Changes in populations of breeding waders on the machair of North Uist, Scotland, 1983 – 1998

R.J. Fuller & D.B. Jackson

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Surveys between 1983 and 1987 confirmed that habitats close to the west coasts of the islands of North Uist, Benbecula and South Uist supported the densest concentrations of breeding waders in Britain. An extensive survey in 1995 revealed that large declines in numbers of breeding waders had occurred since the 1980s, especially on South Uist and Benbecula. Predation by a recently established population of hedgehogs appears to be a major factor contributing to the declines of some species on South Uist. In 1998, a survey was undertaken to clarify the status of breeding waders on three machair sites on North Uist which are hedgehog–free. This survey established that Ringed Plover and Dunlin had declined at two of the sites since the 1980s; at one site, the reductions exceeded 50%. The causes are unclear, though several hypotheses are discussed. In contrast, Oystercatcher had remained stable at one site but had increased at two sites. There was no evidence of long–term population change at any site for Lapwing or Redshank. Variation in detectability with the stage of breeding can be a major source of error in counts of breeding waders; implications for measuring population changes are considered. Future monitoring requirements for waders on the Uists are also discussed.

R..J. Fuller, British Trust for Ornithology, The Nunnery, Thetford, Norfolk IP24 2PU, United Kingdom.
D.B. Jackson, Royal Society for the Protection of Birds, Dunedin House, 25 Ravelston Terrace, Edinburgh EH4 3TP, United Kingdom.

INTRODUCTION

Land lying on the Atlantic fringe of the islands of South Uist, Benbecula and North Uist in the Outer Hebrides is characterised by machair, which is a level plain of vegetated calcareous sand. Parts of this machair plain are cultivated; other areas are permanently waterlogged. A transition zone of rough grazing land, known as blackland, lies between the machair and the acidic peatlands and moorland that occupy the greater part of these islands. The machair and blackland cover approximately 200 km^2. These habitats support the densest concentrations of breeding waders in Britain and form one of the most important wader breeding grounds in western Europe.

In 1983 an extensive survey of breeding waders was carried out on the machair and much of the blackland of the Uists and Benbecula (Fuller *et al.* 1986). The following population estimates were made: Oystercatcher *Haematopus ostralegus* (2700 pairs), Ringed Plover *Charadrius hiaticula* (2250 pairs), Lapwing *Vanellus vanellus* (4350 pairs), Dunlin *Calidris alpina* (3300 pairs, corrected for detectability), Snipe *Gallinago gallinago* (750 pairs) and Redshank *Tringa totanus* (2650 pairs). The numbers of Snipe were probably greatly underestimated (Fuller *et al.* 1983). Subsequent surveys were undertaken in sample areas of machair on North Uist and South Uist in each year between 1983 and 1987 (Fuller & Percival 1988). Throughout this period, high densities of waders were maintained within the study areas.

In 1993 and 1995, surveys of breeding waders were undertaken on the machair of the Uists and Benbecula using methods that were comparable with those of the earlier surveys (Whyte & O'Brien 1995). These surveys indicated that overall numbers of Ringed Plover, Dunlin, Redshank and Snipe had declined since 1983 but that there was no clear change in Oystercatcher and Lapwing. The pattern of decline was most consistent on South Uist where the reductions since 1983 were estimated as: Ringed Plover –58%, Dunlin –65%, Redshank –43% (Whyte & O'Brien 1995). In the 1980s, the northern end of South Uist, especially to the west of Loch Bee, supported exceptional concentrations of breeding Ringed Plover and Dunlin (Etheridge 1982, Fuller *et al.* 1986); these are now greatly reduced. On North Uist the overall pattern was also one of declining numbers of Ringed Plover and Dunlin, but no clear change in the other species.

Predation rates on Ringed Plover, Dunlin and Redshank nests in South Uist were much higher in the 1990s than in the mid 1980s (Jackson 1998). The main nest losses of Ringed Plovers are due to predation by Common Gulls *Larus canus* (Jackson 1998). For Dunlin and Redshank, however, much of the increased predation on South Uist was by an expanding population of hedgehogs *Erinaceus europaeus*. Hedgehogs

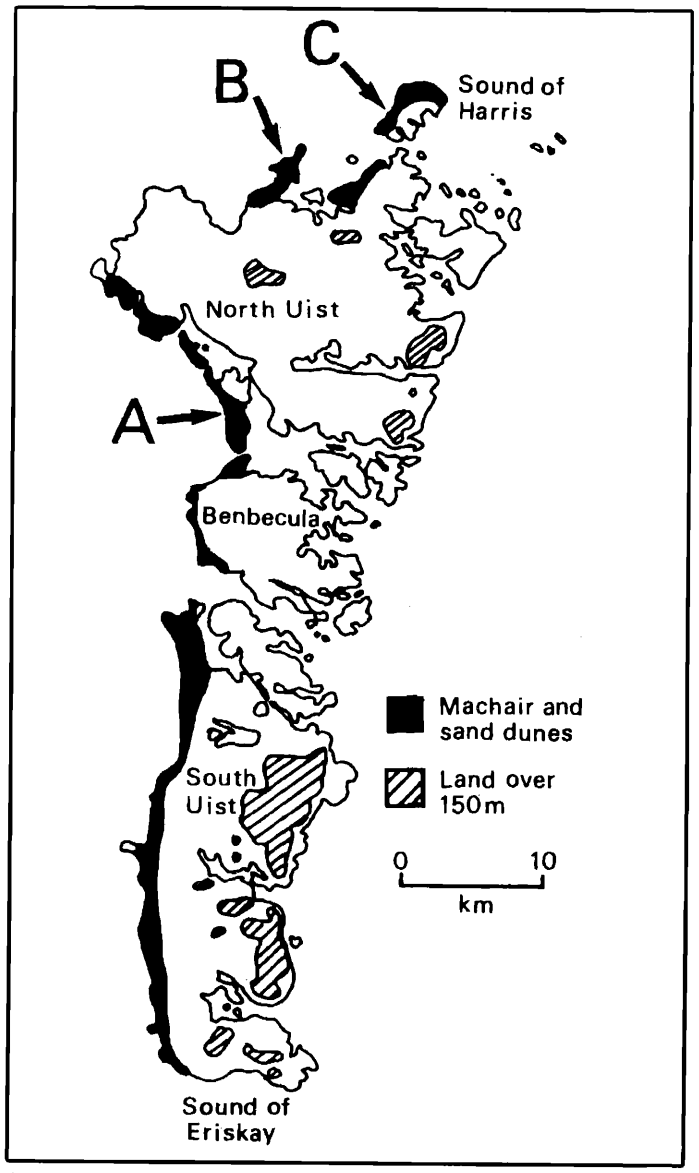


Figure 1 The approximate distribution of machair and sand dunes on North Uist, Benbecula and South Uist. Locations of three areas surveyed in 1998 are shown: (A) Baleshare, (B) Sollas, (C) Berneray.

were introduced into southern South Uist in 1974 and 1975 (Angus 1993) and have subsequently spread throughout South Uist, Benbecula and into the southern part of North Uist. At present all the major wader breeding areas on North Uist and adjacent islands remain free of hedgehogs. It is especially important, therefore, to document current population sizes in these areas so that any future impacts of hedgehogs on wader populations can be measured.

In 1997, breeding success of waders on hedgehog–free areas on North Uist was far higher than on South Uist but was similar to that during the mid 1980s for South Uist (Jackson 1998). In view of this high breeding success and the high site fidelity of these birds (Jackson 1994), it is surprising that the 1993 and 1995 surveys recorded a decrease in populations of Ringed Plover, Dunlin and Redshank on some of these North Uist sites. In 1998 one of us (RJF) resurveyed breeding wader populations on three large areas of machair on North Uist and an adjacent island which he had previously surveyed each year from 1983 to 1987. The aims of the 1998 survey were (a) to clarify the current status of breeding waders in these areas where hedgehogs have yet to become established and (b) to estimate the size of the wader populations before colonisation by hedgehogs. This paper summarises the results of these and earlier wader surveys on three areas of North Uist.

STUDY AREAS

The locations of each study area are shown on Figure 1. Details of each area are given below. Each of these areas was free of hedgehogs in 1998; we can be sure this is the case because searches for hedgehog scats were negative, local crofters have not encountered hedgehogs and no road kills were found in these areas. Furthermore, studies of wader breeding success on Baleshare and Sollas in 1997 did not find any evidence of egg losses due to hedgehogs (D.B. Jackson unpublished). There is also concern that American mink *Mustela vison*, which have established feral populations on Lewis and Harris, might spread to the Uists. At the time of writing, we are unaware of any confirmed records of mink on North Uist or Berneray.

Baleshare (Grid reference NF790610)

An island at the southwest corner of North Uist connected to the main island by a causeway. The island contains large samples of all the typical machair and blackland habitats (Fuller 1981). Waders were surveyed across the entire island (total area 8.8 km^2). Hedgehogs have colonised adjacent parts of southwest North Uist but there is no evidence that a population has become established on Baleshare. Grazing pressure from sheep is currently higher on parts of Baleshare than on the other study areas. Cattle are also grazed on parts of the island.

Sollas (Grid reference NF815764)

This site is formed by the peninsula of cultivated and uncultivated machair and dunes that projects into the Sound of Harris from Sollas and Middlequarter (study area 4.5 km^2). There are only two permanently marshy areas, both on the southern boundary. At the time of the survey there were substantial numbers of cattle grazing parts of the machair.

Berneray (Grid reference NF905820)

The site covers the entire area of cultivated and uncultivated machair and dunes that forms the western half of the island (study area 5.5 km^2). This is the driest of the three study areas with no permanently marshy areas, though there are substantial areas of dune slack which are flooded in winter. At the time of the survey cattle, but no sheep, were grazing the uncultivated machair and dunes.

SURVEY METHODS

The survey methods were exactly the same as those employed in the period 1983–87 except that much of Baleshare and

Table 1 Timing of surveys undertaken at the three sites 1983-1998. 'Early June' indicates that visits were made during the first two weeks of June

	Baleshare	Sollas[6]	Berneray
1983[1]	early June	early June	early June
1984[2]	5-6 June	1-2 June	8 June
1985[2]	7-8 June	6 June	10 June
1986[2]	9-11 June	5 June	4 June
1987[2]	3-7 June	2 June	10 June
1993[3]	31 May-3 June	early June	early June
1995[4]	19-21 June	9 & 16 June	23 June
1998[5]	3-8 June	4-5 June	9-11 June

Notes:
[1]Surveys by NCC/Wader Study group teams of surveyors (Fuller *et al.* 1986)
[2]Surveys by Wader Study Group teams. RJF involved in all these surveys
[3]Baleshare surveyed by RJF. Sollas and Berneray surveyed by Royal Air Force Ornithological Society (RAFOS) (Dodds *et al.* 1995)
[4]Survey by RSPB contract surveyors (Whyte & O'Brien 1995)
[5]Survey by RJF with Vickie Heaney (Sollas) and Ruth Fuller (Baleshare)
[6]The site boundary used in 1984-87 and 1998 differed to that used in the 1993 and 1995 surveys. The latter surveys included enclosed fields between the machair plain and the A865 road. The 1993 and 1995 counts have been adjusted by reference to the pair summary maps to make them comparable with other years

Berneray was surveyed by a single observer (RJF) in 1998 rather than by a team of two or three observers. This is not considered to reduce comparability with earlier surveys. Sollas was covered by a pair of observers in 1998 as was the Eachkamish dune system at the southern end of Baleshare. Details of the methodology are given by Reed & Fuller (1983) and Fuller *et al.* (1986) but a summary of the key points is given here for convenience. The estimation of numbers involves complete coverage of the chosen study area by walking transects placed at 100 or 150 m intervals depending on habitat, terrain and wader densities. A single visit is made during the first two weeks of June. Multiple visits were considered undesirable because of the disturbance caused to the birds and associated predation risks. Exactly the same transect lines were walked in 1998 as in the surveys conducted in 1983–87. Locations of birds are plotted as accurately as possible on 1:10,000 Ordnance Survey maps using species–specific codes (note, however, that the activity codes described in Appendix 1 of Reed & Fuller (1983) were greatly simplified for use in subsequent surveys). Field records of waders are interpreted as 'pairs' using species–specific criteria.

The timing of counts at the three sites in each of the years for which data are available is shown in Table 1. Counts have been undertaken during the first two weeks of June at all sites in all years with the exception of 1995 when the surveys were somewhat later, especially at Baleshare and Berneray.

FACTORS AFFECTING THE INTERPRETATION OF COUNTS

Estimates of numbers of breeding waders for large areas, especially where the birds are at relatively high density, are necessarily inexact and must be interpreted cautiously. Here we describe factors that may affect the reliability of the counts as indices of population level and population trends, rather than factors that influence their absolute accuracy i.e. their relationship to real population size.

Variation in detectability with the stage of breeding can be a major source of error in counts of breeding waders. Oystercatcher, Ringed Plover and Lapwing are highly visible throughout the breeding season and errors generated by low detectability are unlikely to be a problem. However, for Dunlin and Redshank, detectability is highly dependent on the stage of the breeding cycle. These species are very inconspicuous during incubation but become far more detectable when they have young, advertising their presence to observers with alarm calls and mobbing behaviour. The survey period, early June, has been chosen to coincide with the time when most pairs have chicks.

The main disadvantage of early June surveys is that year to year variation in the timing and success of breeding will influence the efficiency of the count. This is a particular problem for Lapwing, Dunlin and Redshank. Conducting surveys at approximately the same time of year cannot guarantee direct comparability of counts from year to year. Ideally, it would be best to survey at the same stage of breeding each year, but this assumes a high level of nesting synchrony within the population, which is unrealistic. Furthermore, the elevated predation rates experienced in recent years, especially on South Uist, may have served to reduce synchrony even further as a result of higher levels of re–nesting.

In the case of Dunlin and Redshank, in a late season many birds may still be incubating in early June and detectability will be relatively low. Furthermore, in some years, Redshank can suffer extremely high local breeding losses (Jackson 1988), which may result in reduced detectability at the time of

the survey or possibly in premature departure of birds. There is, however, little evidence that this factor has introduced large annual variation into the Redshank counts for the three sites studied here. In the case of Lapwing, by the second week of June, sometimes earlier, the birds are starting to gather in flocks. These flocks are excluded from counts because they may be mixtures of adults and juveniles, which have not necessarily bred on the study area concerned. Inevitably, breeding numbers will be underestimated once flocking has started and this problem becomes increasingly severe the later the count. Annual variation in weather conditions and predation pressure, will affect success of first clutches of Lapwings and consequently influence the number of birds that are still on territory in early June. In years with a high failure rate early in the season, many birds will lay repeat clutches and therefore still have eggs or small young in early June. In years of relatively high early success, a much larger proportion of the population will have young close to fledging in early June.

Many variations in estimated numbers between years are likely to reflect differences in counting efficiency and two particular points need to be borne in mind. First, the survey method cannot reliably detect small population changes. Observations of the behaviour of individually marked birds, and experience of variation in the timing of breeding, justify us giving a cautious indication of the scale of the problem. As a rough guide, we suggest that variation in detectability between years, due solely to the above factors, may introduce spurious fluctuations of as much as +/– 20% for Lapwing, Dunlin and Redshank but perhaps less for Oystercatcher and Ringed Plover. Second, there is a strong possibility that some low counts may be artefacts arising from low detectability or late surveys. When interpreting population changes we emphasise cases where there appears to be a systematic directional trend in numbers or where there are large changes between 1998 and the counts of the mid 1980s. We have arbitrarily defined 'a large change' as 40%; this minimises the risk of drawing attention to changes in numbers that may actually be spurious.

In this paper we summarise all available counts for Baleshare, Sollas and Berneray for the period 1983 to 1998. However, we focus especially on a comparison of the counts in 1998 with those made in 1984–87. The reason is that during the 1984–87 period considerable consistency of survey personnel and field methods was achieved. RJF participated in all of the surveys during 1984–87 as well as undertaking the 1993 Baleshare count. This approach seems prudent because there is some evidence that different observers count waders breeding at high density in different ways (Fuller 1983). We do not present estimates of Snipe numbers because the method is far less suitable for estimating densities and trends in Snipe than for the other species (Fuller *et al.* 1983).

RESULTS

All available counts since 1983 are summarised in Figure 2. A comparison of the 1998 counts with those undertaken in the period 1984–87 is given in Table 2. Results for each species are discussed individually below.

Oystercatcher

Baleshare has consistently held an extremely large population of breeding Oystercatchers. There is no evidence of a long–term trend on Baleshare (Figure 2). The 1998 estimate was very close to the highest estimate for the period 1984–87. In contrast, Oystercatchers appear to have increased at both Sollas and Berneray. For both sites, the 1998 estimate was higher than those for each of the years 1984–87 and average numbers were approximately 40% higher than in the mid 1980s (Table 2). Oystercatcher estimates for 1995 are low relative to other years in the 1990s (Figure 2). It seems unlikely that this is a consequence of the relatively late survey dates in 1995 because Oystercatcher is not a species for which survey timing is a critical factor.

Ringed Plover

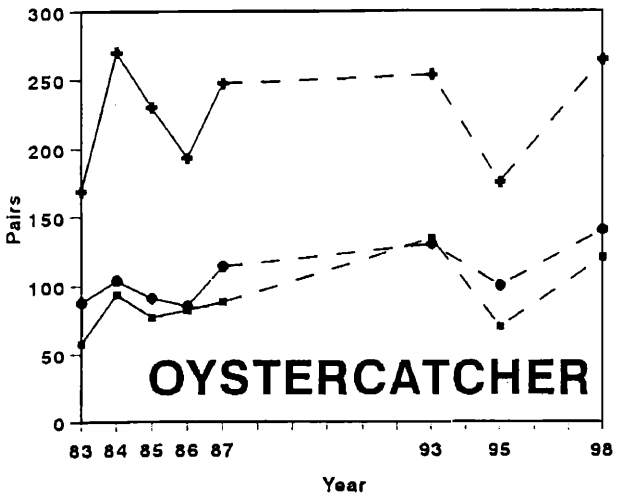
There is clear evidence of a marked decline at both Baleshare and Berneray (Figure 2). The decline occurred earlier at Berneray than at Baleshare. In 1993 estimated numbers on Berneray were very similar to those in 1995 and 1998 and in each of these years were less than half the average for the period 1984–87. At Baleshare, however, the 1993 estimate was very similar to the 1987 estimate but thereafter numbers dropped considerably and in 1998 were on average 34% lower than in the mid 1980s (Table 2). The situation at Sollas is less clear. The 1993 and 1995 surveys followed a very similar pattern to that at Berneray i.e. a very marked decrease since the mid 1980s. The 1998 estimate was, however, considerably higher and was only slightly lower than the 1987 estimate (142 and 159 pairs respectively). The Ringed Plover population at Sollas appears now to be very similar to that in the mid 1980s but numbers are now far lower on Berneray and the situation is intermediate at Baleshare. The relatively late count dates in 1995 are unlikely to have affected estimates of this species.

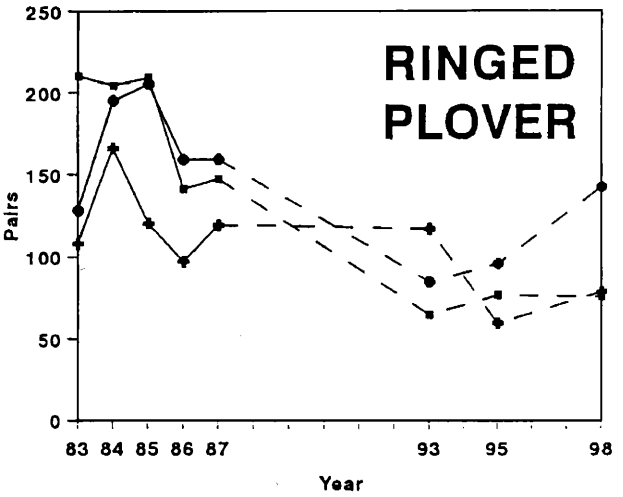
Lapwing

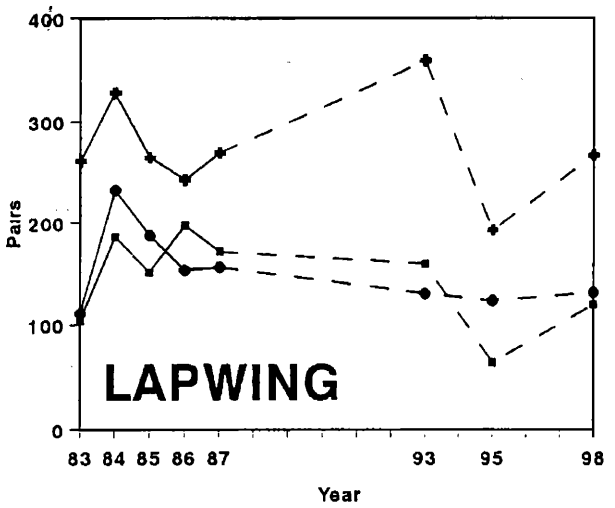
There is little evidence of a systematic trend in Lapwing populations, though numbers may now be lower at Berneray than in the mid 1980s. The relatively low estimates of Lapwings in 1995 were probably a consequence of the late visit dates. This factor is probably responsible for much of the variation between years evident in Figure 2.

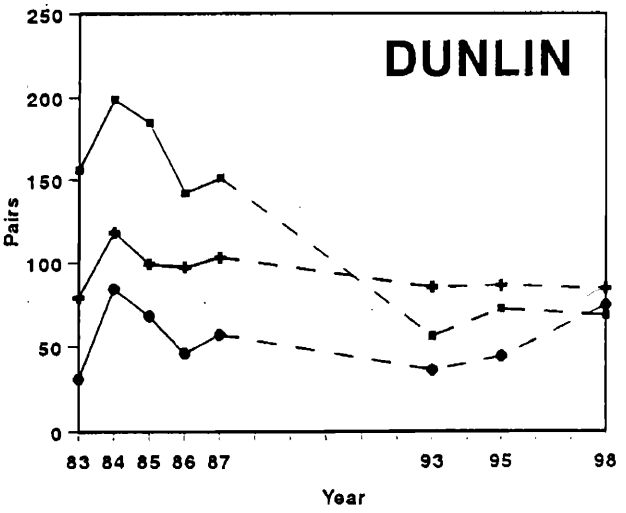
Dunlin

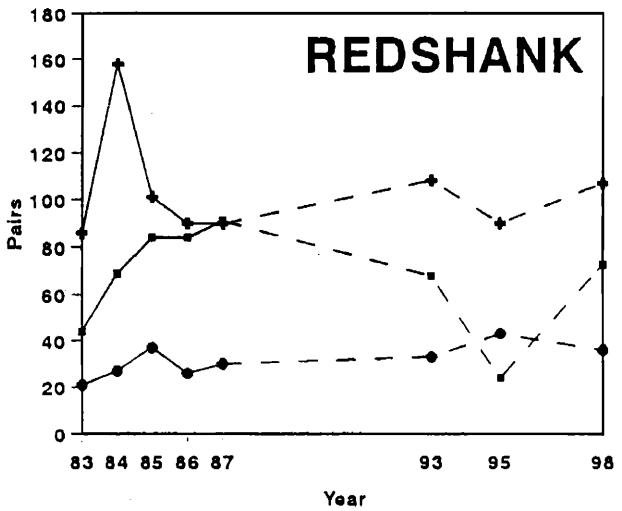
There is strong evidence of a large decline in Dunlin on Berneray since the mid 1980s. The 1998 estimate was 59% lower than the average for 1984–87 (Table 2). Each of the counts made on Berneray in the 1990s has been far lower than any of the counts made in the 1980s (Figure 2). This is in striking contrast to Baleshare and Sollas where numbers have











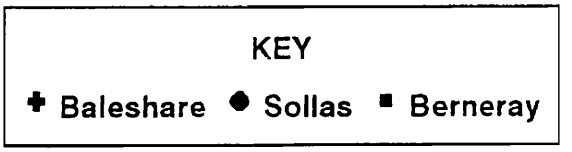


Figure 2 Breeding population estimates (pairs) of Oystercatcher, Ringed Plover, Lapwing, Dunlin and Redshank at Baleshare, Sollas and Berneray 1983–1998.

Table 2 Estimated populations of breeding waders (pairs) in the mid 1980s and in 1998 with % change between these two periods

		Estimates 1984-1987[1]	Estimate 1998	% change[2]
Oystercatcher	Baleshare	239 (193-270)	264	+11% (-2%, +37%)
	Sollas	98 (85-114)	140	+44% (23%, +65%)
	Berneray	85 (77-94)	120	+41% (+28%, +56%)
Ringed Plover	Baleshare	120 (97-166)	79	-34% (-19%, -52%)
	Sollas	177 (159-205)	142	-19% (-11%, -31%)
	Berneray	176 (141-209)	76	-56% (-46%, -64%)
Lapwing	Baleshare	267 (242-328)	266	0 (-19%, +10%)
	Sollas	172 (153-232)	131	-23% (-14%, -44%)
	Berneray	179 (151-197)	119	-33% (-21%, -40%)
Dunlin	Baleshare	101 (97-118)	84	-17% (-13%, -29%)
	Sollas	63 (46-84)	74	+19% (-12%, 61%)
	Berneray	168 (142-199)	68	-59% (-52%, -66%)
Redshank	Baleshare	96 (90-158)	107	+12% (-32%, +19%)
	Sollas	28 (26-37)	36	+29% (-3%, +38%)
	Berneray	84 (69-91)	73	-13% (-20%, +6%)

Notes:
[1]The median estimate for the four years is shown with the two most extreme estimates in parentheses.
[2]% change is the median change between 1998 and each of the four years 1984-87 with the two most extreme values in parentheses.

been relatively stable (Figure 2). Numbers may be gradually declining at Baleshare but at Sollas substantially more birds were estimated in 1998 than in 1993 and 1995.

Redshank

Breeding populations of Redshank were relatively stable at all three sites (Figure 2). At Baleshare there was an exceptionally large estimate of 158 pairs in 1984 but otherwise numbers have remained within the range 86 to 108 pairs. There has also been extremely little variation in estimated numbers at Sollas. At Berneray, with the exception of two low estimates in 1983 and 1995, numbers have ranged between 69 and 91 pairs. The extremely low estimate for Berneray in 1995 was probably a consequence of the very late survey date (23 June) by which time it is likely that many birds would have departed from the immediate vicinity of the breeding areas.

DISCUSSION OF POPULATION CHANGES

Population sizes of Lapwing and Redshank have been largely stable at each of the three sites examined between the early 1980s and the late 1990s. There is evidence of a gradual increase in Oystercatcher numbers at Sollas and Berneray. Ringed Plover and Dunlin populations, however, have definitely declined at some sites. The declines are most marked at Berneray where both species have decreased by more than 50% since the mid 1980s. In contrast to Berneray, there is no clear evidence of a population decline of Ringed Plover or Dunlin at Sollas. The situation at Baleshare for these two species seems to be intermediate between the large decrease at Berneray and apparent stability at Sollas.

This study indicates that predation by hedgehogs is not the only factor driving recent population changes in breeding waders on the Uists. It also demonstrates that on North Uist there are considerable differences between study areas in population trends. At least four types of hypothesis can be advanced to explain the declines in Ringed Plover and Dunlin. We stress that this study has not in any way elucidated the causes of the population changes; these can only be determined through more detailed and intensive work. The hypotheses are: (a) reduced survival outside the breeding season, (b) increasing inter–specific competition, (c) change in quality of breeding habitat, (d) increasing predation pressure. These hypotheses are not mutually exclusive. For example, there can be interaction between habitat change and predation pressure (Jackson 1988).

The first hypothesis is improbable because if there were a pattern of increasing mortality, one would expect a more even pattern of decline in breeding populations across the different

study areas. There is also no evidence that return rates of individually marked adult Dunlin, Ringed Plover and Redshank have changed since the 1980s. It is possible that as the overall population level dropped due to increasing mortality, birds might increasingly concentrate in the best quality breeding areas which would lead to greater declines in some areas than others. However, this would require high natal or breeding dispersal which Dunlin and Redshank do not exhibit according to work undertaken in South Uist, though Ringed Plover does show higher levels of dispersal (Jackson 1994). There is no evidence to support the competition hypothesis. The only species of wader that appears to be increasing is Oystercatcher, which utilises different food resources to Ringed Plover and Dunlin.

The third hypothesis concerns habitat. Breeding Ringed Plovers are strongly associated with cultivated machair on the Uists (Fuller *et al.* 1986, Jackson 1994). There has been no large–scale reduction in the area of cultivated machair since the 1980s that could account for the declines of this species on Baleshare or Berneray. Grazing pressure from sheep has increased on Baleshare since the early 1980s. There are possible implications for breeding success of Dunlin, which may be more exposed to predation in heavily grazed areas where there is reduced vegetation cover. The quality of habitat for feeding chicks may also be reduced, as the vegetation becomes more uniform in structure under heavy grazing. However, this factor does not seem especially relevant on the other study areas, where we do not perceive large changes in grazing pressure. On Berneray the population decline of Dunlin and Ringed Plover appears especially marked within the dune slack areas. This does not necessarily mean that a habitat–specific factor (such as drying out of dune slacks or higher predation rates in dune slacks compared with other habitats) is responsible for the decline. Birds may have gradually redistributed into the most preferred habitats as overall population level has fallen (Fretwell & Lucas 1970). Ringed Plovers nesting in cultivated habitats on the Uists show the capacity to move between breeding seasons to better habitat (Jackson 1994). In conclusion, with the exception of intensified sheep grazing on Baleshare, there have been no obvious changes in habitat since the 1980s that could account for the scale of population changes documented here. We cannot, however, rule out the possibility that subtle changes have occurred in vegetation structure or soil moisture.

The final hypothesis concerns predation. The most important predators of waders in the three study areas are likely to be gulls and crows. Berneray is just 8 km from mink–inhabited Harris but we have no evidence that mink have colonised the island. Little is known about the dynamics of Common Gull or Hooded Crow *Corvus corone* populations in the Uists, nor about their feeding ecology there. Spatial variation in predation pressure on waders may exist on the machair depending on the proximity of gull colonies, availability of alternative food for gulls and crows, and variation in crow control. Large colonies of Common Gulls have been present on both Baleshare and Berneray since at least the 1970s and probably for many years previously. There are relatively few breeding Common Gulls on the Sollas peninsula, the site showing least evidence of declines in breeding waders (though DBJ found that there was severe predation pressure from Common Gulls at Sollas in 1997). Unfortunately there have been no long–term systematic counts of these gull colonies but there is no evidence of an increase in nesting gulls that might be driving increased predation on waders. In fact, on Baleshare it appears that gulls have decreased since the early 1980s. In 1982 RJF estimated that 400–500 'pairs' of Common Gulls, 200 'pairs' of Black–headed Gulls *Larus ridibundus* and 10+ 'pairs' of Herring Gulls *Larus argentatus* were nesting in the dune system (Eachkamish) at the southern end of Baleshare. The numbers of Common Gulls now breeding on Baleshare are very much lower than these estimates. In 1998, DBJ estimated 154 alarming adult Common Gulls, which may represent some 100 'pairs', and a similar number in 1997. Though no systematic counts were made, it is worth noting that in 1998, RJF observed Hooded Crows far more frequently on the Berneray machair than at the other two sites.

Could predation pressure on breeding waders actually have increased, even if gull numbers have been decreasing? This is possible for several reasons. First, this could happen where a habitat change, such as might be brought about by increased grazing pressure, alters vegetation structure and reduces cover for nests and chicks. Second, the number of fences has increased on the machair and dunes since the early 1980s. These may provide look–outs for Hooded Crows, making it easier for them to locate eggs and chicks of waders. Third, it is possible that changes in gamekeeping activity may have resulted in increased predation pressure from Hooded Crows in some areas. Fourth, the importance of waders in the diet of gulls may depend on the availability of other food resources. If Common Gulls are, for any reason, finding it hard to collect food (for example invertebrates on the machair and the shoreline) they may turn increasingly to wader eggs and chicks. It is possible that predation impacts on waders are caused by a small number of individual gulls and that the number of gulls exhibiting this behaviour is not correlated with the overall population size of gulls. Initial observations by DBJ on Common Gull feeding ecology in 1997 suggest that predation on waders is a specialist activity involving some 25% of individual gulls. Finally, it should be noted that small waders may benefit from high nesting densities of larger species, especially Lapwings and terns, which can give air cover' for small waders by vigorously attacking predators (Dyrcz *et al.* 1981). However, this does not seem relevant in explaining the wader declines in the Uists because there is no evidence of a decline in Lapwings or terns.

Based on these recent observations we make three main suggestions. First, some further work on possible changes in habitat would be useful. This could involve examining

fine–grain habitat attributes (vegetation structure, floristics, soil moisture) at sites that have retained waders and those that have lost them; comparisons could also be made with detailed habitat data collected from the three sites in the 1980s (R.J. Fuller unpublished). Second, the role of avian predators, especially of Common Gull and Hooded Crow, in the population dynamics of machair breeding waders is worth close examination. On South Uist, there is evidence that predation pressure from Common Gulls on Ringed Plovers has increased since the 1980s (Jackson 1998). The reasons for this are unknown. Third, periodic monitoring of the wader populations is necessary using methods comparable to previous surveys. Monitoring is especially important in assessing the effects of any future control measures that might be introduced for hedgehogs and in assessing the timing of any changes in wader numbers on North Uist in relation to the expanding hedgehog population. Large sample areas need to be covered, such as those examined from 1984 to 1987, perhaps also including islands in the Sound of Harris because these are unlikely to be colonised by hedgehogs though they may be more vulnerable to mink colonisation. We suggest that counts should be undertaken at three yearly intervals.

For most wader species, rather little is known about the nature of population fluctuations. It could be that stochastic variation in breeding success and adult survival combined with density–dependent forces result in quite wide fluctuations within what are long–term stable populations. Life history traits would be expected to modulate the size of fluctuations. Long lived species, such as Oystercatcher, would be expected to show greater stability than a comparatively short–lived species like Ringed Plover. Without this knowledge it is not possible to assess whether observed declines of some species on North Uist lie within the expected norms of fluctuation. However, on South Uist and Benbecula, where the declines have been larger and more consistent between sites, and where there is clearer understanding of the factors responsible, there is firm cause for concern about the future of the wader populations. We stress that the findings of this study do not in any way diminish concern about the impacts of hedgehogs on the breeding waders of the Uists. Hedgehogs have had a major impact on populations of waders that nest in the damper habitats of South Uist i.e. Dunlin, Snipe and Redshank. Similar population declines are to be expected on mainland North Uist as hedgehogs move further north.
Postscript: Since this article was written, it has been confirmed that mink have colonised North Uist. It has also become clear that feral ferrets are now strongly established on the island.

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