

GREENLAND WHITE-FRONTED GEESE WINTERING ON ISLAY

S.C. Ridgill, C.R. McKay and E.C. Rees

The Wildfowl & Wetlands Trust, Slimbridge,
Gloucester GL2 7BT

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CHAPTER 1 - INTRODUCTION

1.1 Aims of the study

This report reviews previous studies of Greenland White-fronted geese, describes current legislation and conventions relating to the species and presents the results of a study of Greenland White-fronted Geese wintering on Islay in the 1991-92 and 1992-93 winters. Fieldwork during the 1991-92 winter concentrated mainly on identifying sub-populations of Greenland White-fronted Geese throughout Islay and describing their distribution. The study was extended to the 1992-93 winter with a view to conducting more intensive work on a smaller area (five farms in the Loch Gorm 10 km square) to obtain more detailed information on the ecological requirements of the geese.

The study was undertaken by the Wildfowl and Wetlands Trust under contract with Scottish Natural Heritage and aims to:

1. assimilate existing information on population counts (both on Islay and elsewhere in their wintering range), sightings of marked birds, habitat selection and location of roost sites.
2. investigate the ecological requirements of the White-front on Islay with particular reference to social structure of the population, habitat use, feeding site selection and diet.
3. consider the effect of different management strategies on the use of grassland by geese.
4. provide baseline biological information on numbers, distribution, social structure feeding and roost site selection which may be used to compile a conservation management strategy for the species on Islay.

1.2 Background information

1.2.1 Classification

The White-fronted Goose Anser albifrons is a medium-sized grey-brown goose, with white flanks and under tail-coverts, readily distinguished by its white forehead and black bars on the chest and belly (Cramp & Simmons 1977). Of the four races, two occur in Europe: the European White-fronted Goose Anser albifrons albifrons and the Greenland White-fronted Goose Anser albifrons flavirostris, as does the Lesser White-fronted goose which is classified as a separate species Anser erythropus. The conspecific Pacific White-fronted Goose Anser albifrons frontalis and the Tule Goose Anser albifrons gambelli occur in North America.

The Greenland White-fronted Goose was first recognised as a separate race as recently as 1948 (Dalgety & Scott 1948). It is slightly larger than the more wide-spread European White-fronted Goose with much darker underparts and an orange-yellow bill, rather than the pink bill of the European and Pacific White-fronts. Juveniles may be distinguished from the adult birds in that they lack the white forehead, which appears during the first winter, and the black bars on the underparts are missing or incomplete until the second autumn (Cramp & Simmons 1977). Unpublished biometrics data indicates that there are significant differences in weight between the sexes, and also between the age classes, with juveniles being lighter than adult birds for both sexes, and males being heavier than females (Stroud 1992).

The evolutionary origin of the Greenland White-fronted Goose is unclear, but differences in the birds' morphology, ecology and breeding distribution indicate that it was one of the earliest groups to diverge from the Anser albifrons stock (Fox & Stroud 1981; Stroud 1992).

1.2.2 Distribution and migration

The Greenland White-fronted Goose breeds in west Greenland, in lowland regions ranging from 63° to 72°N (Salomonsen 1950, 1967; Stroud 1992) and migrates via Iceland (Francis & Fox 1987) to winter exclusively in Britain and Ireland. Sightings of birds from the Thule region suggests that the breeding range may be extending further north (Best & Higgs 1990); records of Greenland White-fronts in east Greenland, on the other hand, are thought to be of migrating birds (Stroud & Fox 1981; Alerstam et al. 1986). The birds are highly dispersed in the breeding range, so there is unlikely to be an extensive survey of the summer population in the near future due to logistical difficulties in obtaining satisfactory coverage (Stroud 1992).

The first birds usually reach the wintering range in late September, with most arriving during October, although the precise timing of migration each year is likely to be influenced by weather conditions. Departure on spring migration most frequently occurs between 15th to 22nd April (Francis & Fox 1987), but again there is variation between wintering sites and between seasons. The geese are generally recorded at staging areas in southern and western Iceland in late April to early May during spring migration and in late September to early October in the autumn (Francis & Fox 1987; Stroud 1992). A census of staging Greenland White-fronted Geese in 1986 indicated that at least 16% of the population uses migratory sites in Iceland in the spring, where the birds feed predominantly (80%) on improved hayfields (Francis & Fox 1987). It has been suggested that Greenland White-fronted Geese exhibit leap-frog migration, with birds breeding furthest north in Greenland wintering further south in the British Isles and vice versa (Salomonsen 1950, 1967; Boyd 1958). An analysis of ring re-sightings and recoveries supported this view, with the proviso that this pattern was only a general tendency since geese marked at one ringing site were seen at a wide range of wintering sites (Kamp et al. 1988)

Greenland White-fronted Geese have a north-westerly distribution in Britain and Ireland, occurring mainly in NW Scotland, Northern Ireland and the Irish Republic (Stroud 1992). Traditionally the geese were widely dispersed over the blanket bogs and mires of Ireland but drainage of their wintering habitats from the mid 19th century onwards caused them to leave some of their habitual haunts (Ruttledge & Ogilvie 1979), although they are still widespread in western and central parts of the Irish Republic (Stroud 1992). The reclamation of the Wexford Slobbs in the early part of the 20th century resulted in the birds beginning to use this area and it remains the most important Irish wintering site to this day (Ruttledge & Ogilvie 1979; Stroud 1992). In Scotland the birds use a range of scattered and highly traditional sites, particularly in northern and western regions (Stroud 1992), with the island of Islay holding the majority of the Scottish-wintering population (see section 1.2.3 below). Greenland White-fronted Geese now occur regularly at only two sites in Wales - the Dyfi Estuary and in the region of Cors Fochno (Borth Bog) - with very small numbers reported in upland parts of Powys (Fox & Stroud 1986; Stroud 1992). The history of the birds' distribution in England is uncertain due to confusion with the European White-fronted Geese, but traditional haunts around Morcambe Bay and in Cumbria have not been used regularly since the 1950s (Ruttledge & Ogilvie 1979) and only small numbers of vagrants now occur in England (Stroud 1992; Section 1.2.3 below).

1.2.3 Population size and structure

The Greenland White-fronted Goose is one of the rarest goose species in the world. In a review of the available data, Ruttledge and Ogilvie (1979) found a decline in the population wintering in Britain and Ireland from 17,500-23,000 birds during

the 1950s to 14,300-16,600 by the late 1970s. Numbers in Ireland declined by about 50% during this period, from 12,700-17,300 to 7,500-8,600, whilst numbers in Britain rose by some 13% from 4,800-5,900 to 6,500-7,300. The decrease was attributed mainly to loss of habitat, mainly bogs in Ireland, although shooting and disturbance were also thought to be important factors (Rutledge & Ogilvie 1979).

Coordinated censuses of the wintering population have been organised by the Greenland White-fronted Goose Study since 1982, in collaboration with the Nature Conservancy Council and its successor bodies (Scottish Natural Heritage, English Nature and the Countryside Council for Wales), the Irish Wildlife Service, the Irish Wildbird Conservancy, the Department of the Environment, The Royal Society for the Protection of Birds in Northern Ireland, the Forest Service in Northern Ireland and the Wildfowl and Wetlands Trust. Results of the counts indicate a population increase since the early 1980s, from 16,000 in 1983 to 29,954 by spring 1992 (Stroud 1992; Fox et al. in press; Table 1.1). The rate of increase varied markedly in different parts of the wintering range, however (Warren 1990 gives a review). Numbers on the island of Islay, for instance, rose by 186% from c.3,500 in 1983 to c.10,000 in the 1991-92 winter, compared with increases of 77.2% in other parts of Scotland and 81.0% throughout the wintering population during this period (Table 1.1). The population at the other main wintering site for the geese, the Wexford Slobs in the Irish Republic also increased disproportionately (by 113.9% between autumn 1983 and autumn 1988, from Fox et al. in press), resulting in an increasingly high proportion of the population concentrating on these two sites in winter. The number of geese recorded at Wexford has diminished in recent years, however, and Islay alone currently receives up to 40% of the whole of the Greenland White-fronted Goose population (Table 1.1).

An analysis of the social structure of the Greenland White-fronted Goose flock wintering at the Wexford Slobs, based on observations of marked individuals, found not only that offspring associate with their parents throughout their first winter (as has been established for a number of other species of both geese and swans) but that parent-offspring associations are prolonged; some 27% of birds were seen to be associating with their parents in their fifth winter (Warren 1990). Moreover, there was no evidence to suggest that the older offspring were deterred from associating with their parents (and vice versa) upon their parents breeding again. Siblings were also found to associate with each other, even in the absence of the parent birds. The association between parents and their offspring over several winters differs from family relationships recorded in other goose species; Barnacle Goose families usually remain together for only one winter, for instance (Black & Owen 1989), and Ross's Geese, Cackling Canada Geese and Black Brant families may break-up early in the wintering season (MacLandress 1980; Johnson & Raveling 1988; Jones & Jones 1966). Pair formation was recorded for birds known to be two years old, and the mean age of first pairing was 3.4 years. Breeding (ie accompanied by goslings to the wintering

range) was recorded for birds in their third year, and the mean age of first breeding was 4.1 years (Warren 1990).

Table 1.1. Results of censuses of the wintering population, coordinated by the Greenland White-fronted Goose Study since the 1982-83 winter (derived from Stroud 1992; Fox et al. in press).

Year	Season	Islay	Rest of Scotland (%)	Northern			Wales	TOTAL
				Irish Republic	Ire-land	Eng-land		
82-83	Autumn	3,501	3,582	-	-	33	73	n/a
	Spring	3,441 (20.8)	3,768	9,098	161	0	73	16,541
83-84	Autumn	4,592 (29.0)	3,502	7,489	148	1	93	15,825
	Spring	4,198 (23.9)	3,646	9,451	160	4	78	17,537
84-85	Autumn	5,256 (28.2)	4,148	9,007	120	10	76	18,617
	Spring	4,715 (23.6)	4,181	10,769	182	13	88	19,948
85-86	Autumn	6,332 (27.8)	4,821	11,331	164	1	93	22,742
	Spring	5,669 (25.9)	4,255	11,726	142	0	98	21,890
86-87	Autumn	6,126 (29.0)	4,701	10,053	165	3	81	21,129
	Spring	6,486 (27.9)	4,814	11,732	154	0	95	23,281
87-88	Autumn	7,373 (30.8)	4,553	11,788	152	4	102	23,972
	Spring	7,314 (29.6)	4,095	13,030	120	1	127	24,687
88-89	Autumn	7,588 (27.5)	5,035	14,726	112	1	105	27,567
	Spring	6,816 (26.2)	4,933	13,935	179	0	124	25,987
89-90	Autumn	8,560 (31.9)	5,698	12,278	133	16	123	26,809
	Spring	7,209 (27.5)	5,623	13,124	149	1	93	26,239
90-91	Autumn	8,297 (30.6)	6,293	12,237	110	2	170	27,109
	Spring	8,857 (30.1)	6,181	14,052	156	0	150	29,396
91-92	Autumn	10,003 (35.6)	6,077	12,472	160	1	162	28,875
	Spring	9,196 (30.7)	6,678	13,789	148	0	143	29,954
92-93	Autumn	9,600 (36.8)	4,245	12,047	102	1	122	26,117
	Spring	10,836 (39.6)	4,247	11,977	144	14	124	27,342
93-94	Autumn	11,679 (40.9)	4,236	12,416	114	1	123	28,569
	Spring	9,495 (32.8)	4,710	14,464	103	2	143	28,917

NB The 1993-94 figures are provisional estimates, pending the arrival of further data (A. Fox pers. comm.)

1.2.4 Population dynamics

Annual recruitment to the population varied markedly between years, and also between wintering sites, with the percentage of juveniles recorded ranging from around 10% to 35% between 1982 and 1990 inclusive (Stroud 1992). The mean value of 17.5% juveniles recorded for the whole of the wintering population in these years (Stroud 1992) is substantially lower than productivity levels recorded for the European White-fronted Goose, which has an average of 34% young in the population in autumn (Bignal, Stroud & Easterbee 1991).

Annual reproductive success for birds wintering on Islay was consistently lower than for those wintering on the Wexford Slob (with mean values of 15.3% and 17.7% respectively, from Stroud 1992). Differences in the reproductive success of geese at different wintering sites may perhaps be associated with the tendency towards leap-frog migration with the birds on Islay having poorer breeding territories (see section 1.2.2 above), or to feeding conditions in winter influencing the birds' nutrient reserves in spring, which in turn may influence their laying success (Ruttledge & Ogilvie 1979; Ankey & MacInnes 1978).

Variation in reproductive success between years is thought to be attributable mainly to climatic conditions; a combination of weather conditions on the breeding grounds, on migration and on arrival in the breeding range accounted for 60% of the variation in breeding success for Barnacle Geese nesting in Greenland (Fox & Gitay 1991). Predation levels may also affect reproductive success, but these are often associated with weather variables (Birks & Penford 1990; Choudhury & Owen 1993)

The mean brood size of families in winter was high, ranging from an average of 2.7 on Islay to 3.6 at Wexford (Stroud 1992). It is thought, therefore, that the low productivity levels are due to only a small proportion of adult birds raising young each year, but the reason for this is not yet understood (Warren 1990).

An analysis of ring recoveries for birds marked since 1946 indicated an annual mortality rate in the region of 23%, with hunting alone accounting for some 4.8% of annual mortality (Kamp et al. 1988). This exceeded the annual recruitment level of 17.5% and the elevated mortality levels may thus be associated with the decline in population between the 1950s and 1970s, particularly since most of the recoveries were made during the 1950s and 1960s when the Greenland White-fronted Goose was a legitimate quarry species throughout most of its migratory range (Stroud 1992; Section 1.3 below). In a more recent analysis, Bell (1993) estimated an annual mortality rate of 10.96% between 1982/83 and 1990/91, which is similar to the figure of 11.55% annual mortality reported by Choudhury & Owen (1993). The number of geese wintering on Islay rose by 10.8% between 1983/84 and

1991/92 with mean productivity estimated at 16.2% and mean natural apparent mortality at 7.98% (Bell 1993 from Stroud 1992). The discrepancy between the figures, which would indicate an annual increase in population of 8.22% rather than the observed value of 10.8%, was attributed to net immigration from other wintering areas (Bell 1993).

1.2.5 Feeding ecology

Traditionally the Greenland White-fronted Goose occurred mainly on raised or blanket bogs and mires in winter, where they are thought to have fed on typical bogland plants such as Eriophorum angustifolium, Rhynchospora alba and Trichophorum cespitosum (Cadman 1953; Campbell 1947; Pollard & Walters-Davies 1968; Stroud 1992). More recent studies of the birds' diet by faecal analysis indicate that, when feeding on grassland, the birds mainly ingest grasses with low nutrient value such as Agrostis spp., Festuca spp., Deschampsia flexuosa, Cynosurus cristatus, Holcus lanatus, and Anthoxanthum odoratum, as well as Lolium spp. and Equisetum spp. (Mayes 1984; Stroud 1992), and that they continue to select Eriophorum angustifolium at peatland sites (Fox et al. 1990). It is suggested that when feeding on Eriophorum the birds up-root the plant to nip off the lower part of the shoot and "stem-base", which is rich in protein and carbohydrate (Fox et al. 1990). The tendency for geese to feed on grassland during the day appears to have increased in recent years, but they still use nearby peatlands as their roost sites, or if disturbed at their feeding areas (Stroud 1992). A study of the geese wintering at the Wexford Slobbs in the Irish Republic found that the birds at this site showed a strong preference for sugar beet, and also that the main food used changed during the winter from spilt grain on stubble fields in autumn to beet in mid winter to grasslands in the spring (Warren 1990). Although geese commonly feed on potatoes and turnips on Islay, root crops are not thought to be an important part of the diet at other wintering sites (Stroud 1992).

1.2.6 Site fidelity

Individual geese were marked with plastic leg-rings, each engraved with a unique code, during the expeditions to Greenland organised by the Greenland White-fronted Goose Study in 1979, 1984, 1989 and 1992 (Fox & Stroud 1981, 1988), and in Ireland where the ringing was coordinated by the Irish Wildlife Service from 1982 onwards (Warren 1990). Orange neck-collars were also fitted to the birds in some years, including to 25 geese caught on Islay during the 1990-91 and 1992-93 winters inclusive. An initial analysis of the ring re-sighting data showed that the birds are extremely site-faithful in winter; some 85% of individuals observed in successive winters returned to the same sites (Wilson et al. 1991). Within a season less than 1% of marked birds were seen outside the traditional wintering site, and such moves were mostly associated with the use of migratory

sites in autumn (Wilson et al. 1991). Further analysis of site fidelity for birds wintering at Wexford, with the benefit of a further two years' data, similarly found that only 14.4% of marked geese seen in two consecutive winters changed site between winters, and that 2.8% of marked geese moved site within a winter season of which about one third were of birds staging in Scotland before moving on to Ireland (Warren 1990). In addition to showing high levels of winter-site fidelity, individual birds show a preference for a very restricted part of the potential feeding areas within the wintering site (Wilson et al. 1991). These results support observations that the birds continue using their traditional wintering site rather than move to another area even under adverse conditions, such as wetland drainage, change of agricultural practice, hunting pressure and elevated disturbance levels, and that where the adverse conditions persist the wintering goose flock declines in numbers or totally disappears (Ruttledge & Ogilvie 1979; Norriss & Wilson 1988; Stroud 1992).

1.3 Review of legal status

1.3.1 At an international level

With migratory species such as the Greenland White-fronted Goose, international cooperation is required to ensure the conservation of the species throughout its migratory range. The small population size, limited distribution and threat to the habitat of the Greenland White-fronted Goose gave rise to concern for its continued survival. It now receives protection at an international level through governments of countries included in its migratory range signing one or more of the relevant international conventions, thereby declaring their intention to safe-guard the species.

All the countries within the migratory range of Greenland White-fronted Geese (Greenland/Denmark, Iceland, Ireland and the United Kingdom) have signed the Convention on Wetlands of International Importance Especially as Waterfowl Habitat, known as the "RAMSAR Convention". The convention resulted from a series of conferences and technical meetings held during the 1960s, coordinated by the International Waterfowl Research Bureau (IWRB), with the aim of curtailing the destruction of wetland habitats, and was eventually signed at Ramsar in Iran in February 1971. Contracting parties are obliged to designate at least one site in the List of Wetlands of International Importance at the time of signing, ratifying or acceding to the Convention, and further sites may be added subsequently. Article 3(1) of the Convention requires that contracting parties should "promote the conservation of wetlands included in the List". Moreover, Article 3(1) requires the parties to "formulate and implement their planning so as to promote...as far as possible the wise use of wetlands in their territory", irrespective of whether they are included in the Ramsar List. The United Kingdom ratified the Ramsar convention in 1976, Greenland/Denmark in 1978, Iceland

also in 1978, and the Irish Republic in 1985. Some twenty-one sites representing habitat important for the Greenland White-fronted Goose have been listed, including seven in the U.K. (of which four are on Islay), nine in the Irish Republic and five in Greenland, but none so far from Iceland. The sites important for the geese and designated by the different countries under the Ramsar Convention are listed in Table 1.2.

Table 1.2. Sites important for Greenland White-fronted Geese designated under the Ramsar Convention by 1993.

Country and site	Year designated

UNITED KINGDOM:	
Dyfi Estuary, Dyfed	1976
Mouth of Endrick River, Loch Lommond	1976
Gruinart Flats, Islay	1988
Duich Moss, Islay	1988
Glac-na-Criche, Islay	1990
Feur Lochain, Islay	1990
Loch Ken and River Dee Marshes, Dumfries & Galloway	1992

IRISH REPUBLIC:	
Wexford Slob, Co. Wexford	1984
The Raven, Co. Wexford	1986
Pettigo Plateau, Co. Donegal	1986
Owenduff Catchment, Co. Mayo	1986
Owenboy, Co. Mayo	1987
Lough Barra Bog, Co. Donegal	1987
Mongan Bog, Co. Offaly	1988
Easky Bog, Co. Sligo	1990
Meenachullion Bog, Co. Donegal	1990

GREENLAND:	
Aqajarua-Sullorsuaq, W. Greenland	1988
Qinnguata Marraa-Kuussuaq, W. Greenland	1988
Kuannersuit Kuussuat, W. Greenland	1988
Naternaq, W. Greenland	1988
Egalunniut Nuaat-nassuttuut Nunaa, W. Greenland	1988

Whilst the terms of the Ramsar Convention mean that there are few legal obligations on the contracting parties, the Convention is valuable for expressing international concern and applying international pressure for the conservation of important wetland sites, especially through the application of the Ramsar Monitoring Procedure in cases where an internationally important site is perceived as being under threat.

The United Kingdom, Ireland and Denmark (but not Greenland or Iceland) have signed the Convention on the Conservation of Migratory Species of Wild Animals, known as the "BONN Convention", which has the fundamental objective of protecting migratory species. This is achieved by (i) providing strict protection for species listed in Appendix I, which consists of species under threat of extinction throughout or in a major part of their migratory range and (ii) persuading "Range States" to conclude "Agreements" for the conservation and management of Appendix II species. Appendix II includes species where the conservation status would benefit substantially from international cooperation, but a species does not need to be under threat for inclusion in Appendix II (Lyster 1985). All migratory Anatidae species (including the Greenland White-fronted Goose) are included in Appendix II of the Bonn Convention. Article V of the Bonn Convention states that the objective of each "Agreement" shall be to restore the migratory species concerned to a favourable conservation status or to maintain it in such a status, and specific guidelines for such Agreements were described. A Western Palaearctic Waterfowl Agreement has been drafted under the terms of the Convention and will shortly be mailed to all the Range States, with the aim of signing the Agreement in 1994. The Greenland White-fronted Goose Management Plan, developed in Wexford in March 1992 (Stroud 1992), may then be drawn in under the Agreement.

The United Kingdom, Ireland and Denmark (but not Greenland or Iceland) have also signed the Convention on the Conservation of European Wildlife and Natural Habitats, known as the "BERNE Convention". The Convention aims to "conserve wild flora and fauna and their natural habitats, especially those species and habitats whose conservation requires the cooperation of several States, and to promote such cooperation" (Article 1.1) and to give "particular emphasis to endangered and vulnerable species, including endangered and vulnerable migratory species" (Article 1.2) (Lyster 1985). Moreover, the Contracting Parties undertake to "give special attention to the protection of areas that are of importance for the migratory species specified in Appendices II and III and which are appropriately situated in relation to migration routes, as wintering, staging, feeding, breeding or moulting areas" (Article 4.2) and to "take necessary and appropriate legislative and administrative measures to ensure the protection of the wild fauna species specified in Appendix III" (Article 7.1). The Greenland White-fronted Goose is included as an Appendix III species under the Convention. The Berne Convention was ratified by the United Kingdom in May 1982 and brought into effect in September 1982.

The Directive of the council of the European Community on the Conservation of Wild Birds, known as the "EEC Birds Directive" was adopted in 1979 by the United Kingdom, Denmark and Ireland, as Member States of the European Community, but not by Greenland or Iceland. The Directive imposes strict legal obligations on Member States to maintain populations of naturally occurring wild birds at levels corresponding to ecological requirements, to preserve a sufficient diversity and area of habitats for their

conservation, to regulate trade, to prohibit certain methods of capture and killing, and to limit hunting to species able to sustain exploitation (Lyster 1985). Under the Directive, Member States are required to designate Special Protection Areas (SPAs) in order to establish a network of protected birds habitats throughout the Community. Moreover, under Article 4.1 of the Directive, the United Kingdom and the Republic of Ireland are specifically required to establish SPAs for Greenland White-fronted Geese, which is included as an Annex I species in the Directive (Stroud 1992). Although the time-scale for classifying areas as SPAs is at the discretion of the Member States, there is legislative support for enforcing the protection of SPAs thereafter. Article 169 of the Treaty of Rome authorises the Commission to bring an action in the European Court of Justice against any Member State which fails to comply with the terms of the Directive. In addition to the U.K. Ramsar Sites listed in Table 1.2, which all have SPA status except for the Dyfi Estuary, Laggan Peninsula on Islay has been designated as an SPA under the EC Birds Directive.

1.3.2 At a national level

Details of national legislation within the countries of the migratory range relating to the geese and their habitats are described by Stroud (1992). In Great Britain the relevant Acts are the Wildlife and Countryside Act (1981), the Environmental Protection Act (1990), and the Natural Heritage (Scotland) Act (1991). A number of sites important for the geese have been designated as Sites of Special Scientific Interest (SSSIs) under the Wildlife and Countryside Act, which prohibits owners and occupiers of the land from carrying out such operations without notifying the Nature Conservancy Council (or more recently English Nature, Scottish Natural Heritage and the Countryside Council for Wales, depending on the location of the site). Although the Wildlife and Countryside Act recognises an open season for the hunting of White-fronted Geese (including flavirostris) in England and Wales, the only regular site for the Greenland White-fronts (the Dyfi Estuary in Wales) is subject to a voluntary shooting ban (Stroud 1992). In Scotland flavirostris has been protected by the Countryside and Wildlife Act since 1982, although licenses have been issued by the Scottish Office to shoot unlimited numbers on Islay from the 1987-88 winter to the 1990-91 winter inclusive. Thirteen licences were issued and 76 birds shot in the 1987, 2 licences and 6 birds shot in 1988, 8 licences with 45 birds shot in 1989, 13 licences and 62 birds shot in 1990, 12 licences with 37 birds shot in 1991, and one licence with no birds shot in 1992. There were no licenses issued for shooting Greenland White-fronted Geese in 1993, but one licence was issued and 8 birds were shot in 1994 (Scottish Office AFD; R. Lilley pers. comm.).

In Northern Ireland the birds receive statutory protection under The Wildlife (Northern Ireland) Order 1985, and wildfowling clubs operated a voluntary ban for 4 to 5 years prior to 1985. In the Irish Republic, the Wildlife Act (1976) postponed the start of

the shooting season from 1st September (prior to 1977) to 1st October (thereafter), with the open season continuing to 31st January (Stroud 1992). A statutory suspension of all shooting throughout the Republic was imposed from 1982-85 inclusive. Shooting of the geese was reintroduced at Wexford only in 1985-86, and a quota placed on the number of birds that could be shot. More recently a moratorium on shooting is reviewed annually (Stroud 1992).

Conservation legislation in Iceland, notably the Nature Conservation Act No. 47 (1971) and the Bird Protection Act (1966), does not give legal protection to the Greenland White-fronted Geese but the Icelandic Shooting Society encourages a voluntary ban on hunting this species. The Icelandic shooting season opens in the third week of August and closes on 15th March, so the geese are potentially at greatest risk during autumn migration (Ruttledge & Ogilvie 1979). In Greenland the birds were traditionally hunted throughout the summer, eggs were collected and the goslings rounded-up for fattening (Fox & Stroud 1981). The last two practices are now illegal and since c. 1970 the adult birds have been protected during nesting and moult, although shooting in spring and autumn was still permitted (Fox & Stroud 1981; Stroud 1992). In 1985 spring shooting was also banned, and the season is now held to be from 15 August to 30 April (Stroud 1992).

1.4 Review of Greenland White-fronted Goose management plans

Until recent years, active management of the Greenland White-fronted Goose population was based mainly on monitoring numbers with a view to stemming the decline in population (reported by Ruttledge & Ogilvie 1979) through national and international legislation for the control of hunting and habitat destruction, described in Section 1.3 above. The importance of obtaining a better understanding of the biology of the species was also appreciated, however, and research programmes were initiated during the 1980s (Fox et al. 1983). Results of many of the resultant studies are described in Section 1.2 above.

The observation that the geese show an extremely high level of localised site fidelity, often returning to particular fields in successive years (Wilson et al. 1991), enhanced by a high degree of parent-offspring cohesion over several years resulting in extended families using these sites (Warren et al. 1992), has particularly serious conservation and management implications. Bell (1993) further emphasised that population heterogeneity makes each discrete sub-population separately susceptible to the effects of management. Agricultural improvement at traditional sites may result in conflict with the farmers concerned when the geese return and feed on the new crop, but wide-scale scaring is considered inappropriate for the species as it may force the birds outside their home-range into unknown territory (Wilson et al. 1991), although Bell (1993) did find some limited movement between Wexford and Islay in years when licences were issued to shoot birds at these sites. Wilson et al. (1991) further

developed the concept of a "functional unit system", proposed by Tamisier (1979, 1985) and Bignal et al. (1989), for conserving and managing areas for site faithful birds such as the Greenland White-fronted Geese. The system emphasises the need to conserve refuge areas that the birds use at times when their main roosting and feeding areas are disturbed; although the refuge areas may not be regularly used they are thought to be of critical importance when needed.

On the island of Islay a new goose management scheme was introduced by Scottish Natural Heritage (SNH) during the 1992-93 winter to tackle the problem of conflict between geese and the farming community. This was in addition to management agreements developed in the mid 1980s with farmers whose land came within the boundaries of the SSSIs, who received financial support based on the SSSI "profits forgone" system. The new scheme offered financial support for farms outside the management agreement areas in return for positive management to protect Barnacle and White-fronted Geese (Islay Geese Working Group 1992; Choudhury & Owen 1993). During the 1992-93 season 109 of Islay's 130 farmers joined the scheme; the average number of birds on each farm was calculated from monthly counts and the farmers received a payment of £9 per goose. The total payments to farmers at the end of the season was £ 292,000, including payments made under the SSSI management agreements (R. Lilley, SNH, pers. comm.).

In a report to the Scottish Office, Choudhury & Owen (1993) assessed the different methods of determining yield loss, the difficulties in relating this to financial loss, and evaluated the Agricultural Impact Model developed to calculate the costs of goose grazing to individual farmers on Islay. Their review of the literature on agricultural damage indicated that whilst crop damage occurs, especially in the case of spring grazing, the relationship between the intensity of grazing and yield loss is not close because a number of other factors, notably weather and soil water content, affect vegetation growth. Goose grazing accounted for anything from 10% to 45% of variability in yield loss. Nevertheless they considered that the Agricultural Impact Model developed for implementation on Islay was a reasonable approach, despite limitations due to insufficient or a lack of information, including the level of damage caused by White-fronted as opposed to Barnacle Geese. Other possible methods for reducing the conflict between geese and agriculture were discussed objectively, including the possibility of controlling the size of population by culling, scaring geese away from vulnerable crops, establishing refuges or Alternative Feeding Areas (AFAs), and an integrated approach. Some problems associated with the first two suggestions have been mentioned earlier. The development of AFAs has been considered by other authors (Owen 1977b, 1980; Patterson & Fuchs 1991; Vickery & Sutherland 1992), and is operating in a few places in Britain and on a larger scale in North America; the relative costs of paying compensation to farmers and acquiring land to manage it for geese are still under debate (Choudhury & Owen 1993).

The need for a coordinated international conservation plan for the Greenland White-fronted Goose has been recognised for some time and was discussed at the 1990 Montreux meeting of the Ramsar Convention, when representatives of the four Range States agreed to co-operate more closely under Article 5 of the Convention (Stroud 1992). In a further meeting of the Range States held at Wexford, Ireland, in March 1992 the National Parks and Wildlife Service of the Office of Public Works, Ireland, contracted IWRB to develop the conservation plan, which was undertaken by David A. Stroud of the U.K. Joint Nature Conservation Committee (JNCC) in consultation with scientific experts and other interested parties (Stroud 1992).

The international conservation plan, which is still at the draft stage, has five main objectives:

1. To maintain and enhance the population recognising that the current population size represents the absolute minimum.
2. To maintain and enhance viable numbers throughout the present range and to encourage the reoccupation of formerly frequented areas where the geese are now extinct; and to further avoid the contraction of range to a few centres of population
3. To ensure that any interaction with people are according to the principles of sustainability, and to give special emphasis to the avoidance of agricultural conflicts on the wintering and staging grounds.
4. To ensure that the consumptive "use" of the population should be wisely undertaken on the basis of sustainability
5. To ensure full international cooperation between the Range States in joint programmes of monitoring, conservation and liaison to the benefit of Greenland White-fronted Geese, their habitats and the human populations with which the geese come into contact.

Further details of how to achieve these objectives are described in Stroud's (1992) report.

CHAPTER 2 - STUDY AREA AND METHODS

2.1 Description of the study area

The island of Islay lies some 30 kms off the west coast of Scotland (at 55°45'N 6°20'W) in the Inner Hebrides. In the last 50 years agricultural activity on the island has intensified, in line with the government's emphasis on agricultural improvements to increase food production since the Second World War, although crofting has not been as extensive on Islay as on the other Hebridean isles. Some 6,000 ha of Islay's 54,000 ha is improved grassland, dominated by ryegrass (Lolium perenne) and supporting a mixture of dairy, beef cattle and sheep farming (Percival 1988). This includes some 2,500 to 3000 ha of reseeded leys, used primarily for silage production, which are managed on a 5-year rotation and heavily fertilised (DAFS 1987; Percival & Houston 1992; R. Lilley pers. comm.). The island's traditional habitat of moorlands, rough pasture and mires remain in many areas, however (Bignal & Curtis 1991). Mountains and remote deer forests predominate in northern and south-eastern parts of the island, broken moorlands mixed with some agriculture occur in the west, more extensive agricultural areas mixed with some moorland and blanket mire occur in the central region, and low-level blanket mires predominate between the towns of Port Ellen and Bowmore (Bignal & Curtis 1991).

The distribution and behaviour of geese at three farms within the Loch Gorm 10 km square: Sunderland (SU), Rockside (RK), Foreland (FO), and two farms within the adjoining 10 km square: Eorrabus (EO) and Octovullin (OV) (Figure 2.1) were monitored closely during the 1992-93 winter. Sunderland, Rockside and Foreland are predominantly sheep farms but with some cattle grazing and differing levels of management intensity; Rockside is the most intensively managed of the three (with greater levels of fertilisation of grassland and shorter reseed rotation), and Foreland the least intensively managed, with little or no treatment of its grassland. Eorrabus is predominantly a dairy farm (more intensively managed than Rockside) with some sheep also present. Octovullin is a mixed farm, with sheep, cattle and also some arable cultivation (mainly fodder beet and kale).

2.2 The All Islay Count System

Counts of Greenland White-fronted Geese throughout the island of Islay, made in autumn (usually late November to early December) and spring (usually late March), have been coordinated by the Greenland White-fronted Goose Study and organised by Scottish Natural Heritage since the early 1980s. In most years the counts

are made over the two days of a week-end, with observers covering the same sites on two successive days to verify the results. In 1992-93 the number of all Islay counts were increased to one per month because the introduction of the Goose Management Scheme required more detailed information on grazing pressure throughout the island, which in turn was reflected in payments to the farmers.

The count data from 1988-89 to 1991-92 inclusive were made available by SNH for the present study for an analysis of changes in the distribution of geese. This data were categorised on a farm-by-farm basis in the 1991-92 and 1992-93 winters, and according to the 1 km square National Grid in the earlier years. In the 1992-93 winter the number of geese counted in each field was recorded, each record being identified by a numerical code identifying the farm and field, to give greater accuracy in determining the location of the birds and the types of habitat being utilised. For inter-year comparisons of the distribution of the birds the 1991-92 and 1992-93 data were transformed to the 1 km square grid since the precise farms or fields used in earlier years could not be ascertained retrospectively.

2.3 Timing of observations

Detailed observations of Greenland White-fronted Geese on Islay were made from the last week of November to the end of April during the 1991-92 winter and from mid November to the end of April in 1992-93. In the early stages of the study, during the 1991-92 winter, observations were directed towards ascertaining the movements of flocks between roosting and feeding sites with a view to describing the different sub-populations throughout the island. Attempts were also made to relocate all the ringed birds present on the island at regular intervals (twice a month) throughout the 1991-92 winter; in 1992-93 observations were concentrated on the main study area but sightings of birds from other parts of the island were also collated. The location of ringed birds sighted was recorded as a six-figure grid reference, corresponding to the centre of the field in which the bird was recorded, for an analysis of the home ranges of individual geese (see Section 3.1.4). During the 1992-93 winter a concentrated effort was made to catch and mark a sample of birds with neck-collars and radio transmitters, with only limited success (see Section 3.1.3).

Regular observations of five farms comprising the main study area (Sunderland, Rockside, Foreland, Eorrabus and Octovullin) were made during 1992-93 to obtain further information on factors affecting distribution, feeding activities and social structure of the wintering flock. A fortnightly work-plan for data collection during 1992-93 was developed. Six days were devoted to recording the distribution of birds within the main study area (including recording the percentage of juveniles present, the

proportion of birds feeding, the identity of ringed birds present, and making more specific counts of the location of birds within the experimental plots - see Sections 3.1.4, 3.1.5 and 3.2), two days were devoted to recording the birds' feeding activities at different sites (Section 3.3) and two days to habitat assessment (Sections 3.2 and 3.3) within each two week period. Movements to the roost at Moine nam Faoileann (3km north-east of Loch Gorm) and its associated satellite roosts, especially Loch a' Gheoidh (1.5km east of Loch Gorm), were also monitored regularly during the 1992-93 winter (Section 3.4).

More detailed descriptions of the methods used, and types of data collected, are given at the start of the relevant section of the results.

Figure 2.1. Location of farms in the main study area.

- RK = Rockside
- SU = Sunderland
- FO = Foreland
- EO = Eorrabus
- OV = Octovullin

