

Status of Golden Eagle *Aquila chrysaetos* in Britain in 2003

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Capsule The third complete survey of Golden Eagles in Britain found 442 pairs.

Aim To investigate the population size, distribution and breeding success of Golden Eagles in Britain, for comparison with similar surveys in 1982–83 and 1992.

Methods All known home-ranges were surveyed between January and August 2003, to record Golden Eagle presence, breeding attempts and productivity using a three-visit methodology. The first visits were made in January–March to look for the presence of eagles, the second in April–June to detect whether a breeding attempt was taking place and the third in July–August to establish breeding success.

Results In total, 442 pairs were located, a slight increase on the numbers in 1982–83 and 1992. There was considerable variation in population trends at a regional level, with decreases since 1992 in the eastern and south-central Highlands but an increase in the Hebrides. The mean productivity in 2003 was 0.36 fledged birds/pair. There was significant variation in breeding success between regions with, as in previous surveys, productivity being highest in the eastern Highlands.

Conclusion The British Golden Eagle population remains stable. There remain concerns regarding the future of this population, particularly due to the threat posed by illegal persecution, and these results provide some supporting evidence for concerns raised by previous analyses. Persecution related to grouse moor management could be depressing the population in the eastern Highlands, preventing expansion into suitable habitat still unoccupied, and may be reducing the pool of non-breeding adult 'floaters' which act as a buffer against adverse population impacts. However, the survey did detect increases in the Hebridean islands since 1992, which may be because of a reduction in persecution.

Complete censuses of Golden Eagles *Aquila chrysaetos* in the United Kingdom were conducted in 1982–83 (Dennis *et al.* 1984) and 1992 (Green 1996), producing estimates of 424 and 422 pairs respectively. This apparently stable population level was reached following a recovery from much lower numbers in the 19th and early 20th centuries, which were due primarily to high levels of persecution from sheep farmers, gamekeepers and collectors (Watson 1997). The recovery in population size, aided by a reduction in persecution during and following the 1914–18 and 1939–45 wars, and more recently the introduction of stricter protective legislation (in 1954 and 1981), was accompanied by an expansion of geographic range back into many

(but not all) of the areas occupied previously. Breeding resumed in northern England in 1969 and a pair bred in Northern Ireland between 1953 and 1960, although not subsequently. Population estimates in the early 1950s (at least 190 pairs, Nicholson 1957) and 1964–68 (300 pairs, Everett 1971) may have been underestimates, although it is likely that the population was still undergoing recovery during those decades.

The apparent stability at the national scale between the 1982–83 and 1992 surveys hid marked variation in population trends between regions. In particular, there were declines of 27% in the northern moors and fells, and 23% in the north-central Highlands (see below for definitions of regions) between surveys, counter-balanced by increases in the south and east of Scotland. There are concerns about the current status of Golden

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Eagle. Threats from afforestation, changes in upland management, deer and sheep populations, increasing recreational use of upland areas and persecution have all been highlighted as having actual or potential impacts on the UK population (Watson 1997, Watson & Dennis 1992, Watson *et al.* 1992, Whitfield *et al.* 2001, 2004a, 2004b). Furthermore, despite the apparent stability in numbers, there has been no further expansion in the south of the current range into areas once occupied. It is thought that this is due mainly to continuing persecution, principally in the east and south of the present range (Green 1996, Watson 1997, Whitfield *et al.* 2004a, 2004b), despite Golden Eagles being afforded special legal protection under the Wildlife and Countryside Act 1981. The incidence of raptor persecution is highest in eastern and central Scotland, particularly in areas with a predominance of grouse moors (Whitfield *et al.* 2003). The effect of this persecution upon Golden Eagles is evidenced by apparently suitable habitat being unoccupied, and by a higher than average proportion of subadults amongst those breeding pairs that are established (Whitfield *et al.* 2004a). Persecution may have an impact on population levels beyond the area in which it occurs, as it may create an 'ecological trap', with subadult birds from a wider area being attracted in to replace adult birds that have been killed. In the absence of this persecution (estimated at 3–5% of adults per annum) the population would be likely to expand into apparently suitable habitat that is currently unoccupied (Whitfield *et al.* 2004b).

This paper describes the third survey in Britain (effectively Scotland and northern England), conducted in 2003 by the Royal Society for the Protection of Birds (RSPB), Scottish Natural Heritage (SNH) and the Scottish Raptor Study Groups (SRSGs). The population size and distribution are presented, along with data on productivity in 2003. Trends in these measures since the previous surveys, along with the age structure of the population, are presented and discussed in the light of potential pressures upon the eagle population.

METHODS

Studies of Golden Eagles by the RSPB, SRSGs and other ornithologists, stretching back seven decades (including the two previous full surveys), have enabled the collation of a comprehensive inventory of home-ranges (areas of habitat suitable for breeding that have a history of use by Golden Eagles) that have been occu-

ried by resident pairs since the 1960s (Dennis *et al.* 1984). As with the previous surveys, the aim was to visit all these known home-ranges, using standard methods, to count completely the ranges occupied by pairs of eagles. Unpaired birds were recorded in order to assess the size of the non-breeding population, so surveyors were asked to survey all previously occupied home-ranges even if they were now unlikely to be occupied by breeding pairs. To attract more records of non-breeding birds and to detect any expansion of the breeding range into new areas, members of SRSGs and RSPB staff were asked to submit records of eagles sighted away from known breeding ranges (although few were received). Survey coverage was achieved through a combination of the volunteer members of the SRSGs, and SNH and RSPB staff, including eight surveyors employed specifically for the survey. Golden Eagles are protected against unauthorized disturbance by Schedule 1 of the 1981 Wildlife and Countryside Act, so all survey workers worked under licence from Scottish Natural Heritage.

The survey methods were the same as those used in the 1982–83 and 1992 surveys. Each home-range was visited on three occasions, firstly to look for eagles or signs of their presence, then to look for evidence of breeding or further checks for occupation, and finally to record productivity of nesting pairs (see below). However, due to the high demands of fieldwork in the survey year and the large areas to be covered, if an observer did not see any evidence of a breeding pair during the first two visits then the third visit was usually omitted. Surveyors were asked to check all known eyrie sites, to report on the location (whether a tree or cliff nest) and condition (used/unused in 2003) of these. Because a considerable proportion of the survey was done by volunteers, the recording of habitat details was kept simple: surveyors were asked to record the approximate distance to the nearest footpath and (drivable) track, as a potential proxy for disturbance from humans, and the primary land-use within a 6-km radius of the nest-site (this is the range most used for foraging (McGrady *et al.* 2002), although this varies between areas depending on eagle density and habitat quality). Five habitat categories were used: grouse moor, deer forest (upland areas suitable for deer stalking, not usually forested, without significant densities of sheep or cattle), sheep walk, forestry and other (with a short written description requested for land-uses described as 'other').

The first visit, in the period January to mid-March, was to establish the presence, or otherwise, of eagles

during the display and nest-building period when they are at their most conspicuous. All sightings of eagles were recorded and, when possible, each bird was aged according to plumage features, in particular the extent of white in the remiges and retrices (Forsman 1998). Golden Eagles attain full adult plumage at around five to six years old, hence in this paper the term 'adult' refers to this age and older; birds showing signs of immaturity in plumage features are referred to as 'subadults'. Sexing of birds, based on size, was usually possible only if birds were seen together for comparison. If birds were not seen, recently used roost sites with droppings, pellets or prey remains sometimes indicated their presence. Individual eyries were also checked in this period to assess whether sticks or other material had been recently added, or if the nest-cup had been lined. All nest-sites used previously were visited to check for signs of activity; observers were requested to visit all known nest-sites within a home-range even after an active nest had been located, as splitting of home-ranges can occur, with nest-sites of neighbouring pairs as close as 2 km apart.

At least two further visits were required to establish whether a breeding attempt had taken place, and if so whether it was successful. Disturbance of nests during late March to early April was avoided, but checks of occupied nests were made from mid-April onwards. The presence, or otherwise, of eggs and chicks and the approximate age of any chicks (based on size and plumage development) was recorded. It was not a requirement to climb into the eyries to gather this information as the presence of apparently incubating or brooding birds was taken as sufficient evidence that a breeding attempt was in progress. Occupied nest-sites were finally checked in July–August to count the chicks that were close to fledging or had fledged. As part of a scheme to reintroduce Golden Eagles to Donegal, Ireland (O'Toole *et al.* 2002), single chicks were taken (under licence from SNH) from 12 nests that had two chicks.

A home-range was considered to be occupied by a pair of Golden Eagles if a pair of eagles was seen together or if there was evidence of a breeding attempt. This included instances where only one bird was seen, but a nest was newly built-up, even if no further evidence of breeding was recorded. This level of evidence contrasts with that used by Green (1996), who recorded ranges as occupied by pairs only if both birds were seen, but our method gave greater consistency with other studies (Steenhof 1987). The slight difference in the population estimates caused by this

change is discussed in the Results section. A second estimate was generated using the same level of evidence as used by Green (1996), to allow the 1982–83, 1992 and 2003 population estimates to be compared directly.

RESULTS

Population size

Information was collected from 698 home-ranges during the course of the survey. A number of home-ranges in eastern Scotland were not reported as part of the national survey, but were known to have been unoccupied by breeding pairs for several previous years, and were visited during other raptor monitoring in 2003 without revealing any evidence of occupation by resident eagles. Following discussions with local experts, these ranges were incorporated in the survey results as being vacant. It is possible that non-breeding birds were present within some of these ranges. Of the 698 home-ranges surveyed, 442 were occupied by a pair of birds. A further home-range was occupied in the years before and after the survey, and was probably occupied in 2003, but was not surveyed and has been omitted from this analysis. An additional 71 ranges were occupied by one or more individuals but without a pair or evidence of a nest being built up (eagles were recorded in a further four home-ranges, but these were believed to be breeding birds encroaching from neighbouring ranges). A number of home-ranges had become amalgamated, with one pair now occupying a much wider area, thought previously to have been occupied by two or more pairs. Conversely, a small number of home-ranges had been 'split' into separate ranges as new pairs had entered the area and successfully set up a breeding territory. The number of ranges surveyed and the number of ranges found to be occupied by pairs are shown in Table 1. Results are summarized using the 'Brown & Watson' geographical regions (Brown & Watson 1964, see Fig. 1) to allow comparison with the results of the two previous surveys.

Figure 2 illustrates the concentration of eagles in western Scotland, with notably high densities on Mull, southwest Highlands, Skye, parts of Wester Ross and the Outer Hebrides, most noticeably Lewis and north Harris, which had the highest densities of Golden Eagle recorded by the survey.

The age of both birds was recorded for 417 pairs (Table 1). Of these, 378 pairs (90.6%) consisted of two adults, 34 (8.2%) were mixed-age pairs and five (1.2%)

Table 1. Regional breakdown of occupied home-ranges and pair types.

Region	Number of ranges			Pair type				Total surveyed
	Occupied (by any birds)	Occupied (by pair)	Unoccupied (by any birds)	Adult	Mixed-age	Subadult	Unaged	
Eastern Highlands	39	31	51	15	0	0	16	90
Northern moors and flows	26	21	17	16	2	1	2	43
North-central Highlands	62	48	25	42	5	0	1	87
South-central Highlands	45	31	20	26	4	1	0	65
Northwest Highlands	55	45	17	38	4	0	3	72
West Highlands	87	77	11	69	8	0	0	98
Southwest uplands and north England	75	69	21	60	6	1	2	96
Hebridean islands	124	120	23	112	5	2	1	147
Total	513	442	185	378	34	5	25	698

were both subadult birds. The age of pairs was not reported for most ranges in Grampian (eastern Highlands). Totals of 833 adults and 151 subadults were recorded, with a further 54 birds unaged, giving a total of 1038 individuals. The proportion of subadult birds recorded (15.3%) may be subject to slight bias, as

birds viewed at distance might be more readily aged if they show signs of immaturity in the plumage, but in some areas, particular Grampian and Skye (Hebridean islands), there was an under-reporting of non-breeding birds. There was no significant difference between regions in the prevalence of subadult breeding (mixed and subadult pairs combined, $\chi^2 = 6.1$, $df = 7$, ns), but there was a significant variation between regions in subadults as a proportion of all birds seen (and aged)



Figure 1. Regions of Scotland and northern England used to summarize survey results, taken from Brown & Watson (1964). A, eastern Highlands; B, northern moors and flows; C, north-central Highlands; D, south-central Highlands; E, northwest Highlands; F, west Highlands; G, southwest uplands and north England; H, Hebridean islands.

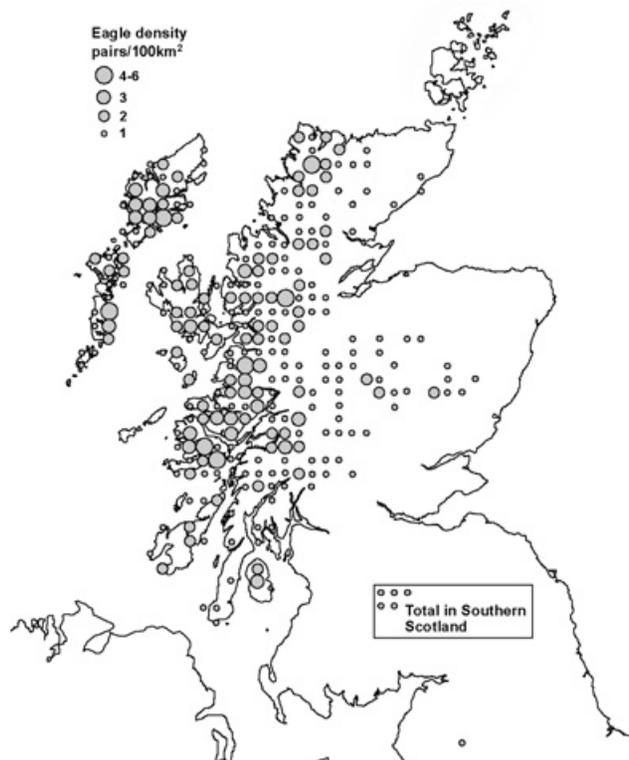


Figure 2. The distribution of pairs of Golden Eagles in 2003. The map shows densities of pairs by 10 × 10 km square. Locations in southern Scotland have been summarized.

($\chi^2 = 17.8$, $df = 7$, $P \leq 0.05$). The proportion of subadults (of all birds that were aged, not just paired individuals) varied from 29% in the south-central Highlands to 8% in the eastern Highlands but, as mentioned previously, this may be due, at least in part, to reporting bias.

Breeding performance

As is typical with large raptors, not all pairs of Golden Eagles attempted to breed in 2003. A total of 262 pairs were known to have laid eggs, and chicks were recorded subsequently in 171 nests. We have adopted the protocol used by Green (1996) in that young recorded in the nest a minimum of eight weeks after hatching are assumed to have fledged, and are referred to as fledged. A total of 145 pairs managed to raise young to fledging (or near-fledging); 160 juveniles were assumed to have fledged (0.36 fledged birds/pair, 1.10 fledged birds/successful nest). However, a further 12 chicks were taken from nests for translocation to Ireland (between one and four chicks were taken from all regions except the northern moors and flows). Given that of 22 eagle pairs that were known to have hatched two eggs without subsequent chick collection, 11 (50%) reared both chicks, it is possible to postulate that approximately half the birds removed would have survived to fledging; six more birds might have fledged in Scotland, hence total productivity may have been near 0.375 fledged birds/pair.

Productivity (fledged birds/pair) varied significantly between regions (Kruskall–Wallis, $\chi^2 = 18.1$, $df = 7$, $P \leq 0.05$), being greatest in the eastern Highlands and lowest in the north-central Highlands and west Highlands (Table 2).

Six mixed-age pairs and one subadult pair attempted to breed, of which two mixed-age pairs successfully

fledged young. Productivity of mixed pairs (0.06 fledged birds/pair) and subadult pairs (no birds fledged) was significantly lower than for adult pairs (0.42 fledged birds/pair) (Kruskall–Wallis, $\chi^2 = 15.4$, $df = 2$, $P \leq 0.01$).

Home-range features

Nest location was reported for 343 pairs of eagles, of which only 16 (4.7%) were nesting in trees; the rest were on cliffs or crags. Deer forest was reported as the predominant land-use within 6 km of 54% of active home-ranges, sheep farming for 35% and forestry and grouse moor for 5% each (although the latter was the dominant land-use in 46% of home-ranges in the east Highlands). However, land-use was not reported from more than half of all ranges, particularly for ranges unoccupied by pairs and those in the east of Scotland, hence the figures are likely to show some biases.

Comparison of 2003 survey results with previous surveys

The number of pairs recorded in 2003 was greater than that recorded by any previous survey. For comparison with the previous survey results, the levels of evidence used in the 1982–83 and 1992 analyses (Dennis *et al.* 1984, Green 1996) were used to assess the 2003 data to provide a comparable estimate of 434 pairs: an increase of 2.4% since 1982–83 and 2.8% since 1992 (Table 3). This second 2003 estimate excluded the eight ranges where pairs were present in 2003, but only a single bird was seen, hence they would have been categorized as not occupied by a pair using the 1982–83 and 1992 criteria. Given the greater survey effort in 2003, it is difficult to assess the exact change in numbers as the

Table 2. Breeding performance of Golden Eagle pairs in 2003 by region.

Region	Pairs occupying home-range	Pairs laying eggs (%)	Pairs hatching chicks (%)	Successful pairs (%)	Number of birds fledged	Productivity (fledged birds/pair)	Fledged birds per successful nest
Eastern Highlands	31	22 (71)	14 (45)	14 (45)	21	0.68	1.50
Northern moors and flows	21	9 (43)	6 (29)	6 (29)	6	0.29	1.00
North-central Highlands	48	26 (54)	17 (35)	10 (21)	10	0.21	1.00
South-central Highlands	31	23 (74)	14 (45)	13 (42)	15	0.48	1.15
Northwest Highlands	45	20 (44)	16 (36)	15 (33)	16	0.35	1.07
West Highlands	77	40 (52)	24 (31)	16 (21)	16	0.21	1.00
Southwest uplands and north England	69	44 (64)	30 (43)	26 (38)	28	0.41	1.08
Hebridean islands	120	78 (65)	50 (42)	45 (37)	48	0.40	1.07
Total	442	262 (59)	171 (39)	145 (33)	160	0.36	1.10

Table 3. Comparison of survey effort and number of eagle pairs recorded from 1982/83, 1992 and 2003 surveys.

Region	1982/83		1992		2003		Change (%)		
	Ranges checked	Pairs	Ranges checked	Pairs	Ranges checked	Pairs ^a	1982/83–1992	1992–2003 ^a	1982/93–2003 ^a
Eastern Highlands	57	30	51	36	90	29 (31)	+20	-19	-3
Northern moors and flows	42	22	40	16	43	20 (21)	-27	+25	-9
North-central Highlands	82	62	83	48	87	47 (48)	-23	-2	-24
South-central Highlands	59	43	58	36	65	31	-16	-17	-28
Northwest Highlands	68	47	73	45	72	43 (45)	-4	-4	-9
West Highlands	95	75	97	79	98	77	+5	-3	+3
Southwest uplands and north England	73	53	86	68	96	67 (69)	+28	-1	+26
Hebridean islands	122	92	122	94	147	120	+2	+28	+30
Total	598	424	610	422	698	434 (442)	-0.5	2.8	2.4

^aNumbers and change estimated using 1992 level of evidence (see Methods) for comparison with previous survey results; actual 2003 numbers are in parentheses.

slight increase may be due in part to increased coverage, but it seems safe to state that the number of occupied ranges has remained approximately stable since 1982. The greatest regional increase in numbers was in the Hebridean islands, particularly in the Uists: of 29 pairs found in the Uists, 12 were in home-ranges where breeding had not been recorded in either of the previous surveys (although six of these had not been surveyed in previous surveys), and two were in newly discovered home-ranges.

The status (whether occupied by a pair of eagles) of the 632 home-ranges checked in both 1992 and 2003 was compared between the two surveys. Seventy-two (11.4%) previously unoccupied ranges became occupied, whilst 67 (10.6%) that were occupied in 1992 were no longer occupied in 2003.

Productivity in 2003 (0.36 fledged birds/pair) lay between the values for 1982 (0.52) and 1992 (0.32). Data gathered from a sample of home-ranges from 1982–99 showed a mean productivity of 0.46 fledged birds/pair (Whitfield *et al.* 2004b), suggesting that 2003 was a poor breeding year, although it is not known how well the sample of ranges surveyed annually reflects productivity in Britain as a whole. Regional variation in productivity shows a similar pattern in all three surveys, with the eastern Highlands having consistently higher productivity in all three surveys, and the northern moors and flows, north-central Highlands and west Highlands having low productivity (Fig. 3). The regional variation in productivity in 2003 was correlated with that in both 1982 ($r_s = 0.75$, $P \leq 0.05$) and 1992 ($r_s = 0.74$, $P \leq 0.05$), suggesting that there is a consistent spatial pattern in productivity. Although there was an indication of a negative relationship

between regional productivity in 1992 and the population trend since then, this was not significant ($r_s = -0.40$, $P = 0.32$).

DISCUSSION

The 2003 Golden Eagle survey recorded more pairs of eagles occupying home-ranges than ever recorded previously: 442 pairs. A second estimate (of 434 pairs), directly comparable with those from the previous two surveys, indicates a 2.8% increase since 1992 and 2.4% since 1982–83. Allowing for the possible impact of greater survey coverage in 2003, this indicates that the population of Golden Eagles in Britain has at least remained stable between 1982–83 and 2003. However, this apparent stability continues to mask considerable change in the distribution of population between regions, as found previously by Green (1996). Most notably, this survey recorded a considerable increase in the Outer Hebrides, with very high densities of pairs on Lewis and Harris, and 12 pairs on the Uists not recorded in either of the earlier surveys, whereas decreases were recorded in the eastern and south-central Highlands.

Despite the stability of the British Golden Eagle population, there remain many apparently suitable areas unoccupied by eagles, particularly in the south and east of the current range, and there is little evidence of expansion into these areas. In addition, despite the highest regional productivity in Scotland (Table 2), there has been a decline in the eastern Highlands, where nearly two-thirds of known home-ranges are now unoccupied by pairs.

Several possible constraints on the eagle population

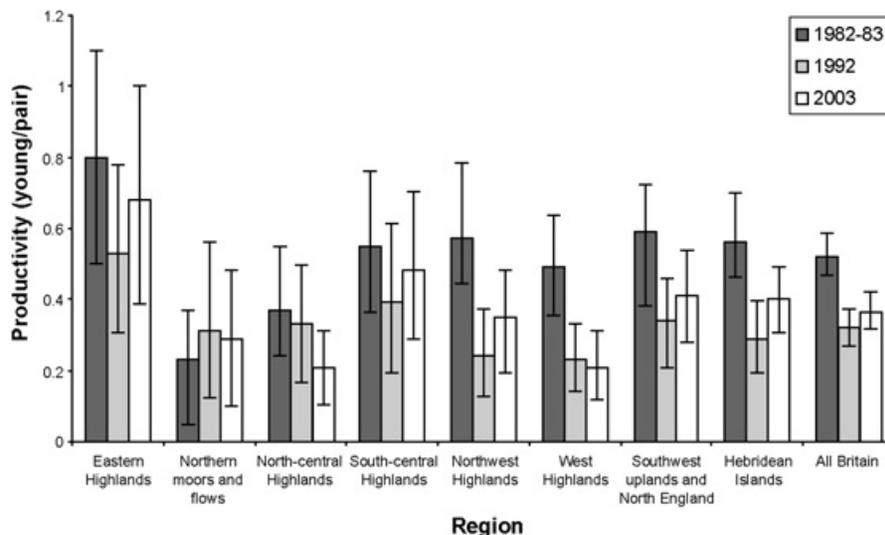


Figure 3. Eagle productivity in Brown & Watson (1964) regions in the 1982–83, 1992 and 2003 national surveys. Bars give 95% confidence limits.

have been identified and investigated by a number of authors. Large-scale afforestation, particularly in Galloway and Argyll, has probably caused the loss of breeding pairs from some home-ranges and the reduction in the breeding success of others (Marquiss *et al.* 1985, Watson 1992, Whitfield *et al.* 2001). However, such reduction in breeding success is unlikely to have caused a population level effect, and the rate of new tree planting has decreased markedly in recent years (RSPB 2002). Increased recreational use of upland areas, leading to disturbance, may adversely affect breeding performance of eagles, or lead to range abandonment (Watson 1997). Although this is unlikely to have a major impact across the whole of the eagle distributional range, there is an obvious potential for local effects (e.g. in popular hill-walking areas), though modelling failed to demonstrate it (Whitfield *et al.* 2007). Further analysis might prove useful, as recreational use of the Scottish uplands is likely to grow. Changes in carrion availability, through the greater control of deer numbers, reduction of sheep stock densities, and the increased removal of carcasses as part of estate management, could potentially affect eagle densities through an influence on both breeding productivity and winter survival (Watson *et al.* 1989, Pedrini & Sergio 2002). In addition, new developments in upland regions, such as wind-farms (Hunt 2002, Orloff & Flannery 1992), may have a future impact on the population.

Productivity of Golden Eagles is known to fluctuate between years, depending on the occurrence of

extreme weather conditions during the breeding season and the availability of food, particularly live prey such as Mountain Hares *Lepus timidus* and Red Grouse *Lagopus lagopus scoticus* (Watson 1997). Therefore, data from single years separated by intervals of over ten years are of limited use for investigating long-term trends in breeding success. However, productivity in both 1992 (0.32 young/pair) and 2003 (0.36 young/pair) was below the threshold (0.5 young/pair) identified by Watson & Whitfield (2002) as being desirable for the long-term maintenance of the population. Persecution can reduce productivity through interference at nest-sites. Watson & Dennis (1992) estimated that the number of birds fledged in the 1982 survey year was reduced by 18% due to deliberate disturbance at nests. However, all three national surveys have detected high productivity in the eastern Highlands, an area with apparently high levels of persecution (see below). This high productivity relative to other regions may indicate a higher availability of live prey, or it may demonstrate a density-dependent effect on eagle productivity (Watson 1997), as eagle density is low in the eastern Highlands.

Despite an emphasis on recording non-breeding birds in the 2003 survey, the proportion of all birds that were aged as subadults declined from 19% in 1992 to 15.3% in 2003. Conversely, the proportion of breeding pairs containing subadult birds increased from 7.4% in 1992 to 10% in 2003. The increased incidence of subadults in breeding pairs can be an indication of poor population health (Kenward *et al.* 2000), for example due to

persecution (Sandeman 1957, Newton 1979). Populations of large raptors in favourable condition usually have a large number of non-breeding adult 'floaters', i.e. individuals ready to recruit into the breeding population when the opportunity arises (Whitfield *et al.* 2004b). The presence of subadults in the breeding population (at increased levels) suggests that such a buffering pool of non-breeding adult birds is absent, or at least depleted, rendering the population susceptible to decline.

The decline in eagle numbers in the eastern Highlands, and the abundance of unoccupied home-ranges in that region, might suggest the principal source of mortality of Golden Eagles in Scotland. Whitfield *et al.* (2003) demonstrated a positive relationship between the incidence of raptor persecution in the uplands and management of moorland for Red Grouse shooting. The eastern distribution of grouse moor in Scotland is reflected in the absence of eagles from large areas of the eastern Highlands, and declines in the numbers that do remain. This decline, despite continued high productivity in the occupied ranges, points to relatively poor survival of subadults and/or adults, providing support for the conclusions of Whitfield *et al.* (2004a 2004b, 2007) on the role of persecution in threatening the Scottish eagle population, although the current study does not rule out other sources of mortality.

The reduction in non-breeding subadults in the population as a whole may be evidence of a 'black hole' effect of regions with high levels of persecution, where wandering subadults are attracted by suitable vacant habitat, only to be killed. Where operative, such a process can spread the impact of persecution by reducing subadult survival over a wide area (Whitfield *et al.* 2004a).

The fact that persecution can artificially suppress eagle numbers is possibly demonstrated by the increase in Golden Eagles in the Hebridean islands and the northern moors and fells. Persecution has declined in these regions in recent years (Whitfield *et al.* 2007) and this has been accompanied by a sharp increase in the number of Golden Eagle pairs. However, other factors, such as changes in ungulate carrion, have not been monitored and so cannot be ruled out.

In conclusion, numbers of occupied Golden Eagle ranges in Britain remain stable. However, this survey has provided evidence consistent with the notion that the current status is threatened by continuing illegal persecution associated with grouse moor management in eastern and southern Scotland. It is possible that

this killing could be preventing the expansion of the population back into areas of suitable habitat that were once occupied, including northern England. However, the potential for population-level impacts from unintentional disturbance and changes in land management also merit further research, as any such current (or future) impacts may be masked by the effects of persecution.

ACKNOWLEDGEMENTS

This survey was funded by the RSPB and SNH as part of the Statutory Conservation Agencies and RSPB Annual Breeding Birds Scheme (SCARABBS). The authors would like to thank the many individuals who helped with the development and organization of this survey, and the research assistants, other conservation professionals and the many SRSGs members who conducted an enormous amount of fieldwork and made this survey possible, including: D. Anderson, S. Benn, J. Bishop, A. Boulton, P. Boyer, J. Boyle, J. Brain, R. Broad, B. Brodie, D. Butterfield, D. Cameron, M. Carthy, J. Chester, G. Christie, R. Cooper, K. Crane, C. Crooke, R. Dennis, D. Dick, C. Donald, D. Dugan, D. Duncan, P. Duncan, B. Etheridge, G. Evans, I. Francis, C. Geddes, A. Gordon, K. Graham, R. Graham, J. Grant, M. Gregory, J. Halliday, S. Hardy, F. Harmer, M. Harvey, P. Haworth, I. Inglis, D. Jardine, K. Lawlor, B. Lowe, L. Lowe, A. Maciver, E. Macdonald, A. MacLennan, I. McPherson, P. Madden, D. Mainland, W. Mattingley, D. Miller, I. Miller, S. Morris, B. Neath, B. Neill, K. Nellist, K. Nelson, C. Park, S. Payne, M. Peacock, D. Pierce, D. Phillips, J. Plowman, B. Rabbitts, R. Rae, A. Ramsey, G. Rebecca, R. Reid, C. Rollie, D. Sargent, D. Shackleton, J. Simpson, L. Steele, A. Stevenson, E. Stuart, A. Summers, B. Swann, G. Tait, T. Talbot, M. Thornton, D. Walker, J. Watson, R. Watson, J. Webb, E. Williams, D. Whittaker, A. Wight, M. Wilson and R. Wood. A. Fielding, R. Gregory and J. Wilson provided valuable comments on an earlier draft. We would also like to thank M. Marquis and G. Sirawardena for their comments.

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(MS received 15 September 2005; revised MS accepted 15 September 2006)