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Sawbill ducks at fish farms in Argyll, western Scotland

D.N. CARSS

The effect of sawbill ducks on stock at fish farms was investigated in north Argyll during 1986 and 1987. There was strong circumstantial evidence at a freshwater cage farm on Loch Awe that Goosanders damaged nets, allowing fish to escape. The six Goosanders killed here in spring 1988 probably reduced the small, local breeding population. Although Red-breasted Mergansers were often seen passing close to farm cages in sea lochs they did not attack stock and consequently were not killed.

Introduction

Fish farming is a rapidly expanding industry in Scotland. The production of Atlantic salmon *Salmo salar* rose from 520 tonnes in 1979 to 10,337 tonnes in 1986, and this trend looks likely to continue. The production of rainbow trout *Oncorhynchus mykiss* (formerly *Salmo gairdneri*) in 1986 was 2317 tonnes. Not surprisingly, fish farms in Europe and North America attract a variety of fish-eating predators (see review in Beveridge 1988). Grey Heron *Ardea cinerea*, Cormorant *Phalacrocorax carbo*, and Shag *P. aristotelis* are the main bird predators at Scottish fish farms, but Goosander *Mergus merganser* and Red-breasted Merganser *M. serrator* are also reported to cause damage (Carss in press).

Farmed fish may be kept in a variety of holding facilities. In Scotland the most commonly used is the cage system; cages are essentially floating collars supporting a net bag which holds the fish, moored offshore in either fresh or salt water. Other methods include ponds, tanks and raceways sited onshore and fed with water pumped either from a nearby river or the sea. This paper reports on a study carried out at marine and freshwater cage farms in north Argyll to determine whether sawbill ducks were a problem, and if so the timing, manner of attack and the amount of damage caused.

Study Area and Methods

The study area was bounded to the north by Loch Creran, to the south by Loch Melfort and stretched from the west mainland coast to the eastern shore of Loch Awe. It included sea lochs Creran, Etive, Feochan and Melfort and numerous running and standing freshwater bodies. Within this area there were 12 fish farm sites producing Atlantic salmon and/or rainbow trout (Fig. 1).

The location, age and sex of all Goosanders seen within the study area between 1 January and 31 July in 1986 and 1987, and of all Red-breasted Mergansers between 1 November 1986 and 31 May 1987, were recorded. In some weeks more than one count was made in a particular locality: in such cases, the highest count was used. Nine of the farms within the study area were visited at least once a month, and managers and staff were asked about damage caused by sawbill ducks. Shot birds were taken away for subsequent examination.

Results

Numbers and sex ratio

Goosander

Of the 83 sightings of Goosanders between 1 January and 31 July 1986, 69 (83.1%)

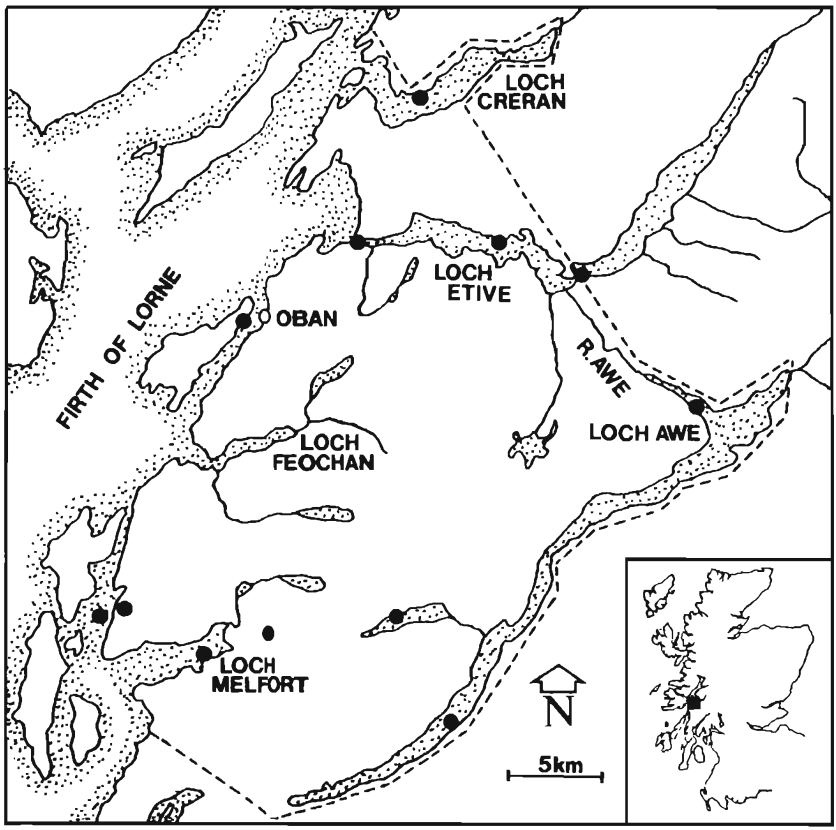

FIGURE 1. Map of the study area showing places named in the text and the location of fish farms (closed circles). *The inland boundary is denoted by a broken line.*

referred to birds feeding near fish cages at one farm in Loch Awe while the remainder were seen on other freshwaters (Fig. 2).

Goosanders visited the Loch Awe farm individually and in small groups of two or three pairs. The largest group (22 drakes and a single duck) was recorded on 27 May. Through the remainder of May, June and July the few birds seen were, with one exception, ducks (Table 1).

In 1987 there were 42 sightings of adults between 1 January and 31 July (Fig. 2), but only 17 (40.5%) were at the Loch Awe fish farm (Table 1). The remaining sightings included 12 on other freshwater bodies and 13 on sea lochs Etive, Creran and Feochan.

Red-breasted Merganser

Although seen throughout the study period, Red-breasted Mergansers were more abundant in the spring. The maximum daily number of Red-breasted Mergansers seen in sea lochs each month from November 1986-May 1987 inclusive was 5, 18, 10, 20, 24, 30 and 7 respectively. Most (97.0%) of the 336 sightings were on sea lochs and the remainder were on freshwaters during April and May. Birds were not seen to be associated with fish farms.

Predation at farms

Goosander

Within the study area, Goosanders were a problem only at a large freshwater cage farm in Loch Awe, where they were implicated in several incidents of damage to cage nets during April 1986, February/March 1987 and February/March 1988. When at the farm, birds were regularly seen in the early mornings and late evenings diving close to a row of rainbow trout cages on the off-shore side of the site.

The nets of several cages in the row were repeatedly torn and frayed in many places at a depth of *c.*1 m. The holes were up to 20 cm long and although the nets were repaired daily, new holes had often appeared by the following morning. There was no evidence that Goosanders were actually taking or damaging fish within the cages but up to 7% of the fish escaped (Farm Manager pers. comm.). To protect stock at this site, Goosanders were shot; these included single drakes in January and February 1986 and March 1987, three drakes and a duck in Feburary 1988 and a pair in March 1988. The stomach contents of four of these birds were examined; three were empty but one contained a rainbow trout *c.*16 cm long and weighing 45 g.

Red-breasted Merganser

During the study, no reports were received of Red-breasted Mergansers causing a problem at any farms, either marine or freshwater, and none were killed.

Discussion

Goosander

From data supplied by local recorders, Meek & Little (1977) estimated the breeding population of Goosanders in Argyll and the Inner Hebrides to be 50 pairs, most of which were on the mainland. Although more recent estimates are not available it is unlikely that the number of breeding birds has changed much since the late 1970s (M. Marquiss, pers. comm.).

Goosanders may be seen in Argyll during any month of the year. Many ducks moult on their breeding grounds, either while tending the brood or immediately after the young have fledged (M. Marquiss, pers. comm.). whereas drakes are not seen from the end of May until December/January.

Dye-marking and ringing in the Borders and Northumberland has demonstrated the existence of a moult migration to north Norway with drakes leaving British waters in late May or early

TABLE 1. The weekly maximum number of male and female Goosanders seen between 1 January and 31 July in 1986 and 1987 at a fish farm on Loch Awe, Argyll.

1986			1987		
Date	Male	Female	Date	Male	Female
7 Apr	2	1	25 Jan	1	0
16 Apr	4	6	28 Jan	1	1
24 Apr	4	4	28 Feb	1	2
2 May	8	4	11 Mar	3	2
5 May	2	1	19 Mar	3	3
19 May	2	0			
27 May	22	1			
6 Jun	0	1			
9 Jun	1	3			
23 Jun	0	1			
10 Jul	0	1			
19 Jul	0	1			

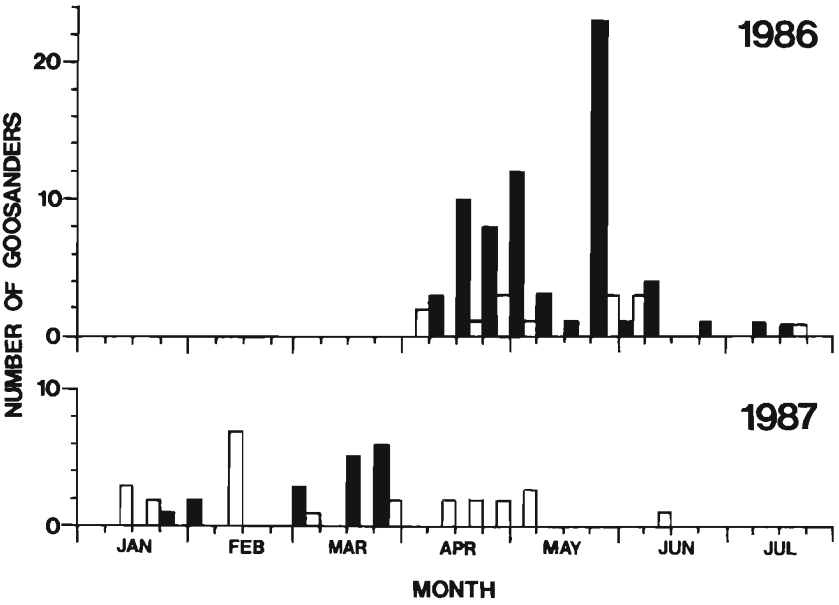

FIGURE 2. The maximum number of Goosanders seen each week at a fish farm on Loch Awe (black) and elsewhere in the study area (open) between 1 January and 31 July in 1986 and 1987.

June (Little & Furness 1985). Estimates of the size of breeding and winter populations suggest that almost all the drake Goosanders in Western Europe moult in this one area. They return to the British breeding areas from late October onwards with some perhaps gathering in the Moray Firth prior to dispersal in January/February (Aspinall & Dennis 1988).

Broad *et al.* (1986) in a survey of the wildfowl on all the open waters in Argyll in 1985 recorded 21 drakes in May before migration but only a single drake in June after migration had occurred. In the present study, a high proportion of Goosanders seen within the study area in 1986 was associated with one cage fish farm on Loch Awe. Here Goosanders were regularly seen during April and the first few days of May. During the rest of the month numbers were low until 27 May when 22 drakes were seen near the farm. Thereafter, birds were only occasionally seen there and these were, with one exception, ducks. This pattern of attendance is thought to be linked with the breeding cycle. Birds visiting the farm during April and early May were paired and presumably feeding intensively prior to, and during, egg laying. In the following weeks during incubation, the birds spend most of their time at the nest site and from mid-incubation onwards the drakes leave to moult. The similarity between the number of drakes on Loch Awe just prior to migration in 1986 and the 21 recorded throughout Argyll in 1985 suggests that Loch Awe may be a gathering point for Argyll drakes before their moult migration. A similar situation was described by Little & Furness (1985) for Hoselaw Loch in the Scottish Borders where drakes from a large area of the Borders and northern England gathered before migration.

In 1987 fewer Goosanders were seen at the fish farm and, during a nationwide sawbill survey conducted by the British Trust for Ornithology during March/April and July, fewer birds were recorded in mid-

and north Argyll as a whole (M. Madders, pers. comm.). The reasons for such annual variations in the numbers of birds counted are unclear. However, Loch Awe is large (3900 ha) and there are many islands so it is likely that, as drakes gather for only a few days, some may have been overlooked. It is also possible that the weather and/or the availability of fish could influence the number of birds on the loch, the length of time they spent there and the attractiveness of the fish farm as a feeding site.

At the Loch Awe farm, the only one in the study area where Goosanders were a problem, the birds showed considerable seasonal and diurnal trends in their attendance. During a few weeks in the spring Goosanders visited the farm in the early morning and late evening which conforms with the pattern of activity described by Sjöberg (1985). There was no evidence that birds took fish directly from the cages, but they did appear able to damage cage nets sufficiently to allow fish to escape. Although Cormorants visited the site throughout the winter (October-April), the period of net damage and subsequent escape of stock coincided exactly with the presence of Goosanders at the farm; no net damage was recorded when Goosanders were absent.

Historically, Loch Awe has been associated with Goosanders since the species began breeding in Scotland at the end of the last century. Along with Loch Ericht (Perth) it is cited by Baxter & Rintoul (1922) as being the first breeding location for the species in Britain, in 1871. It would therefore appear that the loch was an important Goosander site long before the establishment of the fish farm in the mid-1970s. By locating their fish farms on important Goosander lochs, farmers may be increasing the risk of problems from this species, although the time when birds are likely to be a problem is relatively short and predictable.

The number of Goosanders killed at Scottish farms is probably much less than that killed under licence on rivers in an attempt to protect wild salmon stocks (estimated to be approximately 850 birds in 1983 and 1984, Anon. 1985). However the number killed at farms may be locally important. On Loch Awe for instance, two drakes were shot in 1986, one drake in 1987 and four drakes and two ducks in 1988. As only 16 drakes were counted in the whole of Argyll during the 1987 BTO survey and no more than 22 have ever been recorded in recent years, those killed at the farm probably represent a direct loss to the breeding population as they were shot during the period of pair formation and incubation. The effect could become more pronounced if persecution increased further. Within Scotland as a whole, although the freshwater cage production of rainbow trout has stabilized, that of Atlantic salmon smolts is increasing rapidly (DAFS 1986) and as a result increased conflict between the industry and Goosanders may be expected at sites which are important to the Goosander.

Red-breasted Merganser

Red-breasted Mergansers were far more common in the study area than Goosanders. They differed from the Goosanders by being present throughout the year and largely confined to the sea lochs, although some birds did move onto standing freshwaters to breed. They were not associated with fish farms either in the sea or freshwater but were often seen passing close to marine farms in the course of their feeding sessions. There were no reports of the birds causing damage to nets despite the fact that in many cases the design of sea cages was identical to those damaged by Goosanders at Loch Awe. These observations and the lack of evidence of any birds being killed during the study suggest that Red-breasted Merganser predation was not a problem at fish farms in Argyll.

Anti-predator netting

Underwater netting is used at almost all cage farms in an attempt to protect fish stocks.

Either a net bag or weighted sheets of netting are suspended outside the cage nets, but they are not always effective. The distance between cage and anti-predator nets is governed by the width of the cage walkway and is usually no more than 1 m. At this distance water currents and tides can push the nets together and allow potential predators (diving birds and seals) to reach the fish. In some cases cage sides have no walkways and so the cage and anti-predator nets are effectively suspended from the same structure leaving no gap between. Trials are needed to produce a more effective system for keeping the nets a suitable distance apart even in strong tides or currents. Present indications are that weighted sheets of netting alone are rather ineffective, even in conditions of little or no water current, as Goosanders at one freshwater site appeared able to dive beneath them to reach and tear the cage nets.

Acknowledgments

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Damage to fish by seabirds in the Moray Firth

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W.S. MacDONALD

Some of the fish caught during a trawling survey in the Beauly Firth bore marks which had been made by the bills of fish-eating seabirds. Of the 12 species of fish examined, only herring, sprat and whiting were affected. Tests with the bills of dead birds showed that the damage recorded in the Beauly Firth was entirely consistent with the fish having been captured by Guillemots, but which subsequently escaped during underwater manipulation. These are the first known records of the effects of birds on fish in a marine environment.

Introduction

While examining the fish caught during a trawling survey we noticed that some had unfamiliar wounds and/or scars. These marks, which consisted of one or more pairs of parallel or converging lines (Plate 1), were unlike the cuts and abrasions caused either by contact with the net or by the spines of other fish and invertebrates. Matching marks always occurred on each side of the body of the fish and we concluded that they were acquired when the fish escaped from the bill of a predatory bird. Because we had not previously seen this type of damage and did not know of any published reports of damage by birds to wild fish, we recorded the numbers and sizes of all bird-damaged fish in random samples from two trawl catches. This paper describes the nature and frequency of the damage, the species and size of the affected fish and considers the causes of the phenomenon.

Study Area and Methods

The study took place in the Beauly Firth, at the south-western end of the Moray Firth, in north-east Scotland. Throughout most of the Beauly Firth the water is less than 5 m deep but there is a trench of deeper water between the villages of North Kessock and South Kessock. Echo surveys by FRV *Goldseeker* on 15 and 16 March 1989 detected a concentration of fish close to the sea bed in the deeper part of the trench. To establish the identity of these fish, two five minute tows were made with a trawl fitted with a 12 mm mesh codend. All fish from one catch and in a 25% random sample of the other were identified to species, measured (to the cm below) and examined for signs of bird damage. A sample of the damaged fish was preserved in formaldehyde solution and taken to the Banchory Research Station of the Institute of Terrestrial Ecology, where the marks were matched against the bills of dead birds and compared with tracings of bill marks made by captive birds, to identify the species responsible for the damage.

Statistical tests to assess whether the incidence of damage was related to fish size are given in the Appendix. The scientific names of fish are given in Table 1 unless mentioned only in the text.

PLATE 1. Examples of bird-damaged sprat (top), whiting (middle) and herring (bottom) taken in the Beauly Firth in March 1989. *Note the notch in the belly of the uppermost sprat.*

Results

In most cases damage to the fish was superficial, in the form of pressure marks or shallow cuts. However, one sprat had deep cuts and three others had triangular notches in the ventral region (see Plate 1, upper fish) and their wounds, which had been recently inflicted, were so severe that these fish were unlikely to have survived for long. Many fish bore several sets of marks but we cannot say whether these represent several attacks on the same fish or repeated manipulation by the same bird.

Twelve species of fish were taken in the trawl but only herring, sprat and whiting had been damaged by birds (Table 1). It may be significant that herring and sprat are pelagic and whiting semi-pelagic, whereas the other species in the catches are predominantly bottom-living, although cod may occasionally be semi-pelagic (Wheeler 1978). However, it is not possible to decide whether these three species were preferentially attacked because their life style makes them more vulnerable to birds than bottom-living species or because, on the evidence of the numbers taken in the trawl, they were by far the most numerous fish in the area.

The incidence of damage to herring, sprat and whiting of each size class is shown in Table 2. There is a significant difference in the percentage damage to different size classes of herring[1], mainly due to a lack of damage to small fish (< 13 cm). Too few larger fish were caught to be able to say whether damage was less frequent for larger size classes. Much smaller numbers of sprat[2] and whiting[3] were examined and although a greater proportion of them were damaged, the sample sizes for the shorter fish were too small to detect a relationship between size and damage.

Discussion

The damage we observed was consistent with the fish having been held in the bill of a bird. The shape of many of the marks indicated that the fish had been attacked from below, which suggested that a diving species was responsible. A variety of fish-eating diving birds occurs in the inner Moray Firth in winter. However, when the fish were examined at Banchory it became clear that the marks were too small to have been made by large-billed birds such as Cormorant *Phalacrocorax carbo* and Shag *P. aristotelis* and there were no serrations, which eliminated Goosander *Mergus merganser* and Red-breasted Merganser *M. serrator*. The size and shape of the bill marks suggested that an auk was responsible and the most likely predator was the

TABLE 1. Species of fish examined and incidence of bird damage.

Species	Length range (cm)	Number examined	% damaged
Herring *Clupea harengus*	9-22	1862	3.1
Sprat *Sprattus sprattus*	9-14	417	3.8
Whiting *Merlangius merlangus*	10-19	461	8.9
Cod *Gadus morhua*	9-17	79	0.0
Hooknose *Agonus cataphractus*	6-13	12	0.0
Viviparous blenny *Zoarces viviparus*	9-21	43	0.0
Gunnel *Pholis gunnellus*	15-17	4	0.0
Sea stickleback *Spinachia spinachia*	14	1	0.0
Bull-rout *Myoxocephalus scorpius*	ó	1	0.0
Plaice *Pleuronectes platessa*	6-8	8	0.0
Flounder *Platichthys flesus*	10-18	7	0.0
Common dab *Limanda limanda*	14	1	0.0

TABLE 2. Length frequency distributions of the herring, sprat and whiting in the samples and the percentage at each length showing damage by birds.

Total length (cm)	Herring		Sprat		Whiting	
	Number examined	% damaged	Number examined	% damaged	Number examined	% damaged
10	19	0.0	56	1.8	2	0.0
11	30	0.0	86	4.7	26	0.0
12	291	0.0	113	6.2	109	9.2
13	790	3.7	142	2.8	125	8.8
14	523	3.8	20	0.0	117	9.4
15	173	4.6			61	11.5
16	22	0.0			16	12.5
17	3	0.0			4	0.0
18	1	0.0				
19	4	0.0			1	0.0
20	6	0.0				

Guillemot *Uria aalge* because this was the most numerous diving species in the area, with approximately 5000 individuals recorded in the Beauly Firth in early March 1989 (RSPB internal report).

Our data suggest that as many as 9% of whiting were damaged by birds, but several factors may have exaggerated this result. First, damaged fish may be more susceptible to capture by a trawl than intact members of the population. Second, although the inner Moray Firth is a nursery area for young gadoids and an important overwintering area for sprat and juvenile herring, these fish are not permanent residents. They enter the area in autumn and move to the open Moray Firth and beyond in springtime (Saville 1971). The fish shoals detected by *Goldseeker* in March 1989 were smaller than during comparable surveys in November 1988 and February 1989, so the fish sampled in March may have been amongst the latest fish to leave the area. The high incidence of damage may reflect the fact that the longer a fish remains in an area frequented by predators, the greater the probability that it will be attacked. Furthermore, damaged fish may be slower to emigrate.

Even though Guillemots can capture herring, sprat and gadoids as large as, and larger than, the fish we examined (Blake *et al.* 1985; Harris & Wanless 1985) our observations demonstrate that some fish escape. Experiments by Sanford & Harris (1967) with a captive Guillemot *U.a. californica* and live rainbow trout *Oncorhynchus mykiss* showed that the bird usually caught its prey underwater as a result of deliberate pursuit. Fish were always swallowed head-down, after they had been turned by a series of rapid biting-striking movements of the head. The captive bird had no difficulty in turning fish 7-10 cm long to a head-down position even when they had been caught by the tail. However, larger trout (13-23 cm) could only be turned if they had been grasped between the head and the pectoral fins. Nearly all fish of this size that had been caught posterior to the pectoral fins escaped as the bird tried to manipulate them. Our field data agree with these observations; most of the bill marks were between the pectoral fins and the tail (Plate 1) and all the damaged fish in our samples were relatively large (>10 cm).

It is not inherently surprising that some of the fish captured by diving birds manage

to escape and may suffer damage in the process. However, it is somewhat surprising that the literature contains very few reports of damage to wild fish by birds. Smith & Lemley (1986) found that 16% of a population of fathead minnow *Pimephales promelas* had been damaged by birds and Reimchen (1988) found "aviscars" on the bodies of 4.5% of the sticklebacks *Gasterosteus aculeatus* in a Canadian lake. Both records are from freshwater and we believe that our observations may be the first in the marine environment.

It is difficult to assess the implications of our findings. We have shown that some of the fish captured by Guillemots escape, but may be so badly injured as to be unlikely to survive. It could be argued, therefore, that as a consequence of unsuccessful attacks on fish that are difficult to handle more fish are killed by Guillemots than are necessary to satisfy the birds' energy demands. On the other hand, if injured fish are more likely to be caught by Guillemots and other fish-eating birds, fewer of the uninjured members of the population will be eaten. Interactions between predators and prey are complex and are best studied on a community basis.

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APPENDIX. Results of statistical tests

1. Herring. Chi-square = 12.76, 3df, $P<0.01$
2. Sprat. Chi-square = 2.45, 2df, ns
3. Whiting. Chi-square = 0.83, 3df, ns

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Kittiwake attendance patterns during chick rearing on the Isle of May

S. WANLESS AND M.P. HARRIS

Up to 50% of broods of young Kittiwakes on the Isle of May were sometimes left unattended, presumably when both adults were away feeding. The percentage of unattended broods was highest in 1988 when breeding success was 20% lower than in other years. Broods of three were more likely to be left than broods of two, which in turn were left more often than single chick broods. Very few of these neglected young were taken by predators.

Introduction

During the late 1980s and particularly in 1988 there were reports of large numbers of unattended Kittiwake *Rissa tridactyla* chicks in some Scottish colonies (Heubeck, Harvey & Robertson 1987, Harris & Wanless 1989). Breeding success was also lower than has been usual in recent years and the implication was that the birds were short of food during the chick rearing period. In 1986, 1988 and 1989 we made frequent daily counts of the number of broods of Kittiwake chicks that were left unattended on the Isle of May. This paper describes the colony attendance patterns within each chick rearing period and also compares the data from the three years in relation to variations in breeding success.

Study Area and Methods

The study was carried out on the Isle of May, Firth of Forth, Scotland at a colony of about 6000 pairs of Kittiwakes (unpublished data). Checks of 50-150 nests were made around midday from 22 June to 21 July 1986, 4-12 July 1988 and 13 June-14 July 1989. During each check the number of broods of one, two and three chicks that were a) unattended, and b) had at least one adult present were recorded. Although this distinction appeared to be unambiguous, in practice it was confounded by two factors. First, Kittiwakes do not always sit on the nest rim but sometimes stand on a nearby ledge, and second, nests containing neglected young are sometimes visited by Kittiwakes that are not the chicks' parents. The first factor will tend to exaggerate the percentage of unattended young and the second will result in an underestimation of chick neglect. However, in the field we considered that it was usually possible to identify these two events since the behaviour of parent and intruder Kittiwakes towards the chicks differed markedly in that intruders were often very aggressive and this resulted in the chicks adopting a very low crouched posture in the nest. Checks ceased prior to the main fledging period as work in Britanny has shown that after fledging juveniles often move away from their own nests either to the cliff-top or to other nests, where they may even be fed by other adults (E. Danchin pers. comm.). Data on nesting success come from monitoring plots dispersed through the Isle of May colony (Harris 1987).

TABLE 1. Proportions of broods of one, two and three Kittiwake chicks which were unattended by an adult on eight checks during June and July 1986. The mean value, after the first unattended chick was recorded, is also shown.

	Broods of one		Broods of two		Broods of three	
	number checked	% unattended	number checked	% unattended	number checked	% unattended
22 June	18	0	58	0	2	0
27 June	16	0	56	0	2	0
3 July	13	0	80	0	6	0
8 July	33	0	141	1	8	0
11 July	40	0	128	2	7	12
14 July	42	0	127	2	6	17
17 July	53	6	111	26	8	50
21 July	58	0	98	4	8	0
Mean unattended (SE)		1.2 (1.2)		7.0 (4.8)		15.8 (9.2)

Results

Annual attendance patterns

Very few broods were left unattended in 1986 and only on one day (17 July) were appreciable numbers of neglected chicks recorded (Table 1). There was a suggestion that adults were present with broods of three less often than with broods of two, which in turn were attended less than broods of one, but the differences were not significant[1]. The timing of breeding was normal for the Isle of May and breeding success was very high at 1.3 young fledged per completed nest (Table 2).

In 1988, no systematic checks for unattended broods were made until early July when we realized that the number of adults at the colony was greatly reduced and that large numbers of chicks were unattended. Thus, of 79 broods checked on 2 July, 30 (38%) did not have an adult present and the following day the proportion had risen to 52% (n = 90). The number of chicks in each brood was not recorded on these two days. Daily checks over the next nine days showed that, on average, 48% (SE 4) of broods were unattended. On any day, broods of two were significantly more likely to be left unattended than were single chicks (Fig. 1); the mean proportions of two and one were 66% (SE 4) and 31% (SE 4) respectively[2]. There were no nests with three chicks. Although the proportion of unattended broods of one and two chicks showed rather similar day to day variations (Fig. 1) the relationship was just not statistically significant[3]. The timing of breeding was very similar to that in 1986 but breeding success was relatively low at 0.8 young fledged per nest.

In 1989 no unattended broods were recorded from 13 to 23 June in the areas studied although a brood of three chicks elsewhere in the colony was left alone from 1230-1330 h GMT on 20 June and the chicks were again unattended when the nest was checked six hours later (R. Proctor pers. comm.). From 24 June onwards the incidence of unattended broods increased gradually and reached a peak of 55% on 11 July (Fig. 2). After 11 July the proportion of neglected broods of one and two declined slightly; there were too few broods of three on which to make a similar assessment. Daily checks from 24 June to 14 July showed that, on average, 25% (SE 3) of broods were unattended. As in previous years the likelihood of an adult being present on the nest decreased with brood

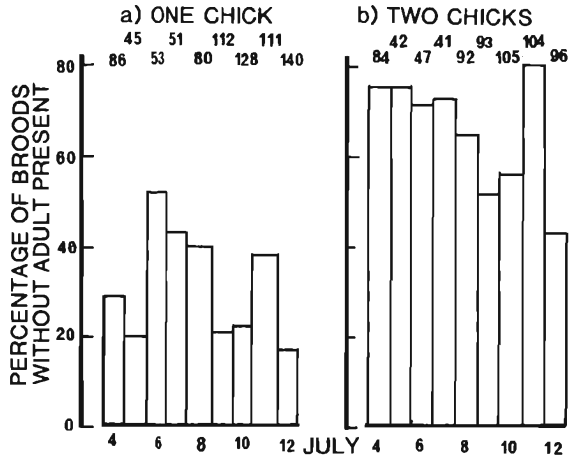

FIGURE 1. Percentage of broods of a) one, and b) two Kittiwake chicks without an adult present on the Isle of May 4-12 July 1988. *Daily sample sizes are shown above each column.*

TABLE 2. Timing of breeding and breeding success of Kittiwakes on the Isle of May in 1986, 1988 and 1989.

	1986	1988	1989
(a) Timing of breeding			
First egg date	9 May	6 May	27 April
First young fledged*	13 July	14 July	1 July
Most young fledged	26 July-10 August	26 July-10 August	17-25 July
(b) Breeding success			
Number of sample areas	16	15	15
Total nests followed	1133	1278	1327
Mean young fledged per completed nest (SE)+	1.3 (0.04)	0.8 (0.08)	1.1 (0.07)

Note: *Dates for first young fledged refer to the whole of the Isle of May colony. Observations in the study plots ceased once young in them started to leave their nests.
+The mean nesting success (SE) is the mean for all the sample areas.

size and broods of two were more than twice as likely to be left alone as single chicks, while broods of three were twice as likely to be left as broods of two. Both these differences were significant[4]. Daily proportions of unattended broods of one, two and three chicks were significantly correlated[5]. Breeding was 10-14 days earlier in 1989 than in 1986 and 1988, and breeding success was good at 1.1 young fledged per nest.

Between-year comparisons

Differences in the frequency and dates of checks in the three seasons hamper between year comparisons but the situation was more severe in 1988 than in 1989 (Figs. 1 and 2) while in 1986 unattended chicks were relatively uncommon. On four of the nine days sampled in 1988 more than 30% of single chicks were alone while on six days more than 60% of broods of two were unattended. Despite the longer sampling

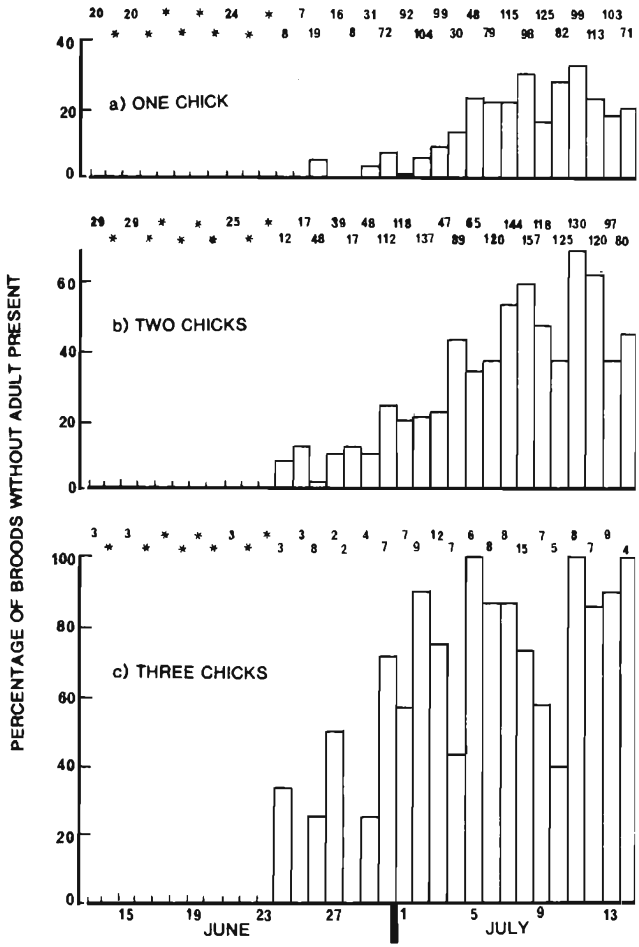

FIGURE 2. Percentage of broods of a) one, b) two and c) three Kittiwake chicks without an adult present showing the onset of brood neglect on the Isle of May on 24 June 1989. *Daily sample sizes are shown and days with less systematic observations are indicated by asterisks.*

period in 1989, these levels were recorded on only one and two days respectively, while in 1986 values never approached these figures.

Chick neglect commenced about two weeks earlier in 1989 than in 1986. The precise timing of the start in 1988 was unknown but it was certainly earlier than 1986. However, the timing of breeding also varied by about 10 days over the three years (Table 2), and thus adults started to leave their chicks unattended at approximately the same relative time within a season when the majority of young were 3-4 weeks old.

Discussion

Attendance patterns of adult seabirds during the breeding season are likely to be closely related to food availability. Thus when food

is abundant both members of the pair might be expected to be present together at the nest for part of the day, and as food becomes scarcer this time will be reduced progressively until a critical point is reached at which both birds need to be away simultaneously to meet their own and their chicks' energy requirements. Typically a Kittiwake nest is attended by at least one adult from the time that it is built until the young fledge, although well grown chicks may occasionally be left overnight (Galbraith 1983). Until recently large-scale neglect of chicks during the day appears to have been rare in Britain, but since 1985 it has been reported from several colonies in Scotland and north England and this has coincided with years of below average breeding success (Heubeck *et al.* 1987, Harris & Wanless 1989).

Our more detailed observations on the Isle of May indicated a close correspondence between chick neglect and reproductive output both in terms of the period of time over which unattended broods were recorded within a season and the average daily proportion of broods without adults.

In all three years the onset of chick neglect coincided with the majority of young reaching 3-4 weeks of age, and broods of two were almost twice as likely to be left alone as single chicks. Both these observations suggest strongly that chick neglect was directly related to increased energy requirements and thus adults with the biggest demands, i.e. those with two medium-large chicks, were most likely to leave their young. Kittiwakes with well-grown chicks have sometimes been recorded standing on ledges near the nest from where they will defend their young (Hatch & Hatch 1988) but we were confident that this explanation did not apply to the Isle of May since there were very few birds present in the colony or in roosts and it seemed probable that the absent birds were away at sea, presumably foraging. While the proportion of unattended broods appeared to provide an index of how hard adults were working to sustain themselves and provision their young, it was not clear whether it reflected any reduction in the food intake of chicks during the period of neglect. Indeed Galbraith (1983) found that broods that were left unattended overnight received significantly more feeds the next morning than those where one adult had been present. Therefore low colony attendance should not by itself be taken as evidence of reduced food intake of the chicks.

In the present study we simply considered how average values for the percentage of unattended broods varied in relation to annual breeding success and made no attempt to examine the consequences of different levels of attendance on the breeding success of individual pairs. We do not know for certain whether in any year chick loss was greater among unattended chicks or whether their growth differed from broods which had adults present. Unattended broods are potentially at risk from a) predators, b) other Kittiwakes, c) adverse weather, and d) becoming seriously fouled by the droppings of Kittiwakes nesting above them. Herring Gulls *Larus argentatus* are well known as predators of young Kittiwakes (e.g. Barrett & Runde 1980, Galbraith 1983, Chapdelaine & Brousseau 1989) and during this study the Isle of May had a breeding population of just under 2000 pairs of Herring Gulls. However, during thousands of hours of observation we have never seen a Herring Gull take a young Kittiwake from a nest, although both Herring Gulls and Great Black-backed Gulls *L. marinus* quickly kill and eat any chicks which fall into the sea. This lack of predation of unattended young is in marked contrast to some other areas such as Shetland where gulls, Ravens *Corvus corax*, and Great Skuas *Catharacta skua* have been recorded killing large numbers of unattended chicks (Heubeck *et al.* 1987).

During more detailed observations of Kittiwake behaviour in 1989, it became apparent that unattended nests were often visited by Kittiwakes that were not the rightful owners. Some of these intruders

made prolonged attacks on the chicks, repeatedly pecking them on the head and neck. On other occasions they appeared to show aberrant nest building behaviour, trampling up and down on the chicks' backs in the same manner as birds usually incorporate mud and vegetation into the nest structure. Young were frequently very dishevelled after such encounters but we had no definite records of chicks dying as a result. The phenomenon also appears to have been widespread in Shetland in recent years (M. Heubeck pers. comm.).

The plumage of unattended chicks sometimes became soiled after heavy rain, particularly when nests were situated in natural drainage channels or under other Kittiwake nests. Intuitively we felt that such chicks would be more susceptible to chilling and would have higher energy requirements compared to young whose plumage was in good condition but again we have no direct evidence of differential mortality.

Kittiwakes on the Isle of May feed their young mainly on sandeels *Ammodytes* spp (Galbraith 1983, Harris & Wanless 1989) and thus changes in adult attendance patterns are likely to reflect variations in the distribution and/or abundance of these fish in the top few centimetres of the sea. If as seems likely, conditions are becoming less favourable for seabirds in the North Sea, it will become increasingly important to obtain indices of food availability during the breeding season for the various species.

Acknowledgments

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APPENDIX. Results of statistical tests

1. Wilcoxon signed rank test, n.s.
2. Paired t-test, mean difference = 35% (SE 4), $t = 9.01$, $n = 9$, $P < 0.001$
3. Angular-transformed data, $r = 0.591$, $df = 7$, $P < 0.1$
4. Mean difference between percentage of broods of one and two chicks unattended = 18% (SE 2), $df = 20$, $t = 7.7$, $P < 0.001$, and between broods of two and three = 30% (SE 5), $df = 20$, $t = 5.7$, $P < 0.001$
5. Angular-transformed data; broods of one and two, one and three, and two and three, $r = 0.86$, $r = 0.72$, $r = 0.66$ respectively, 19 df all $P < 0.001$

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(Ms. received 1 September 1989)

Feral Greylag Geese and other breeding wildfowl in south-west Scotland during 1988

P.J. SHIMMINGS, M. OWEN AND J.L. BURN

The population of feral Greylag Geese in south-west Scotland was the first to be established in Britain and Ireland. It is also the largest, with a total of 1469 birds in June 1988, and accounts for 10% of the total estimated for Britain and Ireland (13,700 in 1985-86). The population is still centred around the area where birds were first released at Lochinch, near Stranraer. White Loch (Lochinch) held large numbers of moulting and breeding Greylags with young in June, and the majority of birds during September. Conflicts may arise with local farmers who wish to control Greylags, but even the largest concentrations found are unlikely to cause much of a problem. The Canada Goose population has also increased, from 80 birds in 1976 to 609 in 1988. The most abundant duck found breeding was Mallard but eight other species also bred at the region's lochs.

Introduction

Greylag Geese *Anser anser*, which once bred over much of Britain (Owen & Salmon 1988), were reintroduced to south-west Scotland in the early 1930s (Young 1972a). The first birds to be released were reared from eggs of the native Greylag population on South Uist (Outer Hebrides) and released as young birds at Lochinch, near Stranraer (Dumfries and Galloway).

Through initial protection and further introductions, numbers increased. Young (1972a) estimated a total population of 1160 Greylags during a survey of all wetlands in south-west Scotland in 1971. Owen & Salmon (1988) indicated that there was little information since 1971, but estimated that there were perhaps 1500 birds in 1985-86.

South-west Scotland is visited in winter by Greylags from Iceland from early October onwards and the two populations probably intermingle and are inseparable until the migrants leave in April. Therefore the feral Greylag population can only be censused in summer after the migrant Greylags have left.

The main aims of the 1988 survey were 1) to count the feral Greylag population in Dumfries and Galloway, 2) to enable estimation of the number of wintering Icelandic birds by accounting for the feral Greylags in the region, and 3) to count all other breeding wildfowl on the lochs.

Methods

Survey work was carried out from 10-24 June and 3-18 September 1988. Figure 1 shows the areas visited in June to check for the presence of Greylags; only areas thought to hold post-moulting geese were visited in September.

During June all waterbodies in south-west Scotland likely to hold Greylags were visited to locate breeding and moulting

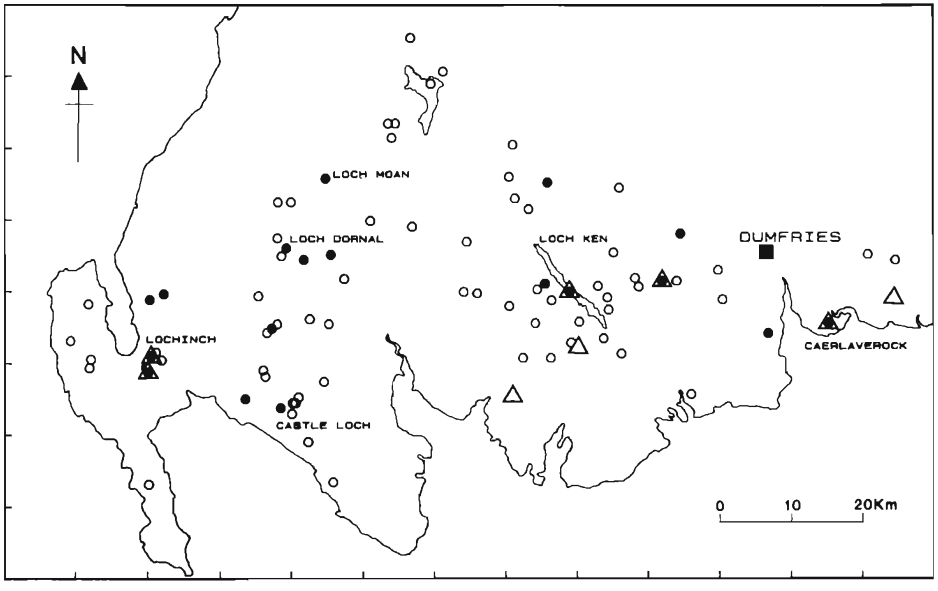

FIGURE 1. Sites visited in the 1988 survey. Filled circles - Greylags present in June; open circles - no Greylags found in June; triangles - Greylags found in September.

flocks. At this time of year geese are either moulting or accompanying flightless young and tend to stay close to water to minimize predation risks. A total of 82 sites (74 in Dumfries and Galloway and 8 in South Ayrshire) were visited in June. Lochs were viewed from several vantage points and each site was surveyed on a single visit on one day. At each site the numbers of adults with young and unaccompanied adults were recorded. The minimum number of adults which bred successfully was estimated by counting the total number of adults accompanying young, regardless of whether these were pairs with individual broods or adults attending creches of goslings. This could perhaps give an underestimate as broods sometimes amalgamate and goslings of one pair are taken over by another.

During September an attempt was made to locate the main post-breeding and post-moulting areas used by Greylags. It was anticipated that the geese would be more concentrated in September and only selected sites previously reported to hold Greylags in late autumn/early winter were visited. This included most of the areas where the birds were found in June, except for Loch Moan and the Loch Dornal/ Ochiltree complex.

Note was also made of all breeding wildfowl in June, and the number of other geese and Mute Swans *Cygnus olor* in September.

Results

Greylag Goose

Population size

Greylags were found at 18 sites in June and at 9 sites in September. In June a total of 1469 Greylag (adults and young) was found (Table 1). The main concentrations were at White Loch (Lochinch), Castle Loch, Loch Dornal, and Loch Moan (Fig. 1). In September, 1190 Greylags (80% of the June

TABLE 1. Number of feral Greylag Geese (adults and young) in south-west Scotland in June and September 1988.

Site	June	Sept
Loch Ree	1	-
Penwhirn Reservoir	15	-
White Loch	511	910
Black Loch	0	2
Soulseat Loch	76	4
Loch Dornal	128	-
Loch Ochiltree	23	-
Loch Moan	104	-
Loch Heron	11	-
Whitefield Loch	18	-
Castle Loch	433	0
River Cree	7	-
Bush Loch	-	16
Loch Ken	42	122
Glentoo Loch	0	19
Mossdale Loch	7	0
Lochinvar	23	-
Glenkiln Reservoir	46	-
Auchenreoch Loch	7	27
Loch Kindar	4	-
Caerlaverock	13	65
Kinmount Ponds	0	25
TOTAL	1469	1190

- = not visited

total) were found, the main concentrations then being at White Loch and Loch Ken.

Breeding

Breeding was confirmed at 16 of the 18 sites where Greylags were recorded in June (Table 2). In all, 175 birds were classed as successful breeders, this being 15.7% of the adult population. This suggests a minimum of 88 successful breeding pairs in 1988. The main breeding sites identified were White Loch (26 successful pairs), Loch Dornal (21 pairs), Soulseat Loch (10 pairs), Loch Moan (6 pairs), and Loch Ken (6 pairs).

A total of 354 young was located in June (Table 2), which is 24% of the total Greylag population found at that time of year; 32 broods were identified and 133 young were within broods, giving a young:adult ratio of 2.1:1. A total of 10 creches, where broods could not be separated, contained a total of 221 goslings which were accompanied by 111 adults, giving a young:adult ratio in the creches of 2.0:1. The similarity of these ratios for broods and creches indicates that creches comprised amalgamations of successful breeders and their young. Brood sizes recorded in the field ranged from 1 to 9 goslings; those with 8 or more may represent amalgamated broods. Creche sizes ranged from 11-56 goslings per creche.

Samples of flocks at five localities in September (October at Caerlaverock) included 27% juveniles, which was close to the proportion (24%) in June (Table 3). Juvenile mortality is probably low, and even if all the geese not located in September were adults, juvenile mortality then would be 9% between June and September. Assuming that adult mortality is lower than juvenile mortality, it seems that most birds not found in September had been overlooked rather than died. Young (1972a) found that juvenile mortality prior to fledging was low.

Failed- and non-breeding Greylags were found to form moulting concentrations, and moulting flocks were observed at 12 of the 18 sites where Greylags were present in June. Large concentrations of 30 or more birds were recorded at White Loch, Loch Dornal and Loch Moan, which are also important breeding sites, whereas Castle Loch was not an important breeding site (only two pairs with young) but held the largest number of moulting failed/non-breeders. Glenkiln Reservoir also had a sizeable moulting flock, but had only three pairs of young.

Post-breeding

During September visits were made to sites believed to hold Greylags at that time of year. The sites surveyed included Lochinch, Castle Loch, and Loch Ken, all of which held large numbers of Greylags in June (Table 1). Visits were not made to the Loch Dornal/Ochiltree area in September.

TABLE 2. Counts of breeding adults, non/failed breeders and young feral Greylag Geese in south-west Scotland in June 1988.

Site	Total number of adults	Adults with young	Failed/ non-breeders	Total young	Young in broods (number of broods)	Young in creches (number of creches)
Loch Ree	1	0	1	0	0	0
Penwhirn Reservoir	4	4	0	11	0	11(1)
White Loch	399	51	348	112	16(6)	96(5)
Soulseat Loch	20	20	0	56	0	56(1)
Loch Dornal	80	42	38	48	12(3)	36(2)
Loch Ochiltree	10	4	6	13	13(2)	0
Loch Moan	82	12	70	22	22(6)	0
Loch Heron	4	2	2	7	7(1)	0
Whitefield Loch	4	4	0	14	14(2)	0
Castle Loch	428	4	424	5	5(2)	0
River Cree	2	2	0	5	5(1)	0
Loch Ken	20	12	8	22	0	22(1)
Mossdale Loch	2	2	0	5	5(1)	0
Lochinvar	11	4	7	12	12(2)	0
Glenkiln Reservoir	37	6	31	9	9(3)	0
Auchenreoch Loch	2	2	0	5	5(1)	0
Loch Kindar	4	0	4	0	0	0
Caerlaverock	5	4	1	8	8(2)	0
TOTAL	1115	175	940	354	133	221

At each site the number of Greylags present was recorded. Numbers at White Loch (Lochinch) had increased from 511 birds in June to 910 in September, and there was also an increase at Loch Ken where 42 geese were counted in June and 122 in September. However at Castle Loch, there were 433 geese in June, but none in September (Table 1).

Other Geese

During June 1988 a total of 363 Canada Geese *Branta canadensis* was found at 10 sites (Table 4). Breeding was recorded at five of the 10 sites visited in June. It was not possible to determine brood size for Canada Geese in most cases as broods were often in large creches, and some flocks consisted of large groups of what were probably non-breeding adults. Not all sites likely to hold breeding and/or moulting Canada Geese were visited in June but it is known breeding occurs regularly at Castle Loch, Lochmaben and at three sites in the River Annan valley (Shimmings unpub.).

In September, Canada Geese were found at 5 sites and numbers had increased to 609 birds (Table 4). The increase since June may have been due either to birds having moulted on river systems in south-west Scotland not surveyed in June, or to an influx of birds from further afield. The Canada Goose population in south-west Scotland has increased markedly from the 80 birds counted in July 1976 (Ogilvie 1977) and new sites have been colonized.

Other species of goose represent stragglers from wintering flocks. The hybrids recorded (Table 4) were 6 Greylag/Canada Goose and 1 Barnacle Goose *Branta leucopsis*/Canada Goose.

TABLE 3. Number of juvenile Greylags in sample counts at five sites in September 1988.

Site	Juveniles	Sample Count	Total Present
White Loch	221	770	910
Loch Ken	7	43	122
Auchenreoch	5	27	27
Kinmount	5	25	25
Caerlaverock	15	71*	71
TOTAL	253 (27% juveniles)	936	

* Sample in October when total had increased from the 65 in September (Table 1).

TABLE 4. Counts of Canada Geese in south-west Scotland in June and September 1988.

Site	June		Sept
	Adult	Young	Total
White Loch	87	31	71
Loch Dornal	25	10	-
Castle Loch	1	0	0
Loch Ken	1	0	5
Colvend Loch	12	0	-
Glenkiln Reservoir	38	0	0
Milton Loch	2	0	0
Loch Kindar	21	4	0
Kelhead Quarry	110	16	0
Kinmount Ponds	4	1	186
Winterseugh Farm	0	0	182
Lochmaben Lochs	-	-	165
TOTAL	301	62	609

- not visited.

Other species:

White Loch; 2 Pinkfooted Geese *Anser brachyrhynchus*, 1 Bar-headed Goose *A. indicus*, 2 Barnacle Geese, 6 hybrid geese
Cults Loch; 22 Pinkfooted Geese
Loch Dornal; 1 Barnacle Goose
Soulseat Loch; 1 Pinkfooted Goose

Mute Swan

Not all sites likely to hold Mute Swans were visited during the survey and pairs and moulting birds on river systems were certainly missed. Mute Swans were found at 12 sites in June and 7 sites in September (Table 5). Average brood size was 3.4 young per brood (n = 13 broods) in June and 3.1 in September (n = 7).

The main sites identified for Mute Swans were Carlingwark Loch (breeding and wintering), Auchenreoch Loch (breeding), and Milton Loch (moulting).

Ducks

The number of duck broods found on a single visit to each site is shown in Table 6. Some ducks, particularly sawbills, may have been missed as rivers were not surveyed. Mallard *Anas platyrhynchos* was the most abundant breeding duck. Loch Ken is locally important, with broods of six different species present in June 1988.

Discussion

The population of Greylag Geese in south-west Scotland has increased from 880 birds in 1966 (Young 1972a) to 1469 in 1988, an average increase of 2.4% per annum. This is considerably less than the 13% increase recorded in Britain as a whole (Owen & Salmon 1988) and probably due to human persecution. Regular complaints are made by farmers in south-west Scotland that Greylags cause damage to grasslands. The complaints intensify in spring, and applications are made and granted to shoot the geese. Feral Greylags are undoubtedly shot during the winter when they mix with wintering Icelandic Greylags.

Eggs have been collected from south-west Scotland to establish flocks elsewhere in Britain (Owen & Salmon 1988). Egg-collecting for this purpose, and collecting as a method of goose control, has probably kept the population in check. Both shooting and egg-collecting are probably limiting population growth, as south-west Scotland contains much suitable breeding habitat for Greylags.

TABLE 5. Counts of Mute Swan in south-west Scotland during June and September 1988.

Site	June			September		
	Adult	Young	Broods	Adult	Young	Broods
Loch Connell	2	0		-	-	
Lochnaw	2	2	2	-	-	
Soulseat Loch	2	2	1	2	3	1
Bush Loch	-	-		2	0	
Loch Mannoch	2	0		-	-	
Loch Ken	10	2	1	13	4	2
Erncrogo Loch	2	0		-	-	
Carlingwark Loch	37	17	3	79	13	3
Threave	17	0		3	0	
Milton Loch	47	0		21	0	
Auchenreoch Loch	10	16	5	24	2	1
Lochrutton	1	0		-	-	
Loch Kindar	28	3	1	-	-	
TOTAL	160	44	13	144	22	7

- not visited

TABLE 6. Breeding ducks in south-west Scotland in June 1988.

Site	Number of broods								
	Wi	Te	Ma	So	Tf	Go	Rb	Gs	Sh
Loch Ree		1							
Penwhirn Reservoir			1						
White Loch			6						1
Cults Loch			1						
Soulseat Loch			1						
Loch Maberry			1						
Loch Moan			1						
Barhapple Loch		1	1						
Mochrum Loch			1						
Loch Trool						1		1	
Loch Grannoch		1	1						
Loch Skerrow			1						
Loch Ken	1		9	1			1	1	1
Erncrego Loch			2						
Carlingwark Loch			1						
Auchenreoch Loch			4		1				
TOTAL	1	3	31	1	1	1	1	2	2

Wi, Wigeon *Anas penelope*; Te, Teal *A. crecca*; Ma, Mallard *A. platyrhynchos*; So, Shoveler *A. clypeata*; Tf, Tufted Duck *Aythya fuligula*; Go, Goldeneye *Bucephala clangula*; Rb, Red-breasted Merganser *Mergus serrator*; Gs, Goosander *M. merganser*; Sh, Shelduck *Tadorna tadorna*.

Greylag breeding success in 1988 was similar to that for the 1963-71 period (Table 7). Neither the proportion of the population breeding nor the proportion of young were significantly different between the two surveys. The brood size is also remarkably similar, an average of 4.1 (range 3.6-4.6 in different years) between 1963-71 and 4.2 in 1988. This suggests that density-dependent effects have not yet begun to operate to reduce productivity, a conclusion supported by the fact that the population has spread little from the areas it occupied in 1971.

TABLE 7. Percentage of feral Greylags with young, failed/non-breeders, and young geese in south-west Scotland in 1966, 1968, 1971 and 1988.

Year	Adults with young (%)	Failed/non-breeders (%)	Young (%)
1966	16	59	25
1968	21	54	25
1971	22	52	26
1988	12	64	24

1966, 1968, 1971 data from Young (1972a).

By September, Greylags moved from their main moulting site at Castle Loch. These birds may have returned to White Loch following moult. In the 1960s Young (1972a) found that Greylags moved from the Lochinch area to their moulting sites. Then the main moulting site was at Loch Ochiltree which held up to 300 moulting birds. During the 1980s however, pressure from angling has increased at Loch Ochiltree. The breeding pairs from there may well be those now using Loch Moan (G. Shaw pers. comm.), and the moulting flock at Castle Loch may result from birds abandoning Loch Ochiltree. There was no moult gathering at Castle Loch in 1962-71 (Young 1972a).

The extent of movement during the winter is not known, but once established in their winter haunts the Greylag flocks probably only move short distances. Greylags move little, even during periods of severe weather (Owen *et al* 1986). Breeding feral Greylags disperse in March and laying is at the end of March/early April. Because the largest concentration of feral Greylags is in the Lochinch area during September-March this is the time when most agricultural damage might occur in that area and when any complaints might be justified. As many of the birds move to other sites to breed from April onwards, this reduces the agricultural impact during the important spring growing period.

In recent years south-west Scotland has held in the region of 8000 Greylag in winter out of a total wintering population of 100,000-150,000. Although making a sizable contribution (20%) to the local flocks, feral birds within the range of migratory Greylags (Scotland, N. Cumbria and Northumberland) are of negligible importance and come well within the counting errors of the November census. It seems reasonable therefore that, as has been the practice, feral birds are disregarded when considering the dynamics of the Icelandic birds.

The 609 Canada Geese found in 1988 represented an increase both in total numbers and range since 1976, when only 70 were found at two sites.

Acknowledgments

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The breeding birds of some built-up areas in south-east Scotland

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Territory mapping showed densities of breeding birds (excluding feral pigeon, House Sparrow and Starling) ranged from 0.25/ha in high-rise developments and 3.9/ha in post-war estates with individual gardens, to 9.0/ha in the Edinburgh Botanic Garden. House Sparrow and Starling densities were estimated at 3.6/ha and 0.9/ha respectively in the estates with gardens.

Species diversity was poor, especially among the high-rise housing, except where relict woodland persisted. Houses with small, individual gardens had only four common species: Dunnock, Blackbird, House Sparrow and Starling. Nearly 30 species held territory in the Botanic Garden, but warblers, buntings and several finches were absent. It is argued that the value of gardens to birds can be exaggerated and more attention should be paid to those areas of scrub and wood edge within towns which are often threatened by development or landscaping.

Introduction

Most of us live in towns and spend more time looking at birds in or near built-up areas than in any other habitat. Quantitative accounts of the breeding bird communities of built-up areas are still rather scarce and, in Britain, have mostly been carried out in the southern half of England (Simms 1975) and in parks or pre-war (1939) suburban estates with fairly large gardens. Housing patterns are rather different in Scotland, which has different building regulations and a higher ratio of local authority housing than in England. This is now changing but even the newer, private estates have much smaller gardens than those studied in London suburbs by Simms and others.

This paper describes the results of bird census work in several areas of modern (post-1945) housing in Edinburgh and East Lothian. For comparison, birds in the Royal Botanic Garden, Edinburgh were also censused. This is an expertly maintained area of trees, shrubs and other horticultural features which probably represents the optimum type of garden for birds that also satisfies human desire for neatness.

Study areas

There were three study sites:

1. A 60.4 ha area of low-rise housing of one or two storeys in Tranent, East Lothian, 20 km east of Edinburgh. All the houses were built after 1945 and most have a garden. The area includes local authority housing built in three stages since 1945 and featuring house types found commonly through central Scotland. The earliest style comprises two storey houses which are semi-detached or in blocks, mostly with privet *Ligustrum ovalifolium* hedges (Plate 1). The

PLATE 1. Post-war council housing at Tranent with privet hedges important to nesting Blackbirds.

next stage comprises terraced housing with smaller gardens, wooden rail fences and areas of grassy open space (Plate 2). The newest stage is a mixed development, recently landscaped with beds of shrubs such as *Berberis spp.*, *Cornus spp.* and small trees, mostly not of native origin. There is also a private housing estate started around 1970 and not yet completed, with a similar density of houses to the adjacent council developments. The owner-occupier houses are of several designs and laid out in terraces or low-rise blocks; all have gardens but only single rail fences, though many now have shrubs or hedges, notably of hybrid cypress x*Cupressocyparis leylandii* (Plate 3).

2. A 118.8 ha area of high-rise housing in Wester Hailes, Edinburgh. Wester Hailes is a large (*c.*18,000 people) suburban estate built in Edinburgh by the local authority after 1960. House types vary from high-rise blocks to smaller units but only a minority of houses have their own gardens, and open space consists mainly of grass with a few beds planted with bushes (Plate 4). There are also a few mature trees which pre-date the estate, and two scrubby areas. One of these is on the edge of a railway and the other is an area in which some native deciduous trees and bushes exist as a relict on one side of the estate.

3. The Royal Botanic Garden, Edinburgh. This famous garden of 30 ha has lawns, shrubberies, trees, a rock garden and a pond. As the emphasis is on maintaining a plant collection there are few parts that are regularly cropped or used for displays of seasonal, annual flowers (Plate 5).

PLATE 2. More recent council housing at Tranent with modern fencing instead of hedges.

PLATE 3. Owner-occupier housing at Tranent built in the 1970s; the limited fencing has encouraged the planting of a variety of trees and bushes.

PLATE 4. Part of the Wester Hailes Estate, Edinburgh, where most houses do not have gardens.

PLATE 5. The Royal Botanic Garden, Edinburgh.

TABLE 1. Number of birds holding territory in three urban areas of Lothian, south-east Scotland, in 1986.

Species	Royal Botanic Garden	Tranent	Wester Hailes
Little Grebe *Tachybaptus ruficollis*	1	0	0
Mallard *Anas platyrhynchos*	1	0	0
Sparrowhawk *Accipiter nisus*	1	0	?
Moorhen *Gallinula chloropus*	1	0	0
Woodpigeon *Columba palumbus*	7	1	0
Collared Dove *Streptopelia decaocto*	6	5	0
Tawny Owl *Strix aluco*	1	0	?
Swallow *Hirundo rustica*	1	0	0
House Martin *Delichon urbica*	0	36	?
Pied Wagtail *Motacilla alba*	0	0	1
Wren *Troglodytes troglodytes*	6	0	1
Dunnock *Prunella modularis*	39	32	5
Robin *Erithacus rubecula*	32	2	1
Blackbird *Turdus merula*	52	146	5
Song Thrush *Turdus philomelos*	19	5	1
Mistle Thrush *Turdus viscivorus*	1	0	0
Whitethroat *Sylvia communis*	0	0	1
Willow Warbler *Phylloscopus trochilus*	0	0	1
Goldcrest *Regulus regulus*	6	0	0
Coal Tit *Parus ater*	6	0	0
Blue Tit *Parus caeruleus*	29	2	4
Great Tit *Parus major*	9	0	0
Magpie *Pica pica*	1	0	0
Crow *Corvus corone*	1	2	1
Chaffinch *Fringilla coelebs*	28	1	3
Greenfinch *Carduelis chloris*	17	5	4
Goldfinch *Carduelis carduelis*	1	0	0
Linnet *Carduelis cannabina*	0	0	2
Bullfinch *Pyrrhula pyrrhula*	3	0	0
Hawfinch *Coccothraustes coccothraustes*	1	0	0
TOTAL TERRITORIES	270	237	30
Density/ha	9.0	3.9	0.25
Feral pigeon *Columba livia*	PNC	0	PNC
House Sparrow *Passer domesticus*	32	215	PNC
Starling *Sturnus vulgaris*	22	55	PNC

1. The last three species are not included in territory totals or densities.
2. PNC = Present, not censused (feral pigeons probably do not breed in RBG).
3. ? = Seen but not definitely holding territory.
4. Species recorded that did not qualify as territory holders were Swift *Apus apus* (all sites) and Siskin *Carduelis spinus* (RBG).

Methods

Territories of breeding birds were mapped between late March and early July 1986. Current recommendations by the British Trust for Ornithology for British Common Bird Census workers are to make most observations in the morning. Due to its opening hours it was not normally possible to visit the Botanic Garden in the early morning or late evening and most visits had to be made in early evening, but R. McBeath was able to supplement my data when the garden was closed to the public. All the visits to Wester Hailes were in early morning and those to Tranent were in the morning and evening. It was not possible to census feral pigeons, House Sparrows or Starlings at Wester Hailes, but an attempt was made to census House Sparrows and Starlings at Tranent and the Botanic Garden.

All scientific names for birds are given in Table 1 unless mentioned only in the text.

Results and Discussion

The Botanic Garden held 270 territories of 25 species together with feral pigeons, House Sparrows and Starlings (Table 1). The post-war low-rise estates at Tranent held 237 territories of 11 species, while the Wester Hailes estate held only 30 territories of 13 species. The number of species found in Wester Hailes is really more than this type of housing development would normally hold as the single Whitethroat, Willow Warbler and Wren and most of the Dunnocks, thrushes and finches occurred in areas of scrub or trees that pre-dated house building but had been left at the edge of the development.

In Tranent songbird density was higher but species diversity was low; only Dunnock, Blackbird, House Sparrow and Starling could be described as common and, in one area where the houses were suitable, House Martins were numerous. During fieldwork it was noticed that Blackbirds were not evenly distributed throughout the census area. Older houses and gardens tended to hold more Blackbirds (Table 2) probably because most of these houses had privet hedges planted by the local authority, and these were invariably used by the Blackbirds for nesting. Of the newer developments, privately owned houses had more Blackbirds in their gardens than local authority housing of similar age. The most likely explanation of this difference is that the local authority housing had been supplied with wooden "ranch rail" fences but the private scheme had very little fencing. This led owners to plant bushes and evergreen hedges which gave similar nest sites for Blackbirds to those found in the gardens of the older council houses. The newest council development, despite extensive landscaping, has as yet few Blackbirds, probably because the bushes are still small.

The Botanic Garden had more birds of more species than the other gardens, and one species, Hawfinch, that is scarce in Scotland, but there were some notable absences. No warblers or buntings held territories and several cardueline finches, such as Linnet and Redpoll *Carduelis flammea*, were absent. This pattern is typical of the Garden, where Redpolls have bred only once in 15 years (R. McBeath pers. comm.). Spotted Flycatcher *Muscicapa striata* and Treecreeper *Certhia familiaris* did not hold territories in 1986 but had done so in previous years. The numbers of some resident species, notably Goldcrest, were relatively low in 1986 due to severe winters in the early 1980s (R. McBeath pers. comm.) but this would apply to all the study areas and should not affect comparisons between them.

The high density of a limited range of species in the Botanic Garden is typical of similar habitats elsewhere. The Blackbird density of 1.7/ha is lower than that found in Oxford Botanic Gardens by Snow (1988) but similar to other habitats he quotes e.g. 1.2/ha in University Parks, Oxford. Blackbird density was higher in parts of Tranent reflecting the fact that some adjacent open spaces such as playing fields,

TABLE 2. Densities of Blackbirds in different house and garden types at Tranent, East Lothian.

	Local authority housing			Owner-occupier houses	
	1945-1960	c.1965-1980	post-1980	1970-1980	post-1980
Garden features	Privet hedges	Wood fences	Open plan, shrubberies yet to establish	Open plan with hedges and shrubs	Open plan planting yet to establish
Area in ha	17.6	19.1	7.6	7.5	8.5
Blackbird territories	72	35	7	29	3
Density/ha	4.1	1.8	0.9	3.9	0.4

which at least some birds used for foraging, were not included in the calculations of area. In the Edinburgh Botanic Garden lawns were interspersed with trees and bushes and the Blackbirds were probably less likely to feed elsewhere. Blackbird density is actually higher in gardens with suitable cover than in woodland (Snow 1988) but this applies to few other species, apart from feral pigeon, House Sparrow and Starling, which are among the few birds to benefit directly from human settlement (Murton 1971). As none of these three species is easily censused by territory mapping the figures obtained in this study must be treated with great caution and a separate study, probably relying on finding nests, would be needed to give realistic figures. These species are so abundant in urban areas that they can sometimes become pests and it is appropriate to exclude them from comparisons between habitats when the aim is to establish what sort of houses and gardens will provide conditions for those birds that people want to encourage.

Simms' (1975) census work in a pre-war London suburb and a study by Batten (1972a) in a newer area nearby showed that, when House Sparrows were discounted, Blackbirds made up from 40-50% of the breeding bird community with Starlings the next most numerous species. Their figures for species such as Robin, Blue and Great Tit, though usually less than 10% of the breeding songbirds, were higher than found in this census in Tranent. This could be because post-war housing estates have smaller gardens which, in turn, usually have fewer trees or shrubberies than older housing. The density of almost 6 territories/ha found by Batten was rather higher than the 4.8/ha in Tranent (when Starlings are included for comparability). Batten (1972b) showed that as his study area was built up the numbers of breeding species declined. He considered that a completely urbanised area where the houses had gardens would hold around 20 regular breeding species; this is around double the number found at Tranent. However the gardens in Batten's study area seem to have been larger and longer established. He suggested that high-rise developments, which he was not able to study in detail, would hold under 10 breeding species. This is in line with the results from Wester Hailes when the birds from the relict wood are excluded.

The differences found at Tranent in the density of Blackbirds between different types of post-war housing demonstrate that, even within the small areas of ground that make up modern gardens, the way they are managed has a considerable effect on their suitability for breeding birds. Bird numbers and variety can be further enhanced by the provision of food and water (Glue 1982). This tends to have a more obvious effect in the non-breeding period, especially during

severe weather, but could affect breeding birds by increasing winter survival rates or allowing early breeding by individuals which had been able to maintain their physical reserves. Several species sometimes breed earlier in gardens than in woods but the situation is complex and artificial feeding may not be the only factor involved (Perrins 1979, Snow 1988).

The limited avifauna found in most of Wester Hailes indicates that modern house designs that have proved unpopular with many tenants also provide a poor environment for wildlife. High-rise blocks are no longer being built by local authorities in Britain and some of the environmental improvements planned for existing schemes such as the provision of individual gardens for terraced houses, or the planting of trees and shrubs, should help breeding birds. However the value of gardens to birds must not be exaggerated. The Botanic Garden, which was the richest habitat found in this study, had an impoverished avifauna compared to deciduous woodland, especially woods with a well-developed understorey (Fuller 1982). Although not included in this study there are habitats within the city of Edinburgh that do hold the warblers, buntings and cardueline finches that were scarce or absent from the Botanic Garden. These are invariably areas with native "weeds" such as nettles *Urtica dioica* and brambles *Rubus spp.* as well as indigenous trees and bushes. The value of this sort of habitat has been demonstrated elsewhere in the Lothians (da Prato 1985); one particularly rich area of scrub and trees held over 30 breeding species at a density equivalent to 22.5 territories/ha. It is important that planners be made aware of the value of such places that are too often marked down for "environmental improvement", which usually means expensive landscaping that reduces the area's suitability for breeding birds. This is particularly unfortunate as the more natural habitats are cheaper to maintain, more resilient to damage, and richer in wildlife and native plants.

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Short Notes

Foraging birds favouring burnt ground in harvested fields

In recent years many farmers have burned the rows of straw left by combine harvesters. Each row is lit and parallel fires run along the rows, burning straw, stubble and other plants below. In dry weather some or all the stubble between the rows also burns. R.J. O'Connor & M. Shrubb (1986. *Farming and Birds.* Cambridge University Press, Cambridge. p. 87) wrote "the immediate consequences of burning are to attract birds to consume the invertebrates exposed by the incineration of the straw", but they did not document any examples.

In east Scotland, where straw burning is widespread, I have noticed foraging Lapwings *Vanellus vanellus,* Common Gulls *Larus canus,* Herring Gulls *Larus argentatus,* Black-headed Gulls *L. ridibundus,* Rooks *Corvus frugilegus* and Starlings *Sturnus vulgaris* concentrating on burnt strips. In August 1989, concentrations of Herring Gulls and Rooks foraged on burnt stubble only three hours after it was burnt. Table 1 gives examples from Angus, Kincardineshire and Aberdeenshire of the use by birds of these stubble fields. Counts were made from a car on public roads, so the birds were undisturbed.

Birds often foraged along the 60-80 cm wide burnt strips, but also crossed from one strip to the next, spending little time foraging in between. As the burnt black surface is largely bare and warms up in the sun, invertebrates may be easier to see and catch; it may also be easier for birds to walk there than on stubbly ground. Gulls which are sitting on the ground while resting and sleeping during daylight also favour burnt

TABLE 1. Typical examples of bird numbers foraging on burnt and unburnt stubble.

Date	Place	Crop	% of field burnt, visually estimated to nearest 5%	No. of foraging birds on	
				burnt stubble	unburnt stubble
26.10.86	NW of Brechin	Wheat	25	32 Lapwings	0
				61 Common Gulls	0
				c.100 Starlings	0
1.11.86	SW of Laurencekirk	Barley	30	28 Lapwings	2
		Barley	55	36 Common Gulls	1
2.11.86	NE of Newburgh	Barley	25	68 Lapwings	0
				48 Black-headed Gulls	0
23.8.87	NE of Ellon	Barley	20	32 Lapwings	11
5.9.87	W of Newburgh	Oilseed rape	15	89 Lapwings	0
24.9.88	SW of Kintore	Barley	20	48 Common Gulls	2
				25 Black-headed Gulls	0
6.8.89	SW of Stonehaven	Barley	10	225 Herring Gulls	10
				31 Rooks	1

Note: For each species on each field, the binomial probability of obtaining such a high, or higher, proportion of birds on burnt ground, on the hypothesis of a random distribution of birds, was less than 0.1%.

patches, possibly because it is warmer and easier to sit there (e.g. in August 1989 I saw 42 Common and 114 Herring Gulls sitting on burnt stubble in a barley field south-east of Banchory, but no gulls were on the 65% of the field that was unburnt). In July-August 1989, birds feeding on grain, including Woodpigeons *Columba palumbus*, finches, buntings and at times Rooks, were all on unburnt ground. In such cases, although the grain on the burnt stubble was easier to see than on the unburnt stubble, it was probably less palatable because the grains were partly burnt.

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Successful autumn nesting of Raven

On 1 January 1989 we saw a pair of Ravens *Corvus corax* paying close attention to a particular section of cliff on the Galloway coast. From previous experience we knew this to be a Raven nesting site, and thinking that the birds might have started to build we looked over the cliff. We were astonished to see, 10 m below, one large, almost fledged chick on the edge of a complete, well-lined nest. The young bird was fully feathered with the tail feathers about 20-50 mm beyond the sheath. Quill sheaths were also visible on some secondaries.

On 7 January the nest was empty and, although a thick sea-fog prevented any search for the birds, there was no reason to believe that the chick had not fledged successfully. On 28 January Ravens were again absent but whereas the nest had formerly been copiously covered in droppings, these had been washed away and there was nothing to suggest that it had been used recently.

Allowing three weeks for incubation and five weeks before fledging, this Raven pair must have laid around the first week in November. The only other late autumn breeding attempts we can trace relate to 1) a nest with four eggs found near Sedbergh in October 1945, which was subsequently robbed *(Westmorland Gazette* 13 Oct 1945; *BB* 39: 83-84), and 2) a nest with six eggs found in S. Wales in November 1988 which was also unsuccessful (R.E. Tallack *pers. comm.*). There were no examples among the 2096 Raven nest record cards held by the BTO; it therefore seems likely that the Galloway Ravens provide the first record of successful autumn breeding for the species in Britain.

Ravens are well known as early breeders, regularly laying in February and sometimes in January, but autumn records are too far outside the normal breeding season to be considered as early nesting. They are much more like the autumn nesting that has often been noted in Rooks *Corvus frugilegus*, which has been known since the days of Gilbert White (Yarrell, W. 1845. *A History of British Birds.* Vol. 2. John van Voorst, London. pp. 103-104). Rooks have a pronounced autumn breeding activity which includes carrying sticks, sometimes building nests, and occasionally even laying eggs and hatching young. However, no young are known to have fledged from such nests (Coombs, F. 1978. *The Crows.* Batsford, London. p. 94).

On 9 April 1989 there were three small Raven young in the same nest in Galloway which were fledged successfully. There was no way of knowing if the same parent birds were involved.

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Diet of Snowy Owls on Cairn Gorm plateau in 1980 and 1987

In his general survey of the Cairn Gorm hill birds, A. Watson (1966, *SB* 4: 179-203) gave records of Snowy Owls *Nyctea scandiaca* on the Cairn Gorm plateau, pointing out that they occurred in years of Ptarmigan *Lagopus mutus* abundance and that nesting might be possible in a year of high Ptarmigan numbers. At that time there was sparse information on diet. This note assesses diet from the contents of pellets collected in recent years and reviews the published information for Scotland.

A single male Snowy Owl summered on the Cairn Gorm plateau in 1980 and pellets cast in July were collected from one of its roosts. In 1987 a female summered and pellets were collected in late June, July and early August; some were not fresh and could have lain for months.

As Snowy Owls tend not to pluck their prey but to consume it in large lumps, pellet contents reflect the diet well. The 1980 pellets contained the undigested remains of at least two small wader chicks, four full-grown Ptarmigan and three young game birds (Table 1). The 1987 pellets contained remains of mountain hare *Lepus timidus* leverets, field voles *Microtus agrestis*, a full-grown Red Grouse *Lagopus l. scoticus*, some wader chicks and Ptarmigan. The largest item was a leveret of 815 g (calculated from the length of the jawbone) which was about one-third grown. Mountain hare and Ptarmigan together comprised at least 96% of the diet by weight.

There are two published notes on Snowy Owl diet in this area. A male which summered in 1952 and 1953 had fed on a mountain hare and several grouse-like birds, probably Ptarmigan (Tewnion, A. 1954. *Cairngorm Club Journal* No. 89). Pellets from a male in 1965 contained the remains of mountain hare, Ptarmigan and field voles (Weir, D. In: Nethersole-Thompson, D. & Watson, A. 1981. *The Cairngorms.* Melven, Perth. p. 143). The same authors also report that Snowy Owls resident on moorland in lower Speyside in the mid-1970s fed on mountain hare and Red Grouse. Three studies of diet elsewhere in Scotland also emphasised the importance of young hares or rabbits *Oryctolagus cuniculus* and large birds. Ten pellets from a bird summering in Orkney contained the remains of half-

TABLE 1. The contents of Snowy Owl pellets from Cairn Gorm plateau in 1980 and 1987

Prey Item	Minimum no. of items in sample		Total	
	In 1980 (6 pellets)	In 1987 (24 pellets)	% items	% by weight (total 8.6 kg)
Short-tailed field vole	—	8	19	3
Mountain hare+	—	10	23	44
Red Grouse (full grown)	—	1		
Ptarmigan (full grown)	4	3	47 (All tetraonids)	52 (All tetraonids)
Tetraonid chicks*°	3	9		
Wader chicks**	2	3	12	1
TOTAL PREY ITEMS	9	34		

Notes:

\+ Mean weight = 337 g + 61 (SE) (range 155 to 815) calculated from jawbone lengths (Flux, J. 1970. *J. Zool., Lond.* 161: 75-123).

* Mean weight = 58 g + 8 (SE) (range 30 to 105) calculated from tarsus lengths (Marquiss, unpublished data).

° At least 6 (probably all) were Ptarmigan.

** At least 3 (probably all) were Dotterel *Charadrius morinellus.*

grown rabbits (Balfour, E. 1964. *SB* 3: 33-34) and owls on Lewis fed exclusively on young rabbits weighing 130-700 g (Marquiss, M. & Cunningham, W.A.J. 1980. *SB* 11: 56-57). At Fetlar, Shetland the onset of breeding coincided with the emergence of small rabbits. Initially they dominated the diet but as small to half-grown rabbits became scarce, the owls preyed mainly upon large and medium-sized birds, particularly the chicks of Oystercatcher *Haematopus ostralegus* and Whimbrel *Numenius phaeopus* (Robinson M. & Becker, C.D. 1986. *BB* 79: 228-242). Apparently, nowhere in Scotland have Snowy Owls sustained themselves on rodents, which are the main prey of breeders in the Arctic (e.g. Watson, A. 1957. *Ibis* 99: 419-462; Wiklind, C.G. & Stigh, J. 1986. *Ornis Scand.* 17: 268-274). On the Cairn Gorm plateau rodents are smaller than those found in the Arctic and were a minor part of the diet. The main prey sustaining owls were leverets, which are only seasonally available, and Ptarmigan, which are at low density in some years.

Snowy Owls could perhaps nest in a year of very high Ptarmigan numbers, as in the central highlands of Iceland where there are no rodents and they feed mainly on Ptarmigan (Watson, 1966). Between 1940 and 1988 at least five adult males, a young male and two females have been recorded in the Cairngorm mountains (Nethersole-Thompson, D. & Watson, A. 1981 and *SBRs*). In contrast to the Northern Isles, females were rare and only once were a male and female present in the same year (1980). However, as the male was on the Cairn Gorm plateau and the female in the Grampians, they were too far apart to meet.

We thank Chris Thomas, Keith Duncan, Stuart Rae and Richard Thaxton for collecting pellets. The field work in 1987 was carried out as part of the Nature Conservancy Council Mountain Plateau Ecology Project, who thank the RPSB for permission to work on their Loch Avon reserve. Adam Watson commented on the draft.

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Starlings excavating nest holes in sand dunes

On 4 May 1989 a Starling *Sturnus vulgaris* was observed leaving a hole in a sand dune at Tres Ness, Sanday, one of the Orkney Islands. The dune was about 12 m high and the hole, the only one in the dune and *c.*2 m from the base of the dune, entered at a point where a small sand cliff abutted with loose sand sloping at about 45°. Small claw marks in the damp sand indicated regular entering and exiting the hole which was 10 × 8 cm at its entrance. On the following day the hole entrance had been covered by a sand slip. Knowing its location the site was excavated and, following the horizontal tunnel in for about 0.5 m from where the entrance had been, a wider chamber was found, about 20 cm wide, where there was the initial construction of a nest. Lengths of marram grass *Ammophila arenaria* had been worked into a wreath-like base. An additional tunnel ran back from the nest chamber for about another 0.5 m and was inclined slightly upward.

On the same day two more holes were found in the same dune system but about 100 m from the destroyed nest. These were in a small sand cliff and the tunnels extended back for only short distances (10 and 25 cm). The presence of the birds and claw marks indicated that they were excavating fresh nest sites. C. Feare (1984. *The Starling*. Oxford University Press, Oxford) lists a large number of hole sites that Starlings use for nesting but this is the first recorded instance of Starlings excavating their own nest holes.

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Early return of Oystercatchers to north-east Scotland in spring 1989

The winter and early spring of 1988/89 were exceptionally mild and there were many reports of unusually early nesting, flowering and insect activity (e.g. Morison, J.I.L. & Spence, R.A. 1989. *Weather* 44: 176-179; *BTO News* 161: 14). During the course of a study on farmland waders from 1986-88 at Finzean, 37 km WSW of Aberdeen in north-east Scotland, we caught and wing-tagged breeding adult Oystercatchers *Haematopus ostralegus* each year. We recorded the dates on which we first saw marked birds in the study area in 1987 and 1988, and knew from reported sightings that they wintered around the British coast from Aberdeen to the Exe estuary in Devon (720 km SSW). Because the weather was so mild in 1989, we thought that Oystercatchers would return early. To test this visits were made to Finzean twice a week in February and March to compare the date of first sightings of marked birds with the two previous years. For each year, the number of birds seen by a given date was expressed as the percentage of the total number seen by the end of March.

Birds began to return to the breeding grounds earlier in 1989 (Fig. 1). Fifty percent of all marked birds seen had returned by 6 March (6 and 10 days earlier than in 1988 and 1987 respectively), and 95% had been seen by 17 March (10 and 12 days earlier than in 1988 and 1987 respectively). The results for 1989 are conservative as observations were made daily in 1987 and 1988, but birds which may have been present but were overlooked in 1989 would not be seen for at least another three days.

The mean monthly temperatures for Exmouth, Devon, close to the most southerly wintering location, and at Craibstone, Aberdeen (the site nearest to Finzean for which meteorological data were available) show progressively milder temperatures for both February and March from 1987 to 1989 (Table 1, data from *Monthly Weather Report*, HMSO, London). These data indicate that over the three years considered, there was a close correspondence between dates of arrival at Finzean (and presumably the dates of departure from wintering grounds) and February and March temperatures.

The data presented in Fig. 1 include sightings of 24 birds caught in 1986 which were common to all years and 21 birds caught in 1987 which were common to two years. It could therefore be argued that the observed pattern was due to birds returning progressively earlier as they became older. To allow for this possibility, the analysis was repeated with individuals represented only once; although sample sizes were reduced, the pattern in Fig. 1 was unaltered. Therefore we conclude that mild weather was an important factor affecting the time of return to the breeding grounds.

An advantage of early return for

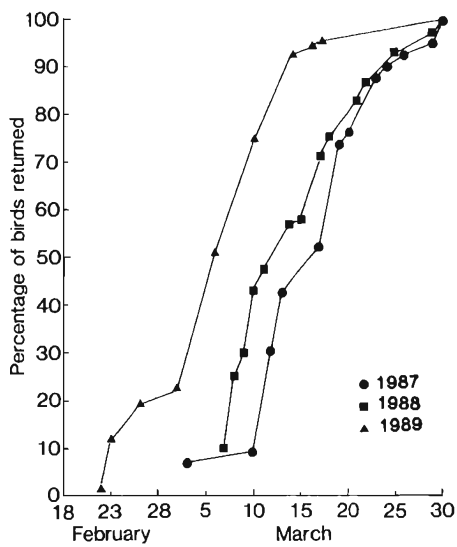

FIGURE 1. Dates on which marked Oystercatchers returned to Finzean, Aberdeenshire in 1987-89. *The number of birds which returned by a particular date is expressed as a percentage of the total present by the end of March each year (n = 40 in 1987, n = 60 in 1988, n = 62 in 1989).*

TABLE 1. Air temperatures (°C) at Exmouth, Devon, and Aberdeen in February and March 1987-89.

	FEBRUARY			MARCH		
	Mean		Difference mean (A + B) from 1951-80 average	Mean		Difference mean (A + B) from 1951-80 average
	Max. (A)	Min. (B)		Max. (A)	Min. (B)	
a) Exmouth						
1987	8.0	2.5	+0.3	8.9	2.8	−0.6
1988	8.9	2.8	+0.9	10.5	5.3	+1.4
1989	11.0	3.8	+2.2	12.1	4.8	+1.8
b) Aberdeen						
1987	5.4	0.1	+0.1	6.1	0.2	−1.2
1988	6.0	0.8	+0.8	7.2	0.9	−0.2
1989	7.8	1.0	+1.8	8.9	1.3	+0.8

Oystercatchers would be that they could breed earlier. Chicks which hatch early are better able to avoid the adverse effect of dry spells in mid-summer (N. Picozzi & D.C. Catt, unpublished data). However, there can be a cost to an early return. M. Bell's (*SB* 15: 106-113) counts at Aberdeen showed that once the winter flock there dispersed, Oystercatchers did not return even if weather conditions inland deteriorated, and A. Watson (*SB* 11: 55-56) recorded Oystercatchers starving in inland Kincardineshire and Aberdeenshire in bad weather in March 1979. Fortunately, in 1989 the weather remained favourable.

We are obliged to colleagues for their helpful comments.

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Cliff nesting Merlins in north-west Sutherland

According to the literature, Merlins *Falco columbarius* seldom nest on cliff ledges in Britain, but usually nest on the ground or in the tree nests of other birds (*BWP* Vol 2; Brown, L. 1976. *British Birds of Prey.* Collins, Glasgow). In other parts of the Merlin's range, however, such as Iceland and Newfoundland, cliff nesting appears to be more common (Cade, T.J. 1982. *Falcons of the World.* Collins, Glasgow).

Since 1972, we have monitored the numbers and distribution of breeding Merlins in a 3000 ha study area in NW Sutherland. Each year, between two and four pairs are known to have nested. To date, we have found a total of 12 nests; 11 were sited on six steep, but well-vegetated cliff faces, and one was in vegetation on the top of an isolated 7 m lump of Lewisian gneiss. Two of the cliff nests could not be inspected due to their inaccessibility; the other nine were located 15-150 m above the base of the cliff. Clutch sizes ranged from three to five eggs (mean = 4.5, SD 0.7, n = 10).

At one cliff, Merlins bred every year

between 1974 and 1980. However, in 1981 the site was occupied by a pair of Peregrines *Falco peregrinus*. Although the Peregrines reared young, they have not nested there since, and Merlins have not subsequently reoccupied the site. Golden Eagles *Aquila chrysaetos* sometimes nested on this cliff up to the early 1960s. At another site, Merlins nested on the same cliff as a pair of Kestrels *Falco tinnunculus*. We have found no Merlin nests on the ground or in trees even though sites comparable with those used on moorlands in other parts of the British range are available. A possible explanation is that the cliff sites are better protected against the wide variety of ground predators that occur on the study area.

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Inland Fulmars on St Kilda

Many observers have noticed the coastal distribution of the Fulmar *Fulmarus glacialis* at St Kilda and have commented on their slowness to adopt inland breeding as has occurred at other colonies. This note describes some confusion in the literature about the history of inland breeding on Hirta and gives more precise details of my own observations of an inland site there in 1961 and 1962. Tasker *et al (SB* 15: 21-29) state that a few Fulmars "now nest inland" on Hirta and that "this habit started around 1981". However K. Williamson and J.M. Boyd (1960. *St Kilda Summer.* Hutchinson, London) recorded "inland" sites among the Mullach Bi crags overlooking Glen Mor since 1956 but did not know if breeding occurred. M.P. Harris and S. Murray (1978. *Birds of St Kilda.* NERC, Cambridge) state "some few pairs have nested high up on the cliffs of Mullach Bi ..... since the early 1950s" but it is not clear how inland these sites were.

Inland breeding in Glen Mor was recorded on 5 July 1959 by Dr D.G. Boddington, and what I presumed to be the same colony, on an inland cliff, had at least one young on 23 August 1961 *(SB* 2: 459-467). This site could not be described as "high up on the cliffs of Mullach Bi" (the highest peak of which is 355 m) as I estimated the position at about 57° 49′ 5″ N and 8° 36′ 15″ W, some 150 m above sea level and *c.*400 m south-west of the head of Glen Bay. This was the site where 42 sitting birds were counted on 28 April 1962 (*SB* 2: 459-467). Thus the history of inland nesting of Fulmars at their oldest and largest colony in Britain goes back further than that suggested by Tasker *et al.*

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Summer flocks of juvenile Starlings

Dr C.J. Henty's note (*SB* 15: 135) on the summer flocking of juvenile Starlings *Sturnus vulgaris* reminded me that when I lived in Manchester half a century ago and walked on the hills, I used to see flocks of Starlings, mostly birds of the year, in the summer. This is recorded in my *Birds and Woods* (1962. Oxford University Press, Oxford, p. 264). The following locations where flocks were seen are those noted in my diaries:

1. Crowden Great Brook (north of A628 Manchester-Sheffield road, G.R. SK: 060620), 28 July 1934 on moorland dominated by cotton grass *Eriophorum vaginatum* and wavy hair grass *Deschampsia flexuosa.*

2. Three Shire Heads (near Buxton, G.R. SK: 010685), 23 June 1935 on cotton grass moorland.

3. Higher Disley (Cheshire, G.R. SJ: 980840), 29-30 June 1935 on moorland with mat-grass *Nardus stricta* dominant.

4. Between Wensleydale and Cray (Yorkshire, G.R. 943791), 19 September 1967, seen from the road.

Localities 1-3 are at or above 380 m (1250 ft) O.D., and Cray lies at 304 m (1000 ft) O.D.

Evidently this moving to the hills by Starlings, mostly but not exclusively young, is normal in the north. Since in England the Starling breeds mostly in towns many of the birds must have come long distances but probably not further than they have been recorded as travelling between their winter roosts and their feeding grounds. Neither I in *Birds and Woods* nor E. Sims in *Woodland Birds* (1971. Collins, London) recorded such flocks in woodlands.

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OBITUARY

JAMES WATT MACDONALD 1928–88

Jimmy Macdonald died from a heart attack on 28 December 1988. He was a member of the SOC and RSPB but few Club members will know how much this modest and retiring man contributed to ornithology and conservation. Born in Fife, he qualified as a veterinary surgeon at Glasgow in 1954. After work in general practice at Keith, and at the BOCM Poultry Diagnostic Laboratory he joined the staff of the Ministry of Agriculture (MAFF) Veterinary Laboratory at Lasswade in 1956. Very unusually in his profession, he worked wholly on birds for more than 30 years. He became highly expert in the diagnostic pathology of poultry and wild birds and was active in several fields of poultry disease research.

Dr J.E. Wilson, when Director at Lasswade, began long-term studies of wild bird disease and mortality and Jimmy entered keenly into this field, continuing from 1962 a series of papers in *Bird Study*. His authoritative post-mortems contributed especially to the many studies by others from the 1950s which established the role of organo-chlorine pesticide use in the population declines of many birds. He was very often able to qualify, reduce or exclude the possibility that other factors were involved in deaths, and his name appears in the acknowledgments of most of the important papers.

Jimmy's post-mortems were notably important when the widespread, deliberate poisoning of predatory birds became evident in the late 1960s. He ensured that he was very well-informed on many aspects of this problem, and we may owe more than ornithologists appreciate to his discrete advice to public service colleagues. His reports and advice also were very valuable to many ecological studies, such as the long-term grouse work at Banchory, and to those of many individuals. They also contributed in no small measure to the better husbandry of zoo birds.

His colleague C.J. Randall wrote in *The Veterinary Record* of Jimmy as "most courteous and considerate ..... freely shared and extensive knowledge ..... the most unassuming of men and never pushed himself forward". We miss him and extend our warmest sympathy to his wife, his daughter and his two sons, and to the many friends of this good man.

D.N. Weir

Items of Scottish Interest

The papers and reports on birds in Scotland listed here deal mainly with status and distribution. Papers in the widely available journals *British Birds, Bird Study* and *Ringing and Migration* are excluded. Most are available in the Waterston Library for reference. Items marked with an asterisk are available from the SOC postfree to members at the prices quoted.

The librarian is glad to receive reprints or copies of papers on any aspect of ornithology or general natural history.

Scientific papers

Baillie, S.R. & Milne, H. 1989. Movements of Eiders on the east coast of Britain. *Ibis* 131: 321-335.

Benn, S., Murray, S. & Tasker, M.L. 1989. The birds of North Rona and Sula Sgeir. Nature Conservancy Council, Seabirds at Sea Team, Aberdeen (47 pp) £5.00*.

Birkhead, T.R. & Lessells, C.M. 1988. Copulation behaviour of the Osprey. *Anim. Behav.* 36: 1672-1682.

Black, J.M. 1988. Preflight signalling in Swans: a mechanism for group cohesion and flock formation. *Ethology* 79: 143-157. A study of Whooper and Bewick Swans in Scotland.

Black, J.M. & Owen, M. 1988. Variations in pair bond and agonistic behaviors in Barnacle Geese on the wintering grounds. Pp. 39-57 in *Waterfowl in Winter* M.W. Weller (Ed), Univ Minnesota Press. A study in Scotland.

Black, J.M. & Owen, M. 1989. Parent-offspring relationships in wintering Barnacle Geese. *Anim. Behav.* 37: 187-198. A study in Scotland.

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Fuller, R.J. & Percival, S.M. 1988. Surveys of breeding waders in the southern isles of the Outer Hebrides, 1983-1987. Nature Conservancy Council, CSD Report no. 904 (40 pp). A study of waders of the machair.

Furness, R.W. 1988. Predation of ground-nesting seabirds by island populations of Red Deer and sheep. *J. Zool. (Lond.)* 216: 565-573. The effects on the breeding success of terns, skuas and Manx Shearwaters.

Galbraith, H. 1989. Arrival and habitat use by Lapwings in the early breeding season. *Ibis* 131: 377-388.

Green, P.T. & Theobald, C.M. 1989. Sexing birds by discriminant analysis: further considerations. *Ibis* 131: 442-447. Based on a study of Rooks and Jackdaws in south Scotland.

Harris, M.P. & Wanless, S. 1989. Fall colony attendance and breeding success in the Common Murre. *Condor* 91: 139-146. A study of Guillemots on the Isle of May 1982-87.

Hudson, A.V. & Furness, R.W. 1989. The behaviour of seabirds foraging at fishing boats around Shetland. *Ibis* 131: 225-237.

Mayhew, P. & Houston, D. 1989. Feeding site selection by Wigeon in relation to water. *Ibis* 131: 1-8. A study at Caerlaverock on the Solway Firth where up to 800 Wigeon regularly winter.

Mitchell, J. 1989. David Bruce – the early naturalist years. *Forth Naturalist and Historian* 11: 89-93. Bruce was the first to find nesting Dotterel in Britain.

Mitchell, J. 1987. The Ruby-crowned Kinglet at Loch Lomond: supplementary notes. *Scott. Nat.* 1987: 47-48. Supporting the contention that the Ruby-crowned Kinglet should be on the British list.

Monaghan, P., Uttley, J.D., Burns, M.D., Thaine, C. & Blackwood, J. 1989. The relationship between food supply, reproductive effort and breeding success in Arctic Terns. *J. Anim. Ecol.* 58: 261-274. Compares breeding failure in Shetland with breeding success on Coquet Island, Northumbria in 1987.

Newton, I. 1988. A key factor analysis of a Sparrowhawk population. *Oecologia* (Berlin) 76: 588-596. An analysis of the breeding population in Eskdale, southern Scotland over the period 1972-86.

Newton, I., Bogan, J.A. & Haas, M.B. 1989. Organochlorines and mercury in the eggs of British Peregrines. *Ibis* 131: 355-376. This study covers 1963-86 in eight regions of Britain and Ireland, including four in Scotland.

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Stroud, D.A. (Ed) 1989. Birds on Coll and Tiree: status, habitats and conservation. Edinburgh, Nature Conservancy Council/Scottish Ornithologists' Club (191 pp) £6.50*.

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Ward, S. & Bullock, D.J. 1988. The winter feeding ecology of the Black-tailed Godwit – preliminary study. *Wader Study Group Bull.* 53: 11-15. A study on the Eden estuary, Fife.

Watson, A., Payne, S. & Rae, R. 1989. Golden Eagles: land use and food in northeast Scotland. *Ibis* 131: 336-348.

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Proc. 1st Symposium on the Golden Eagle in Europe. Published by Centre Recherche Alpin Vertebres, 1987 (175 pp). Available from S. Michel, Le Coin, 05350 Molines en Queyras, France.

Bird Reports

Argyll Bird Report for 1987 + 1988. (47 pp) C.A. Galbraith, A.R. Jennings and M. Madders (Eds) 1989. £5.50*.

Angus and Dundee Bird Report for 1987. (50 pp) R.D. Goater (Ed) 1989. £3.25*.

Arran Bird Report for 1988. (15 pp) M. Dunn (Ed) 1989. £1.00*.

Ayrshire Bird Report for 1988. (44 pp) Angus Hogg (Ed) 1989. £2.00*.

Birds of Eigg. (24 pp) J. Chester 1988. Scottish Wildlife Trust. £1.50*.

Central Region Bird Report for 1987. C.J. Henty 1989. In *The Forth Naturalist and Historian* 11: 63-82. £3.30*.

Colonsay Bird Report for 1988. Pages 2-15 of an unpublished report *Natural History of Colonsay and Oransay – Report from the Milbuie Log 1988* by J. & P.M. Clarke 1989.

Dumfries and Galloway Region Bird Report for 1988. (18 pp) A.D. Watson (Ed) 1989. £2.30*.

Dunbartonshire and Stirlingshire, Peregrine report for 1988. (2 pp) J. Mitchell 1988. An unpublished report in a long-standing series.

Highland Bird Report for 1987. (21 pp) R. Dennis (Ed) 1988. £1.00*. The fifth in a series covering the south of the Highland Region which includes the districts of Ross-shire, Inverness, Badenoch and Strathspey, Skye and Lochalsh, and Lochaber.

Islay Bird and Natural History Report for 1988. (20 pp) M.A. Ogilvie (Ed) for the Islay Natural History Trust 1989. £1.00*.

Isle of May Bird Report for 1985-87. (72 pp) published for the Isle of May Bird Observatory Trust 1989. £3.00*. This revives a series which commenced with 1935.

Isle of May Bird Report for 1988. (c.50 pp) Isle of May Bird Observatory Trust 1989. £2.00*.

Loch Lomond, Heronry report for 1988. (1 p) J. Mitchell 1988. An unpublished report in a long-standing series.

Loch Lomond, 1988 census of territorial waders. (1 p) J. Mitchell 1988. An unpublished report in a long-standing series.

Lothian Bird Report for 1988. (108 pp) I.J. Andrews (Ed) 1989. £4.00*. Includes a 58 page systematic list, and numerous short articles.

Moray and Nairn Bird Report for 1988. (59 pp) M. Cook (Ed) 1989. £2.00*.

North-East Scotland Bird Report for 1988. (65 pp) M.L. Tasker (Ed) 1989. £2.50*.

Orkney Bird Report for 1988. (78 pp) C. Booth, M. Cuthbert & E. Meek (Eds) 1989. £2.50*.

Perthshire (Central and South-West), Peregrines

and Ravens in 1988. (2 pp) P. Stirling-Aird 1989. An unpublished report in a long-running series.

Rhum Bird Report for 1987. Pages 15-25 of *Rhum National Nature Reserve Wildlife Report 1987* by Wilf Nelson 1988.

Rhum Bird Report for 1988. Pages 22-34 of *Rhum National Nature Reserve Wildlife Report 1988* by Wilf Nelson 1989.

St. Abbs Head National Nature Reserve seabird sample counts and seabird census 1988. (21 pp) K.J. Rideout & V. Egan 1989. A report to the Nature Conservancy Council, SE Scotland Region, Edinburgh.

Threipmuir Reservoir/Bavelaw Marsh Bird Report for 1988. (19 pp) Allan W. Brown. In *Bavelaw Marsh Nature Reserve Annual Report for 1988* published by Dept. Planning, Lothian Regional Council 1989.

W.G. Harper

Errata: Bell, M.V., Dunbar, J. & Parkin, J. (1988) 15: 49-60. The captions for Fig. 3 were inadvertently transposed. The upper graph should be labelled Pinkfeet (× 1000) and the lower Greylag (× 1000). McGowan, R.Y. (1988) 15: 90. Table 1 caption – for 1982, read 1892. The printers apologise for these errors.

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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 drawn so as to permit reduction to half their original size. If necessary they may be submitted without lettering and accompanied by a photocopy showing the lettering required. Captions should be typed on a separate sheet. Relevant line-drawings (in ink) will be welcomed, as will photographs (preferably black & white glossy prints).

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