Disturbance and flock size changes in Greenland Whitefronted Geese wintering in Ireland

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Introduction

The Greenland White-fronted Goose, *Anser albifrons flavirostris*, has a northern and western winter distribution in Ireland and Britain, coincident with the original distribution of bogland where it traditionally fed. Population estimates fell from 17,500–23,000 in the 1950s to 14,300–16,600 by 1979, but the decline had not been uniform throughout the winter range. Numbers in Scotland increased slightly and in Wexford remained constant but the population declined by about 60% in the west and midlands of Ireland (Ruttledge and Ogilvie 1979). Protection was introduced in Scotland and the Republic of Ireland in 1982, while voluntary bans operated in Wales and Northern Ireland from before this date. Consequently the population had increased to nearly 20,000 by spring 1985.

Most Irish flocks outside Wexford still feed in semi-natural habitats. Ruttledge and Ogilvie (1979) dscribed how flocks have been partially or wholly constrained from leaving bogland by the small size and high disturbance levels on alternative grassland areas. Habitat loss, shooting and disturbance were cited as the most important factors in the decline of this segment of the population. Elsewhere most wintering flocks have adapted to farmland feeding on large estates or on islands and have benefitted from limited access, controlled shooting and large feeding areas within which they could move when disturbed (Ruttledge and Ogilvie 1979).

Geese are inefficient herbivores and must spend most winter daylight hours feeding. Consequently, disturbance was the most important factor limiting goose distribution on farmland (Kuyken 1969; Owen 1972) and has been given as the cause of declines and desertions of European White-fronted Geese, *A.a. albifrons*, in Hungary (Sterbetz 1967) and Britain (Ogilvie 1968), whilst access to large areas rarely visited by man have been described as 'decisive' in determining selection of feeding areas by Bean Geese, *A. fabalis*, in southern Sweden (Mathiasson 1963). Although drainage was the commonest reason recorded for desertion of wet grassland sites by Greenland White-fronted Geese (Ruttledge and Ogilvie 1979), Owen (1972) suggests that increased agricultural disturbance resulting from drainage is the important factor rather than drainage itself. On the positive side, about ten statutory no-shooting areas were declared for Greenland White-fronted Geese, mainly for the larger flocks, during the 1970s.

During the winters 1982–83 to 1984–85, the Wildlife Service organised a survey of the numbers and distribution of Greenland White-fronted Geese as part of a larger conservation programme in Ireland and Britain. The status and winter distribution have already been described in a series of annual reports by the Greenland White-fronted Goose Survey, Aberystwyth and the Wildlife Service, Dublin. In this paper disturbance data from standardised survey cards is analysed to see whether changes in flock size were influenced by disturbance.

Methods

Field visits were made at least monthly during the winters 1982–83 and 1984–85. For the duration of a visit observers recorded the length of time geese were present, the number and type of disturbances and whether disturbed geese left the site. The area of a feeding site is delimited by all the recorded observations or field signs of geese within 1 km of each other.

Feeding in larger areas tend to reduce flying time and energy costs since disturbed geese can move short distances within a site, while having a large number of sites from which to choose affords more comprehensive protection from locally adverse feeding conditions. The energetic costs of disturbance are a function of both the disturbance rate and the degree to which the number and size of the feeding sites within a flock's range can protect geese from disturbance. These elements can be quantified by a disturbance index (P_s/R) for each site, where P_s is the probability of geese staying at a feeding site after a disturbance and R is the disturbance rate. A disturbance was

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included in the analysis only when it caused geese to take flight and where there was an observed cause of the incident. Disturbances caused by observers were excluded, because visits were normally limited to one per month and the calculation of disturbance rates is unlikely to have been significantly affected. The index was then summed for each site for which an arbitrary figure of more than five disturbances were observed and at which geese were present for more than 5% of the total time observed at all sites within a flock's range. The summed total gave a disturbance index for each flock, although insufficient data were available for all flocks. Favourable ranges where feeding sites are large and geese are well shielded from disturbance are represented by larger index values, unfavourable ranges by smaller ones.

In order to relate numerical changes of flocks to the quality of the feeding range in the period 1950s to 1982–83 (when no comparable data on disturbance had been collected), flocks were categorised primarily according to the number and size of feeding sites within their feeding range. These categories are defined as follows:-

A. Ranges with more than 10 feeding sites, one or more being over 400 ha. On various grassland habitats. Partial protection of all flocks by no-shooting areas or private estates.
B. Ranges with 3 or more feeding sites, each site usually under 100 ha, maximum 250 ha. On wet grassland or callows. Largely unprotected.
C. Ranges with 1 or 2 feeding sites, each site under 100 ha, on a variety of habitats. Largely unprotected.

Results

Change in flock size from 1982–83 to 1984–85

Figure 1 relates the changes in maximum flock size to disturbance indices in 18 flocks in the west and midlands of Ireland between 1982–83 and 1984–85. Maximum counts for both winters are recorded in the Appendix. Change in flock size was significantly correlated to the disturbance index (r_s=0.50, df=16, P<0.05, Spearman's rank correlation). However, the relationship was considerably affected by one flock with an

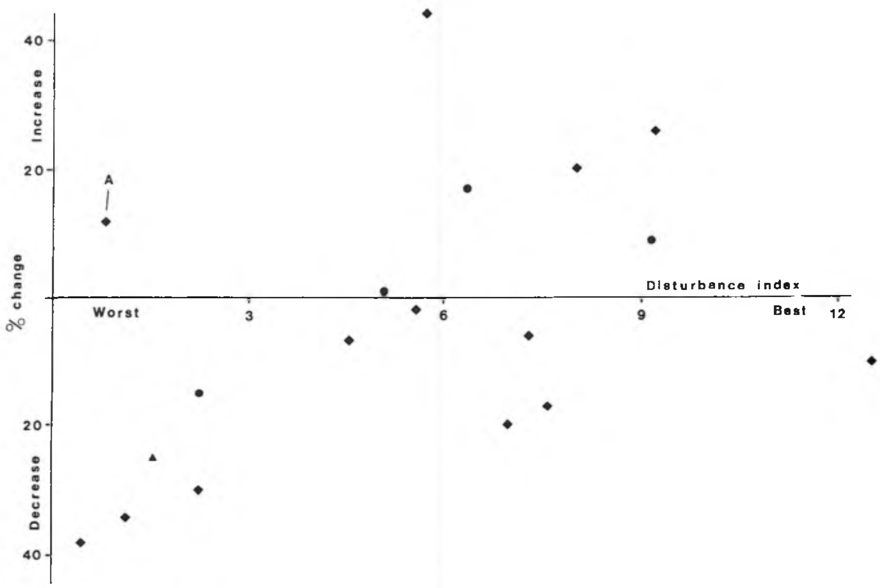

Figure 1. Relationship of change in flock size, measured by % change of maximum count between 1982–83 and 1984–85, to a disturbance index during the same period. Each point represents one flock; data restricted to Irish flocks outside Wexford. Flocks primarily on dry pastures shown by ●, on wet pastures by ◆ and on bogland by ▲. For method of calculating disturbance index and for statistics see text.

unusually small disturbance index value (A in Figure 1). Several feeding sites of flock A have become known since the period on which this analysis was based and one or more major feeding sites probably still remain undiscovered to judge by the frequency with which this flock has been missed during counts. Thus its disturbance index was underestimated. When this flock is excluded from the analysis, a significantly improved correlation between change in flock size and disturbance index results (r_s= 0.63, df=15, P<0.01).

The disturbance index value of the intercept of the regression line on the x-axis for a particular change in flock status provides a quantified management objective. However, there are two unrelated problems with fitting a regression line. The first is the non-normal distribution of both sets of data. The points represent means of three years data and the points themselves can be assumed to be normally distributed about the x and y axes. Secondly, the correlation is not described by a straight line, but the number of points are too few to define their distribution and to make the apropriate transformation. For practical purposes, the regression equation was repeatedly calculated as flocks of larger and larger disturbance index value were added one by one. The estimate of the required intercept that is most accurate and economic is given by the regression line with the steepest slope and narrowest confidence limits. This was percentage change in flock status = $-39.8+7.42x$ ($\pm$2.40, 95% confidence limits), n=8.

Disturbance rates

Table 1 shows that overall disturbance levels are much higher on dry grasslands, whether semi-natural or reseeds, than on wet grasslands, callows and bogland. Farming activities are primarily responsible for the threefold difference in disturbance levels. Heavier disturbance on drier soils results from a larger proportion of arable land and more frequently outwintered stock, whereas wet grasslands in winter are generally too fragile for stock or machinery.

At first the higher overall disturbance levels on dry grassland seem at odds with the general trend for Greenland White-fronted Geese to move to more intensely farmed areas. But there field and farm sizes are larger and disturbed geese are more likely to move within sites. Also goose flocks are often either protected (even though the primary motive may be stock protection), or shooting is managed and disturbance is limited by restricting public access. Protected geese respond less frequently and less intensely to disturbances and they habituate fairly quickly to farming

Table 1. Variation, by habitat, in the type, importance (top row, % occurrence) and rate (bottom row, no./hr) of disturbance during and after the shooting season. Data for individual sites in flock ranges in the west and midlands of Ireland, 1982–83 to 1984–85.

	Arrival to 31 January					1 February to Departure				
Disturbance due to:	Farming	Shooting	Aircraft	Other [a]	n Total	Farming	Shooting	Aircraft	Other [a]	n Total
Dry grasslands	56% 0.29	10% 0.05	15% 0.07	19% 0.10	41 0.51[b]	49% 0.25	3% 0.02	12% 0.06	36% 0.18	33 0.51[b]
Wet grassland/callows	48% 0.08	22% 0.04	10% 0.02	20% 0.03	40 0.17	32% 0.05	16% 0.03	26% 0.045	26% 0.045	19 0.17
Blanket bog	22% 0.015	11% 0.005	0% 0.0	67% 0.04	9 0.06	50% 0.03	0% 0.0	25% 0.015	25% 0.015	4 0.06

[a] Causes of disturbance in 'other' category, by habitat; dry grasslands – 2 raptor, 2 fox, 1 dog, 1 thunder, 4 horse riding, 1 fox hunting, 2 pedestrian, 5 boat, 1 gamekeeping, 1 fisherman (6 non-human, 14 human); wet grassland/callows – 1 dog, 1 raptor, 1 deer, 3 boat, 3 traffic, 2 fishermen, 2 gamekeeping (4 non-human, 10 human); blanket bog – 1 fox, 1 deer, 1 forestry, 1 turf-cutting, 1 boat, 1 traffic, 1 pedestrian (2 non-human, 5 human).

[b] As there was no significant difference in disturbance rates during and after the shooting season (t_s=1.131, df=16, ns), the mean value for the winter period has been used in the calculation of rates for each type of disturbance.

disturbance. Thus a shift of feeding areas to extensive farmland can give a larger value of the disturbance index even without reduction of agricultural disturbance. In fact significantly less disturbance was recorded from estates and naturally protected islands than from other farms in the 'dry grassland' category (Table 2). This is largely because milking herds are usually overwintered in sheds and such agricultural activity as there is on the fields is often mechanised.

The shooting component of disturbance rates is of similar absolute value in dry and wet grasslands but is of greater relative importance in the latter (Table 1). On average shooting caused a quarter of all wet grassland disturbances, but in wildfowling areas it could be much more important. Heavy shooting pressure, combined with small size of wet grassland feeding sites, was suspected as causing the near desertion by four flocks in Co. Clare by 1981–82 and for their subsequent rapid recolonisation after the shooting moratorium was introduced.

Table 2. The probability of disturbed geese staying at a feeding site (P_s) and the disturbance rate (R), (means with 95% confidence limits), in different habitats. Data for individual sites in 'Rest of Ireland' flock ranges, 1982–83 to 1984–85.

Habitat	P_s	R (no./hr)
Dry grasslands	0.396±0.154 n=10	0.509±0.235 n=14
Wet grasslands and callows	0.269±0.124 n=16	0.171±0.077 n=20
Islands and areas of limited access	–	0.074±0.064 n= 7
Blanket bog	0.048±0.047 n=12	0.061±0.047 n=13

Changes in status from the 1950s to 1982–83

When flocks are grouped by the number and size of feeding sites, a similar pattern of flock declines and extinctions in relation to quality of the feeding range is apparent between the 1950s and 1982–83 as was found in the present study (Figure 2 and Appendix).

Flocks with the best feeding ranges (category A) have moved to extensive areas of farmland or callows. While some can be difficult to count accurately, their status appears to have changed relatively little since the 1950s. Ruttledge and Og·!vie (1979) were concerned at the loss of raised bogs which were used for feeding or as refuges. However, the concurrent creation

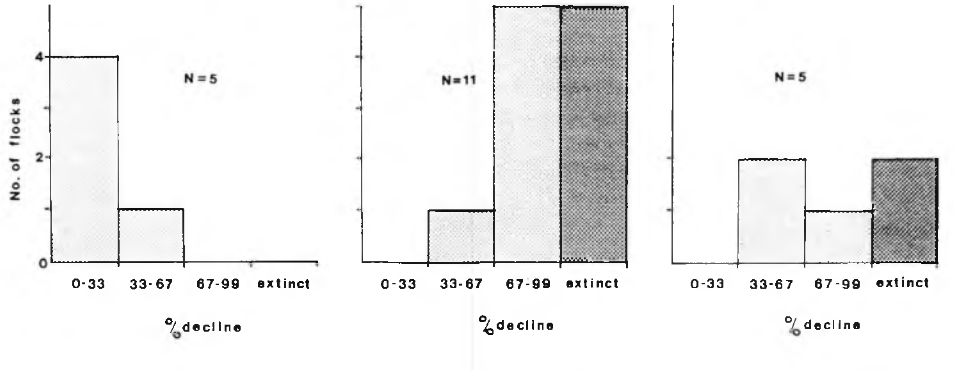

Figure 2. Change of flock status from 1950s to 1982–83 in relation to feeding range characteristics, west and midlands of Ireland. Category A flocks (left), B (centre) and C (right). Status change was calculated as percentage change in maximum counts between the two periods; data for the 1950s from Ruttledge and Ogilvie (1979).

of no-shooting areas for many of the larger flocks has so far evidently compensated for the loss of bogs since these flocks have increased since 1982–83.

The flocks most threatened by drainage were those with a number of small, wet grassland feeding sites (category B). Overall these flocks have had the highest rate of decline. Of the seven Irish flocks which became extinct during this period (Table 3), five were of this type and three were affected by drainage (Ruttledge and Ogilvie 1979). Many category B flocks used turlough areas in the mid-west and were also subject to high levels of shooting disturbance. Protection has reversed their fortunes and these flocks are now stable or increasing.

Table 3. The number of Greenland White-fronted Goose flocks that have become extinct since the 1950s and the number currently extant. The number of extinct Irish flocks has been estimated from data on the number and distribution of deserted haunts, compiled by Ruttledge and Ogilvie (1979). Data for Scotland from Greenland White-fronted Goose Survey annual reports.

	Extinct		Extant
Period	1950s – 1982	1982–87	1987
Scotland	0	2	25+
Ireland	7	1	32

Flocks with the smallest ranges (Category C) have also fared badly, particularly where the number of alternative feeding sites is also small. This category includes the other two flock extinctions. The original bogland range and the grassland areas to which these flocks moved afforded little protection to increased disturbance levels. Arterial drainage and shooting have not been important pressures but small scale agricultural development and increased recreational disturbance have continued to erode their marginal suitability. At Rahasane, Co. Galway, for instance, deeper flooding of the feeding site, resulting from extensive field drainage upstream, periodically restricts the Whitefront's feeding area to the more disturbed periphery. All flocks in this category have recently shown net declines in numbers.

Discussion

Disturbance effects

It is apparent from Figure 1 that much of the variation in flock size changes was associated with disturbance levels. Disturbance effects could operate in two ways. Firstly, a smaller disturbance index may favour smaller flocks if as a result their tolerance of disturbance increases. Owens (1977) found that the distances at which disturbed Brent Geese, *Branta bernicla*, were put to flight decreased with smaller flock size and suggested this could be one reason why flocks feeding in narrow creeks were small. More importantly, disturbance levels directly influenced the energetic costs of feeding, and hence the suitability of a site, by increasing flying time and reducing time available for feeding (cf. White-Robinson 1982).

Disturbance-mediated declines may be caused by increased mortality, reduced breeding success, emigration, or by any combination of these. It might be expected that significant levels of disturbance would affect breeding performance by reducing body condition, but there was no correlation between disturbance index and the proportion of juveniles in each flock, expressed as a percentage of the winter mean (Spearman's rank correlation coefficient = 0.0, df=9, ns). However, the lack of an observed relationship does not mean that disturbance levels have no effect on subsequent recruitment since successful breeders might redistribute themselves between winters and such a pattern would then be masked. There is some indication from age counts that a redistribution of families does in fact happen, locally at least, but data on movements of marked birds are so far too limited to draw any conclusions.

Vulnerability to disturbance

Comparative data on disturbance rates of geese are scarce. Greenland White-fronted Geese on callows of a remote Shannon tributory made 0.088 disturbance flights/hour (calculated from data in Mayes, 1985), close to the mean figure for sites of limited access recorded by this study. Brent Geese in SE England were much more disturbed, the mean number of disturbance flights/hour varying between 0.28 in the quietest sites to 2.4 at weekends in the most disturbed areas (Owens 1977). In Essex, Brent Geese made significantly more frequent disturbance flights (although of shorter duration) when feeding on saltmarshes compared with feeding on farmland (White-Robinson 1982). Greenland White-fronted Geese wintering in Ireland generally had low disturbance levels, mean rates varying from 0.06 to 0.51 flights/hour according to habitat (Table 2).

Even so, the small disturbance indices of many category B and C flocks will not allow geese to tolerate further deterioration in range quality (Figure 1). A substantial increase in agricultural disturbance levels following drainage, comparable to the difference between wet and dry grasslands recorded in Table 2 would cause the geese to desert, as suggested by Owen (1972). This is particularly so when several sites within a catchment are affected simultaneously by an arterial drainage scheme. The vulnerability of these flocks is primarily due to the small size of individual feeding sites and is compounded when few alternative feeding areas were available. This relationship between drainage, disturbance and food resource dispersion explains the higher extinction rates of Irish flocks generally and of Category B flocks in particular. Drainage has been an important factor in flock extinctions. The desertion by three out of four category B flocks on wet grassland sites coincided with drainage (Rutledge and Ogilvie 1979) but none of the six extant flocks' ranges were arterially drained. Two points follow from this. Unprotected flocks were unable to cope with the additional disturbance pressures resulting from arterial drainage, and all became extinct. Secondly, numbers have remained stable or increased since protection in flocks whose feeding grounds have not been arterially drained, while agricultural disturbance levels have remained unchanged. This implies that shooting pressures were the principal factor in earlier declines, although not apparently causing any flock extinctions.

Tolerance of disturbance may also vary according to diet. Figure 1 suggests that flocks on dry and improved pastures have a greater tolerance than those on wet pastures, but sample sizes are small. Geese that feed on high energy waste from cereal and root crops show a greater wariness and tolerance of disturbance than grazers (Owen 1972). Increased digestibility of grasses, characteristic of better grasslands, can be expected to confer the same advantage.

Management prospects

Flocks of Greenland White-fronted Geese on semi-natural habitats have responded to protection and the creation of no-shooting areas by heavier use of favoured feeding sites. Amongst category C flocks for instance, mean attendance at major feeding sites (expressed as the % of visits that geese were present) has shown a significant increase from 74% to 84% in the five years since protection (one-tailed t-test for paired samples, $t=2.83$, $df=5$, $P<0.05$). Even when goose numbers involved are less than 100, problems with farmers have occurred where geese are using improved grassland. There has been no proportional increase in use of reseeded grassland by Whitefronts in the last five years, but complaints about damage are likely to increase as numbers continue to grow.

Protection from shooting and disturbance have led to increases in most flocks on medium and good quality feeding ranges. Flocks on the River Shannon may be vulnerable to disturbance from shooting in winter and from pleasure cruisers and fishing in spring because of the linear distribution of feeding sites along the river; three other flocks had rather small disturbance indices (Figure 1). Otherwise present measures appear to afford adequate protection from disturbance pressures for these flocks.

However, flocks in category C remain threatened. All seven flocks on ranges with one or two small feeding sites have continued to decline since 1982–83. These flocks are a conservation priority but it must be remembered their small disturbance indices have been calculated for the period after the shooting moratorium started and improved management beyond statutory protection will be difficult to achieve. Even with successful management, their future is dependant on the good will of one or two landowners.

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Summary

An index of disturbance was calculated for wintering Greenland White-fronted Goose flocks based on observed disturbance rates and the refuge qualities of feeding ranges. In the three years following protection, changes in status of individual flocks were correlated with their disturbance indices. Agriculture was the single most important source of disturbance and overall rates of disturbance were highest on intensively managed land. However, the smallest indices (most disturbance) were calculated for flocks with few, small feeding sites. Such flocks are generally declining. Consequences of arterial drainage and shooting are discussed. Flocks with better quality feeding ranges are stable or increasing as a result of protection and are not currently threatened by arterial drainage.

Prior to protection numerical trends of flocks showed a similar correlation with range quality. Differences in patterns of flock declines and extinctions before and after protection are consistent with known changes in disturbance pressures.

Appendix

Flock sizes used in the analyses. Numbers are maximum estimates for the 1950s (Ruttledge and Ogilvie 1979) and maximum spring counts for 1982–83 and 1984–85 (Wildlife Service records). Flock ranges are defined in Ruttledge and Ogilvie (1979).

	1950s	1982–83	1984–85
CATEGORY A			
Ls. Foyle and Swilly	350	217	254
L. Drumharlow	–	145	174
L. Gara	500	300	328
R. Suck	400	358	450
Little Brosna	400	374	299
Ls. Iron, Ennel	500	366	370
CATEGORY B			
Ls. Kilglass, Forbes	500	95	106
L. Conn	–	114	97
Rostaff, Altore	–	107	100
Lr. L. Corrib	200	83	69
Rahasane	300	67	63
Carran, Lehinch	500	34	49
Tullagher	300	41	27
L. Derg	450	16	–
R. Barrow (E)	50+	extinct (unknown causes)	
R. Suir (F)	200	extinct (arterial drainage)	
Killorglin (H)	50	extinct (field drainage)	
Clare R. (QT)	100+	extinct (arterial drainage)	
Loughglinn (UV)	80–120	extinct (turbary)	
CATEGORY C			
Bunduff	100	13	8
L. Macnean	200	80	56
Caledon	–	84	82
Kilcolman	50	21	19
N. Antrim Moors (B)	unknown	extinct (unknown causes)	
L. Key (Y)	50	extinct (afforestation)	
OTHER			
Killarney Valley	–	69	52

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