird Expedition to Baffin Island.

In 1946 George Waterston, Arthur Duncan and others were reviving the Scottish Ornithologists' Club and Wynne-Edwards arrived just at the right time. He provided an instant link with centres of learning in natural science at home and abroad. He also gave professional academic backup to what was essentially an amateur movement out of which, very shortly, was to emerge the professional cadre of natural scientists who would forge the basis of nature conservation in Scotland. In the choice, training and deployment of these scientists in public life he was to play a leading part in conservation over the next 25 years. Though Wynne was a classical zoologist of the old school, devoted to scholarship, he was also a pragmatist with a rare insight into the ways in which science can be put to the service of the community. One of the many outlets of his talents and energy was the SOC. He became an Hon. Vice President and joint founder of the Aberdeen Branch of the Club, a Trustee of the Fair Isle Bird Observatory and the chief editor of the resurrected *Scottish Naturalist,* a connection which lasted until 1964 when he became co-editor of the new *Journal of Applied Ecology.*

His intellectual life was greatly tempered by his desire for physical fitness, coupled with a love of the mountains and wild country. He became a life member of the Cairngorm Club and was a leading figure in the Aberdeen Branch of the Scottish Ski Club. At the age of 62 he broke the record for a traverse on foot of the 6 main summits of the Caringorms by 96 minutes. True to character, he would appear at meetings in shorts having run the distance while others travelled by car. With brief case in rucksack, he walked across the Mounth and Lairig Ghru to meetings in Tayside and Speyside. He ran regularly on hill and shore, plunged in river and sea at all seasons, and often cycled to the mouth of the Don to have his picnic lunch while botanising and bird watching.

Wynne-Edwards' main endeavours were focussed in the building of one of the finest university departments of zoology in Europe. He took the entire establishment from its old quarters in Marischal to the new building in Old Aberdeen in 1970 and he founded the Culterty Field Station at Newburgh in 1958. The pre-eminence of Aberdeen zoology rested largely upon Wynne's scientific reputation which was greatly enhanced by his highly controversial challenge to Darwinian orthodoxy. In his great work *Animal Dispersion in Relation to Social Behaviour (1962),* he proposed that animals cooperate for the benefit of the group, that they compete for territory and status rather than food, with the losers having to accept their lot. He stated that animals are not, as Darwin supposed, always striving to increase their numbers, but are instead programmed to regulate their numbers. Group selection he saw operating in the differential survival of populations. A precis of the book in the *Scientific American* in 1974 sold 350,000 copies.

The theory was roundly rejected but Wynne was never persuaded that he was wrong. After 25 years of debate, when he was 80 years of age, he published his second work

Evolution Through Group Selection (1986). He took his belief in group selection to the grave and is recognised today as one of the most important fundamental biologists of this century having "done a great service in forcing people to think carefully about the evolution of social behaviour, especially altruism" (Krebs and Davies in *Behavioural Ecology: an Evolutionary Approach,* 1978, p8).

Wynne's contribution to science in public life was prodigious both locally and nationally. His influence was inspirational and ranged from the careers of individual students and scientists to the movements of Government policy, affecting the lives of millions. He was in at the birth of nature conservation in Britain and became a long standing member of the Nature Conservancy and its Scottish and Scientific Policy Committees. In 1956 he initiated a research project on the population ecology of Red Grouse, which led to the setting up of the research station at Hill of Brathens, Banchory, and this is still in progress. This served as a prelude to his appointment as a member of the newly created Natural Environment Research Council in 1964. He was later to become its Chairman in 1968-71 - a very difficult time in NERC which resulted in the split of the Nature Conservancy into the Nature Conservancy Council and the Institute of Terrestrial Ecology in 1972. He was also a Vice Chairman of the Red Deer Commission 1959-68, President of the Scottish Marine Biological Association 1967-73, the British Ornithologists' Union 1965-70 and of Section D of the British Association for the Advancement of Science in 1974. He was a member of the Advisory Committee on Fishery Research and the Royal Commission on Environmental Pollution and a Leverhulme Fellow 1978-80. He held honorary membership of 5 biological societies. He was elected a Fellow of the Royal Society of Edinburgh in 1950, the Royal Society (London) in 1970, and was awarded 3 medals: the Neill Prize of the RSE, the Frith medal of the Zoological Society of London and the Godman-Salvin medal of the BOU. In 1973 he was appointed a CBE but many felt that he deserved a greater accolade.

In the formal setting, Wynne-Edwards was the polished, dignified academic, but he had within him other dignities - the sensitive instincts, wonder and burning curiosity of the naturalist and the love and devotion of the family man with 7 grandchildren and 7 great grandchildren. His memorial takes physical form in the Department of Zoology with its Culterty Field Station in Aberdeen University. In science he will be remembered for his Theory of Group Selection, which might gain greater acceptance in future than it did in his lifetime. In education, a generation of natural scientists were fired by his example, enlightenment and romantic spirit. In human affairs, his influence will live on in that great cultural movement which seeks enduring harmony between man and nature.

Information contained in this obituary has been provided by Professor David Jenkins, Dr Adam Watson and Professor Paul Racey, to whom Professor Wynne-Edwards was mentor and friend.

J Morton Boyd

Advice to Contributors

Authors should bear in mind that only a small proportion of the *Scottish Birds* readership are scientists, and should aim to present their material concisely, interestingly and clearly. Unfamiliar technical terms and symbols should be avoided wherever possible and, if deemed essential, should be explained. Supporting statistics should be kept to a minimum. All papers and Short Notes are accepted on the understanding that they have not been offered for publication elsewhere and that they will be subject to editing. Papers will be acknowledged on receipt and will be reviewed by at least 2 members of the editorial panel and, in some cases, by an independent referee. They will normally be published in order of acceptance of fully revised manuscripts. The editor will be happy to advise authors on the preparation of papers.

Reference should be made to the most recent issues of ***Scottish Birds*** for guidance on style of presentation, use of capitals, form of references, etc. **Papers should be typed on one side of the paper only, double spaced and with wide margins; 2 copies are required and the author should also retain one.** We are happy to accept papers on Applemac computer discs. We cannot handle other formats because both the SOC computers and those at our printers are on the Apple system. Please contact Sylvia Laing on 0131 556 6042 to discuss this. Headings should not be underlined, nor typed entirely in capitals. Scientific names in italics should follow the first text reference to each species. Names of birds should follow the official Scottish list (*Scottish Birds* Vol 17 : 146-159). Only single quotation marks should be used throughout. Numbers should be written as numerals except for one and the start of sentences. Avoid hyphens except where essential eg in bird names. Dates should be written:.....on 5 August 1991.....but on the 5th (if the name of the month does not follow). Please note that papers shorter than c700 words will be treated as Short Notes, where all references should be incorporated into the text, and not listed at the end, as in full papers.

Tables, maps and diagrams should be designed to fit either a single column or the full page width. Tables should be self explanatory and headings should be kept as simple as possible, with footnotes used to provide extra details where necessary. Each table should be on a separate sheet. Maps and diagrams should be in Indian ink and be camera ready, but drawn so as to permit reduction to half their original size.

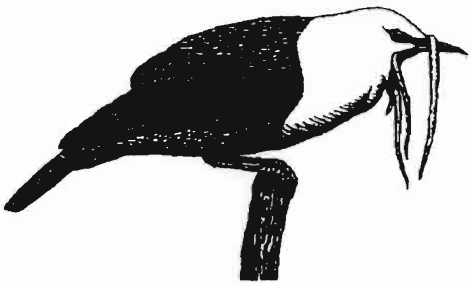
Human induced increases of Carrion Crows and gulls on Cairngorms plateaux by **Adam Watson**. *Scottish Birds* 18(4):206 - 207

Parts of these 2 paragraphs were omitted by the printer.

Since 1970, I have seen Crows on most parts of A south to Ben Macdui summit, but mainly on north parts on and near Cairn Gorm. I counted Crows and people on 30 parts. Out of 7 where I saw no Crows, 5 were among the 6 parts where I saw nobody. Parts where no Crows and people were seen lay away from the main walkers' routes to and from Cairn Gorm, Ben Macdui and Cairn Lochan, mostly on steep rough bouldery corries. On the 30 parts for all 46 years combined, Crow and people densities were related (n-30, rs=0.69)

The highest Crow density (23.2 per ha in 1971-88) was at Lochan Buidhe (next paragraph) followed by 3.4 at the March Burn nearby, Cnap Coire na Spreidhe near the Ptarmigan Restaurant (1.1), Coire Domhain (1.0, associated with garbage at snow holes), Cairn Lochan (0.7), Ben Macdui summit and west of Cairn Gorm (0.6), and lower elsewhere.

Corrected copies of the complete paper can be supplied by contacting Sylvia Laing at 21 Regent Terrace, Edinburgh EH7 5BT.

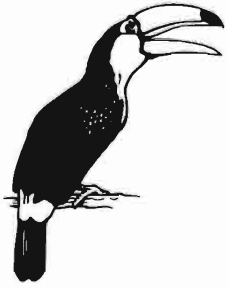


NEOTROPICAL BIRD CLUB

Neotropical bird club launched

A club has been launched to promote the study and conservation of the birds of the Neotropics (South America, Central America and the Caribbean). It is currently seeking founder members to help reach the launch budget of £2000, which is required to get the club running and to publish the two first issues of its intended journal 'Continga'. Founder members will be asked to pay a minimum of £25, and will be formally acknowledged in the first issue of 'Continga'. 'Continga' will provide a colourful and much needed forum for exchange of information on the avifauna of this extremely rich and diverse area, and will contain papers and features on the birds and their conservation as well as news of recent observations and discoveries (at present, new species are still being discovered at the rate of more than two a year). It is hoped that in due course the club will be able to provide direct funding and support for practical conservation programmes.

For further details and membership forms, please contact:
Rob Williams,
Publicity Officer,
Neotropical Bird Club,
c/o The Lodge,
Sandy,
Bedfordshire SG19 2DL



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