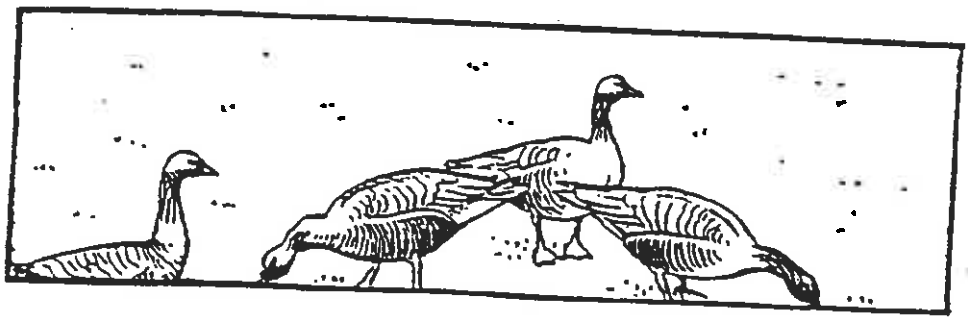
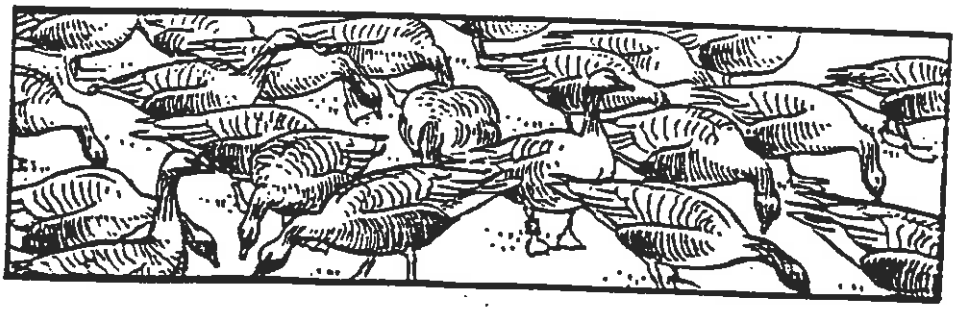


GREY GEESE IN THE MORAY FIRTH

Ian J Stenhouse

October 1993



DISTRIBUTION LIST

Scottish Natural Heritage		
HQ Bonnington,	Library	1
NW Region -	HQ	6
	Western Isles	1
	Dingwall	3
	Golspie	1
	Stornoway	1
NE Region -	HQ	2
	Keith	1
	Strathspey	1
	Orkney	1
	East Grampian	1
Wildfowl and Wetlands Trust		
Slimbridge -	Library	1
	Carl Mitchell	1
RSPB - Highland		
Inverness -	Library	1
	Ron Summers	1
Aberdeen -	Ken Shaw	1
RSPB - Edinburgh		
HQ -	Library	1
	Dave Beaumont	1
Highland Ringing Group	Bob Swann	1
Moray Firth Goose Study Group	Ivan Brockway	1
University of Aberdeen	Ian Patterson	1
FWAG Grampian	Nicky Penford	1
Inverness Wildfowling Club	Iain Finlayson	1
SOAFD		
Aberdeen -	Gordon McKilligan	1
Inverness		1
SAC	Rob Fuchs	1
Others	Ian Stenhouse	2
		36

CONTENTS

1. INTRODUCTION

Before most of the lowland forest of Britain was cleared and the marshes drained, every species of goose in Britain, both resident and migratory, would have been restricted to a particular wetland habitat to which they were specifically adapted.

Now fens and marshes have almost completely disappeared and lowland bogs have been drained and claimed for agriculture. These pressures on traditional goose areas may have been the driving force behind changes in the distribution of some species and the cause of considerable changes in their habitat use.

Wild geese have used agricultural land in Britain since early this century, with some species relying almost entirely on arable habitats as feeding for several decades (Kear 1963).

However, there is much variation in feeding behaviour between goose species, and often even within a species from one region of their overall range to another. Birds in one region of the country may develop a particular feeding strategy which is not of advantage in another region eg Pink-footed geese in Norfolk spend 75-80% of foraging time on sugar beet tops (Gill 1993), which is simply not grown, and therefore not available, in other areas.

While several populations and regions have been extensively studied, and some areas have initiated experimental management schemes, the variation of crop availability and goose behaviour from region to region requires that a blanket strategy be avoided. Management techniques which prove effective in one region of the country may or may not be applicable elsewhere.

Only with a clear understanding of goose numbers, distribution, and feeding behaviour within a well-defined area can we begin to (1) establish whether geese are causing economic damage, and (2) determine a management plan that would be appropriate to that particular population and its feeding preferences.

This project aims to quantify the numbers and distribution of migratory grey geese and swans around the Moray Firth fringe, identify their main feeding areas and investigate current trends in their feeding behaviour, and assess local opinion through liaison with landowners, wildfowlers, and conservationists.

1.1 Introduction to the study area

The study area covers 122,000 hectares (ha) of the Moray Firth fringe from Loch Fleet in Sutherland, south through Easter Ross, and east through Inverness and Nairn, to Spey Bay in Morayshire.

The Moray Firth Basin (Map 1) is a region geographically set apart from the rest of Scotland by the mountains along the southern and western boundaries. To the east, however, the way is open to incoming migrants; indeed the converging arms of the coast form a funnel concentrating birds into the sheltered inner firths.

The Firth is a complex area of coastal and estuarine habitats, with extensive intertidal flats. The extent of these mud and sand flats is far greater than anywhere else in the Highlands, and their rich invertebrate fauna and beds of eelgrass, glasswort species and *Enteromorpha* algae all provide an important food source for large numbers of waterfowl (Pritchard *et al* 1992). In this central section the climate is relatively mild, and many migrants are content to remain throughout the winter months.

The area is also somewhat set apart in other ways. Agriculture in the highland region as a whole constitutes 93 per cent rough grazing, with only 7 per cent under crops. The Moray Firth fringe, however, provides shelter, excellent soils, and a good growing climate. The result of this is that most of the land immediately around the Firth is arable. Cereals are the most important crop for this area, particularly malting barley.

In many ways the Moray Firth fringe is quite unlike the rest of the highlands, and is visibly reminiscent of the gently rolling agricultural landscape of the north-east of Scotland.

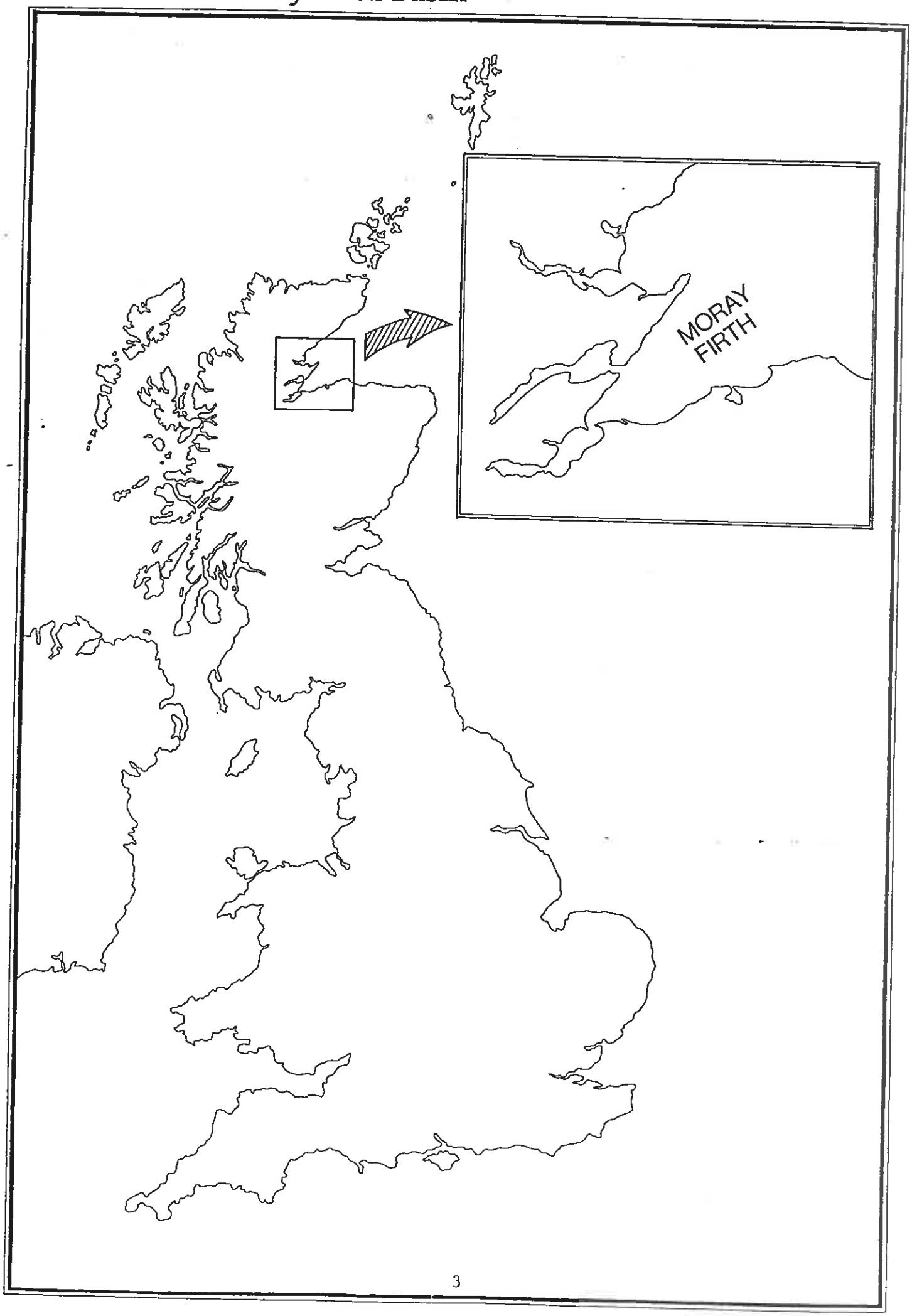
1.1.1 The study area

The study area (Map 2) includes thirteen well-established goose roost sites, all of which are very close to, if not completely surrounded by, productive farmland.

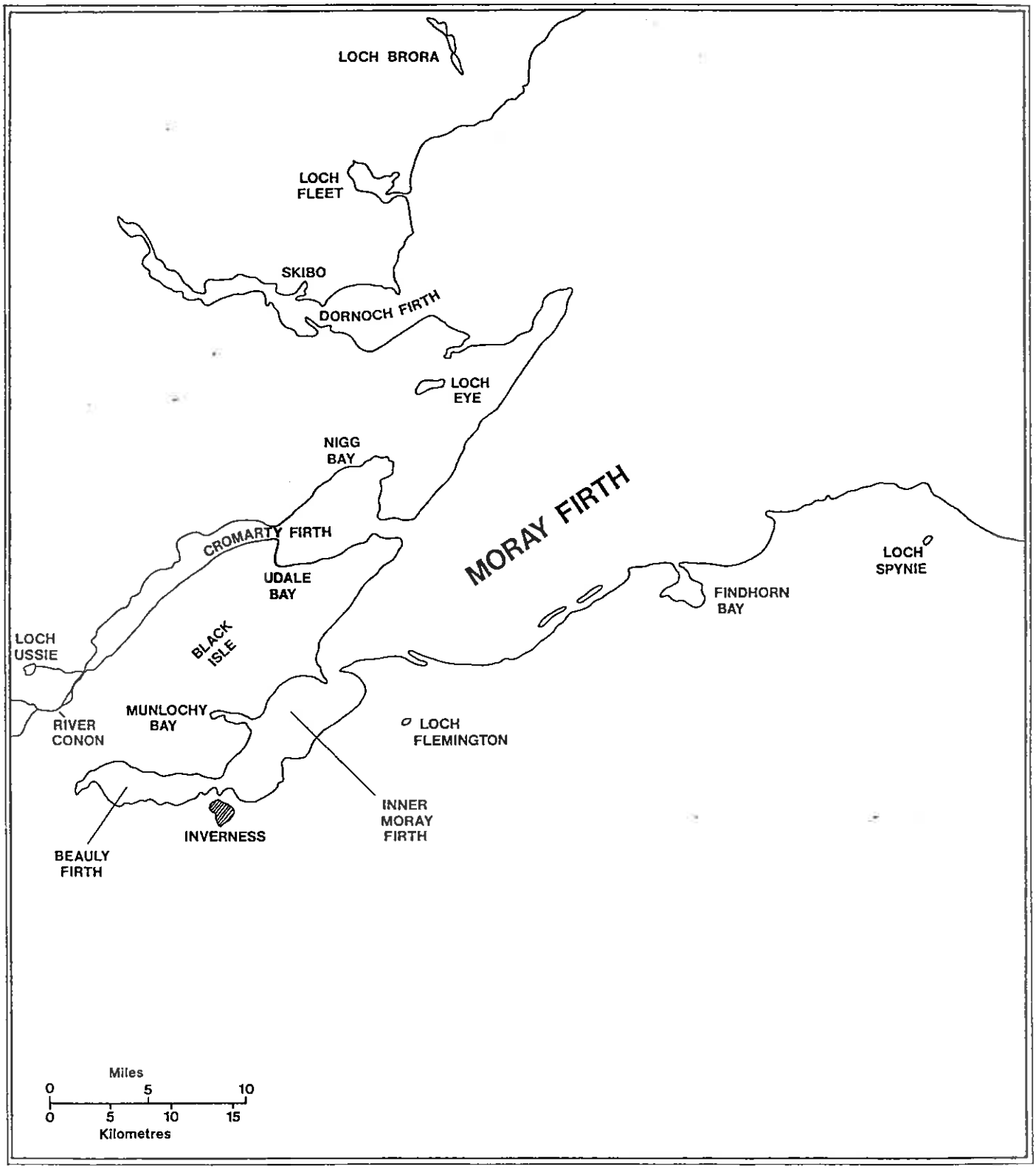
1. Loch Fleet NH788966 in the north of the study area is a shallow, sheltered basin, with a wide expanse of sandflats, extending to 500 ha, with small patches of saltmarsh. Loch Fleet is far enough from the main complex of three firths to be regarded as a separate unit.

2. The Dornoch Firth NH780860 has a large area of intertidal flats and extensive sands, which is fairly open to the sea and exposed to easterly winds. Roosting wildfowl tend to use the upper reaches of the firth, or 3. the small, sheltered Skibo estuary (70 ha) on the northern shore, and occasionally Ardmore Bay (40 ha) on the southern shore.

MAP 1 : The Moray Firth Basin



MAP 2 : The Study Area



4. Loch Eye NH831798 which lies between the Dornoch and Cromarty Firths, is an inland freshwater site amounting to 165 ha. It is a shallow, low-lying, nutrient-rich loch of international importance, and hence designated a Site of Special Scientific Interest (SSSI), Statutory Bird Sanctuary, and RAMSAR site.

The Cromarty Firth NH570590 is a moderately large estuary, with a relatively narrow entrance and a deep water channel. The firth is an ideal site for use by the oil industry, and as such has seen much industrial growth in recent years. However, three areas are still frequented by good numbers of wildfowl.

5. The Conon Islands NH553566 on the mouth of the River Conon show a transition from mudflats up through shingle banks, saltmarsh, brackish pools and wet pasture.

6. Nigg Bay NH790730 provides a large expanse, some 1,600 ha, of sheltered mudflats.

7. Udale Bay NH717660 on the southern shore shows a further 530 ha of sandflats, fringed with saltmarsh. Together, Nigg and Udale Bays form a National Nature Reserve.

8. Loch Ussie NH505570 just west of Dingwall, is a small but diverse SSSI. The loch covers an area of 85 ha, and is surrounded by farmland to the north and by a broad belt of conifers on the other three sides. The shores are fringed with rush and sedge, and are sheltered in many places by native scrub. There are also several small islands, all heavily overgrown with trees.

9. Munlochy Bay NH670530 on the southern shore of the Black Isle, is a sheltered estuary running virtually east-west off the Inner Moray Firth. The Bay is protected on the northern and southern shores by low hills, and shows an extensive area of tidal flats, saltmarsh, and reedbeds.

10. The tidal flats of the Beauly Firth NH575480 are some 1,000 ha in extent, fringed with saltmarsh and low-lying pasture, overgrown and marshy in places. This is a favoured site of overwintering Whooper Swans.

11. Loch Flemington NH810520 on the southern shore of the Moray Firth, is a low-lying, shallow water body which has experienced problems associated with nutrient enrichment for a number of years. It continues, however, to attract small numbers of wildfowl throughout the year.

12. Findhorn Bay NJ044626 also on the southern shore of the Moray Firth, is a broad, sheltered, sandy harbour, similar in many ways to Loch Fleet. The bay is roughly 580 ha, much of which is exposed at low water. The area is highly disturbed, however, with the runways of an airfield immediately to the east.

13. Loch Spynie NJ237664 the most important site on the southern shore, was originally formed on the low-lying coastal plain between Elgin and Lossiemouth when a narrow shingle spit grew across the mouth of the tidal inlet, enclosing a shallow fertile lagoon more than 650 ha in extent. In the early 1800s the cutting of the Spynie Canal reduced the surface area to little more than 30 ha, since then reedbeds have encroached considerably and recent drainage has destroyed much of the marshy pasture land of the western edge. The wildlife of the loch has been heavily hunted in the recent past and the sediment contains a large amount of lead shot. Despite the water level being raised in the hope that birds could no longer reach the contaminated sediment, this still occasionally causes lead poisoning when ingested by some of the larger, longer-necked species of wildfowl. The loch continues to attract a large and varied wildfowl population throughout the year.

Two other sites, Loch Brora NH853078 in Sutherland and Lower Bogrotten NJ482619 in Morayshire were thought to be of lesser importance but included in the monthly roost and area counts whenever possible.

1.1.2 Feeding behaviour

Geese fed in the surrounding farmland at varying distances from each of the main roost sites.

Generally, throughout the autumn and winter, geese move to their feeding grounds at dawn and return to the safety of a freshwater roost site at dusk. They may also return to 'loaf' around a roost in the middle of the day, or if undisturbed will loaf on their feeding grounds. It is common for geese to feed at night by the light of a full moon.

In spring, when the birds are preparing for migration and breeding, they become less reliant on the main freshwater roost sites and spend longer and longer on their feeding grounds. The birds spend the shorter spring nights on the feeding grounds, saving energy by not flying to and from a roost site and allowing more time to feed.

2. BACKGROUND

2.1 Population trends

2.1.1 Geese

The two most abundant goose species found overwintering in Britain are the Greylag goose, *Anser anser*, which breeds in lowland Iceland, and the Pink-footed goose, *Anser brachyrhynchus*, which breeds in central Iceland and eastern Greenland.

A nationwide census of these species, carried out annually by the Wildfowl and Wetlands Trust (WWT) since the 1950s, has revealed a steady growth in numbers (Figure 1) with time (Owen 1990).

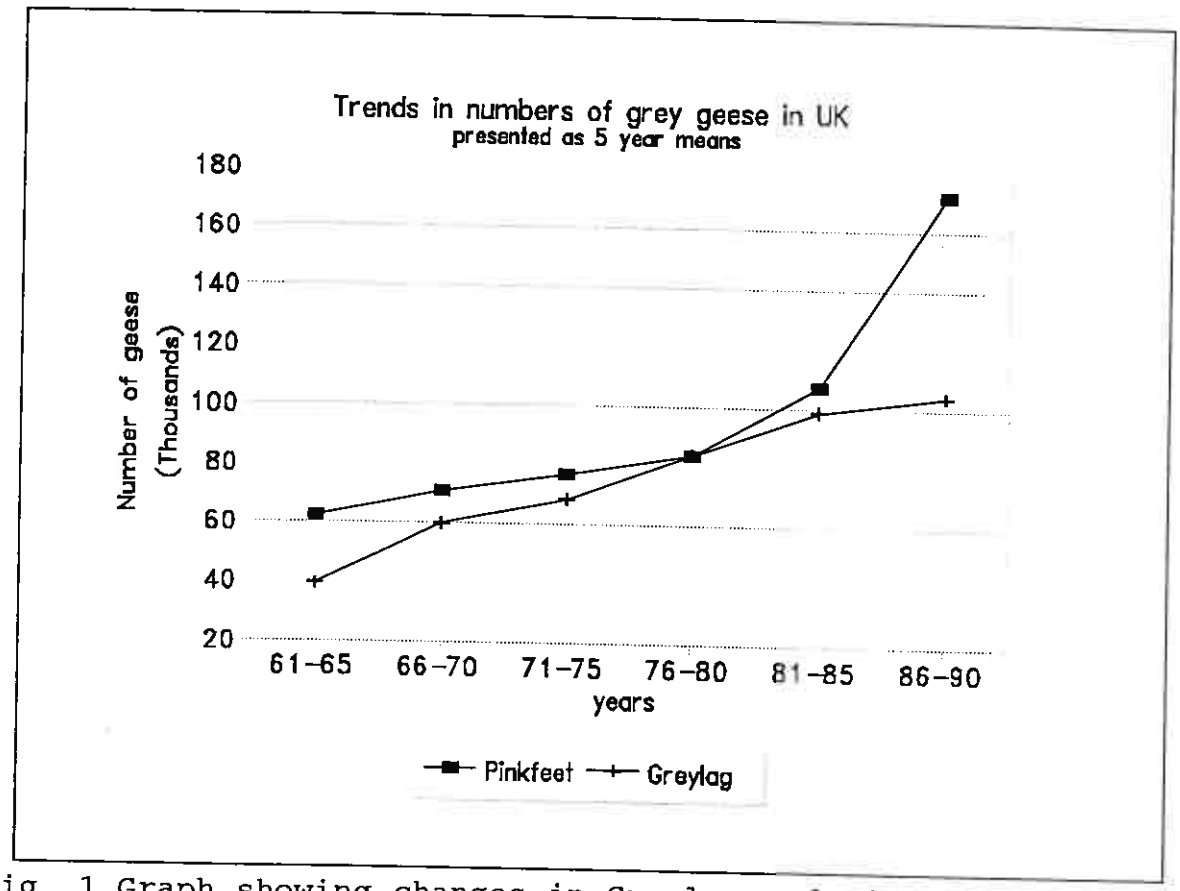


Fig. 1. Graph showing changes in Greylag and Pink-footed goose numbers in the UK over 30 years, from 1961-90, presented as five year means (WWT).

In the early stages of the WWT counts, there was some evidence of decreasing breeding success (ie reduced clutch size, reduced fledging success) estimated from the population of juveniles and mean family size soon after arrival in the U.K. (Ogilvie & Boyd 1976). It was felt at the time that such decreases were probably due to density-dependent pressures on the breeding grounds. However, in these initial studies, sample sizes were often small and the data should be interpreted cautiously (Patterson & Giroux 1990).

Excluding these early years, the proportion of adults breeding successfully has shown no decline, and the percentage of juveniles has shown no significant decrease in mean family size ie there is no evidence of density-dependent factors operating on the population (Fox *et al* 1989). Thus, either the birds have not reached a detrimental density on their breeding ground, or the population increases have involved extension of breeding ranges rather than increasing density. Indeed there is some evidence that eastern Greenland may have increased in importance as a breeding area for the Pink-footed goose (Madsen *et al* 1984). Pinkfeet may also have moved into areas of Iceland where they were previously unknown, and areas where they were once exterminated (Fox *et al* 1989).

The wintering ranges in Britain have shown substantial changes over recent years, with large increases in east central Scotland and north Scotland, and decreases on the Solway Firth and in most of England, except Lancashire (Boyd & Ogilvie 1969). Figure 2 shows the total number of Greylag for Ross & Cromarty, Inverness & Nairn, and Moray districts each November, from 1975 to 1988, as shown by the WWT Grey Goose Census. Although the numbers vary widely from year to year, a simple regression shows the general increase in numbers of Greylag in this region.

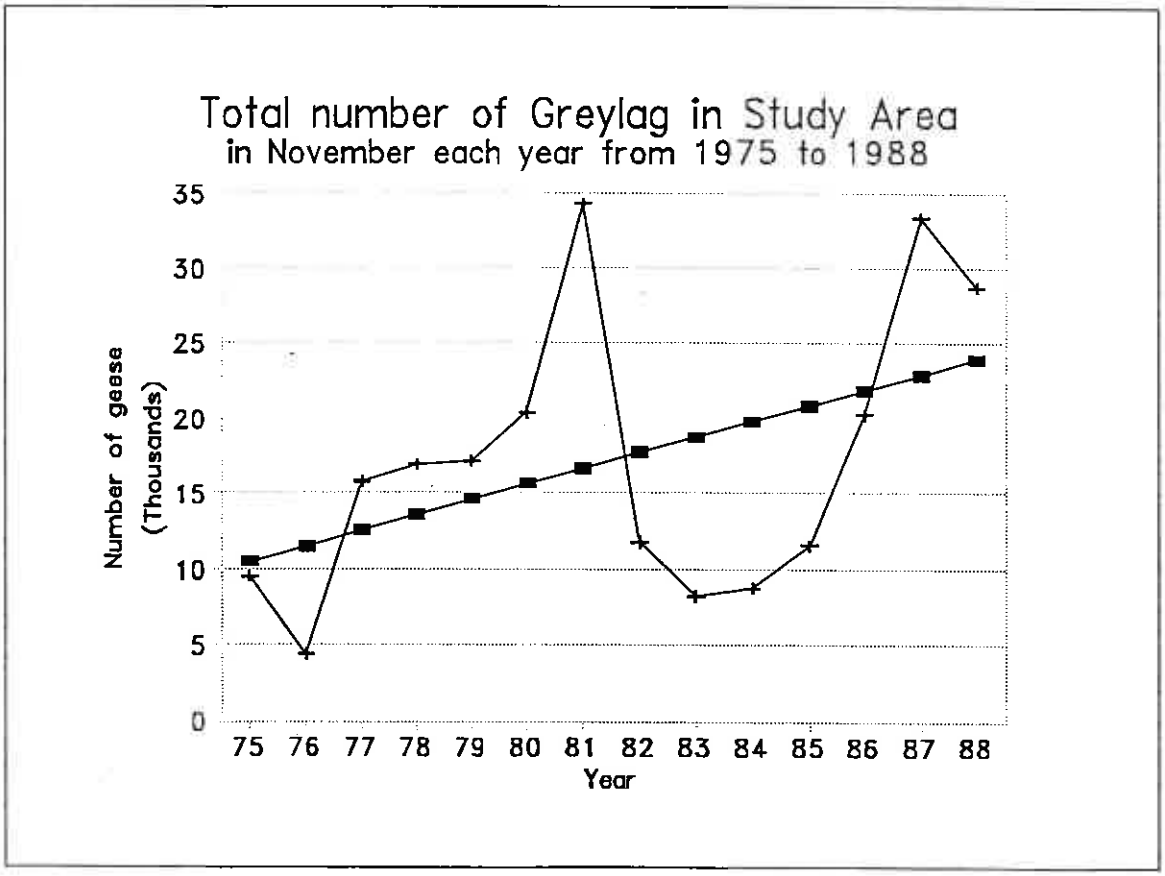


Fig. 2: Total number of Greylag in the study area each year, from 1975 to 1988, with simple regression showing the general trend.

2.1.2 Swans

The Icelandic-breeding population of Whooper swans, *Cygnus cygnus*, is only partially migratory, with some birds remaining in Iceland to winter on the south and west coast and around hot springs. However, most of this population winters in Britain, with the vast majority in Scotland, where the largest numbers are counted in November, when swans *en route* to Ireland as well as Scottish wintering birds are present.

Detailed counts for this species are rare and the population dynamics remain unclear. The few reliable counts that are available, however, do suggest an upward trend (Owen *et al* 1986), from an estimated 4,000 in Britain in the early 1960s, approximately 5,000 in the late 1970s, to somewhere in the region of 9,000 in the early 1990s.

The distribution of these overwintering birds has changed considerably in recent years (Owen *et al*. 1986), with numbers increasing markedly around the Moray Firth. Numbers have decreased in the Outer Hebrides, and particularly in east central Scotland, which held the largest concentrations in the 1960s.

2.2 Possible reasons for population growth

A number of factors may be responsible for these widely recognised and much publicised increases in goose numbers.

2.2.1 Agriculture

Changes in agricultural practice over the last 40 years have progressively increased the area of cereals and high quality pasture, thus providing more and more opportunity for grazing geese and swans.

2.2.2 Conservation

There have been substantial political developments in bird conservation both nationally and internationally in recent years (Owen 1990). The introduction of legislation and the consequent development of conservation policies has considerably increased protection for both species and habitats.

2.2.3 Mortality

The mortality rate of both goose species has declined markedly due to stricter control of hunting practices. This has been achieved through legislation, which maintains a short open season and prevents the sale of dead wild geese, as well as the introduction of Codes of Practice by shooting organizations themselves, such as the British Association for Shooting and Conservation (BASC).

2.2.4 Climate

Climate plays an important part in the breeding success of Arctic-nesting birds, as well as on wintering grounds where mortality may be reduced during mild winters. Any effects of climate change, due to global warming, on goose populations remains unclear.

It is the combination and interplay of these factors which make the issue of goose management such a complex and wide-ranging one.

2.3 The problem of crop damage

Crop damage is defined as "the degradation by waterfowl of crops cultivated for objectives other than the conservation of waterfowl" (Moser & Kalden 1992). In Europe, the most frequently recorded damage takes place during the winter and spring period, on arable and grass crops. The destruction of high value crops such as vegetables is rare, but does occur in Scotland.

The most obvious consequence of goose grazing is an effect on crop yield. However, crop damage may occur as a result of trampling, known as 'puddling', which may lead to uneven ripening of crops, damage of the soil structure, and an increase in weeds.

Many studies have been carried out in several countries over the last 20 years to assess the effect of goose grazing on arable crops. However, this has proven to be extremely difficult and enormous variability exists in the results of such studies, from considerable loss in yield, through no loss, to an increase in yield.

The difficulties in assessing the effects of goose grazing arise because yield is highly influenced by the complex interactions of many different factors. These include season, weather, soil type, crop type, stage of growth, grazing intensity, and the goose species involved.

In the UK, crop damage is negligible in its effect on overall national yields (Owen 1990). However, due to the gregarious nature of geese, damage may be concentrated locally around major goose roosts, where individual landowners claim to suffer considerable economic losses.

3. METHODS

3.1 Numbers and distribution

3.1.1 Roost counts

Thirteen major and two lesser roosting sites were identified across the study area, each of which was counted monthly from October to January, by a local bird-watcher with a good knowledge of the site. The counts were mostly carried out at dawn on a pre-arranged date, however counts for a few roosts proved to be more accurate when carried out at dusk on the previous evening. These counts were arranged to coincide with the new moon, since the birds may remain on the fields to feed by the full moon.

3.1.2 Area counts

With the onset of spring, and an increasing day length, the behaviour of the birds changes dramatically. They are no longer faithful to the main roosts and may choose instead to remain out in the fields at night. This inevitably means that counting only the roosts in spring does not provide an accurate number of birds in the area. In order to overcome this problem, the study area was divided into small blocks (Map 3), each one assigned to an observer with a knowledge of the area, and counted monthly from February to April. Each block was counted by the observer driving around the area on a pre-arranged two hour period (1000 hrs - 1200 hrs) so that the larger study area was counted simultaneously.

3.1.3 Marking

A number of birds were 'marked' in order to track their movements throughout the study area, and across the country. The birds were marked using two methods -

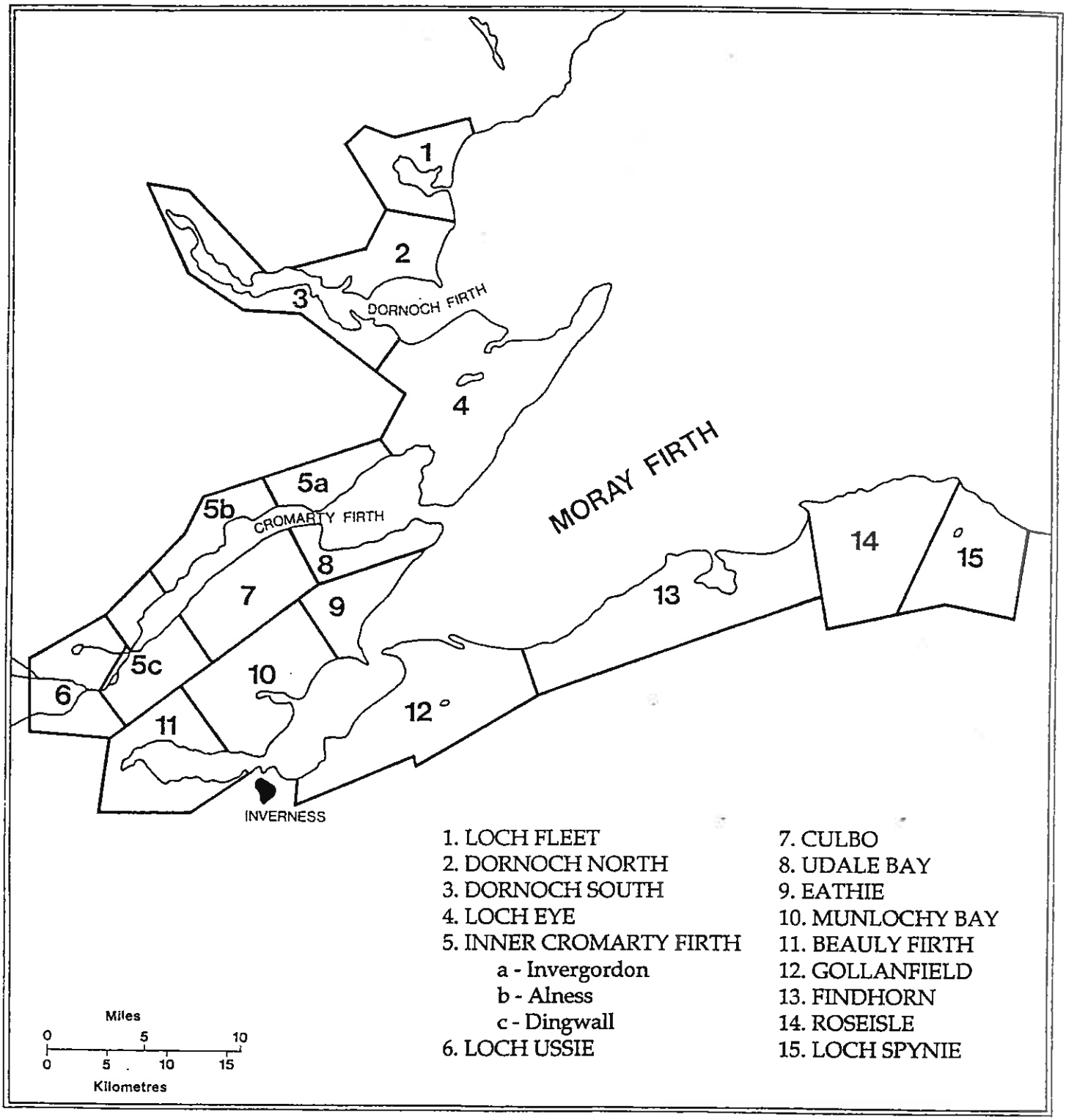
Ringing, a permanent marker, providing long term data on movements, breeding success, longevity etc.

Plumage dyeing, a temporary marker (until the next moult), providing short term data on movements during one season.

The birds were caught, using standard cannon-netting methods, by the Highland Ringing Group. Netting was carried out on the shore of Loch Eye in winter (Nov) and spring (Mar/Apr). All these birds were measured for wing, tarsus, and head/bill lengths. Weight, age and sex were also determined, providing valuable data for WWT population studies.

The winter catch of 100 Greylag and 25 Pinkfeet were given a standard BTO numbered metal ring on the right leg, and their tail and undertail coverts were dyed yellow, using picric acid. The Greylag were also given a white colour ring, with an individual two-letter code, on the left leg.

MAP 3 : Area Counts



1. LOCH FLEET
2. DORNOCH NORTH
3. DORNOCH SOUTH
4. LOCH EYE
5. INNER CROMARTY FIRTH
   - a - Invergordon
   - b - Alness
   - c - Dingwall
6. LOCH USSIE
7. CULBO
8. UDALE BAY
9. EATHIE
10. MUNLOCHY BAY
11. BEAULY FIRTH
12. GOLLANFIELD
13. FINDHORN
14. ROSEISLE
15. LOCH SPYNIE

The spring catch of 137 Greylag and 10 Pinkfeet were also given a standard BTO numbered metal ring on the right leg and a white colour ring on the left leg (Greylag with a 2 letter code, and Pinkfeet with 3 letter code). However, in an attempt to separate the catches, these birds were dyed yellow on the tail, undertail coverts, and forewing.

3.2 Feeding behaviour

3.2.1 Feeding area census

The study area was roughly divided into six regions (Map 4), based on local knowledge of goose behaviour in the area, each of which was counted consecutively every two weeks. Each region was traversed by road and track to allow the best view of as much of the surrounding country as possible. A series of environmental data were recorded for each observation of feeding geese or swans, from as safe a distance as possible so that observation did not disturb the birds and affect their distribution.

3.2.2 Habitat Availability

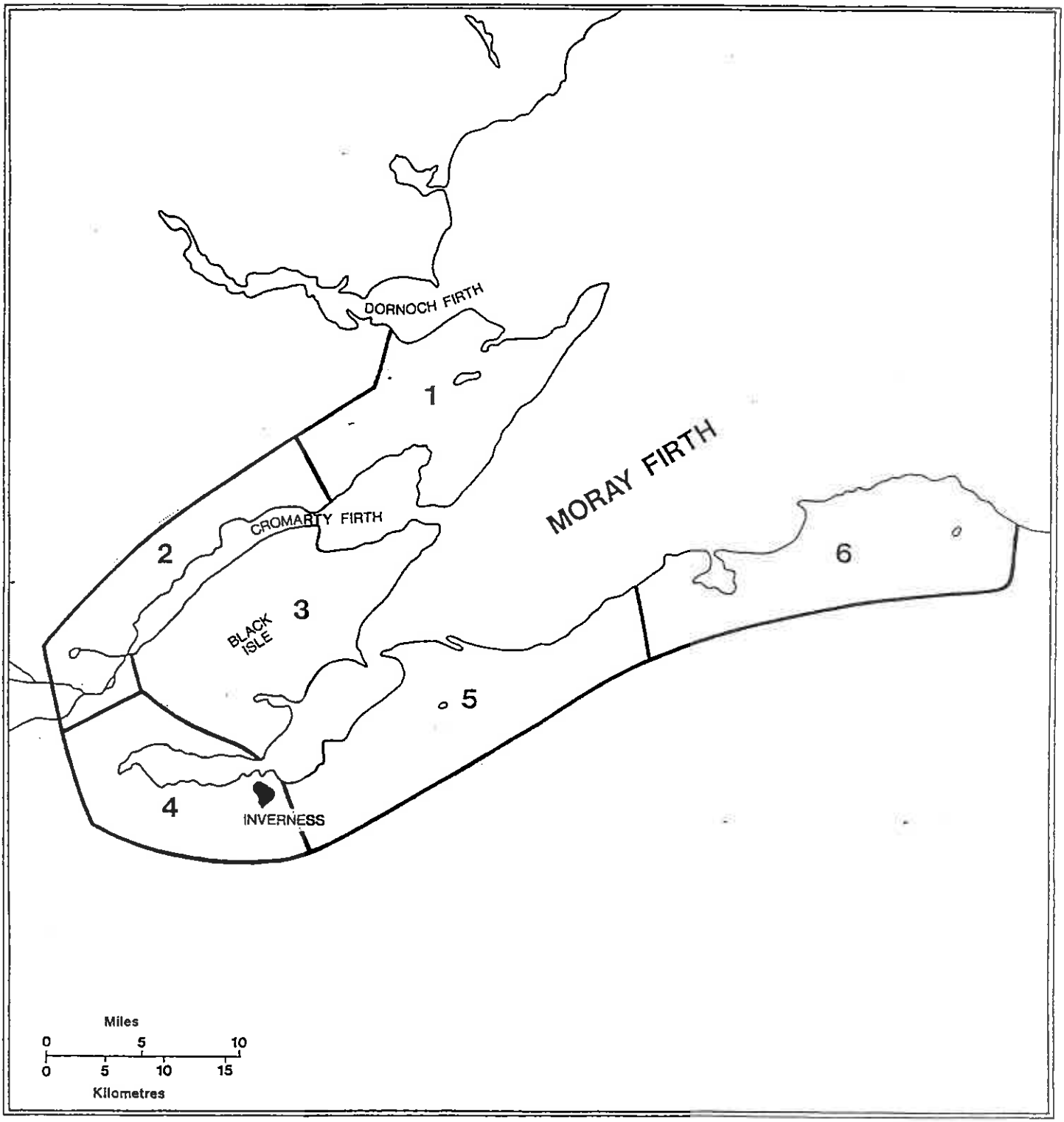
Six road transects (Map 5) of 5 km were established throughout the study area. Three times during the study (autumn, winter and spring) crop type and area were recorded for each field on both sides of the road transect. This method assumes that the area of each crop is proportional to the length of each crop along the transect. The proportion of each crop type available can be calculated from the total length along the transect of each crop observed divided by the total transect length (60 km). This provides a sample of the crops available to the birds, and a clear picture of changes in land use, through the seasons.

Information on the total area of each crop grown in the study area was supplied by the Scottish Office Agriculture and Fisheries Department. This consisted of the total area of each crop in the ground on the 1 June 1992, for each Parish or group of small Parishes. This data could provide a check on the effectiveness of the transect habitat availability sampling.

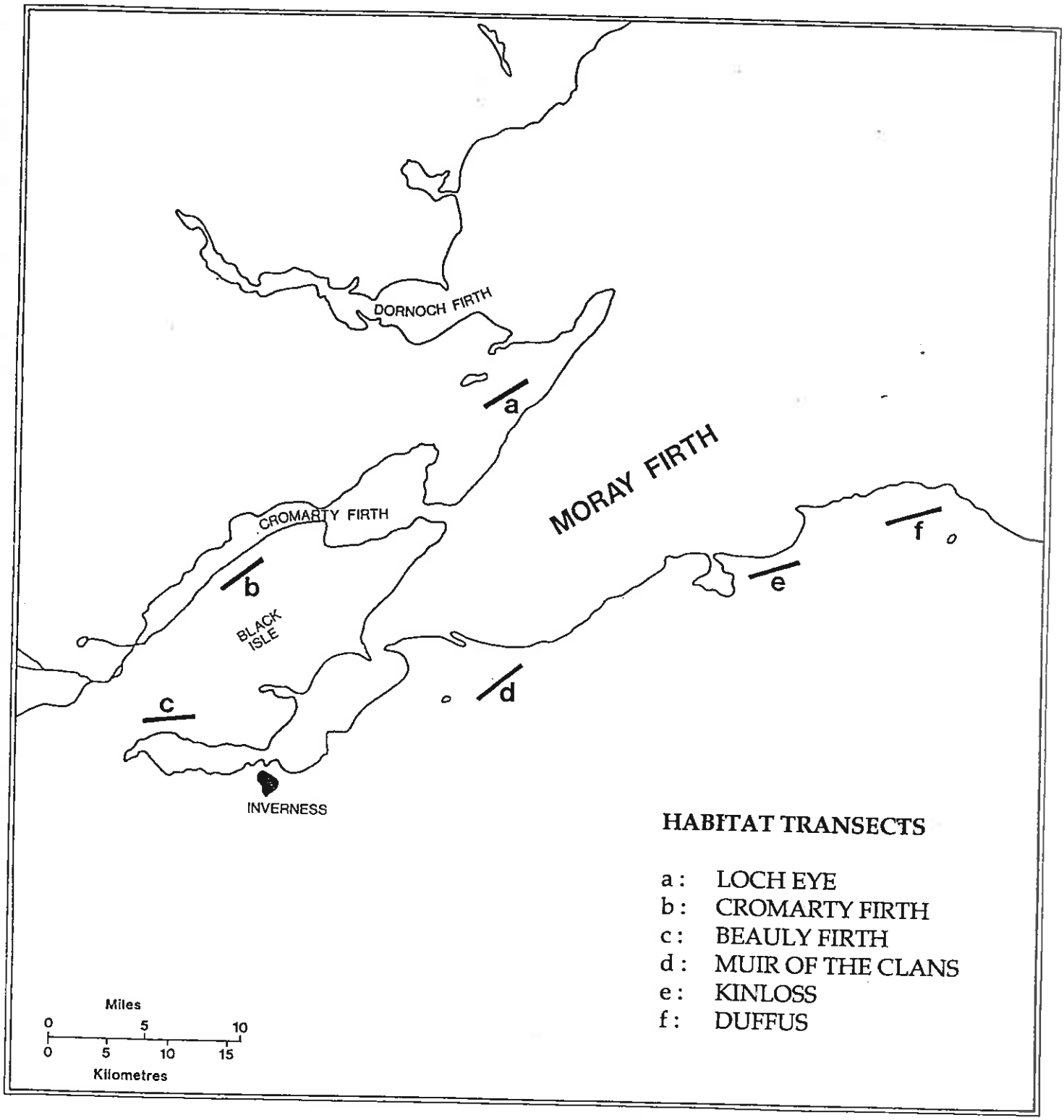
3.2.3 Paired Fields

To investigate reasons, other than crop type, for the use of a feeding site, a series of environmental variables were recorded for fields visited by birds, called 'goose fields', and compared with that of a nearby field (two fields away in a random direction) not visited by birds, called 'non-goose fields'. This was also carried out three times during the study (autumn, winter and spring) in conjunction with the habitat transects.

MAP 4 : Feeding Census Areas



MAP 5 : Habitat Transects



4. RESULTS

4.1 Numbers and Distribution

4.1.1 Roost and area counts

The coordinated roost and area counts, from October to April, provided good cover throughout the study period, with reasonably good visibility on all count days.

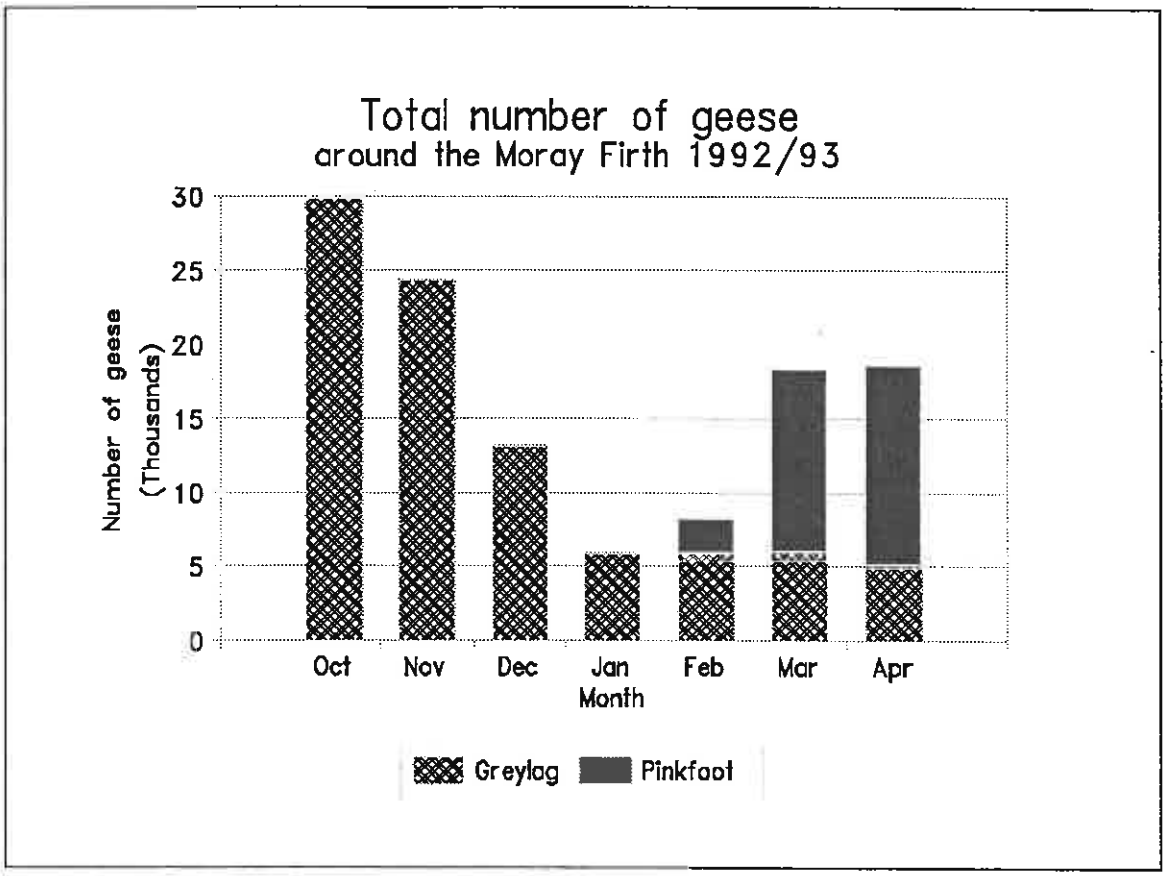


Fig. 3. Total goose numbers in the study area, using data from roost counts (Oct - Jan) and area counts (Feb - Apr).

Figure 3 shows a large influx of Greylag in autumn, peaking at around 30,000 in October, which fell to 24,400 in November and 13,100 in December, with a marked decrease to around 6,000 in January. This decrease was perhaps accelerated somewhat by severe weather conditions in the area, with several days of heavy snow. The number remains settled around 6,000 through the spring, with these birds leaving in late April.

Figure 3 shows a very different pattern for Pinkfeet, with birds passing through in autumn and building up in spring. The numbers built up to around 2,300 in February, with a sudden increase to around 12,400 in March and over 13,500 in April, with these birds leaving in early May.

Tables 1 to 3 show a breakdown of the total numbers of geese across the study area for each month, from roost and area counts.

Table 1: Greylag - Monthly roost counts for Nov 1992 to Jan 1993

ROOST	October	November	December	January
Loch Brora	-	3	-	-
Loch Fleet	950	1570	800	-
Loch Evelix	1155	830	650	150
In Dornoch Firth	-	1560	278	120
Loch Eye	16842	6574	531	850
Nigg Bay	22	0	-	-
Udale Bay	0	105	480	187
Cromarty Firth	0	-	587	188
Loch Ussie	0	6	0	0
Munlochy Bay	235	2230	0	0
Beauly Firth	3400	530	94	23
Loch Flemington	0	0	0	0
Findhorn Bay	490	4900	3570	1357
Loch Spyne	4800	3100	2250	3000
Lower Bogrotten	2000	3000	3900	34
TOTAL	**29894**	**24408**	**13140**	**5909**

Table 1 shows the distribution of Greylag across the roost sites, from October 1992 to January 1993. During the peak, in October, more than half of the birds are concentrated around Loch Eye, with smaller concentrations around the Beauly Firth and Loch Spynie. November shows declining total numbers with a much reduced concentration around Loch Eye, and concentrations around Munlochy Bay, Findhorn Bay, Loch Spynie and Lower Bogrotten. December shows a slightly more even distribution, with some concentration around the eastern roosts. By January, however, the total number has settled to around 6,000 with only one major concentration around Loch Spynie.

Table 2 shows the distribution of Greylag across the areas, from February 1993 to April 1993. Total numbers remain relatively stable and the birds continue to disperse fairly evenly across the study area through February and March. In April, however, the birds begin to concentrate somewhat in the Loch Eye and Roseisle areas, before they return to their breeding grounds in Iceland.

Table 2: Numbers of Greylag in areas between Feb 1993 and Apr 1993

AREA	**February**	**March**	**April**
Loch Brora	2	173	-
Loch Fleet	163	164	-
Dornoch North	875	442	-
Dornoch South	0	942	343
Loch Eye	1202	589	1420
In Cromarty Firth	63	280	0
Loch Ussie	837	498	0
Culbo	1150	0	0
Eathie	0	360	0
Udale Bay	24	0	78
Munlochy Bay	0	0	0
Beauly Firth	120	52	0
Gollanfield	699	629	70
Findhorn	0	414	526
Roseisle	323	932	2000
Loch Spynie	430	515	730
TOTAL	**5888**	**5990**	**5167**

Roost counts were not tabulated for Pinkfeet since very few birds were observed in the area during the autumn and winter. Table 3 shows the distribution of Pinkfeet across the areas, from February 1993 to April 1993, when the birds return to the region. February shows an early concentration around the Gollanfield area, and little use of the northern end of the study area, north of Loch Eye. March shows total numbers increasing dramatically, with a concentration remaining around Gollanfield and a large concentration around Eathie. These concentrations remain through April, with the rest of the population fairly evenly distributed across the study area, except the northern end.

Table 3: Numbers of Pinkfeet in areas between Feb 1993 and Apr 1993

AREA	February	March	April
Loch Brora	0	0	-
Loch Fleet	0	0	-
Dornoch North	1	49	-
Dornoch South	0	20	38
Loch Eye	200	813	1036
In Cromarty Firth	0	0	0
Loch Ussie	10	0	0
Culbo	20	0	60
Eathie	0	5500	4500
Udale Bay	800	0	927
Munlochy Bay	0	1015	640
Beauly Firth	0	1085	843
Gollanfield	1298	2350	3100
Findhorn	0	0	1100
Roseisle	1	65	1200
Loch Spynie	20	1510	70
TOTAL	**2350**	**12407**	**13514**

4.1.2 Marking

Sightings of marked birds are displayed on a series of four maps. Greylag records have been split into three periods (Maps 6 to 8) to clarify movements through each season, while the few Pinkfeet records are displayed on one map representing the whole study period (Map 9).

Map 6 (November and December) shows a concentration of marked Greylag close to the original marking site, as well as a general movement south-east into Grampian region, as far east as the Loch of Strathbeg, and south into east-central Scotland.

Map 7 (January and February) shows rather fewer of the marked Greylag concentrated around the marking site, with a similar distribution generally south and east. One Greylag, however, was recorded as far south and west as Soulseat Loch, Galloway.

Map 8 (March and April) shows Greylag marked in spring tended to remain in the area they were caught ie there is no obvious movement south and east. Previously marked birds tended to concentrate and drift north again, with records as far north as South Ronaldsay, Orkney, in April.

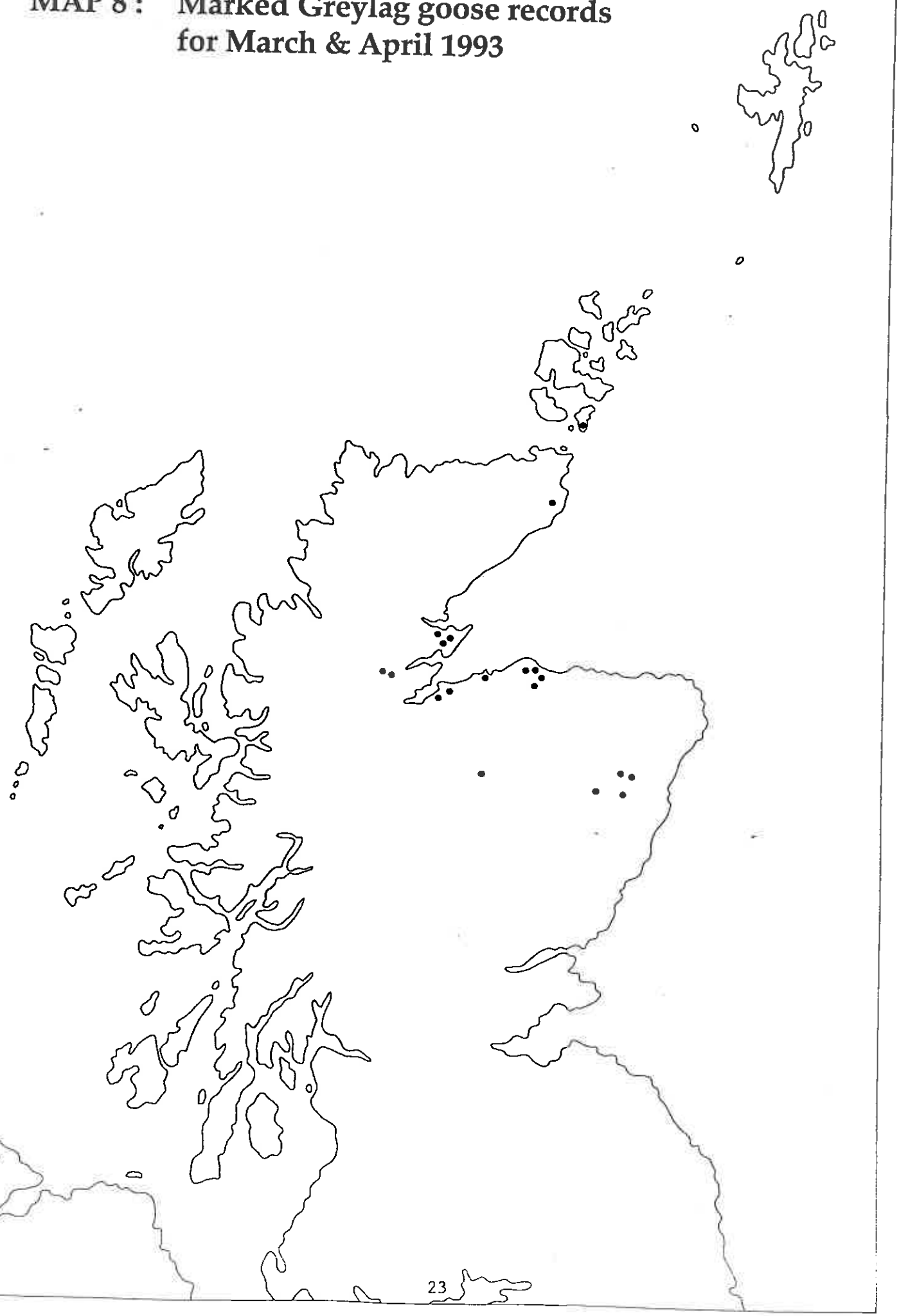
Three colour rings were also read for Greylag on their return to eastern Iceland, in late April 1993.

Map 9 shows a different pattern for marked Pinkfeet, with definite movement east to Loch of Strathbeg and south-east into Fife and as far as Midlothian. One Pink-footed goose marked at Loch Eye on 29 November 1992 was recorded at Memsie, near Fraserburgh, on 1 December 1992, travelling somewhere in the region of 115 km (72 miles) in two days! This certainly gives a clear indication of the scale of movement geese are capable of in a short period.

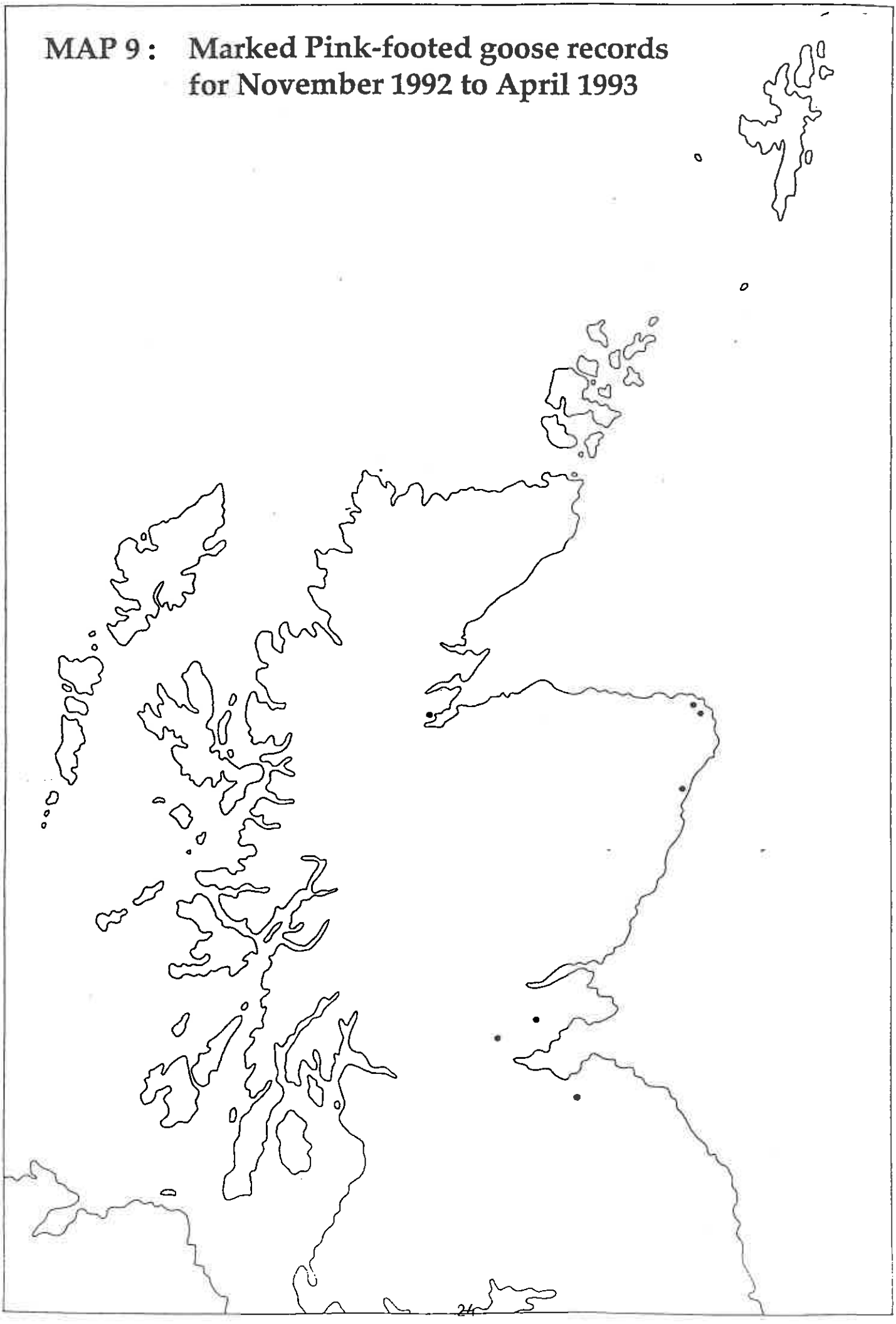
MAP 6 : Marked Greylag goose records for November & December 1992

MAP 7 : Marked Greylag goose records for January & February 1993

MAP 8 : Marked Greylag goose records for March & April 1993



MAP 9 : Marked Pink-footed goose records for November 1992 to April 1993



4.2 Feeding behaviour

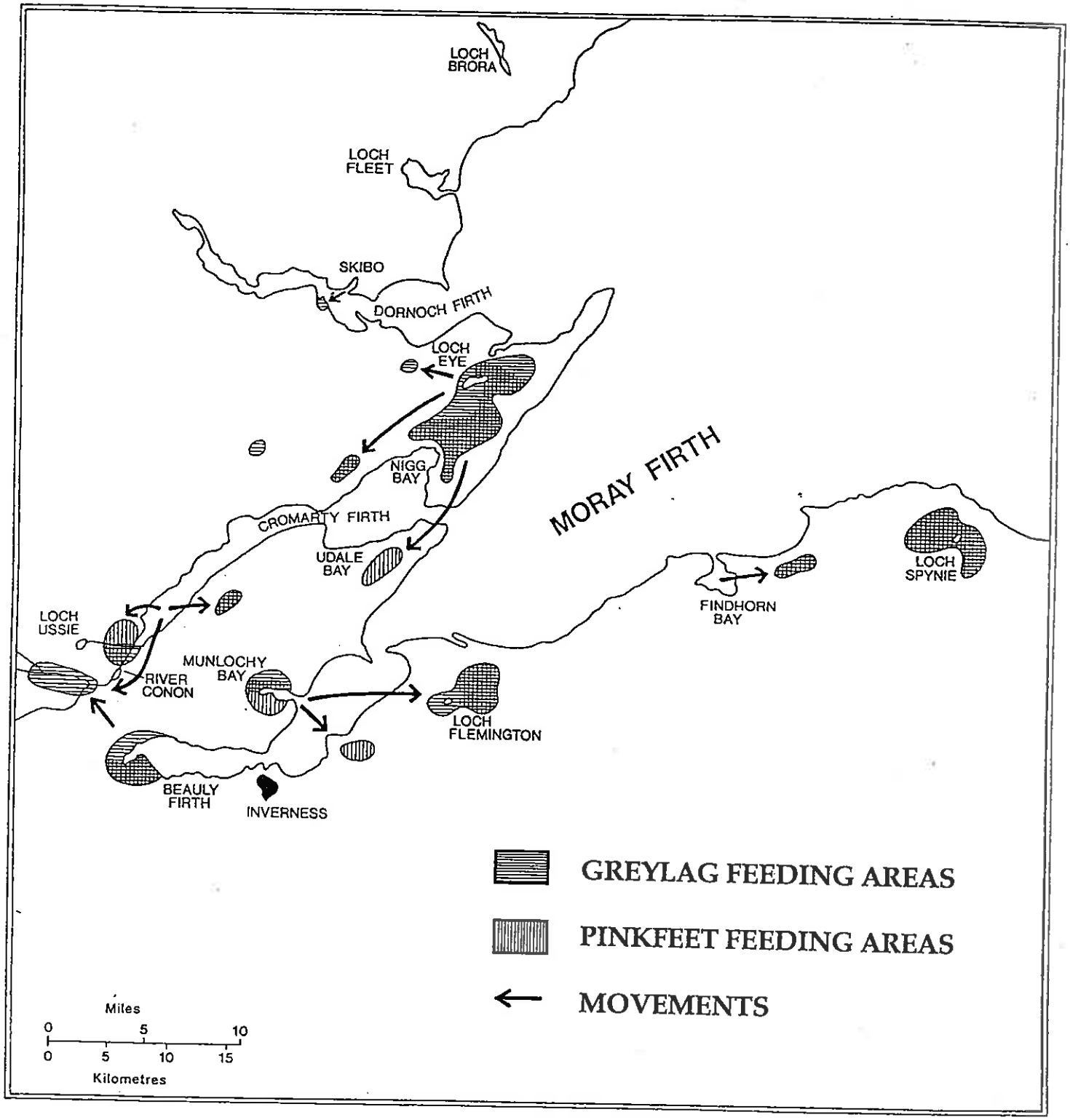
4.2.1 Feeding area census

Two hundred and seventy-five observations were made of feeding geese and swans throughout the study period. These birds were observed using nine of the crop categories, in one hundred and sixty fields.

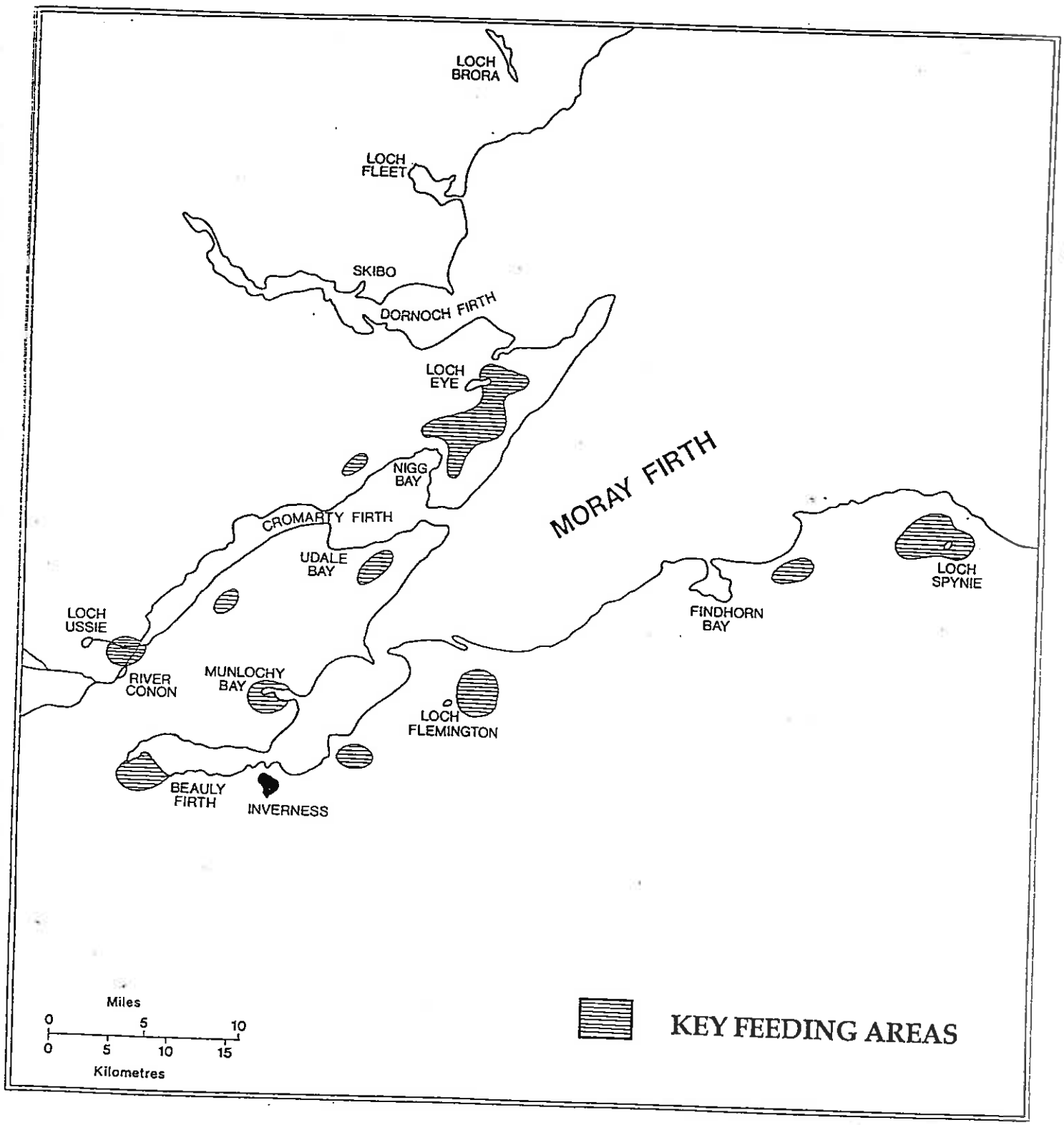
Map 10 shows the major feeding areas surrounding the main roost sites and satellite areas which are within easy reach of the roosts. It proved to be extremely difficult to assess flight lines and map movements between roosts and feeding areas, particularly around the central complex of firths and the Black Isle. The solid arrows on Map 10 represent likely movements between roosts and feeding areas.

Map 11 highlights the key feeding areas used by both species in spring.

MAP 10 : Main feeding areas & movements around the Moray Firth



MAP 11 : Key feeding areas in Spring



4.2.2 Crop use

Figures 4 to 6 are designed to display the crop use by each species throughout the study period, as shown by the Feeding Area Census. The total number of birds observed in each crop type during each two week census period has been plotted.

It is clear from figure 4 that Greylag fed almost entirely on cereal stubbles in autumn, taking advantage of newly sown grain in November, where they could find it. Improved grassland was used throughout, taking on increased importance in late December and becoming the dominant crop used through the spring. A small amount of germinated winter cereal and rough grazing was also used in spring.

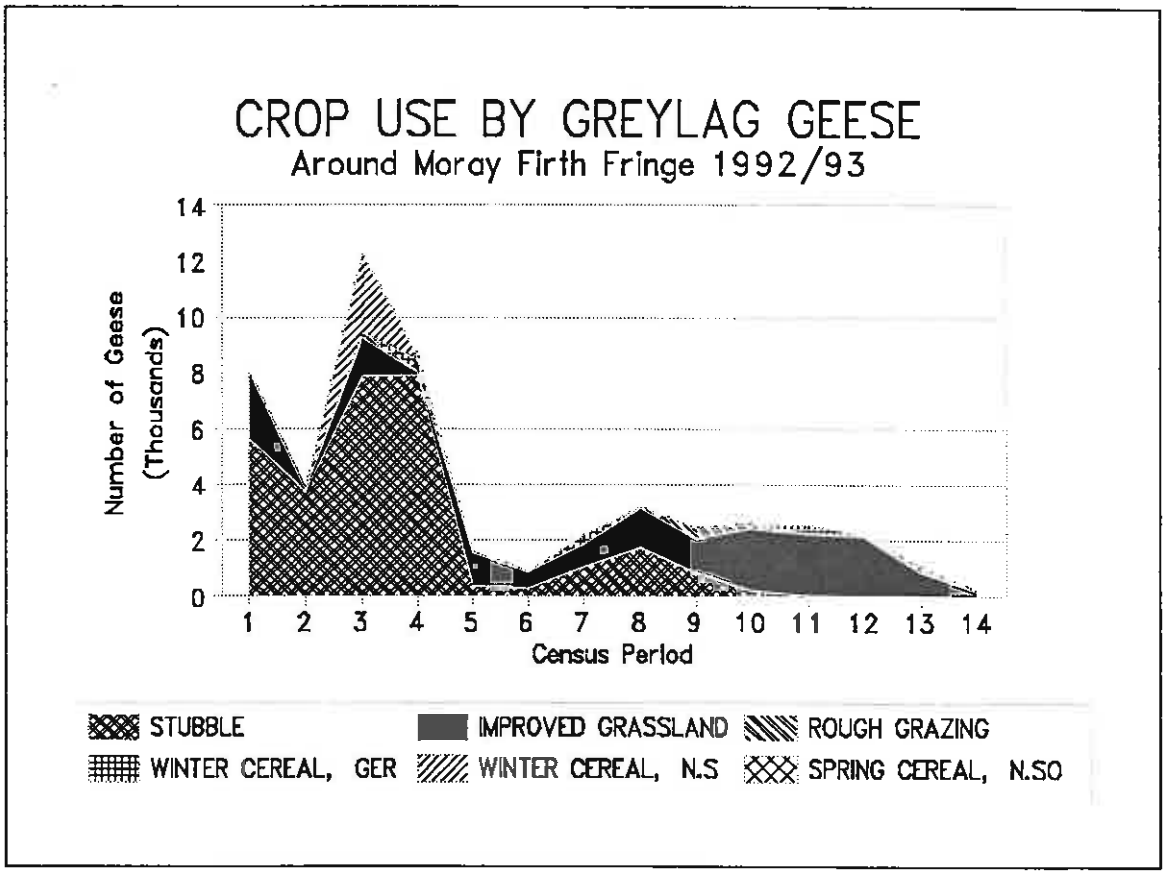


Fig. 4. Crop use by Greylag geese, showing numbers of birds observed in each crop type for each census period - 1) late October, 2) early November, 3) late November, 4) early December, 5) late December, 6) early January, 7) late January, 8) early February, 9) late February, 10) early March, 11) late March, 12) early April, 13) late April, 14) early May.
GER = germinated, N.SO = newly-sown.

A few records also show a use of turnips during the poorest weather, in late December and January, however the numbers of geese involved are so small that this does not appear in Figure 4.

Figure 5 shows intense use of Improved grassland by Pinkfeet throughout the study, with only a small use of cereal stubbles in February when the birds began to build up in numbers. By March, improved grassland was clearly the most important crop, with some use of germinated winter cereals. In April Pinkfeet began to take advantage of newly sown grain and the new growth in rough grazing.

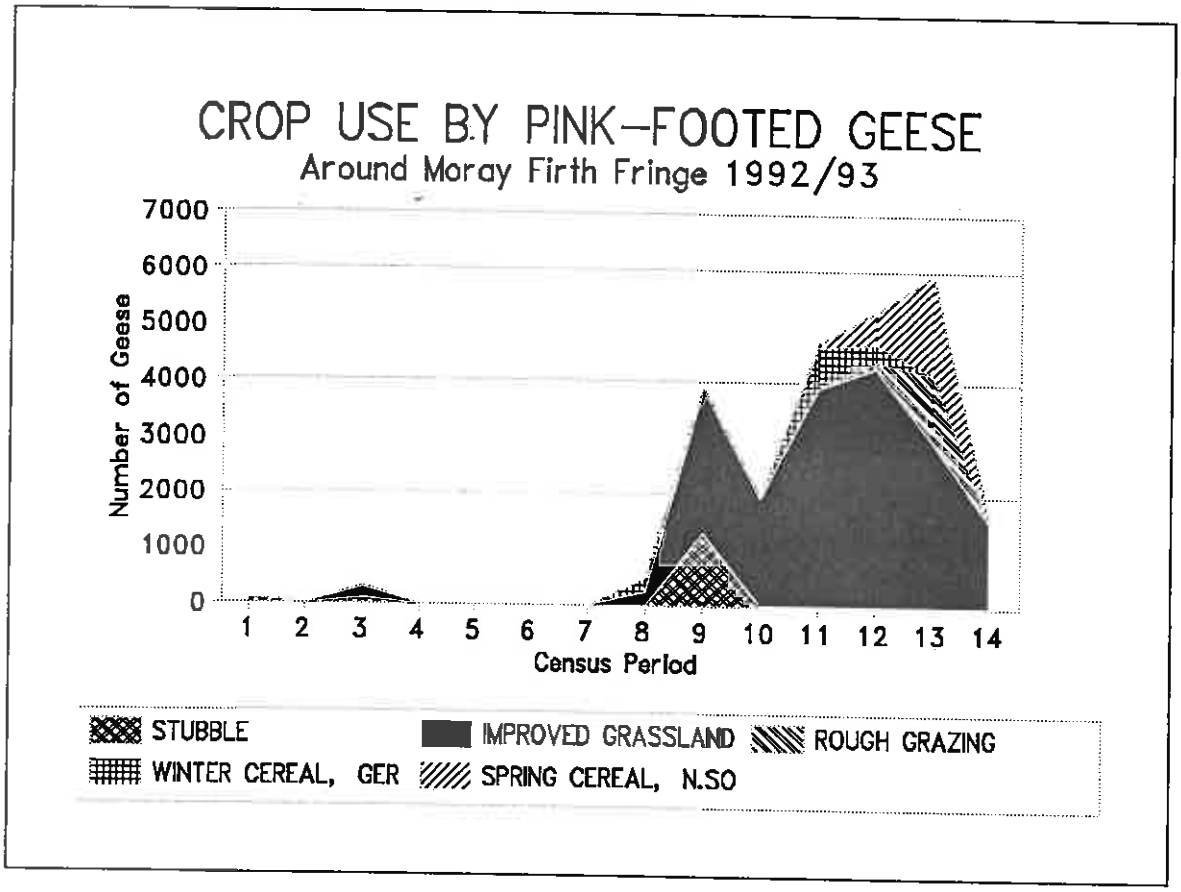


Fig. 5. Crop use by Pinkfeet, showing numbers of birds observed in each crop type for each census period -
1) late October, 2) early November, 3) late November, 4) early December, 5) late December, 6) early January, 7) late January, 8) early February, 9) late February, 10) early March, 11) late March, 12) early April, 13) late April, 14) early May.
GER = germinated, N.SO = newly-sown.

Whooper swans (Figure 6) show a very different pattern, feeding entirely on cereal stubbles in autumn. In January they began to move onto Oilseed rape, and by February they no longer used stubble and were found concentrated on germinated winter cereals and rape.

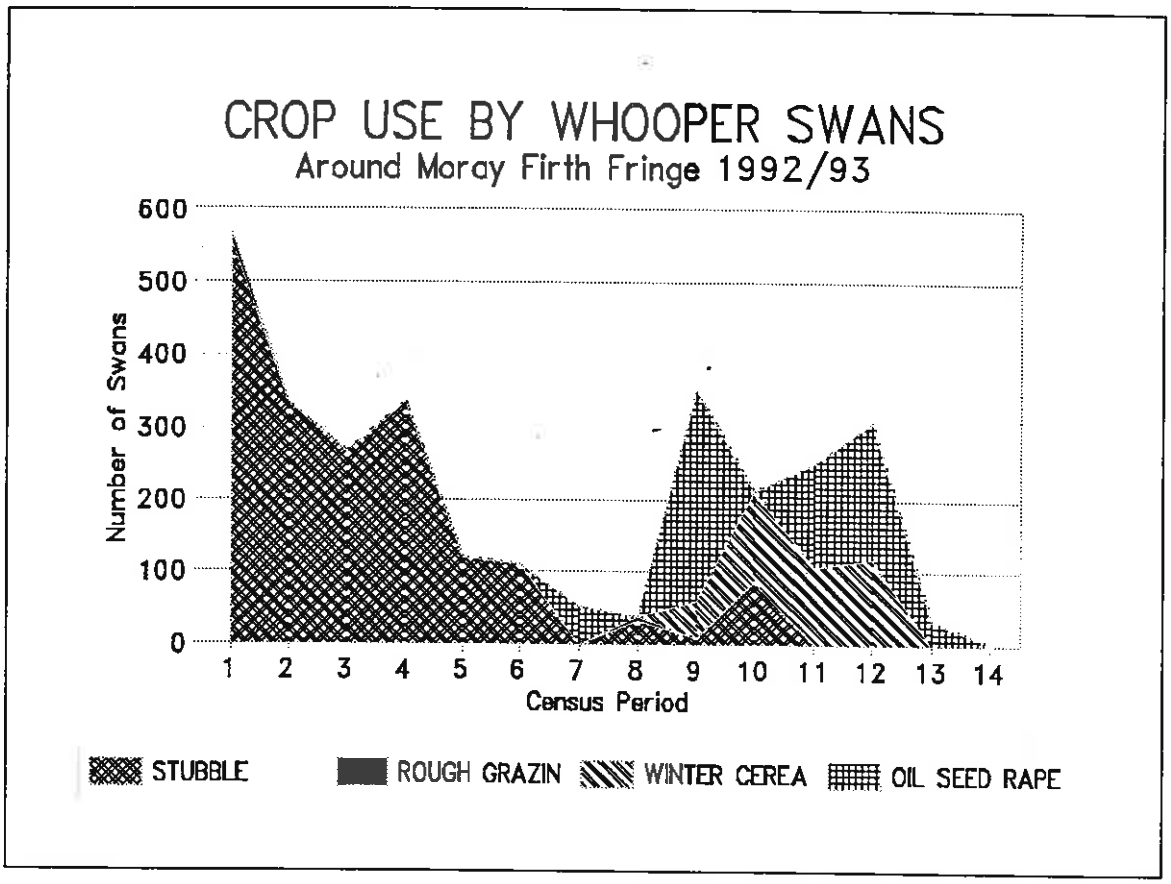


Fig. 6. Crop use by Whooper swans, showing numbers of birds observed in each crop type for each census period - 1) late October, 2) early November, 3) late November, 4) early December, 5) late December, 6) early January, 7) late January, 8) early February, 9) late February, 10) early March, 11) late March, 12) early April, 13) late April, 14) early May.

4.2.3 Habitat availability

Tables 4 to 6 display the results of the habitat transects.

Table 4: Length (km) of each crop type along transects and proportion of crop available in autumn 1992

	TRANSECT						
CROP TYPE	a	b	c	d	e	f	PROP
Imp Grass	1.85	2.80	2.25	4.85	1.50	3.25	**0.27**
R Grazing	0	0	0	0	0	0	-
W Cereal (ns)	0	0	0	0	0	0	-
W Cereal (g)	1.30	1.40	0.90	0.55	2.00	0.45	**0.10**
S Cereal (ns)	0	0	0	0	0	0	-
S Cereal (g)	0	0	0	0	0	0	-
Stubble	3.65	4.90	4.55	2.75	4.20	2.50	**0.37**
Carrots	0	0	0	0	0	0	-
Potatoes	0	0	0	0	0	0	-
Turnips	0.50	0.15	0	0	0.65	0	**0.02**
Set-aside	0	0	0	0	0	0	-
Oilseed Rape	0.90	0	0.50	0	0	0	**0.02**
Linseed	0	0	0	0	0	0	-
Other	2.50	0.75	1.45	1.75	2.00	4.00	**0.20**

In autumn (Table 4) there is a larger proportion of cereal stubble available than improved grassland, and these two crop types make up the majority of habitat available. A small proportion of winter cereal shows germination. Turnips and oilseed rape are available in very small proportions.

Table 5: Length (km) of each crop type along transects and proportion of crop available in winter 1992/93

	TRANSECT						
CROP TYPE	a	b	c	d	e	f	**PROP**
Imp Grass	1.60	3.20	2.75	4.60	1.55	3.10	**0.27**
R Grazing	0	0	0	0	0	0	-
W Cereal (ns)	0	0	0	0	0	0	-
W Cereal (g)	3.25	0.85	0.80	0.75	2.05	1.35	**0.14**
S Cereal (ns)	0	0	0	0	0	0	-
S Cereal (g)	0	0	0	0	0	0	-
Stubble	3.30	4.70	2.60	2.40	1.95	2.00	**0.27**
Carrots	0	0	0	0	0	0	-
Potatoes	0	0	0	0	0	0	-
Turnips	0.50	0.05	0	0	0.65	0	**0.01**
Set-aside	0	0	0	0	0	0	-
Oilseed Rape	0.85	0.20	0.50	0	0	0	**0.02**
Linseed	0	0	0	0	0	0	-
Other	0.50	1.00	3.40	2.20	4.10	3.85	**0.24**

In winter (Table 5) the proportion of improved grassland available remains the same, while the proportion of cereal stubble decreases. However, these two crop types remain the majority of habitat available, with a slight increase in the proportion of winter cereal germinated. There is a decrease in the proportion of turnips available, but oilseed rape remains the same.

In spring (Table 6) the picture is quite different, with practically no cereal stubble available. The proportion of improved grassland remained the same throughout, with an equal proportion of newly sown spring cereal available at this time of year. The proportion of germinated winter cereal has increased, and some spring cereal shows germination. The proportion of turnips available has decreased further, while oilseed rape has remained the same throughout.

Table 6: Length (km) of each crop type along transects and proportion of crop available in spring 1993

	TRANSECT						
CROP TYPE	a	b	c	d	e	f	**PROP**
Imp Grass	1.10	3.25	2.70	4.65	1.45	2.95	**0.26**
R Grazing	0	0	0	0	0	0	-
W Cereal (ns)	0	0	0	0	0	0	-
W Cereal (g)	3.50	0.90	1.65	0.45	2.10	2.50	**0.18**
S Cereal (ns)	2.35	4.05	1.40	2.10	3.95	2.40	**0.26**
S Cereal (g)	1.20	1.00	2.65	0.25	0	0	**0.08**
Stubble	0.40	0.40	0.50	0	0.20	0.70	**0.03**
Carrots	0	0	0	0	0	0	-
Potatoes	0	0	0	0	0	0	-
Turnips	0	0	0	0	0.40	0	**0.00**
Set-aside	0	0	0	0	0	0	-
Oilseed Rape	0.85	0.20	0.50	0	0	0	**0.02**
Linseed	0	0	0	0	0	0	-
Other	1.00	0.50	0.90	2.35	2.00	1.80	**0.14**

Table 7 displays the area of each crop type and the proportions available, as shown by the SOAFD Agricultural Census for June 1992. This Parish data covers all of the study area and more, including a large area of hill ground with improved grassland and rough grazing not much used by grey geese. I have ignored the large area of rough grazing and included only arable land in the calculation of proportions of crop available.

Table 7: Total area (ha) of each crop type and proportion of crop available in June 1992 - from SOAFD Agricultural Census

CROP TYPE	AREA (ha)	PROPORTION
Improved Grass	43,032.9	0.52
Winter Cereals	7,244.9	0.08
Spring Cereals	23,919.5	0.29
Carrots	195.5	0.00
Potatoes	1,249.6	0.01
Turnips	2,195.5	0.02
Set-aside	2,449.1	0.02
Oilseed Rape	1,461.4	0.01
Kale	26.5	0.00

It is difficult to compare this summer data with the autumn, winter and spring transect results since the categorisation of crops is inconsistent, and the Parish boundaries stretch over a much larger area than the study area which the transects represent.

When compared with the results of the spring transects, the closest seasonal match, the two sets of data show a general similarity. Improved grassland and spring cereals make up the vast majority of habitat available, with only very small proportions of a few other crop types appearing.

However, the proportion of improved grassland is much greater in the summer Parish data than the spring transect data. This is likely to be an effect of the Parish data including a large area of hill ground, some of which will have been recorded as improved, although it is not part of the low-lying arable fringe around the Moray Firth.

I believe that habitat assessment using transects was a valuable method which provided a good sample and does represent the proportions of each crop type available to grey geese in each season and across the study area.

4.3 Statistical Analysis

4.3.1 Crop selection

Crop selection by geese was explored using the Jacob Selection Index (Table 8). Indices of selection can be determined from the equation:

$$Q = r(1-p) / p(1-r)$$

where r is the proportion of birds in a given habitat, and p is the proportion of that habitat available.

This test was run using the proportion of crop available, from habitat transects, and the proportion of birds observed in each crop type during the same census periods in which the habitat transects were recorded. Since there were so few Pinkfeet in the study area through the autumn and winter, counts for both species have been lumped together for these seasons.

Table 8: Indices of Selection by grey geese for different crops
Values over one indicate positive selection

CROP	AUTUMN	WINTER	SPRING	
	both spp	both spp	Greylag	Pinkfeet
Improved Grass	0.33	1.00	139.4	12.9
Stubble	3.02	2.12	-	-
W Cereal (g)	2.68	1.45	0.04	0.29
S Cereal (ns)	-	-	-	0.35
Turnips	-	5.21	-	-

The results in Table 8 show positive selections by grey geese for stubble and germinated winter cereal in autumn, and for stubble, germinated winter cereal and turnips in winter. In spring, the species show independent positive selections for improved grass.

4.3.2 Paired fields

A series of statistical tests, using the Paired Field data, compared 'goose fields' and 'non-goose fields'.

4.3.2.1 Crop types

Chi-square tests were used to determine whether there were any statistically significant differences between the crop types found in goose and non-goose fields (Table 9) ie do the chosen goose fields show a different pattern of crop types than the random non-goose fields? No significant differences were found between goose and non-goose fields for stubble and other crop types ($X^2_1 = 3.67$) in autumn, for grass, stubble and others ($X^2_2 = 4.42$) in winter, and for grass, spring cereals and others ($X^2_2 = 5.64$) in spring. However, it should be noted that in each case the test statistic was close to the 5% probability threshold. Therefore, trends in the data would suggest that the chosen goose fields do have a different pattern of crop types than the random non-goose fields.

Table 9: Crop distribution for goose fields and non-goose fields

CROP TYPE	GOOSE FIELDS			NON-GOOSE FIELDS		
	autumn	winter	spring	autumn	winter	spring
Improved Grass	2	10	8	6	4	6
R Grazing	0	1	3	0	0	1
W Cereal (g)	0	4	4	5	9	7
S.Cereal (ns)	0	0	15	0	0	10
S.Cereal (g)	0	0	1	0	0	1
Stubble	24	11	1	16	14	5
Turnips	0	0	0	1	0	0
Oilseed Rape	0	0	0	0	0	1
Plough	4	4	1	2	3	2

4.3.2.2 Boundary types

Mann-Whitney U-tests were employed to determine differences between goose and non-goose fields for boundary types, percentage standing water, and nearest occupied building (Table 10). No significant differences were observed.

Table 10: Boundary types for goose & non-goose fields. Values are the percentage of the perimeter bounded by different structures.

	GOOSE FIELDS		NON-GOOSE FIELDS	
	median	range	median	range
Boundary types				
% wire fence	100	0-100	100	0-100
% hedge/wood	25	0-100	25	0-100
% drystane dyke	0	0-100	0	0-100
% road/track	25	0-50	25	0-66
% standing water	0	0-50	0	0-30
Nearest occupied building (m)	100	50-1000	100	50-600

4.3.2.3 Field area

A two-way Analysis of Variance (ANOVA) on the field areas (Table 11) showed significant difference between goose and non-goose fields, with goose fields being larger ($F_{1,180} = 3.0$, $P = 0.08$). As well as a significant seasonal change ($F_{2,180} = 7.9$, $P < 0.001$) with goose fields tending to be smaller in winter compared with autumn and spring.

Table 11: Field areas (ha) for goose fields and non-goose fields

SEASON	GOOSE FEILDS			NON-GOOSE FIELDS		
	mean	st dev	range	mean	st dev	range
Autumn	11.8	5.2	5-25	9.5	3.2	4-17
Winter	8.0	3.5	3-19	8.7	3.2	4-19
Spring	12.2	6.2	5-32	10.5	4.0	4-25

4.3.2.4 Livestock

The relationships between geese and livestock was also examined, comparing the presence of sheep and cattle between goose and non-goose fields. Selecting only grass fields, a significant association was found between geese and grass fields without sheep ($P = 0.021$), using the Fisher Exact (two-tailed) test. The presence of cattle in the area was so rarely recorded that the data is unsuitable for statistical analysis.

Table 12: The presence of livestock in grass fields between goose and non-goose fields for the total transect data.

	SHEEP		CATTLE	
	present	not present	present	not present
GOOSE FIELDS	2	22	0	24
NON-GOOSE FIELDS	7	10	1	16

4.3.3 Flock size

Tables 13 and 14 display the sample size, median, first and second quartiles, and range of flock sizes for each species in each census period. The median and range together indicate changes in the flock sizes throughout the seasons.

Table 13: Greylag flock sizes for each census period - 1) late October 2) early November 3) late November 4) early December 5) late December 6) early January 7) late January 8) early February 9) late February 10) early March 11) late March 12) early April 13) late April 14) early May.

CENSUS PERIOD	SAMPLE	1st	MEDIAN	2nd	RANGE
1	11	280	500	825	70-2600
2	6	130	270	460	94-2600
3	26	82	315	600	2-2800
4	14	86	315	920	2-2200
5	7	90	240	350	35-560
6	9	38	72	180	15-480
7	11	68	130	205	34-804
8	15	65	204	305	8-500
9	10	50	113	300	5-750
10	11	111	236	400	50-786
11	10	50	274	320	8-900
12	12	32	114	325	3-540
13	10	40	81	190	20-300
14	3	20	20	109	20-197

Greylag flock sizes (Table 13) appear large when the birds first arrive, but soon begin to decrease through the autumn. A sudden decrease is clear during early January, coinciding with the poorest weather conditions and heavy snowfall. Flock size builds up again through February and March, but decreases quite rapidly from early April until the birds leave in late April/early May.

Table 14: Pinkfeet flock sizes for each census period - 1) late October 2) early November 3) late November 4) early December 5) late December 6) early January 7) late January 8) early February 9) late February 10) early March 11) late March 12) early April 13) late April 14) early May.

CENSUS PERIOD	SAMPLE	1st	MEDIAN	2nd	RANGE
1	4	6	19	40	4-50
2	-	-	-	-	-
3	2	6	41	75	6-75
4	-	-	-	-	-
5	-	-	-	-	-
6	-	-	-	-	-
7	-	-	-	-	-
8	5	20	220	220	17-220
9	10	40	136	520	17-1445
10	4	40	246	939	15-1450
11	11	52	163	710	11-1550
12	12	100	221	380	25-2200
13	14	210	305	700	18-980
14	5	130	160	470	108-780

Pinkfeet flock sizes (Table 14) appear low in autumn when the birds are passing through the area. When the birds return in early February flock size is much increased and remains fairly stable throughout the spring, although the range does narrow considerably.

4.3.4 Field use

Figure 7 shows the total number of fields used by Greylag and Pinkfeet throughout the study period. There was a steady increase in the total number of fields used by Greylag throughout the study period. This suggests that Greylag continually select new fields at an even rate throughout the seasons. The number of new fields used does not appear to be density-dependent, since it remains steady through the seasons while the total number of Greylag decreases dramatically from autumn to winter.

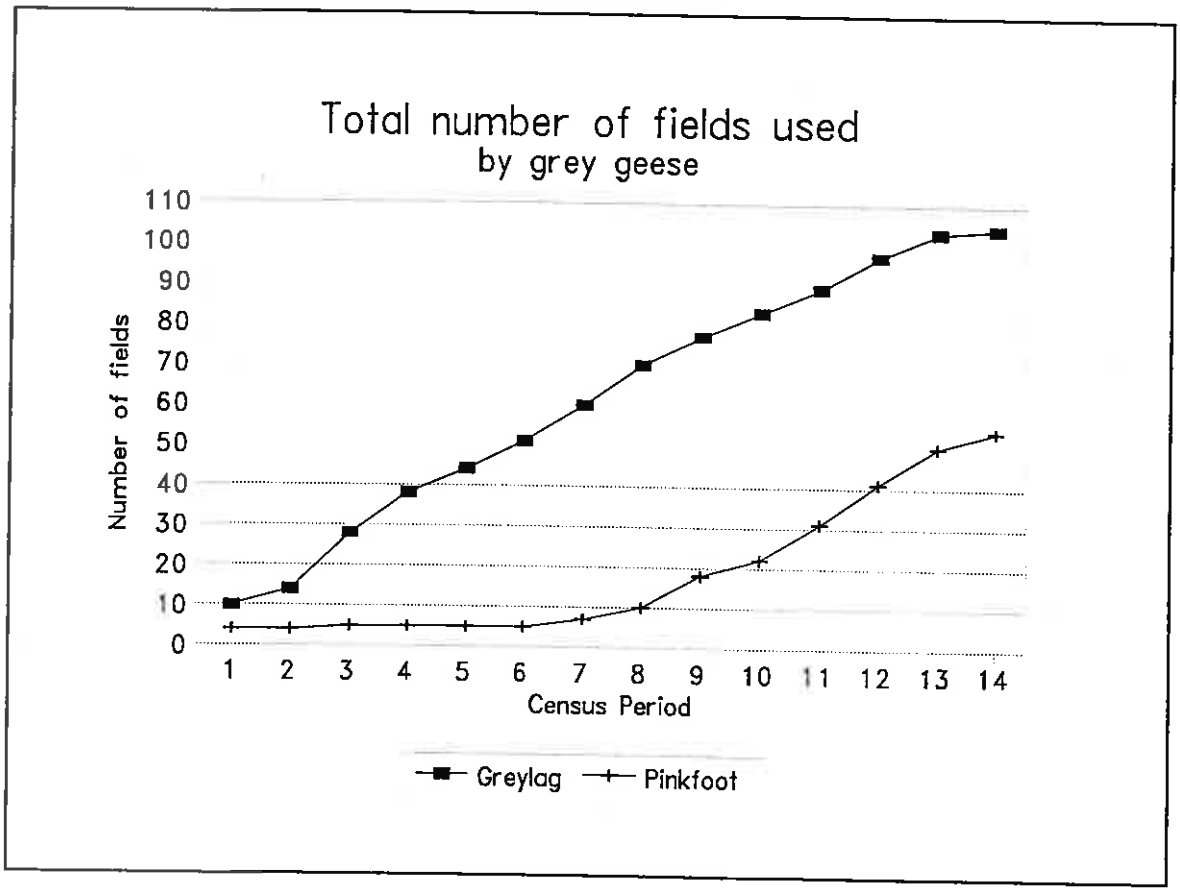


Fig. 7: Total number of fields used by Greylag and Pinkfeet for each census period.

The total number of fields used by Pinkfeet (Figure 7) does not increase through autumn and winter since only a few birds were recorded passing through in autumn. However, after Pinkfeet returned to the area in spring, the pattern was similar to that of the Greylag, with total number of fields used increasing steadily. Again, the number of new fields used does not appear to be density-dependent, remaining steady while the total number of Pinkfeet increased dramatically through the spring.

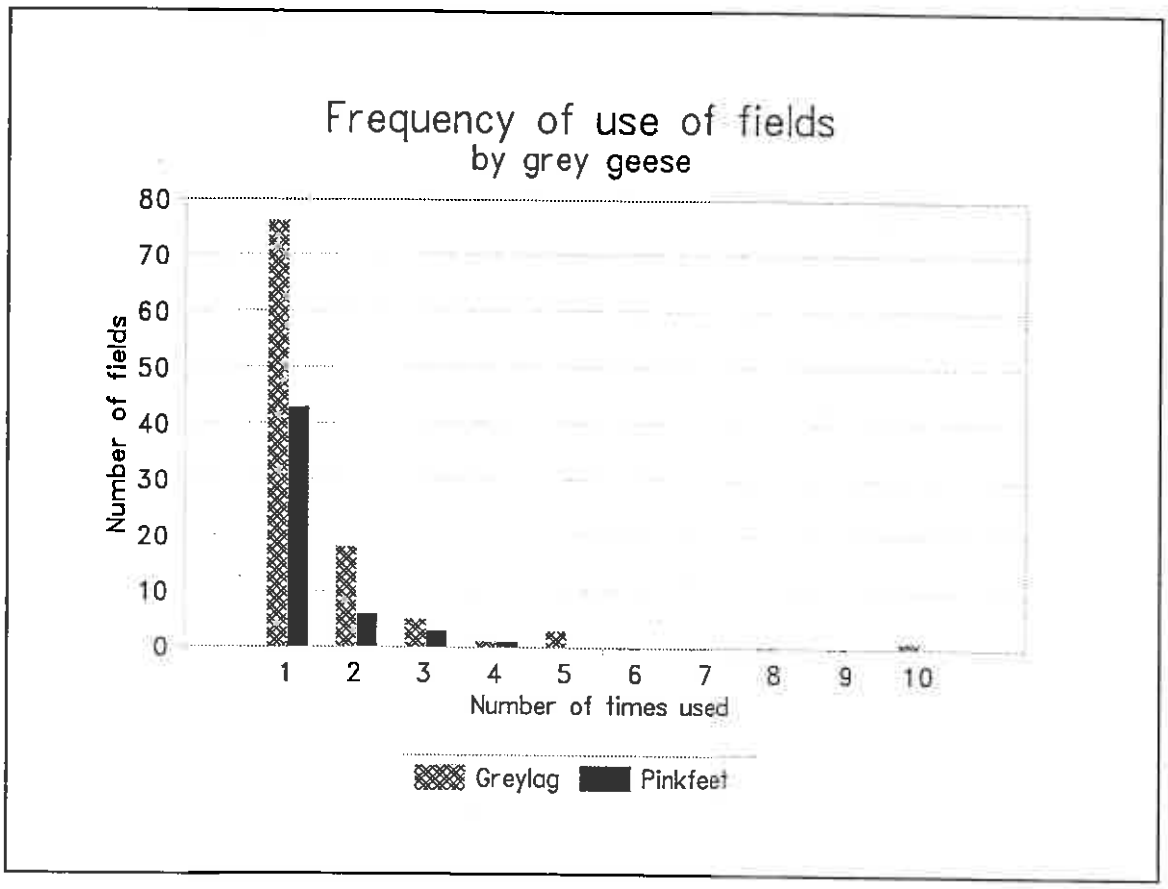


Fig. 8: Frequency of use of fields by grey geese.

Figure 8 shows the frequency of use of fields by grey geese. Greylag used 76 fields once, 18 fields twice, 5 fields three times, 1 field four times, 3 fields five times, and 1 field ten times. Pinkfeet used 43 fields once, 6 fields twice, 3 fields three times, and 1 field four times.

It is clear that both Greylag and Pinkfeet concentrated their activity in a small number of fields and used a large number of additional fields far less frequently.

4.3.5 Distance from roost

The median distances travelled from roost sites to feeding areas by both species is displayed in Table 15 for each season. Sample size, first & second quartiles, and range are also shown.

Table 15: Median distance from roosts travelled by each species (km).

	SAMPLE	1st	MEDIAN	2nd	RANGE
GREYLAG					
autumn	53	2	4	6	1-20
winter	44	2	4	4	0-20
spring	25	1	2	3	0-15
PINKFEET					
autumn	6	1	4	6	1-13
winter	4	1	2	8	1-13
spring	24	1	2	4	1-19

The distance each flock travelled from a roost was extremely difficult to assess, since so many possible roost sites exist within a relatively small area, particularly around the central complex of firths. Roost sites could only be identified where flocks were reasonably close to a roost, therefore the median distances displayed in Table 15 may be low.

4.3.6 Licences

Licences allowing shooting outwith the open season can be issued to landowners who have proved severe damage to crops due to goose grazing, and have tried alternative methods of scaring. These licences, issued by SOAFD, include restrictions on dates when shooting may occur, and the number of guns on each occasion.

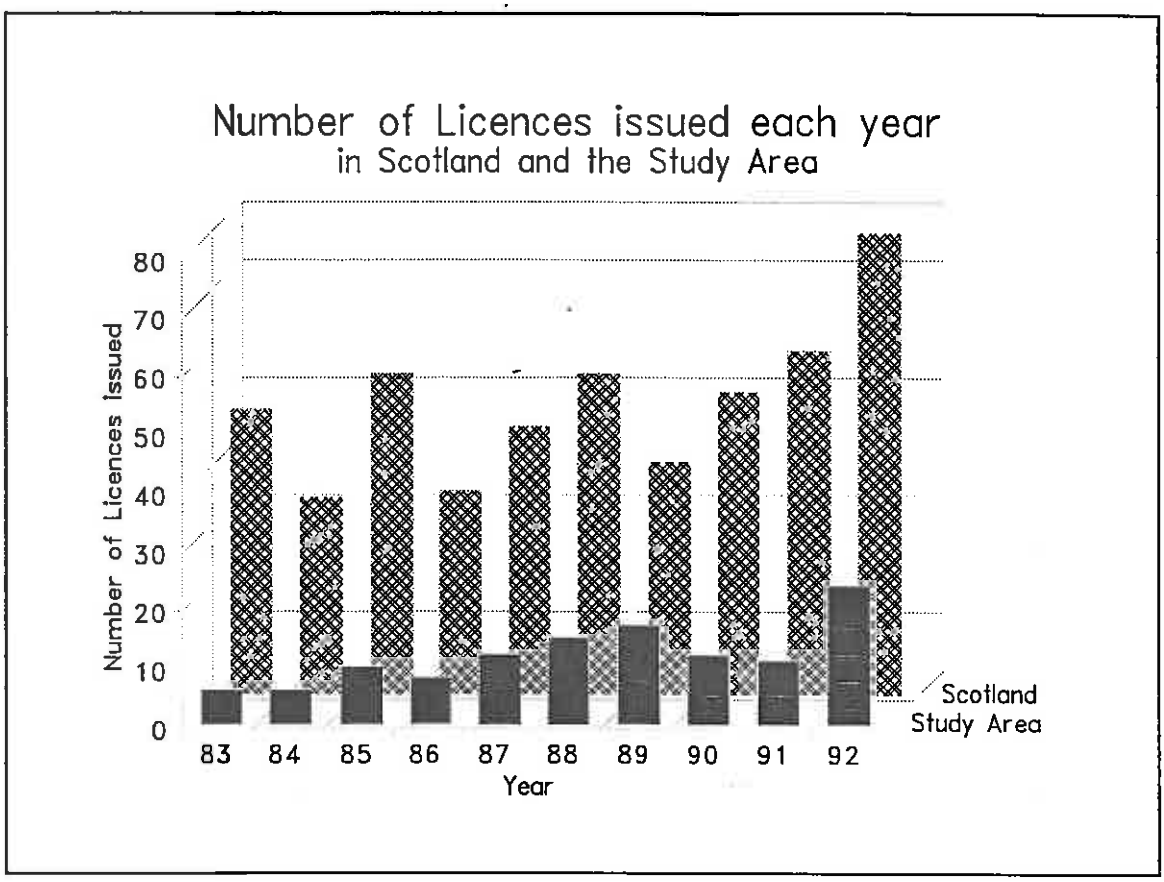


Fig. 8: The total number of goose licences issued each year in Scotland and the study area.

The total number of licences issued each year from 1983 to 1992 has been plotted in Figure 8 for Scotland and the Study Area. The number of licences issued nationally appears to vary widely, however, there does appear to be a sustained increase from 1989 to 1992. In the Study Area, the number of licences issued does not vary so much, building steadily to a peak in 1989, decreasing again in 1990 and 1991, and increasing suddenly in 1992.

The number of birds shot under licences issued by SOAFD is explored in Figures 9 and 10.

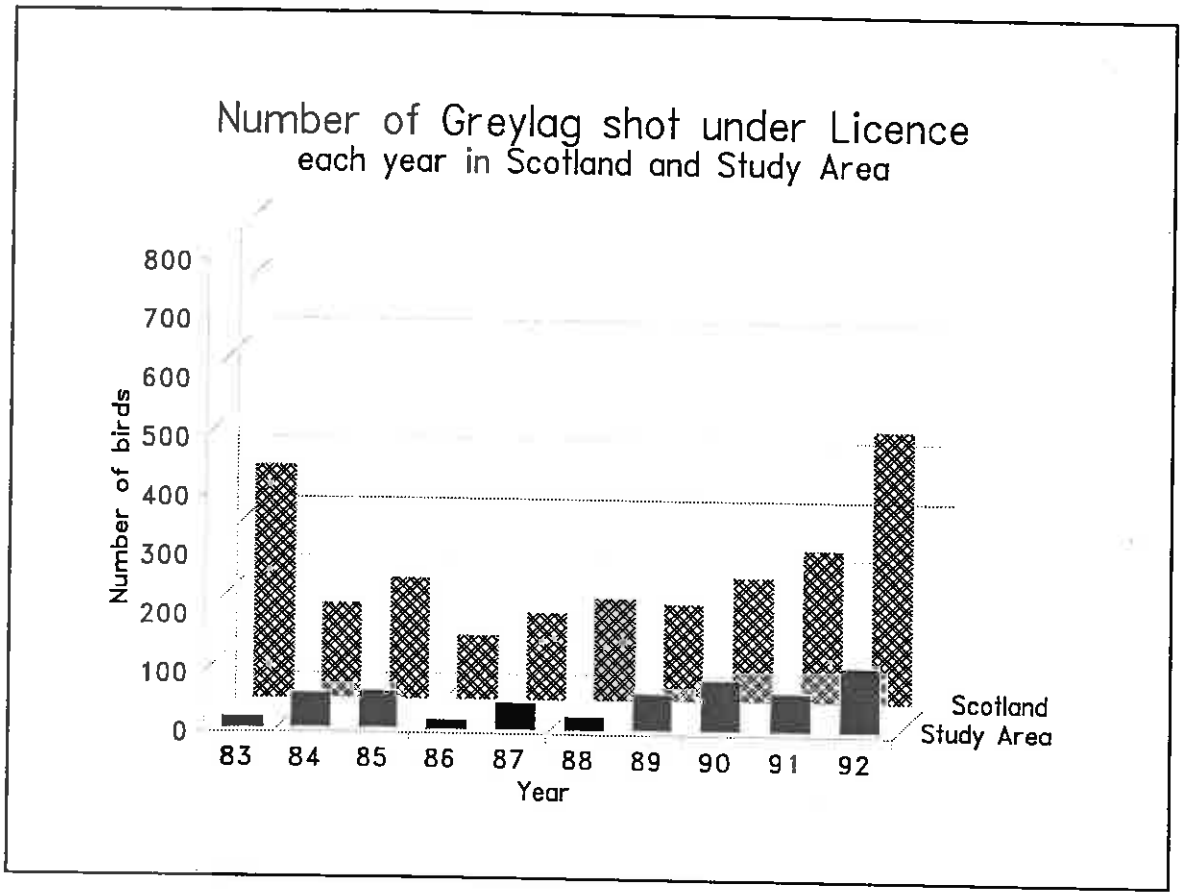


Fig. 9: Total number of Greylag shot under licence each year in Scotland and the study area.

In Figure 9, the number of Greylag shot under licence nationally varies from one year to the next, but there does appear to be a steady increase from 1989 to 1992. In the Study Area, the number of Greylag shot under licence also varies enormously from one year to the next and appears to bear little relation to the total number of licences issued in the area.

In Figure 10, the number of Pinkfeet shot under licence nationally also varies from one year to the next, although there does appear to be a slight increase from 1987 to 1991, with an enormous increase in 1992. In the Study Area, the number of Pinkfeet shot under licence remains very low throughout the period from 1983 to 1991, but again there is a big increase in the number of birds shot in 1992.

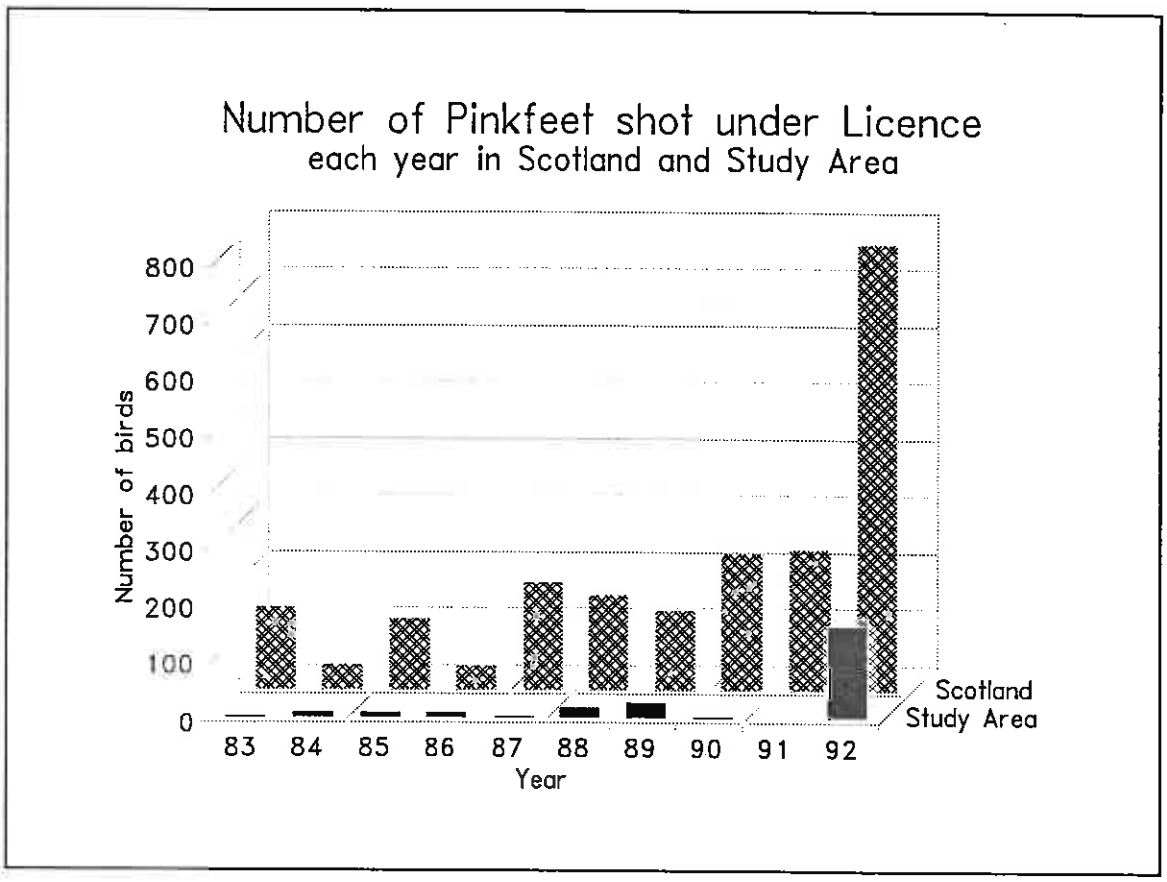


Fig. 10: Total number of Pinkfoot shot under licence each year in Scotland and the study area.

4.4 Summary of Results

Greylag and Pink-footed goose populations have shown marked increases in recent decades both locally and nationally.

Greylag arrived in the area in late September and built up quickly to a peak around 30,000 in October, with birds concentrated in large numbers around a few major roosts.

Pinkfeet also arrived in the area in late September, but quickly passed through en route to southern wintering areas.

In autumn, Greylag fed almost entirely on cereal stubble and showed a positive selection for stubble and germinated winter cereals.

Greylag numbers decreased rapidly through the autumn and early winter to around 6,000 in January, and remained settled around this figure through the late winter and spring.

During the winter, Greylag showed a positive selection for stubble, germinated winter cereals, and turnips.

From January onwards improved grassland became increasingly important to the Greylag, and the large concentrations of birds began to break up.

Pinkfeet numbers began to build up in this area in February, reaching a peak of around 13,500 in April, with birds concentrated in large numbers in a few major feeding areas.

Pinkfeet used improved grassland intensively, and remained in large concentrations throughout the spring.

Both species showed a positive selection for improved grass in spring.

Both species preferred large fields, although fields used tended to be smaller in winter than in autumn and spring.

Both species used new fields at a similar steady rate throughout the seasons.

Both species used a large number of fields only once, and concentrated activity took place in very few fields.

Both species avoided grass fields with sheep.

4.5 Local perceptions

4.5.1 Landowners

Through discussion with local representatives of the agricultural community I am of the impression that landowners in the area have a very clear perception of the situation. A vast increase in the numbers of grey geese has long been recognised, as have widespread changes in their distribution. Where landowners are particularly badly affected, views are often extreme. However, most landowners seem happy to see geese, but claim to be simply unable to sustain the financial pressures they generate. Geese are believed to create problems for landowners in two important ways, 1. by causing direct damage to crops, and 2. by restricting options in the planning of crop rotations and timing of sowing.

Problems are seen to be worse on large farms, especially where the amalgamation of small farms has left large areas of arable land uninhabited. These areas, where large numbers of geese may go unnoticed and undisturbed for some time, may have an ongoing problem throughout the winter. Mostly damage is recognised as a spring problem.

The geese are known to concentrate on cereal stubble in autumn, cleaning out spilled grain, and move into germinating wheat in winter. In spring almost any crop with young shoots is thought to be open to damage, but particularly improved grass. The timing of sowing and condition of the seedbed are considered critical, since it is thought that geese will not land in crops greater than approximately 6 inches tall.

A problem is also recognised with whooper swans, which are known to concentrate in oilseed rape in spring. Since these birds are larger and heavier than geese they are thought to cause serious damage through 'puddling'. Some landowners seem unaware of the special protection status of whoopers.

There is a general view that conservation groups have encouraged the increase in numbers of geese through extensive protection of species and roost sites, while doing nothing to consider the implications of such legislation or deal with the consequences.

The main objection of landowners in the area is to goose numbers, and most feel that some sort of population control must be employed to reduce numbers to a "reasonable" level. However, landowners are not happy about wildfowlers from other areas moving in to take away large numbers of dead birds. They would rather see the ban on the sale of dead wild geese lifted, allowing local benefit from the income this could generate.

Many landowners would like to see compensation in some form, and recognise that it could be achieved through a non-rotational set-aside scheme which included specific management for geese.

However, it is noted that this would not address the problem for hill farmers who are dependent on a limited area of arable land to feed their stock in winter.

It is clear that many landowners in the area would be willing to take part in pilot projects aimed at tackling these problems.

4.5.2 Conservationists

The local conservationists also have a clear perception of the situation. However, there is an underlying view that goose numbers have risen due to changes in agricultural practice and that the problems should therefore be solved by the agricultural community, using their own funds.

Most conservationists in the area are slightly unnerved by the pilot scheme recently introduced on Islay and fear that it may become a precedent which will only increase calls for compensation across the country. However, they argue that if, and only as a last resort, compensation is really deemed necessary it must be a positive payment in response to specific management for geese, as opposed to a negative payment for the acceptance of goose damage.

Opinion varies as to whether goose populations should or could be controlled, and there is definite concern as to the ethics of setting arbitrary population limits.

4.5.3 Wildfowlers

Wildfowlers in the area appear to have a fairly clear understanding of the situation, and certainly recognise increases in the numbers of grey geese and changes in their distribution. They do not appear to take much interest in Pinkfeet, however, and are much fonder of the Greylag for their sport. There are very few Pinkfeet in the area until after the season has closed, and they are believed to be much less predictable than the Greylag.

The local wildfowling community seem very much in favour of the type of restrictions on shooting provided by the formation of a Local Nature Reserve (LNR). Attempts have been made to gain LNR status for the Beauly Firth, in the belief that this would protect the area from 'cowboys'. The local wildfowling clubs strongly believe in protecting both roosts and feeding areas, and have introduced a voluntary ban on shooting at roosts. However, they worry that there is nothing to prevent outsiders from moving in to these areas. They do not like the idea of relaxing the ban on the sale of dead wild geese, and imagine that putting a price on a birds head will only encourage "wholesale slaughter".

Attempts have been made by wildfowlers on the Beauly Firth to keep geese off arable crops using scarecrows, which are moved daily. However, there appears to be little thought as to any role they could play in coordinated management schemes.

*****

In my opinion there is still a lack of real understanding between the interest groups. It is clear that most landowners do not understand the comprehensive international legislation to which the UK is bound, and conservationists and wildfowlers appear to have little understanding of the heavy financial burden that landowners close to large roosts can be faced with.

A forum must be set up to allow the transfer of information between these parties, and the open discussion of opinions, views and solutions. Only through such discussion will these groups begin to educate each other and build the trust necessary if they are all to play appropriate roles in the formation of local goose management policies.

5. DISCUSSION

5.1 Feeding behaviour

The pattern of feeding behaviour around the Moray Firth is similar to that found in other studies (Newton & Campbell 1973, Bell 1988, Patterson *et al* 1989), where seasonal changes in the birds' diet followed the seasonal changes in foods available. Around the Moray Firth, Greylag concentrated on stubble in autumn and early winter, and both Greylag and Pinkfeet concentrated on improved grass and spring cereals in spring. As in these other studies, little use was made of winter cereals. Greylag were observed in turnips on a few occasions in January, coinciding with a cold period and heavy snowfall. Similarly, turnips were eaten by Greylag around Loch Leven only when alternative foods were scarce, as during snow (Newton & Campbell 1973). Although carrots did not figure prominently in the habitat availability data, they were grown in a few sites within the study area and Greylag were recorded feeding on waste roots left behind after harvest. Carrots are known as a favoured food of Greylag in Scotland and of Pinkfeet in Lancashire (Owen 1990).

Flock size has been shown to fall during severe weather (Cranswick 1992) and Greylag flock size decreased considerably in January, coinciding with the cold period and heavy snowfall. Newton and Campbell (1973) suggest Pinkfeet feed in larger, tighter flocks and are generally more wary than Greylag. Although median flock sizes remained fairly similar and stable for both species through the spring, the range does suggest that Pinkfeet gathered in larger flocks than the Greylag at this time.

The species appear to be similar, in terms of consistency of use of fields, using a large number of fields once and concentrating activity in very few fields, suggesting that neither species is particularly predictable outside the core area.

Field size and situation are recognised as major determinants of field choice (Newton & Campbell 1973, Gill 1993), and field area was found to be important around the Moray Firth. Geese fed in large fields throughout the seasons, using smaller fields in winter than in autumn and spring.

Due to the complexity of the area, it was extremely difficult to asses which roost a feeding flock were associated with unless the birds were very close to the roost site. Around the Moray Firth, the median distance from roost to feeding site was 2 to 4 km for both species. Patterson *et al* (1989) showed a median distance from roost to feeding areas ranging from 2 to 5 km. In some areas, Greylag tend to feed closer to the roost than Pinkfeet (Newton & Campbell 1973, Patterson *et al* 1989). However, Greylag have been shown to range further than Pinkfeet at roost sites in the north-east of Scotland (Bell 1988). Obviously there is variation in the relationship between these species from site to site, and it is unclear which situation prevails around the Moray Firth, again due to the number and complexity of roost sites.

5.2 Management

This project did not attempt to assess the extent of damage, rather to pinpoint the key areas which may be under pressure from grazing geese at the most crucial period of crop growth. The problem of crop damage is relatively short-lived, as well as limited in area, and it is the key areas identified as spring feeding grounds that should be targeted, should the situation ever warrant positive management.

North-West and North-East Regions are in the difficult position of having several important goose populations within a geographically complex area. Each situation may demand a different approach, each population may require different management techniques.

It is clear that two main views exist on effective goose management. One view is to prevent birds feeding in agriculturally sensitive areas by scaring and provide specifically managed alternative feeding areas (AFAs) where they may feed undisturbed. However, providing AFAs may simply accentuate the concentration effect around major roost sites, and undisturbed grazing on quality pasture may increase survival and breeding rates and simply allow the population to increase further still.

Another view favours disturbing large concentrations of birds around major roost sites and thereby lessen grazing pressures by dispersing the birds across a wider area. However, dispersal of the birds across a wider area may simply spread the problem of agricultural conflict further.

Neither of these suggested solutions seem ideal, and it is likely that a combination of methods may be required. Effective management of goose populations will involve manipulation of their spatial and temporal distribution (Moser & Kalden 1992), which requires coordination at local, national and international levels. However, any organised scaring designed to push birds around an area must be very carefully controlled.

It is a common belief among landowners that it is possible to limit goose populations by relaxing sport hunting regulations or culling. However, it is not the total size of the goose population which leads to crop damage; rather it is the spatial and temporal distribution of that population across the wintering range (Moser & Kalden 1992), in relation to the distribution of sensitive crops.

Area staff dealing with landowners must appreciate the complexities of the overall issue as well as each local situation. The problem is not so much of repelling geese from farmland as a whole, but of protecting crucial fields for relatively short periods (Newton & Campbell 1973). There are a number of ways in which landowners may be able to help themselves protect sensitive crops from goose grazing. However, this may require changes in attitude towards their own land management, which may be the most difficult barrier to overcome.

Landowners may be able to lessen the attractiveness of sensitive crops by:-

1. Planting sensitive crops in highly disturbed areas eg near occupied buildings, roads etc.

2. Planting sensitive crops in small fields eg < 5 ha.

3. Removing ease of access to sensitive crops eg plant hedgerows and trees between roosts and adjacent crops.

4. Breaking up large open spaces eg renew field boundaries with hedges, trees, and dykes.

5. Managing vulnerable fields for stock early eg plan to have livestock in fields before geese build up in spring.

6. Disturbing the birds routine through regular use of a variety of approved scaring devices eg scarecrows, flags, tapes, balloons, bangers etc.

6. RECOMMENDATIONS

Unfortunately, there is no quick and easy solution to the goose issue, however, long-term commitment to the following options may help:-

Local Goose Group/Committee

Encourage a forum for discussion of issues, current trends etc between local interest groups, including SNH officers, which could provide a focus for any future management decisions.

SOAFD

Press SOAFD to provide agricultural support mechanisms in the region, by:

* including goose management options in long-term set-aside scheme
* designation of Environmentally Sensitive Areas for geese.

Education

Encourage education of landowners and the public on the issue by:

* informing local landowners of the options open to them
* reversing the general view of landowners that 'geese = damage'
* informing the public of the advantages of geese within our natural heritage.

Research

Ensure adequate monitoring of goose populations in the region by:

* encouraging increased interest in grey geese by the existing network of voluntary counters coordinated by the Wildfowl and Wetlands Trust
* provide financial support for further research in the region eg the work of the Highland and Grampian Ringing Groups, and the Moray Firth Goose and Swan Study Group contributes an enormous amount to our understanding of population dynamics in the region, and yet they are desperately in need of suitable equipment to continue. It would not take much in the way of financial support to boost this valuable work.

Management

* Examine closely the results and effects of pilot projects in the UK, particularly the situation around Loch of Strathbeg.

* Encourage the creation of an international framework for dealing with agriculture/waterfowl conflict within the EC, or wider.

7. REFERENCES

BELL, M V, 1988 Feeding behaviour of wintering Pink-footed and Greylag Geese in north-east Scotland. Wildfowl 39: 43-53.

BOYD, H & M A OGILVIE, 1969 Changes in the British wintering population of Pink-footed Goose from 1950-1975. Wildfowl 20: 33-46.

CRANSWICK, P A, 1992 Distribution of Pink-footed and Greylag Geese in South-east Scotland especially in relation to disturbance. Report to NCCS.

FOX, A, H GITAY, M OWEN, D SALMON and M OGILVIE, 1989 Population dynamics of Icelandic nesting geese, 1960-1987. Ornis Scand 20, 4: 289-297.

GILL, J, 1993 Pink-footed geese in Norfolk. *In* Proc Conf on Current Issues in the Ecology and Conservation Management of Arctic Breeding Geese. BOU, Sunderland, 1993.

KEAR, J, 1963 Wildfowl and agriculture. *In* Atkinson-Willes, G (Ed), Wildfowl in Great Britain. HMSO.

MADSEN, J, D BOERTMANN and C MORTENSEN, 1984 The significance of Jameson Land, East Greenland, as a moulting and breeding area for geese: results of censuses 1982-1984. Dansk Orn Foren Tidsskr 78: 121-131.

MOSER, M E and C J KALDEN, 1992 Farmers and waterfowl: conflict or co-existence. From Waterfowl and Agriculture, IWRB No 21, Van Roomen, M (Ed).

NEWTON, I and C CAMPBELL, 1973 Feeding of geese on farmland in east-central Scotland. J Appl Ecol 10: 781-801.

OGILVIE, M A and H BOYD, 1976 The numbers of Pink-footed and Greylag Geese wintering in Britain: observations 1969-1975 and predictions 1976-1980. Wildfowl 27: 63-75.

OWEN, M, 1990 The damage-conservation interface illustrated by geese. Ibis 132: 238-252.

OWEN, M, G ATKINSON-WILLES and D SALMON, 1986 Wildfowl in Great Britain (2nd). Cambridge University Press.

PATTERSON, I J, S ABDUL JALIL and M L EAST, 1989 Damage to winter cereals by Greylag and Pink-footed geese in north-east Scotland. J Appl Ecol 26: 879-895.

PATTERSON, I J and J-F GIROUX, 1990 Breeding success of Icelandic Pink-footed Geese *Anser brachyrhynchus* and Greylag Geese *Anser anser* in different areas of Iceland in 1987 and 1988. Wildfowl 41: 13-17.

PRITCHARD, D *et al* (Eds), 1992 Important Bird Areas in the UK including the Channel Islands and the Isle of Man. RSPB.

8. ACKNOWLEDGEMENTS

I would like to thank Nigel Buxton, SNH, and Ron Summers, RSPB, for their guidance and support throughout this project. All SNH staff who were involved in the project, especially Iain Findlay, Peter Wortham, David Law, Allan Leitch, and Jill Matthews.

I am grateful to the Moray Firth Goose and Swan Study Group, the Highland Ringing Group, and the Wildfowl and Wetlands Trust for providing valuable information, as well as their enthusiasm and encouragement.

I am indebted to all the dedicated voluntary goose counters who contributed to the fieldwork -

I Brockway, D Butterfield, M Cook, B Etheridge, R Evans, R Graham, S Graham, M Harvey, P Hirst, D MacAllister, S Payne, G Prest, B Proctor, A Ramsay, A Scobbie, J Smith, B Swann, F Symonds, B Taylor, M Thomson and F Wilkinson.

9. APPENDIX

FEEDING DATA — GOOSE PROJECT

Nos. _____ & _____ & _____

Date: _____ Time: _____

Field No: _____ Grid: _ _ _ _ _ _ _ _

WEATHER:

SPECIES	No. Feeding	No. Alert	TOTAL
1: Grey Lag Goose			
2: Pink Footed			
3: Whooper Swan			

ROOST INFORMATION:

Roost no./Name/Grid	Distance

CROP INFORMATION:

1	Improved Grass	IG	8	Carrots	RC
2	Rough Grazing	RG	9	Potatoes	RP
3	Winter Cereal, Germ D	WG	10	Turnips	RT
4	Winter Cereal, N.Sown	WS	11	Set-Aside	SA
5	Spring Cereal, Germ D	SG	12	Oilseed Rape	OR
6	Spring Cereal, N.Sown	SS	13	Linseed	LS
7	Stubble	ST	14	Plough	PL
			15	Other	OT

NEAREST BOUNDARY:

1. WOOD	2. HEDGE	3. WALL	4. WIRE
5. DITCH	6. TRACK	7. ROAD	

PROXIMITY TO NEAREST BOUNDARY (Metres): _____

STANDING WATER (%): 0 30 50 70 100

COMMENTS:

FIELD DATA GOOSE PROJECT

FIELD NO:	DATE:
GRID REF: __ __ __ __ __ __ __ __	SURVEY TYPE: F T

AREA (ha):

ASPECT:

N E S W NE NW SE SW

EXPOSURE: (Open --> Enclosed)

0 1 2 3 4 5

Boundary Type:

Wood	0	1	2	3	4
Hedge	0	1	2	3	4
Wall	0	1	2	3	4
Wire	0	1	2	3	4
Ditch	0	1	2	3	4
Track	0	1	2	3	4
Road	0	1	2	3	4

COMMENTS:

SCOTTISH NATURAL HERITAGE: GOOSE PROJECT

HABITAT AVAILABILITY

DATE	GRID REF	CROP	FIELD AREA	FIELD ASPECT	FIELD EXP	BOUNDARY TYPES	STANDING WATER	NEAREST OCC. BUILDING	LIVESTOCK

SCOTTISH NATURAL HERITAGE: GOOSE PROJECT

ROOST COUNT DATA

ROOST SITE: _____ DATE: _____ TIME: _____ GRID REF: _____

WEATHER:

_____

_____ COUNT ACCURACY (1-3) _____

SPECIES	COUNT	FLIGHT LINE	COMMENTS (DISTURBANCE, VISIBILITY ETC)	NO. REMAINING AT ROOST	TOTAL COUNT

Scottish Natural Heritage : Goose Project

Dyed Bird Records

DATE	GRID REF.	LOCATION	RING No.	FLOCK SIZE	COMMENTS