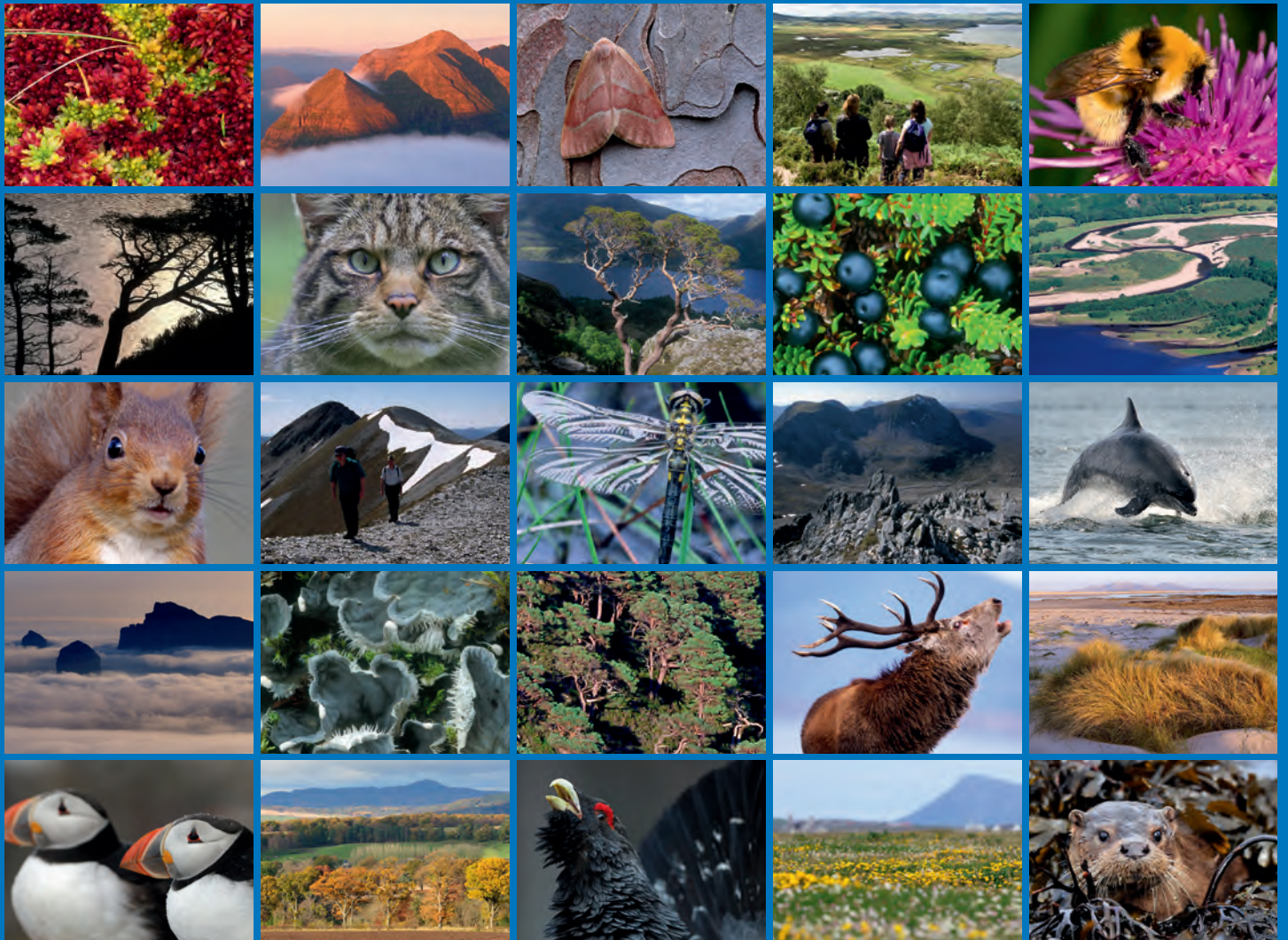


The Scottish gannet survey 2004





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COMMISSIONED REPORT

Commissioned Report No. 628

The Scottish gannet survey 2004

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COMMISSIONED REPORT

Summary

The Scottish gannet survey 2004

Commissioned Report No. 628

Project No: F04AC301

Contractor: Centre for Ecology and Hydrology

Year of publication: 2015

Keywords

Gannet; Site Condition Monitoring; SPA; Sula Sgeir.

Background

Scotland's Special Protection Areas (SPAs) support 80% of the British breeding population of northern gannets *Morus bassanus*. There are 15 'aggregations of breeding birds' features that are notified for gannet in Scotland, seven of which are on SSSIs and eight on SPAs.

Site condition monitoring is carried out on a six-year rolling programme. The gannet had low priority in Seabird 2000 and no counts were made of the three largest colonies, nor was Sula Sgeir, the site of the annual guga hunt, counted. This contract aimed to: assess numbers and conservation status, list any threats and establish survey protocols for gannet colonies on Bass Rock, Sule Skerry, Sule Stack, Sula Sgeir, Flannan Isles, St Kilda, Ailsa Craig and Scare Rocks. For Sula Sgeir, population effects of the annual cull were also assessed.

Main findings

- Aerial surveys were carried out in 2004 for all the colonies except Sule Skerry where a land count was made.
- Mean population estimates were: Bass Rock (48,065 Apparently Occupied Sites (AOS)), Sule Skerry (57 AOS), Sule Stack (4,618 AOS), Sula Sgeir (9,225 AOS), Flannan Isles (2,760 AOS), St Kilda (59,622 AOS), Ailsa Craig (27,130 AOS), and Scare Rocks (2,394 AOS).
- Over the last 10 years, the sustained increase in gannet numbers in Scotland has slowed, and in some cases been reversed.
- Scotland remains the stronghold of the northern gannet with 70% of the UK and Irish population and 44% of the world population. The St Kilda and Bass Rock SPAs together currently hold 59% of the Scottish population and just over a quarter of the world's gannets.
- The population on Sula Sgeir has increased at a much lower rate than any other UK.

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1. INTRODUCTION

1.1 Background and rationale

In the breeding season, Scotland's SPA suite for northern gannet *Morus bassanus* supports, on average, 80% of the British breeding population and about 62% of the international population. The national importance for gannet is well recognised in the UK SPA network (10 SPAs, eight in Scotland) with an ensuing responsibility to meet the required monitoring and reporting targets to the European Commission.

Site condition monitoring (SCM) is a six-year rolling programme of assessment of all notified features of interest on designated sites in the UK. Such areas include sites of special scientific interest (SSSIs), special protection areas (SPAs) and RAMSAR sites. There are 15 'aggregations of breeding birds' features that are notified for gannet in Scotland, seven of which are on SSSIs and eight on SPAs.

The time series of counts of gannet colonies goes back almost 100 years and is undoubtedly one of the best sets of counts of seabirds anywhere in the world. The last two full surveys were carried out in 1984/85 and 1994/95, the latter suggesting that Scotland had about 50% of the world's gannets, breeding in 13 colonies. Over 97% of the UK population nest in SPAs.

Since another survey was provisionally planned for 2004/5, the species was not given high priority in the Seabird 2000 survey programme. Numbers at some colonies were assessed but many were not, and there was therefore little contemporary data on breeding gannet numbers. In particular, no recent counts were available for the three largest Scottish colonies that made up 62% of the UK population at the time of the last survey: St Kilda (27% of UK population, 20% of the world population), the Bass Rock (19% UK), Ailsa Craig (16% UK). A current count was also required for Sula Sgeir (5% UK), since 2,000 chicks are killed here annually for human consumption.

1.2 Survey objectives

The primary aim of this study was to collect data on the number of pairs of breeding gannets at the following sites (further described in Section 1.3): Bass Rock, Sule Skerry, Sule Stack, Sula Sgeir, the Flannan Isles, St Kilda, Ailsa Craig and Scare Rocks. More specifically, the objectives were:

1. Primarily to meet SNH's obligations of 'site condition monitoring' for breeding aggregations of gannets and to collect data on the number of pairs of breeding gannets at all the sites listed.
2. To determine the conservation status of the gannet at each site as per the current SSSI and SPA guidelines and to report on the population status of the gannets at each site and for Scotland as a whole.
3. To assess the effect of the annual cull of gannets on Sula Sgeir in the context of the national population.
4. To determine which activities, if any, are impacting on the study sites.
5. To establish a survey protocol that is repeatable on a six yearly cycle.

It was also expected that the findings of this study would contribute to the UK national survey of gannets and add to the wider international estimate. Counts in 2004 were also planned for most other colonies within the species range including Ireland, the Channel Islands, Norway, France, Germany, France and Canada.

1.3 Location, description and conservation status of sites

Figure 1 shows the locations of the Scottish colonies surveyed for this contract in 2004.

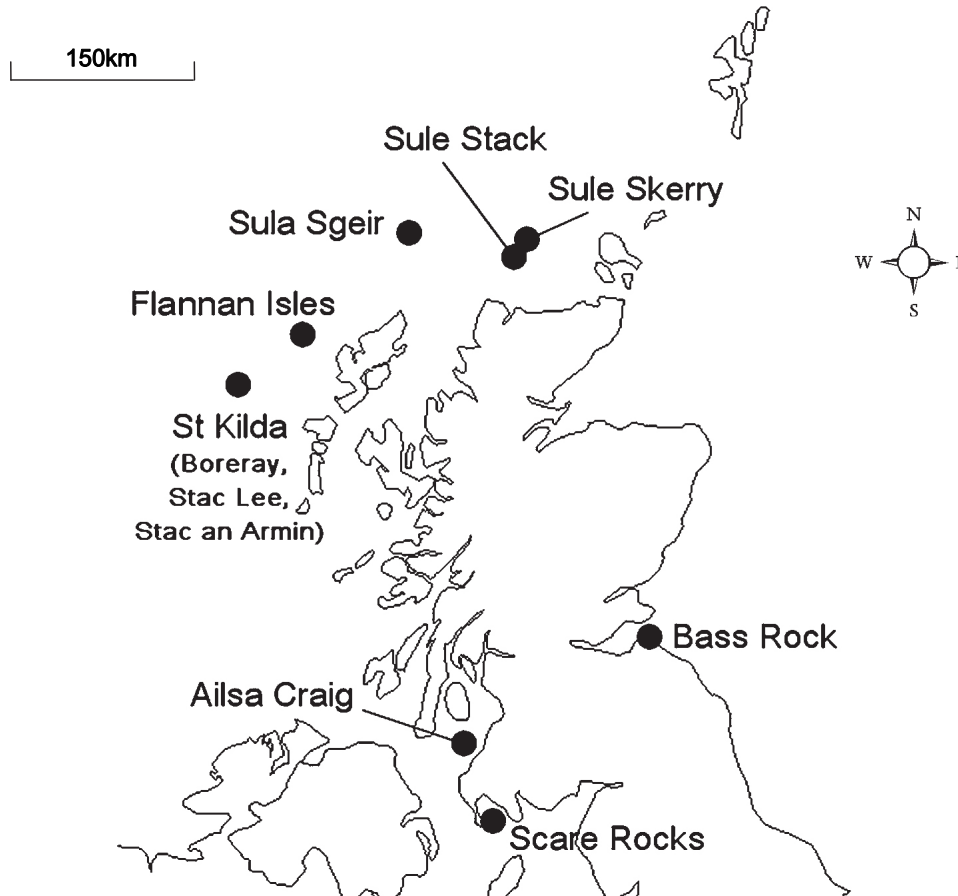


Figure 1. Locations of the eight Scottish gannetries surveyed in 2004.

1.3.1 Bass Rock

Location: 56°05'N 02°36'W, NT602873, 3km offshore from East Lothian, in the Firth of Forth.
Colony establishment: Prior to 1597 (Fisher & Vevers, 1943).
Conservation status: SSSI / SPA.

Successful aerial surveys were made on 1 and 11 June 1985, and on 11 July 1994 (Murray & Wanless, 1986; 1997). The colony was sub-divided into distinct count sections in 1985 (Figure 2) and these have since remained unaltered. Two further count sections were added in 2004, to accommodate colony expansion. Since 1994, birds have started to nest in a previously unused coastal area (now Section 11) and have spread over the summit, down to the ruined garden walls (now Section 12; Figure 2). Although most of the birds in Section 12 are non-breeders, pockets of nesting occur throughout the section, with particularly high numbers adjacent to Sections 7 and 8.

Threats: Disturbance caused by visitors, resulting in loss of eggs and small young to gulls.

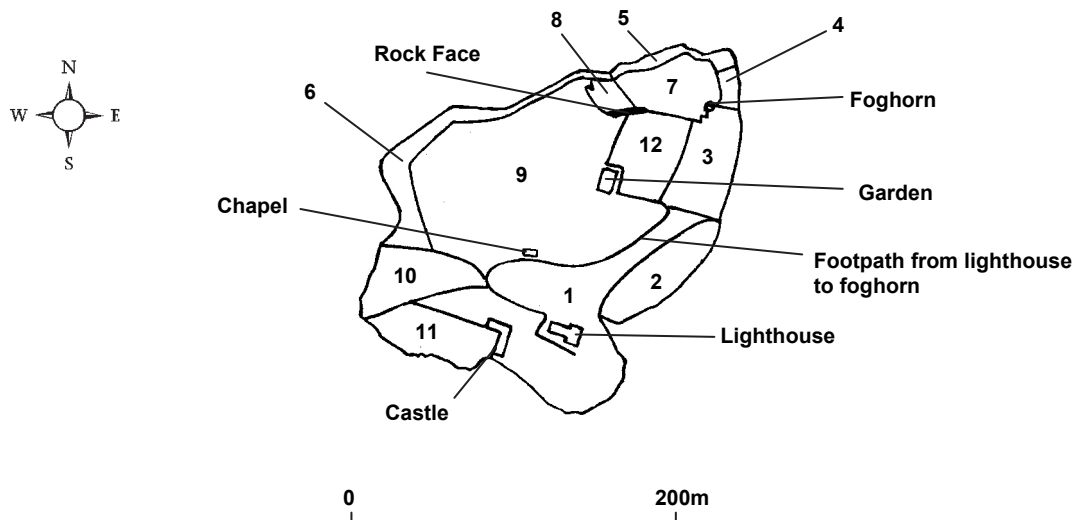


Figure 2. The main features of the Bass Rock, and the boundaries of count sections.

1.3.2 Sule Skerry

Location: 59°05'N 04°24'W, HX621244, 60km west of the Orkney Islands.
Colony establishment: 2003 (Budworth & Blackburn, 2004).
Conservation status: SPA.

Between 1992 and 2001, gannets were periodically recorded ashore on the west side of Sule Skerry (Sule Skerry Ringing Group, pers.comm.). In 2002, gannets were seen 'loafing' in the Stack Geo area and on 13 July 2003 15 pairs had nests with either eggs or chicks among nesting guillemots (Budworth & Blackburn, 2004).

Threats: None obvious.

1.3.3 Sule Stack

Location: 59°02'N 04°30'W, HX565177, 64km west of the Orkney Islands.
Colony establishment: Prior to 1710 (Fisher & Vevers, 1943).
Conservation status: SPA / SSSI.

The first successful aerial survey was made in 1969 for Operation Seafarer (Cramp *et al.*, 1974). The survey on 15 July 1985 was too distant from the rock, and almost certainly overestimated population size (Wanless, 1987). Subsequent surveys have been closer and, on 15 July 1994, the colony was sub-divided into eight distinct sections (Figure 3). These sections were also used in 2004.

Threats: None obvious.

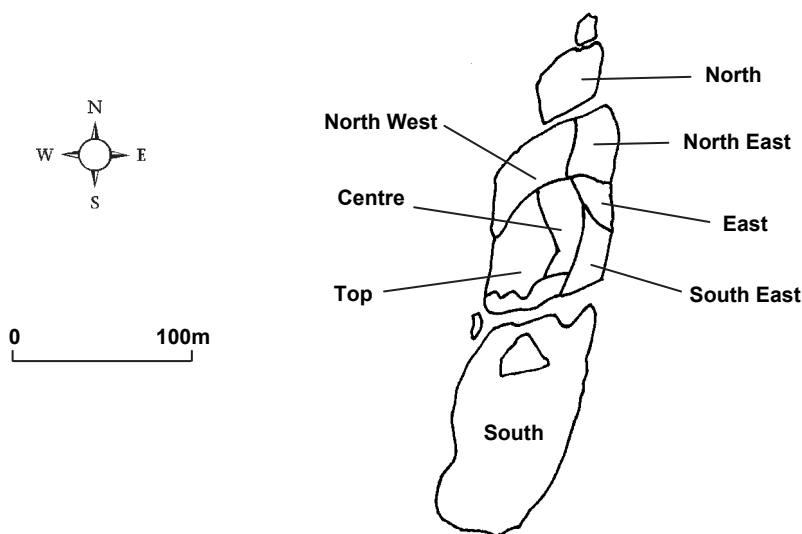


Figure 3. The positions and boundaries of count sections on Sule Stack.

1.3.4 Sula Sgeir

Location: 59°06'N 06°09'W, HW620305, 64km north of Lewis in the Western Isles.
Colony establishment: Prior to 1549 (Fisher & Vevers, 1943).
Conservation status: SSSI / SPA.

The first close aerial photographs were taken on 30 July 1947 but no counts could be made from them (Atkinson 1949). On 8 July 1969, the RAF successfully flew a survey as part of Operation Seafarer (Cramp *et al.*, 1974). Photographs of the rock, with gannets present, were taken in 1980 prior to the construction of a small lighthouse. No counts could be made from these, but small increases in colony extent compared with 1969 were noted in one area (Wanless, 1987). On 15 July 1985, 100% aerial coverage of the colony was achieved and the island sub-divided into seven count sections (Figure 4). These were subsequently used in the surveys of 15 July 1994 and 26 May 2004.

Threats: Sula Sgeir is the only colony in Britain or Ireland at which young gannets are killed for human consumption. The hunt is carried out annually by the men of Ness, from the parish of Barvas in Lewis, and was first described in 1549 (Munro, 1774). The Protection of

Birds Act 1954 gave the gannet complete protection in Britain, but the Gannets on Sula Sgeir Order 1955, allowed the Ness men to continue the hunt. The Wildlife and Countryside Act 1981 requires the licensing of the hunters, the taking only of birds of the year and a quota of 2,000, set by the Scottish Executive, with advice from Scottish Natural Heritage. There is, however, no independent check on the numbers killed or disturbance caused. For discussion of the possible effects of the hunt on the colony, see Nelson (1978) and Wanless & Harris (2004), and for discussion of other forms of visitor disturbance see Benn *et al.* (1989).

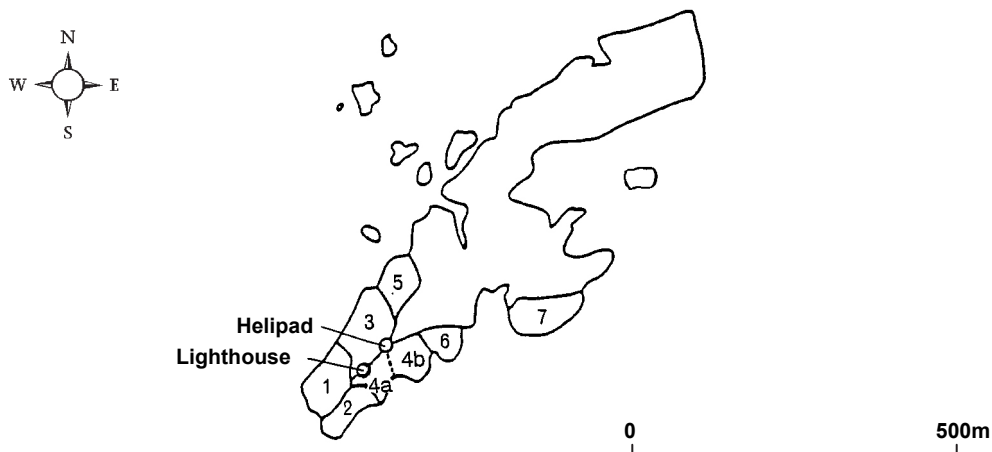


Figure 4. The positions and boundaries of count sections on Sula Sgeir.

1.3.5 Flannan Isles

Location: 58°18'N 07°36'W, NA690465, 27km west of Lewis in the Western Isles.
 Colony establishment: Found 1969 (Cramp *et al.*, 1974).
 Conservation status: SSSI / SPA.

The Flannan Isles consist of a widely spread group of seven small islands, rock stacks and skerries. Gannets breed on Roareim and its adjacent rocks. The colony was first recorded in 1969 during Operation Seafarer, when there were 16 nests (Cramp *et al.*, 1974). A flight in 1977 found an estimated 20 pairs (Hopkins, in Nelson, 1978). The first aerial survey was undertaken on 15 July 1994 and five distinct sub-colonies were defined (Figure 5; Murray & Wanless, 1997). These sections were also used in 2004.

Threats: Illegal killing of young. There have been unsubstantiated rumours that the colony was raided at least once in the late 1990s and young gannets taken for human consumption.

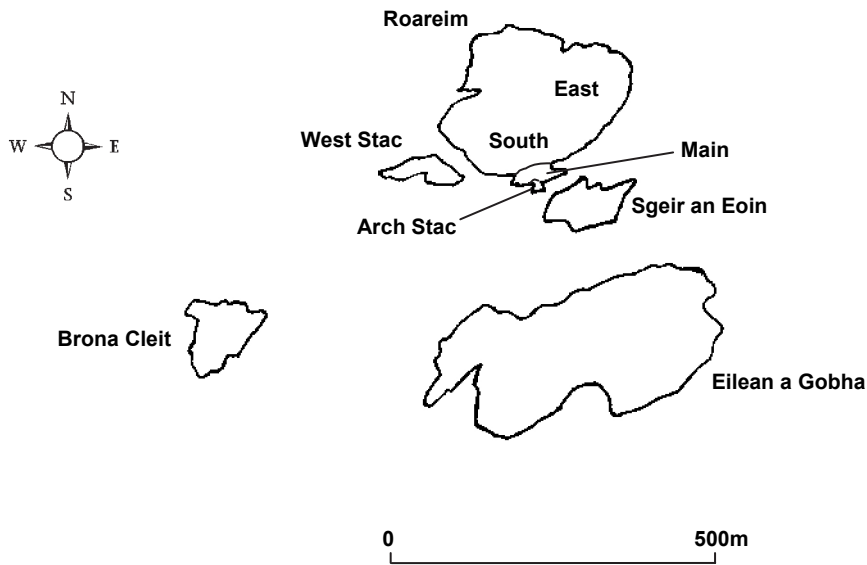


Figure 5. The positions of count sections on Roareim, Flannan Isles.

1.3.6 St Kilda (Boreray, Stac Lee and Stac an Armin)

Location: 57°53'N 08°30'W, NA155050, 66km west of North Uist in the Western Isles.
 Colony establishment: Prior to 1549 (Fisher & Vevers, 1943).
 Conservation status: SSSI / SPA. World Heritage Site.

The St Kilda archipelago consists of four islands and a number of smaller rock stacks. Gannets breed on Boreray, Stac Lee and Stac an Armin (Figure 6). Aerial photographs were taken by the RAF on 31 August 1941 and 30 April 1942. Coverage was incomplete but allowed Fisher & Vevers (1943) to make some population estimates. Fisher (1948) photographed the stacks from the air on 30 July 1947 and also made some estimates. The first comprehensive aerial survey was based on photographs taken by the RAF on 13 May 1959, following J.M. Boyd's brief. Using these photographs, Boyd (1961) sub-divided Boreray (Figure 7) and the stacks into 116 sections, but the lack of defined boundaries makes some of these sections difficult to identify. Consequently, the sections on Boreray have been amalgamated to 26 (Table 7), while on Stac Lee and Stac an Armin, Boyd's numbered system has been dropped and the sections redrawn and renamed (Murray & Wanless, 1986; see image files for Stac Lee and Stac an Armin). The aerial surveys in 1969 (Dixon, 1973) and 1985 (Murray & Wanless, 1986) were only partially successful, although 100% coverage was obtained for both Stac Lee and Stac an Armin in 1985. The survey on 15 May 1994 obtained 100% coverage of both stacks and 98% coverage of Boreray (Murray & Wanless, 1997).

Threats: Rock climbing. The National Trust for Scotland (NTS) owns and administers the islands. Recently, they have come under sustained pressure from the Scottish Mountaineering Council (www.mountaineering-scotland.org.uk) to allow rock climbing on the islands, in particular to allow access to both Stac Lee and Stac an Armin in summer. The web-site argues that the stacks are so big that it must be possible for NTS to designate a bird-free route to the summits of both. This is not possible. The access routes on Stac Lee are narrow and dense with breeding gannets, and the slopes of Stac an Armin are equally packed with both northern fulmar *Fulmarus glacialis* and gannet nests. The web-site wrongly argues that the stacks are bird-free after July whereas, in fact, nestling gannets are

at their most vulnerable in late July to mid-September. On Stac Lee in particular, late summer disturbance would cause massive loss of young from the ledges.

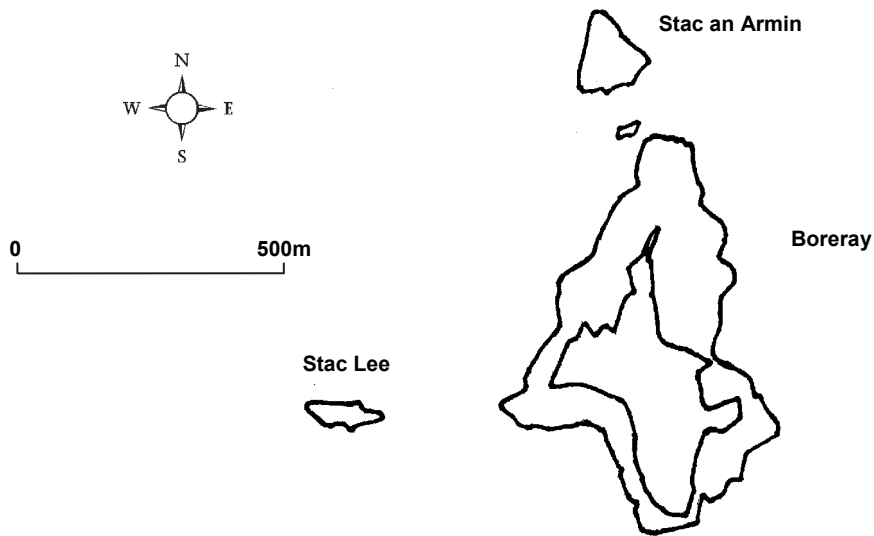
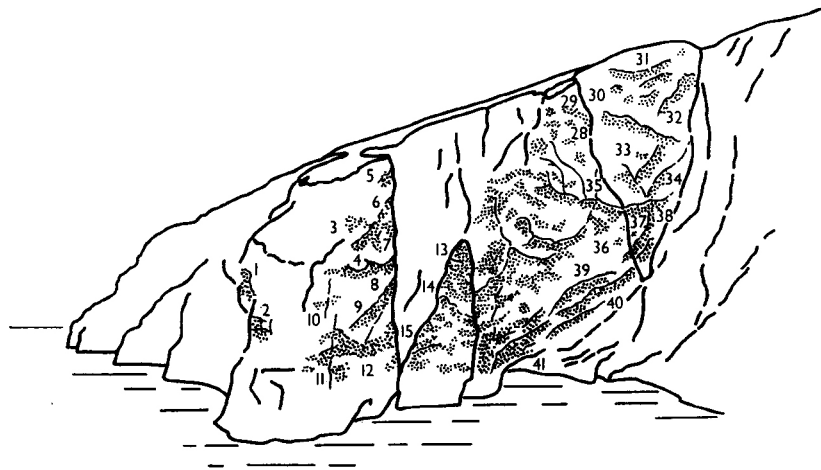
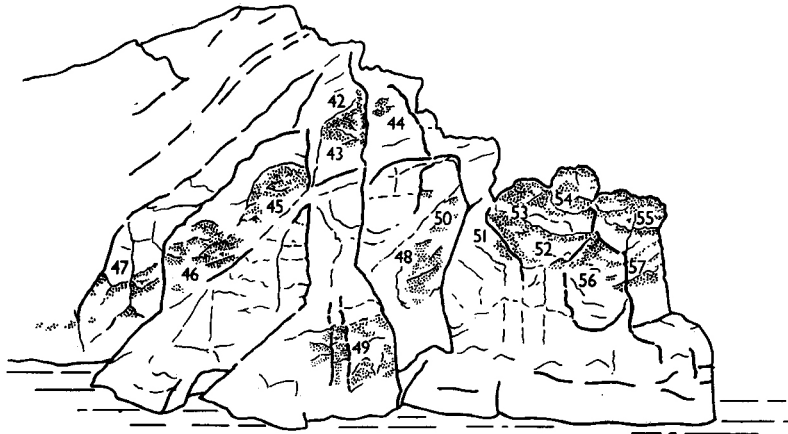


Figure 6. The positions of the St Kilda sub-colonies.

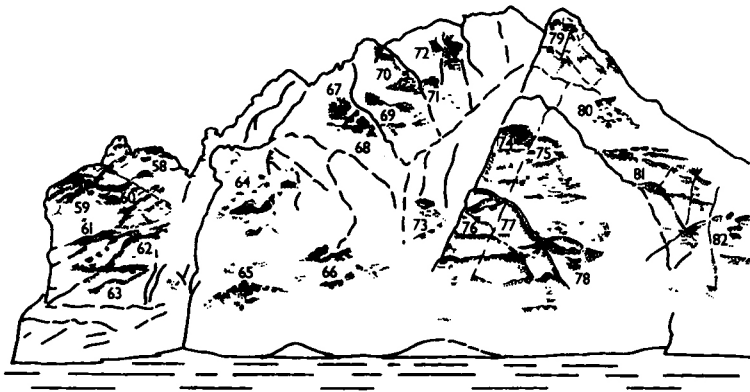
a) Count sections 1-41, on the east side of Boreray (Boyd 1961).



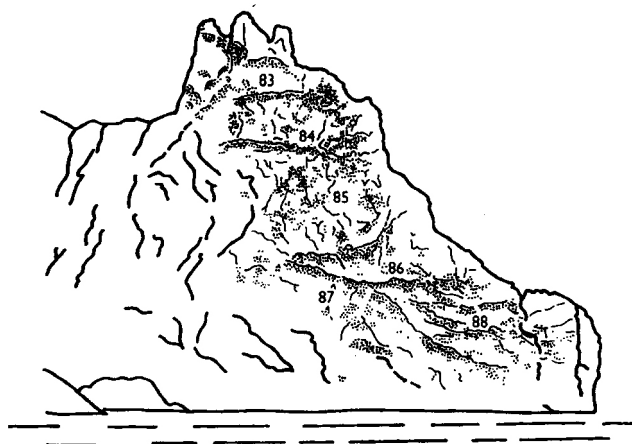
b) Count sections 42-57, on the east side of Boreray (Boyd 1961).



c) Count sections 58-82, on the west side of Boreray (Boyd 1961).



d) Count sections 83-88, on the west side of Boreray (Boyd 1961).



e) Count section 89, on the south side of Boreray (Boyd 1961).



Figure 7. The positions of count sections on Boreray.

1.3.7 Ailsa Craig

Location: 55°15'N 05°08'W, NX020995, in the entrance to the Firth of Clyde, 16km west of the Ayrshire coast.
Colony establishment: Prior to 1526 (Fisher & Vevers, 1943).
Conservation status: SSSI / SPA.

The first aerial photographs were taken on 24 August 1941, but apparently were not the basis for the colony count made earlier that year (Fisher & Vevers, 1943). The first complete aerial survey was carried out on 5 August 1995 (Murray & Wanless, 1997). For that count the colony was divided into 19 sections based on 23 sections originally used by Gibson (1951) and Wanless (1979). Some sections were amalgamated because increases in adjacent sections made it difficult to distinguish the original boundaries, or because of differences in viewing angle between the previous sea-based censuses and the aerial survey (Figure 8). The sections were further reduced to 18 in 2004, for similar reasons.

Threats: Recommencement of quarrying in 2002 and associated disturbance and risk of re-introduction of rats. Low-flying aircraft, particularly helicopters, operating out of Turnberry and Prestwick on sightseeing tours around the island.

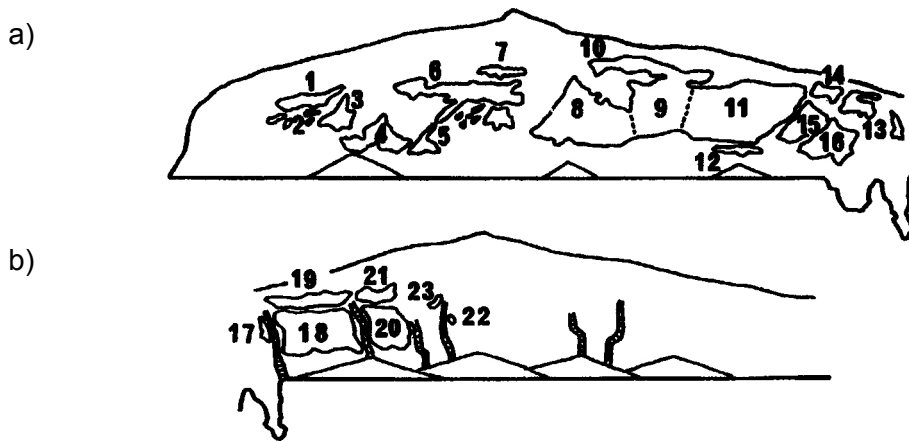


Figure 8. The positions of count sections on Ailsa Craig, viewed from the west
 a) The positions of count sections 1-16 b) the positions of count sections 17-23.

1.3.8 Scare Rocks

Location: 54°42'N 04°40'W, NX260340, in Luce Bay, on the north side of the Solway Firth.
 Colony establishment: 1939 (Fisher & Vevers, 1943).
 Conservation status: SSSI.

Gannets breed on the main rock and an adjacent rock stack. For counting, the colony is sub-divided into four sections (Figure 9). The first aerial survey was carried out on 5 August 1995 (Murray & Wanless, 1997).

Threats: Potential for disturbance from unauthorised visitors.

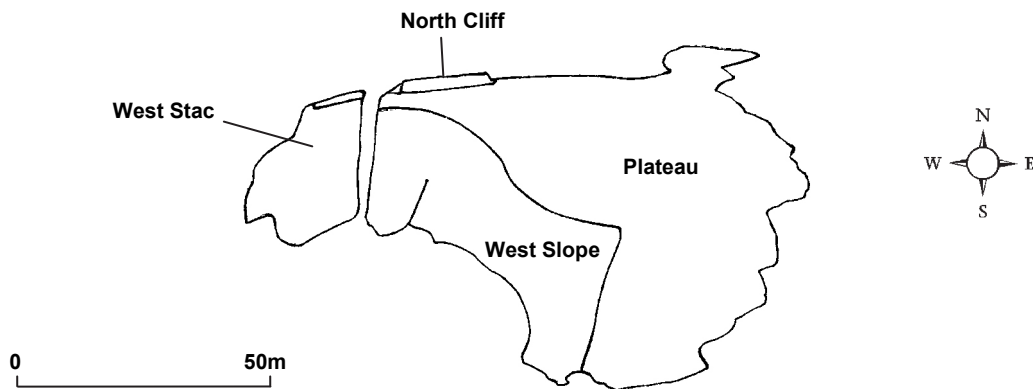


Figure 9. The positions and boundaries of count sections on Scare Rocks.

2. METHODS

For further methodological details see Walsh *et al.* (1995) and Gilbert *et al.* (1998).

2.1 Collection of aerial photographic images

An aerial survey of Scottish gannet colonies requires extensive preparation and planning by a full-time co-ordinator with experience of the survey methodology and first hand knowledge of all the colonies, a slow, twin-engine aircraft and an experienced and skilful pilot. Also required is a team of backup photographers available at a few hours notice, preferably with experience of aerial survey and with a reasonable tolerance of air-sickness. Three photographers, including the co-ordinator, are the recommended minimum required to cover the colonies surveyed for this contract, and are absolutely essential for St Kilda.

The ideal time to conduct a survey is between mid-May and mid-June. However, there are formidable logistic problems in achieving this. Constraints include weather conditions, prior aircraft charter commitments and military activity, the latter being a particular problem for St Kilda, which is in the centre of a rocket testing range. Scare Rocks and Sule Stack are also at the edge of military firing ranges. All three ranges were active in 2004, although only at St Kilda was access difficult to arrange.

The main determinant of the success or failure of a survey flight is the weather. Local weather around inshore colonies such as Ailsa Craig, Bass Rock and Scare Rocks can be assessed before take off by contacting local harbour masters. For the more distant colonies however, local weather conditions can only reliably be assessed for St Kilda, which has a resident population and summer warden. Aerial surveys obviously require good visibility, but wind speeds below 10-12 knots are also important, as turbulence quickly becomes a hazard over and near islands when flying at the survey height of around 350m. For the higher islands of St Kilda and Ailsa Craig, cloud ceilings need to be at least 800m, twice the height of the islands. Because of their height, these colonies can often be cloud capped when the surrounding area is in sunshine. It is therefore imperative to be certain of weather conditions around a colony before a flight, and prudent to postpone it if there is any doubt.

It is preferable for surveyors to use their own cameras, or simple models they can quickly familiarise themselves with, to photograph the colonies. Each photographer should have access to two loaded cameras when surveying begins, and an excess of spare K64 colour slide film. The cameras used in 2004 were all 35mm reflex cameras with a standard (50 mm) lens. Telephoto or zoom lenses are not recommended.

The co-ordinator should always sit next to, and be in headset contact with, the pilot. As well as taking photographs, the co-ordinator must decide when coverage of the colony is complete.

In general, nesting gannets are unaffected by aircraft whereas non-breeders and club birds will fly off. A survey should not commence until these birds have left. Gannets rarely fly higher than the summit of the colony, and at the approach of an aircraft those that leave the colony do so by flying low over the water or settling on it. The one notable exception is the Bass Rock where non-breeders remain on the ground. These birds may be so accustomed to military aircraft flying low and close to the colony that they no longer react to the presence of aircraft. This was first noted in 1994 and birds behaved similarly in 2004.

Safety considerations mean that only twin-engine aircraft can be used for flights over the sea. The aircraft used in all previous surveys, and in 2004, was an eight-seater Islander. Its main advantage is its ability to fly slowly, at speeds down to 70 knots, while accommodating up to four photographers in the rear seats. This ensures that colonies are photographed

several times and from different angles with each circuit of the aircraft. Thus, maximum photographic coverage of the colony is obtained in the minimum time, thereby reducing disturbance to the colony.

On approach to any colony the method of operation is similar. The landing lights are switched on to make the aircraft as obvious as possible, and the colony is circled at an altitude of about 1000m. This allows the pilot to become familiar with the area and to ensure that club birds disperse. With the co-ordinator and photographers on the right hand side of the aircraft, the approach is made clockwise, spiralling down in tightening circles until a suitable survey height has been reached. These methods, or a variant of them, can be applied at all colonies, with the exception of Boreray (St Kilda). The gannets here nest from sea level to the summit of the island at close to 400m, on the south, east and west coasts. The rock architecture is a complex mosaic of spires, buttresses and overhanging rock walls that require survey runs to be made parallel to the cliffs at different altitudes. Due to its height, the island is prone to turbulence in even light winds, and a close approach can be difficult. Pilots or co-ordinators of any future survey should gain experience of other colonies before attempting Boreray.

A detailed breakdown of the survey flights flown in 2004 is given in Table 1. The pilot in all cases was George Cormack of Hebridean Air Services, based at Cumbernauld Airport, the aircraft was a twin engine, eight seater Brittain Norman Islander and the co-ordinator was Stuart Murray.

Table 1. Details of survey flights of gannetries in 2004.

Date	Photographers	Airport / Colony	Landed / Arrived ^a	Departed ^a
26 May 2004	Matt Parsons (JNCC) Stuart Benn (RSPB) Jill Harden (NTS)	Inverness		11 :30
		Sule Stack	12:20	12:34
		Sula Sgeir	13 :05	13 :15
		Flannan Isles	13 :51	14 :01
		Stornoway	14:27	15:47
		Inverness	16:50	
6 June 2004	Stuart Benn (RSPB) Tony Mainwood	Cumbernauld		12:15
		Ailsa Craig	12:54	13:11
		Scare Rocks	13:33	13:41
		Cumbernauld	14:31	
21 June 2004	Stuart Benn (RSPB) Tony Mainwood	Cumbernauld		10:05
		St Kilda	11:52	12:19
		Benbecula	12:41	13:28
		Bass Rock	14:59	15:15
		Cumbernauld	15:43	

^a All times are in BST.

2.2 Counting from projected slides

The 2004 survey was carried out using similar methods to those adopted in 1984/85 and 1994/95 (Murray & Wanless, 1986; 1997), with colonies counted from aerial photographs. Using the methodology described above, each colony was photographed several times and from several angles to ensure complete coverage. The resulting colour transparencies were used to form a mosaic of the colony (to prevent missing areas or double counting). In general, the same count section boundaries were employed as in the last two censuses, although some changes were made (for details see Section 1.3). The only practical counting unit is the apparently occupied site (AOS), a site occupied by one or two gannets, irrespective of whether nest material is present. Slides were projected onto a suitable surface and AOSs marked off as they were counted. Sites clearly occupied by non-breeders were excluded wherever possible. Counts were made by one or two observers. Observer 1 (Stuart Murray) did two or three counts for each section of each colony. Observer 2 (Sharon Evans) counted all of Ailsa Craig and Sula Sgeir, and sub-samples of the other colonies.

2.3 Land-based visits and counts

Land visits were made to Sule Skerry, the Bass Rock and Boreray to take photographs, to confirm the extent of non-breeding, and to make supplementary land-based counts respectively. Relevant colony-specific results are presented in the appropriate sections of the report. In all cases, land visits were conducted in such a way as to minimise any disturbance to breeding birds.

2.4 Calculating intra- and inter-observer error

Intra- and inter-observer error (%) was calculated as:

$$\frac{\text{mean difference between the counts (usually two, occasionally three)} \times 100}{\text{mean count}}$$

2.5 Calculating rates of change

Average rates of change for each colony were calculated using the following equation:

$$P_2 / P_1 = (1 + r)^t$$

where r is the rate of population change, P_1 is the nest or site count in the earlier survey, P_2 is the nest or site count in the later survey and t is the number of years between the two counts. Counts of Scottish gannetries made up to 1995 are summarised in Fisher & Vevers (1943, 1944), Nelson (1978) and Murray & Wanless (1986, 1997). Where possible, counts for a colony are presented in terms of its constituent sections to facilitate future calculations of population changes.

2.6 Calculating Scottish, UK and international totals

The count unit does not provide an estimate of the number of breeding pairs, nor is it strictly correct to equate occupied sites with pairs, as some sites may be held by a single bird for at least a year (Nelson 1978). As recognised in previous censuses, the unavoidable lack of standardisation in count units across colonies makes it difficult to calculate an overall total for Scotland in terms of a common unit. Our estimate of the Scottish population, and the northeast Atlantic total, is therefore a combination of totals of apparently occupied sites at the majority of colonies and a few counts of nests. No correction factors were applied to either unit and, for convenience the overall total is expressed in terms of apparently occupied sites (AOS).

3. RESULTS

3.1 Photographic images

The slides used for determining the position of count sections and for making counts are supplied with this report. Each is labelled as follows: Colony Name_x_y_04, where x is the individual slide number and y is the total number of slides for that colony. A digital copy (jpeg file) of each slide, showing count section boundaries, is contained on the CD ROM called 'Image Files', and named in the same way. On the same CD ROM, an excel spreadsheet, called 'The Slide Directory' describes what is shown on each slide and whether it was used for a count. Clicking on the icon in the 'Image File Name' column of this spreadsheet will link through to the relevant image.

3.2 Counts of Apparently Occupied Sites (AOS)

Table 2 summarises the results of total AOS counts for each colony in 1984/85, 1994/95 and 2004. Colony-specific, section-by-section breakdowns of the 2004 counts are given in subsequent sections and tables. The spreadsheets called 'Counts of AOSs 2004' and 'Trends', on the CD ROM entitled 'Raw Data', contain the data used to create these tables. In the former file, there is a column detailing the names of the slides used to count each section. In the tables, repeat counts made by Observer 1 are labelled as Obs 1.1, Obs 1.2 and so on, while counts by Observer 2 are labelled as Obs 2.

Table 2. The numbers of pairs of breeding gannets (AOS) at each colony in 1984/85, 1994/95 and 2004, with overall percentage changes and per annum (pa) percentage changes.

Colony	1984/85	1994/95	2004	% Change			
				1985-94	1994-2004	pa 1985-94	pa 1994-04
Bass Rock	21,559	39,751	48,065	84.4	20.9	6.3	1.9
Sule Skerry	0	0	57				
Sule Stack	5,880 ¹	4,888	4,618	-16.9 ¹	-5.5	-1.8 ¹	-0.6
Sula Sgeir	9,143	10,440	9,225	14.2	-11.6	1.3	-1.2
Flannan Isles	223	1438	2760	544.8	91.9	23.0	6.7
Boreray	24,676	32,818	32,333	33.0	-1.5	2.9	-0.1
Stac Lee	13,521	14,660	13,369	8.4	-8.8	0.8	-0.9
Stac an Armin	11,853	12,950	13,920	9.3	7.5	0.9	0.7
St Kilda Total	50,050	60,428	59,622	20.7	-1.3	1.9	-0.1
Ailsa Craig	21,997	32,456	27,130	47.6	-16.4	3.6	-2.0
Scare Rocks	770	1,952	2,394	153.5	22.6	8.8	2.3

Footnote: ¹ Sule Stack count in 1985 overestimated colony size, therefore values for decadal decrease also overestimates (see Section 1.3.3)

3.2.1 Bass Rock

Colony status: Increasing.

The survey was made on 21 June 2004 and achieved 100% photographic coverage. The quality of all the images was excellent. The mean count total was 48,065 AOS (Table 3), representing an overall increase of 20.9% since 1994, at an average rate of 1.9% pa (Table 2). The colony has more than doubled in size since 1985.

Comparison with the 1994 aerial photographs clearly shows large increases in colony extent, the most obvious being in Section 9. Here, breeding birds have become established up to the summit of the rock, although the extent of the expansion is complicated by the large numbers of non-breeding and club birds around the section edge. The reluctance of these non-breeders to leave the colony at the approach of an aircraft meant that a land visit had to be made on 17 July 2004, to define the limits of breeding in this section and in Section 12. This latter newly defined section holds the majority of non-breeders, and also c.1000 AOS, where the colony has spread upslope from the adjacent Sections 7 and 8.

Birds have colonised Section 11 since 1994 and both this section and Section 12 have space for future increases. Sections 1, 3, 7, and 10 also show increases in colony extent. Section 8 has no room for the colony to expand, and appeared to be full in 1995. Numbers in cliff-side Sections 2, 5 and 6 appeared to have declined compared with both 1994 and 1985, though the reason for this is unclear.

Table 3. Counts (AOS) for Bass Rock in 2004.

Count Section	Counts (AOS)			
	Obs 1.1	Obs 1.2	Obs 2	Mean
1	4,168	4,006		4,087
2	235	244		240
3	7,390	7,061		7226
4	341	357		349
5	427	456		442
6	1,023	1,108		1,066
7	7,972	8,216	8288	8,191
8	3,683	3,376		3530
9	18,700	19,010		18,855
10	2,840	2,560	3149	2,925
11	157	156		157
12	1,000	1,000		1,000
Total	47,936	47,550		48,065

3.2.2 *Sule Skerry*

Colony status: Establishing.

To prevent any possible disturbance to this newly established colony, no overflight was made. A count by D. Budworth on 8 July 2004 gave c.40 occupied nests, at least 10 of which had chicks. Counts by S. Murray, S. Wanless and M.P. Harris, from a photograph (print) taken on land that day by D. Budworth and A. Blackburn, all suggested 57 occupied sites. However, there were slight differences in the interpretation of the photograph, so the true total was probably 55-60 AOS.

3.2.3 *Sule Stack*

Colony status: Stable.

The survey was made on 26 May 2004 and achieved 100% photographic coverage. The quality of the images was excellent. The average count total was 4,618 AOS (Table 4), an overall decrease of 5.5% since 1994, at an average rate of 0.6% pa (Table 2).

Comparisons with the 1994 photographs found no changes in the largest sections, but a small increase in the number of AOSs was apparent on the South section. The apparent overall small decrease is within the limits of intra- and inter-observer difference and the population can be considered as stable.

Table 4. Counts (AOS) for Sule Stack in 2004.

Count Section	Counts (AOS)			
	Obs 1.1	Obs 1.2	Obs 2	Mean
South	115	128		121
Top	1,565	1,598		1,581
Centre	602	663		633
East	347	355		351
South East	578	560		569
North West	713	782		748
North	0	0		0
North East	563	578	660	615
Total	4,483	4,664		4,618

3.2.4 *Sula Sgeir*

Colony status: Decreasing.

The survey was made on 26 May 2004 and achieved 100% photographic coverage. The quality of the images was good to excellent. The average count total was 9,225 AOS (Table 5), a decline of 11.6% since 1994, at 1.2% pa (Table 2).

Comparison with the 1994 photographs, particularly those of the summit plateau and around the Heli-pad, revealed no changes in colony extent, either increases or decreases, nor any differences in the limits of sub-colony boundaries. However, birds appear to be nesting at relatively low densities throughout the colony, which may result in a shrinking of boundaries and make further decreases more apparent.

Table 5. Counts (AOS) for Sula Sgeir in 2004.

Count Section	Counts (AOS)				
	Obs 1.1	Obs 1.2	Obs 1.3	Obs 2	Mean
1	632	470	452	574	546
2	348	300	308	355	337
3	2,729	2,238	2,257	2,292	2,350
4a	1,975	1,736	1,679	2,092	1,944
4b	1,237	1,132	1,081	1,091	1,121
5	0	0	0	0	0

6	1,438	1,284	1,268	1,348	1,339
7	1,653	1,421	1,532	1,642	1,589
Heli-pad	0	0	0	0	0
Total	10,012	8,581	8,577	9,394	9,225

3.2.5 Flannan Isles

Colony status: Increasing.

The survey was made on the 26 May 2004 and achieved 100% photographic coverage. The quality of the images was excellent. The average total was 2,760 AOS (Table 6), an increase of 91.9% since 1994, at 6.7% pa (Table 2).

Comparison with the 1994 photographs clearly showed increases in five of the six colony sections, most notably on the South colony of Roareim, and the offshore islet Sgeir an Eoin. The exception was in the East section (Figure 5), which was a club site in 1994, and where breeding was suspected, but not confirmed. In 2004 the section appeared to be used entirely by non-breeders, which left the ground on the approach of the aircraft.

Table 6. Counts (AOS) for the Flannan Isles in 2004.

Count Section	Counts (AOS)				
	Obs 1.1	Obs 1.2	Obs 1.3	Obs 2	Mean
East	0	0	0		0
West Stac	49	56	49		51
Arch Stac	151	136	148		145
Sgeir an Eoin	612	578	586	657	625
Main	1,323	1,274	1,308		1,302
South	586	663	663		637
Total	2,721	2,707	2,754		2,760

3.2.6 St Kilda (Boreray, Stac Lee and Stac an Armin)

Colony status: Stable.

The aerial survey on 21 June 2004 gave total coverage of the stacks, but was less complete for Boreray, which also suffered from poorer quality photographs. The group total was 59,622 AOS (Table 7), a slight decrease of 1.3% since 1994, at 0.1% pa (Table 2). Overall no changes in nest densities were detected compared with 1994. There were, however, small increases in colony extent in Section 83 to 88 on Boreray, and on the East Face and South Centre sections of Stac an Armin. On Stac Lee, the empty ledges on North Face and Bothy Face remain uncolonised.

3.2.6.1 Boreray

Colony status: Stable.

The survey was made on 21 June 2004 and achieved 97.3% photographic coverage. The quality of the images varied from reasonable to good, with part of Section 3 to 12 of not very

high quality (see image Boreray_5_41_04). Here, 582 AOS were added to the section total, based on land counts made on 18 August 2003. Because of the complexity of the cliff structure, small areas in some sections are virtually impossible to photograph from the air. These have been identified from past land visits, and were counted from the land on 18 August 2003. The figures were included in the final section totals. These were: 80 AOS in Section 80 and 195 AOS in Section 81/82.

The combined air and land counts gave an average total of 32,333 AOS (Table 7), a trivial overall decrease of 1.5% since 1994, at 0.1% pa (Table 2). Comparison with the 1994 photographs failed to detect any changes in colony extent, except for a small increase on the upper east side of Section 83 to 88. Given the available information, as well as intra- and inter-observer variation, numbers on Boreray are probably stable.

3.2.6.2 Stac Lee

Colony status: Stable.

The survey was made on the 21 June 2004 and achieved 100% photographic coverage. The quality of the images varied from good, in the deep shadow of the North Face, to excellent in the sunlit sections of the South Face. The average total was 13,369 AOS (Table 7), a decrease of 8.8% since 1994, at 0.8% pa (Table 2).

Comparison with the 1994 photographs failed to find any obvious changes in the densely packed Top Table or on narrow ledges that comprise breeding sites on other areas of the stack. Areas unoccupied in 1994, that are apparently suitable breeding habitat, remain unoccupied and have not changed in extent. The apparent decrease is within the limits of intra- and inter-observer variation and suggests that numbers are stable.

3.2.6.3 Stac an Armin

Colony status: Increasing.

The survey was made on 21 June 2004 and achieved 100% photographic coverage. The quality of the images was good for the West Face and excellent for all other sections. An average total of 13,920 AOS was counted (Table 7), an increase of 7.5% since 1994, at 0.7% pa (Table 2). Comparison with the 1994 photographs clearly shows areas of increase, at the foot of the prominent centre gully of the South Summit/East Face colony and the lowest corner of South Centre colony. Increases in numbers in both these areas were first noted in 1994.

Table 7. Counts (AOS) for St Kilda in 2004.

Sub-colony	Count Section	Counts (AOS)			
		Obs 1.1	Obs 1.2	Obs 2	Mean
Boreray	1	26	33		30
Boreray	2	64	52		58
Boreray	3 to 12	1,912	1,530		1,721
Boreray	13 to 15	1,684	1,432		1,558
Boreray	16 to 41	5,215	5,796		5,506
Boreray	42 to 43	1,486	1,333		1,410
Boreray	44	66	63		65
Boreray	45	582	543	624	593

Boreray	46	641	579		610
Boreray	47	678	690		684
Boreray	48	838	869		854
Boreray	49	1,085	1,002		1,044
Boreray	50	22	27		25
Boreray	51 to 57	4,098	3,872	4,509	4,247
Boreray	58 to 63	2,488	2,327		2,408
Boreray	64	507	504		506
Boreray	65	387	385		386
Boreray	66	482	418		450
Boreray	67 to 72	1,800	1,789		1,795
Boreray	73	324	319		322
Boreray	74 to 78	2,388	2,353		2,371
Boreray	79	514	569		542
Boreray	80	342	321		332
Boreray	81 to 82	1,541	1,632		1,587
Boreray	83 to 88	2,889	2,860		2,875
Boreray	89	334	390		362
Boreray	Total	32,393	31,688		32,333
Stac Lee	Top Table	7,208	6,938	7,421	7,247
Stac Lee	Bothy Face	1,277	1,268		1,273
Stac Lee	Casting Point	2,326	2,158		2,242
Stac Lee	North Face	2,730	2,484		2,607
Stac Lee	Total	13,541	12,848		13,369
Stac an Armin	South Summit / East Face	9,377	9,501	10,220	9,830
Stac an Armin	Lower East Face	1,384	1,487		1,436
Stac an Armin	West Face	1,187	1,123		1,155
Stac an Armin	South Centre	1,435	1,427		1,431
Stac an Armin	Lower South Ledge	68	70		69
Stac an Armin	Total	13,451	13,608		13,920
St Kilda	Total	59,385	58,144		59,622

3.2.7 Ailsa Craig

Colony status: Decreasing.

The survey was made on 6 June 2004 and achieved 100% photographic coverage. The overall quality of the images was good. The average total was 27,130 AOS (Table 8), a decrease of 16.4% since 1995 at 2% pa (Table 2). Comparison with the 1995 photographs showed small increases along the upper colony limit of Section 9/10/11 but a decrease in breeding density, leaving a near empty swath through this section (see image files Ailsa Craig_7_13 & Ailsa Craig_8_13). An increase in density has also taken place in Section 21 but without noticeable changes in the colony extent. Elsewhere, there appear to be no changes to colony boundaries and the small gaps separating Section 6 from Section 7, and also Section 13/14 from adjacent sections, apparent in 1995 are still obvious.

The decrease seems to be due to an overall decline in breeding density, reflected in both observers' results for 2004 (Table 8). The late date of the count in 1995 (5 August) may have contributed to the higher count that year, but that does not explain the large drop in numbers in, for example, Section 8. There may have been an element of over-counting in 1995, and repeat counts of some sections by SM support this explanation. However, even if the 1995 total was too high and is adjusted downward to 30,844 AOS (SM's lower count), rather than the published average of 32,456, then the colony has still shown a decrease, albeit at a lower rate.

Table 8. Counts (AOS) for Ailsa Craig in 2004.

Count Section	Counts (AOS)			
	Obs 1.1	Obs 1.2	Obs 2	Mean
1	1,000	952	1,041	1,009
2	95	52	96	85
3	223	205	275	245
4 / 5	1,236	1,046	1,303	1,222
6	1,425	1,180	1,363	1,333
7	878	702	828	809
8	2,283	2,591	2,985	2,711
9 / 10 / 11	10,885	10,019	10,223	10,338
12	127	141	180	157
13 / 14	1,370	1,197	1,538	1,411
15 / 16	2,168	2,058	2,445	2,279
17	37	23	45	38
18	745	644	727	711
19	3,308	3,105	3,758	3,482
20	262	174	321	270
21	649	715	912	797
22	0	0	0	0
23	214	213	258	236
Total	26,905	25,017	28,298	27,130

3.2.8 Scare Rocks

Colony status: Increasing.

The survey was made on 6 June 2004 and achieved 100% photographic coverage. Encroaching sea fog affected the brightness of the images, but good results were achieved nonetheless. An average total of 2,394 AOS was counted (Table 9), representing an overall increase of 22.6% since 1995 at an average rate of increase of 2.3% pa (Table 2). Comparisons with the 1995 aerial photographs provided no evidence of any change in density, but small increases in colony extent were apparent at the lower edge of the Plateau section.

Table 9. Counts (AOS) for Scare Rocks in 2004.

Count Section	Counts (AOS)			
	Obs 1.1	Obs 1.2	Obs 2	Mean
West Slope	235	217		226
West Stac	118	124		121
North Cliff	34	42		38
Plateau	1,949	1,800	2,143	2,009
Total	2,336	2,183		2,394

3.3 Intra- and inter-observer differences

Even when photographs are of high standard, there is variation among counts made by each observer and among different observers (Harris & Lloyd 1977). Observer effects were also apparent in the 2004 gannet survey (Table 10 and Tables 3-9 above). As expected intra-observer differences were generally less than inter-observer differences, with the latter indicating directional bias; Observer 2 consistently counted higher than Observer 1. Results indicated that changes associated with observer error in 2004 were generally between 5-10%. These values were similar to those recorded previously in the 1984/85 and 1994/95 surveys (Murray & Wanless 1986, 1997; Wanless 1987). Differences in count totals between 1994/95 and 2004 of <10% were therefore interpreted as indicating no overall change and approximately stable numbers. However, in all cases careful inspections of sections were made to pinpoint any major changes in colony extent or nesting density.

3.4 Scottish gannets in a national and international context

The current importance of Scottish gannetries in a Scottish, UK and Irish, NE Atlantic and world context is presented in Table 11.

Table 10. Intra- and inter-observer differences for 2004 AOS colony counts.

Colony	Total Counts (AOS)						Intra-Observer Error (%)	Inter-Observer Error (%)
	Obs 1.1	Obs 1.2	Obs 1.3	Obs 1 Mean	Obs 2	Overall Mean		
Bass Rock	47,936	47,550		47,743		48,065	0.8	5.8 ^a
Sule Stack	4,483	4,664		4,574		4,618	4.0	14.5 ^b
Sula Sgeir	8,581	8,577	10,012	9,057	9,394	9,225	10.6	3.7
Flannan Isles	2,721	2,707	2,754	2,727		2,760	1.1	10.4 ^c
Boreray	32,393	31,688		32,041		32,333	2.2	12.1 ^d
Stac Lee	13,541	12,848		13,195		13,369	5.3	4.8 ^e
Stac an Armin	13,451	13,608		13,530		13,920	1.2	7.9 ^f
St Kilda Total	59,385	58,144		58,765		59,622	2.1	7.8 ^g
Ailsa Craig	26,905	25,017		25,961	28,298	27,130	7.3	8.6
Scare Rocks	2,336	2,183		2,260		2,394	6.8	13.4 ^h

^a Based on recount of 23% of total

^d Based on recount of 15% of total

^g Based on recount of 37% of total

^b Based on recount of 13% of total

^e Based on recount of 54% of total

^h Based on recount of 84% of total

^c Based on recount of 23% of total

^f Based on recount of 71% of total

Table 11. The importance of Scottish gannetries in a Scottish, UK and Ireland, northeast Atlantic and world context in 2004.

Colony	Population size (AOS)	Percentage of population in			
		Scotland	UK & Ireland ¹	NE Atlantic ²	World ³
Bass Rock	48,065	26.3	18.4	15.4	11.6
Sule Skerry	57	0.0	0.0	0.0	0.0
Sule Stack	4,618	2.5	1.8	1.5	1.1
Sula Sgeir	9,225	5.1	3.5	2.9	2.2
Flannan Isles	2,760	1.5	1.1	0.9	0.7
St Kilda	59,622	32.7	22.9	19.1	14.4
Ailsa Craig	27,130	14.9	10.4	8.7	6.6
Scare Rocks	2,394	1.3	0.9	0.8	0.6
Fair Isle ⁴	1,875	1.0	0.7	0.6	0.5
Foula ⁵	919	0.5	0.4	0.3	0.2
Troup Head ⁶	1,547	0.8	0.6	0.5	0.4
Hermaness ⁷	15,633	8.6	6.0	5.0	3.8
Noss ⁸	8,652	4.7	3.3	2.8	2.1
Westray ⁹	14	0.0	0.0	0.0	0.0
Total	182511	100.0	70.0	58.3	44.1

Best available population estimates:

Sources: ⁴ Fair Isle Bird Observatory

⁷ Duffield (2003), for 2003

¹ 260,622 AOS

⁵ S. Gear

⁸ Marshall & Thomas (2003), for 2003

² 312,922 AOS

³ 413,944 AOS

⁶ JNCC

⁹ RSPB

4. DISCUSSION

4.1 Colony sizes in 2004 and long term trends

Aerial surveys of all the well established gannetries were successfully carried out in 2004 and a land count and photographs of the newly founded colony on Sule Skerry were also obtained. Survey methodology was very similar to that used in 1984/85 and 1994/95, the 2004 co-ordinator was involved in all three surveys and all counts were made in conjunction with previous census material. Therefore comparability of counts across surveys should have been maximised. However, despite this high level of standardisation it should be noted that intra- and inter-observer differences indicate that errors of 5-10% are associated with count estimates, even when the standard of photographs are excellent and the counter is highly experienced and familiar with the colonies.

Photographs used in the survey were taken with SLR cameras using 35mm film. However, high quality digital images were made from the slides and the count sections for each colony marked on. These images constitute a valuable and easily accessible archive of count material from the 2004 survey and will greatly enhance the quality of future site condition monitoring possible for these colonies.

Estimates of population size were obtained for each of the gannetries surveyed and the current boundaries of the areas occupied are clearly shown on the digital images/slides. Hence any future changes in abundance and/or size at these colonies will be readily apparent.

Comparison of colony totals with previous estimates indicate that the sustained period of population increase recorded at colonies of gannets in Scotland throughout the twentieth century has slowed, or in some cases been reversed, over the last 10 years. Thus, for six of the seven colonies, the rate of change between 1994/95 and 2004 was markedly lower than over the previous decade and numbers at four of the colonies were stable or decreasing (Table 2).

A recent analysis of gannet ringing recoveries for the UK and Ireland suggests a reduction in annual survival of adults over the last 10 years (Wanless et al. in press). Such change could at least partly explain the slowing down in population growth reported here. Together these findings highlight an important shift in the population status of Scottish gannetries with an associated imperative to monitor future changes in status.

4.2 National and international importance of Scottish gannetries

The 2004 survey indicated that Scotland remains the stronghold of the northern gannet population with 44% of the world population. St Kilda is still the largest colony holding 33% of the Scottish total and 14% of the world total. However, the supremacy of St Kilda is being challenged by the Bass Rock, where numbers are still increasing. Bass Rock now holds 26% of the Scottish population and 12% of the world total. Thus together these two colonies currently contain nearly 60% of the Scottish total and just over a quarter of the world's northern gannets.

4.3 Effects of the guga hunt at Sula Sgeir

The men of Ness, Isle of Lewis are licensed to take up to 2,000 nearly fledged young (known as gugas) each year for salting and local sale for human consumption. As has been highlighted previously (e.g. Wanless & Harris, 2004), it is difficult to make a full assessment of the effects of this sustained harvest of young gannets due to the lack of any data on demographic parameters e.g. breeding success, adult survival or recruitment for gannets on

Sula Sgeir. However, assuming that gannets on Sula Sgeir have a similar breeding success to other Scottish colonies, the licensed harvest could represent about 30% of the annual production of chicks. Between 1985 and 2001 a total of 33,690 gannet chicks were reported killed, only in 1999 was the reported annual total not exactly 2,000 (Scottish Executive figures).

An indication of effects at the population level can be obtained by comparing the long term rate of change on Sula Sgeir with that of other UK and Irish gannetries (Figure 10). The plot indicates that Sula Sgeir is an outlier having a markedly lower rate of change, given its size, than any other colony. Lack of suitable nesting areas does not appear to be the limiting factor and no other threats are apparent. Hence adverse direct (or indirect through disturbance) effects of the guga hunt cannot be discounted.



Figure 10. Log-log plot of the rates of change in numbers of gannets at UK and Irish gannetries between 1969 and 2004 in relation to colony size in 1969.

The majority of colonies lie close to the line indicating density dependent population regulation. The point representing Sula Sgeir falls well below the line indicating a much lower rate of increase than expected.

5. RECOMMENDATIONS

1. Given the apparent change in population status of Scottish gannetries on SPAs and SSSIs reported here and the possible decline in adult survival rate (Wanless *et al.*, 2006), it is essential to establish a survey protocol that is repeatable every six years in order to deliver high quality site condition monitoring.

We recommend the use of aerial surveys as this is the only method that provides estimates of population size that are comparable with previous counts thus enabling population trends to be determined. The logistics involved with chartering a suitable aircraft and an experienced pilot and having a team of photographers on standby to take advantage of suitable flying conditions mean that a full-time co-ordinator is essential. The vagaries of the Scottish weather coupled with restrictions due to military activity means that obtaining coverage of the colonies within the recommended time frame (mid May to mid June) is challenging and contingency plans need to be in place to deal with any failure to meet these time constraints. Full details of the recommended survey methods are given in Section 2.1 of this report.

2. Having taken the photographs, obtaining totals of the number of AOSs is also a major undertaking and requires count sections to be identified and delimited on the slides to facilitate comparisons with previous surveys.

We recommend maintaining the sections currently used (see Section 1.3). The digital archive accompanying this report will serve as a baseline for this and provide a useful tool for future surveys.

3. Counting the AOSs in each section is a time consuming process that involves subjective decisions about what constitutes an occupied site or a non breeding bird.

We recommend that the methodology used in this survey, whereby slides were projected onto a screen and AOSs were physically marked off, be continued. This approach has the advantage that the observer scrutinises each potential AOS and makes the best assessment of what to include in the total. However this method is very labour intensive.

We recommend that the feasibility of using computer software to count apparently occupied sites is investigated. However, before this approach is used for a full scale survey it should be rigorously tested in a pilot study involving colonies with contrasting topographies to investigate how the approach works using images taken from different altitudes and angles.

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