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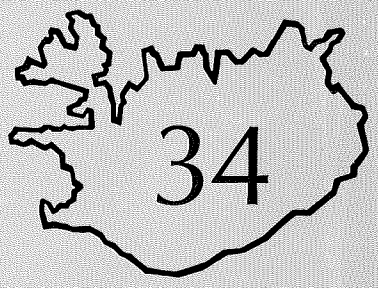

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The numbers and distribution of the Great Skua *Stercorarius skua* breeding in Iceland 1984-1985

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Abstract. The breeding population of the Great Skua *Stercorarius skua* in Iceland was censused in the summers of 1984 and 1985. It numbered about 5400 pairs, which is about 42% of the entire North Atlantic population. The survey was based on the line-transect technique, but two outwash plains, together 1000 km^2 in area, were covered from an aeroplane. The importance of the distribution of the colonies is discussed in relation to factors which may influence this. Other species of birds breeding in the Great Skua colonies are listed.

CONTENTS

INTRODUCTION

The Great Skua *Stercorarius skua* breeds in the Shetlands, Orkneys, Outer Hebrides and other Scottish islands, on the Faroes and in Iceland. It also breeds irregularly on the Scottish mainland (Cramp & Simmons 1983), and a few pairs in Norway, Spitsbergen, and on Bear Island (Vader 1980).

Censuses have been made of almost all the major breeding colonies in the world (Evans 1984, Furness 1986). Iceland, though being the second most important area next to the Shetlands, was the main exception. An estimate of the breeding population was made by Gudmundsson (1954), but opinion has been divided on whether the population was increasing or declining (Dickens 1964, Björnsson 1976). Census in Iceland was thus much needed so that a complete up-to-date picture of the size of the Great Skua breeding population in all of the North Atlantic, would be available.

It seemed particularly interesting to study the topography of the breeding grounds, since in Iceland, the Great Skuas primarily breed on large open fluvio-glacial plains, in contrast to their moorland breeding habitat in Shetland and Faroes. The census also provided an opportunity to study the feeding ecology of the species. This last part of the study is reported on elsewhere (Hansen & Lange, in prep.).

METHODS

The distribution of the Great Skua breeding colonies in Iceland is fairly well known (Timmermann 1949, Gudmundsson 1954, Björnsson 1976). The main grounds are the fluvio-glacial outwash plains of the southeast. There are also minor colonies along the southern and southwestern coasts, and a few along the eastern and northern shores. In 1982 a single pair was found breeding 120 km from the coast, at Thjórsárver in central Iceland (Thorleifsson 1983), but breeding so far inland is reckoned to be quite exceptional.

Aevar Petersen of the Icelandic Museum of Natural History provided maps showing the known and potential breeding sites of the Great Skua in Iceland. This very helpful information was supplemented with a study of the literature. Whenever work was started at a presumed breeding site, a contact was made with the local farmers for detailed information. They turned out to be extremely well informed about the breeding distribution, but they almost always overestimated the number of pairs.

The study was basically a one-visit census based on the line-transect technique. Breeding pairs of the Great Skua react violently to any interference by diving and attacking the intruder, which makes breeding pairs easy to detect on a line-transect (Fig. 1). The territories of Great Skuas were searched for eggs or chicks, when adult birds were present in the colonies, without showing any aggressive behaviour.

The breeding colonies were traversed by walking and breeding pairs plotted on maps. The distance between transects varied from 50 to 300 m, depending on local conditions, visibility, and the density of breeding pairs. We have no quantitative information on territory size in Iceland, but in general the radius of territories was bigger than the 50 m recorded in Shetland by Furness (pers. comm.). Notes were taken on the vegetation and topography, as well as other species of birds observed in the breeding areas of the skuas.

At a few sites, especially on small inacces-

Fig. 1. Working with Great Skuas. Öxarfjördur, July 1984. Photo: Peter Lange.

sible islands in rivers, a telescope (25 x 60) was used to observe the parents feeding their chicks, chicks walking around, etc. which of course, gives some uncertainty. Such colonies were, however, small.

The big fluvio-glacial plains of Skeidarársandur and Brunasandur, with a combined area of about 1000 km^2, were covered by an aeroplane. The glacial rivers constantly change their course, which make maps inaccurate, and many areas are inaccessible by foot. The aerial survey was carried out on 19 July 1985. Great Skuas reacted to a low-flying aeroplane in the same way as they do to ground intruders. The birds flew up and around in the territories, making it easy to detect and count the pairs. The plane was hired at Vík and the pilot had a good knowledge of local conditions. By 19 July quite a few pairs will have failed breeding, but we have no data on this point.

The aerial survey was started east of Ingólfshöfdi, and we flew due north on a straight line to the Skeidarárjökull glacier. There we turned southwest, starting on a series of parallel transects 25 km long and 1.5 km apart. The plane flew at a height of 45-60 m, at a speed of 100-130 km/h.

We do not think many territories were overlooked in the aerial survey although transects were 1.5 km apart. In order to test the aerial survey results, the area between Salthöfdi and the river Hólá (in Öraefi), was covered both by plane (600-650 pairs) and by land-based line-transects (660-730 pairs). It is assumed that the average of the land transect (695 pairs) is nearer the true value. Since the aerial survey results were 9% lower, all these figures have been adjusted accordingly.

When making a census of breeding Great Skuas it is possible to overestimate the number of breeding pairs by recording non-breeding territory holders (Cramp, Bourne & Saunders 1974). To solve this problem a test was carried out at nearly all colonies. All pairs in a representative part of the colony were counted, and all nests, eggs and chicks were recorded to obtain a figure of the number of non-breeding territory holders. This figure was then used to adjust the totals for the entire colony. The number of non-breeding pairs holding territories varied between 5 and 10%, so the average of 7% was deducted from the air survey data from Skeidarársandur and Brunasandur.

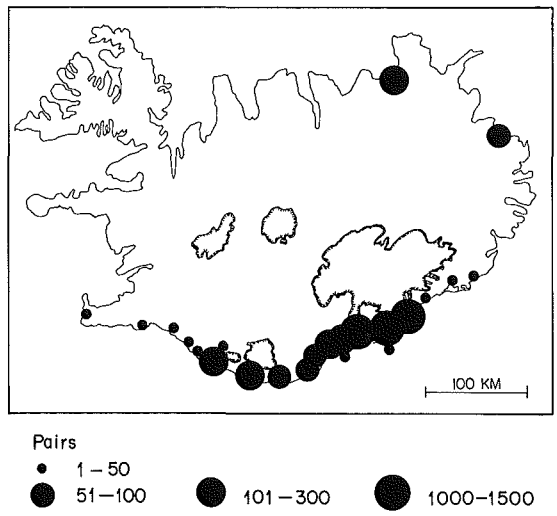


Fig. 2. The distribution and size of Great Skua colonies in Iceland 1984-85.

At nearly all colonies pellets regurgitated by Great Skuas were collected. Corpses of all dead birds taken by Great Skuas were identified. Outer primary feathers from adult Great Skua corpses were collected for later heavy metal analysis (cf. Furness et al. 1986).

It took us two summers to cover all the colonies. In the summer of 1984 we stayed in Iceland from 21 June to 19 July, covering the east coast from Öxarfjördur in the north to Höfn in the south. In the summer of 1985 the area between Reykjanes in the west and Höfn in the east was covered between 27 June and 1 August.

RESULTS

In Table 1, the estimated number of breeding pairs in each colony, the approximate sizes of the breeding areas, and the number of pairs/km^2, are given. Fig. 2 shows the breeding distribution of the Great Skua in Iceland, with an indication of the size of the colonies.

Fig. 3 shows the regions in Iceland covered by Maps I-XI, which give the location of the Great Skua colonies in more detail. Place names are also given as further help in localizing the colonies.

A total of 23 separate colonies were identified, containing from 35 to 1418 pairs each.

Some of these colonies were divided into smaller sub-colonies. Great Skuas are known to have bred at one additional locality. It was sometimes difficult to determine, whether two close-lying colonies were one or two colonies. Notes were also made on the vegetation and basic topographic features of the areas.

COLONY DESCRIPTIONS

1. Hafnasandur. Map I.
10-12 pairs. 1-2 July 1985.

The colony is south of Keflavík, between Hafnir and cape Reykjanes, on the Hafnasan-

Table 1. The number of breeding pairs of Great Skua *Stercorarius skua* in the different colonies in Iceland 1984-1985. The table also shows the approximate sizes of the breeding areas (km^2), and the density of pairs (pairs/km^2).

	Colony name	Map no.	No. prs (Conf. interval)[1]	Mean	Freq. (%)[2]	Area (km^2)[3]	Prs/km^2
1.	Hafnasandur	I	10-12	11	0.2	14	0.8
2.	Thorlákshöfn	II	6-8	7	0.1	16	0.4
3.	Thjórsá	III	10-12	11	0.2	-	-
4.	Rangársandur	III	10-12	11	0.2	6	1.8
5.	Bergthórshvoll	III	10-12	11	0.2	3	3.7
6a.	Markarfljót west	III	80-90	85	1.6	-	-
6b.	Markarfljót east	III	45-50	47.5	0.9	-	-
7.	Markarfljót north	III	10-15	12.5	0.2	-	-
8a.	Skógasandur	IV	175-190	183	3.4	14	13
8b.	Sólheimasandur	IV	70-80	76	1.4	8	9.5
9a.	Múlakvísl south	V	68-78	73	1.4	7	10
9b.	Múlakvísl north	V	2-3	2.5	0.0	-	-
10.	Mýrdalssandur	V	46-55	50.5	0.9	46	1.1
11.	Kúdafljót	V	50-68	59	1.1	-	-
12a.	Medallandssandur	V	70-85	77.5	1.4	-	-
12b.	Eldvatn	V	35-42	38.5	0.7	10	3.9
13.	Mávabót	V	18-25	21.5	0.4	14	1.5
14.	Brunasandur	VI	40-60	50	0.9	45	1.1
15a.	Skeidarársandur	VI	1275-1560	1418	26.2	400	3.5
15b.	Ingólfshöfdi	VI	4-6	5	0.1	-	-
16.	Öraefi	VII	1200-1440	1320	24.2	27	49
17a.	Breidam.sandur west	VII	1180-1370	1275	23.6	34	38
17b.	Breidam.sandur east	VII	210-240	225	4.2	23	9.9
18.	Steinasandur	VIII	11-15	13	0.2	-	-
19.	Hornafjardarfljót	VIII	4-6	5	0.1	-	-
20.	Lónsvík	IX	4-6	5	0.1	8	0.6
21a.	Héradssandur west	X	78-96	87	1.4	20	4.4
21b.	Héradssandur east	X	12-14	13	0.2	9	1.4
22.	Öxarfjördur	XI	210-240	225	4.2	30	7.5
23.	Skjálfandi	XI	see text	-	-	-	-
Total			4943-5890	5418.5			

Notes:
[1]Confidence interval is based on line-transects, and gives the lowest and highest number of pairs breeding in the colonies. The confidence interval varied between 10 % for small colonies and 20 % for larger colonies. Therefore the same confidence interval (one standard deviation) cannot be used for all colonies.
[2]Frequency is the number of pairs per colony x 100 divided by the total number of pairs in Iceland.
[3]The colony area is calculated where possible, and is defined as the area which holds all the breeding pairs.

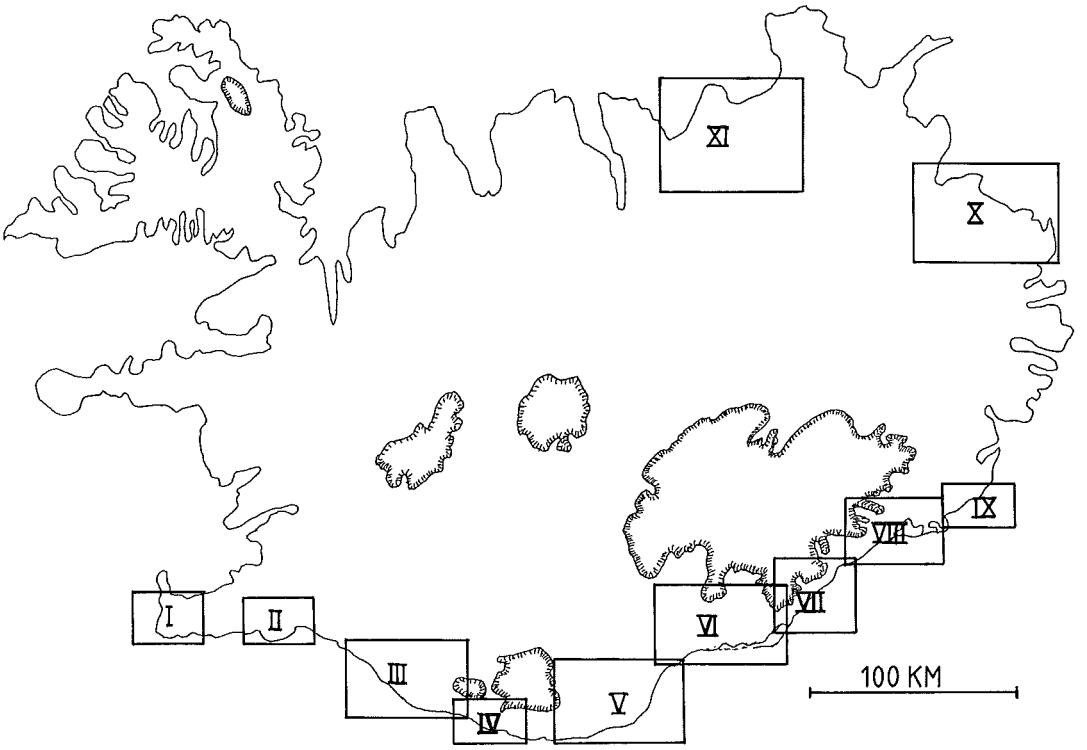
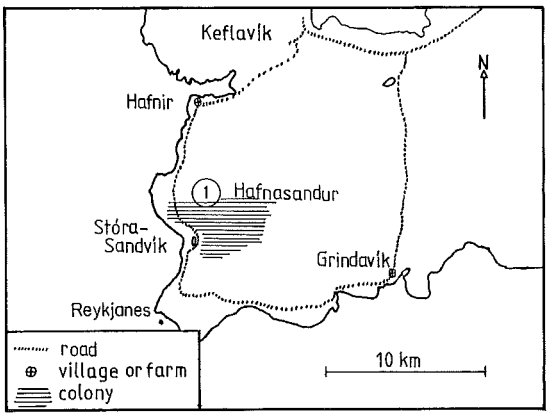


Fig. 3. The location of Great Skua colony areas covered by maps I-XI.

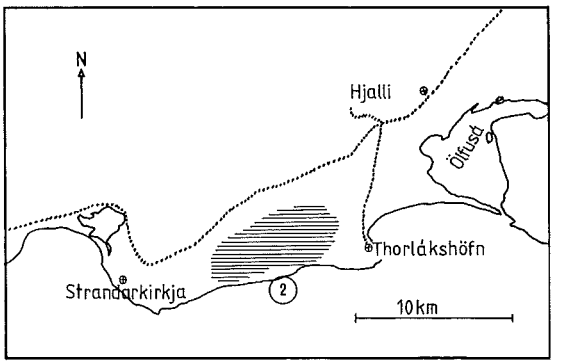
dur gravel plain, inland from Stóra-Sandvík. This is a very dry area consisting of old lava fields with sand dunes, mostly covered by Lymegrass *Elymus arenarius* and very little other vegetation. The skuas bred very scattered on the dunes.

2. Thorlákshöfn. Map II.
6-8 pairs. 30 June 1985.

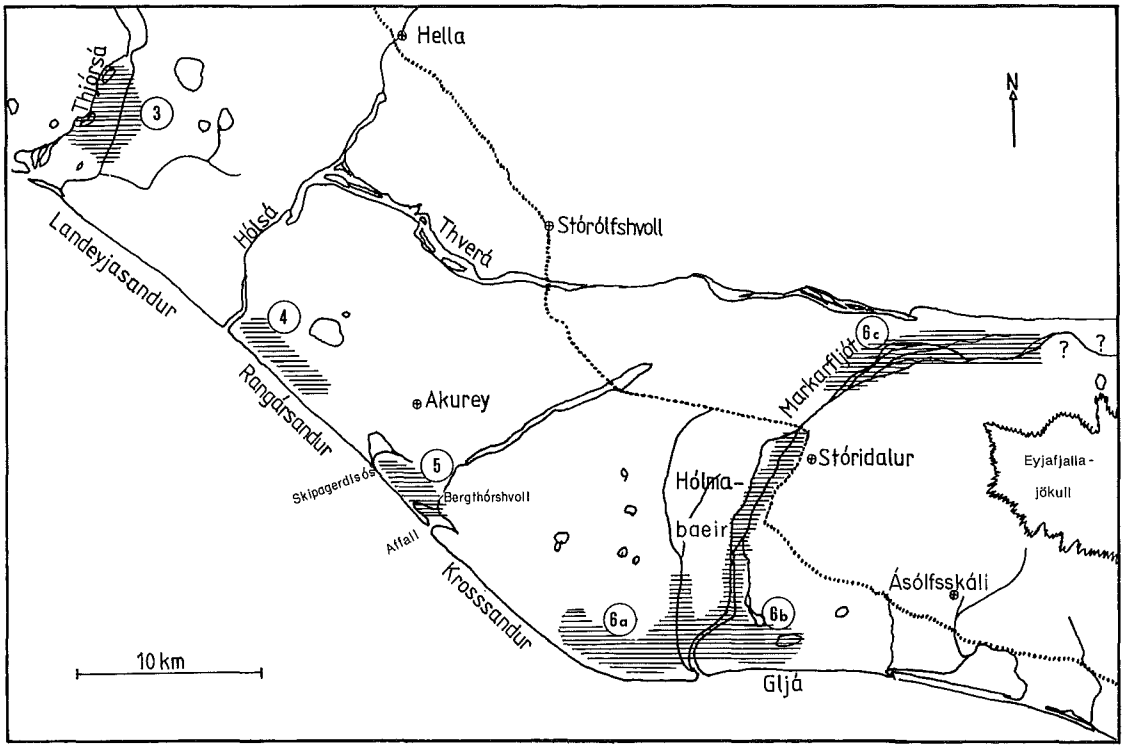
The colony is placed west of the village on a huge sand dune area towards Strandarkirkja. Topographically similar to Hafnasandur.



Map I. The location of the Great Skua colony at Hafnasandur, Southwest Iceland.



Map II. The location of the Great Skua colony at Thorlákshöfn, Southwest Iceland. Signature as in Map I.



Map III. The location of the Great Skua colonies in the Landeyjar area in South Iceland.

3. Thjórsá. Map III.
10-12 pairs. 29-30 June 1985.

About 1/3 of the pairs were breeding on the east bank of the river. The remaining pairs were breeding on small islands in the river, consisting of alluvial deposits (gravel), with grass and Iceland Rush *Juncus arcticus*. The east bank was meadow-like grassland. Most of the west bank was cultivated, consisting of hay fields and grassland where no Great Skuas bred.

4. Rangársandur. Map III.
10-12 pairs. 3 July 1985.

The colony was on the northwest part of the sandur, southeast of the river Hólsá. The nests were on dunes covered with Lymegrass.

5. Bergthórshvoll. Map III.
10-12 pairs. 3 July 1985.

The colony is placed in a dune area near the coast, between Skipagerdisós and the former river Affall. Same description as for Rangársandur.

6a. Markarfljót, western part. Map III.
80-90 pairs. 4-7 July 1985.

The breeding area comprises the southern parts of Hólmabaeir, Búdarhólshverfi, and the southeast part of Krosssandur. The Hólmabaeir and Búdarhólshverfi colonies are mostly on grassland, but on the southern part of these areas, there were sandbars consisting of alluvial deposits from the glacier river. The vegetation was Willow *Salix* sp., Crowberry *Empetrum nigrum*, Iceland Rush, and grasses. In some places a thin moss-carpet covered the sand. In the southern part of the delta, towards the sea, there were huge areas of alluvial deposits (black sand) completely devoid of vegetation and birds. In the southeastern part of the Krosssandur, the skuas were breeding on dunes with Lymegrass.

6b. Markarfljót, eastern part. Map III.
45-50 pairs. 4-7 July 1985.

In the area called Gljá, which consisted mostly of dunes covered with Lymegrass, 10-12 pairs

were breeding. Here we found a nest, which was only a small depression in the sand, and without any vegetation in the nest or nearby. This was our only record of a Great Skua breeding in a nest without any nest material. The rest of the pairs were breeding on small islands in the delta, consisting of alluvial deposits covered with Iceland Rush and grasses.

7. Markarfljót, north of road no. 1. Map III.
Min. 10-15 pairs. 4-6 July 1985.

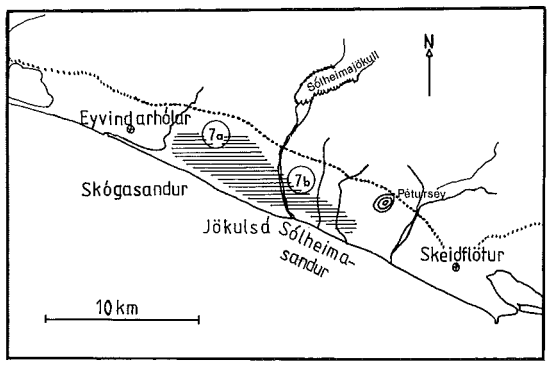
The birds were breeding on the alluvial plains of Markarfljót. We only covered the outer parts of the plain, from road no. 1, approximately 15 km towards Thórsmörk. Probably some Great Skuas are breeding on the innermost part of the plain (A. Petersen, in litt.).

8a. Skógasandur. Map IV.
175-190 pairs. 8-9 July 1985.

The area is situated from the river Skógá eastwards towards Jökulsá. Skógasandur is a stony, dry sandur mostly covered with grasses and moss (Fig. 4), but parts are mostly devoid of vegetation. Small dunes covered with Lymegrass were scattered throughout the area towards the shore.

8b. Sólheimasandur. Map IV.
70-81 pairs. 8-9 July 1985.

Same description applies as for Skógasandur. The area east of Húsá, called Eyjarmýri, is more wet and meadow-like. The Great Skuas were breeding scattered towards Pétursey.



Map IV. The location of the Great Skua colonies at the Skógasandur-Eyjarmýri area, South Iceland.

Fig. 4. Turf with Great Skua nest (near the book). Skógasandur, July 1985. Photo: Peter Lange.

9a. Múlakvísl, southern part. Map V.
68-78 pairs. 10 July 1985.

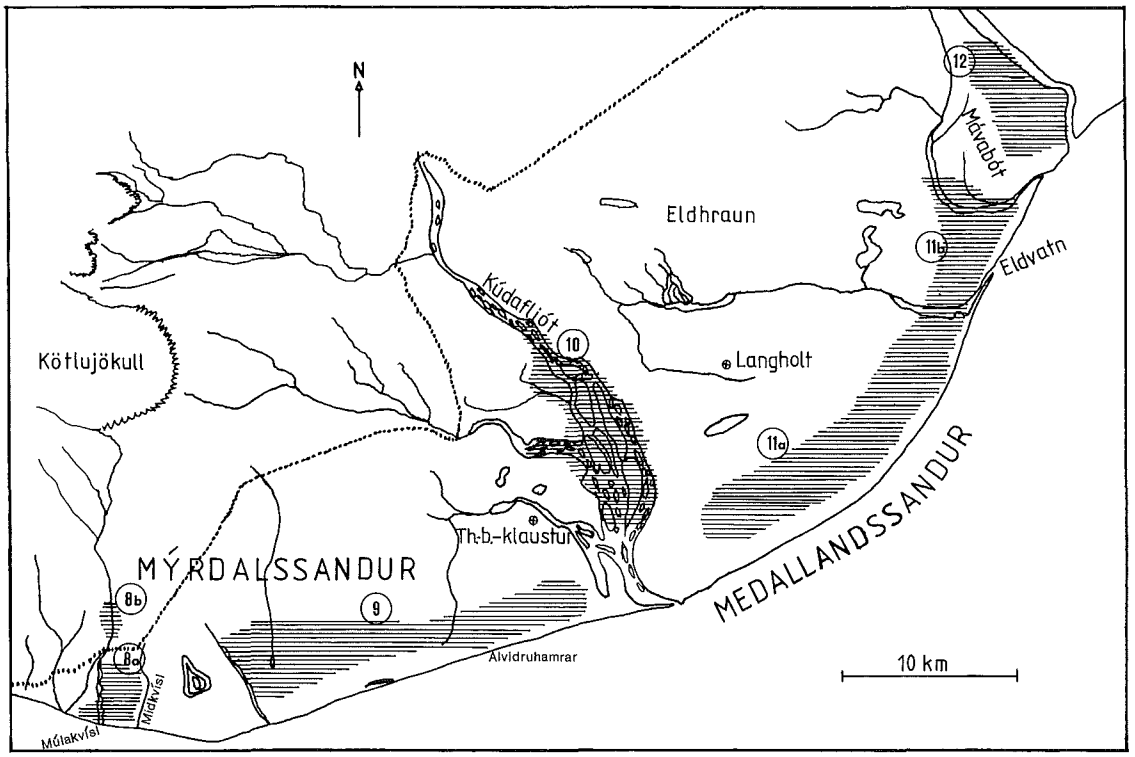
The breeding area is primarily situated between the two glacial rivers Múlakvísl and Midkvísl. The vegetation in the area was quite unusual. It consisted of a thick moss-carpet with some Iceland Rush. From Múlakvísl towards Midkvísl the vegetation becomes increasingly less dense, and from Midkvísl eastwards to Hjörleifshöfdi, there was no vegetation. In this small area we found a density of 10 pairs/km^2, which is remarkably high compared with the rest of the region (see Table 1).

9b. Múlakvísl, northern part. Map V.
2-3 pairs. 10 July 1985.

The birds were breeding north of road no. 1, on small islands in the river.

10. Mýrdalssandur. Map V.
46-55 pairs. 11-13 July 1985.

The breeding areas were situated between Hjörleifshöfdi and the river Kúdafljót. The area was covered on foot from Mýrnatangi to the emergency shelter at Alvidruhamrar. In this area 30-53 breeding pairs were found on Lymegrass dunes. By aeroplane 8-10 pairs were counted between Alvidruhamrar and Hjörleifshöfdi (see Methods). The birds were breeding on dunes covered with Lymegrass. From Sandvatn to Alvidruhamrar including Bólhraun there was no vegetation except dunes covered with Lymegrass near the beach.



Map V. The location of the Great Skua colonies on Mýrdalssandur and Medallandssandur, South Iceland.

The rest of the Mýrdalssandur, e.g. the big plains around road no. 1, were completely free of vegetation, and consisted mostly of huge areas of black sand. In these areas there were no birds at all.

11. Kúdafljót. Map V.
50-60 pairs. 14-16 July 1985.

Pairs were breeding on very moist small islands in the river Kúdafljót. The islands were mostly covered with Iceland Rush, grasses and moss. Some of the pairs were breeding on small tussocks carried ashore by the river (Fig. 5).

12a. Medallandssandur. Map V.
70-85 pairs. 14-16 July 1985.

The colony is situated in the eastern parts of Medallandssandur and in the area Sjávarmelar east of Medallandssandur. This is a huge area, mostly covered with Lymegrass dunes whereupon the Great Skuas often had their nests. The Sjávarmelar area was covered by aeroplane (see Methods).

12b. Eldvatn. Map V.
35-42 pairs. 14-16 July 1985.

The colony is situated northeast of the river Eldvatn where 25-30 pairs nested on Lymegrass dunes. The remaining pairs bred in moist meadow-like areas covered with Iceland Rush and grasses.

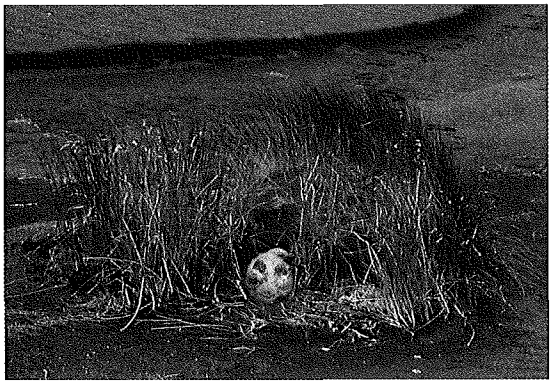


Fig. 5. An unusual nesting place of Great Skua on a piece of turf. A 15-20 days old nestling hiding in the foreground. July 1985. Photo: Peter Lange.

13. Mávabót. Map V.
18-25 pairs. 19 July 1985.

On Mávabót which consisted of dunes covered with Lymegrass, 8-10 pairs were breeding. The rest of the birds were breeding in the surrounding area called Landbrotsvötn, which was a very wet area, mostly covered with grasses. Census was made by aeroplane (see Methods).

14. Brunasandur. Map VI.
40-60 pairs. 19 July 1985.

The pairs were breeding on sand dunes between the grassland part of Brunasandur and the flooded areas of Skeidarársandur. The colony consisted of three sub-colonies. Census was carried out by aeroplane (see Methods).

15a. Skeidarársandur. Map VI.
1275-1560 pairs. 19 July 1985.

Skeidarársandur is the largest of all the sandurs in Iceland, formed by alluvial deposits carried by glacier rivers from the Vatnajökull, the largest ice cap on Iceland. The Skeidará river changes its course constantly making it difficult to draw precise maps of the area.

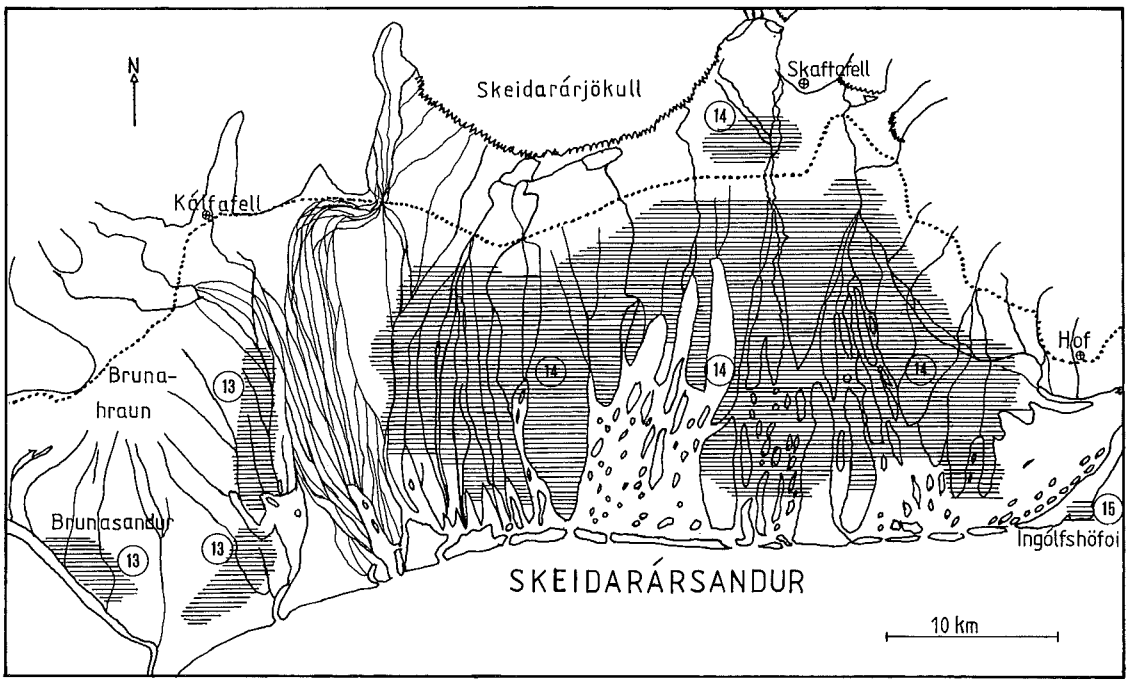
The description and precise distribution of the vegetation and birds on Skeidarársandur is insufficient, because the census was made from aeroplane. In general, grasses, Iceland Rush and moss were found at most of the breeding sites. Though, in some parts there were dunes, on which the Great Skuas were breeding. A big part of the western fringe of Skeidarársandur was flooded, probably by the river Núpsvötn.

15b. Ingólfshöfdi. Map VI.
4-6 pairs. 19 July 1985.

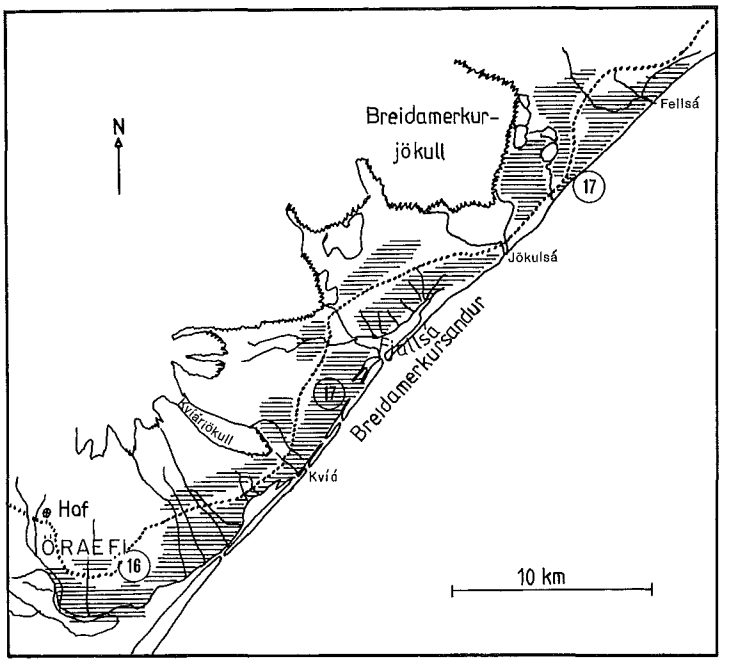
The pairs were breeding on the plateau of Ingólfshöfdi, a small headland on the coast of Skeidarársandur. The census was made from an aeroplane (see Methods).

16. Öraefi. Map VII.
1200-1400 pairs. 19-21 July 1985.

In this area the colony with the highest density of breeding Great Skuas, was found, in some places more than 50 pairs/km^2 (see Table 1).



Map VI. The location of the Great Skua colonies in the Brunasandur area and on Skeidarársandur, South Iceland.



Map VII. The location of the Great Skua colonies in Öraefi and the Breidamerkursandur areas, South Iceland.

In the Öraefi region Great Skuas were breeding everywhere from west of Nestangi to the river Kvíá, except in the most wet and swampy areas around the rock Salthöfdi. In the Öraefi region we even saw Great Skuas holding territories on hay-fields. Some nests were placed only about 300 m from the farm houses at Hofsnes.

The vegetation was mostly dominated by grasses and Iceland Rush. The area west of Kvíá is covered with moss and some Iceland Rush. Nearly all the pairs breeding in Öraefi were found east of Nestangi. About 20 pairs were breeding north of road no. 1.

17a. Breidamerkursandur, western part.
Map VII.
1180-1370 pairs. 21-25 July 1985.

The breeding area covered the sandur from Kvíá to Jökulsá. It is also a very densely populated area (see Table 1).

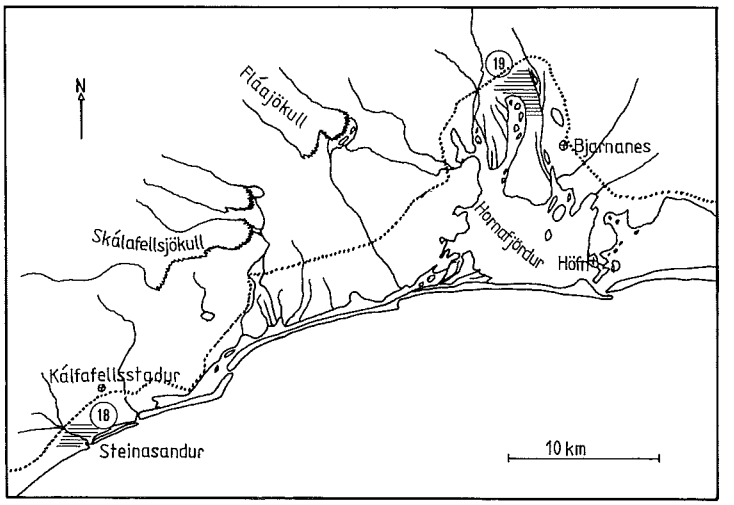
The area is quite dry and relatively uniform, mostly covered with a moss carpet and low Iceland Rush, being the typical vegetation on the Breidamerkursandur (Fig. 6). About 10% of the pairs were breeding in the moraine hills north of road no. 1.

17b. Breidamerkursandur, eastern part.
Map VII.
210-240 pairs. 21-25 July 1985.

The area is situated between Jökulsá and Fellsá. North of road no. 1 the area is dominated by glacial deposits (moraines), with little vegetation. The area south of road no. 1 is more level ground and sandur-like. Most of the area was sparsely covered with moss and Iceland Rush.

When comparing the eastern and western

Fig. 6. Typical Great Skua breeding area. The vegetation is mostly Iceland Rush, typical for Breidamerkursandur. July 1985. Photo: Peter Lange.



Map VIII. The location of the Great Skua colonies in the Sudursveit and the Hornafjördur areas, Southeast Iceland.

part of Breidamerkursandur, it is significant that the Great Skuas prefer the flat sandurs, and not the hilly moraines, for breeding (see also Table 1 and Discussion).

18. Steinasandur. Map VIII.
11-15 pairs. 25 July 1985.

The small colony is placed south of the road, on a typical sandur-area, covered with grasses and Iceland Rush.

19. Hornafjardarfljót. Map VIII.
4-6 pairs. 28 June 1985.

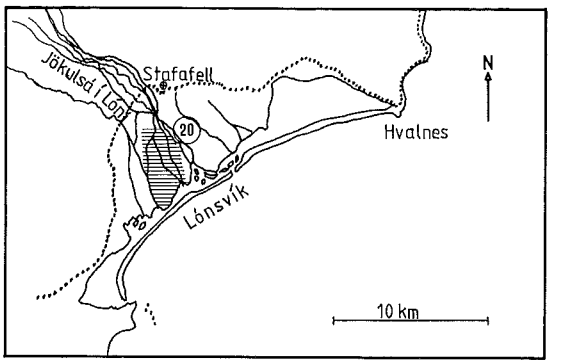
The birds were breeding on small islands in the river Hornafjardarfljót, a typical wet sandur area, with Iceland Rush and low grasses. The Great Skuas were counted by telescope.

20. Lónsvík. Map IX.
4-6 pairs. 12-14 July 1984.

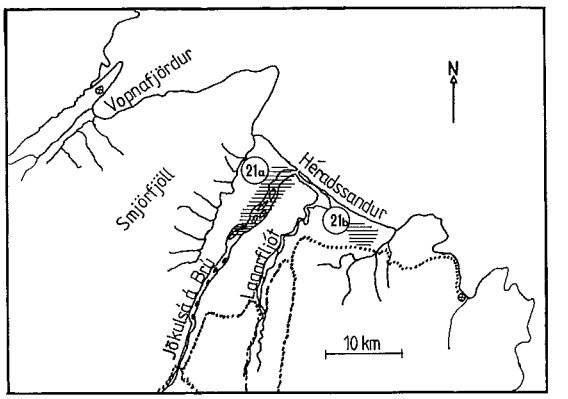
The pairs were breeding on small islets in the river Jökulsá í Lóni.

21a. Héradssandur west. Map X.
78-96 pairs. 20-25 June 1984.

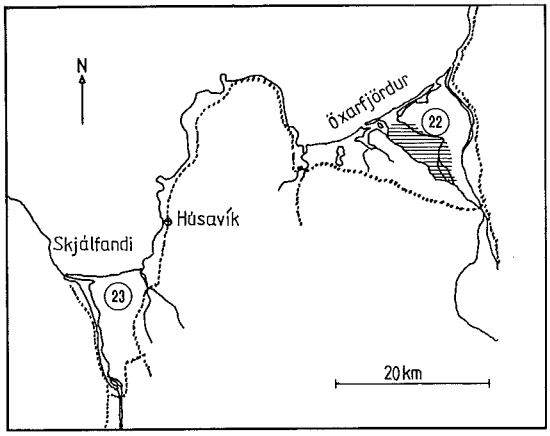
Great Skua breeding sites were located in Hróarstunga, on islets in the river Jökulsá á Brú, and on the sandur south of Lagarfljót river. The vegetation was grasses, moss, Iceland Rush and in some places low Willow.



Map IX. The location of the Great Skua colony at Lónsvík, Southeast Iceland.



Map X. The location of the Great Skua colonies at Héradsflói, Northeast Iceland.



Map XI. The location of the Great Skua colony in Öxarfjördur, North Iceland.

21b. Héradssandur east. Map X.
12-14 pairs. 27-28 July 1985.

The pairs were breeding south of Lagarfljót and north of the road no. 94. The vegetation was grasses and moss.

22. Öxarfjördur. Map XI.
210-240 pairs. 1-5 July 1984.

The birds were breeding on a dry, uniform area called Flatir, located in the eastern part of the sandurs of Öxarfjördur. The vegetation was rich, with moss, grasses, Willow, and Iceland Rush (Fig. 7).

23. Skjálfandi. Map XI.
? breeding. Not visited (see text).

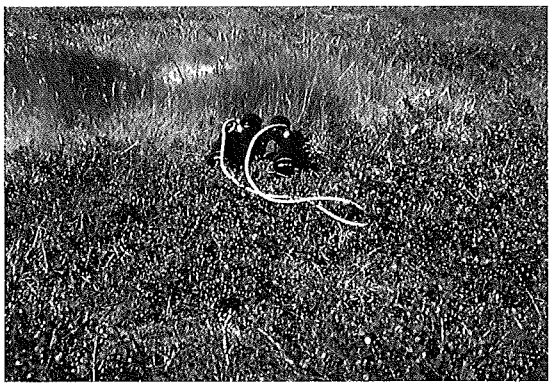


Fig. 7. Turf with a Great Skua nest in the centre of a territory. Öxarfjördur. July 1984. Photo: Peter Lange.

This area was not visited by the authors. The information was given by I. Petersen (in litt.), who worked in the area for several summers. West of Skjálfandi two breeding attempts have been confirmed, one in 1978 and one in 1980, but due to human persecution no breeding attempts were later recorded in the area.

AREAS SURVEYED BUT WITHOUT NESTING GREAT SKUAS

Visits were made to a number of potential Great Skua breeding localities, without finding any breeding birds. These were:

The west bank of the river Thjórsá, the central and southwest part of Rangársandur, and the central and northwest part of Krosssandur, all on Map III. These areas were visited 29 June – 3 July 1985, and the northern parts of Kúdafljót, Map V, on 12-13 July 1985.

In Southeast Iceland the inner parts (north of main road) of the Jökulsá í Lóni area, Hamarsfjördur, surroundings of Djúpivogur and Breiddalsvík (no maps), were visited in July 1984. In Northeast Iceland Vopnafjordur (Map X) was not visited, but according to A. Petersen (in litt.) there are probably a few pairs breeding in this area.

OTHER BIRD SPECIES

While working in the Great Skua colonies, several other bird species were recorded.

Twelve species were recorded regularly in the skua colonies, and breeding (nest, eggs or young) was confirmed for eight of these. These observations are summarized below:

Red-throated Diver *Gavia stellata*. Breeding in colonies no. 6a, 16, 17a, 17b, and 21.

Whooper Swan *Cygnus cygnus*. Adults with pulli in colonies no. 6a, 6b, 10, 12, 20, and 21.

Greylag Goose *Anser anser*. Not breeding, but found moulting in most colonies.

Eider *Somateria mollissima*. One female with young was seen on a small pond in the colony at Markarfljót (6b).

Ringed Plover *Charadrius hiaticula*. Very common among the nesting Great Skuas, recorded in colonies no. 4, 6, 8a, 8b, 9a, 16, 17a, and 17b.

Golden Plover *Pluvialis apricaria*. Several

birds showed breeding behaviour at Breidamerkursandur (17b), but breeding was not confirmed.

Dunlin *Calidris alpina*. Very commonly observed resting among the breeding Great Skuas.

Whimbrel *Numenius phaeopus*. Recorded in colonies no. 1, 2, 6a, 17a, 17b, 21b, and 22. No evidence of breeding.

Red-necked Phalarope *Phalaropus lobatus*. Very common among the skuas. Recorded in nearly all the colonies. Probably most of the birds were resting or migrating. No evidence of breeding.

Arctic Skua *Stercorarius parasiticus*. Recorded in colonies no. 1, 2, 6a, 6b, 8b, 12, 13, 16, 17a, 17b, 20, and 22. Missing in the most densely populated parts of the Great Skua colonies.

Great Black-backed Gull *Larus marinus*. Very common breeding birds among the skuas, often being the only other breeding species in their colonies. Breeding was confirmed in colonies no. 2, 4, 5, 6a, 6b, 7, 8a, 9a, 17b, 20, 21, and 22. There were 30-40 pairs at colony no. 4.

Arctic Tern *Sterna paradisaea*. Terneries were recorded in colonies no. 6a, 17a, and 17b.

Some of the species, e.g. the Ringed Plover and the Red-necked Phalarope were found very commonly among the skuas. We never saw Great Skuas attacking birds of these species. On the other hand, attacks on larger species, e.g. gulls *Larus* spp., Arctic Skua and geese *Anser* spp., were observed in most colonies. Greylag Geese were not breeding in the skua colonies, but they were often seen on rivers or the sandurs in huge moulting flocks. On several occasions Great Skuas were observed chasing one or two geese, obviously with the purpose of killing them. Several carcasses of Greylag Geese were found which showed the success of such attacks.

DISCUSSION

In 1984 the survey was started on 21 June, and in 1985 on 27 June, since this is the main hatching period for Great Skua in Iceland (Gudmundsson 1954). The young had fledged by the latter half of August. We left Iceland on 19 July in 1984, and on 1 August in 1985. Thus the survey was made during the chick-rearing period.

The present material pays no attention to the fact that weather conditions may have influenced the number of territory-holding and breeding pairs. It is unknown if bad weather conditions affected the breeding success in the two survey summers. Nevertheless, it is supposed, that only extremely bad weather conditions affects the breeding success of the Great Skuas.

While working in the colonies, it was discovered that in general adult birds reacted more violently and aggressively to intruders after hatching of the eggs. As our method is based on a one-visit line-transect between late June and August, the aggression level of the birds may have influenced the results, as highly aggressive birds are more easy to record than less aggressive ones. This source of error is thought to be very small, as the biggest colonies on the southwest coast were censused in the middle of July in the chick-rearing period.

A part of the census was made from the air, and this obviously places some uncertainty on the results. Nevertheless, we think this method was worth trying. Tests showed that comparable results can be obtained by this method and the land-based line transect method, though we think the latter is more accurate.

According to the census, the breeding population of the Great Skua in Iceland consists of between 4943 and 5890 pairs (mean = 5418; Table 1). Gudmundsson (1954) estimated about 6000 breeding pairs in Iceland, which shows a good agreement with the results of the present survey. The North Atlantic population of the Great Skua comprises about 13000 breeding pairs (Furness 1986), and the breeding population in Iceland is some 5400 pairs, which is 42% of the entire population. Together with Shetland, Iceland is the species' stronghold in the North Atlantic.

The breeding sites of the Great Skua in Iceland are of two topographic types, the sandur and the dune areas. In 1984-85 only some 5% of the population, 250-300 pairs, were breeding on dune areas. These areas were uniform and mostly covered with Lymegrass, in contrast to the sandur areas, which varied in vegetation and wetness.

More than 95% of the pairs were breeding on sandur areas, which consists of alluvial de-

posits from braided glacial streams. These streams divide, rejoin and change their courses, leading to a continuous formation and destruction of sand flats and gravel bars. These areas form the main breeding habitat of Icelandic Great Skuas. Because of the unequal extent of the two types of breeding habitats, it was not possible to determine the preferential breeding habitat of the Great Skua in Iceland. Yet, in areas where both types of landscapes were present, for instance at Skógasandur (South Iceland), the skuas mostly breed on the sandur areas.

Most of the sandur areas are very unstable, and this instability is said to cause displacement of the colonies (Furness 1986). For example, breeding numbers on Breidamerkursandur was estimated as 1500 pairs in 1954 (Gudmundsson 1954), but only 425 pairs in 1961 (Dickens 1964). Similarly, Björnsson (1976) estimated that 1500 pairs were breeding in the area between Jökulsá and Skeidará, while the present census in this area gave between 2560 and 3180 pairs (mean = 2915) in 1985. For Skeidarársandur Björnsson (1976) estimated 3000 pairs, where the present survey gave between 1200 and 1500 pairs (mean = 1350).

It is possible to interpret these changes in terms of the Skeidarársandur skuas moving to the Öraefi area, but it is unknown whether this has actually taken place. In general, further studies are needed to clarify the extent to which population changes in individual colonies and areas, are due to local factors, and interchange between the areas, or some other reasons.

The Skeidarársandur, Öraefi and Breidamerkursandur colonies hold nearly 80% of the entire breeding population in Iceland. These areas also hold the greatest density of pairs (Table 1). This is very significant, and is not due to the lack of human presence. In the Faroes Great Skuas breed far away from inhabited areas (Bengtson & Bloch 1983). At Öraefi, in Southeast Iceland, Great Skuas were found breeding within 300 meters of farms, and in some places they were even breeding on cultivated hayfields. This implies that, even if persecution takes place here, it does not significantly affect the Great Skuas' choice of breeding sites. Food availability probably is the main factor determining the site and size of the colonies. The Öxarfjördur area, Northeast Iceland (Map XI), for instance, is about five times as big as Breidamerkursandur. Both consist of sandur with similar vegetation, but there were seven times as many breeding pairs on Breidamerkursandur.

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