Section 1.2.3.2. Range and movement

[The following section is abstracted from Wilson et al. 1991 where further details can be found]

Data on movements and fidelity derive from two co-operative, ringing schemes. Birds were ringed with darvic leg rings in Greenland during expeditions to Greenland in 1979 and 1984 (Fox & Stroud 1981, 1988). Much larger numbers of geese have been regularly caught at the Wexford Slobs in a continuing programme that started in winter 1983/4.

Observations of individually marked birds showed the majority to be extremely faithful to winter sites, either to their site of capture (Wexford) or to the sites at which they were first seen (Greenland ringed geese).

Between winter site fidelity

Birds ringed at Wexford have been seen at 10 sites in Scotland, in Lancashire and 13 sites in Ireland away from Wexford; substantially throughout the wintering range. The greatest number of Wexford ringed geese were seen on Islay. Whilst 6.8% of those geese ringed at Wexford have been recorded at some stage on Islay, only 4.4% (24/549) seem to have permanently changed wintering area. Thus one way exchange between these sites occurs, but seemingly only at very low levels. When numbers of ringed geese seen at Scottish sites are expressed as a proportion of flock size, the high proportion of resightings on Islay is due to the larger numbers there.

Some site interchange within Ireland occurs, but involves only a very small proportion of the ringed sample of geese. Of 1979 Greenland ringed geese, 10 changed wintering areas between winters in nine years. Of 1984 Greenland ringed geese, 10 moved wintering site between winters in four years, including three birds which moved from Wexford to Islay and one which undertook the reverse move.

There was no apparent sexual difference in the proportion of geese changing wintering area.

The greatest number of moving birds were in their second year, and even where the age of the geese was not precisely known, it is clear that the majority of moving birds were young rather than older (of known age birds, over 67% moved before they were 3 years old).

The proportion of geese moving between wintering sites was larger for Wexford ringed (82/549 = 14.9%) than for Greenland ringed (21/281 = 7.5%) geese. This difference may possibly relate to differential observability of darvic leg rings compared to neck collars. Birds moving to new sites may be more likely to be recorded if they have neck-collars rather than more inconspicuous leg-rings, particularly in parts of the winter range where it is difficult to stalk close enough to read leg-rings.

Within-winter site fidelity
Sightings of both Greenland ringed and neck-collared geese show very low levels of between site movement within a winter. Four broad patterns or movement 'strategies' can be identified.

a) Birds which remain loyal to the same restricted areas of Wexford Slobs after ringing. These are the vast majority of the ringed sample (85.0% of birds when considering between year changes, 99.6% of birds when considering within winter changes).

b) Birds which remain loyal to Wexford but which are sometimes recorded staging in Scotland (mainly on Islay or Kintyre) in early autumn (13 of 33 (39%) within-winter movements). Such staging has long been suspected because peak numbers at Wexford do not occur until December or January (Wilson & Norriss 1985). However, these staging birds occur individually or as families rather than as large identifiable groups on Scottish areas (c.f. Easterbee et al. 1987).

c) Birds regularly recorded at Wexford, but which apparently change wintering site in one year or are wind-drifted to unusual sites following severe weather. This includes two birds which were blown off course and seen in Inverness in October: a total of two of 33 within-year movements).

d) Wexford ringed geese which winter before November and after February elsewhere in Ireland (18 of 33 (54.5% of within-year movements). Such birds appear to use Wexford during mid-winter, but occur at other Irish sites at other times. It appears that only small numbers of geese move from Wexford in this way. This had been suspected on the basis on previous census discrepancies; Wilson & Norriss (1985) reported consistent sudden increases of 600 - 1,600 geese at Wexford between late December and late January.

Site fidelity at a local level: within and between winters
Monitoring movements of individually marked birds has demonstrated a very high degree of fidelity at a local level. Geese not only return to traditional wintering areas rather than other parts of the wintering range, but also show preference to a very restricted part of the potential feeding areas within these sites.

On Islay, (total area 61,812 ha - not all of which is suitable habitat) the total of 7-8,000 geese is split up into 40-50 fairly discrete flocks (which may further split or amalgamate according to a variety of local conditions). Where these flocks contain ringed birds, the areas they use are well defined (Figure 1.2.3.1.1) by the movements of the marked birds they contain. At the Wexford Slobs, records of neck-collared birds clearly demonstrate the existence of sub-flocks. Figures 1.2.3.1.2 shows the distribution of sightings for two typical geese and demonstrates their markedly different ranges within the Slobs.

The high level of site fidelity supports observations that when site conditions become less favourable in the short and medium terms, birds remain rather than moving to other areas. This is the explanation of several previous flock extinctions which have been linked to wetland drainage, increased mortality through shooting (Ruttledge & Ogilvie 1979) or increased levels of disturbance due to agricultural change (Norriss & Wilson 1988).

There is a small, long-term, movement of birds between-sites, but it is not nearly as great as the levels of between-site movement recorded for other geese. Thus, in terms of the conservation of this population, the protection of important wintering areas and the enhancement of conditions there, are of particular importance. This must be an important management aim at all sites: geese will not necessarily move to 'better' areas of their own accord.

The concept of 'functional unit systems' (Wilson *et al.* 1991), is valuable when considering site management for such highly site-faithful geese as these since it serves to focus attention on <u>all</u> areas used by the birds (Figure 1.2.3.1.3). Areas such as key feeding sites and traditional roosts, where flocks spend much time, will be obvious candidates for conservation attention, however other areas are also important. In this context, many flocks at traditional Irish sites have experienced declines associated with both high levels of disturbance <u>and</u> the loss of undisturbed refuge areas to which geese can resort (Ruttledge & Ogilvie 1979). Many such refuge areas have been lost to geese because of commercial development or afforestation of peatlands. Others have become less suitable owing to other land-use changes (Norriss & Wilson 1988). Refuges such as these clearly form part of the functional units of these flocks, and practical conservation needs to embrace the management of these wider areas as well as sites used more frequently for feeding or roosting. Although they may not be so regularly used, they can be of critical importance when needed.

Movements of marked geese should be studied at a local scale to elucidate flock functional units as a first step in determining which areas should be subject to conservation management.

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Figure 1.2.3.2.1. Sightings and 'home range' of a darvic ringed goose (A14) in the Avenvogie area of Islay; 1979-1988. Grids are 1 km squares of the Ordnance Survey. Different symbols indicate sightings in eight different winters, 1979/80 - 1986/87. Not all the area within this 'range' is suitable habitat, e.g. much is coniferous plantations.

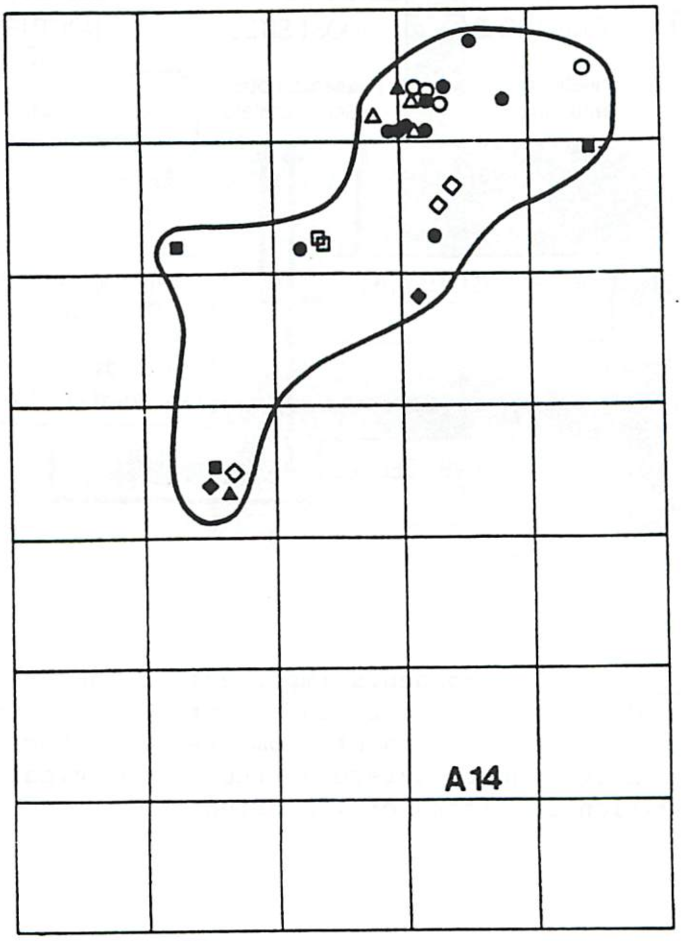
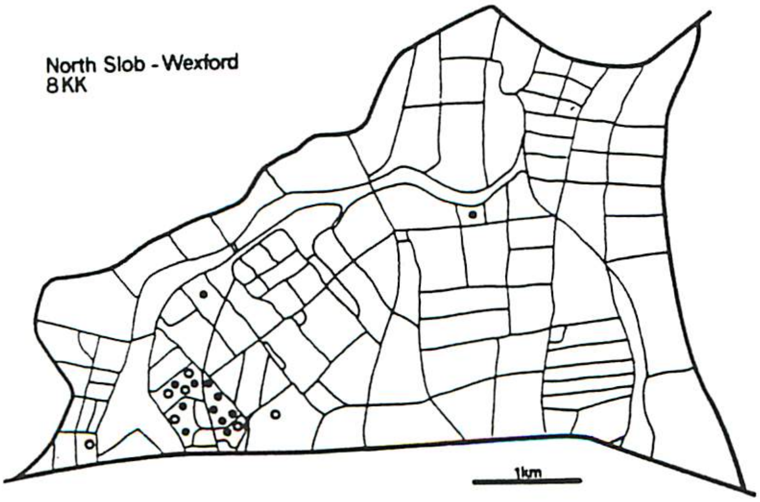
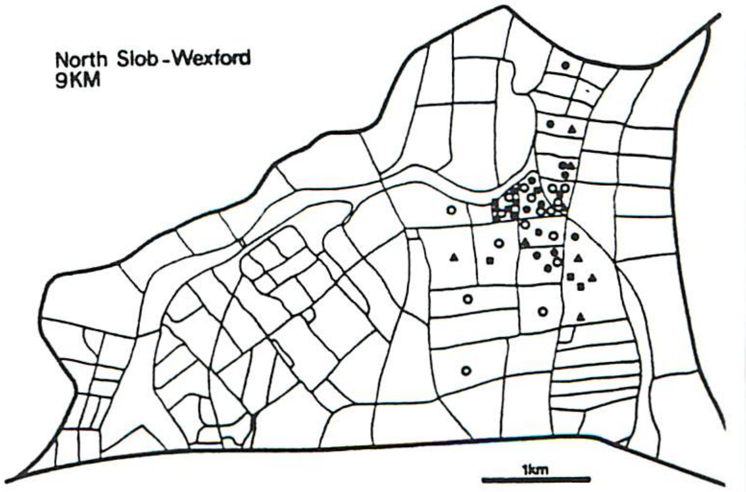


Figure 1.2.3.2.2. Sightings and 'home-range' of a darvic neck-collared geese on the Wexford Slobs 1984/8501987/88. Symbols indicate use of fields in different years. The different symbol shapes indicate different years of sightings: 1984/85 (filled circle), 1985/86 (open circle), 1986/87 (square), 1987/88 (triangle).

A typical member of the central subgroup



A typical member of the southwestern subgr



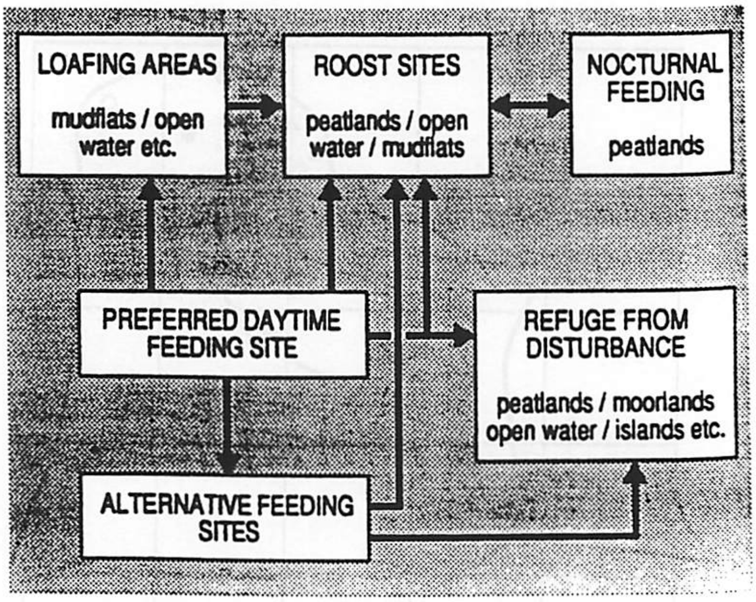


Figure 1.2.3.2.3. Components important in the definition of Greenland White-fronted Goose functional unit systems. Arrows indicate movements between different components of 'home-range'. Each of these areas require further investigation to determine their ecological and social significance for conservation of flocks of wintering geese.

Section 1.2.3.3. Population structure

It has long been thought that Greenland White-fronted Geese exhibit classic leapfrog migration, with birds breeding furthest north in Greenland wintering further south in Britain and Ireland and vice versa (Salomonsen 1950, 1967; Boyd 1958). This has been borne out by more recent analysis of ringing recoveries (Kampp *et al.* 1988).

The majority of birds ringed in the extreme northern Upernavik district were recovered in Wexford, whilst the majority ringed in Eqalummiut nunaat towards the southern half of the range have been recovered in Scotland. Unfortunately too few birds have been ringed and recovered from the extreme south of the range to offer any meaningful interpretation from this area.

However, the leapfrog pattern is only a tendency, as geese recovered so far show a remarkable range of recovery sites. Figure 1 shows the distribution throughout the wintering range of geese ringed in Eqalummiut nunaat. A feature of these sightings/recoveries has been their wide dispersion - all the more extraordinary since all geese were ringed in a very limited area (c. 400 km^2) of west Greenland. The most extreme example was of a flock of 11 moulting non-breeders captured on a single small lake in 1979. By 1987/88 seven of these geese had occurred at nine widely spread sites in Scotland and Ireland.

More information is required concerning this segregation. Given that birds in winter tend to be highly site loyal (section 1.2.3.1), this pattern represents a widespread segregation of flocks from one Greenland site to many different wintering grounds rather than birds wandering between different sites during winter or on migration.

Although the race of Greenland White-fronted Geese has been generally considered as one population, the situation at is clearly complex at sub-population level. Not only is there leapfrog migration (above) but different population segments show different breeding success (section 1.2.4.1). Considerable further darvic ringing is required to investigate population structure. In the absence of ringing in the extreme south of the breeding range, nothing can be concluded about the migration patterns of these birds, although recent Scottish sightings of birds ringing towards the south (Kangerlugssuaq) conform to the expected pattern. It should be a priority to investigate the movements of these birds.

The segregation of birds within the population implies that different population segments (whether on the breeding, migration or wintering areas) may experience different mortality rates reflecting different conditions. Such heterogenity within the population will add to the problems of calculation of mortality/survivorship from pooled ringing recoveries (Kampp *et al.* 1988), and point to the urgent need for further and stratified ringing, both on a range of breeding and wintering areas.

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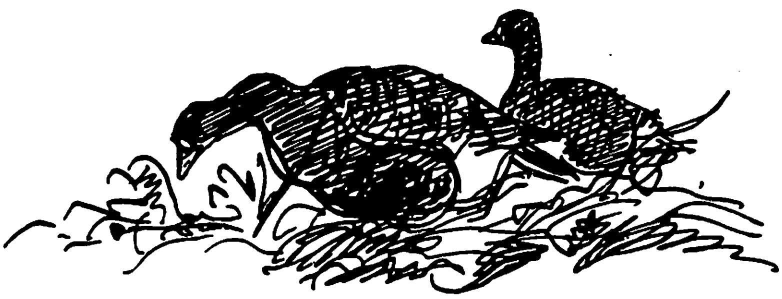

Section 1.2.3.4. Census techniques

Greenland
Ground census is difficult and best undertaken during the moult period when geese are flightless. Count methods and goose behaviour during moult as it effects census are described by Stroud (1981) and Belman (1981). Aerial census methods are described by Fox & Stroud (1988).

Iceland
Most census to date has been undertaken as ground counts (Francis & Fox 1987). Counts of geese as they fly to roost have also been undertaken (Gardarsson 1976).

British Isles
A co-ordinated international census has been undertaken since 1982/83 (Stroud 1983). This involves the collation of counts undertaken at all the sites. Where a site is not counted during the census period, either the closest count undertaken that winter is taken, or data is used from the previous winters census. These interpolated counts make up a very small proportion of the estimated population total. In general, monitoring quality is good, compared to the problems encountered with other goose species. This is because of the generally small size of the flocks and the traditional localities used.

At complex sites, specific counting routes have been devised to enhance count efficiency e.g. Islay (Easterbee *et al.* 1990), Caithness (Fox & Laybourne 1985), Rhunahaorine (Bignal 1988) and Wexford (Walsh & Merne unpublished).

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Section 1.2.4 Population dynamics

Section 1.2.4.1 Productivity

Greenland Whitefronts differ from other races of White-fronted Geese by their low productivity as recorded on the wintering areas. Whilst the long-term breeding success of other White-fronted Goose races is high, the long-term performance of Greenland Whitefronts is much less; only 15.3% on Islay and 17.8% at Wexford (Table 1.2.4.1.1). However, although the overall population productivity is low, those pairs that do breed do so very successfully.

The mean size of families in autumn is high, averaging 2.7 and 3.6 on Islay and at Wexford respectively (Table 1.2.4.1.1). This compares with means of 34% young (mean brood size 2.6) for European Whitefronts, 37.0% and 37.5% (broods 2.2 and 2.5) for two North American subspecies (Ogilvie 1978) and 30-37% young for Tule Whitefronts (Timm *et al.* 1982).

Both the low productivity and high average brood size indicate that an exceptionally small number of pairs successfully breed. Indeed, in 1983, from a population of c. 17,700 only an estimated 724 pairs returned with young to the wintering grounds (Table 1.2.4.1.2).

However, in a study of breeding biology, Fox & Stroud (1988) showed that apparent productivity recorded at different stages of the year (clutch size c.f. brood size on hatching c.f. brood size in late summer c.f. brood size on the wintering areas) showed a significant decline with time. Thus in considering the 'production' figures here, it must be remembered that these are already lower than actual production occurring in Greenland i.e. clutch sizes. This will not affect conservation actions based on these figures however, since they reflect real losses.

Geese wintering in different parts of Britain and Ireland appear to have differing absolute breeding success. However, the long-term productivity trends of Islay, other Scottish, Wexford and other Irish population segments are all highly correlated.

Geese return to Wexford with consistently more young and with larger families than birds wintering on Islay and elsewhere in Scotland. Ringing recoveries (summarised by Salomonsen 1987; Belman 1981; Kampp *et al.* 1988) indicate a tendency towards leapfrog migration (section 1.2.3.2). Ruttledge & Ogilvie (1978) speculated that this differential breeding performance may be due to differences in forage quality on the wintering grounds. Since winter feeding and spring body condition (especially fat and protein reserves) are important determinants of subsequent clutch size (Ankney & MacInnes 1978), higher quality spring forage in Wexford may lead to these geese returning to the breeding grounds in better condition compared with those wintering on Islay or elsewhere in Scotland, thus leading to observed differences in breeding success. This hypothesis remains to be tested.

Alternatively, observed differences in productivity may be due to factors in Greenland.

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Table 1.2.4.1.1. Productivity data for the main Greenland Whitefront wintering areas of Islay, Scotland and Wexford, Ireland.

BREEDING SEASON	ISLAY % young	ISLAY mean brood size	ISLAY sample size	WEXFORD % young	WEXFORD mean brood size	WEXFORD sample size
1962	14.1%					
1963	17.0%					
1964	15.1%					
1965	15.4%					
1966	26.1%	2.7	582*			
1967	16.0%	1.7				
1968	16.2%	1.5			4.1	
1969	9.3%	2.0			3.9	
1970	12.5%	2.8		15.5%	3.7	
1971	7.4%	2.0		14.8%	3.4	
1972	4.6%	2.2	1347	12.7%	3.8	
1973	15.1%	2.8	1600	20.5%	3.7	
1974	18.4%	2.9		17.7%	3.6	
1975	21.4%	3.2		25.6%	3.8	
1976	20.8%	3.4		19.6%	3.9	
1977	10.2%	3.1		12.2%	3.5	
1978	9.7%	2.8		13.2%	2.9	
1979	11.9%	2.8	1440	11.7%	2.8	
1980	23.3%	3.1	1787	20.7%	3.9	
1981	14.3%	3.1		14.6%	4.1	
1982	12.9%	2.7	1309	18.8%	3.6	
1983	9.9%	2.7	2121	12.3%	3.4	4399
1984	12.1%	2.8	1920	18.6%	3.5	3656
1985	27.3%	3.6	3136	34.4%	3.9	3801
1986	10.1%	2.8	3190	16.6%	3.4	5046
1987	17.7%	2.4	3941	18.5%	3.7	5659
1988	18.2%	3.0	1736	22.1%	4.3	6275
1989	18.7%	2.8	4392	15.9%	3.5	6715
1990	19.0%	3.0	3770	16.6%	3.7	6945
MEAN	15.3%	2.7		17.7%	3.6	
St. dev.	5.4	0.5		5.2	0.3	

From Ogilvie (1983 and in litt.), O.J. Merne and J. Wilson in litt., and Greenland White-fronted Goose Study reports.
* possibly unrepresentative in view of the small sample size.

Table 1.2.4.1.2. Breeding performance of different population segments of the Greenland White-fronted Goose in 1982. Data from Wilson & Norriss (1985); Stroud (1983, 1984, 1985); Greenland White-fronted Goose Study (1986).

PRODUCTIVITY IN 1982

AREA	% young	Mean brood size	Total popn.	Estimated total young	Estimated total families
Wexford	19.5%	3.31	5113	997	301
Other Irish sites	18.5%	2.50	2994	554	221
Islay	12.9%	2.71	3501	452	167
Other Scots. sites	13.8%	3.16	3615	499	158
Welsh sites	16.6%	3.25	78	13	4
TOTAL	16.44%	3.08	15301	2515	851

PRODUCTIVITY IN 1983

AREA	% young	Mean brood size	Total popn.	Estimated total young	Estimated total families
Wexford	12.3%	3.37	6258	770	228
Other Irish sites	13.9%	2.40	3230	449	187
Islay	9.9%	2.66	4592	455	171
Other Scots. sites	9.2%	2.40	3503	322	134
Welsh sites	10.5%	2.67	93	10	4
TOTAL	11.35%	2.77	17670	2006	724

PRODUCTIVITY IN 1984

AREA	% young	Mean brood size	Total popn.	Estimated total young	Estimated total families
Wexford	18.7%	3.46	6097	1140	329
Other Irish sites	16.1%	3.58	3355	540	151
Islay	12.1%	2.84	5256	636	224
Other Scots. sites	16.0%	3.10	4158	665	215
Welsh sites	10.9%	2.66	76	8	3
TOTAL	15.78%	3.09	18942	2989	922

PRODUCTIVITY IN 1985

AREA	% young	Mean brood size	Total popn.	Estimated total young	Estimated total families
Wexford	34.4%	3.89	7930	2728	701
Other Irish sites	22.6%	2.99	3565	806	269
Islay	27.3%	3.56	6332	1729	485
Other Scots. sites	26.3%	3.45	4719	1241	360
Welsh sites	0.0%	0.0	93	0	0
TOTAL	28.73%	3.57	22639	6504	1815

PRODUCTIVITY IN 1986

AREA	% young	Mean brood size	Total popn.	Estimated total young	Estimated total families
Wexford	16.6%	3.43	7033	1167	340
Other Irish sites	14.4%	2.48	3185	459	185
Islay	10.1%	2.88	6126	619	215
Other Scots. sites	11.8%	2.49	4701	555	223
Welsh sites[1]	-	-	81	9	3
TOTAL	13.29%	2.90	21126	2809	966

PRODUCTIVITY IN 1987

AREA	% young	Mean brood size	Total popn.	Estimated total young	Estimated total families
Wexford	18.5%	3.69	7988	1478	400
Other Irish sites	21.7%	3.16	3952	858	271
Islay	17.7%	2.42	7373	1305	539
Other Scots. sites	18.2%	2.74	5036	916	334
Welsh sites[2]	10.8%	2.75	102	11	4
England	-	-	4	-	-
TOTAL	18.67%	2.95	24455	4568	1548

[1] Estimated productivity for Welsh site to be the same as the overall British mean productivity.
[2] Estimated productivity for Welsh site to be the same as the overall British mean productivity.

PRODUCTIVITY IN 1988

AREA	% young	Mean brood size	Total popn.	Estimated total young	Estimated total families
Wexford	18.5%	3.69	5659	1046	283
Other Irish sites	15.4%	2.70	4328	666	247
Islay	18.2%	2.96	7588	1381	466
Other Scots. sites	20.0%	2.84[1]	4810	962	339
Welsh sites	10.9%	2.87[1]	105	11	4
TOTAL	18.08%	3.04	22490	4066	1339

PRODUCTIVITY IN 1989

AREA	% young	Mean brood size	Total popn.	Estimated total young	Estimated total families
Wexford	15.9%	3.46	8238	1310	377
Other Irish sites	16.0%	2.68	4040	646	241
Islay	18.7%	2.76	8560	1600	580
Other Scots. sites	19.6%	2.86[2]	5735	1124	393
Welsh sites	22.5%	2.82[2]	123	28	10
England	-	-	16	-	-
TOTAL	17.62%	2.94	26712	4708	1601

PRODUCTIVITY IN 1990

AREA	% young	Mean brood size	Total popn.	Estimated total young	Estimated total families
Wexford	16.6%	3.7	8072	1340	362
Other Irish sites	16.9%	2.44	4275	722	296
Islay	19.0%	3.02	8297	1576	522
Other Scots.[3] sites	18.2%	2.81	6295	1146	408
Welsh sites[3]	18.8%	3.02	170	32	10
TOTAL	17.76%	3.01	27109	4816	1598

[1] assuming same brood size as Britsih average
[2] assuming same brood size as British average
[3] Estimated productivity for Welsh site to be the same as the overall British mean productivity.

Section 1.2.4.2 Adult survival and mortality

The only two published analyses (Boyd 1958; Kampp *et al.* 1988) of Greenland Whitefront mortality are both based on the same data: the ringing scheme of the Zoological Museum in Copenhagen initiated in the 1940s by the late Finn Salomonsen.

The ringing analysis of Kampp *et al.* (1988) indicated an adult mortality rate of 23%. Hunting alone gave a mortality of at least 4.8% annually (9.6% in first-year birds), but these estimates are certainly too low since not all shot geese are retrieved and not all recovered rings are reported. The true harvest could be twice as high, although the relative values, implying that first-years Whitefronts have twice the risk of being shot are probably accurate however (Kampp *et al.* 1988).

An adult mortality rate of 23% is comparable to that for other hunter grey geese (Cramp & Simmons 1977). Most estimates for other species have been based on ringing, using more or less adequate techniques, and as in Kampp *et al.* (1988) the data sets have often been rather small.

Kampp *et al.* (1988) chose Haldane's method of calculating mortality by necessity, since the date did not allow calculation of age- and year-specific survival rates. The validity of the result depends on how well the assumptions of constant mortality and recovery rates are fulfilled. The result obtained will at best be a reasonable, though somewhat vaguely define mean value.

The calculated mortality rate seems to exceed average recruitment. Among the potential problems may be varying mortality rates between sub-populations, combined with a bias in recoveries in favour of the high mortality population segments may well be involved, however; this would be the case if hunting was an important mortality factor (as it certainly must be), and if different sub-populations experienced different hunting pressures (c.f. Pollock & Raveling 1982).

However, the mortality rate of Kampp *et al.* (1988) and productivity data refer to different periods, with most of the ringing recoveries stemming from the 1950s and 1960s when the subspecies was legitimate quarry in most of its world range. In view of the considerable recent change in its protected status, it is vital that ringing, both conventional and darvic is undertaken more intensively in future.

Kampp *et al.* (1988) concluded that our present understanding of the population dynamics of Greenland White-fronted Geese is poor, although accumulating controls of individually marked birds may change this situation. Until then, the gaps in our knowledge should urge caution in the conservation of the race. The impact of hunting on the population processes of other arctic nesting geese have been well documented (e.g. Ebbinge 1985). The combination of low productivity and normal (rather than low) mortality in the Greenland Whitefront is no cause for contentment, the less so because the population, by its limited size, will necessarily be vulnerable.

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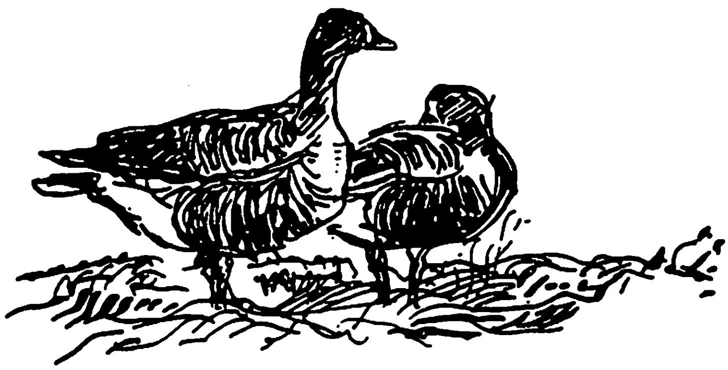

Section 1.2.4.3 Behavioural observations

There have been no detailed ethological research on Greenland White-fronted Geese, although some observational studies have been undertaken on the breeding grounds (Madsen 1981; Stroud 1983; Fowles 1981; Fox & Madsen 1981; Fox & Ridgill 1985).

These studies, and analyses of resightings of ringed geese (Warren 1990; Warren *et al.* in press) have shown that Greenland White-fronted Geese have an extended and complex family structure. This is of particular relevance to conservation management.

Further specific studies are required to elaborate details, but Greenland Whitefronts appear to be unusual amongst geese in showing a greatly extended period during which offspring stay with parents. This is manifest on the wintering grounds as large 'extended families' which contain not only parents and young of the year, but also small numbers of offspring from previous years. On the breeding grounds there are suggestions that some of these offspring assist with vigilance at nests and with brood rearing (Stroud 1983; Madsen 1981).

This complex social structure, coupled with the strong between-winter site-fidelity (section 1.2.3.1) has implications for methods of site management adopted. Highly disruptive techniques (e.g. wide-scale scaring to alleviate agricultural damage) may have particularly adverse consequences for Greenland Whitefronts.

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Section 1.2.5 Diet

Section 1.2.5.1 Vegetation community selection

Winter (Britain and Ireland)
In the past it seems probable that the race was dependent to a great extent on areas of raised bog and oceanic blanket bog (Owen 1976; Fuller 1982). The earliest studies on winter diet showed that many typical bog plants were taken: ***Eriophorum angustifolium*** (Ruttledge 1929; Cadman 1953, 1957), ***Rhynchospora alba*** (Cadman 1953, 1957; Pollard & Walters-Davies 1968) and ***Trichophorum cespitosum*** (Campbell 1947).

Both intensive and low-intensity agricultural habitats are used in some areas of the winter range; increasingly so in some regions. Where birds feed during the day on pastures, they still resort to peatlands at night, or in the event of disturbance.

In the main wintering areas of Islay and Wexford, use of autumn stubbles is commonplace, although at least in Wexford, its use is in proportion to its extent (i.e. there is no positive selection) (Warren 1990). Here spilt barley grain is eaten in large quantities whilst available. Winter wheat is an insignificant part of the diet at Wexford (Cramp & Simmons 1977), and is not grown on Islay.

At Wexford and to a lesser extent on Islay, potato and turnip eating has been recorded, but generally root crops are unimportant food items in many parts of the range (Wexford being an exception). Feeding in beet fields is also important at Wexford and is used as a 'sacrifice crop' for the management of the geese on the Wexford Wildfowl Refuge.

Use of salt marshes is not common, but a few flocks seem to have a tradition of feeding in such areas. The Dyfi Estuary flock regularly graze both on the saltings, where they take largely *Festuca rubra*, and also on the mudflats of the estuary where they eat *Spartina townsendii* shoots (Fox & Stroud 1985). Similar saltmarsh grazing is found at a few other Scottish and Irish sites (e.g. at Lowlandsman Bay, Jura, and two sites in Co. Clare: the River Fergus Estuary and at Lehinch), although the Dyfi flock is the only one known to eat *Spartina*.

In summary, the geese select a wide variety of habitats for feeding, but prefer wetland areas. In Ireland, the use of marsh, callows (seasonally flooding grassland) and wet pasture is especially widespread. As a population they remain dependent on peatlands at least for roosting. This wetland feeding is in marked contrast to that shown by the closely related European White-fronted Goose (Owen 1972, 1976).

Staging areas (Iceland)
There is very little detailed information on habitat utilisation in Iceland and no specific studies.

<u>Summer (Greenland)</u>

A study of the summer feeding of Greenland White-fronted Geese was reported by Madsen & Fox (1981). Feeding site selection changed significantly through the summer although wetlands were used at all times. They found that from the pre-nesting period to incubation, and during hatching to fledging, the geese followed the delay in growth of emergent aquatic and marsh vegetation up an altitudinal gradient from lowland areas to higher lakes. Thaw also proceeds slowly up an altitudinal gradient, starting in the lowest areas of the valleys and progressing until it reaches the plateaux and highest hill tops. The changing use of wetland feeding sites is related to this temperature gradient which results in delayed plant growth at higher altitudes (Fox *et al.* 1983: Figure 1.2.5.1.1).

Other studies have found the peak protein content of monocotyledonous plants to occur just before maximum growth, whereas fibre content is at its lowest. By following the different growth seasons of the same plant species, the geese are in a favourable position to optimise their nutritive intake, always selecting fresh shoots prior to maximum growth as they move along this altitudinal gradient of production.

Madsen & Fox (1981) studied feeding site selection in Eqalummiut nunaat, an area with a continental-type climate, with low precipitation and rapidly draining soils. Here wetlands are discrete, usually small and associated with lakes, pools or stream margins. Thus, because extensive marsh areas are rare, these feeding areas are limited and provide a potentially finite food resource for the geese in summer - it is thought especially so during the moult period. However, with the present population size and dispersion, it is unlikely that the geese are seriously limited by food, although more detailed studies are required.

Eqalummiut nunnat is an area of glacially scoured plateaux of between 400 - 600 m above sea level. It is deeply incised by a few trough like valleys which extend from sea-level to c. 300 m altitude. Topographically, although Eqalummiut nunaat is similar to large areas of the southern/central breeding grounds, further north, other breeding areas occur at low altitude in regions with maritime climate. Feeding strategies found in Eqalummiut nunaat are unlikely to be exactly similar in these other regions and further studies are clearly required throughout the range.

Notwithstanding the lack of studies from other these areas, it is clear that lowland sites are of particular importance to the geese on their arrival in Greenland. Some sites appear to be traditionally used as arrival areas of great importance in spring feeding (Fox & Madsen 1981; Fox & Ridgill 1985). Feeding in these areas most probably has a major influence on breeding success, and at least some southerly arrival areas are used as staging sites for geese that breed further north (Fox & Ridgill 1985).

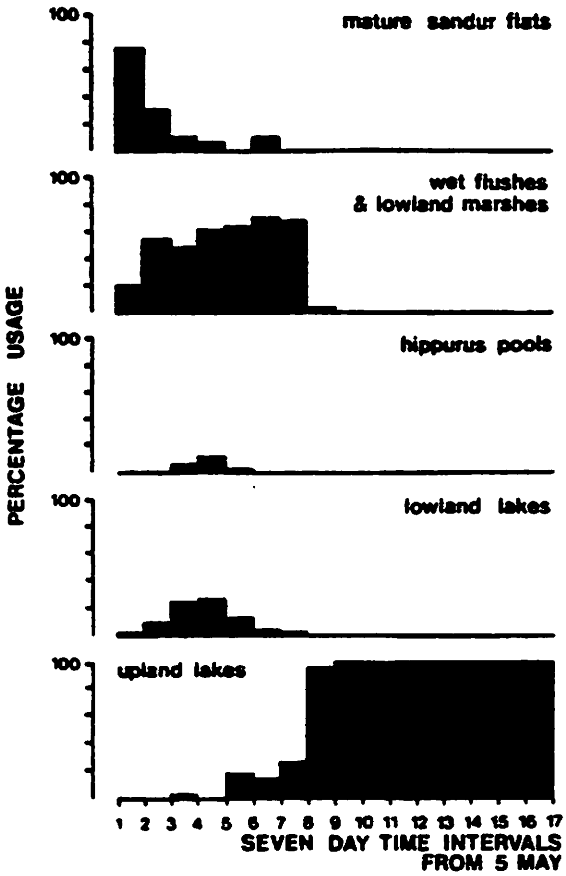

Figure 1.2.5.1.1 Usage of feeding sites by Greenland White-fronted Geese in Eqalummiut Nunaat, west Greenland throughout the summer of 1979 (from Madsen & Fox 1981).

Section 1.2.5.2 Vegetation utilization (faecal analysis)

Winter (Britain and Ireland)
A range of poor quality agricultural grasses have been identified as comprising the bulk of the diet on farmland: ***Deschampsia flexuosa, Agrostis tenuis*** (Pollard & Walters-Davies 1968), ***Agrostis*** spp., ***Anthoxanthum odoratum, Cynosurus christatus, Festuca rubra, F. ovina, F. pratensis, Holcus lanatus, Lolium*** spp., ***Equisetum*** spp. (Mayes 1984), Glyceria fluitans (Pollard & Walters-Davies 1968; Mayes 1984).

Dicotyledons are also taken from cultivated areas, ***Ranunculus acris*** and ***R. flamula*** roots and stem-bases and ***Trifolium repens*** stolons being commonly taken (Mayes 1984; Owen & Cramp & Simmons 1977).

As indicated in the previous section, spilt barley grain is eaten in large quantities whilst autumn stubbles are available available. Likewise, although at Wexford and to a lesser extent on Islay, potato and turnip eating has been recorded, generally root crops are unimportant food items in many parts of the range (Wexford being an exception). Feeding in beet fields is also important at Wexford.

Staging areas (Iceland)
There have been no detailed studies of vegetation utilisation on the staging areas in Iceland. However observations indiacte that on hayfields ***Phleum pratense*** is taken, whilst in wetland areas ***Eriophorum angustifolium*** and ***Carex lyngbeii*** are the main food items (Fox unpubl.).

Summer (Greenland)
A study of the summer diet of Greenland White-fronted Geese was reported by Madsen & Fox (1981). Fencker (1950) described the geese as feeding on ***Empetrum*** and 'dead grasses' on their arrival at Sarqaqdalen when snow cover was complete, feeding later on ***Equisetum*** and a variety of grasses after thaw.

Madsen & Fox (1981) compared diet as indicated by epidermal analysis of faecal samples with detailed sampling of the vegetation at feeding sites (Figure 1.2.5.2.1). All sites were wetlands, with a common presence of ***Eriophorum angustifolium*** and ***Carex rariflora***. The diet was highly specific at all times; throughout the sampling period only 10 species exceeded a frequency of 10% in a single sample.

Diet changed significantly through the summer as indicated below.

Pre-nesting period
On arrival in early May, geese were confined to low altitude wetlands where shallow water pools and the uppermost soil horizons underwent rapid thaw. Geese fed particularly on the underground storage organs from the previous years growth. Samples indicating

feeding on the rhizomes of ***Puccinellia deschampsiodes*** and the tubers of ***Triglochin palustre***. ***Hippuris vulgaris*** was taken in pools where geese selected the submerged parts and left the upper stems.

Incubation period
Nest sites were in close proximity to open water or marshes where nesting birds could feed during incubation (Fox & Stroud 1988). Just prior to and during the first half of incubation ***Eriophorum angustifolium*** was eaten almost exclusively. At times, geese fed not only on rhizomes and roots, but also on submerged fresh shoots. ***Carex rariflora*** was also an important food. Madsen & Fox (1981) speculated that some observations may indicate a nesting female feeding on insects.

Post-incubation
During the latter part of incubation, non-breeding birds moved to higher altitude and there fed around lake margins on marsh vegetation. Food was similar to that taken at lower altitudes earlier in the season but with less ***Eriophorum angustifolium***. The dominant feature of the diet was ***Carex rariflora***.

Geese grazed the fresh leaves and shoots of vegetation, and no roots were found in the faeces at this time. Generally, diet was more varied than before. Grasses and above ground parts of Cyperaceans formed a greater part of the diet, with ***Poa pratensis*** being particularly favoured. This species, with ***C. rariflora***, ***Eriophorum*** spp. and ***Equisetum variegatum***, was most frequent in the faeces. ***Trisetum spicatum***, a snow-patch grass, showed increasing frequency towards the end of the summer - marking the movement of geese in late summer to feed in snow-patches.

Madsen & Fox (1981) found a significant difference in food selection between adults and goslings (Figure 1.2.5.2.2.), although feeding occurred in the same lake-edge habitats. ***Equisetum variegatum*** was greatly preferred by goslings making up half of the food sample when they were two weeks old, whereas adults did not utilise this species more than might accidentally have been taken with other food items. The goslings also grazed several herbs absent from the adult diet such as ***Stellaria*** and ***Polygonum***. By the end of June, the difference in diet between goslings and adults had become less apparent, with substantially the same foods being taken by mid-July. Madsen & Fox (1981) considered that the difference in gosling diet might relate to the differential digestibility of food items.

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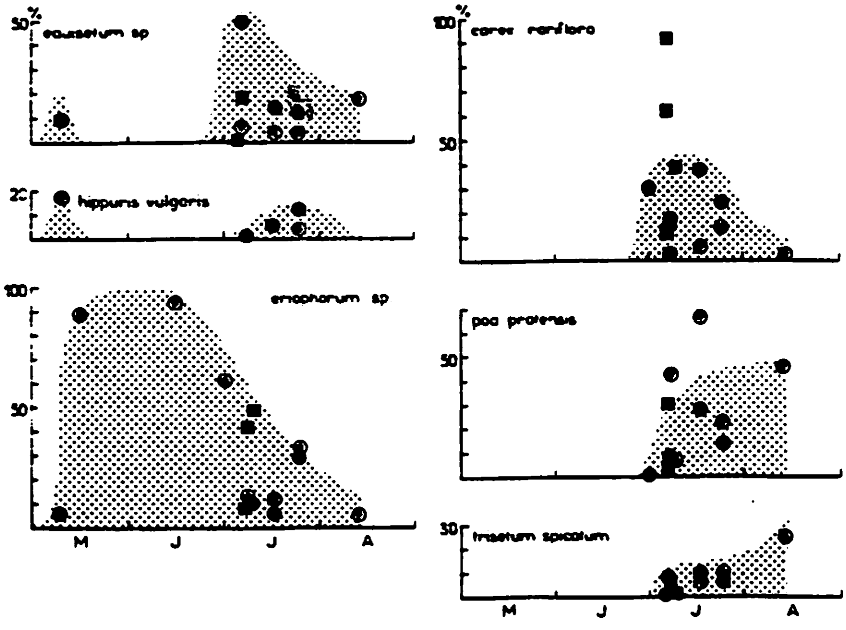
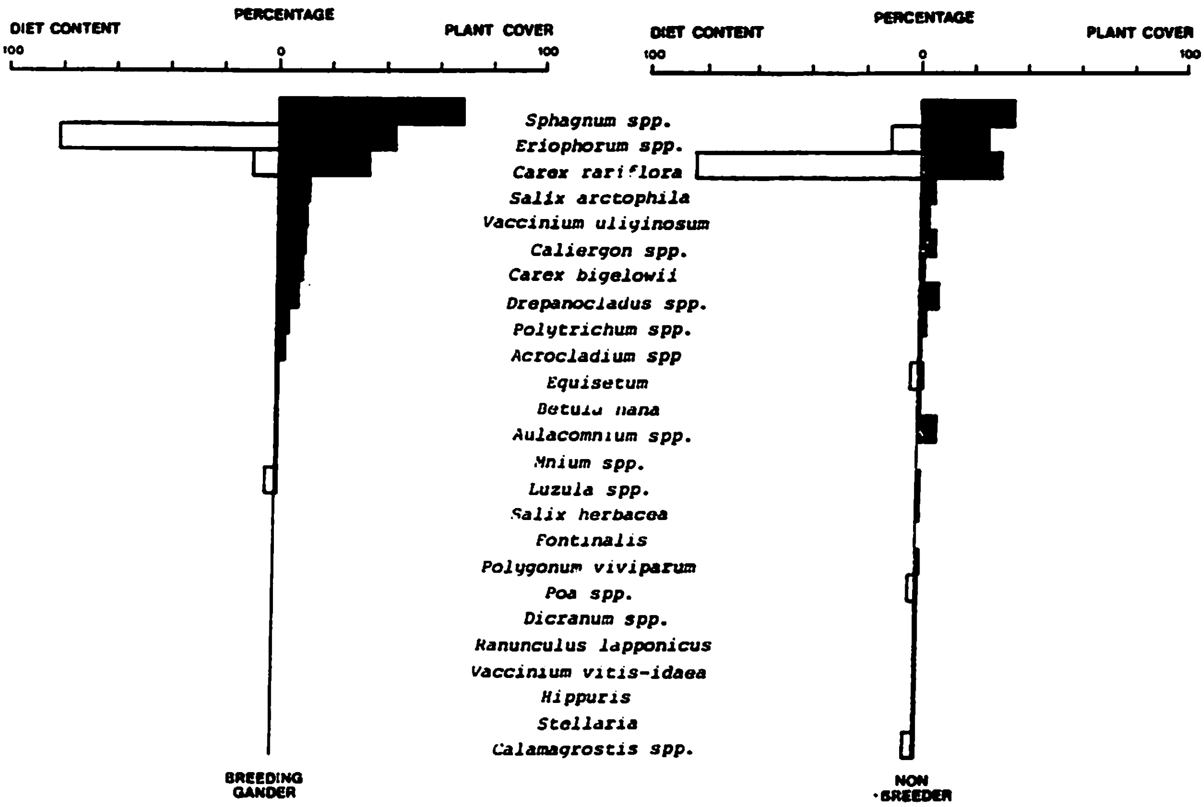


Figure 1.2.5.2.1. Seasonal changes in the utilisation of six major food plants by Greenland White-fronted Geese during summer 1979 (from Madsen & Fox 1981). Percentages represent frequency of occurrence in faecal analysis: filled circles indicate gosling diet, squares indicate non-breeder diet and surrounded circles indicate adult diet. Shaded areas indicate generalised usage patterns.



a) Selectivity of breeding ganders during incubation (based on analysis of faecal material and mean percentage plant cover in a marsh feeding area (from Madsen & Fox 1981).

b) Selectivity of non-breeding geese during June (based on analysis of faecal material and mean percentage plant cover at six different sites (from Madsen & Fox 1981).

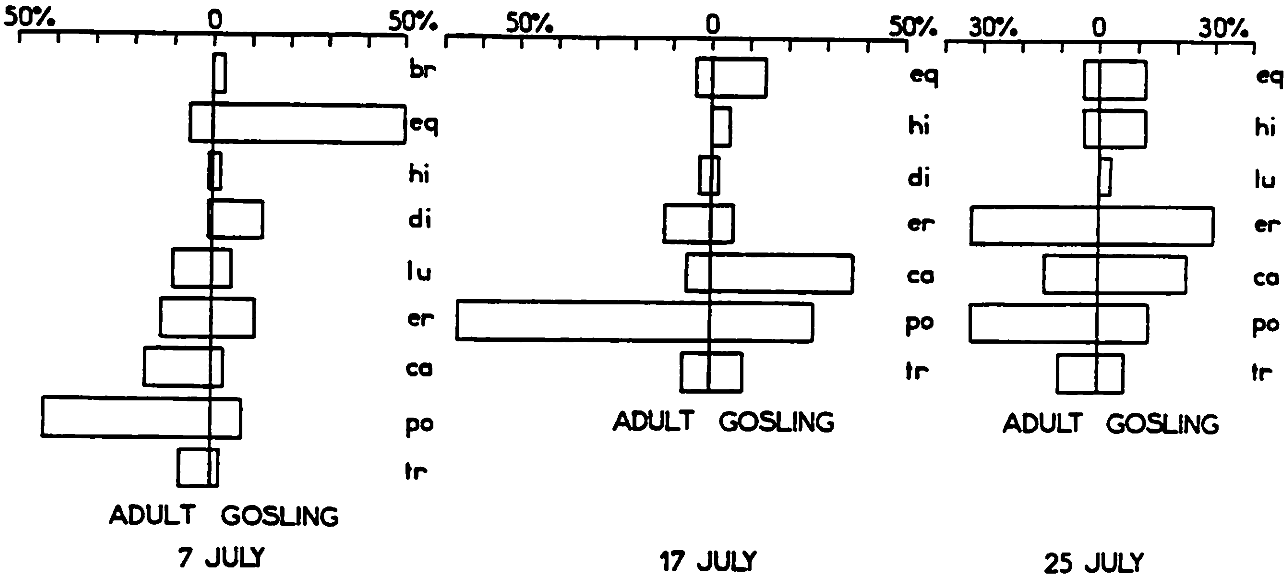


Figure 1.2.5.2.2. Parental and gosling food items during July. Percentages represent frequency in faecal analysis. Abbreviations: br = bryophytes, eq = *Equisetum* sp., hi = *Hippuris vulgaris*, di = dicotyledons, lu = *Luzula* sp., er = *Eriophorum* spp., ca = *Carex rariflora*, po = *Poa pratensis*, tr = *Trisetum spicatum* (from Madsen & Fox 1981).

Section 1.2.6 Cultural

Section 1.2.6.1 History of human perception/utilisation

Greenland
The breeding areas of the geese are generally remote from permanent human habitation. There thus seems to have been little dependence by Greenlanders on the geese. However, during the moult period, when the geese are flightless, some birds have been rounded up. By employing these skills Dr Finn Salomonsen encouraging the capture and ringing of many hundreds of geese between the 1940s-1960s. The only settlement known to have 'specialised' in goose capture was Ikamiut on the edge of Naternaq. Clearly the high densities in this area made such efforts worthwhile.

It was apparently traditional to capture goslings for captive rearing and slaughter in winter. These were often sold by Greenlanders to Danish households for fattening prior to the Martinmas and Christmas festivals (Salomonsen 1951). This practice has now been forbidden (Salomonsen 1970).

Considering shooting, Muller (1896) commented that *"Being on a Caribou hunt one could probably stalk a group of roosting geese if one had the patience. However one does not wish to scare off the Caribou that are in the surrounding area by firing uneccessary shots. Therefore goose hunting is rarely or never practised. The gain as compared to the effort put into it would never equal Caribou hunting."* Nearly a hundred years later, almost exactly the same point of view was put to Higgs (1981) by Greenlanders at a summer camp in Eqalummiut nunaat.

The only exception to this was in early spring when, at some staging/arrival sites, significant numbers of birds were shot. These arriving flocks gathered in traditional areas that thaw early. Shooting at these areas was undertaken not only by Greenlandic hunters, but also by personnel from the Sondre Stromfjord Air Base (Fox *et al.* 1983). Aside from the risk of disturbance at a critical period, Fox *et al.* considered that shooting the early arrivals in spring might result in a disproportionate kill of breeding adults.

Iceland
There is little information on past perceptions or utilisation of Whitefronts in Iceland. Presumably, as with the other migratory geese in this country, they would have been shot for eating in spring and autumn.

Scotland
As in Ireland and Wales, the geese were regarded as elusive quarry of hill lochs and moorland. The literature of the Victorian hunters relates to shooting expeditions after these geese in the

Highlands, although there would presumably have been local hunting activity also.

Until recent times, there is no evidence that the geese were regarded as a major agricultural problem.

Wales
The geese seem always to have been restricted in distribution in Wales. There appears not to have been any significant conflict with agricultural interests. As in Ireland, the geese had a reputation amongst wildfowlers for being elusive quarry of hill lochs and bogs (Cadman 1956, 1957).

When the Cors Fochno/Dyfi Estuary flock declined marked in numbers in the early 1970s, there was considerable local support for a variety of schemes to encourage the conservation of the flock (Wrigley 1973). The lead was particularly taken by local wildfowlers who considered ways of promoting Greenland Whitefront conservation in mid-Wales (Wrigley 1975).

Northern Ireland
There is no history of shooting of Greenland Whitefronts on their farmland habitats.

Irish Republic
As in Britain, the geese have long been prized as elusive quarry for wildfowlers. There seems not to have been the same perception of agricultural problems in Ireland compared to parts of Scotland, either past or present.

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Section 1.2.6.2 Current status of human perception/utilisation

Greenland
There is little human disturbance of geese during the summer. With changing social conditions in Greenland, traditional summer hunting practices in larger settlements have been neglected and legislation introduced protecting the geese (Salomonsen 1970; Ministeriet for Gronland). It is not known how many geese are shot each autumn, or are illegally killed at other times. Limited information from Greenlandic hunters suggests that very few are taken, although they are a prized quarry because of the difficulty of stalking close enough to shot.

Iceland
Agriculture
The geese are not present for long enough, or in sufficient numbers, to constitute a serious agricultural problem, despite occurring in areas of the most intensive farming (Francis & Fox 1987). Perceptions are probably influenced however, by their co-occurrence at certain times, with larger numbers of Greyland and Pink-footed Geese. On some farms, however, they are tolerated and shooting is not permitted. This results in local 'refuge' areas in regions which are otherwise heavily shot-over e.g. Hvanneri.
Shooting
Almost all shooting occurs on the autumn migration since spring shooting is illegal, although it undoubtedly occurs. No figures are available for the number of geese shot in Iceland, but Francis & Fox (1987) reported one unofficial estimate from members of Skotveidifelag Islands (the Icelandic Shooting Society) of c.800 birds per season (which was thought to be an underestimate). Other more recent estimates suggest a total bag of c.2,000 Greenland White-fronted Geese in autumn 1989, with an individual bag following one dusk roost flight of c.200 geese. Although formerly, numbers shot there were thought to be low (Lampio 1974; Ruttledge & Ogilvie 1979), recent information (WWT unpublished) and ringing recoveries (GWGS and NPWS unpublished) suggest that numbers shot are significant and increasing.

There appears to be no move towards prohibition or restriction of shooting of Whitefronts in Iceland. Voluntary constraint is actively promoted by Skotveidifelag Islands, but its members only constitute a small proportion of all hunters (c. 400 out of c. 8,000). Recent information suggests that goose shooting is growing in popularity and is now being undertaken especially by town-dwellers.

Scotland
Agriculture
Farmers attitudes to geese in Scotland are variable. In some areas, such as some farms on Islay, geese are perceived to cause serious agricultural damage. These perceptions have increased in line with the increase in the Islay population in recent years

(Bignal *et al.* 1991), resulting in calls for drastic culls of the population. These attitudes are not shared by the whole farming community however, and the geese are tolerated or welcomed by others as a traditional part of the winter landscape. Indeed, many regard them as true 'Ileachs' (islanders of Islay). These views are not newsworthy however, and are less apparent from outside of the island. Elsewhere in Scotland attitudes range from local hostility near major population centres, through indifference, to positive concern for the well-being of the geese, especially by landowners near small and remote flocks.

Shooting

There is no current sport shooting in Scotland, the geese having been protected since 1982 by the 1981 Wildlife & Countryside Act. Licenses to shoot unlimited numbers of geese following complaints of alleged damage have been issued on Islay since 1987/88 (Brodie 1991). The conditions of these licenses allow their transfer to persons shooting for sport. Abuse of licenses has been witnessed, and the primary aim in some areas of Islay seems to have been shooting for sport rather than the control of alleged damage. Wildfowling organisations have been supportive of the need for conservation measures in Scotland.

Wales

Agriculture

No problems of agricultural conflict are known from Wales.

Shooting

Although the geese remain legal quarry in Wales, voluntary restraint occurs at both regular sites. On the Dyfi Estuary a shooting ban is promoted by the Dyfi Wildfowling Association. At the Powys site, the flock is protected on their Llyn Hir feeding area through the agency of a local fishing club who hold the shooting rights also.

Northern Ireland

Agriculture

No problems of agricultural conflict are known from Northern Ireland.

Shooting

Shooting is not currently permitted.

Irish Republic

Agriculture

Problems of agricultural conflict in Ireland are generally localised to a few areas holding significant numbers of Greenland Whitefronts. The major area of conflict, whether real or perceived is on the Wexford Slobs. Many of the other flocks elsewhere either use a large number of feeding sites or occur in such low densities as to avoid major conflicts.

Shooting

In contrast to Scotland, Greenland Whitefronts have been traditionally much more important as a quarry in Ireland. This is because of the absence of large Irish wintering populations of

Pink-footed and Greylag Geese, although the latter used to be locally important as a quarry species, particularly in Wexford. It is thus the only potential quarry species of goose wintering in Ireland. A consequence has been strong calls from the National Association of Regional Game Councils (NARGC) and others for continued goose shooting in recent years i.e. following the shooting moratorium imposed in 1983. Goose shooting has been called for, not only at the main population centre at Wexford, but also in other areas. However, NARGC acknowledge that shooting is not desirable at many of the smaller 'down-country' flocks. At the same time, NARGC regard the major threat to the population as the uncontrolled shooting in Iceland in autumn.

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Section 1.2.6.3 Past management in nature conservation

Basic information on numbers, distribution, ecology and behaviour was lacking in the late 1970s. Available information (Ruttledge & Ogilvie 1979; Owen 1978) suggested that the population was small and declining, and that productivity was low (Ogilvie 1978). On the basis of long term mean figures, only c.810 pairs bred successfully each year out of a population of c.15,000. In the late 1970s it became apparent that a massive and continuing loss of the traditional wetland habitat (mainly peatlands), was having a severely detrimental effect on Greenland White-fronted Geese especially in Ireland (Owen 1978; Ruttledge & Ogilvie 1979; Ryan & Cross 1984; Reynolds 1984; Stroud 1984b).

In response to these information needs, a broad programme of conservation orientated research was initiated in the late 1970s:

Greenland
Following Muller's (1896) behavioural observations, early studies gave some information on breeding behaviour and ecology in the Sarqaq area of Nugssuaq Halvo (Fencker 1950) and elsewhere (Salomonsen 1950, 1967). More recent biological expeditions in 1979 and 1984 to Eqalummiut nunaat have given basic descriptive information on summer ecology and behaviour (Fox & Stroud 1981, 1988a; Fox *et al.* 1983; Birks & Penford 1990).

More recent aerial surveys in 1988 and 1989 have given a better understanding of distribution and highlighted the importance of certain areas for the population (Fox & Stroud 1988b), especially Naternaq (Lersletten). Recent ground counts have also been undertaken in more northerly areas (Frimer & Nielsen 1990; Bennike 1990; Thing & Ettrup unpublished; Table 1.2.3.2), some of which have been undertaken by, or at the instigation of, the Home Rule Authorities.

Geese have been ringed in Greenland using darvic colour rings in 1979, 1984 (Eqalummiut nunaat), and 1989 (Kangerlugssuaq).

1n 1985 the legal status of the geese was altered with spring shooting (after 1 May) being forbidden, and shooting allowed only between 15 August - 30 April (effectively only mid-August - September). Protection of important breeding areas was given on 27 January 1988 with the designation of five Ramsar sites holding an estimated 8,950 geese (Table 1.2.6.3.1; Figure 1.2.6.3.1).

Table 1.2.6.3.1. Estimated numbers of Greenland White-fronted Geese protected on Ramsar sites in Greenland.

Location	Area (km^2)	Estimated no. of geese
Eqalummiut Nunaat - Nassuttuup Nunaa[1]	5,000	2,500+
Naternaq (Lersletten)[2]	1,500	6,000
Aqajarua - Sullorsuaq[3]	300	250+
Qinnguata maraa - Kuussuaq[4]	60	100
Kuannersuit kuussuat[5]	45	100+

There is no active research for goose conservation currently being undertaken by state bodies, although some of the programmes above have been aided by state funding.

Iceland
No research for goose conservation has been initiated by state bodies, but some private indivduals and groups from Britain and Ireland have undertaken studies on migrating geese (mainly the Wildfowl and Wetlands Trust and Greenland White-fronted Goose Study). Work undertaken has included an inventory of wintering sites, census of staging areas, studies of feeding ecology and observations of individually marked geese.

There are no statutorily protected sites for Greenland White-fronted Geese in Iceland (Figure 1.2.6.3.2).

Britain
The species was given protection in Scotland under the Wildlife and Countryside Act 1981 (effective from October 1982). At the same time a series of co-ordinated censuses was organised in Britain and Ireland to provide information on distribution and numbers in winter (Easterbee *et al.* in prep.; sections 1.2.3).

The distribution of designated sites of international importance (Ramsar sites and SPAs) for geese is shown in Figures 1.2.6.3.3 and 1.2.6.3.4.

Ireland
In Ireland a three year temporary shooting ban was introduced for the winters of 1982/83 to 1984/85 inclusive. A state-funded research programme has been investigating the feeding ecology and

[1] Kangaatsiaq & Sisimiut kommuner
[2] Qasigiannguit & Kangaatsiaq kommuner
[3] Qeqertarsuaq kommune
[4] Qeqertarsuaq kommune
[5] Qeqertarsuaq kommune

productivity of the geese (Mayes 1984, 1991; Wilson & Norriss 1983, 1984, 1985; Norriss & Wilson 1986, 1988, 1990, 1991). A marking programme has also been undertaken to investigate site fidelity (Warren 1990; Wilson *et al.* 1991) and a site inventory compiled as a necessary aid to peatland site conservation.

The distribution of designated sites of international importance (Ramsar sites and SPAs) for geese is shown in Figures 1.2.6.3.3 and 1.2.6.3.4.

Summary
Table 1.2.6.3.2.summarises the extent of present site-based protection in each Range State according to the principal statutory or non-statutory designations. It does not indicate the full extent of other site-based protection, such as local nature reserves or other forms of informal site protection or management for geese.

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Table 1.2.6.3.2. LISTING OF SITES USED BY GREENLAND WHITE-FRONTED GEESE WHICH HAVE STATUTORY PROTECTION UNDER NATIONAL OR INTERNATIONAL LEGISLATION.

GREENLAND

National Code	Name	Co-ordinates	Area (hectares)	Numbers of geese	National designation (see glossary for abbreviations)	International Designation Ramsar	SPA
	Eqalummiut Nunaat-Nassuttuup Nunaa		500,000	2,500+		Ramsar	
	Naternaq (Lersletten)		150,000	6,000		Ramsar	
	Aqajarua - Sullorsuaq		30,000	250+		Ramsar	
	Qinnguata maraa - Kuussuaq		6,000	100		Ramsar	
	Kuannersuit kuussuat		4,500	100+		Ramsar	

ICELAND

There are no statutorily protected sites for Whitefronts in Iceland but the following sites are listed in the Nature Conservation Council's Register of Sites of Scientific Interest.

National Code	Name	Co-ordinates	Area (hectares)	Numbers of geese	National designation (see glossary for abbreviations)	International Designation Ramsar	SPA
S001	Safamyri	67 47'N 20 35'W	200	4,000	SSI		
S002	Skumsstadavatn	63 42'N 20 30'W	800	1,000	SSI		
S005	Pollengi	64 10'N 20 26'W	1,000	+	SSI		
S006	Oddaflod	63 46'N 20 27'W	700	+	SSI		
SW006	Olfusforir	63 57'N 21 15'W	1,000	+	SSI		
W004	Ferjubakkafloi-Nordura	64 38'N 21 44'W	1,500	1,200	SSI		

SCOTLAND

National Code	Name	Co-ordinates	Area (hectares)	Numbers of geese	National designation (see glossary for abbreviations)	International Designation Ramsar	SPA
22WDA	River Dee (Parton to Crossmichael), Wigtownshire	NX 710685	516.6	360	SSSI, NCR	pRamsar	pSPA
22WCT	Kenmure Holms, Wigtownshire	NX 710685	154.1	as above	SSSI, NCR	pRamsar	pSPA
22WDB	Threave and Carlingwark Loch, Wigtownshire	NX 743625	309.1	as above	SSSI, NCR	pRamsar	pSPA
22WFC	Torrs Warren - Luce Sands, Wigtownshire	NX 140545	2,409.0		SSSI, NCR	pRamsar	pSPA

22WGT	Central Lochs, Bute, Mid-Argyll	NS 075615	187.0	SSSI		
22WLC	An Fhaodhail and the Reef, Tiree, North Argyll	NM 014454	319.4	SSSI, NCR	pRamsar	pSPA
22WHG	Crossapol and Gunna, North Argyll	NM 124530	973.0	SSSI, NCR	pRamsar	pSPA
22WGH	Hough Bay and Ballevullin machair, Coll	NL 943463	503.3	SSSI, NCR	pRamsar	pSPA
22WKW	Totamore Dunes, North Argyll	NM 173574	127.6	SSSI, NCR	pRamsar	pSPA
	Tiree and Coll			pSSSI	pRamsar	pSPA
22WJR	Lismore Lochs, North Argyll	NM 808376	110.5	SSSI, NCR	pRamsar	pSPA
22WLP	Oronsay, North Argyll	NR 350875	329.4	SSSI		
22WLN	Loch Fada, Colonsay, North Argyll	NR 383956	86.6	SSSI		
22WHR	Eilean na Muice Duibhe, Islay, South Argyll	NR 320550	574.0	SSSI, NCR	Ramsar	SPA
22WGR	Bridgend Flats, Islay, South Argyll	NR 330620	331.0	SSSI, NCR	Ramsar	SPA
22WLG	Feur Lochain, Islay, South Argyll	NR 252695	384.1	SSSI, NCR	Ramsar	SPA
22WGW	Glac na Criche, Islay, South Argyll	NR 225708	265.0	SSSI, NCR	Ramsar	SPA
22WJC	Gruinart Flats, Islay, South Argyll	NR 285665	3,170.0	SSSI, NCR	Ramsar	SPA
22WAY	Rhinns of Islay, Islay, South Argyll	NR 235620	8,311.9	SSSI, NCR	pRamsar	pSPA
22WJN	Laggan Peninsula, Islay, South Argyll	NR 297555	1,270.0	SSSI, NCR		SPA
22WKB	Moine Mhor, South Argyll	NR 817931	657.6	SSSI, NCR, NNR	pRamsar	
22WKE	Rhunahaorine Point, South Argyll	NR 695493	325.8	SSSI, NCR, NNR	pRamsar	pSPA
22WKP	Tangy Loch, South Argyll	NR 695282	75.4	SSSI	pRamsar	pSPA
22WKY	Ulva Lagoons and Danna Island, South Argyll	NR 700800	769.7	SSSI		
24WAL	Broubster Leans, Caithness	ND 035611	172.4	SSSI, NCR		
24WBK	Loch Heilen, Caithness	ND 255684	104.4	SSSI	pRamsar	pSPA
24WBL	Loch Lieurary, Caithness	ND 074642	40.8	SSSI		
24WBM	Loch More Wetlands, Caithness	ND 065459	703.3	SSSI	pRamsar	pSPA
24WBR	Loch of Wester, Caithness	ND 325592	68.6	SSSI	pRamsar	pSPA
24WCW	Loch of Winless, Caithness	ND 294545	28.4	SSSI	pRamsar	pSPA
24WBT	Loch Scarmclate, Caithness	ND 189596	110.0	SSSI	pRamsar	pSPA
24WBV	Loch Watten, Caithness	ND 230560	432.6	SSSI, NCR	pRamsar	pSPA
24WBZ	Moss of Killimster, Caithness	ND 304552	186.8	SSSI		
24WAR	Shielton Peatlands	ND 220465	5,593.0	SSSI, NCR	pRamsar	pSPA
24WGT	Claish Moss, Lochaber	NM 720675	563.0	SSSI, NCR, NNR	pRamsar	
24WHJ	Kentra Bay and Moss, Lochaber	NM 650685	998.7	SSSI, NCR	pRamsar	
24WHV	Loch Shiel, Lochaber	NM 800720	2,404.0	SSSI, NCR		pSPA
24WMX	Loch Eye, Ross & Cromarty	NH 831798	195.4	SSSI, NCR	pRamsar	pSPA
24WDN	Loch Bee Machair, Western Isles	NF 755430	797.0	SSSI, NCR	pRamsar	pSPA
24WXC	Loch Hallan, Western Isles	NF 738244	364.1	SSSI, NCR		
23WSC	Loch of Isbister and the Loons, Orkney	HY 254240	104.5	SSSI		

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WALES

32WDF	Dyfi, Dyfed/Powys	SN 640955	2,785.0	SSSI, NNR, NCR	Ramsar
32WER	Llyn Mawr, Montgomery	SO 008971	20.1	SSSI	

NORTHERN IRELAND

Thought to be no ASSIs covering flocks of Greenland White-fronted Geese

REPUBLIC OF IRELAND

There are few statutorily protected sites for Whitefronts in Ireland but the following sites are listed as Areas of Scientific Interest. Statutorily protected sites (Nature Reserves, Refuges for Fauna or National Parks) are indicated as Nature Reserves.

Donegal	5	Inch Lough	C 35 22	369	ASI
Donegal	23	Blanket Nook	C 30 19	as above	ASI
Donegal	20	River Foyle	C 35 10	as above	ASI
Donegal	18	Meenagoppoge bog	B 96 22	249	ASI
Donegal	29	Dunfanaghy Lake(s)	C 00 36	as above	ASI
Donegal	111	Calabber	B 98 23	as above	ASI
Donegal	113	Lough Trusk	B 91 23	as above	ASI
Donegal	51	West of Ardara/Maas Road	G 60-70,90	128	ASI
Donegal	106	Meenaguse	G 90 86	as above	ASI
Donegal	107	Lough Nillan/Tullynadobbin	G 80 89	as above	ASI
Donegal	108	Lough Ananima	G 78 95	as above	ASI
Donegal	2	Lough Barra bog	B 92 10	21	ASI, NR, NP
Donegal	34	Gannivegil bog complex	B 82 06	as above	ASI
Donegal	105	Durlough	G 665875	23	ASI

Donegal	109	Loughs Unna and Unshagh	G 555825	as above ASI	
Donegal	110	Lough Nalughraman	G 645880	as above ASI	
Donegal	12	Durnesh Lough	G 87 69	224 ASI	
Donegal	14	Dunragh Loughs/Pettigo Plateau	H 00 74	as above ASI, NR	Ramsar?
Donegal	38	Lough Derg	H 00 70	as above ASI	
Sligo	28	Bunduff Lough	G 72 56	16 ASI	
Cavan	1	Lough Oughter	H 34 05	63 ASI	
Mayo	7	Loughs Conn & Cullin	G 21 10	167 ASI	
Mayo	101	Owenboy	G 05 175	as above ASI, NR	
Sligo	10a	Lough Easky Bog West	G 420270	32 ASI	
Sligo	10b	Lough Easky Bog East	G 470270	as above ASI	
Mayo	5	Ininshkea Islands & Carrick Moylenecurhaga	F 56 22	157 ASI	
Mayo	14	Inishglora	F 61 31	as above ASI	
Mayo	18	Termoncarragh Lake	F 66 34	as above ASI	
Mayo	116	Annagh/Termoncarragh Machair	F 65 34	as above ASI	
Mayo	25	Carrowmore Lough	F 83 28	as above ASI	
Mayo	102	Carrowmore Lake shore	F 865300	as above ASI	
Mayo	104	Slieve Fyagh	F 92 29	as above ASI	
Mayo	8	Owenduff	F 86 07	as above ASI	Ramsar???
Mayo	97	Lough Feeagh	F 945010	as above ASI	
Mayo	98	Altaconey	F 97 08	as above ASI	
Mayo	127	Derry Upper [= Lough Manan ???]	M 213743	as above ASI	
Mayo	15b	Lough Mask (Fox Hill) [= Owenbrin ???]	M 05 60	145 ASI	
Mayo	45	Sheeffry Hills	L 86 70	as above ASI	
Mayo	52	Derrycraff	M 005728	as above ASI	
Mayo	95	Erriff Valley/Derrycraff	M 005728	as above ASI	
Mayo	96	Lough Eighter	L 84 755	as above ASI	
Galway	2	Errisbeg and Bogland North	L 70 40	134 ASI	
Galway	109	Bealacooan Bog	M 05 30	as above ASI	

Galway	162	Lettershinna bog complex	L 83 44	as above ASI
Galway	163	Ooria-Shannavara bog complex	L 93 43	as above ASI
Galway	164	Leam Bog complex	M 03 42	as above ASI
Galway	165	Lough Nagarrivhan	L 000355	as above ASI
Galway	60	Blindwell Turlough	M 350590	187 ASI
Galway	6	Rahasane Turlough	M 48 20	125 ASI
Galway	63	Creganna Marsh	M 38 22	as above ASI
Clare	21	Tullagher Lough	Q 95 61	66 ASI
Clare	4	Mullagh More and surrounds	R 31 94	74 ASI, NP
Clare	10	Ballyeighter Loughs	R 34 92	as above ASI
Clare	39	Lough Atedaun	R 29 88	as above ASI
Clare	49	Carran Turlough	R 29 98	as above ASI
Clare	67	Inagh Estuary	R 10 885	as above ASI
Clare	79	Moyree River	? ??????	as above ASI
Clare	70	O'Grady Lough	R 835610	26 ASI
Limerick	2	Aughinish-Askeaton	R 31 53	21 ASI
Clare	8	River Fergus Estuary	R 35 70	as above ASI
Clare	20	Shannon Airport Shore	R 37 59	as above ASI
Roscommon	17	Lough Gara	M 70 95	605 ASI
Roscommon	48	Callow Bog	M 68 96	as above ASI
Sligo	23	Lough Gara	G 71 00	as above ASI
Roscommon	35	Lough Drumharlow	G 90 02	176 ASI
Leitrim	21	Lough Rinn	N 10 93	240 ASI
Longford	2	Lough Forbes and Castleforbes demesne	N 09 82	as above ASI
Longford	20	Ballykenny	N 02 79	as above ASI
Longford	26	Fisherstown Bog	N 075770	as above ASI
Roscommon	28	Kilglass and Grange Loughs	M 98 88	as above ASI
Roscommon	36	Lough Boderg and Bofin	N 03 90	as above ASI

Westmeath	5	Lough Derravaragh	N 40 67	375 ASI	
Westmeath	7	Lough Owel	N 39 57	as above ASI	
Westmeath	13	Lough Ennell	N 40 45	as above ASI	
Westmeath	15	Lough Iron	N 35 61	as above ASI	
Longford	4	Arnee Pt. - River Inny	N 10 55	125 ASI	
Roscommon	5	Lough Ree	N 01 53	as above ASI	
Westmeath	8f	R. Inny Mouth	N 10 54	as above ASI	
Galway	41	Cloonloughlin and Mount Talbot Callows	M 82 53	432 ASI	
Roscommon	12	Cloonloughlin and Mount Talbot Callows	? ??????	as above ASI	
Galway	27	Suck River, Ballyforan-Shannonbridge	M 84 32	as above ASI	
Roscommon	7	Suck River, Ballyforan-Shannonbridge	M 84 32	as above ASI	
Roscommon	4	Lough Funshinagh	M 93 51	as above ASI	
Roscommon	16	Lough Croan Turlough	M 88 50	as above ASI	
Offaly	6	River Shannon Callows	N 98 23	as above ASI	
Roscommon	6	River Shannon Callows	N 04 52 - M 97 25	as above ASI	
Offaly	6a	Mongan Bog	N 03 30	as above ASI, NR	
Galway	133	Lough Lurgeen	M 66 59	88 ASI	
Galway	7	River Shannon Callows	M 84 23	548 ASI	
Offaly	6	River Shannon Callows	N 98 23	as above ASI	
Tipperary	22	River Shannon Callows	M 89 07	as above ASI	
Tipperary	1	Little Brosna River	M 98 11	as above ASI	
Offaly	1	Little Brosna River	M 98 11	as above ASI	
Offaly	38	All Saints Bog	N 01 11	as above ASI	
Tipperary	1a	Redwood Bog	M 94 12	as above ASI	[? site destroyed?]
Laois	1	Abbeyleix Woods	S 42 82	66 ASI	
Laois	6	Curragh	S 35 77	as above ASI	
Laois	31a	Grantstown Woods	S 33580	as above ASI, NR	
Cork	29	Kilcolman Bog	R 58 11	15 ASI	
Kerry	73	Doo Lough	W 025860	30 ASI	

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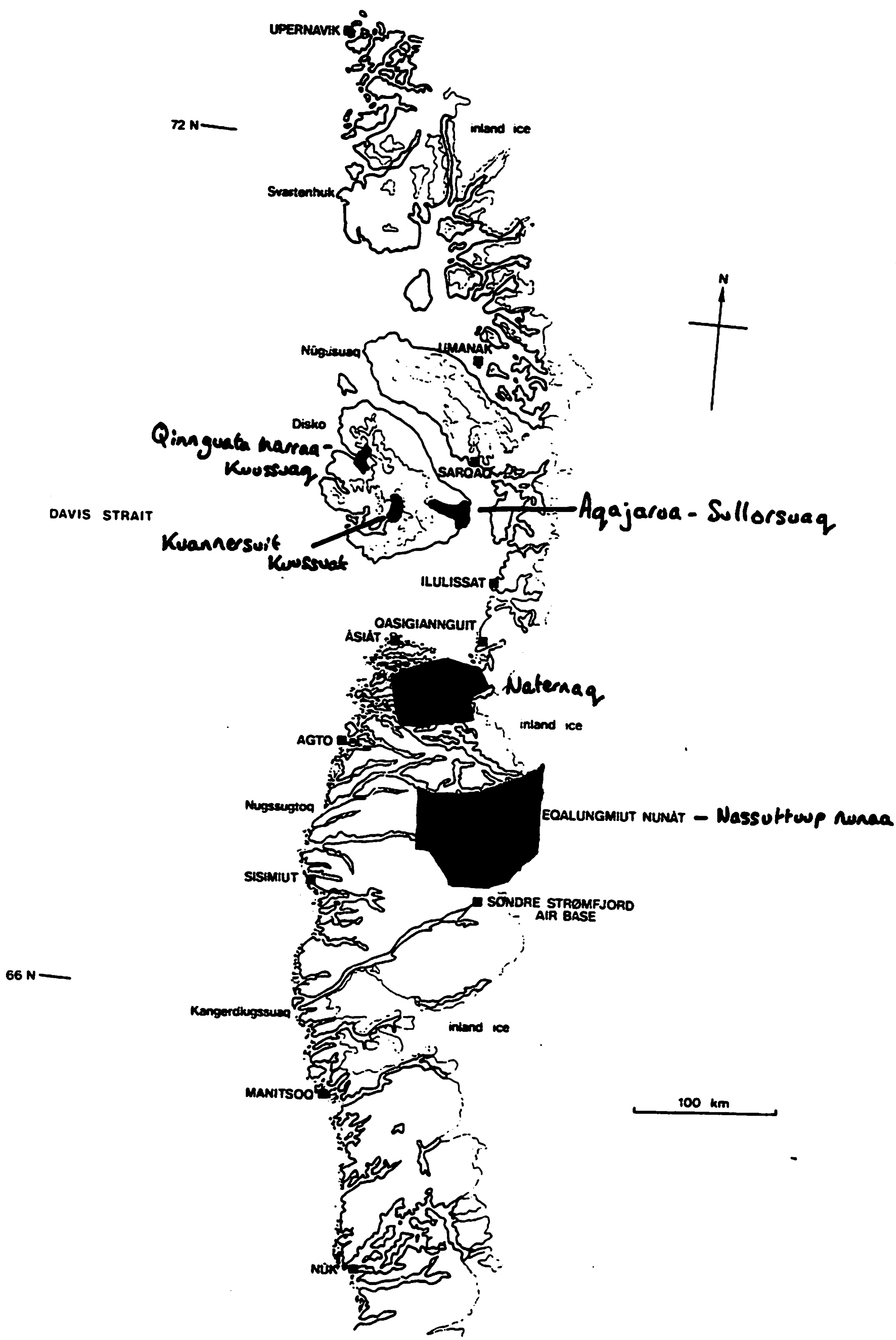
Kerry	9	Killarney Valley	V 93 84	40	ASI, partly NP	
Kerry	21	Mangerton Mountain	V 97 80	as above	ASI, NP	
Kerry	69	Eirk Bog	V 851785	as above	ASI, partly NR	
Kerry	15	Clogherhead/Cove	Q 32 03	31	ASI	
Wexford	6	Wexford Slobs and Harbour	T 08 24, T 03 24, T07 16	9,000	ASI, partly NR	Ramsar?
Wexford	23	Tacumshin Lake	S 05 06	as above	AS1	
Wexford	38	Cahore Polders	T 21 45	as above	AS1	

Figure 1.2.6.3.1. Distribution of Ramsar sites in Greenland designate primarily for Greenland White-fronted Geese.



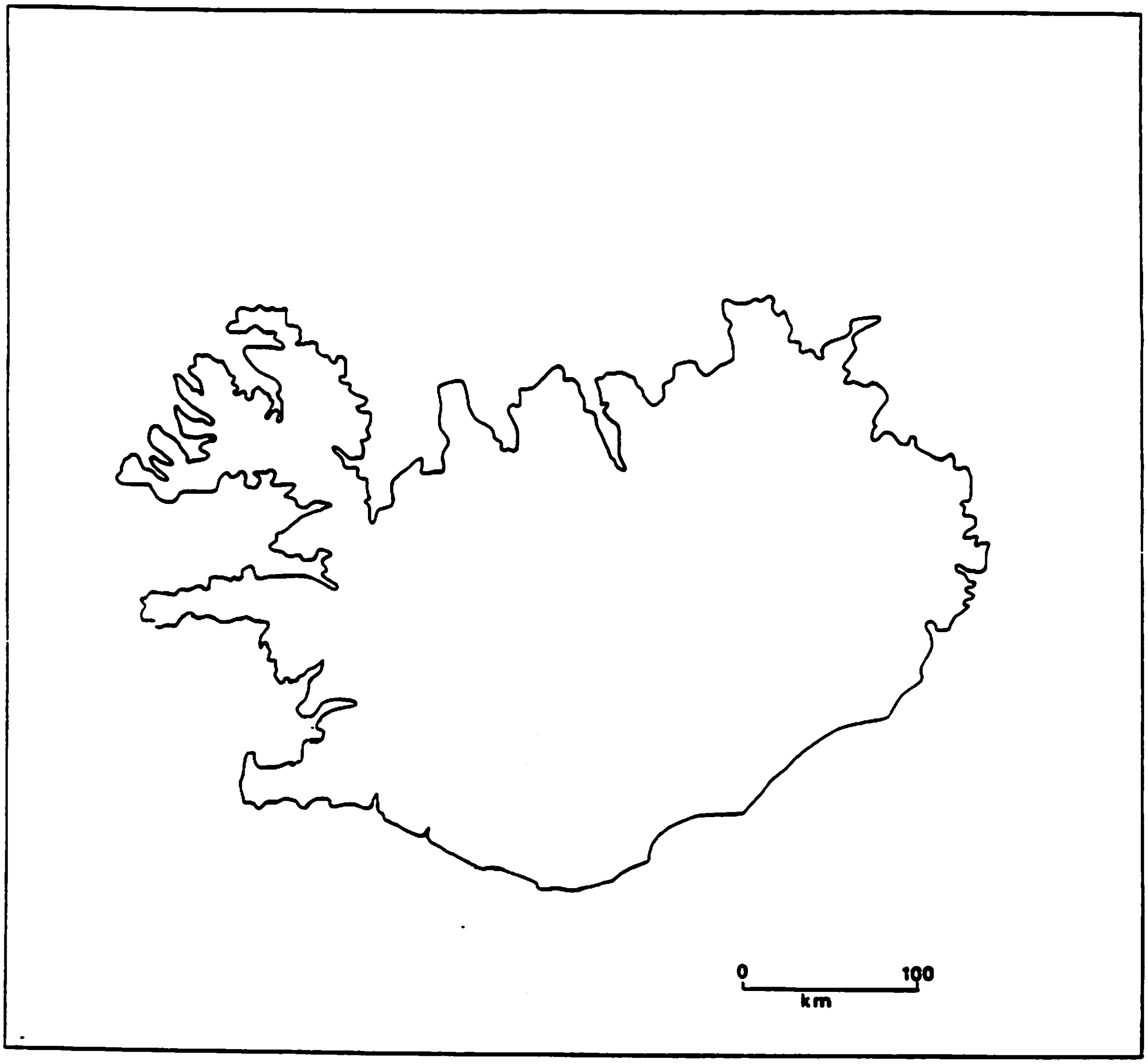


Figure 1.2.6.3.2. Iceland; no statutorily protected areas for the Greenland White-fronted Geese.

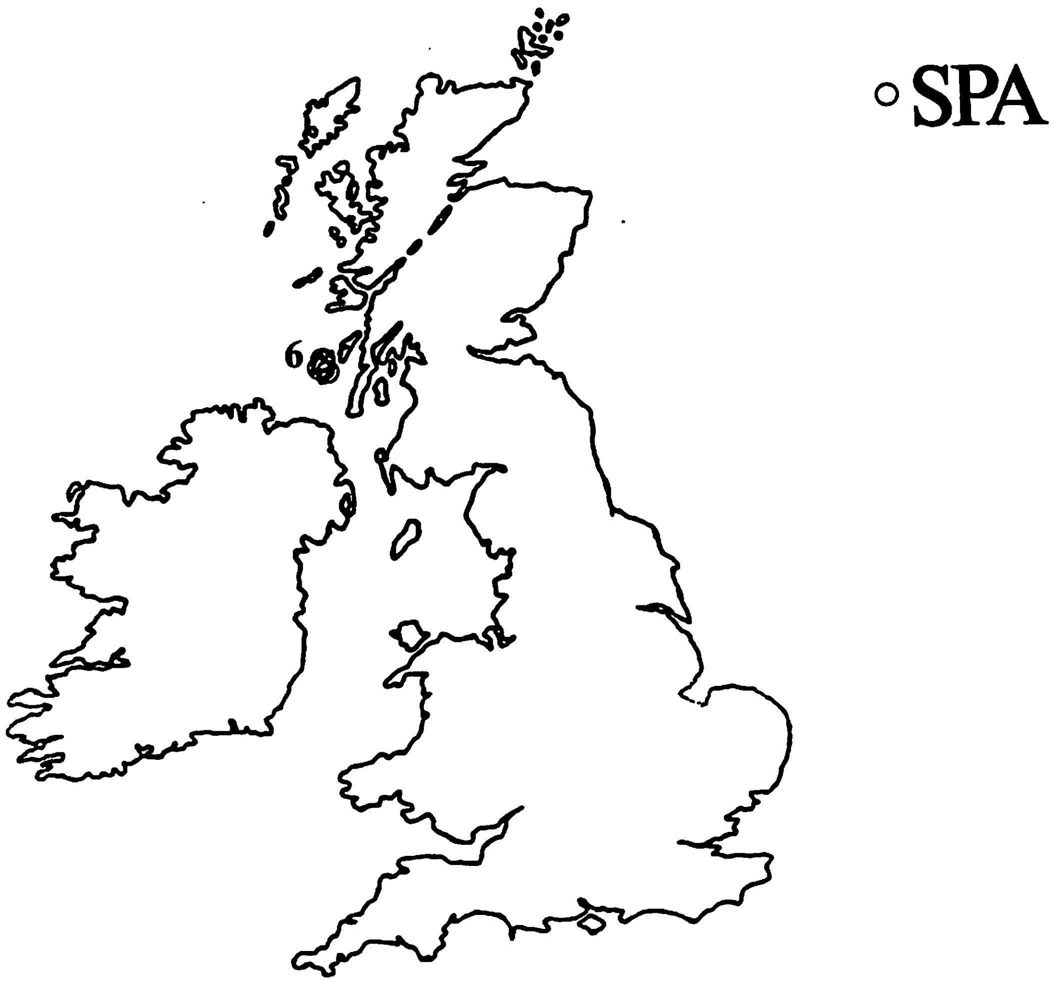


Figure 1.2.6.3.3.
The distribution of Greenland White-fronted Goose wintering sites designated as Special Protection Areas under the EEC Birds Directive in Britain and Ireland.

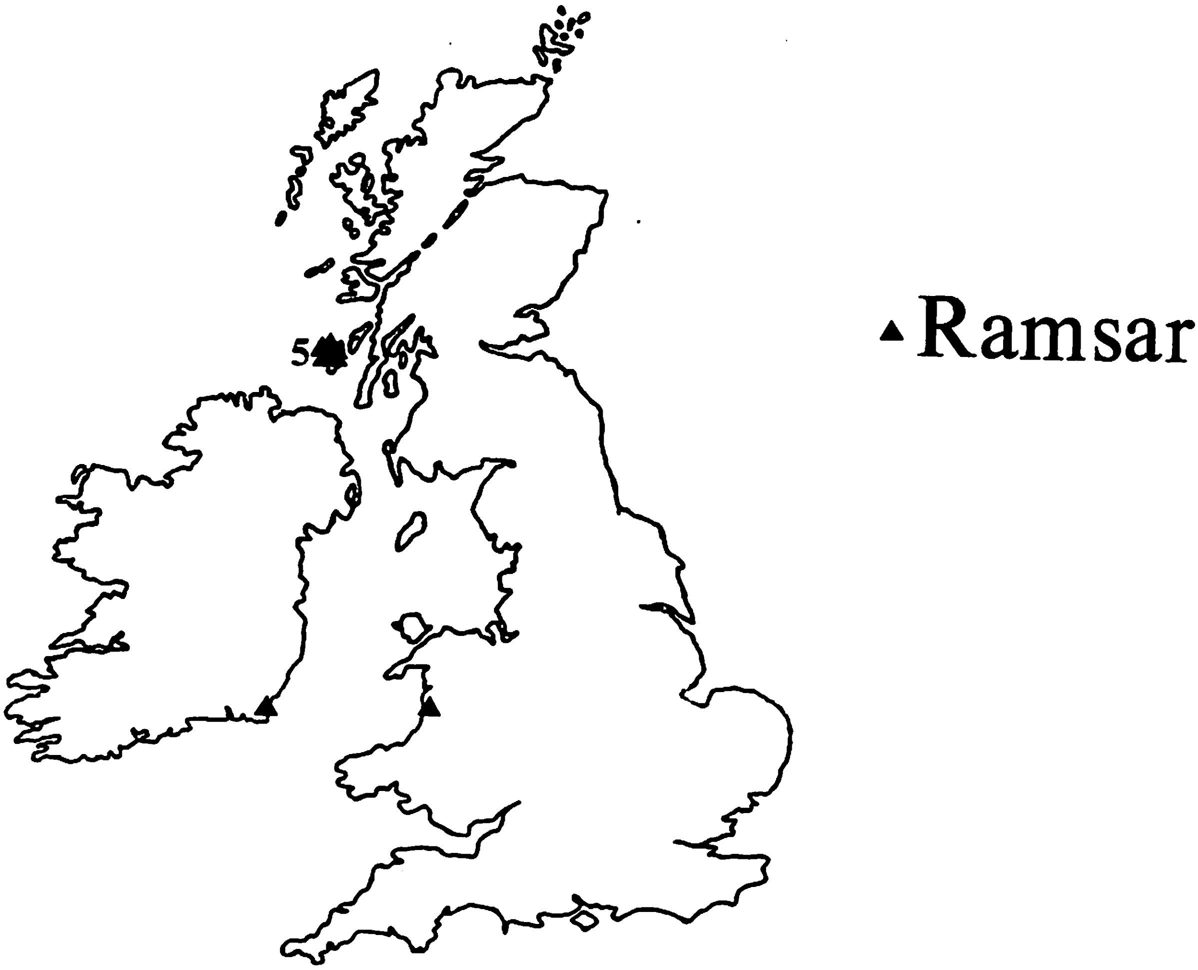


Figure 1.2.6.3.4.
The distribution of Greenland White-fronted Goose wintering sites designated as wetlands of international importance under the Ramsar Convention in Britain and Ireland.

Chapter 1.3 Environmental information

This chapter assembles physical, biological and cultural information to describe the population, and the implications that these have for management.

Section 1.3.1 Physical

Section 1.3.1.1 Climate

Greenland
In the south of their range the geese occur in regions with a continental-type climate with severe, cold winter and warm dry summers. In this region their distribution is also altitudinally determined with generally no breeding records in areas >500m a.s.l. Further north the range extends into coastal areas (Salomonsen 1950), subject to more maritime influences. The precise factors determining breeding distribution are unclear, but climate is likely to play a major 'ultimate' role as it interacts with the length of summer, vegetation and topography.

Iceland
The geese stage in western and southern area subject to an oceanic climate.

British Isles
The wintering range is essentially western and northern, occupying oceanic and hyperoceanic bioclimatic zones (Birse 1971). The range lies almost entirely west of the long-term average 3^{o} C January isotherm (Belman 1981). In ecological terms this reflects climatic determination of the distribution of traditional habitats: western blanket bog and oceanic raised bog. The selection of areas with high average winter temperatures reflects the need for access to a subterranean food resource in winter - a resource denied in more easterly (and high altitude) peatlands subject to longer periods of winter freezing.

Section 1.3.1.2 Hydrology

In considering the needs of the geese special attention should be paid to the hydrological integrity of wetland roost or feeding sites. Peatlands such as raised and blanket bogs can be damaged by the effects of water-table drawdown following drainage or ditching (see Lindsay *et al.* 1988 for further details).

On some sites, only the very wettest areas close to bog pool complexes are used for feeding or roosting. However, protection of these areas alone could prove ineffective since such pools are hydrologically associated or linked with the wider mire expanse. In most such cases on blanket bogs, site boundary determination will need to be linked to mire macrotopes (Lindsay *et al.* 1988) wherever possible. Where this is not possible owing to historical land-use, then the site will need to be as hydrologically sustainable as possible. In these cases, positive conservation management (such as ditch blocking to raise water-tables) will usually also be desirable.

Some of the hydrological influences on wetlands originate from far outwith the site. In these instances, site protection may not be the best solution to the problems. Where such changes may potentially influence a wetland or other area, a full Environmental Impact Assessment should be undertaken at an early stage. This will need to address not only immediate effects of development, but also consequential effects on other sites, possibly far removed from a development.

Section 1.3.1.3 Geology/Geomorphology

Geology and geomorphology do not greatly influence the geese on the wintering grounds. In Iceland the southern lowlands and the western staging areas are both regions of uplifted marine sediments about 8,000 years old. In Greenland some of the most important breeding areas are also on platforms of uplifted marine sediments (Harder *et al.* 1949). Important feeding areas used by geese on their arrival in the southern part of the range derive from active geomorphological processes in glacial sandur valleys (Fox & Madsen 1981). These areas are possibly subject to active successional change and in some cases, possibly erosional change.

Section 1.3.1.4 Soils and substrates

In Scotland, the present geographic distribution, from Sutherland, Caithness and Orkney in the north through the Hebrides to Kintyre and Galloway in the south, correlates well with the distribution of oceanic peatlands (especially blanket bog (Lindsay *et al.* 1988) and coastal raised mires) - the original habitat of the geese (Owen 1978). In Ireland the same is true and the original distribution was closely linked to the distribution of peatland sites (Ruttledge & Ogilvie 1979).

The distribution of blanket bog is climatically determined (Section 1.3.1.1).

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