WINTER SITE FIDELITY IN GREENLAND WHITE-FRONTED GEESE *Anser albifrons flavirostris*, IMPLICATIONS FOR CONSERVATION AND MANAGEMENT

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ABSTRACT Greenland White-fronted Geese *Anser albifrons flavirostris* darvic ringed in a small area of west Greenland dispersed widely over the wintering area in Scotland and Ireland. As with a larger number of geese ringed at the main wintering site at the Wexford Slobs, SE Ireland, they were extremely site-faithful in winter. Approximately 85% of the birds observed in successive winters returned to the same sites. Within the same winter, less than 1% of the geese moved between sites, and most such moves were associated with autumnal staging en route to final destinations. Moreover, geese showed individual and specific preferences for very restricted parts of potential feeding areas. Such extreme site fidelity has major implications for conservation which are discussed. In particular, wide-scale scaring is an inappropriate management tool, and it is necessary to focus conservation actions on all traditional areas used by flocks.

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INTRODUCTION

The population of Greenland White-fronted Geese *Anser albifrons flavirostris* is small and their world range limited. Breeding occurs in low-arctic west Greenland between 63° and 72° N (Salomonsen 1950), and they migrate via Iceland (Francis & Fox 1987) to winter in Ireland, Scotland, Wales and, in the past, peatland areas in north-west England (Ruttledge & Ogilvie 1979). The population traditionally wintered on lowland peatlands within their present range. However, increasing levels of peatland destruction, particularly in Ireland (Ryan & Cross 1984), drainage and agricultural intensification of wetland feeding areas, together with high shooting mortality and disturbance, have caused the population to decline. Ruttledge & Ogilvie (1979) estimated the population to have declined from between 17 500 - 23 000 birds in the late 1950s to about 14 300 - 16 600 birds in the late 1970s, with an estimated 50% decline in Ireland over the same period (from 12 700 - 17 300 to 7500 - 8600).

In the early 1980s the goose was given enhanced protection in most parts of its world range (detailed in Stroud *et al.* in press) and research programmes were initiated (Fox *et al.* 1983). Much of this work was particularly aimed at accurate estimation of population size and improved knowledge of distribution (Stroud *et al.* in press), as well as an investigation of the factors important in their conservation management (Norriss & Wilson 1988). Information on site fidelity and within- and between-winter site movements is fundamental to practical site-based conservation. Studies of individually darvic ringed birds were necessary to build on earlier information from the Greenland ringing scheme (Kampp *et al.* 1988).

The data on movements and fidelity presented here derive from two co-operative, ringing schemes. Birds were ringed with darvic leg rings in Greenland during expeditions to the breeding grounds in 1979 and 1984 (Fox & Stroud 1981,

1988). Much larger numbers of geese have been caught on a more regular basis at the main Irish wintering site at the Wexford Slobs, Co. Wexford in a continuing programme that started in winter 1983/4.

METHODS

Catching geese

In Greenland, adult and juvenile geese were caught during the July and early August moult period and ringed with white Darvic leg rings with black lettering (coded letter-digit-digit: Belman 1981). The geese were ringed within Eqalummiut nunaat (67° 30'N 50° 30'W), a 750 km^2 area of low-arctic tundra (Fox & Stroud 1981). In Ireland, geese were cannon-netted during October to December using a single 30m x 20m net propelled by six cannons. Cannon-netting over plots of unharvested cereals resulted in significantly higher proportions of known-age geese in the catch compared to flocks (average of 54.4% young in catches 1983-88 cf. overall average of 19.1% young in flocks in same period). All geese were fitted with darvic neck collars and leg rings (both coded digit-letter-letter). Collars were orange with black lettering. Leg rings were usually white, although initially a very few geese were ringed with orange leg rings. Geese were banded and ringed, sexed by cloacal examination, and age, head, wing and tarsus length, and weight were recorded.

Search coverage of wintering sites for ringed geese

Marked geese could potentially distribute themselves among a wide range of sites through Ireland and western Britain (wintering areas are summarised by Ruttledge & Ogilvie 1979). Search effort was concentrated at the two principal wintering areas: the Wexford Slobs in SE Ireland and Islay W Scotland. At Wexford, frequent checks were made throughout the winter, whilst on Islay most flocks were checked on at least a monthly basis in most winters. Elsewhere, coverage was less intense, although generally good. All flocks were counted in autumn and spring for the international census counts.

RESULTS

Loss of leg rings and neck-collars

Only one instance of a leg ring being lost has been noted. There was no first winter (0-6 months after trapping) loss of neck collars (N = 68), but this increased to 4.3% in the first winter after trapping (12 - 18 months; N = 41), 9.4% in the second winter (N = 107) and 7.7% in the third winter (N = 13). Most lost collars were first noted missing during the 1985/86 winter, the only period when shooting in Ireland was permitted. Loss was mainly due to collar breakage when hit by pellets.

Distribution of resightings

The majority of ringed geese were 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) (Table 1). 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, which is perhaps all the more extraordinary when it is considered that all the geese were ringed in a very limited area (c. 400 km^2) of west Greenland. Indeed, the most extreme example was of a small flock of 11 moulting non-breeders captured on a single small lake in 1979. By 1987/88 seven of these geese had been seen or recovered in winter from nine widely spread sites in Scotland and Ireland. Fewer ringed geese were recorded at Irish sites, but conditions at many of these sites make identification of leg ringed geese very difficult in comparison with Scottish sites (e.g. the short grazed pastures of Islay).

Between winter site fidelity

Birds ringed at Wexford were seen at 10 sites in Scotland (involving 57 different geese), in Lancashire (one goose) and 13 sites in Ireland away from Wexford (involving at least 41 different

Table 1. Summary data for resightings of darvic ringed Greenland White-fronted Geese ringed in Ireland between 1983/84 and 1987/88, mainly on the Wexford Slobs, and in Eqalummiut Nunaat, west Greenland in 1979 and 1984. Between year *n* indicates the total number of between-year changes/total number of bird-years for which there are records. Within year *n* is the total number of within-year changes/total number of goose sightings. For Greenland ringed birds, the totals "seen only at ringing" also includes birds seen (or shot) in Iceland, or controlled in Greenland, but never recorded from the wintering grounds.

	Between year changes				Within year changes				
	Total birds	*n*	(%)	No. geese involved	*n*	(%)	No. geese involved	No. seen in only 1 winter	No. seen only at ringing
Wexford	531	82/549	(14.9)	68/331	35/8643	(0.4)	33/516	185	15 (2.8)
Greenland	181	21/281	(7.5)	16/83	1/747	(0.1)	1/112	29	69 (38.1)

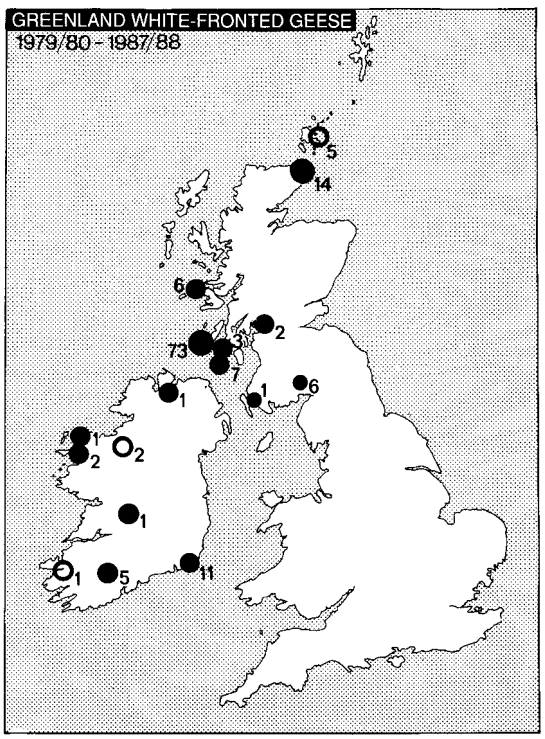

Fig. 1. Distribution and number of sightings of different Greenland White-fronted Geese in Britain and Ireland ringed with darvic leg rings in Eqalummiut nunaat (67° 30'N, 50° 30'W) during summer 1979 and 1984. Open circles indicate Greenland ringed birds seen but not specifically identified. Not shown is one bird seen in Kintyre, Scotland but later recorded outside the normal wintering range in

geese); 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 the mean November count for the years 1984/85 to 1987/88 inclusive), it would seem that the high proportion of resightings on Islay is simply due to the large numbers there. Some site interchange within Ireland occurs, but it involves only a very small proportion of the ringed sample of geese. Of 1979 Greenland ringed geese, 10 have changed wintering areas between winters in nine years. Of 1984 Greenland ringed geese, 10 have 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. Of 77 geese moving area whose sexes were known, 39 were male and 38 were female. A further 13 moving geese were of unknown sex. 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 (expressed against total goose-winters of observations) was larger for Wexford ringed (14.9%; N = 549) than for Greenland ringed (7.5%; $N = 281$) 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 (Table 1). 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 (39% of within-winter movements out of 33). 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 (cf. Easterbee *et al.* 1987).

(c) Birds which were 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 (54.5% of within-year movements out of 33). Such birds appear to use Wexford during the mid-winter period, 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) previously reported consistent sudden increases of 600 - 1600 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, both at Wexford and on Islay. In both areas, geese not only return to these

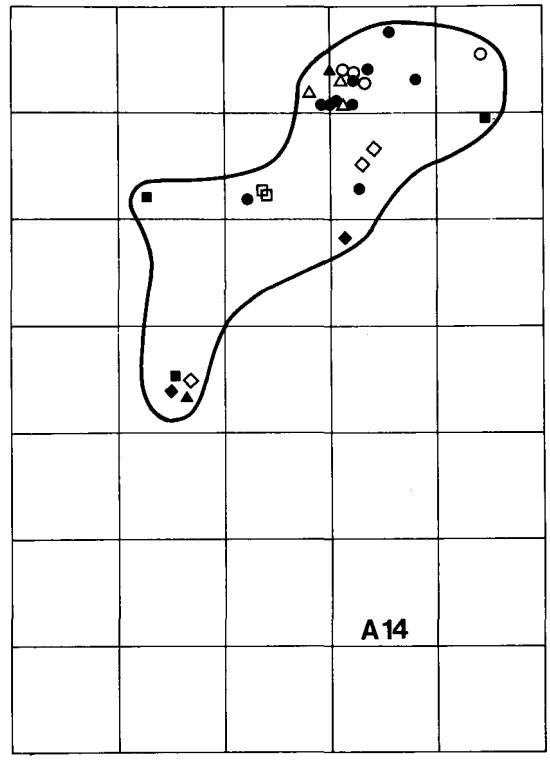

Fig. 2. Sightings and 'home range' of a Greenland darvic ringed goose (A14) in the Avenvogie area of Islay; 1979-1988. Grids are 1 km squares of the Ordnance Survey. Different symbols indicate sightings in 8 different winters, 1979/80 - 1986/87. Not all the area within the 'range' is suitable habitat, e.g. much is coniferous plantations.

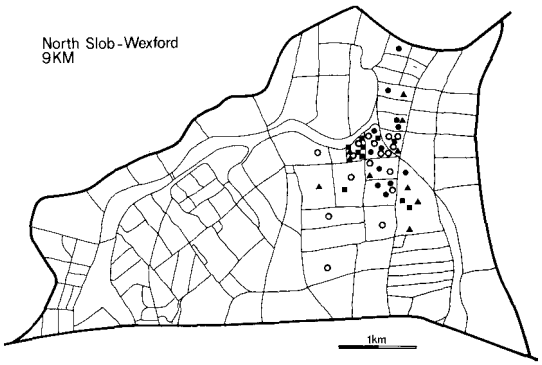

Fig. 3. Sightings and 'home-range' of darvic neck-collared geese on the Wexford Slobs 1984/5 - 1987/8. A typical member of the south-western subgroup (9KM). Symbols indicate use of fields in different years. The different symbol shapes indicate different years of sightings: 1984/85 (filled circle), 1985/86 (open circle), 1986/87 (square), 1987/88 (triangle).

areas rather than other parts of the wintering range, but also show preference to a very restricted part of the potential feeding areas. On Islay, (total area 61 812 ha - not all of which is suitable habitat) the total of 7-8000 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 (Fig. 2) by the movements of the marked birds they contain. At the Wexford Slobs, a total of 8-10 000 geese feed across an area of farmland some 1000 ha in extent. Records of neck-collared birds clearly demonstrate the existence of sub-flocks. Figures 3 & 4 show the distribution of sightings for two typical geese and demonstrate their markedly different ranges within the Slobs.

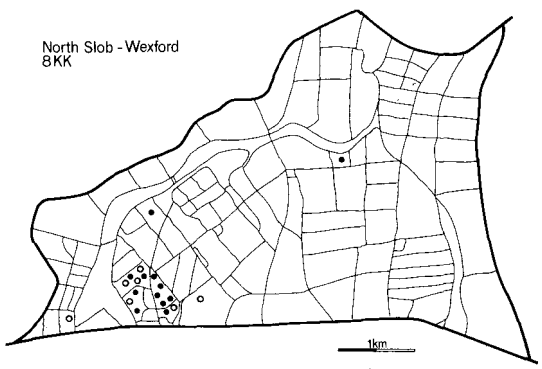

Fig. 4. Sightings and 'home-range' of darvic neck-collared geese on the Wexford Slobs 1984/5 - 1987/8. A typical member of the central subgroup (0JT). Symbols indicate use of fields in different years. The different symbol shapes indicate different years of sightings: 1984/85 (filled circle), 1985/86 (open circle), 1986/87 (square), 1987/88 (triangle).

DISCUSSION

Greenland White-fronted Geese present a range of important and interesting conservation and management problems. The population is small and occurs at relatively few sites across a wide range of Ireland and western Britain. Site use is highly traditional, and desertion and declines in these areas have been attributed to changing land-use and management (Ruttledge & Ogilvie 1979; Norriss & Wilson 1988). Thus it is necessary to understand factors important in the dispersion of geese to, and among, these sites.

The dispersal strategy of the geese ringed in Greenland has been considered by Fox *et al.* (1983) and Kampp *et al.* (1988). It is similar to that shown by some other arctic-breeding geese where dispersal from one summer area is virtually throughout the wintering range, implying that birds in one winter flock come from many different breeding areas. The greatest number of site changes involved birds in either their second or third years, at a time when family parties break-up and presumably at or around the time when pairing occurs. Pairing of young birds to mates of different wintering areas may initiate between-year site changes. However, it is clear from the resighting data that many birds caught together in their first winter, stay together in stable sibling groups for several years after capture. Some geese caught together as non-breeders (and probable siblings) in Greenland in 1979 have remained together in small groups or sub-flocks to the present. Knowledge of distinct sub-flocks, each with an exclusive or discrete range, within wintering areas is important for future monitoring of these

goose populations. Raveling (1969, 1979) suggested that such social sub-units for Canada Geese (*Branta canadensis interior*) have a high degree of relatedness and use the same breeding areas. Raveling also pointed out that, where such sub-flocks exist, there is a need to ensure that geese are caught from a wide variety of sites within one area so that a representative selection of geese from all sub-flocks are marked. Such has tended to be the case at Wexford, but clearly needs to be considered in the planning of future catch strategy as well as stratification of monitoring population parameters.

Conservation implications

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). In the long-term, the present study indicates that there is a small degree of between-site movement, but it is not nearly as great as the levels of between-site movement recorded for other geese.

Thus, in terms of the conservation management of this population, the protection of important wintering areas and if possible, 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 high field loyalty has implications for management to reduce conflict with agriculture (Stroud *et al.* in press). Agricultural intensification (particularly reseeding, fertilisation or planting of root-crops) of fields used by geese that were previously managed in a traditional or low-intensity manner can create perceived, or even actual conflict. Geese may continue to use these areas with resultant perceived or actual damage. This has recently occurred on farms in the Loch Gorm area of Islay. Resultant negative attitudes by farmers to geese feeding in areas that they have always used, have now spread more widely on the island (cf. Tacha *et al.* 1979). The presence of discrete flocks with distinct home-ranges also has important consequences for management. NCC (1988) stated that management policies for Greenland White-fronted Geese on Islay need to be different from those for the more highly gregarious Barnacle Geese *B. leucopsis*. This is supported by the present results which indicate that wide-scale or quasi-random scaring would be an inappropriate management tool, given sub-flock identities and their discrete home-ranges. Any scaring, if appropriate at all, needs to be precisely targeted to protect specific areas at risk of serious damage and to be successful needs to attempt to move birds to alternative areas within existing home-ranges rather than force them into unfamiliar territory.

The concept of 'functional unit systems', proposed by Tamisier (1979, 1985) and developed by Bignal *et al.* (1989), is valuable when considering site management for such highly site-faithful geese as Greenland White-fronted Geese, since it serves to focus attention on all areas used by the birds (Fig. 5). Areas such as key feeding sites and traditional roosts, where flocks spend much time, will

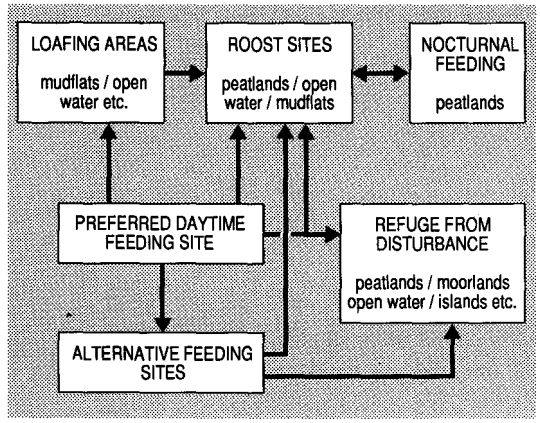

Fig. 5. Components important in the definition of Greenland White-fronted Goose functional unit systems. Arrows indicate movements between different components of 'home-range'. Each of these areas require further investigation to determine their ecological and social significance for conservation of flocks of wintering geese.

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 and 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. This is a first step in determining which areas should be subject to conservation management. The potential for further studies must not, however, deter action now to protect those wider areas known to be important for flocks of Greenland White-fronted Geese throughout the wintering range.

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SAMENVATTING

Groenlandse Kolganzen, afkomstig van een klein deel van het broedgebied, blijken zich gedurende de winter over het gehele overwinteringsgebied in Ierland en Schotland te verspreiden (Fig. 1). De meeste in Wexford (Ierland) geringde individuen vertonen daar echter wel een zeer sterke binding met een eenmaal gekozen overwinteringsplaats. Ongeveer 85% van de ganzen die tijdens opeenvolgende winters werd waargenomen bevond zich in hetzelfde gebied (Tabel 1). Binnen dezelfde winter wordt minder dan 1% van de ganzen in verschillende gebieden waargenomen, maar bij het grootste deel hiervan is sprake van waarnemingen in het najaar bij het pleisteren op weg naar de uiteindelijke winter-bestemming. Individuele ganzen vertonen in hun wintergebied bovendien verschillende voorkeuren voor zeer beperkte delen van het potentiële foerageergebied (Fig. 2, 3 & 4). De plaatsgebondenheid van deze ganzesoort in de winter dient zeker in beschouwing te worden genomen bij het vaststellen van de functionele eenheden voor deze soort en bij het nemen van beschermende maatregelen (Fig. 5). Het op grote schaal verjagen is in geen geval een geschikt middel voor het beheer van deze soort.