

*Breeding ecology and diet
of Great and Arctic skuas
on Handa Island 2009*



**Handa Island Skua Project
Annual Report 2009**

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1 Summary

2009 saw the seventh full season of activities by the Handa Island Skua Project. Productivity of Handa's Great (*Stercorarius skua*) and Arctic skua (*S. parasiticus*) populations continued to be monitored following standard methodologies, and chicks ringed with standard BTO and Darvic colour rings. As in previous years productivity of Great skuas was monitored by focusing on a representative sample of 80 pairs spread across 2 study sites, and the whole Arctic skua population was monitored. Great skua diet continued to be monitored by systematic sampling of regurgitated pellets from breeding pairs and club-sites.

The all-island survey of Great skuas was carried out on the 22nd and 23rd June and counted 266 apparently occupied territories (AOTs), a very slight decrease from last year. The small Arctic skua population increased slightly from 2008, with 21 pairs breeding and 3 pairs holding territory.

Great skua productivity was high this year, with 0.83 chicks fledged per pair, the highest productivity recorded since 2004. Interestingly, productivity was higher in Study Site 1 than Study Site 2 for the first recorded time (0.97 vs. 0.69 respectively).

Arctic skuas had an excellent breeding season, with productivity at 1.24 chicks fledged per pair, the highest figure since 2004. Post fledging mortality was also low, with 6 chicks confirmed or presumed dead. Their numbers continued to increase in the stronghold above Traigh Shourie, and co-operative defence against the Great skuas was frequently seen.

138 Great skua and 20 Arctic skua were given BTO rings and coloured Darvic ring this year. There were many re-sightings of chicks colour ringed in 2004 this year, especially around the shores of Swaabie Loch, a new club-site.

Pellets were collected from 30 territories this year, split equally between study sites, and from the club-sites. The club-site moved this year from its previous position in the north-east of the island to the shores of Swaabie Loch. However, both breeding and non-breeding birds bathe in Swaabie Loch so it is uncertain this year if pellets collected are wholly representative of the non-breeders diet. 1024 pellets were collected in total, with 797 from breeding birds and 227 from the club-sites. As in previous years, pellets were split fairly evenly, with fish comprising 46% and bird 50% of breeders' diet. The slight increase in bird pellets over previous years may reflect availability, as 2009 was a successful breeding season for many of the seabirds on Handa Island.

1.1 Outputs

Summary breeding results were provided for the annual Handa Ranger's 2009 report and were also posted on the Handa Island Skua Project website (www.handaskuas.org). Census and productivity data are also uploaded to the website of the JNCC Seabird Monitoring Programme.

Rebecca Green presented a poster of her 2008 honours project at the 10th International Seabird Group Conference in Bruges in March. Two further papers for peer-reviewed journals, including a collaboration with Norman Ratcliffe of the British Antarctic Survey, are in preparation.

Previous reports of the Handa Island Skua Project, and other research and monitoring results, are available at <http://www.handaskuas.org/research>.

2 Methods

Claire Smith began to map Great skua territories in the 2 study sites on 6th June, and was joined on 9th June by Rebecca Green, who continued as the full time fieldworker from then until 21st August. Andrew Ramsay visited at key times throughout the breeding season, often joined by Nigel Richards, to assist with chick finding and ringing. Visits were timed with reference to mean laydates as determined from previous years' data (Jones, Green & Smith, 2008; Jones *et al.*, 2008).

The all-island survey was carried out on 22nd and 23rd June, following standard methodology as described in Walsh *et al.* (1995). Methods for locating and marking nests, monitoring productivity and recording Arctic skua post fledging mortality were also consistent with previous seasons (Jones, 2003; Smith & Jones, 2004, 2005, 2006, 2007; Jones, Green & Smith, 2008). This year, all breeding Arctic skuas (see Appendix 2) and a sample of 80 Great skuas across the 2 study sites (see Appendix 1) were monitored. In previous years, Study Site 1 has been consistently less productive than Study Site 2, which contains fewer breeding pairs of Great black-backed gulls (GBBs). See Jones, 2003 for a detailed methodology and Smith & Jones, 2004 for a detailed explanation of selection of study sites.

The length and breadth of all eggs were measured to the nearest 0.5mm using callipers, and egg volume calculated using $0.00048 \times \text{length} \times \text{breadth}^2$ (Coulson, 1963). Laydates were estimated for all nests of known hatching date, by subtracting the gestation periods of 29 and 25 days for Great and Arctic skuas respectively (Hamer, 2001; Phillips, 2001).

For the purpose of studying diet, regurgitated pellets were collected weekly from 30 Great skua territories (15 in Study Site 1 and 15 in Study Site 2; see Appendix 1). They were also collected from the club-sites. It became apparent early in the season that the club-site had moved from its previous position in the north-east of the island to the shores of Swaabie Loch. This movement to a bathing site used by breeders and non-breeders means dietary analyses should be treated with caution this year as the pellets collected from the club-site will be from breeders and non-breeders. Territories were cleared of pellets on 9th June and pellet collection began on 15th June. The old club-site was cleared of pellets on 11th June and pellet collection began on 18th for just 2 weeks; the new club-site was cleared on the 24th June and pellet collection began on 28th June. Fish species were identified in the laboratory by otoliths, with reference to an identification guide (Harkonen, 1986).

The number of birds at great and Arctic skua club-sites were counted opportunistically throughout the season, as were the numbers bathing in Swaabie Loch.

3 Results

3.1 Population

Great skua

The all-island census was conducted on 22nd and 23rd June, and recorded 266 AOTs (Figure 1).

Great skuas appeared to abandon their previous club-site this year in favour of a new one at Swaabie Loch. However, breeding Great skuas also used the shore after bathing in the loch so it was often difficult to distinguish between the two. The maximum club-site count at the new site was of 50 birds on 17th July, with an additional 82 Great skuas in the water. The maximum count at the old club-site was just 6 birds on the 16th June; as there were nearby AOTs identified by the all-island census, these were probably breeding birds.

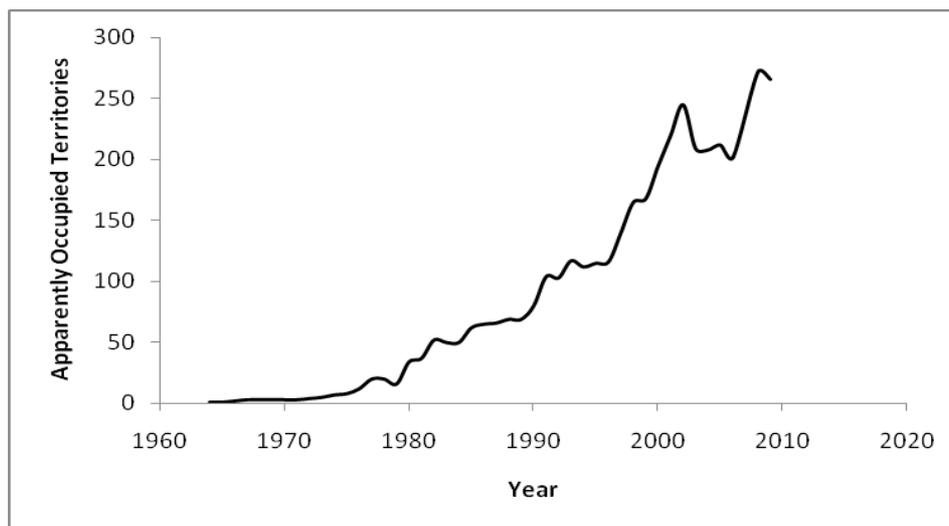


Figure 1: Number of Great skua apparently occupied territories on Handa Island since 196

Arctic skua

A total of 21 Arctic skua nests plus 3 apparently occupied territories (AOTs) were located on Handa this year (Appendix 2), a slight increase from 18 breeding pairs and 2 AOTs in 2008 (figure 2).

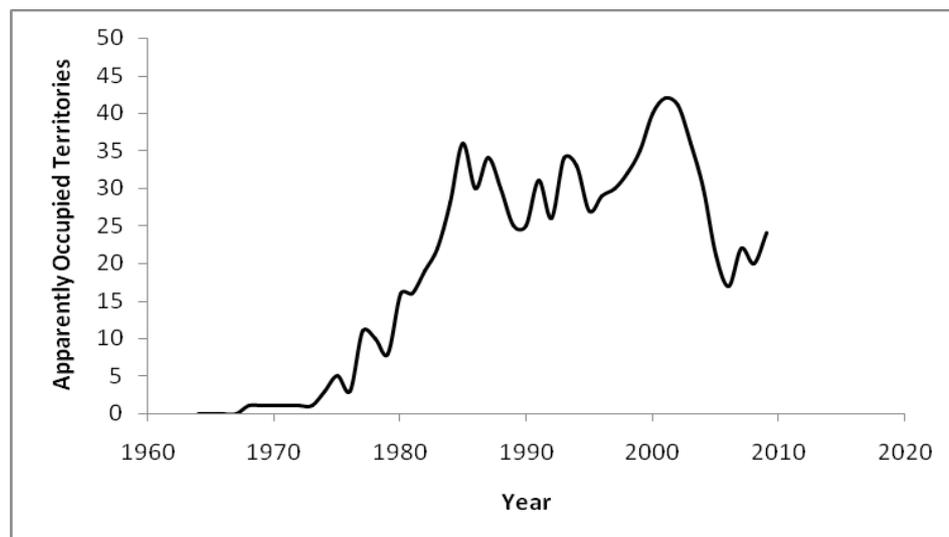


Figure 2: Number of Arctic Skua apparently occupied territories on Handa Island since 1964.

The area just south of the village and north of Traigh Shourie grew in density this year with 7 territories, and 5 territories around Bothy Loch, the site of the previous Arctic stronghold (Jones, 2003). Cooperative defence against Great skuas and other birds such as ravens was frequently observed in these areas.

Of the 48 Arctic skuas on Handa either breeding or holding territory, 17 were light phase and 31 dark. These comprised 10 dark/dark pairs, 3 light/light pairs with the remaining 11 pairs mixed. Due to variation between observers in the perception of recording intermediate phases, these were not recorded this year; however, it is worth noting that there was 1 bird in particular that was identified by common consensus to be an intermediate phase. See Appendix 2 for adult colour phases and Table 1 for colour phases of the adults and their fledged chicks.

Table 1: Phases of breeding adults and fledged Arctic skua chicks, 2009. ‘U’ indicates colour phase undetermined; gaps indicate no chicks hatched.

Adult phases	Chick 1 phase	Chick 2 phase
Dark/Dark	Dark	Light
Dark/Dark	Dark	Dark
Dark/Dark	Dark	
Dark/Dark	Dark	Light
Dark/Dark	Dark	
Dark/Dark		
Dark/Dark	U	
Dark/Dark	U	U
Dark/Dark		
Dark/Light	Light	
Dark/Light	Dark	U
Dark/Light	Dark	Dark
Dark/Light	Dark	
Dark/Light	Dark	Light
Dark/Light	Light	
Dark/Light	U	U
Dark/Light	Dark	U
Dark/Light	Dark	Light
Light/Light	Light	U
Light/Light	Light	U
Light/Light	Dark	Light

3.2 Breeding Statistics

Table 2: Breeding statistics of Great and Arctic skuas on Handa 2009. Sample sizes are in parentheses.

	Breeding pairs monitored	Mean lay date	Mean egg volume	Mean clutch size	Hatching success (%)	Fledging success (%)	Chicks fledged per pair
Great Skua Total	80	23 May (65)	78.75 (72)	1.74 (80)	82 (78)	58 (78)	0.825 (80)
Study Site 1	38	24 May (33)	79.82 (34)	1.84 (38)	86 (36)	61 (36)	0.97 (38)
Study Site 2	42	23 May (32)	77.80 (38)	1.64 (42)	78 (42)	54 (42)	0.69 (42)
Arctic Skua	21	6 June (14)	44.96 (17)	1.95 (20)	83 (18)	79 (18)	1.24 (21)

¹ For Great skuas, we used the egg with the greatest volume (Furness, 1987); for Arctic skuas, we used the egg with the greatest volume, except where we observed which egg was laid first, in which case we used the α -egg ($n=3$)

² Great skuas were considered fledged if still alive after 40 days; Arctic skuas were considered fledged if still alive after 28 days

Great skuas

Table 2 summarises the breeding statistics for the Great and Arctic skuas. Productivity for the Great skuas in 2009 was 0.825, the highest since 2004. In addition, productivity in Study Site 1 was higher than in Study Site 2 for the first time since 2004. The difference was significant (Mann-Whitney U test: $n_1 = 38$, $n_2 = 42$, $P = 0.045$). The clutch size was also significantly smaller in Study Site 2 (Mann-Whitney U: $n_1 = 38$, $n_2 = 42$, $P = 0.044$).

As in previous years, most mortalities occurred during chick stage when the chick was less than 10 days old. However, this year the number lost at this stage was lower than the average for previous years, at 25.2% (Table 3).

There were few Great black-backed gull territories in Study Site 1 this year; 4 pairs nesting with 1 of these failing very early on, compared to 7 pairs in 2006 and 10 pairs in 2004 (Smith 2004; Smith & Jones 2006; A. Ramsey pers. comm.).

Table 3: Great skua mortality factors, showing proximate causes of breeding failure on Handa Island in 2009, compared to the 4 year average from 2003-2006.

		2003-2006 average (%)	2009 (%)
<i>n</i>		-	134
Egg stage	Addled	13.5	14.2
	Died hatching	0.9	1.5
	Loss by predation	5.2	2.2
	Total egg loss	18.8	17.9
<i>n</i>		-	111
Chick stage	Chick loss 0-10 days	49.4	25.2
	Chick loss 10+ days	14.2	17.1
	Total chick loss	64.4	42.3

The average lay date this year was 23rd May; earlier than the average since 2003 but not as early as 2008 (Figure 3).

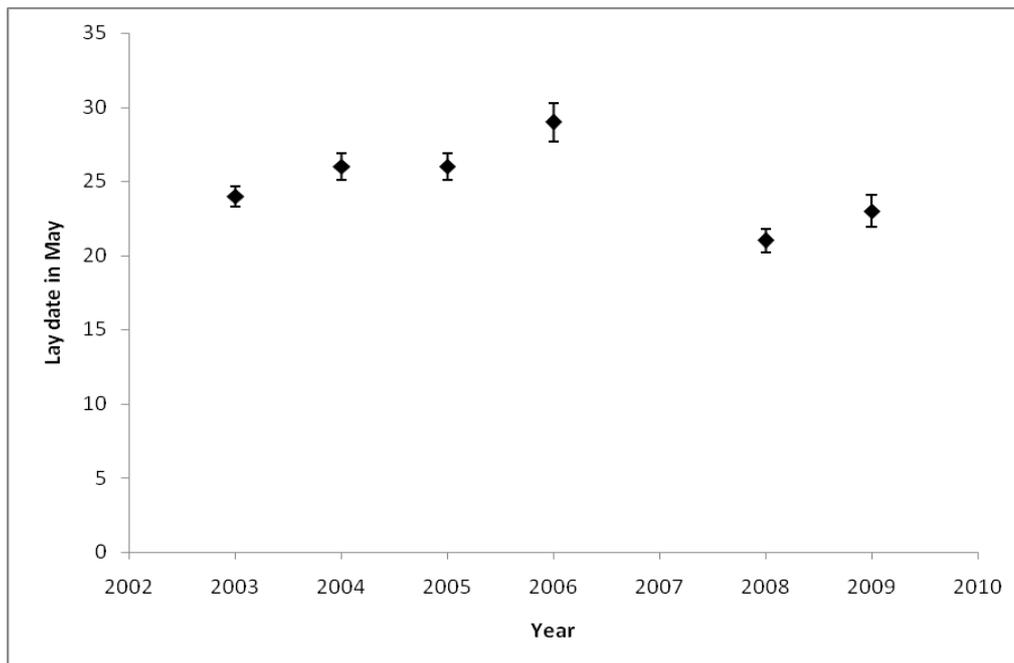


Figure 3: Mean lay dates of the Great skuas on Handa Island from 2003 to 2009 with standard error (no data from 2007).

Arctic skuas

This year 26 chicks Arctic skua chicks fledged, a higher figure than last year. Productivity was 1.24 chicks fledged per pair, the highest figure since 2004 (Table 2).

There were 3 eggs known to be addled and 1 chick that died while hatching. 1 chick was found dead in the nest at 1-2 days old. Post-fledging mortality was low compared to previous years at 23%; 2 fledged birds were found dead on a nearby Great skua territory and a further 4 were missing and assumed predated

One chick was observed alive but not flying several days after its expected fledge date, even though its sibling had fledged. On closer examination it appeared to have a malformed wing on the right side, which prevented it from fully extending. The parents were observed feeding the bird. However, it was later found dead, and appeared very thin.

3.3 Diet

Great skuas

A total of 1024 single item pellets (797 from territories and 227 from club-sites) were collected this year. The number of bird and fish pellets were fairly evenly represented on breeding territories (Figure 4).

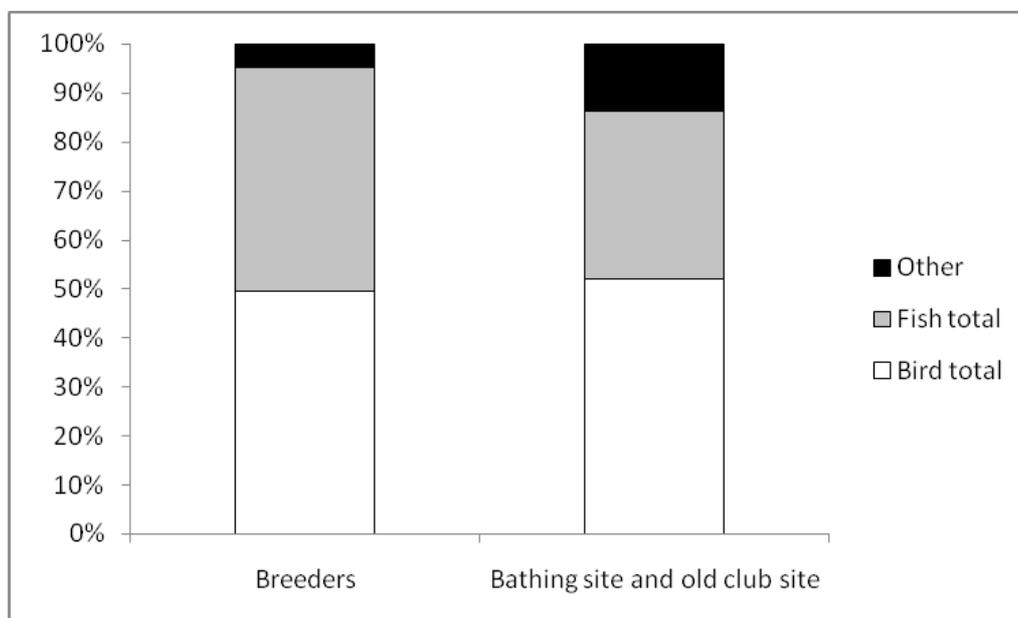


Figure 4: Percentage composition of food items in Great skua diet among breeders (on territory) and non-breeders (at club-sites). Based on single item pellets only (n=1024).

As in previous years, the vast majority of otoliths were from Norway pout (*Trisopterus esmarkii*), with Whiting (*Merlangius merlangus*) the next most common species. Auk was the most consumed bird species (Table 4). No new food items were recorded this year. There were many occasions when large numbers of sprats were found regurgitated on the territories; similar observations were made in 2004.

Table 4: Great skua single item pellets collected from 30 territories and club-sites, 2009.

	% of total pellets collected	
	Breeders	Bathing-site and old club-site
Fish total	45.80	34.36
Bird total	49.56	51.98
Other	4.64	13.66
Sand eel	0.63	0.00
Fish other	45.17	34.36
Auk	31.74	29.96
Gull	15.18	18.50
Fulmar	2.38	2.20
Storm Petrel	0.25	1.32

4 Ringing

A total of 138 Great skua and 24 Arctic skua chicks were ringed on Handa this year. All chicks were fitted with colour rings on the left leg (in addition to standard BTO rings on the right). The styles of Darvic colour rings fitted this year are shown below (Figure 5), with the exception of 1 Great skua that was ringed with a white/black Darvic ring .



Figure 5: The style of Darvic rings deployed on (a) Arctic skuas and (b) Great skuas on Handa in 2009.

Since annual monitoring started in 2003, a total of 739 Great skuas have been fitted with BTO rings and 430 colour-ringed. 100 Arctic chicks have been fitted with BTO rings and 44 colour ringed (Table 5).

Table 5: The numbers of Great and Arctic skuas ringed since 2003.

	Great Skua		Arctic Skua	
	BTO	Colour	BTO	Colour
2003	106	0	27	0
2004	117	50	29	0
2005	22	22	0	0
2006	47	47	2	2
2007	121	88	13	13
2008	188	63	5	5
2009	138	138	24	24
	739	430	100	44

4.1 Re-sightings and recoveries

Great skuas

This year, juvenile birds with white Darvic rings on their left leg were often sighted at Swaabie Loch (Table 6 and Figure 6). In addition adults were observed with BTO rings on five occasions in June and July.

Table 6: Great skua re-sightings and recoveries on Handa Island, 2009.

Date	Year of birth	Ring details	Location	Notes
14/04/09	2004	E1 white	Neist Point - Skye	Alive
06/06/09	2008	B6 Blue		Dead
16/6/09	2008	C7 blue. No remains	C4	Dead
24/6/09	89-93	Left: blue/white Right: orange/green	Trig point	Alive, breeding.
5/7/09	2005	5 juveniles with white rings	Swaabie loch	Alive
5/7/09	89-93	Left: yellow/white Right, green/BTO	Swaabie loch	Alive
7/7/09	2008	BTO ring MA22581 on remains		Dead
26/7/09	2007	D4 red. No remains	I5	Dead
30/7/09	2004	I2 white on adult	Sheep fank	Alive
2/8/09	2004	1 juvenile with white ring	Swaabie loch	Alive
9/8/09	2004	2 juveniles with white rings	Swaabie loch	Alive



Figure 6: Juvenile Great skua with white Darvic ring to left leg, at Swaabie Loch.

5 Discussion

5.1 *Breeding performance: Great skua*

Great skua productivity, at 0.83 chicks per pair, was the second highest since current monitoring began in 2003 (Figure 7, below). Only 2004 was a more productive year with 0.88 chicks per pair. On the other Scottish colonies productivity was mixed, with some areas of low and others of high productivity in parts of Shetland and Orkney (and certainly not enough to offset the long-term declines in the Northern Isles, SBG newsletter 112).

For the first time since 2003, productivity was significantly higher in Study Site 1 (formally known as the 'Valleys of Doom') than Study Site 2 (0.97 vs. 0.69). The reason for this is yet unknown. Over the last five to ten years there has been a marked decline in the numbers of Great black-backed gulls breeding across the island (Ramsey, pers. comm.). Study Site 1 held 10 pairs in 2004 and their presence was thought to negatively impact the productivity of the Great Skuas due to predation. This year just 4 pairs held territory in Study Site 1. Clutch size was also significantly lower in Study Site 2, although there was no significant difference in alpha egg volume. Interestingly, the mean egg volume this year was the lowest on record since 2004. Whether this is indicative of a population with a decreasing mean age of female breeders is unclear, though our ringing study may shed light on this possibility in years to come.

The ringing effort continued this year with 138 Great skuas given BTO and colour rings, bringing the total given BTO rings since 2003 to 739, and the total given colour rings to 430. Re-sightings of juvenile birds ringed on Handa in previous years continued. As these colour-ringed birds recruit to the population we are gaining valuable information on age-structure, philopatry, survival and dispersal of birds fledged from Handa. In the future, we plan to use a different colour of Darvic ring each year, so that birds can be assigned to year from a brief sighting without having to be able to read the code on the ring.

5.2 *Breeding performance: Arctic Skua*

The number of Arctic skua AOTs increased slightly from 2008, from 18 to 21 pairs. Productivity was the highest since 2004 (Figure 7, below), with 1.24 chicks fledged per pair, and post fledging mortality was the lowest recorded at 23% (post fledging mortality was not recorded in 2004). Co-operative defence by the adult Arctic skuas against Great skuas and occasionally other birds such as ravens was frequently seen, especially in the current stronghold above Traigh Shourie. In 2003 co-operative defence was regularly observed, and was seen to be effective against predators intruding in the Arctic skua breeding 'stronghold'. Since 2004 there was a decrease in breeding density and this behaviour was not seen again until 2008; meanwhile productivity had fallen significantly and post fledging mortality had been high. The increased observation of this behaviour over the last two years is a welcome sight, and is very probably linked to increased productivity. This relationship between territory density, co-operative defence and breeding performance will be the subject of a future paper.

In August, fledged Arctic skuas were often seen chasing the Arctic terns over Traigh Shourie, one of their breeding sites (possibly attempting to kleptoparasitise them, possibly just practising). This had not been seen for several years and is another promising sign of a reviving Arctic skua population.

5.3 The longer-term 'trends'

Figure 7 below illustrates breeding performance in the Great and Arctic skua populations on Handa over the last seven years. It reinforces the notion that 2009 was a very good year for Handa's skuas - by far the best in terms of chicks fledged since 2004. This year there was clearly no shortage of food for these top predators, as well as a decrease in predators on their own eggs and chicks, and if this scenario continues, parameters other than food availability - such as availability of quality breeding territories - will more likely regulate their local abundance.

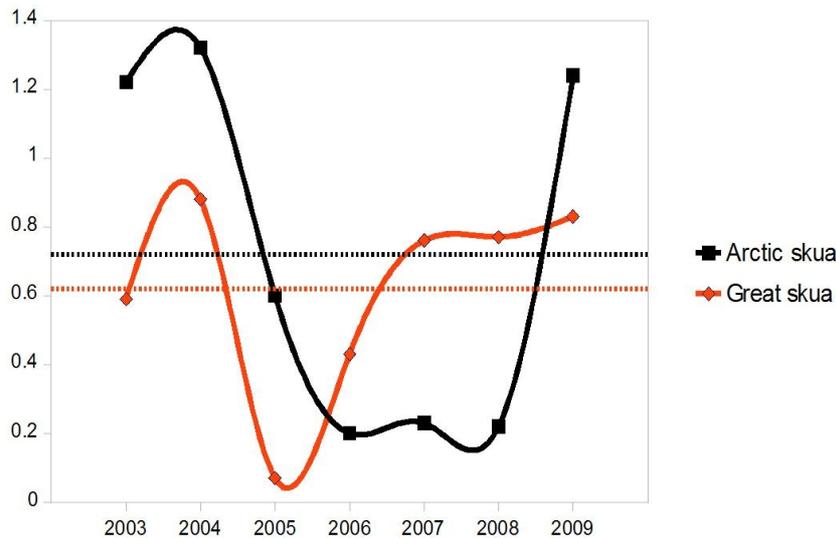


Figure 7: The productivity, defined as chicks fledged per pair, for Great and Arctic skuas since 2003-9. The dotted lines represent the 7-year average (mean) for each species.

The overall message of this graph, however, is that productivity among both of Handa's skua species is showing huge inter-annual variation. Seven years is clearly not long enough to fully understand 'trends' in either species (if indeed there are any 'trends'). Moreover, it highlights the value of consistent long-term monitoring: for example, if Arctic skuas had been monitored only in 2004 and 2009, a highly misleading picture would have been given of a thriving breeding population.

5.4 Great skua diet

2009 saw an increase in our sampling effort of Great skua diet, both in terms of number of breeding territories covered, and total number of pellets collected. Overall the composition of their diet was fairly consistent with previous years, though with a slight increase in the proportion of bird in breeders' pellets (up to 49.6% of single-item pellets in 2009 compared with 43.2% in 2008). The proportion of auk in their diet has risen the most notably over the last two years: 32% in 2009 and 29.6% in 2008, compared with approximately 23% from 2005-7). In 2009 this is at least partially attributable to an unusually (for recent years) successful breeding season among Handa's common guillemots and razorbills.

Storm petrels continue to be found (though often outside of our sampling territories), and their breeding on the island still awaits confirmation. Also in 2009, several whole sprats were found on territories, and more than one chick was seen regurgitating great numbers of these fish. This had not been regularly observed since 2004 - the last very good year for breeding bonxies before 2009.

6 Workplan – 2010

In 2010, we again propose that a student at postgraduate level (to be recruited in early 2010) be based on the island constantly from early June until mid-late August. S/he will be trained by C. Smith & R. Green at the beginning of June, and further supported on occasional visits throughout the season by CS, RG, T. Jones, A. Ramsay and other volunteers from the Highland Ringing Group. CS will also make the first visit to the island towards the end of May to establish the study sites. Thus we aim to collect a dataset consistent and comparable with those from 2003-2009, and to complete another original research project.

In summary, we plan the following fieldwork on the island in 2010. These dates have been coordinated with Glen Campbell to ensure there are no clashes with weeks when he is planning to lead SWT work teams on the island in 2010.

Date	Data collected	Fieldworker(s)
22-24 May	Great skua nests, mapping, egg volumes & clutch size	CS +1
5-14 June	Great and Arctic skua nests, mapping, egg volumes & clutch size; all-island survey; training of student	CS& Student
10 June – 25 Aug	Great skua chicks, Arctic skua nests and chicks, Great skua pellets, ringing, fledglings and post-fledging mortality; original research project	Student ¹

¹with support from CS, RG, TJ and Highland Ringing Group

7 Funding

In 2009, the Handa Island Skua Project received small grants from The Seabird Group (£600) and the Scottish Ornithologists Club (£550), and continued in-kind support from the Scottish Wildlife Trust. R. Green received £250 from Anglia Ruskin University towards her attendance at the International Seabird Group Conference in Bruges March 2009, at which she presented results from the 2008 field season.

Funding applications for the 2010 field season are in preparation.

8 Acknowledgements

We are grateful to the Scottish Wildlife Trust and Highland Ringing Group for their ongoing support of our work; to Dr Jean Balfour and Mr Balfour, Sven Ramussen and the Handa Island Management Committee for the continuing privilege of working on Handa's seabirds; and to Amy Corton, this year's Ranger for her fine company, logistical support and help with fieldwork. Funding this year came through small grants from the Seabird Group and the Scottish Ornithologists Club. Special thanks as ever to Andrew Ramsay for his unerring dedication and support, and to Dr. Nancy Harrison for her advice and assistance over the last year. Cheers to boatmen Paul and Roger, and to all the volunteers who helped with fieldwork, with special mention for Nigel Richards and David Hamilton.

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Appendix 1: Map of Great skua study nests 2009, showing study sites and territories monitored for productivity and diet.

