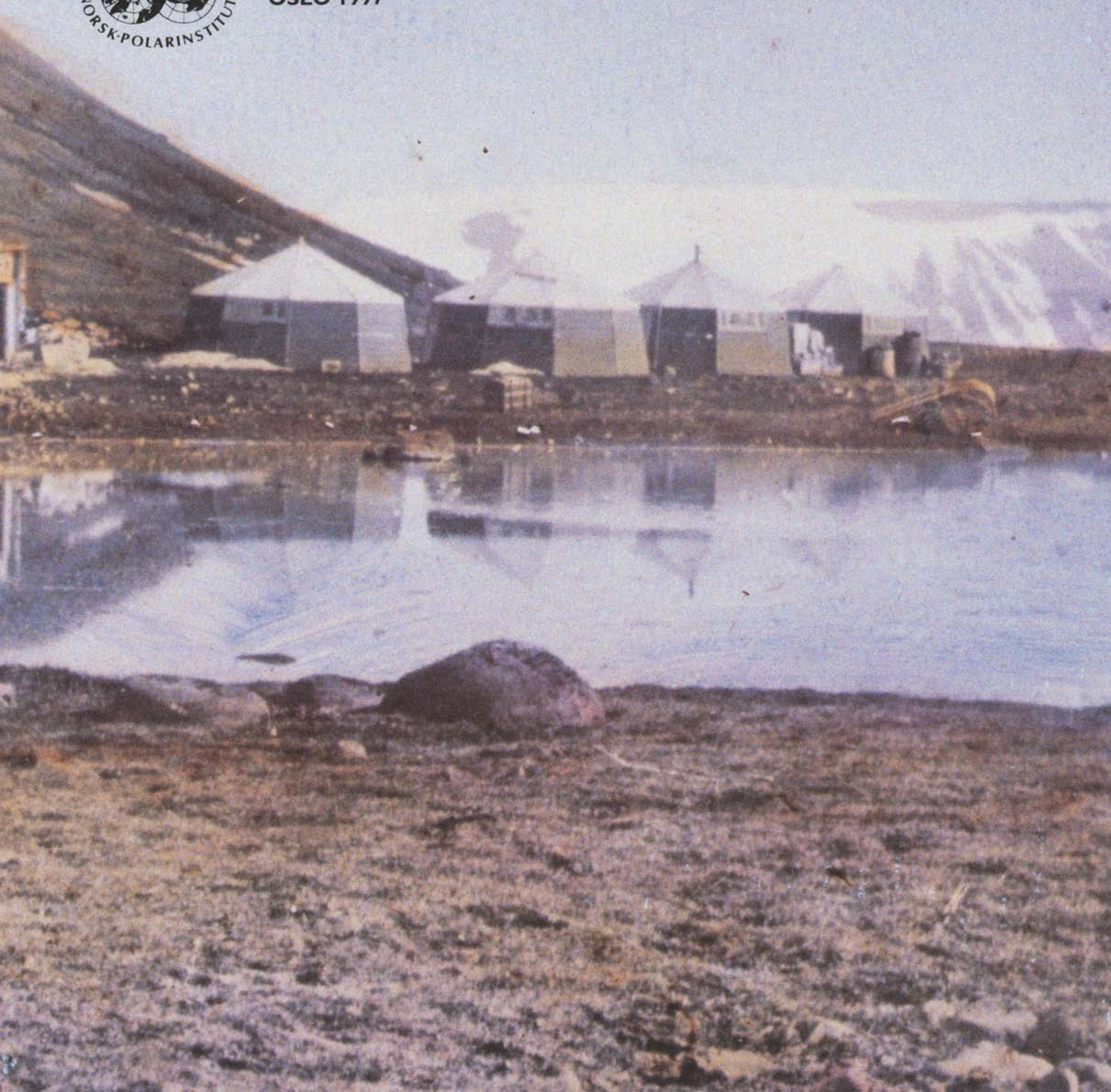


**SUSAN BARR (Editor)**

**The FRAM anniversary cruise  
to Zemlja Franca-Iosifa  
23 August – 5 September 1996**



**MEDDELELSER NR. 149  
OSLO 1997**







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**The FRAM anniversary cruise to Zemlja Franca-Iosifa  
23 August - 5 September 1996**

Final cruise report from the Norwegian Polar Institute, Oslo

**NORSK POLARINSTITUTT  
OSLO 1997**

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Cover: Copy of a hand-coloured lantern slide of Jackson's base "Elmwood" on Cape Flora, from Nansen's own collection. Norsk Polarinstitut's photo archives.

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# C O N T E N T S

Barr, S.: Cruise report .....	5
<i>SCIENTIFIC REPORTS</i> .....	9
Barr, S.: Study and documentation of historical sites .....	11
Orheim, O. & Barr, S.: Nansen's and Johansen's route from Cape Norvegia to Cape Flora .....	15
Bakken, V., Strøm, H. & Terticky, G.: Seabird investigations at Cape Flora, Northbrook Island .....	16
Bakken, V.: Ivory Gull research on Zemlja Franca-Iosifa .....	18
Wiig, Ø. & Boltunov, A. : Marine Mammals .....	21
Verkulich, S.R., Drewry, D.J., Orheim, O. & Burlakov, Yu.K.: Glaciological observations in the Zemlja Franca-Iosifa archipelago, August 1996 .....	23
Makshtas, A.P.: The total ozone content measurements during the <i>Fram</i> anniversary cruise to Zemlja Franca-Iosifa	30



*The cruise participants.  
Photo: Svein E. Furulund/Aftenposten*

SUSAN BARR:

## CRUISE REPORT

### TRANSPORT

Norsk Polarinstitutt's (NP) research vessel *Lance* transported the expedition from Longyearbyen, Svalbard – Zemlja Franca-Iosifa – Longyearbyen. An AS350B helicopter and rubber boats were used for local transport in the archipelago.

### PARTICIPANTS IN ADDITION TO THE CREW OF THE LANCE

*From Norway:*

- Olav Orheim, NP director, glaciologist
- Vidar Bakken, NP, biologist
- Susan Barr, NP, ethnologist/historian
- Hallvard Strøm, University of Trondheim, biologist
- Øystein Wiig, University of Oslo, sea mammal scientist
- Marit Greve, Nansen's granddaughter
- Christian K. Rytter, member of the Fram Committee
- Per Antonsen, Ministry of the Environment
- Ole Kristen Harborg, Norwegian Broadcasting Company (NRK)
- Espen Gleditsch, NRK
- Cato Guhnfeldt, Aftenposten newspaper
- Svein E. Furulund, Aftenposten newspaper
- Ole Martin Bjørnhaug, helicopter pilot
- Gaute Wiger, helicopter mechanic

*From Great Britain:*

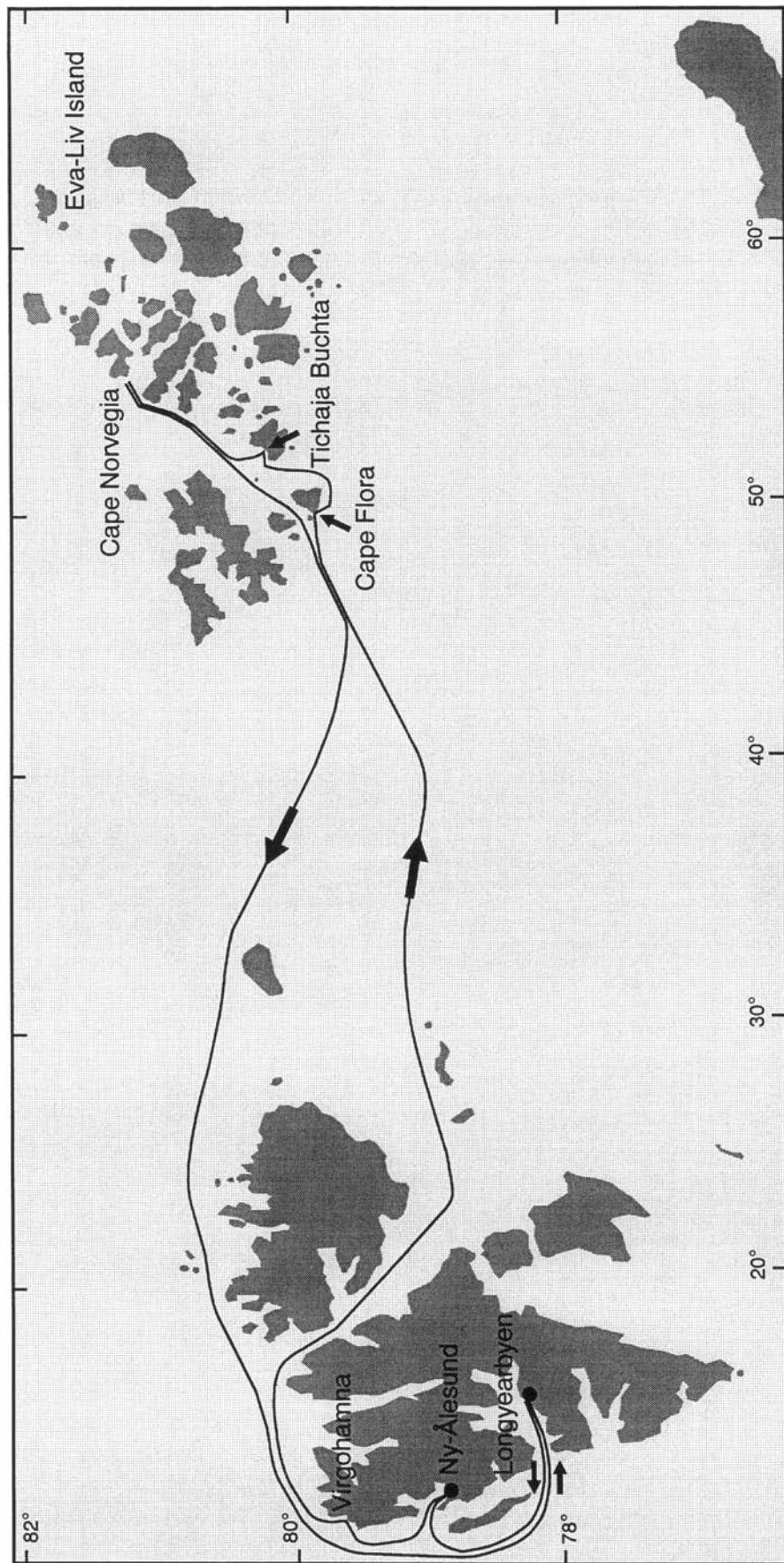
- David Drewry, Natural Environment Research Council (NERC), glaciologist

*From Russia:*

- Iury Konstantinovitch Burlakov, State Duma, Moscow
- Igor Roumiantsev, Russian Embassy, Oslo
- Andrei Boltunov, All-Russian Research Institute for Nature Protection (PRIRODA), Moscow, sea mammal scientist
- Alexandr Makshtas, Arctic and Antarctic Research Institute (AARI), St Petersburg, meteorologist
- Grigorij Terticky, PRIRODA, biologist
- Sergei Verkulich, AARI, glaciologist

### PURPOSE

One hundred years ago, 13<sup>th</sup> August and 20<sup>th</sup> August 1896, Fridtjof Nansen and the polar ship *Fram* returned to Norway after their three-year drift in the ice across the Arctic Basin. Nansen and Hjalmar Johansen had left the *Fram* in March 1895 to make an extra strike for the North Pole. They turned at 86°14'N and retreated southwards across the ice towards land, which happened to be Zemlja Franca-Iosifa. Here the approaching winter forced them to undertake an overwintering in a small, primitive, stone-and-turf hut. After nearly nine months in this "hole in the ground", they continued south-westwards through the archipelago, and met by the most fortunate coincidence the English explorer Frederick Jackson, who



Route of the «Fram» anniversary cruise, August - September 1996

was spending three years researching the islands from his base at Cape Flora. This meeting saved Nansen and Johansen the necessity of realising their plan to paddle their kayaks across the Barents Sea to Svalbard, a trip which would possibly have cost them their lives.

Norsk Polarinstitutt's cruise with the *Lance* was planned as one of several Norwegian celebrations of Fridtjof Nansen's remarkable expedition with the *Fram*. Supported by the Fram Committee, the expedition was to have joint Norwegian, Russian and British participation to mark the fact that Nansen's Norwegian expedition met with a British expedition on what is today Russian territory. Together the group, representing the three nations, would erect a memorial plaque in three languages at Cape Flora, where the meeting took place. The expedition would in addition attempt to follow as closely as possible Nansen's and Johansen's route through the archipelago from the wintering site at Cape Norvegia to Cape Flora. On the way scientific observations and studies would be made within several disciplines: polar history, ornithology, sea mammal studies, glaciology and meteorology, by scientists from the three nations.

Norsk Polarinstitutt is most grateful to the vice president of the Russian Duma, Arthur Chilingarov, and his staff, and to the Russian Embassy in Oslo for their efforts to make this anniversary cruise a success, and to the Fram Committee in Oslo for their economic support to the research projects.

## THE CRUISE

### *24<sup>th</sup> – 26<sup>th</sup> August*

The *Lance* left Longyearbyen on the morning of the 24<sup>th</sup> and sailed north of Spitsbergen and southwest through Hinlopenstretet. The research settlement of Ny-Ålesund and Virgohamna, the site of two airborne attempts to reach the North Pole, were visited on the way. Virgohamna was of particular interest for our expedition as the *Fram* met the Swedish balloonist Salomon August Andrée here in 1896, soon after the Norwegian expedition escaped from the ice after three long years.

### *26<sup>th</sup> – 28<sup>th</sup> August*

On the evening of the 26<sup>th</sup> the first sea ice was met in a belt between Svalbard and Zemlja Franca-Iosifa. Our Russian escort ship, the *Irtisch*, met us at the arranged position off Cape (mys) Flora on the morning of the 27<sup>th</sup>, and passport and visum control was carried out before we went ashore. Two days were spent on Cape Flora, where the memorial plaque was raised with enthusiastic participation of all three nationalities, including representatives from the *Irtisch*. In addition, the various historical remains in the area were surveyed and a small hut from the *Lance* was placed on the cape as living quarters for two ornithologists who were to spend a few days there. The walrus colony nearby was visited by the sea-mammal scientists. Throughout the cruise, scientific investigations in the various disciplines were carried out whenever the opportunity arose, and lectures explaining the research projects were held onboard.

### *28<sup>th</sup> -29<sup>th</sup> August*

Cape Flora was left on the afternoon of the 28<sup>th</sup> and the *Irtisch* escorted the *Lance* northwards to Tichaja Buchta, where the now-abandoned geophysical station was visited on the 29<sup>th</sup>. In the summer seasons 1990-1992 NP participated in a joint Russian (first Soviet)-Norwegian-Polish research station in one of the buildings. Ostrov Jackson was reached in the evening of the 29<sup>th</sup>.



### *30<sup>th</sup> August*

Nansen's and Jackson's wintering site at Cape (mys) Norvegia was visited and documented. This, as the visit to Cape Flora, was a memorable event for the Norwegian participants, and in particular for Nansen's granddaughter. A helicopter reconnaissance of seabird cliffs and sea mammals was flown around the island and some glaciological studies were carried out.

The two ships then turned back towards Cape Flora, meeting on the way the only slight hindrance from drift ice experienced during the cruise. Both on the north and southward journey the exact route taken by Nansen and Johansen was reconstructed as correctly as possible by comparing Nansen's published description with the actual landscape.

### *31<sup>st</sup> August*

At Cape Flora again. New ice on the sea and newly-fallen snow on the hilltops showed that the short summer was almost over. Historical and sea-mammal studies were carried out while the ornithologists and their hut were fetched on board. Ornithological studies were carried out as the ships then moved westwards past ostrov Bell and Zemlja Georga. A final passport control was held before the *Irtisch* was thanked for leading us safely through the archipelago. We are most grateful to the officers and crew of the *Irtisch* for the competent, friendly and helpful way in which they carried out their escort task.

### *1<sup>st</sup> – 4<sup>th</sup> September*

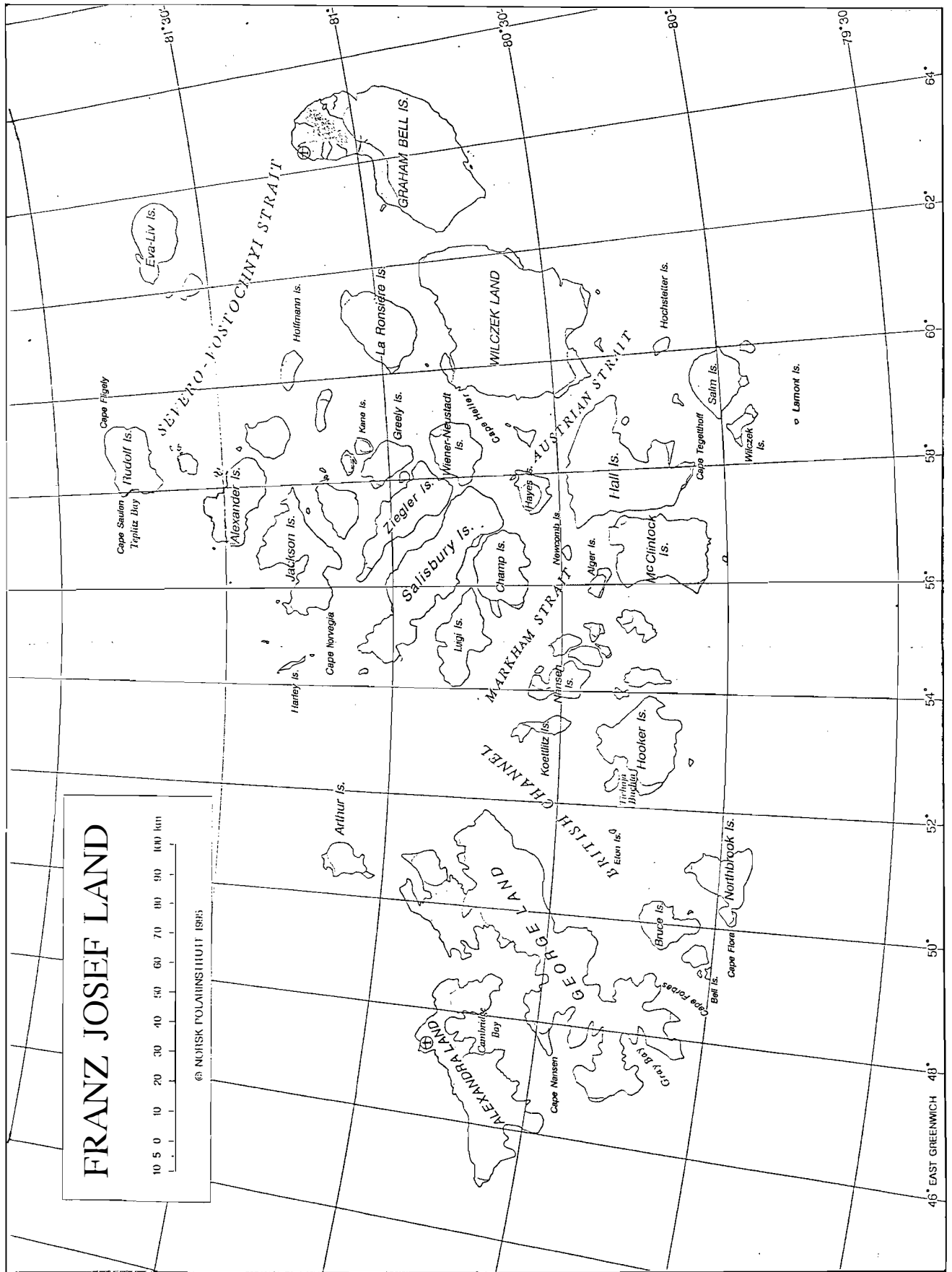
Westwards towards Svalbard. Ostrov Viktorija and Kvitøya were seen and passed at some distance, the weather being too bad to visit the latter as had been planned. The route this time went north of Nordaustlandet, round northwest Spitsbergen and to Longyearbyen.

## **POSTSCRIPT**

On September 6<sup>th</sup> there was an extensive and prestigious celebration in Oslo of the 100<sup>th</sup> anniversary of the *Fram* expedition. This started with a reception by the Mayor in the City Hall, followed by a cultural and scientific programme in the University Aula, attended by Their Majesties King Harald and Queen Sonja, and completed with a dinner given by the Government in the Hall of the Akershus Festning. Dr Chilingarov was happily able to attend these events. The cruise of the *Lance* and some of the immediate results from investigations carried out, played a major part in the celebrations.

The cruise was covered extensively by several large articles in the national newspaper *Aftenposten*, and two short programmes in the national television service NRK.

SCIENTIFIC REPORTS



SUSAN BARR:  
Norwegian Polar Institute, Oslo

## STUDY AND DOCUMENTATION OF HISTORICAL SITES

### BACKGROUND

The study was based on the fact that this author visited Zemlja Franca-Iosifa in 1990 with the intent of finding Fridtjof Nansen's and Hjalmar Johansen's wintering site from 1895-96, and of studying other historical sites of importance for Norwegian polar history (Barr 1991). At this time the archipelago had been a closed area since the early 1930s and the historical sites had therefore been spared newer human impact. Both mys Flora and mys Norvegia were visited in 1990 and have since that time been visited by a number of tourist groups. The revisit in 1996 was an excellent opportunity to compare the effects of such visits on vulnerable arctic sites (see Barr 1994).

With particular respect to the Nansen anniversary it was intended to follow as closely as possible the actual route taken by Nansen and Johansen, and to compare the geographical area today with that described in the published accounts of the two men.

### CAPE FLORA

This is one of the most-accessible areas of the archipelago with regard to ice conditions and is also a natural site for shorter or longer stays in the area. The area therefore shows evidence of use by different expeditions over a number of years. From literature studies (see Barr 1995) we know of the following expeditions which are the origin of the historical remains to be seen at Cape Flora today:

- Benjamin Leigh Smith (English) 1881-82
- Frederick Jackson (English) 1894-97
- Captain Støkken (Norwegian) 1901
- V.I. Al'banov (Russian) 1914
- Hertha (Gerta) relief expedition (Russian) 1914

Other expeditions which are connected with the area through written descriptions and photographs include:

- Fridtjof Nansen (Norwegian) 1896
- Walter Wellman (American) 1898
- Duke of Abruzzi (Italian) 1899, 1900
- Fiala-Ziegler (American) 1904-05
- Hjalmar Riiser-Larsen (Norwegian) 1928
- Otto Ju. Šmidt (Russian) 1929

Many other expeditions have visited Cape Flora during the years, but without leaving physical or documentary evidence of importance.

The main event at Cape Flora during our expedition was the erection of a memorial post and plaque to the meeting 100 years ago between Fridtjof Nansen and Frederick Jackson.

The meeting itself took place on the sea ice off the cape, so the memorial was raised near to the remains of Jackson's base Elmwood. The memorial was made to match as far as possible a similar post and plaque raised at Cape Norvegia in 1990 to commemorate the wintering by Nansen and Johansen. The plaque at Cape Flora bears the following text in Norwegian, English and Russian:

1911 Fridtjof Nansen met Frederick Jackson here 17.6.1896  
after the drift with "Fram" over the Arctic Ocean (1893-1896)  
and the wintering on Jackson Island with Hjalmar Johansen  
August 1996

Considering the fact that there has been a considerable number of visitors to the site since this author saw it in 1990, there was little noticeable evidence of wear and tear either on the monuments and sites or the vegetation. The stove and kettle which were so prominent beside the remains of Elmwood in 1990 (photograph Barr 1991:299) had gone. These were apparently removed to Moscow by P.V. Bojarskij already later in 1990. Unfortunately the work to erect the monument caused some impact on the surrounding vegetation, but this is an area with relatively strong growth and the impact is hopefully of a temporary nature.

The remains of Leigh Smith's wintering house were located. This is now right on the erosion edge of the shoreline so that only the back foundation wall and part of one side remains. Within a few years this will probably have disappeared.

The grave of a member of Jackson's expedition was located. As far as is known this is the first time the grave has been registered for many years.



*A polar bear shows interest in the memorial plaque newly erected on Cape Flora. Photo: Hallvard Strøm.*



The fact that the ship name GERTA (with Russian letters) and the remains of the date 1914 could still be seen on the large boulder by the Elmwood remains was also noted.

### CAPE NORVEGIA

Comparison with 1990 showed that the remains of Nansen's and Johansen's winter hut, the immediate area around this and the monument which was raised in 1990, all were apparently undisturbed by the amount of new visitors to the site. However, the area adjacent to the site and to the north showed a considerable amount of wear from helicopter landings and human traffic. Considering the historic importance of the site, and therefore its attraction as a tourist goal, the wear was, however, of an acceptable level and the tourist operators can be praised for their handling of the problem.

While we were at the site, we were presented with plans by a Russian group to develop the area of the site for tourism. The opinion of the Norwegian participants, in particular including Nansen's granddaughter, is that the site should be left as nearly as possible undisturbed and undeveloped so that visitors, in a controlled manner, may feel some of the atmosphere from the time when the two men stayed for a while in this total wilderness.

### DEPOTS

On this trip there was unfortunately no opportunity to investigate the sites of depots which Jackson laid down during his exploration of the area and which were intended for Nansen and the *Fram* men on the offchance that they came by that way. The approximate positions known from Jackson's published account (Jackson 1899) were however noted, and it is hoped there may be a new opportunity in the near future.

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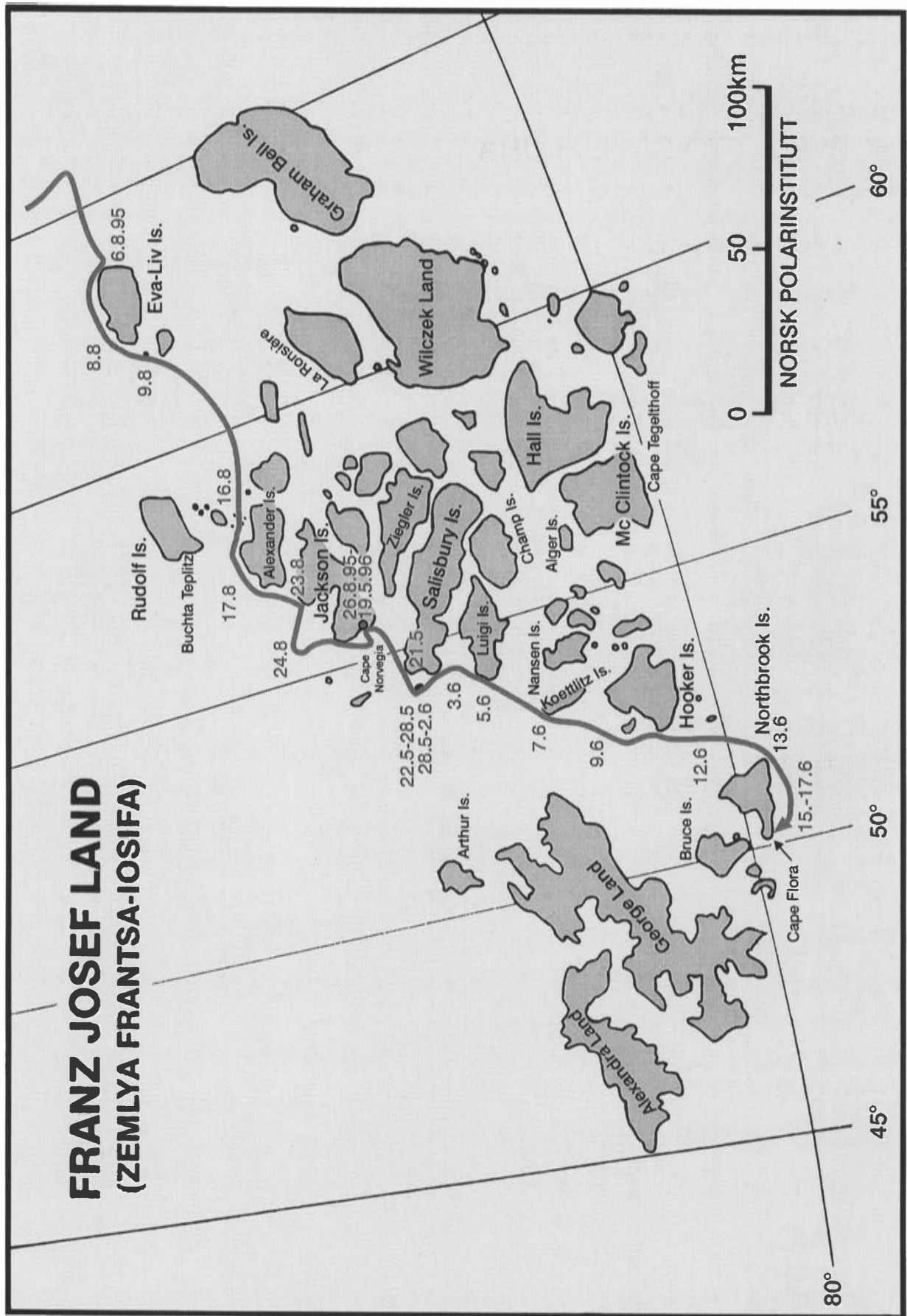
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# FRANZ JOSEF LAND (ZEMLYA FRANTSJA-IOSIFA)



OLAV ORHEIM & SUSAN BARR:  
Norwegian Polar Institute, Oslo

## NANSEN'S AND JOHANSEN'S ROUTE FROM CAPE NORVEGIA TO CAPE FLORA

Fridtjof Nansen and Hjalmar Johansen travelled over then-unmapped parts of Zemlja Franca-losifa during their journey from Cape Norvegia to Cape Flora in May-June 1896. When they started from their winter quarters, they in fact believed that they were *not* at Zemlja Franca-losifa, and several periods of bad visibility on the way hampered attempts to understand the geography of the area. During the stay with Frederick Jackson at Cape Flora, Nansen was able to compare his crude map with Jackson's map of the same area, and to adjust and expand it. However, because of the reasons stated above, the original route as described by Nansen cannot easily be ascertained on modern maps. In order to relocate the positions Nansen described (Nansen 1897), it was necessary to be on site and compare his map and written descriptions of physical features with present visual observations and modern maps.

During the anniversary cruise northwards and southwards between the two locations, Nansen's written description was compared in this manner and a new and accurate map of the route Nansen and Johansen took was plotted. Fig.2 shows the reconstructed route. This is to our knowledge the first time such a map has been made. The exact position off Cape Flora, where a fortunate accident had forced Nansen to stop thus enabling him to hear the dogs at Jackson's camp, was also plotted and documented.

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VIDAR BAKKEN<sup>1</sup>, HALLVARD STRØM<sup>2</sup> & GRIGORI TERTICKY<sup>3</sup>:

## SEABIRD INVESTIGATIONS AT CAPE FLORA, NORTHBROOK ISLAND

### BACKGROUND

Brünnich's Guillemot is probably the second most numerous seabird species in the Barents Sea. The total population is minimum 1.6 million pairs distributed in 234 colonies (data from the Colony Register for the Barents Sea, 1996), but many colonies, specially in the eastern part of the Barents Sea, have not been counted recently. The total population on Zemlja Franca-Iosifa is minimum 30,000 pairs distributed in 19 colonies, but this population estimate is only based upon counts in five of these colonies (data from the Colony Register for the Barents Sea, 1996).

At least parts of the Brünnich's Guillemot population in the Barents Sea migrate out from the area in winter; important winter areas are around Iceland, southwest of Greenland and Newfoundland (Kampp 1988). Birds ringed in Svalbard, Novaja Zemlja, Kola and on the Norwegian coast are recovered in these areas (Kampp 1988, data from the Norwegian Ringing Scheme). From ringing of chicks at Kovalskifjellet in Storfjorden almost 4% of the birds are reported as shot in the waters around Greenland and Newfoundland during 2-3 years after ringing (Norwegian Polar Institute, unpublished data). A similar picture was also obtained from another colony in Svalbard. In 1994 2750 Brünnich's Guillemots were ringed at Bezymyannaya Bay, Novaja Zemlja, but none of these has yet been recovered. This may indicate that birds breeding in the area have different migration patterns compared to the Svalbard population. To complete the picture we also wanted to ring Brünnich's Guillemots in Zemlja Franca-Iosifa to see if they have similar migration routes to the Svalbard population. Data from Svalbard have shown that the proportion of recoveries of birds ringed as chicks is much higher than for birds ringed as adults (unpublished data). At Cape Flora mainly chicks were to be ringed.

Colonies in Zemlja Franca-Iosifa are in general seldom visited, and in addition to working with ringing of Brünnich's Guillemot chicks, we wanted to do population counts of other breeding seabirds in the colony.

### PERSONNEL

Two persons, Hallvard Strøm and Grigorii Terticky, stayed in the colony 27-31 August. A hut was transported ashore by the helicopter and used for accommodation.

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<sup>2</sup> University of Trondheim, Norway

<sup>3</sup> All-Russian Research Institute for Nature Protection, Moscow, Russia

## RESULTS

The time for the expedition did not coincide well with the fledging period for chicks of Brünnich's Guillemots at Cape Flora; most of them had left the breeding ledges before we arrived at the colony. As a result only five chicks were ringed on the beach after fledging. Their mean weight was 201g.

This colony is very good for ringing of chicks. After fledging, they all land on the beach and are easy to catch. In this colony about 10,000 pairs of Brünnich's Guillemot were breeding in 1992 (Frantzen et al. 1992). It is one of the largest colonies in Zemlja Franca-Iosifa. Uspenkij (1958) estimated it to include 100,000 individuals in 1957.

It was too late in the season to do detailed mapping of the colony as many birds had already left the area. However, most Kittiwakes were still present. A total count of the colony showed a total of 4,397 occupied nests. In 1992 the population was estimated at 3,500 pairs (Gavrilo et al. 1993), while it was about 25% higher in 1996.

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VIDAR BAKKEN:  
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## IVORY GULL RESEARCH ON ZEMLJA FRANCA-LOSIFA

### BACKGROUND INFORMATION

The Ivory Gull *Pagophila eburnea* breeds in the arctic zone in Russia, Svalbard, Greenland and Canada (Blomqvist & Elander 1981; Cramp & Simmons 1983). The world population is estimated at about 14,000 pairs (Volkov & Korte in press), but exact numbers are unknown for many regions.

In the Barents Sea, the Ivory Gull breeds at Svalbard, Zemlja Franca-Iosifa and the northern part of Novaja Zemlja (Volkov & deKorte in press). Many nest in steep cliffs sometimes more than 20 kilometres from the shore. In some areas, i.e. on Victoria Island, they breed on flat ground. They may breed in association with Kittiwakes and other seabirds, but often many colonies consist exclusively of Ivory Gulls.

In Zemlja Franca-Iosifa Ivory Gulls are found breeding in ten colonies (data from the Colony Register for the Barents Sea 1996). Most of the colonies are situated in the southern part of the archipelago. The largest one is found on Victoria Island, which is also a part of Zemlja Franca-Iosifa, but not protected as zakaznik as the rest of the archipelago. No population estimates exist for seven of the colonies. Uspenkij & Tomkovich (1986) estimated the population on Zemlja Franca-Iosifa at 'some thousands', but according to the colony register, less than 1000 pairs are documented.

The main aim of the investigation was to conduct new counts in the Ivory Gull colonies on Zemlja Franca-Iosifa. High priority was given to colonies where no previous counts existed. In addition we looked for new colonies not earlier registered.

### FIELD WORK

The helicopter was used to reach the known colonies and to search for new. The helicopter surveys were combined with the surveys for pinnipeds. Ivory Gulls were also searched for in the colony at Cape Flora.

### RESULTS AND DISCUSSION

No Ivory Gulls were registered in the colony at Cape Flora. Nor did we find any breeding Ivory Gulls in other colonies searched by helicopter. Ivory Gulls might possibly breed among Kittiwakes in some of the colonies, but from the helicopter it was difficult to spot the Ivory Gulls among the Kittiwakes.

Older data show that the main Ivory Gull breeding colonies should be in the eastern and western parts of Zemlja Franca-Iosifa. We did not visit these areas during the expedition. We had planned to visit Cape Mary Harmsworth and Victoria Island, but did not get permission to land with the helicopter. At Cape Mary Harmsworth there are some old observations of a large colony of Ivory Gulls (Clark 1898). Victoria Island had one of the largest known colonies of Ivory Gulls in the world in 1994 and 1995 (Forsberg 1995; Vuilleumier 1995).

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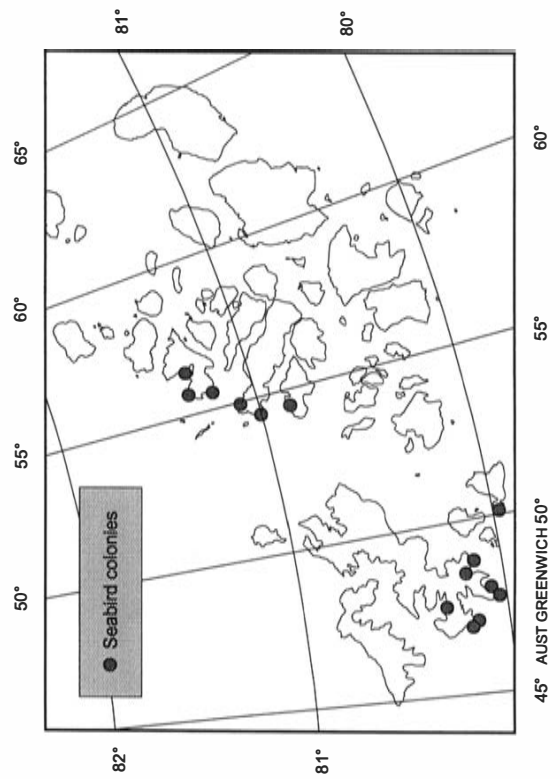
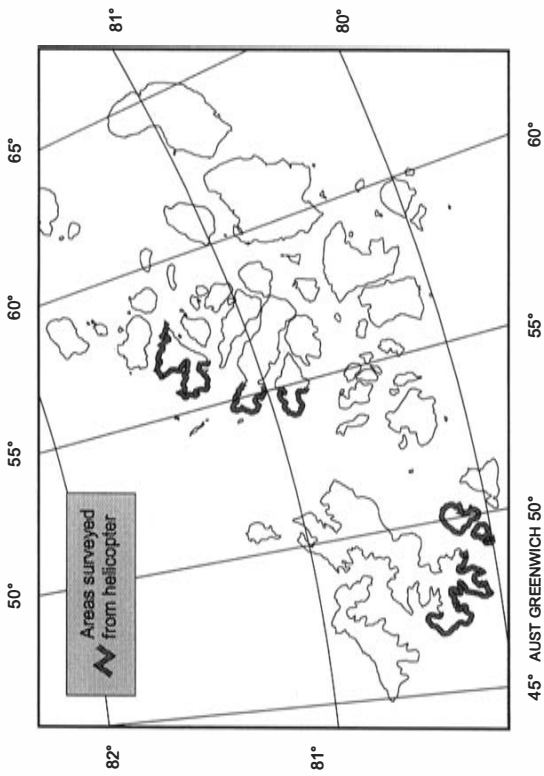
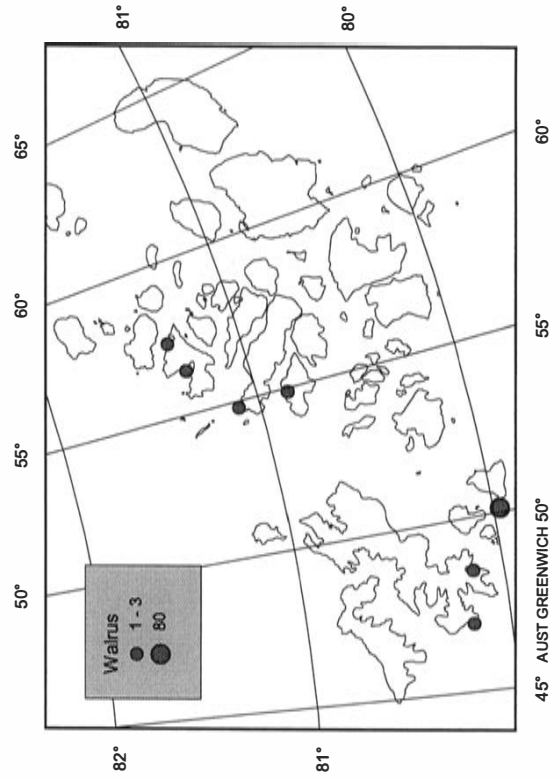
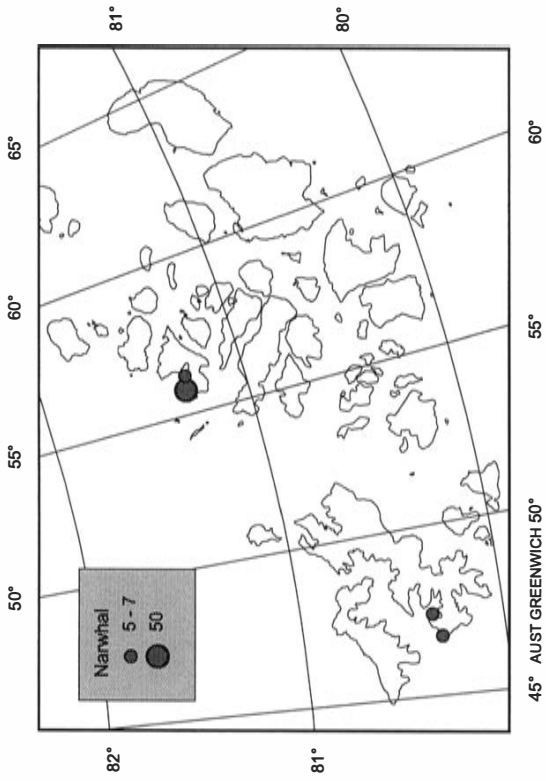
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## MARINE MAMMALS

### INTRODUCTION

Little is known about the walrus of the western European Arctic. Recent studies have been undertaken in Svalbard, and in parts of Zemlja Franca-losifa, but recent scientific information on walrus from the Russian Arctic is largely non-existent. However it is clear that walrus in all areas of their European Arctic range were over-harvested up to the mid 1950s. The result was that they were virtually exterminated in several of these areas. In Svalbard they were probably exterminated, but there were apparently still a few hundreds left in Zemlja Franca-losifa. The largest remaining groups were probably found in the Zemlja Franca-losifa – Kara Sea area. Today there are signs, at least in Svalbard and in the White Sea area, that walrus are recolonizing their former distribution areas.

Zemlja Franca-losifa is a key area for understanding the status of the walrus in the western European Arctic. It is of special interest to map the haul-out sites presently used in the archipelago, to determine the age and sex structure of the animals using these sites, to find out how many walrus there are in Zemlja Franca-losifa in the summer, and finally to determine to what degree walrus migrate between Zemlja Franca-losifa and neighbouring areas.

### GOALS

The main goal for the fieldwork was to survey and count walrus and to collect biopsy samples of walrus for analyses of genetic differences between Zemlja Franca-losifa and Svalbard. In addition, we would also count other marine mammals and were particularly interested in the bowhead whale, which has been seen in the operation area on several occasions.

### RESULTS

We managed to take seven skin biopsies of walrus hauled out on the icy shore of Gunther Inlet at Northbrook Island on 31 August. This day there were about 100 walrus at this site. One calf was observed with umbilical cord. Four days before (on 27 August) about 80 walrus were observed from the air at the same site.

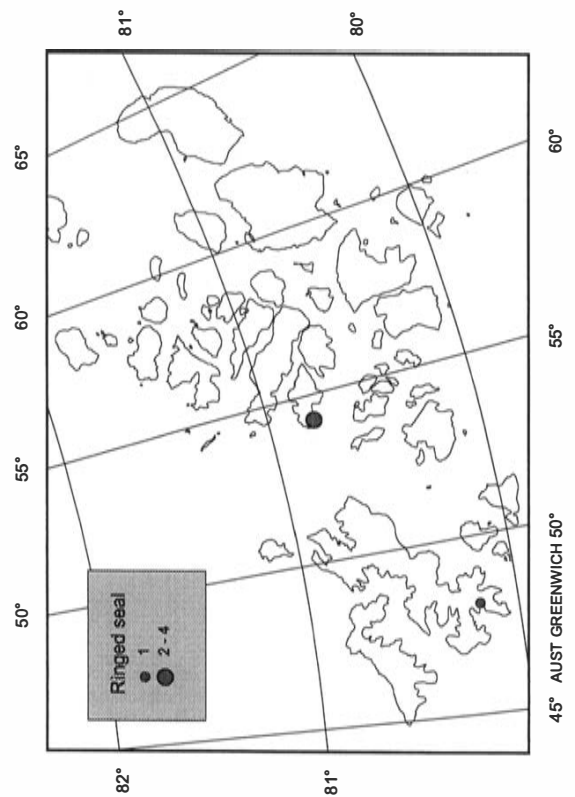
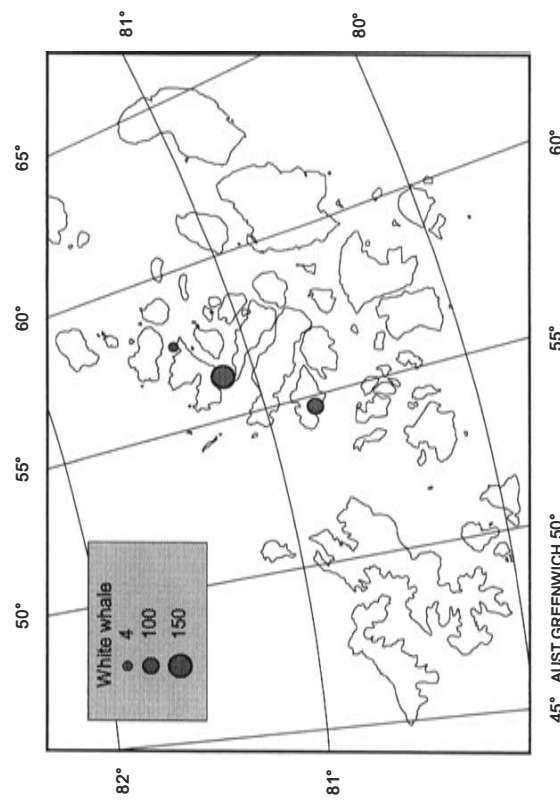
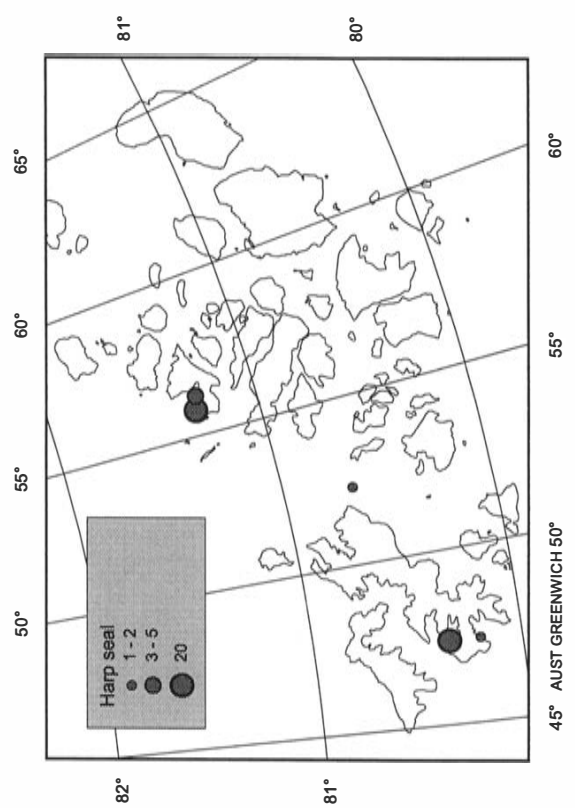
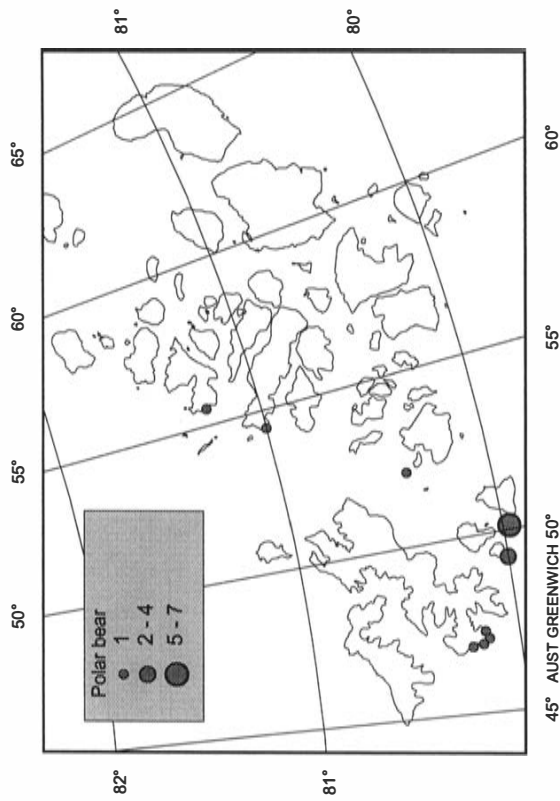
All observations of marine mammals and survey areas are shown on the maps. The most remarkable observations were those of the narwhales at the north side of Jackson Island and on the east side of George Land, and the beluga whales at the east side of Jackson Island and the south of Luigi Island. Flocks of harp seals were observed in connection with the narwhales. On our way back to Svalbard many walrus were observed in the water near Viktoria Island.

A total of 18 polar bears (or families), and very few ringed and bearded seals were observed.

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## GLACIOLOGICAL OBSERVATIONS IN THE ZEMLJA FRANCA-IOSIFA ARCHIPELAGO, AUGUST 1996

### INTRODUCTION AND BACKGROUND

Glaciers cover about 85% of the total land area of Zemlja Franca-Iosifa and are the main component of the landscape. Active glaciological studies were carried out here mainly in the middle of this century: in 1947-1952 (with a break in 1949-1950) by specialists of the All-Union Arctic Institute (later the Arctic and Antarctic Research Institute – the AARI), in 1957-1959 by scientists of the Institute of Geography of the USSR Academy of Sciences (IGAN), and in 1960-1962 again by participants of the AARI expeditions. During this time glaciologists carried out detailed studies of the glaciers on Hooker Island (in the course of the first two expeditions) and short-term observations of the glaciers on Hooker Island (in the course of the first two expeditions) and short-term observations of the ice caps of more than ten other archipelago islands. The obtained results along with earlier data were summarized by Shumskij (1949), Grosval'd et al. (1961, 1973), Govorukha (1963, 1988a), and in other publications serving as a basis for our current knowledge about the glaciology of Zemlja Franca-Iosifa.

Further glaciological studies in the archipelago were performed in the 1980s-1990s in the course of several joint expeditions: the expedition of the AARI and the All-Union Nature Research Institute in 1981, the expedition of IGAN and Stockholm University in 1990, the expedition of the State Moscow University and the Murmansk Marine Biological Institute with the participation of American scientists in 1992, and the expedition of IGAN, Scott Polar Research Institute and Ohio State University in 1994. They have provided additional information on the thickness of glaciers, features of their morphology and regime (Glazovskij et al. 1995; Grovorukha 1988b; Lefauconnier 1992).

As a result of the work performed, there is a sufficiently clear understanding of the general and specific features of the glaciation of Zemlja Franca-Iosifa (Table 1). However, the relation of the ice caps to climatic and other causes is still an important question. Resolving this is complicated by the remoteness of the region and the long breaks in observations. Thus work which continues the measurement series and balance estimates of the archipelago glaciers in some form or other is of significance. In this paper we present the results of the glaciological observations which were carried out during the *Fram* anniversary cruise to Zemlja Franca-Iosifa.

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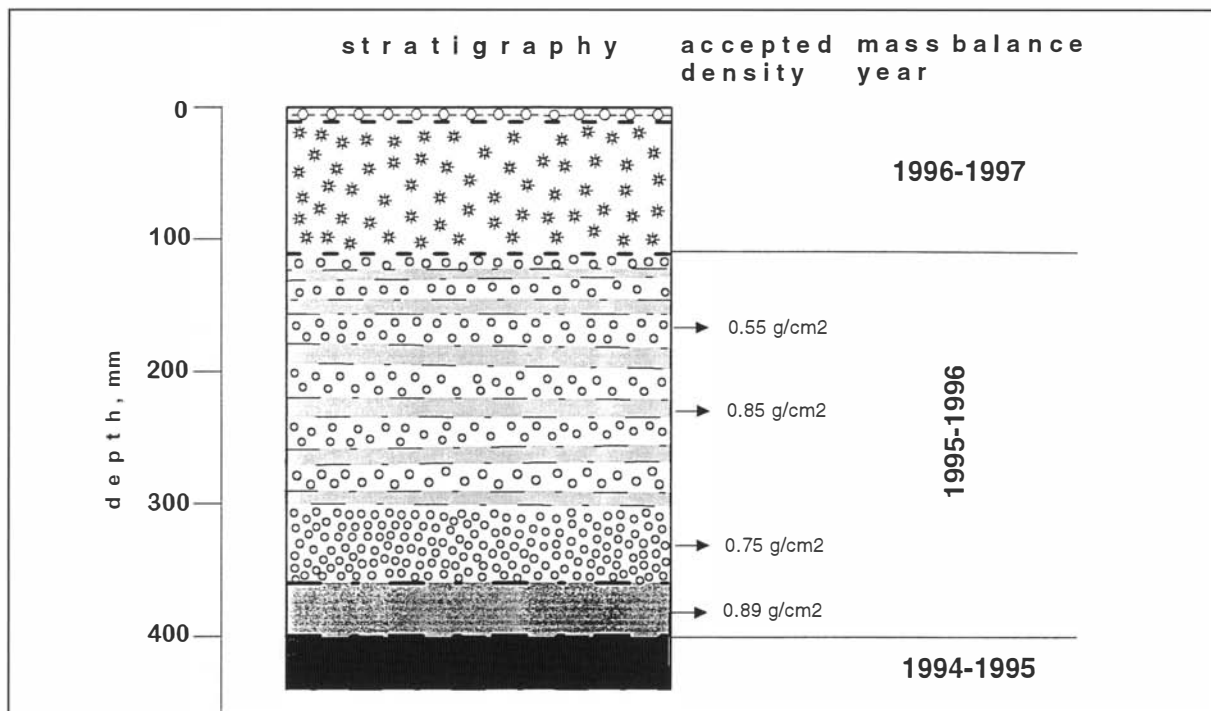
<sup>1</sup> State Scientific Center-Arctic and Antarctic Research Institute, St. Petersburg, Russia

<sup>2</sup> Natural Environment Research Council, Swindon, UK

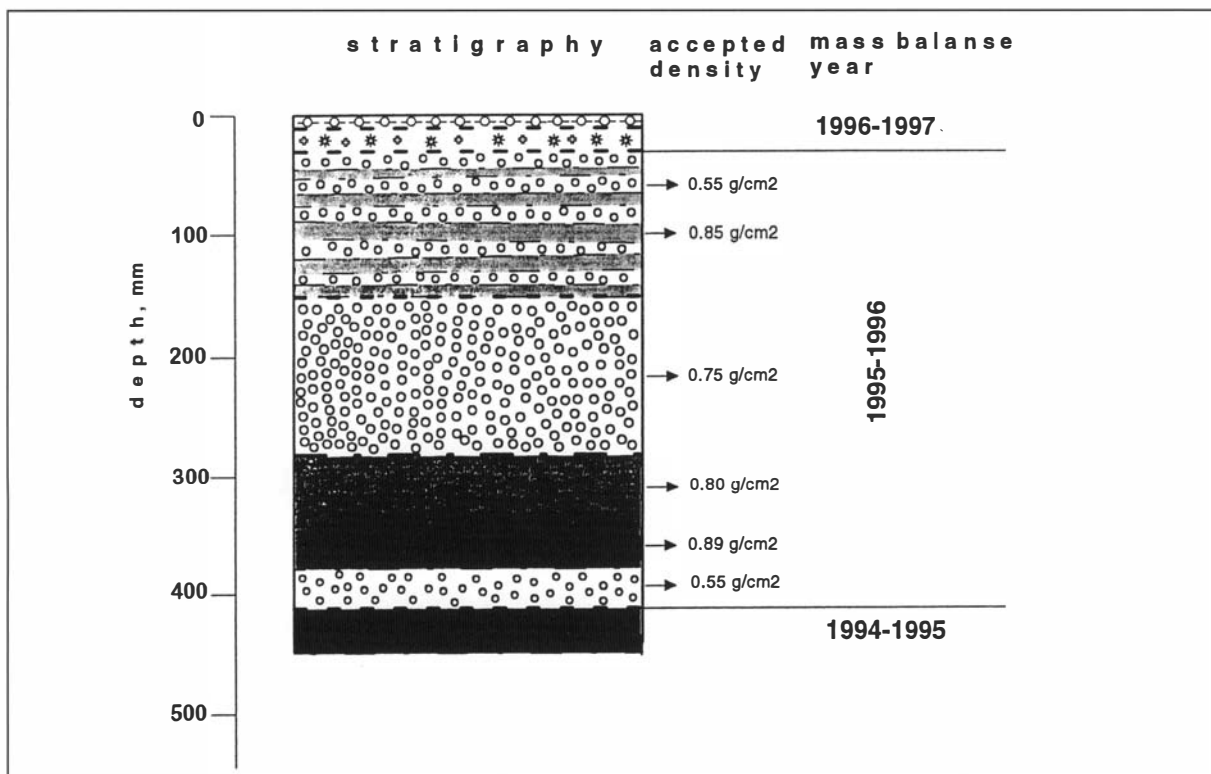
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<sup>4</sup> State Duma (Parliament), Moscow, Russia





b. Northbrook Island, Zemlja Franca-Iosifa, 28.8.1996, Station 2.  
 Location: 79°59'21"N, 50°57'35"E  
 Altitude: 373 m a.s.l.



c. Jackson Island, Zemlja Franca-Iosifa, 30.8.1996, Station 3.  
 Location: 81°12'42"N, 55°47'15"E  
 Altitude: 463 m a.s.l.

Table 1: Main characteristics of glaciation in the Zemlja Franca-Iosifa archipelago (according to Grosvald et al. (1973) and Govorukha (1988a))

Area of the archipelago (km <sup>2</sup> )	16134
Area of glaciers (km <sup>2</sup> )	13735
Extent of glaciation in the region (%)	85.1
Mean thickness of glaciers (m)	180
Morphological	Ice caps; (valley) outlet; cirque; hanging and wall-sided
Glaciological zones	ablation; superimposed ice; firn
Equilibrium line height (m, asl)	200-300
Firn line height (m, asl)	380-400
Accumulation zone area (km <sup>2</sup> )	5300
Ablation zone area (km <sup>2</sup> )	8435
Accumulation area: ablation area	0.63
Mass balance for 1929-1959 (kg m <sup>2</sup> )	-210

## FIELD RESULTS

Glaciological observations were made in situ of the glaciers on Northbrook and Jackson Islands (see map), as well as visually onboard ship and during the helicopter flights of other ice masses in the archipelago. During the visits to the highest areas of the ice caps the structure of the ice-firn sections was investigated and described at three sites (Fig. 1). The descriptions include estimates of the density of the snow layers (by hardness), firn (by hardness and porosity) and ice (by the character of bubble inclusions). As is seen in Fig. 1, the structure of the sections was on the whole of one type: under the layers of fresh and slightly transformed snow with the total thickness of 2 to 12 cm there is a band of alternating layers of firn and bubbly ice with the total thickness of 29 to 38 cm lying on the old ice.

Since melting on the glaciers had practically ended by the time of the observations (at least in the highest areas under consideration), the accumulated firn-bubbly ice stratum in the sections represents the net mass balance for the 1995-1996 balance year; the snow cover already belongs to the onset of accumulation in 1996-1997. Based on the measured thicknesses and the assumed density values, the net balance value for 1995-1996 can be estimated at the observation sites. For the two glacial domes on Northbrook Island at the heights of 320 and 373 m a.s.l. this proved to be about 200 mm of water equivalent and for the glacial dome on Jackson Island (at the height of 463 m a.s.l.) about 250 mm of water equivalent. It should be noted that the values obtained do not take into account possible,

but not very probable, losses which could occur during the maximum ablation period due to old ice melting and water runoff.

Visual determination of the location of the equilibrium line, the firn line, and the extent of glaciological zones on the glaciers was difficult onboard the ship due to the frequent presence of low cloud hiding the middle and uppermost parts of the ice caps (higher than 150-200 m asl), as well as by fresh snow obscuring colour differences between the surfaces of the glaciological zones. However, during flights above the glaciers of Northbrook and Jackson Islands the zone of intense summer melting was observed to extend to a height of not less than 280-300 m asl, where amongst the snow cover bare ice was observed in some places. Visual identification of the zones of ablation and superimposed ice within the height range was not possible and no landings on the slopes of the glaciers were made.

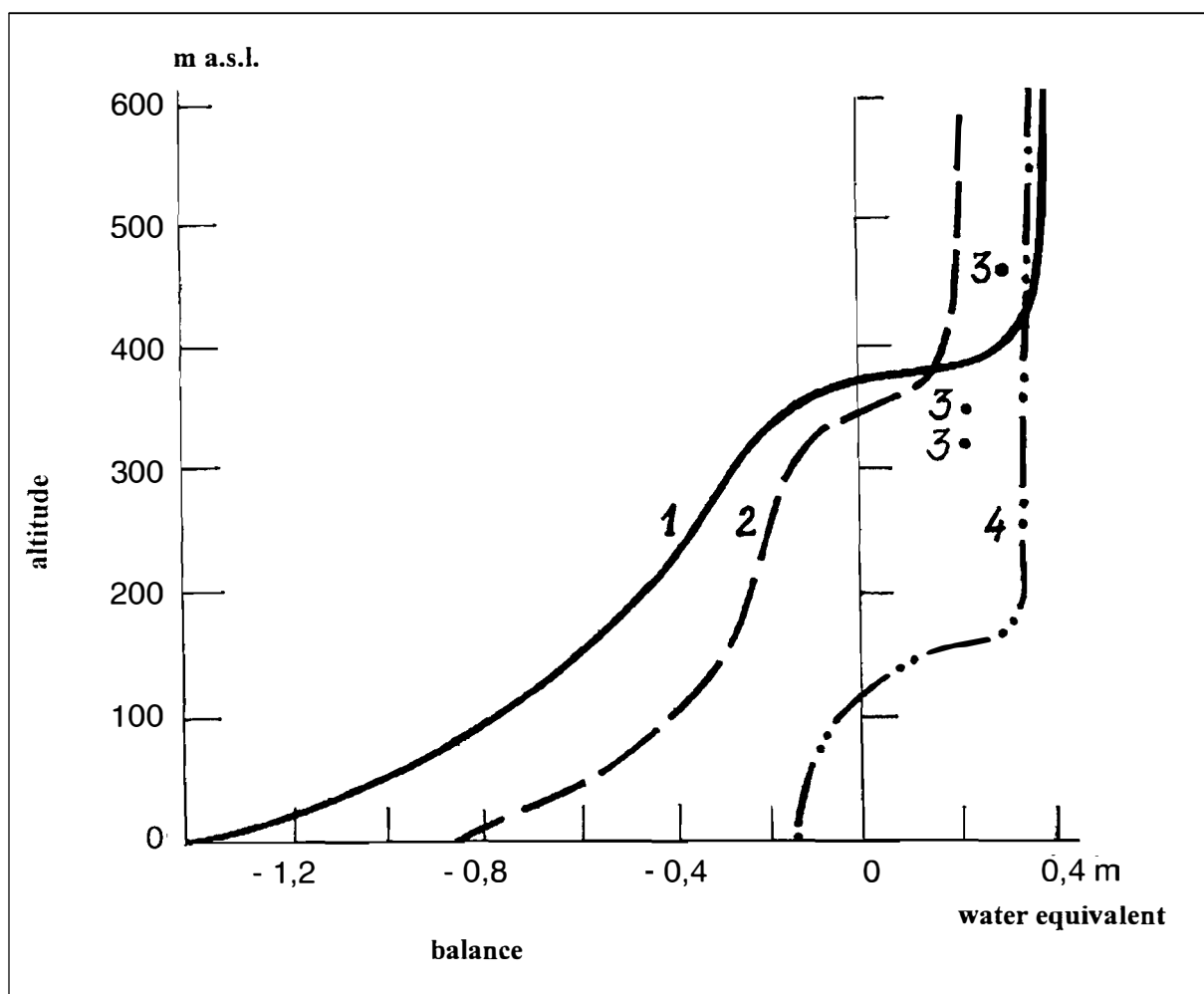


Fig. 2. Distribution of balance values for glaciers on Zemlja Franca-Iosifa: 1. Hooker Island for 1958-1959 (Grosvald et al. 1973); 2. Hooker Island for 1957-1958 (*ibid.*); 3. Northbrook and Jackson Islands for 1995-96; 4. total for the equilibrium regime conditions of the glaciers at Zemlja Franca-Iosifa (Grosvald et al. 1973).

## INTERPRETATION AND CONCLUSION

Ice and firn layers in the study sections indicate that infiltration and recrystallization took place in the 1995-1996 balance year. According to Grosvald et al. (1973) and Govorukha (1988a), this type of ice formation is typical of the firn zone of Zemlja Franca-Iosifa glaciers.

As is seen from Table 1, the lower boundary of the firn zone (the firn line) is located at an average height of about 380-400 m a.s.l. In certain years, however, it can drop to about 300 m a.s.l., especially in the north-eastern, south-eastern and south-western parts of the archipelago (Govorukha 1988a; Markin 1962). This fact is confirmed by our observations which have revealed the presence of the firn zone at the ice caps of Northbrook Island at heights of about 320 m and 370 m a.s.l.

It is apparent from Fig. 2 that the value of the net balance at heights of 320 m and 370 m a.s.l. for the ice caps of Northbrook Island exceeds noticeably the values known from observations on nearby Hooker Island. The net balance at our observation point (at around 460 m a.s.l. on Jackson Island) exceeds the values of the 1957-1958 balance curve, but is smaller relative to the values of the 1958-59 balance curve of Hooker Island. Based on these comparisons, it is possible to suggest that the net balance in 1995-1996 was not less than the known ones from the results of preceding studies.

It is more difficult to estimate the ablation component of the 1995-1996 balance. From our visual observations, the area of surface melting extended up to a height of not less than 280-300 m a.s.l., that is close to the suggested lower boundary of the firn zone. If one assumes that the vertical development of the zone of superimposed ice in this year reached its maximum (about 100 m – see Table 1), then the equilibrium line at the end of the 1995-1996 balance year could drop to around 200 m a.s.l. on Northbrook Island (i.e. much lower than in curves 1 and 2 in Fig. 2). However, even with this assumption the equilibrium line does not come down to the corresponding level calculated under conditions of an equilibrium regime (curve 4 in Fig. 2).

The results of our observations suggest that compared with the 1957-1958 and 1958-1959 balance years, the balance of the glaciers of the archipelago in 1995-1996 was probably equal or more positive. However, it remained negative with regard to the balance necessary to maintain an equilibrium regime in Zemlja Franca-Iosifa.

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## THE TOTAL OZONE CONTENT MEASUREMENTS DURING THE FRAM ANNIVERSARY CRUISE TO ZEMLJA FRANCA-IOSIFA.

### INTRODUCTION

The problem of the ozone spatial-temporal distribution at high latitudes has attracted the increasing attention of scientists since the great depletion of ozone content over Antarctica (ozone hole) was discovered (Farman et al. 1985). The main direction of the scientific investigations of ozone content dynamics is the search for those atmospheric constituents which are most dangerous to the existence of the ozone layer above the Earth. At the same time the special features of the regions where ozone depletion was found were not properly taken into account. As mentioned in the paper by Shirochkov & Nagurny (1992), notable features of the high latitude regions in both hemispheres are the dynamic ionospheric-magnetospheric disturbances with a great variety of intensities and duration.

Four types of ozone distribution are currently recognised (Hrgian, 1973):

1. Polar – total ozone content 0.4 atm.cm
2. Moderate – total ozone content of the order 0.34 atm.cm
3. Tropical – 0.26 atm.cm
4. Combined – when, with a maximum of ozone density at a height of 19 – 21 km a secondary maximum at a height of 11-14 km occurs. In this type the total ozone content reaches values up to 0.66 atm.cm.

In high latitudes ( 70-80°N ) the largest values of total ozone content (TOC) have been noted. Polar and combined types of ozone distribution have been observed in this region, together with the fact that the annual variation of TOC has a maximum in the spring (April-March) and a minimum in the winter months.

In May-June 1987, during the first scientific expedition to the Geographic North Pole on the Soviet atomic icebreaker *Siberia* (Nagurny et al. 1990), in a region between the archipelagos of Svalbard and Zemlya Frantsa-Iosifa, the maximum values and maximum daily variations of TOC in comparison with other regions of the Western part of the Arctic Basin were noted. In a specified region the values of TOC in May 1987 were of the order of 400-500 Dobson units (1 atm.cm = 1000 Dobson units) with a mean daily variability of about 150 Dobson units. The variation had expressed correlation with the variation of the level of geomagnetic activity. The last circumstance, i.e. a connection between large irregular variations of the TOC with strong geomagnetic activity occurring around the auroral oval, has led to the assumption of an important role by geophysical processes, together with photo-chemical processes, in the formation of the ozone layer in the Arctic (Shirochkov & Nagurny 1992).

The Fram Anniversary cruise to Zemlja Franca-Iosifa on *r/v Lance* took place in the same region where the *Siberia* had sailed in 1987. This gave the possibility of repeating the same observations, but in another season and under different intensity of solar activity.



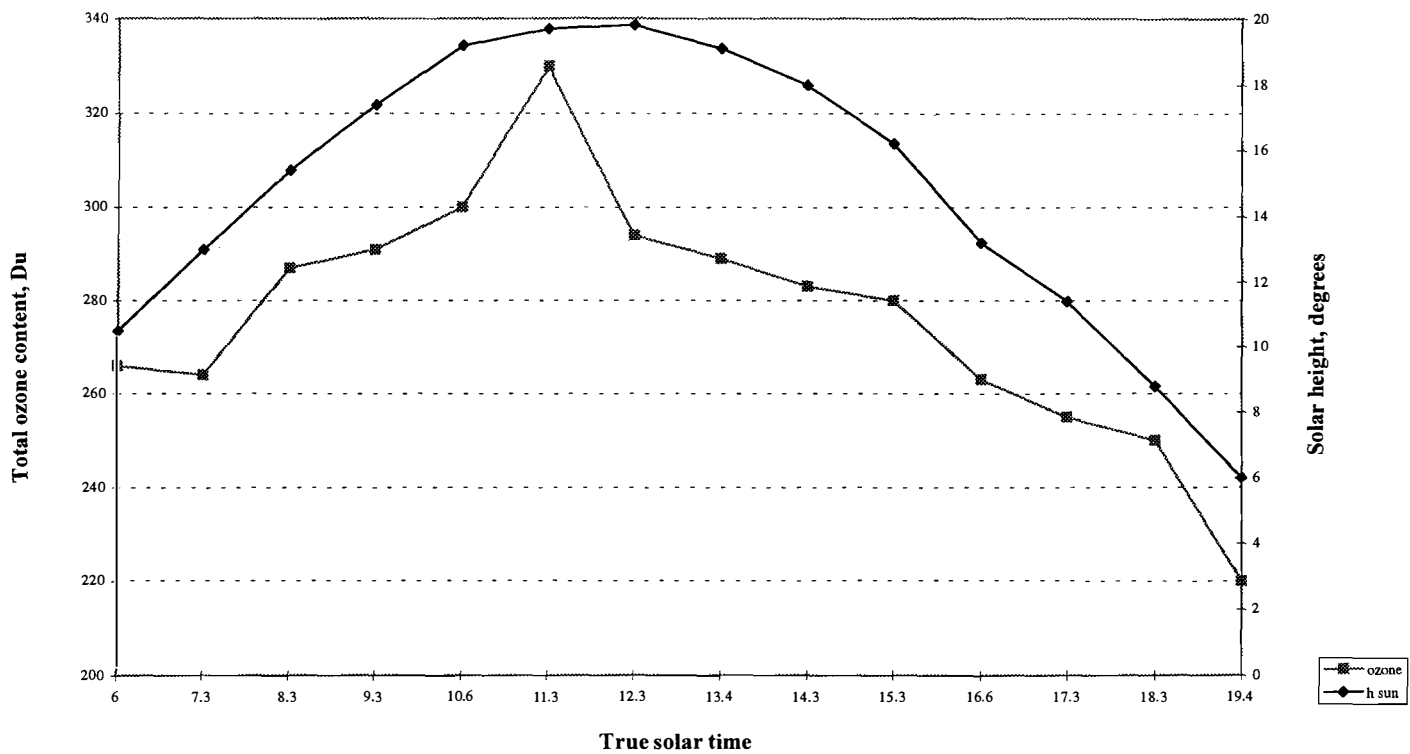


Fig. 1. The daily variability of maximum total ozone content (28.08.1996)

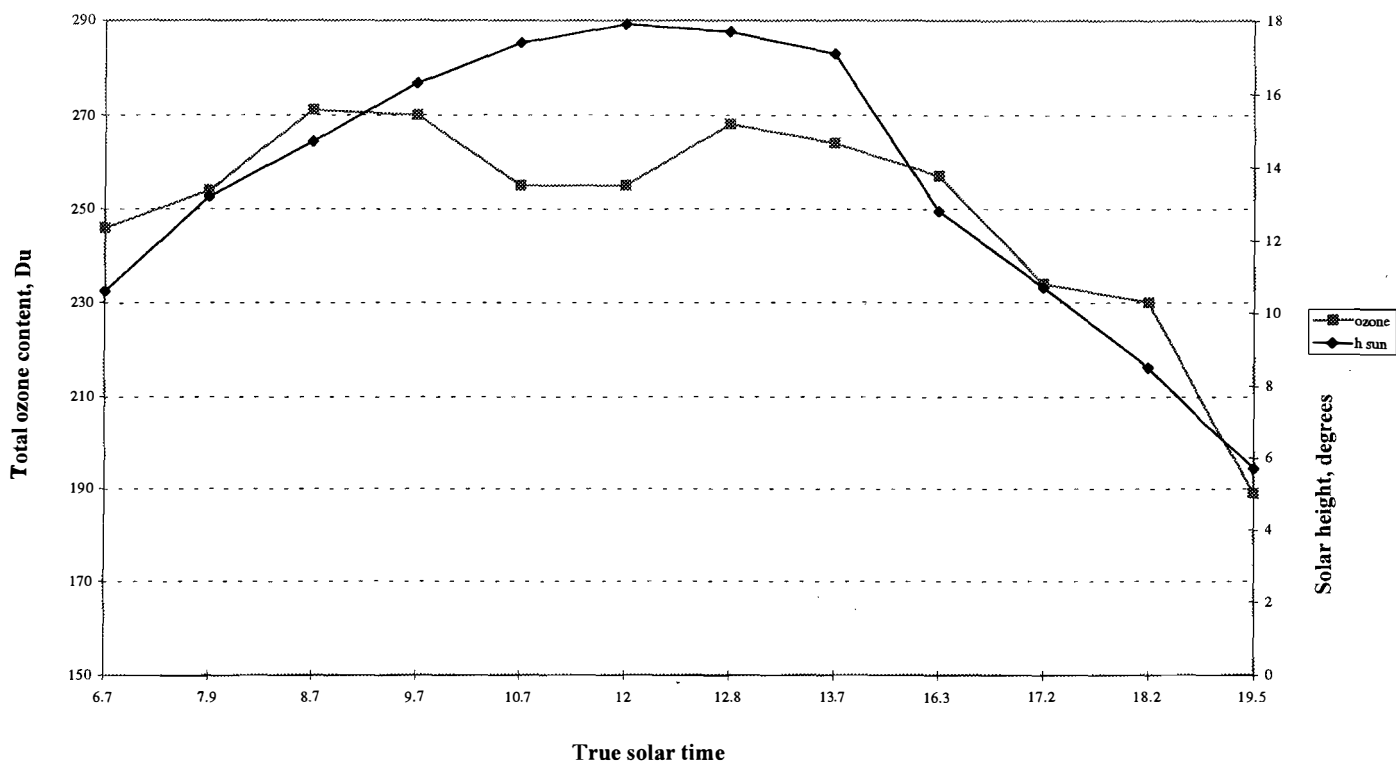


Fig. 2. The daily variability of minimum total ozone content (30.08.1996)

## **METHOD**

Every hour during the period August 24 – September 2, 1996 observations of the total ozone content (TOC) in the region of navigation (79-81.5°N) were carried out at a time when the sun height was more than five degrees. 111 cycles of observation were performed. A modernised standard ozonometer M-124 with broadband filters, designed and produced by the Main Geophysical Observatory (MGO) in St Petersburg, Russia, was used.

The calculations of TOC from the observation data are based on an integrated method of incoming solar radiation measurements in two ranges of spectrum, one of which is in a band of ozone absorption (300 nm), and the other on the edge of this band (326 nm). The method allows the exclusion of the influence of atmospheric aerosols, which also absorb registered ultraviolet radiation. The device was calibrated in the MGO by comparison with the standard Dobson spectrometer N108. The relative error of the total ozone content measurements made by this ozonometer is not more than 3-5%. For the low solar zenith angles (sun height less than ten degrees) this error is smaller than 8% (Nagurny & Shirochkov 1989). The TOC was defined in Dobson units with a nomogram, developed at the MGO.

## **RESULTS**

In Figs.1 and 2 the daily variations of ozone concentration together with solar altitudes are shown for days with maximum and minimum TOC indicated during the expedition. The graph shows that the total ozone content had an evident diurnal variation closely connected with the sun's height. The graph can then be compared with the results of the 1987 expedition, where the measurements of total ozone content were carried out with an identical method of observation in the same region, but in summer and with lower solar activity. This shows that the daily variability of TOC had maximum values approximately two times smaller than in 1987, and that it varied in limits from 320 up to 190 Dobson units.

Data on the inter-daily variability of TOC, shown in Table 1, demonstrate that even at a maximum of sun height, when the instrumental and methodical errors of determination of TOC are at a minimum, its values varied over a rather wide range (from 310 up to 240 Dobson units). The cause of this variation can be connected with the variation of the synoptic situation or geomagnetic activity.

## **CONCLUSION**

Certainly, the above-mentioned data have a preliminary character. It remains to conduct a comparison of collected data with the information on variability of the geomagnetic activity level in order to investigate the interrelation revealed earlier of TOC with this parameter. It is also of interest to compare the data with measurements of TOC executed in Ny-Alesund, Svalbard for the purpose of a valuation of spatial-temporal variability of the total ozone content in the Arctic Basin and its connection to features of circulation of the atmosphere in the western part of the Arctic.

Table 1: Total ozone content variability during the expedition in 1996

Date	Total ozone content (Du)	Sun height (dg)
25.08	300	20.6
26.08	283	21.0
27.08	296	20.0
28.08	308	19.5
29.08	272	18.9
30.08	259	17.6
31.08	260	18.4
01.09	243	18.8
02.09	262	17.1

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