Ministry of Environment and Energy
National Environmental Research Institute

Offshore seabird distributions during summer and autumn at West Greenland

Ship based surveys 1977 and 1992-2000

NERI Technical Report No. 370

[Blank page]

Ministry of Environment and Energy
National Environmental Research Institute

Offshore seabird distributions during summer and autumn at West Greenland

Ship based surveys 1977 and 1992-2000

NERI Technical Report No. 370
2001

David Boertmann
Anders Mosbech
Department of Arctic Environment

[Blank page]

Data sheet

Title:	Offshore seabird distributions during summer and autumn at West Greenland
Subtitle:	Ship based surveys 1977 and 1992-2000
Author(s):	David Boertmann & Anders Mosbech
Department(s):	Arctic Environment
Serial title and no.:	NERI Technical Report No. 370
Publisher:	Ministry of Environment and Energy National Environmental Research Institute ©
URL:	http://www.dmu.dk
Date of publication:	September 2001
Referee:	Christian Glahder
Please cite as:	Boertmann, D. & Mosbech, A. 2001: Offshore seabird distributions during summer and autumn at West Greenland. Ship based surveys 1977 and 1992-2000. National Environmental Research Institute, Denmark. Technical Report no. 370.

Abstract: This report presents the phenological and distributional results from ship based seabird surveys off West Greenland performed by NERI in the summers and autumns of 1992 to 2000. The results are compared with seabird counts carried out from offshore stationary platforms in 1977.

Keywords:	Seabirds, West Greenland, distribution, phenology
Editing complete:	13 Sept. 2001
Financial support:	Danish Environmental Support Fund from the Danish Environmental Protection Agency under The Arctic Environmental Program, grant M123/001-0029
ISBN:	87-7772-634-0
ISSN (electronic):	1600-0048
Number of pages:	57
Internet:	This report is only available as a PDF-file from NERI's homepage: http://www.dmu.dk/1_viden/2_Publikationer/3_fagrapporter/rapporter/fr370.pdf

Contents

Summary

This report presents the phenological and distributional results of seabird surveys carried out by ship in West Greenland waters. In 1977 observations were carried out from stationary platforms (oil exploration supply ships) and in the period 1992 to 2000 observations were carried out from sailing ships.

The results from 1977 are presented as observations per 5-day periods and give an impression of the species temporal occurrence. The 1992-2000 results are presented as distribution maps. These show densities for more numerous and widespread species, and actual observations for the less numerous species.

Seabirds mainly fulmar, kittiwake and more locally great shearwater are numerous and widespread during summer. Concentrations do occur, but rather rarely. Presently the knowledge on the factors governing these concentrations is limited, except that operating shrimp trawlers may play a major role.

During the autumn the numbers of seabirds increase as migrants from local and international populations of mainly thick-billed murre and little auk arrive to spend the winter in West Greenland waters. Huge concentrations of thick-billed murres, common eiders and king-eiders may occur then, and such concentrations are vulnerable to oil spills. A crude estimate of the numbers of thick-billed murres present in the areas surveyed in 1992-2000 in September-October reach 693,000 birds.

Dansk resumé

Denne rapport beskriver de udbredelsesmæssige og fænologiske resultater af DMU-AM's skibsbaserede havfugle-optællinger på havet ud for Vest Grønland. Materialet er suppleret med data fra togter udført af i 1988 af Ornis Consult. For mere talrige arter har vi udarbejdet kort over tætheder i perioderne sommer (juli og august) og efterår (september og oktober). For de øvrige arter vises kort med de egentlige observationer. Desuden beskrives resultaterne fra optællinger udført fra tre olieboreplatforme stationeret i Davis Stræde i sommeren og efteråret 1977.

Havfuglene forekommer vidt udbredt og talrigt på havet ud for Vest Grønland om sommeren. Det drejer sig især om mallemukker, rider og mere lokalt og ustadigt også storskråber. Men forekomsterne er sjældent så koncentrerede at fuglebestandene kan blive truet af et oliespild. Der er indtil videre ikke tilstrækkelig viden til at kunne forudsige, hvad der betinger koncentrationerne af de forskellige arter. Nogle er givet betinget af arbejdende rejetrawlere, andre af oceaniske forhold, som bør studeres nærmere.

I løber af efteråret stiger fuglenes antal ved ankomsten af trækfugle fra internationale og nationale bestande af f. eks. polarlomvie og søkonge. Og områdernes følsomhed overfor oliespild stiger dermed. De kystnære farvande i Vest Grønland mellem Kap Farvel og Disko Bugt er et meget vigtigt overvintringsområde for havfugle, og især polarlomvie kan forekomme i meget store koncentrationer.

Et estimat baseret på tæthedsfordelingen giver 693,000 polarlomvier til stede i de gennemsejlede områder (indenfor 100 km fra kysten) mellem 68º 30′ N (Disko Bugt) og 61º N i perioden september-oktober.

Introduction

Seabirds are among the most vulnerable organisms to marine oil spills, and large oil spills have the potential to reduce populations and colonies (Mosbech 2000). Knowledge on the distribution of seabirds in West Greenland waters is therefore important information in relation to the regulation of oil exploration activities, oil spill sensitivity mapping and contingency planning.

NERI-AE has since 1992 collected data concerning seabird distribution in the waters off West Greenland. The purpose of this project is to improve the knowledge of offshore distribution, abundance and distributing factors of seabirds in West Greenland. Survey platforms have been both aircrafts and ships. The ship-based surveys have mainly been surveys of opportunity carried out from ships with other tasks such as marine biology and fishery research as well as seismic surveys. One dedicated seabird survey was carried out in 1993. However, collection of seabird data to fill data gabs from the vast sea area of Greenland is a continuing process utilising ships of opportunity.

Results of offshore ship-based surveys between 62º and 68º N latitude have been reported in Mosbech et al. (1996) and Mosbech et al. (1998). Results of offshore aircraft-based surveys have been reported in Mosbech and Johnson (1999).

This report gives an updated summary of the NERI-AE ship based seabird surveys between 60º and 71º N in the period 1992 to 2000 supplemented with the results from surveys carried out by Ornis Consult in 1988 (Durinck and Falk 1996). In the summer and autumn of 1977 systematic seabird observations were carried out from three oil exploration sites in the Davis Strait. The results from these stationary observation platforms are presented briefly to give a better impression of the temporal distribution of the birds.

DANCEA
Danish Cooperation for Environment in the Arctic
Ministry of Environment and Energy

The present project has received financial support from the Danish Environmental Protection Agency under The Arctic Environmental Program through grants from the Danish Environmental Support Fund. (Later termed DANCEA – Danish Cooperation for Environment in the Arctic). The authors are solely responsible for all results and conclusions presented in the report and this does not necessarily reflect the position of the Danish Environmental Protection Agency.

Acknowledgement

Help from our colleagues Louise Grøndahl and, Christian Glahder is gratefully acknowledged. Thanks also to the crews of the different survey ships, the observers (Table 1), to the Greenland Institute of Natural Resources for access to the trawler Paamiut during shrimp surveys in 1992 and 2000, to the Japanese trawler Shinkay Maru in 1992 and to Fugro-Geoteam for access to their seismic vessel in 1998. The 1977 data were collected by Biokon aps.

Methods and material

During all the surveys (Table 1, Maps 1-3) seabirds were recorded in transects following the standardised method of Tasker et al. (1984) with snap shot sampling of flying birds following Webb & Durinck (1992). Off transect observations as well as ship following birds and miscellaneous observations made during inter-transect sailing were also recorded.

Year	Observation period	Ship	Observation time	Observers
1992	16-30 July	Paamiut	81 h 18 m	Jose Nymand, Michael Køie Poulsen
1992	10 Aug -12 Sept.	Shinkay Maru	80 h 40 m	Jan Durinck
1992	22 Aug.-21 Sept.	Paamiut	106 h 17 m	Marianne Krag Petersen, Christian Glahder
1993	15 Sept.-17 Oct.	Adolf Jensen	180 h 58 m	David Boertmann, Christian Glahder, Frank Riget, Marianne Krag Petersen, Anders Mosbech, Jose Nymand
1994	21 July-14 Aug.	Thetis	101 h 48 m	Jan Durinck
1998	2-23 Aug.	Geo Scanner	101 h 17 m	Kaj Halberg
1999	22-30 June	Adolf Jensen	27 h 37 m	Henrik Skov
2000	29 July-14 Aug.	Paamiut	76 h 00 m	David Boertmann

Table 1. The NERI ship based surveys 1992-2000.

When performing transect surveys, all birds within 300 m at the one side of the ship with the best observation conditions were sampled in two or more distance intervals. The observed numbers of birds were summarised in 10-min. observation periods. Knowing the ships speed, the density of each species was calculated for each 10-min. period (typically covering approximately 1 km^2). The seabird density has for simplicity been calculated for the 300 m strip, without compensation for the increased (species specific) probability of overlooking birds on the water the further away they are. The use of such correction factors for birds would mainly affect the alcid density estimates. Dependent on species, flock size, seastate and ship size (height of observation platform) density estimates should be multiplied by a factor 1.2 to 2.2 (Skov et al. 1995). However, given the coarse resolution of the available data in time and space, it was decided to keep the data modelling simple. Snapshots of flying birds are included in the density calculations. Transect surveys were conducted when ships were steaming or performing seismic surveys. During trawling the speed was too low to make transect surveys.

The vast sea area has only been sparsely covered in time and space by the surveys, therefore the data are not adequate for a general mapping of bird densities. For species, which were recorded in reasonable numbers on the transects, densities are calculated and extrapolated up to 15 km from the transect line (see below). Less

abundant bird species have been dealt with as total numbers observed, not related to effort, only giving a general picture of the distribution.

Density calculations

The density data for the abundant bird species have been compiled across years (1988-2000) in two 2-month periods (July-August and September-October), in which the total survey effort has been considered reasonable (Table 2). The densities are presented on colour coded density maps, which show transect lines and bird densities, calculated by using inverse distance weighting of the densities calculated for each 10-min. period (power 2, radius 15 km). Thus densities are averaged between years where there are transects from several years in the same area, and densities are depicted no more than 15 km from a transect. These maps include data collected in the months July through October by us 1992-2000 and by Ornis Consult in 1988 (Durinck & Falk 1996). However, our own 1998 data are excluded, as flying birds were not sampled in a way comparable to the other surveys.

Month	Ornis Consult 1988	NERI 1992	NERI 1993	NERI 1994	NERI 2000	Total
July-Aug.	114	959	0	606	456	2135
Sept. -Oct.	557	566	1081	0	0	2204

Table 2. Survey effort (number of 10-min. watches) in the two 2-month periods, used in the density calculations.

Less numerous species (Table 4) are presented on maps as actual numbers recorded on and outside the transects, and including observations of ship following birds and miscellaneous observations made during intertransect sailing. These maps include data collected June through October during our own surveys 1992-2000 (Table 2). The corresponding data from 1988 has been published elsewhere (Durinck & Falk 1996).

All maps with densities, distributions and survey routes, are presented in the section "Maps".

Drill site	Position	Observation period
Hellefisk I	67° 53′ N, 56° 44′ W	19 June - 9 Sept.
Ikermiut I	66° 56′ N, 56° 35′ W	3 July - 31 Aug.
Nukik I & II	65° 38′ N, 54° 46′ W	11 July - 13 Sept.

Table 3. The three stationary observation sites in 1977.

Observations in 1977

In the summer of 1977, seabirds were counted from three oil exploration drilling sites in the Davis Strait (Table 3, Map 2). The observation platforms were standby-ships, only moving in the vicinity of the platforms. The observations were recorded in 10-min. periods, as many hours as possible due to weather and light conditions (Fig. 1).

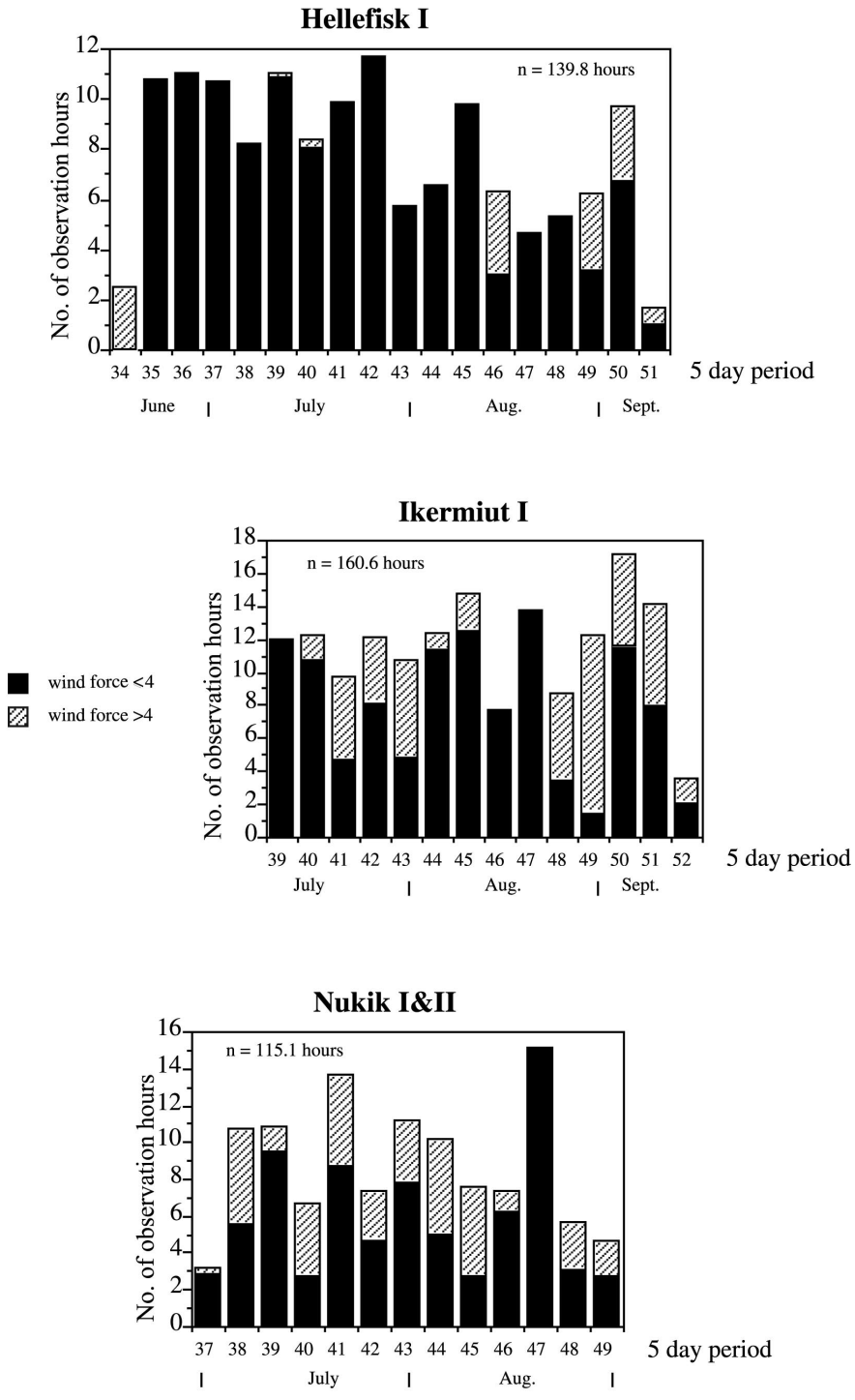


Fig. 1. Observation effort at the three drill sites in 1977.Effort divided in time during winds weaker or stronger than force 4 (beaufort). Se appendix 1 for definition of the 5-day periods.

The observations from 1977 are summarised in 5-day periods (Appendix 1). In case of resting birds near the observation sites, the highest number recorded during the five-day periods is presented.

The present report focuses on the offshore area although some transects touch inshore areas. Offshore observations of inshore species for example indicating migration routes are included. While the sporadic observations of inshore species are better dealt with in connection with inshore surveys, why near-shore species like mallard *Anas plathyrhynchos*, red-breasted merganser *Mergus serrator*, white-tailed eagle *Haliaeetus albicilla* and purple sandpiper *Calidris maritima* are not treated in this account.

Species account

The most numerous species, which are shown on density maps, include northern fulmar, great shearwater, kittiwake, thick-billed murre, black guillemot, little auk and atlantic puffin. The remainder and less numerous species recorded during the surveys are listed in Table 4.

Species	Earliest observation	Latest observation	No. of records	No. of individuals	Observation years
Great northern diver	24 June	17 Oct.	15	19	92, 93, 99
Great shearwater	2 Aug	23 Aug.	399	1146	92, 94, 98
Sooty shearwater	23 Aug	23 Aug.	1	1	98.
Leach's storm-petrel	14 Aug	17 Oct.	13	14	93, 94
Northern gannet	17 July	17 July	1	1	92.
Great cormorant	13 Aug.	27 Sept.	14	39	92, 93, 2000
Common eider	17 July	17 Oct.	29	266	92, 93,
King eider	1 Oct	22 July	97	1963	92, 93, 94, 98, 2000
Harlequin duck	18 July	12 Oct.	2	5	92, 93
Long-tailed duck	4 Sept	17 Oct.	28	185	92, 93
Red-necked phalarope	1 Aug.	19 Sept.	12	23	92, 93, 94, 98, 2000
Grey phalarope	25 July	21 Sept.	39	132	92, 93, 98
Phalarope sp.	18 July	13 Oct.	16	80	92, 93
Pomarine skua	24 June	17 Oct.	437	701	all
Arctic skua	22 June	9 Oct.	85	148	all
Long-tailed skua	24 June	22 Aug.	57	72	92, 94, 98, 99, 2000
Great skua	19 July	16 Oct	36	40	92, 93, 94, 98
Sabine's gull	18 July	3 Sept.	25	36	92, 94, 98, 2000
Lesser black-backed gull	12 Aug.	12 Aug.	1	1	2000.
Herring gull	24 June	13 Aug.	9	10	94, 98, 99, 2000
Iceland gull	21 July	13 Oct.	79	233	all
Thayer's gull	24 June	9 Aug.	7	9	92, 94
Glaucous gull	25 June	17 Oct.	480	3230	all
Great black-backed gull	24 June	17 Oct.	268	1015	all
Ross's gull	24 July	24 July	1	1	92.
Ivory gull	23 July	26 July	12	36	92.
Arctic tern	22 June	26 Sept.	107	309	all
Razorbill	24 June	17 Oct.	22	29	92, 93, 94, 98, 99
Common guillemot	10 Aug.	19 Sep.	2	2	92.
Atlantic puffin	18 July	17 Oct.	911	1241	92, 93, 94, 98, 2000

Table 4. Observations of less numerous species during the NERI 1992-2000 surveys.

Great northern diver / common loon *Gavia immer*

Only few observations (Table 4, Map 4), and almost all (n= 13) from the period 27 September to 17 October (1993). Most of these autumn birds (expect two) were flying and probably on migration.

Northern fulmar *Fulmarus glacialis*

The fulmar is the most widespread and numerous seabird during summer. Fulmars occurred in moderate concentrations along almost all transects in both periods (Map 5). Very high local concentrations were encountered, usually in connection with shrimp trawler activity.

These observations are in agreement with earlier information (Brown et al. 1975, Brown 1986). Many of the fulmars in the offshore waters probably originate from breeding colonies outside Greenland, as indicated by a much higher ratio of dark morph birds (Table 5) than in the Greenland breeding population (1 %) (Boertmann 1979).

The observations in 1977 showed the same pattern, that fulmars are omnipresent, and occur in high concentration when trawlers operate near the observation sites (Fig. 2).

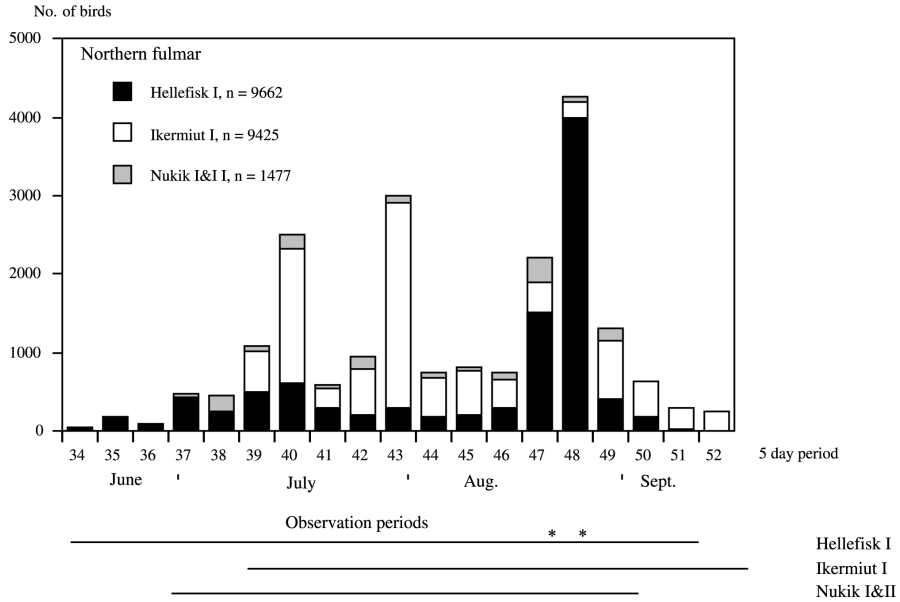


Fig. 2. Numbers of resting northern fulmars at the three drill sites in 1977. Highest number in each 5-day period shown. The asterisks at Hellefisk I indicate the presence of operating shrimp trawlers in the vicinity.

Sooty shearwater *Puffinus griseus*

Only one observation (Table 4, Map 6) of this rare visitor to the Davis Strait (Boertmann 1994).

Great shearwater *Puffinus gravis*

Great shearwaters were only observed in the waters off Nuuk despite a high effort further north in 1992-2000 (Maps 6, 7). Of 399 observations only one is from 1992 and 29 are from 1994, the remaining are from 1998 when in total 1050 birds were recorded. All observations are from August (Table 4).

In 1977, a few shearwaters were seen at the northernmost site, and were most abundant at the southernmost site (Fig. 3), except for an observation of a single flock of 3000 at Ikermiut I.

Great shearwaters visit Davis Strait from June to September, with a peak in August. They sometimes venture as far north as Disko (Salomonsen 1967, Kampp & Kristensen 1980). The variation in numbers and distribution between years seems to be large, which also is apparent from our surveys. According to Huetmann &

Diamond (2000) birds observed in the NW Atlantic after July are very likely to be non-breeders.

Leach's storm-petrel *Oceanodroma leucorrhoa*

All, expect the one from August 1994, were observed in October 1993 (Table 4, Map 6). This species is considered as a rather rare, but regular visitor mainly late in the autumn (Boertmann 1994). Our observations are in accordance with this pattern.

Date	Hour (Greenland time)	Position	Total no. of birds	Proportion of dark birds %	Behaviour
1 Aug.	1650	67.58º N 58.15º W	104	34.6	Flying when ship was trawling
1 Aug.	2030	67.57º N 58.48º W	158	36.7	Resting on water near stationary ship
2 Aug.	925	67.78º N 58.82º W	184	57.6	Flying when ship was trawling
2 Aug.	2200	68.13º N 59.40º W	190	15.8	Resting on water near stationary ship
3 Aug.	1410	68,33º N 58.62º W	256	23.4	Resting on water near stationary ship
4 Aug.	1200	69.00º N 58.97º W	35	2.9	Resting on water near stationary ship
4 Aug.	1600	69.20º N 58.68º W	124	3.2	Resting on water near stationary ship
4 Aug.	1625	69.20º N 58.68º W	151	6.0	Flying when ship was trawling
5 Aug.	1500	68.93º N 57.65º W	150	0	Resting on water near stationary ship
5 Aug.	1730	68.78º N 58.23º W	107	0.9	Resting on water near stationary ship
6 Aug.	1925	68.24º N 56.48º W	167	4.19	Resting on water near stationary ship
7 Aug.	1330	67.90º N 57.00º W	124	8.9	Resting on water near stationary ship
7 Aug.	2020	68.12º N 56.73º W	50	14	Resting on water near stationary ship
7 Aug.	2100	68.13º N 57.28º W	81	11.1	Resting on water near stationary ship
8 Aug.	1330	68.35º N 56.10º W	53	22.6	Resting on water near stationary ship
9 Aug.	1920	69.38º N 56.33º W	21	9.5	Resting on water near stationary ship
10 Aug.	1140	68.56º N 55.39º W	72	2.8	Resting on water near stationary ship
10 Aug.	1530	68.53º N 54.88º W	68	7.4	Resting on water near stationary ship
10 Aug.	1710	68.57º N 54.82º W	51	5.9	Resting on water near stationary ship
13 Aug.	900	68.67º N 54.00º W	78	7.7	Resting on water near stationary ship

Table 5. Proportion of dark morph birds among northern fulmars observed during the survey in August 2000. Dark birds are the types D and DD sensu Franeker & Wattel (1982).

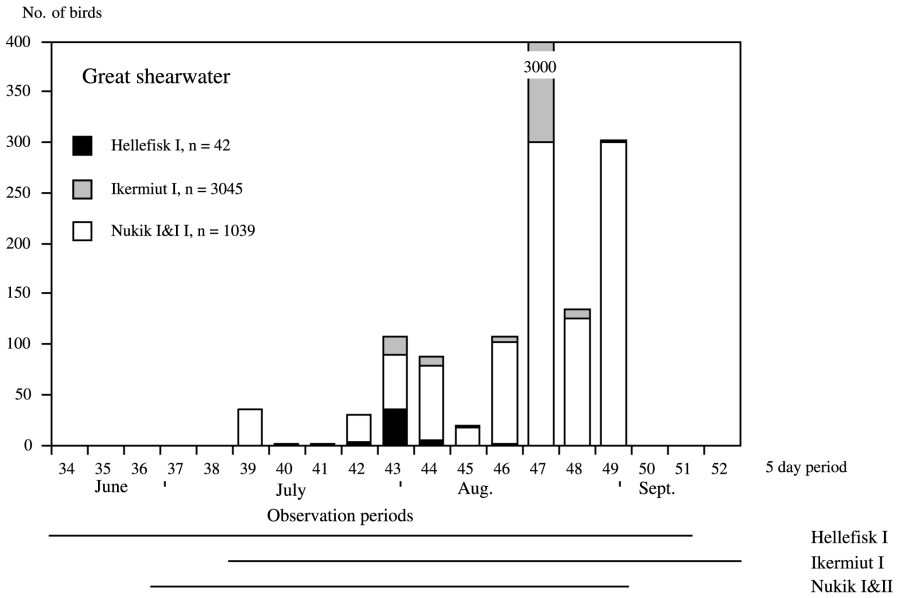


Fig. 3. Numbers of resting great shearwaters at the three drill sites in 1977.

Great cormorant Phalacrocorax carbo

Only a few observations and all from inshore waters (Table 4, Map 4). All observations are from the period August and September, and all within the breeding range of the species in Greenland, indicating that the autumn dispersion have not yet taken place in September.

Northern Gannet *Morus bassanu*

Only one observation (Table 4, Map 6), which is surprising, as the species usually is described as a regularly occurring summer visitor (Salomonsen 1990, Boertmann 1994).

Common eider Somateria mollissima

Only recorded in 1992 and 1993 and mainly in inshore waters (Table 4, Map 8). A few were seen offshore on the banks south of Nuuk, and these were all flying birds, probably on migration.

King eider *Somateria spectabilis*

The major part (n = 1746) of the king eiders recorded during our surveys 1992-2000 were seen in inshore waters at Disko near and at well known moulting sites (Mosbech & Boertmann 1999) in late August 1992 and in September 1993 (Table 4, Map 8). The remaining part (n = 217 in 44 flocks) were seen in the period 22 July to 1 October and mainly offshore. These birds were flying and could be on migration towards moulting and wintering grounds in Greenland. However, 12 of the flocks were observed within the

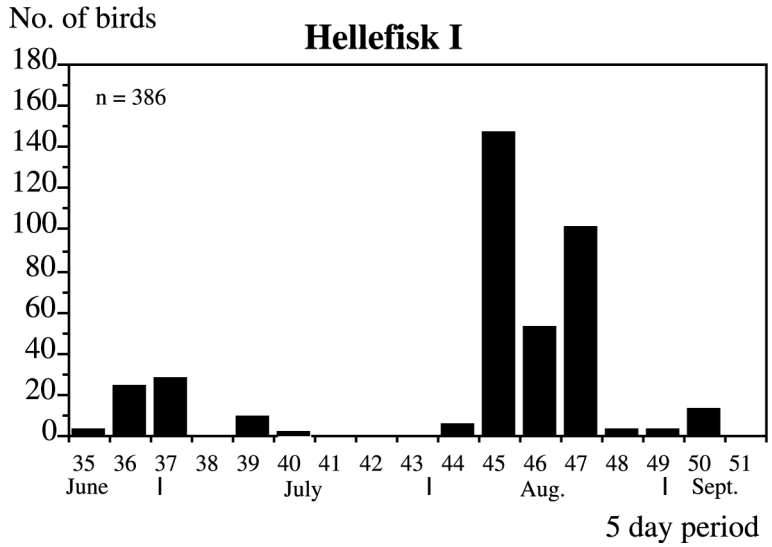


Fig. 4. Numbers of mainly flying king eiders at the northernmost drill site (Hellefisk I) in 1977.

50 m isobath on Store Hellefiskebanke, where recent satellite telemetry studies have shown that post moulting king eiders assemble from October (Mosbech in prep.).

In 1977, a few hundred king eiders were recorded passing by the northernmost drill site (Hellefisk I) 140 km offshore in June and again in mid-August (Fig. 4). Except for the few observations in August 2000, no flight directions were recorded on these birds. The June birds were probably late spring migrants on their way to breeding grounds in Canada, and the August birds were probably on moult migration towards Greenland, where the major moulting ground are at Disko and further north. None were recorded at Ikermiut I, and only 13 eiders sp. were observed at Nukik I&II.

Harlequin duck *Histrionicus histrionicus*

Only two observations: A male in July 1992 and a flock of females/juveniles in October 1993 (Table 4, Map 9). Both concerned flying birds far offshore, and may have been birds on moult migration (the July male) or autumn migration (the October flock) from Canada.

Long-tailed duck *Clangula hyemalis*

A few small flocks of long-tailed ducks were recorded during September and October in 1992 and 1993 (Table 4, Map 9). All were flying and may have been birds on migration.

Phalaropes *Phalaropus spp.*

The two species red-necked (*P. lobatus*) and grey (red) phalarope (*P. fulicarius*) are treated together as they are very difficult to separate at sea, and most observations concern unidentified phalaropes.

Phalaropes have in 1992-2000 been recorded from mid-July, in small flocks and throughout the surveyed waters, although scattered in most areas (Table 4, Map 10). The shelf between Nuuk and southern Paamiut municipality hold most of the observations. None were seen during the June 1999 survey, indicating that the autumn migration begins later.

In 1977, remarkable high numbers of phalaropes, most likely grey, were recorded in early September, when several 100 passed by and rested on the water at Ikermiut I (Fig. 5). In the same period 13 were seen at Hellefisk I and 118 were seen on a trip between the observation site and land. All these birds at Hellefisk I were identified as grey phalaropes.

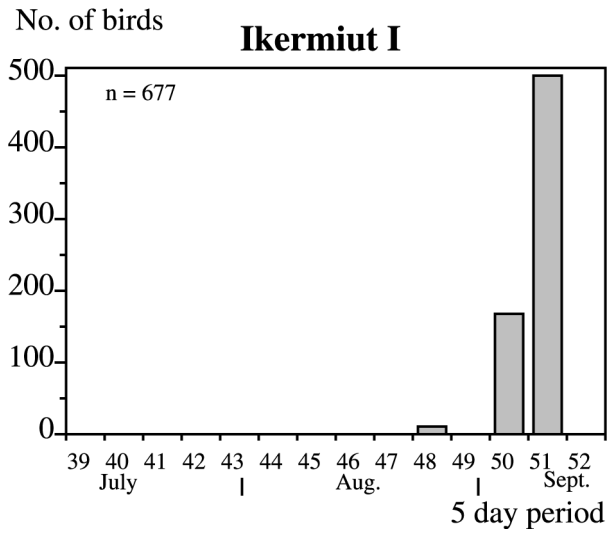


Fig. 5. Numbers of resting and flying phalaropes (most likely grey) at the central drill site (Ikermiut I) in 1977.

Pomarine skua / pomarine jeager S*tercorarius pomarinus*

The most numerous of the four skua species (Table 4, Map 11). The major part of the observations during 1992-2000 are from the waters to the north of 63° N. The area further south was surveyed only in September and October,when almost no pomarine skulas were observed. This indicates that most of the pomarine skuas have left the Greenland waters by early September. Elsewhere the pomarine skuas were recorded along most of the transects both on the banks and above deeper waters. No density map has been prepared as most of the skuas were recorded off transect and as ship followers. This temporal pattern is confirmed by the 1977 information (Fig. 6), when very few pomarine skuas were observed into the first week of September.

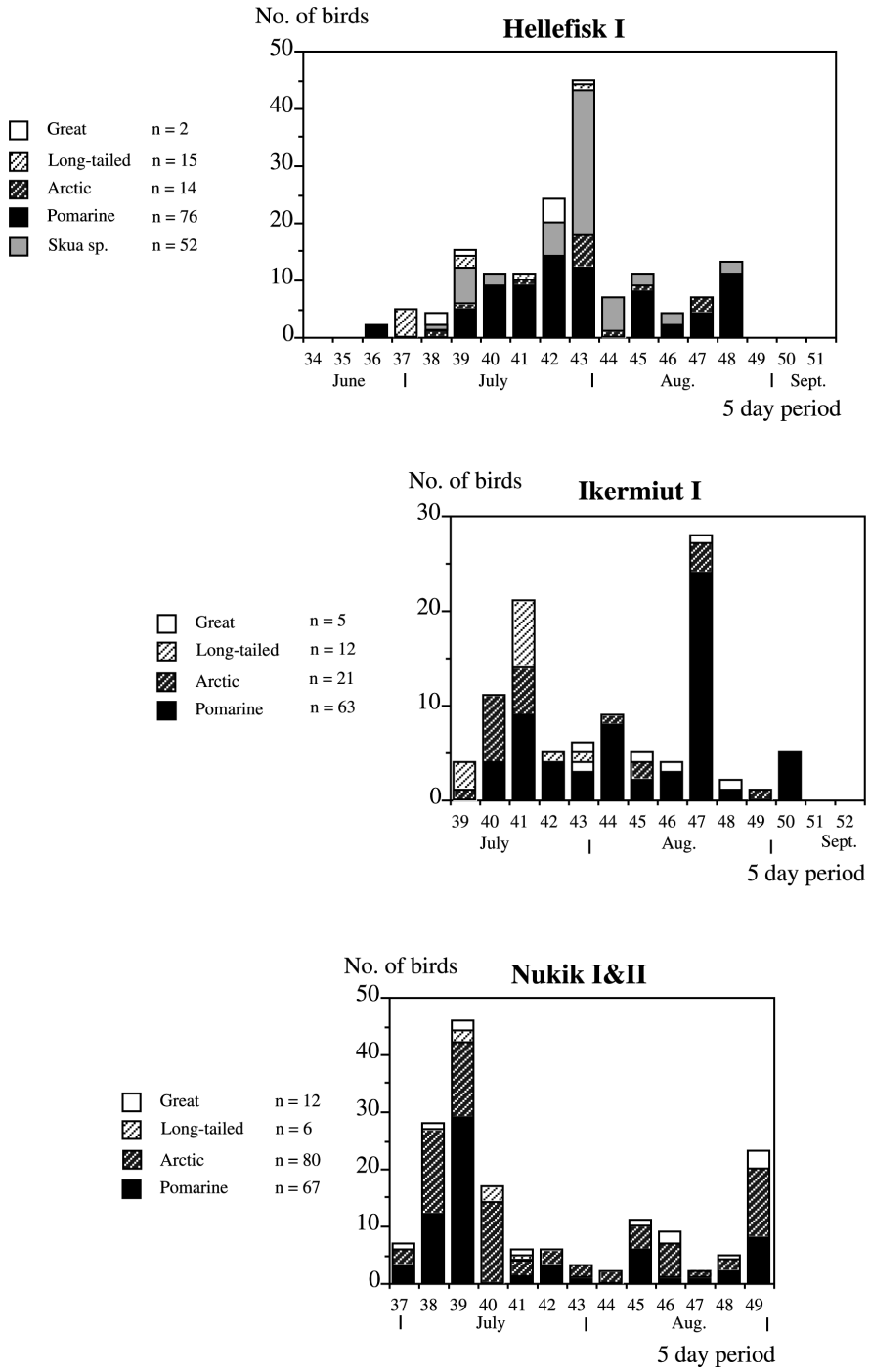


Fig. 6. Numbers of skuas at the three drill sites in 1977. Both resting and flying.

Arctic skua / arctic jeager *Stercorarius arcticus*

Much less numbers were recorded of this species compared to the pomarine skua, but mainly in the same areas (Table 4, Map 12). The temporal occurrence of the two species seem to be identical. The many observations in the Disko Bugt area refer probably to local breeding birds. In 1977, arctic skuas were recorded through August (Fig. 6).

Long-tailed skua ***Stercorarius longicaudus***

Much scarcer compared to the preceding species (Table 4). The major part of the records is from outside the 200 isobath (Map 12), and the latest observation was made in late August (Table 4), indicating an earlier departure from the Greenland waters than the other skuas. In 1977, long-tailed skuas were only recorded in July (Fig. 6).

Great skua ***Stercorarius skua***

With 36 records from mid-July through mid-October (Table 4, Map 12), the great skua was the most rare skua during the 1992-2000 surveys. The major part of the population seems to have left by the end of August. In 1977, 19 great skuas were observed and most numerous at Nukik I&II the southernmost site (Fig. 6).

Sabine's gull ***Larus sabini***

This gull was recorded 35 times during the 1992-2000 surveys: Once in July and the remaining during the period 9 August to 3 September. Usually single birds, and occasionally in flocks up to four individuals (Table 4, Map 13). Juveniles were seen from 10 August and onwards. Most of the observations are from outside the 200 m isobath.

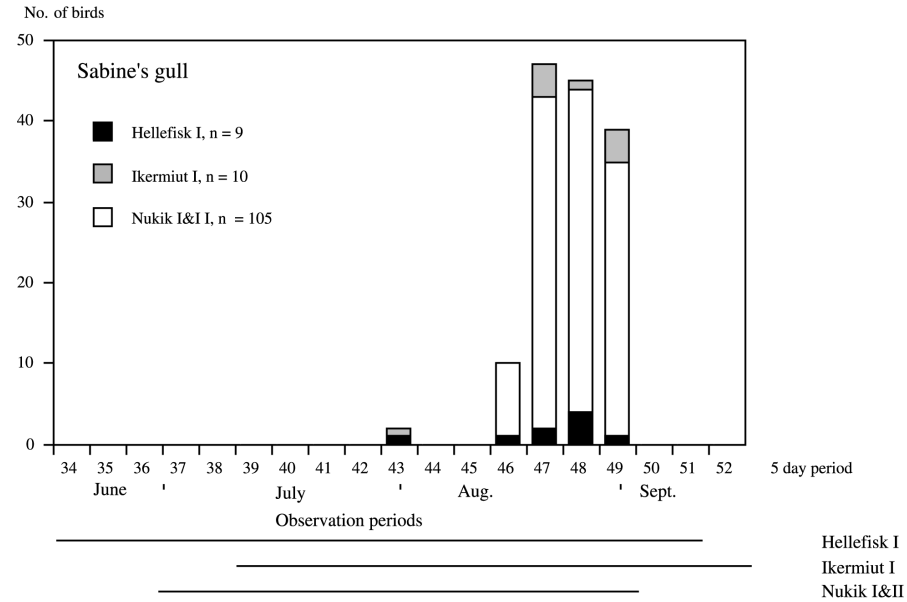


Fig. 7. Numbers of Sabine's gulls at the three drill sites in 1977. Both resting and flying birds included.

In 1977, 124 Sabine's gulls were observed (Fig. 7). The major part (n = 105) were observed at Nukik I&II, just inside the 200 isobath. All observations, except for two in late July, were from the period 15 August to 2 September, confirming the pattern seen in 1992-2000. The July birds are probably non-breeders or failed breeders, and the autumn migration seems to be initiated in the Davis Strait in mid-August.

Iceland gull *Larus glaucoides*

Although the most numerous gull in the inshore waters, amazingly few were recorded during our surveys (Table 4, Map 15). In the summer only offshore birds were recorded, indicating that observers either neglected this species or just included it under glaucous gull. Only one large concentration was recorded, in autumn and this was in inshore waters.

Not recorded in 1977, probably because Iceland gulls were included among the glaucous gulls.

Glaucous gull *Larus hyperboreus*

This common gull was recorded almost everywhere, although in small numbers far from the coast. It was much more frequent offshore than Iceland gull (Table 4, Map 16). During autumn from August much more glaucous gulls were seen offshore.

In 1977, some Iceland gulls are probably included in the glaucous gull observations. The most significant feature in 1977 is the increase in birds from late August (Fig. 8). This is probably related to the post breeding dispersal of the gulls, a pattern also apparent from the distribution of observations in June-July compared to August-October.

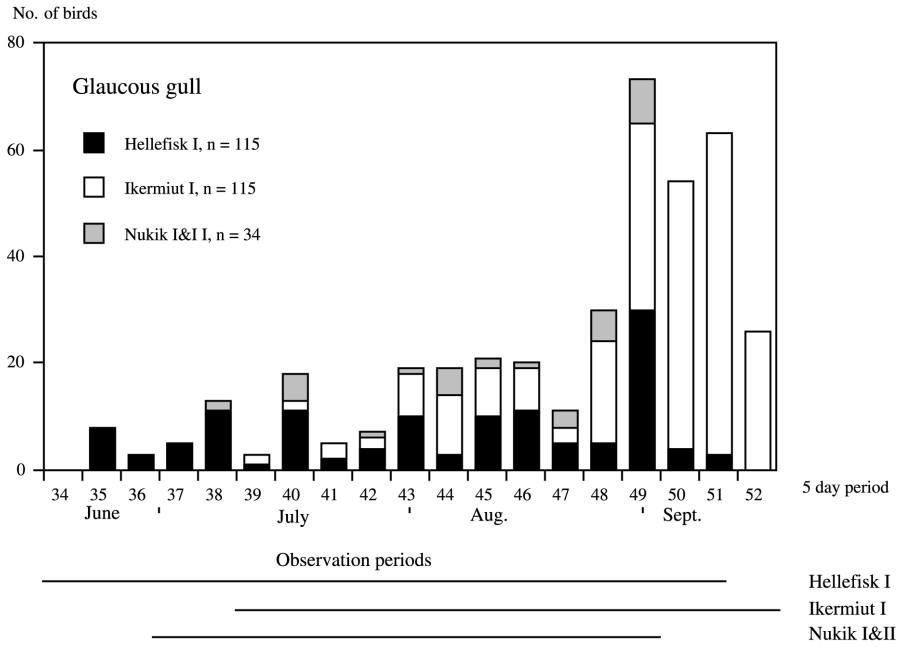


Fig. 8. Numbers of resting glaucous gulls at the three drill sites in 1977. Some Iceland gulls are probably included.

Great black-backed gull *Larus marinus*

This large gull was not as widespread as the glaucous gull during the 1992-2000 surveys, although there is some observation far offshore. Larger congregations were recorded on Danas Banke (Table 4, Map 17). Few where recorded in June and July, and this

corresponds with an increase in numbers from early August in 1977 at the three drilling sites (Fig. 9). Again, this is probably linked to the post breeding dispersal, and indicates also that in the breeding period great black-backed gulls are more closely related to the coast.

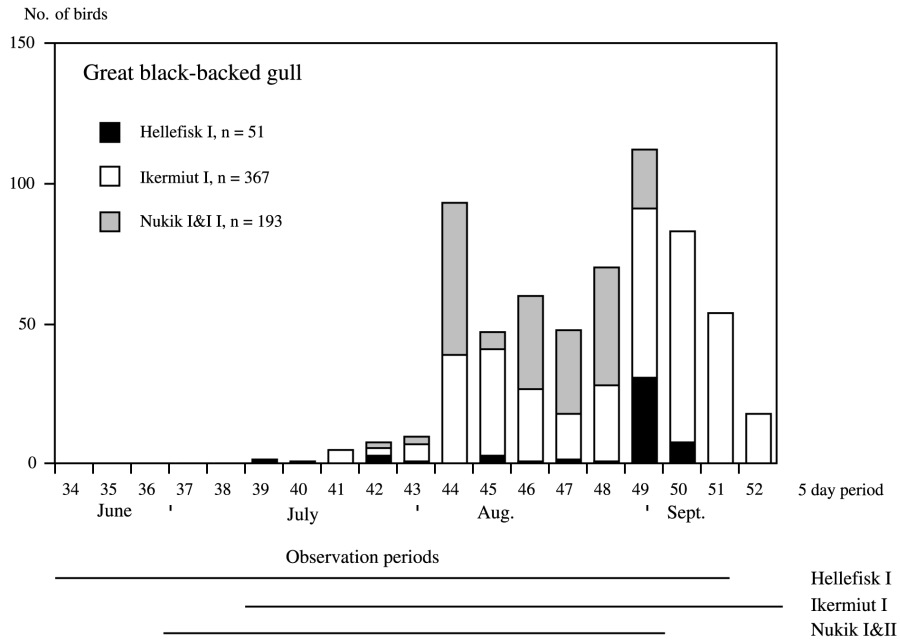


Fig. 9. Numbers of resting great black-backed gulls at the three drill sites in 1977.

Black-legged kittiwake *Rissa tridactyla*

Kittiwakes were observed along many transect in low densities, both summer and autumn (Map 18). Particularly far from the Greenland coast kittiwakes were absent from many transects. Dense concentrations were seen at a few sites often near shrimp trawlers, resting on icebergs or at feeding areas such as outer Disko Bugt or at the entrance to Godthåb Fjord.

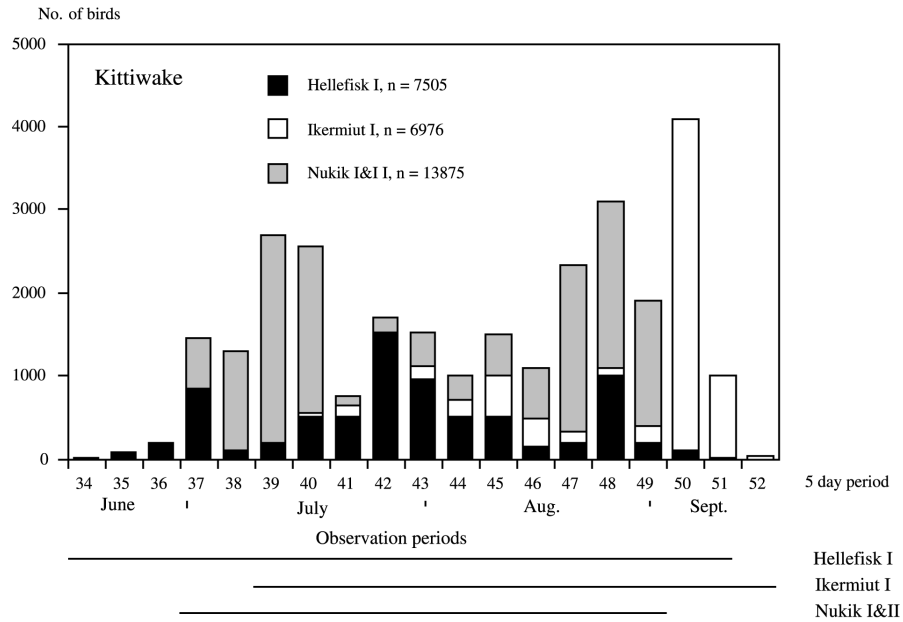


Fig. 10. Numbers of mainly resting kittiwakes at the three drill sites in 1977.

Kittiwakes were seen in highly fluctuating numbers at the three drill sites in 1977, and they were often attracted to the sites and rested there in large flocks (Fig. 10). There is a tendency to decreasing numbers of kittiwakes at the northernmost site (Hellefisk I) through August and early September, while numbers increased through August at the southernmost site. This could be an indication of a southward movement. Kittiwakes were often attracted to the drill sites resting there on the water in large flocks.

Ivory gull *Pagophila eburnea*

Ivory gulls were recorded only in the period 23-26 July 1992 (Table 4, Map 13) in the central Davis Strait when the survey ship operated in and near drift ice (the "West Ice"). At least 36 different birds were observed. Up to 17 individuals were seen together near the ship.

In 1977, ivory gulls were seen in the same area (from the northernmost drill site) in late June and early July, when ice were present (Fig. 11), and at a few other situations when ice was absent.

Other gulls *Larus spp.*

Lesser black-backed gull (*L. fuscus*) was only recorded once, close to the coast (Table 4, Map 14). Herring gulls (*L. argentatus*) were recorded nine times, all early in the survey season (Table 4, Map 14) with the latest 10 August. Thayer's gulls (*L. thayeri*) were recorded seven times and also early during the survey season. All were seen very far from the Greenland coast (Table 4, Map 14). Ross's gull (*Rhodostethia rosea*) was seen once, an immature together with the ivory gulls in 1992 (Table 4, Map 13).

Arctic tern *Sterna paradiseae*

In total, 107 observations of 309 birds (Table 4, Map 19). The coastal observations probably include mainly local breeding birds, while offshore observations probably are non-breeders, and from late July when the first juveniles were observed also migrants. The terns seem to have left Greenland waters by late September.

Arctic terns were observed in very low numbers from the three drill sites in 1977 (in total 70 birds), with the majority in August (Fig. 12).

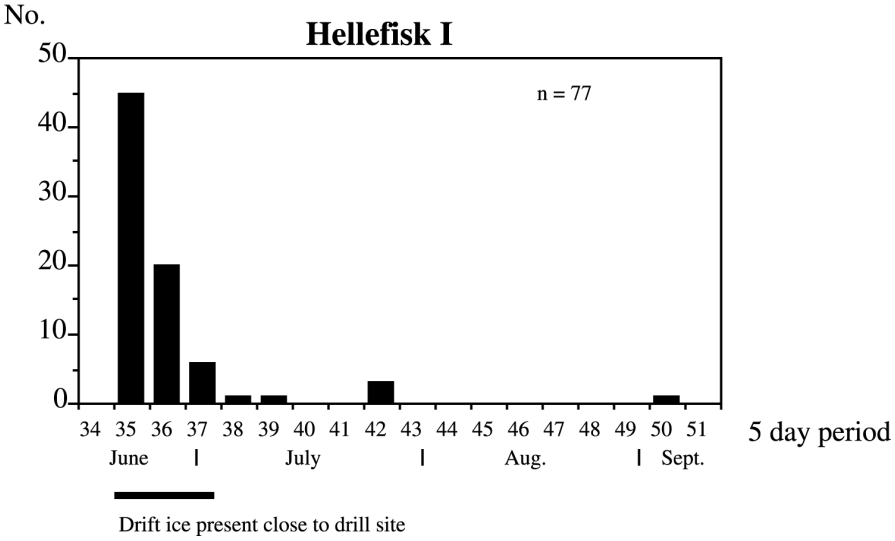


Fig. 11. Numbers of resting and flying ivory gulls at the northernmost drill site (Hellefisk I) in 1977.

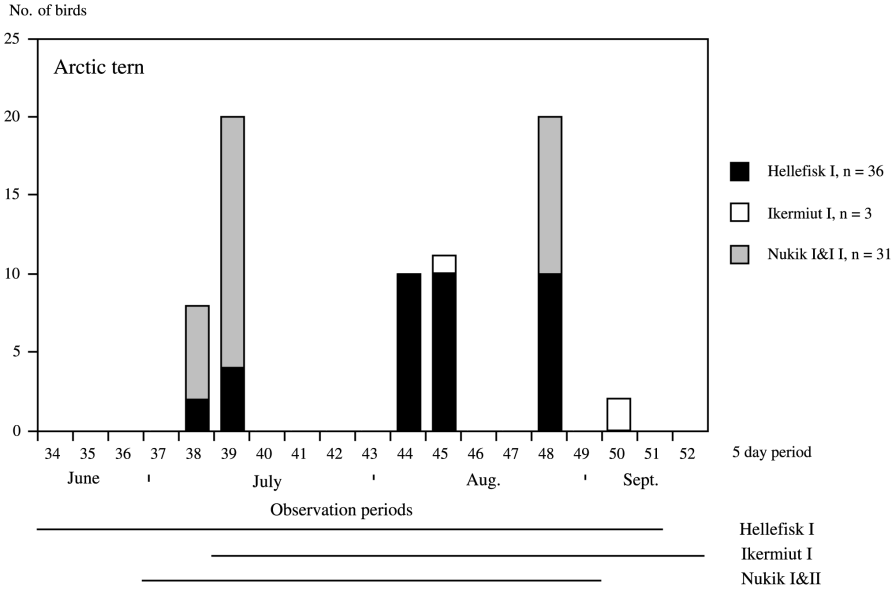


Fig. 12. Numbers of arctic terns, both resting and flying, at the three drill sites in 1977.

Common guillemot/murre *Uria aalge*

Only two observations, both from 1992 (Table 4, Map 20).

Thick-billed murre / Brünnich's guillemot *Uria lomvia*

Thick-billed murres were seen along many transects in low numbers both during summer and autumn (Map 21). In July/August a few concentration areas were observed near the coast between Nuuk and Maniitsoq and on the outer edge of Store Hellefiskebanke. Those near the coast in the summer may represent local breeders at feeding grounds, while those further offshore may be birds on swimming migration. During September and October Thick-billed murres were recorded much more frequently on the banks, and concentrations were recorded in several areas (Map 21).

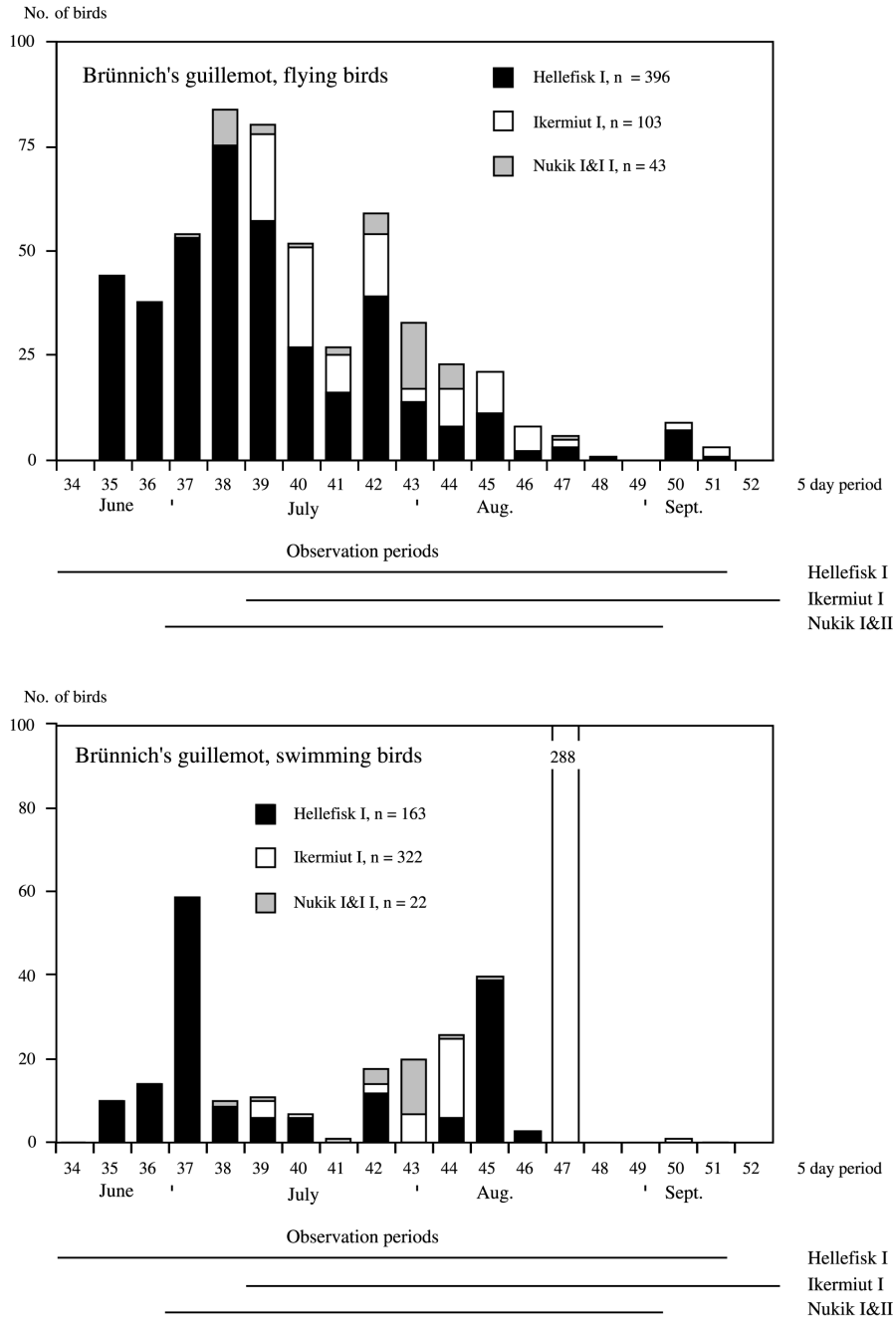


Fig. 13. Numbers of thick-billed murres at the three drill sites in 1977. Upper graph only flying birds, lower graph only swimming birds. Only observation made during wind force 4 or lower included.

The survey effort in September - October between 61° N and the Disko Bay (68° 30′ N) is fairly good within about 100 km of the coast including altogether 1393 10-min survey watches covering an area of 1303 km². We have estimated the total number of thick-billed murres in this area using the density interpolations in Map 21, and this results in a figure of 506,000 birds for the 54,173 km² where densities have been interpolated. The average density of birds is 9.3 birds/km² with a range from 0 to 466 birds/km². Using a conservative correction factor of 1.5 for incomplete detection of birds on the water (74%, number of flying birds not corrected) within the 300 m wide transects (Skov et al. 1995) we get an estimate of 693,000 murres. This estimate is conservative as it does not account for birds in the unsurveyed areas not covered by the interpolations.

In 1977 thick-billed murres were rather numerous at the three drill sites. The relationship between flying and swimming birds were inversely related (Fig. 13), with many flying birds in June and July and with increasing numbers of swimming birds from late July to mid-August. The swimming birds in August were probably moulting birds unable to fly on their swimming migration. No juvenile birds were recorded in 1977, but in 2000 several adults in company with juveniles were seen 7-9 August on the NW corner of Store Hellefiskebanke and the western part of Disko Banke.

Razorbill ***Alca torda***

Recorded most years, but in very low numbers: in total 22 records concerning 29 individuals, widely distributed on the fishing banks and also on deeper waters (Table 4, Map 20). There were very few observations in 1977, when only six birds were recorded in July and only from the two northern sites Ikermiut I and Hellefisk I.

Black guillemot ***Cepphus grylle***

During summer most of the observation are from inshore waters where only low concentration were seen (Maps 22). In the autumn black guillemots were also recorded further offshore, but still in low concentrations. Black guillemots were seen in very low numbers at all three drill sites in 1977: in total 17 observations from all three sites and dispersed in June, July and August.

Little auk / dovekie ***Alle alle***

Except for a few birds seen to the south of Nuuk, the summer observation of little auks were situated to the west and north of Store Hellefiskebanke (Map 23). Along most transects in that area, low concentrations were recorded, but along a few high concentrations were seen. In autumn it is obvious that the little auks occur closer to the coast and more abundant and widespread (Map 23).

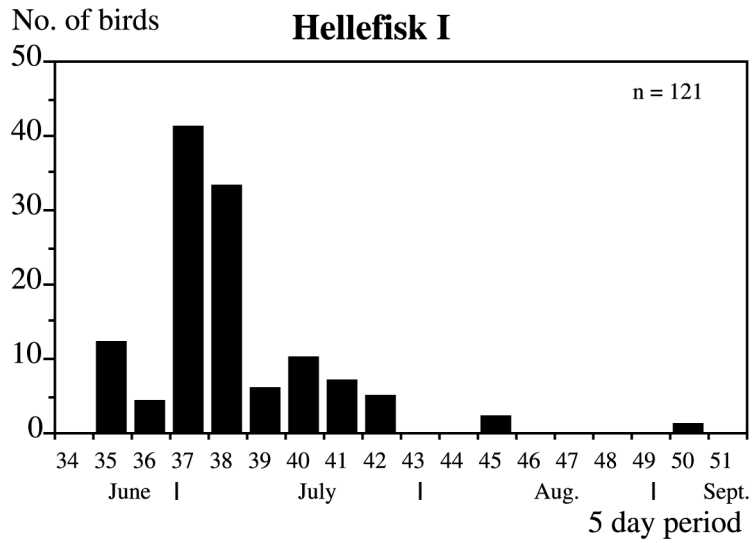


Fig. 14. Numbers of little auks at the northernmost drill site in 1977. Both resting and flying birds included.

In 1977, little auks were, except for one bird, observed only at the northern drill site (Hellefisk I), in the same general area as where most little auks were observed during the July-August 1992-2000 surveys (Fig. 14).

Atlantic puffin *Fratercula arctica*

Summer records (June-August) of puffins were restricted to the outer Disko Bugt area and to the waters west of Nuuk, where a total of 85 birds in 54 flocks were recorded (Map 24). Large breeding colonies are located on the coast of these areas (Boertmann et al. 1996), and most of the birds probably represent local breeders, although some were seen at considerable distance from the coast. During autumn the offshore numbers increased considerably and showed considerable variation between years, with 1993 as a peak year when 924 puffins (703 observations) were recorded (Map 25). The origin of the puffins in autumn 1993 was possible Iceland, as indicated by a single ring recovery (Boertmann & Mosbech 1999). Only three puffins were observed from the drill sites in August 1977: one at each site.

Discussion

The summer months (July and August)

During the summer months June, July and August there are many seabirds in the offshore waters of Southwest Greenland. The most numerous and widespread species are northern fulmar, kittiwake and thick-billed murre. However, the densities of these species are generally low, with local concentrations at feeding areas, breeding colonies (near the coast) and other resting sites.

Thick-billed murres have been recorded feeding at sites more than 100 km from their breeding sites in N Greenland (Falk et al. 2000). It is however our general impression that the breeding murres of Southwest Greenland usually feed closer to their colonies, for example in the mouth of the same fjord as their colony is situated. The thick-billed murre concentrations recorded close to the coast in summer, may very well relate to local breeding birds. It seems more likely that the murres recorded further offshore in summer are non-breeders. But late in the summer flightless adult and juvenile birds on swimming migration may also contribute to some of the offshore concentrations.

That non-breeding kittiwakes stay offshore Southwest Greenland waters is well known. Many of these are immature birds, and ring recoveries prove that many non-breeding birds from other N Atlantic populations stay in Greenland during the summer (Salomonsen 1967). How far local West Greenland breeders venture offshore to feed is not know, but large scale feeding migration in and out of fjords where the colonies are situated is a common feature, and these birds may feed for example on the fishing banks. The concentrations of kittiwakes seen to the south of Godhavn and in the mouth of Godthåb Fjord may be such local breeding birds.

Fulmars breed in such low numbers in Southwest Greenland that they do not contribute significantly to the vast numbers occurring offshore Southwest Greenland. These birds are probably mainly non-breeders, which originate from breeding populations outside Greenland, where the proportion of dark birds is higher than among the fulmars breeding in entire West Greenland. Concentrations of fulmars in summer are usually associated with operating shrimp trawlers, where food is easily found. Whether oceanic features may generate good and more predictable feeding opportunities in the area is not known, but seems likely.

At least one more species, the great shearwater, may occur in significant concentrations. This species is a summer visitor to Greenland waters, and the majority occurring here are presumed to be immature birds (Huettmann & Diamond 2000). The numbers occurring in Greenland seem to fluctuate considerably between years, and likewise also the distribution towards north. This could be governed by oceanic features, such as the influx of relatively

warm Atlantic water, but remains to be studied. At least off the Godthåb Fjord a concentration area appear (Map 7, note that the 1998 data are not included). In the waters off Nuuk (Fyllas Banke, Toqqusaq Banke), great shearwaters are usually recorded in large numbers along side many other seabirds and marine mammals. This area seems to be one of the most predictable marine hot spots for birds in the summer months in West Greenland.

Less numerous, but widespread in summer are the skuas, mainly pomarine and arctic. Most of these are non-breeding immatures and failed-breeding adult birds (mainly the long-tailed and pomarine skuas), which roam the offshore areas, and rarely occur in significant concentrations. The largest numbers have been recorded in the waters off Nuuk.

Among the gulls, the three large species - glaucous, Iceland and great black-backed - occur widespread, but usually in low numbers offshore and particularly outside the 200 isobath in very low numbers. Iceland gull seems to be most scarse of the open sea, while glaucous and great black-backed have been recorded in the central parts of the Davis Strait. The observations at the drill sites in 1977, indicate that the numbers of the large gulls increase from early August, which may relate to a post-breeding dispersal.

A remarkable summer occurrence is the ivory gulls recorded at the edge of the drift ice in central Davis Strait, both in June 1977 and in July 1992. The birds seen in July hardly can be breeding birds, and perhaps these birds are non-breeders staying the drift ice edge zone throughout the summer.

Two types of migrants occur in the summer: birds on moult migration on their way from Canadian breeding grounds to moulting (and later wintering) grounds in West Greenland; and the other type which are early autumn migrants. These are on passage, and will, during this time of the year, congregate in coastal habitats and inshore waters, why offshore concentrations will not occur. The king eiders and the single male harlequin duck observed flying offshore in the summer are most likely on moult migration. Sabine's gull, the phalaropes, and the arctic terns are on the other hand early autumn migrants. They may occur in small concentrations at favourable, but most likely, very unpredictable feeding sites.

Many species occur offshore during summer in low numbers. These are mainly non-breeding segments (immatures) of seabird populations breeding in boreal areas, as for example great skua, northern gannet and herring gull. Or they are from breeding populations in Greenland or Canada, which either are small or mainly restricted to the inshore waters as for example black guillemot, razorbill, Atlantic puffin, common guillemot, Thayer's gull and lesser black-backed gull. Concentrations of these species are not likely to occur in offshore waters.

For many species, the waters off Nuuk seems to be important during the summer months. However, the observation effort in

these waters was much higher there than in other parts of the Greenland waters, because extensive seismic activity was carried out in connection to the Statoil exploration drilling in 2000. Taking this into account, there is although no doubt that the waters off Nuuk, around the Fyllas Banke and Toqqusaq Banke are very important feeding grounds for seabirds and marine mammals, and that some certain oceanic features may facilitate this.

The autumn months (September and October)

The most numerous species in the autumn months are northern fulmar, kittiwake, thick-billed murre and little auk. The distribution patterns for the fulmar and the kittiwake are almost similar to the summer period: they are widespread and concentrations occur here and there where favourable feeding opportunities occur, for example at operating shrimp trawlers and at the entrance to Godthåb Fjord. Both species will decrease in numbers towards the winter, when both occur in small but somewhat fluctuating numbers.

The thick-billed murre numbers increase considerably during the autumn, and they become abundant on the fishing banks and in inshore waters. Dense concentrations have been recorded at several sites, particularly between 62° 30′ N and 64° N. A crude estimate based on the density calculations gave 693,000 murres present in the surveyed area in the region between 61° N and Disko Bugt in the autumn months of September and October.

The migrational pattern of the thick-billed murres in the North Atlantic is rather complicated, but ring recoveries show that birds from at least Arctic Canada, Iceland and Svalbard move to West Greenland waters to winter (Falk & Kampp in prep.). The total winter population in West Greenland is unknown, but may exceed one million birds (Falk & Kampp 1992). It is well known that the murres occur closer to the coast during the autumn and winter. The majority of the bagged thick-billed murres are also shot (hunting take place close to the shore) during November-February.

Little auk shows almost the same distribution pattern in autumn as the thick-billed murre. They become widespread on the banks, particularly to the south and west of Nuuk. From ring recoveries it is documented that little auks from Svalbard move to West Greenland waters for the winter. Birds from the huge Avanersuaq and Scoresby Sund populations may also occur, but no ring recoveries can support this (and very few have actually been ringed in these populations). The arrival pattern to West Greenland indicate that Avanersuaq birds occur (Falk & Kampp 1992), and the distribution of the little auks in September and October (Map 23) also indicate that birds arrive from the north. The number of little auks in offshore West Greenland waters is unknown, but may reach considerable numbers.

An unexpected high number of Atlantic puffins were recorded in September and October 1993 (Map 25). In total, we estimate that

75,000 puffins were present in the waters between 62° N and 66° N. This is much more than the Greenland breeding population can support, and a ring recovery from this period indicate that the many puffins were of Icelandic provenience (Boertmann & Mosbech 1999). Puffins are usually regarded as rather rare in offshore West Greenland waters, as exemplified by the 1988 surveys (Map 25).

All three populations of large gulls - glaucous, Iceland and great black-backed - stay during winter in West Greenland. The largest congregations of these gulls were recorded during the autumn surveys. A least in the northern part of the surveyed area, these gulls were missing or at least recorded in extremely low numbers on the transects far from the coast (only very few of such transects were sailed in September and October compared to the summer period). Later in the winter these gull may occur in much large concentrations (Durinck & Falk 1996).

Great northern diver, skuas, Sabine's gull, Arctic tern, and the phalaropes all were recorded in few numbers during the autumn surveys. They are all migrating species, which leave the Greenland waters during September or October.

Remarkable were the observations of Leach's storm-petrels in October 1993. This species is assumed to be a rather rare but regularly occurring autumn visitor offshore, although most of the reported records were storm driven specimens found inland or close to the shore. Our observations confirm this assumption.

The seaducks, common eider, king eider, long-tailed duck and harlequin duck, all winter in the West Greenland near shore waters in considerable numbers and concentrations. Offshore these species were mainly recorded flying, probably on migration to winter habitats. King eider is in this context more interesting, because dense concentrations have recently been discovered wintering in offshore and ice covered waters on Store Hellefiskebanke (Mosbech & Johnson 1999). These concentrations were not encountered during our autumn surveys, although some flocks were observed there as early as in September. Recent satellite tracking of king eiders in Greenland indicate that the post moulting king eiders arrive at these winter sites in October (Mosbech in prep.).

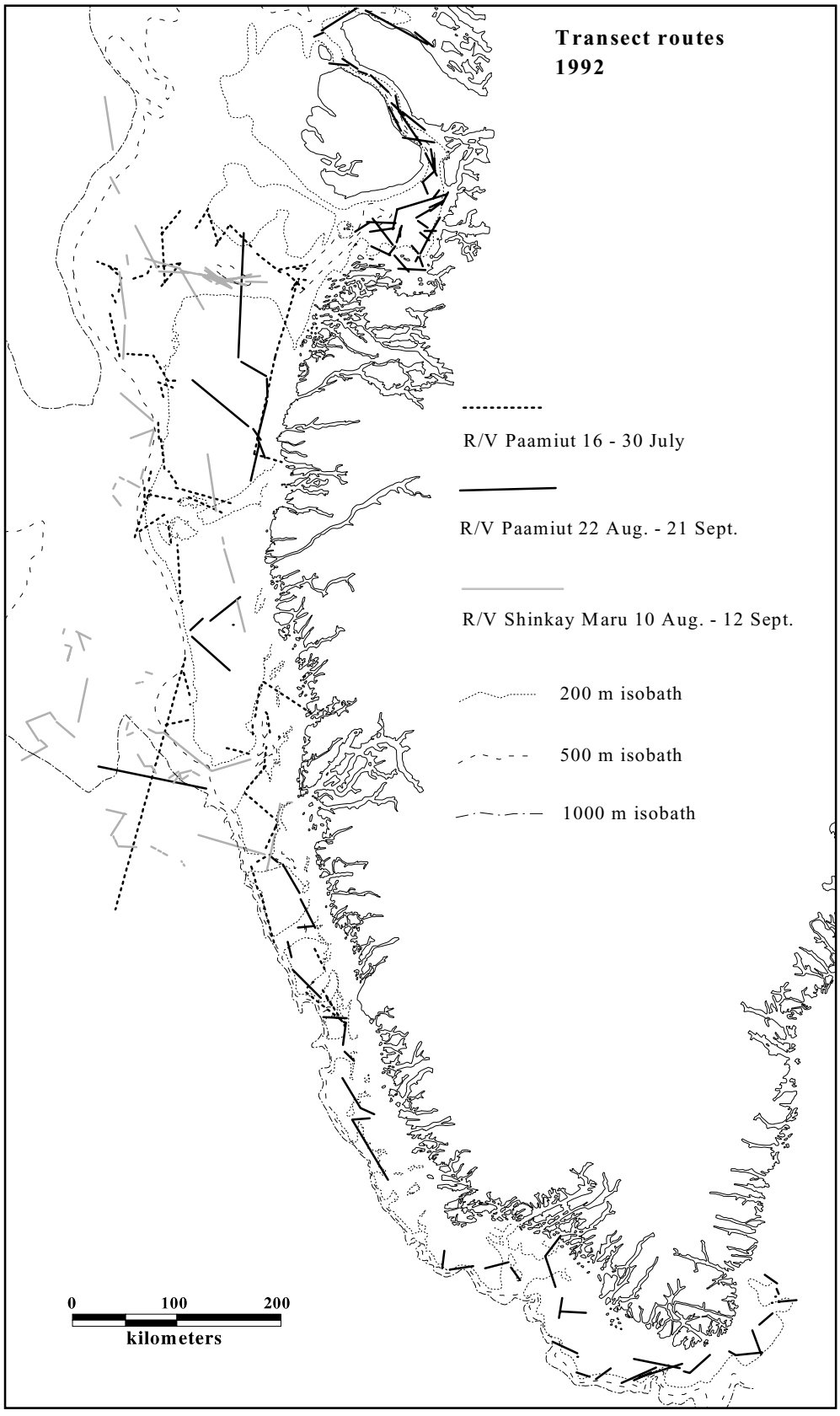
Conclusions

During the summer months seabirds occur widespread and numerous in the offshore areas, but rarely in concentrations vulnerable in an oil spill context. We still lack the knowledge to make any predictions on the occurrence of such concentrations. However, at least some are the result of operating shrimp trawlers, and others are most likely governed by oceanic features, which remain to be studied.

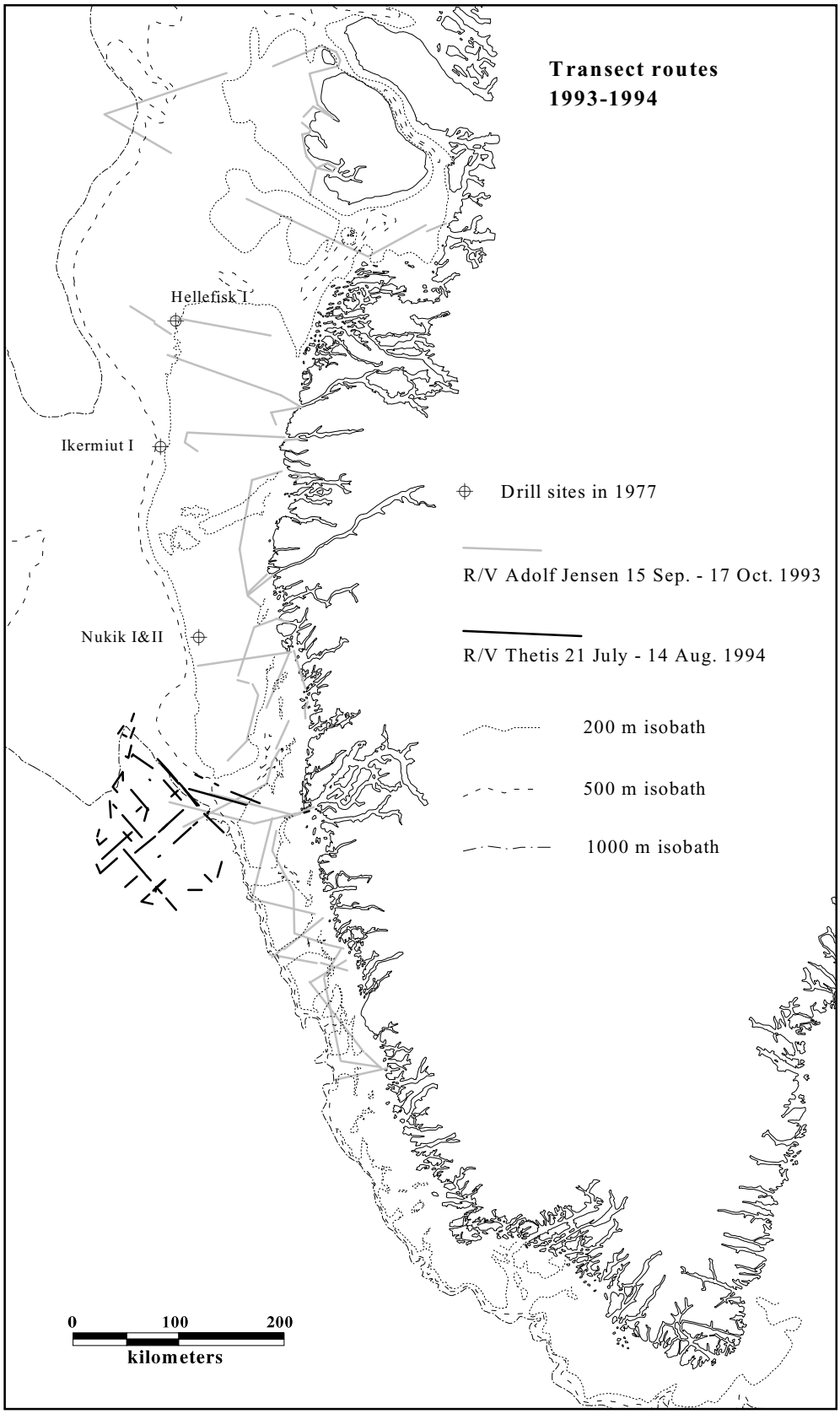
During the autumn the vulnerability of the seabird populations in the West Greenland offshore waters increase, because both Greenland and international seabird populations assemble there.

There is no doubt that the most oil spill sensitive period in terms of seabirds of the offshore waters of West Greenland is the winter. Huge numbers of birds winter there, and they are often concentrated by ice conditions or along the coastal parts.

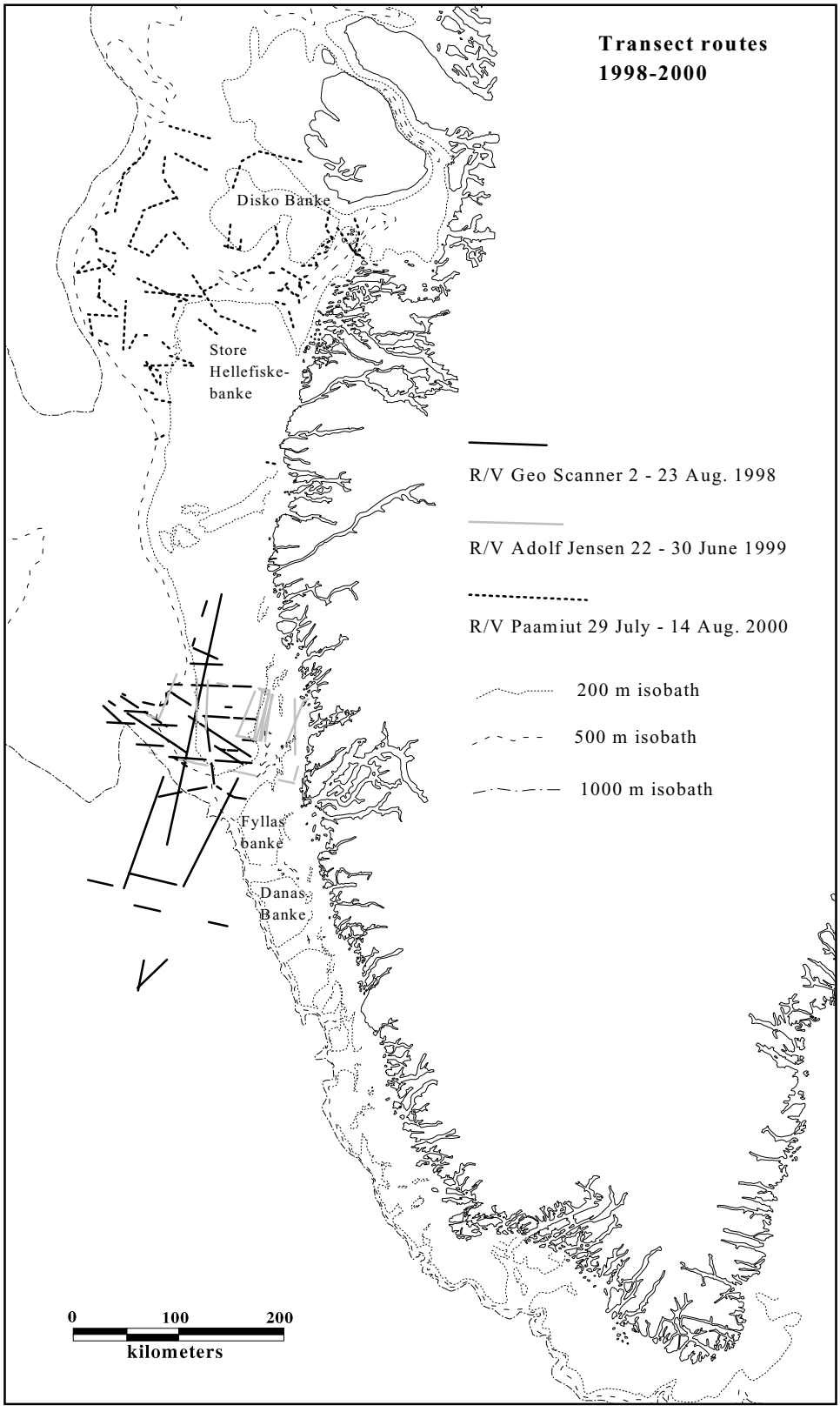
Maps



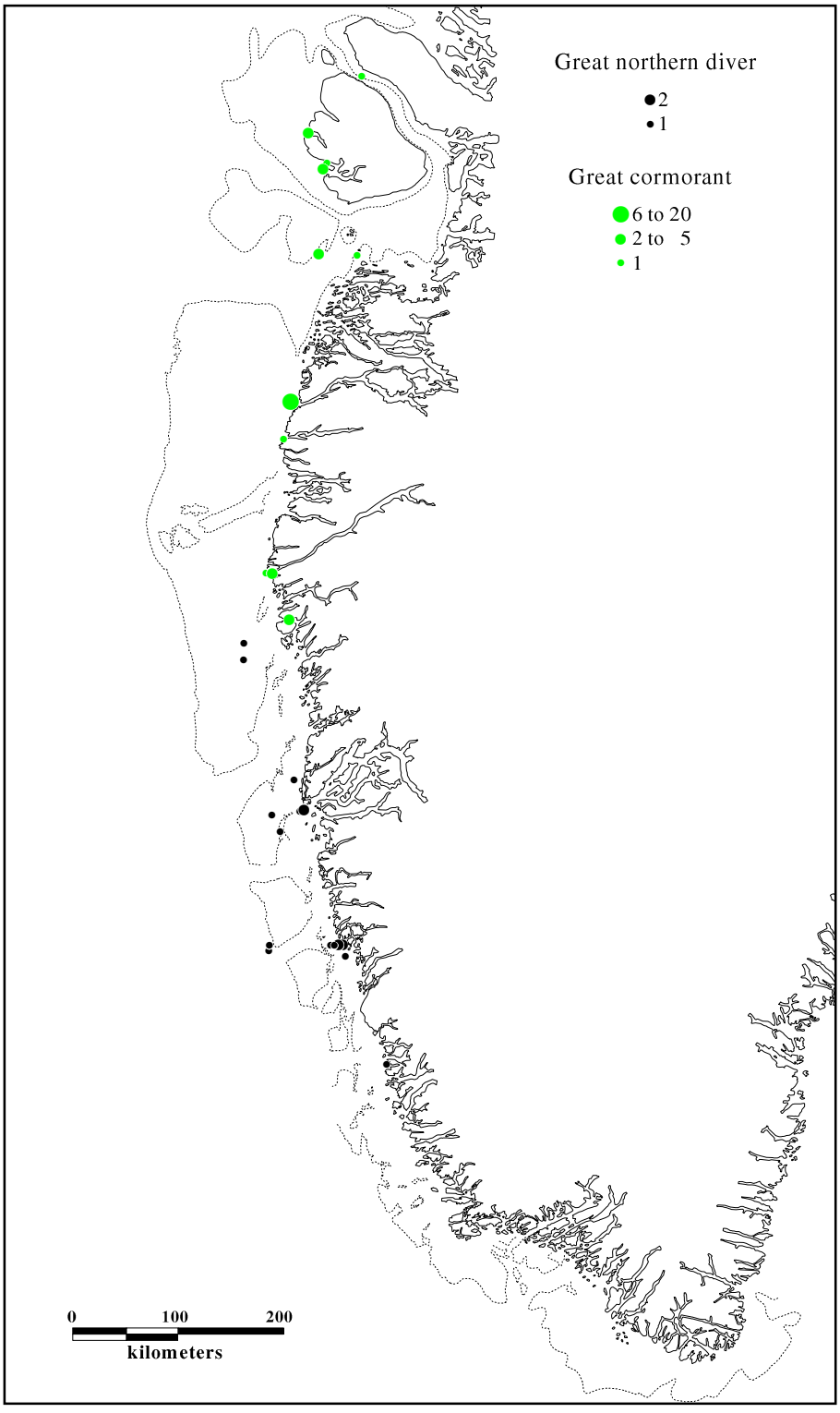
Map 1. The transects sailed during the surveys in 1992.



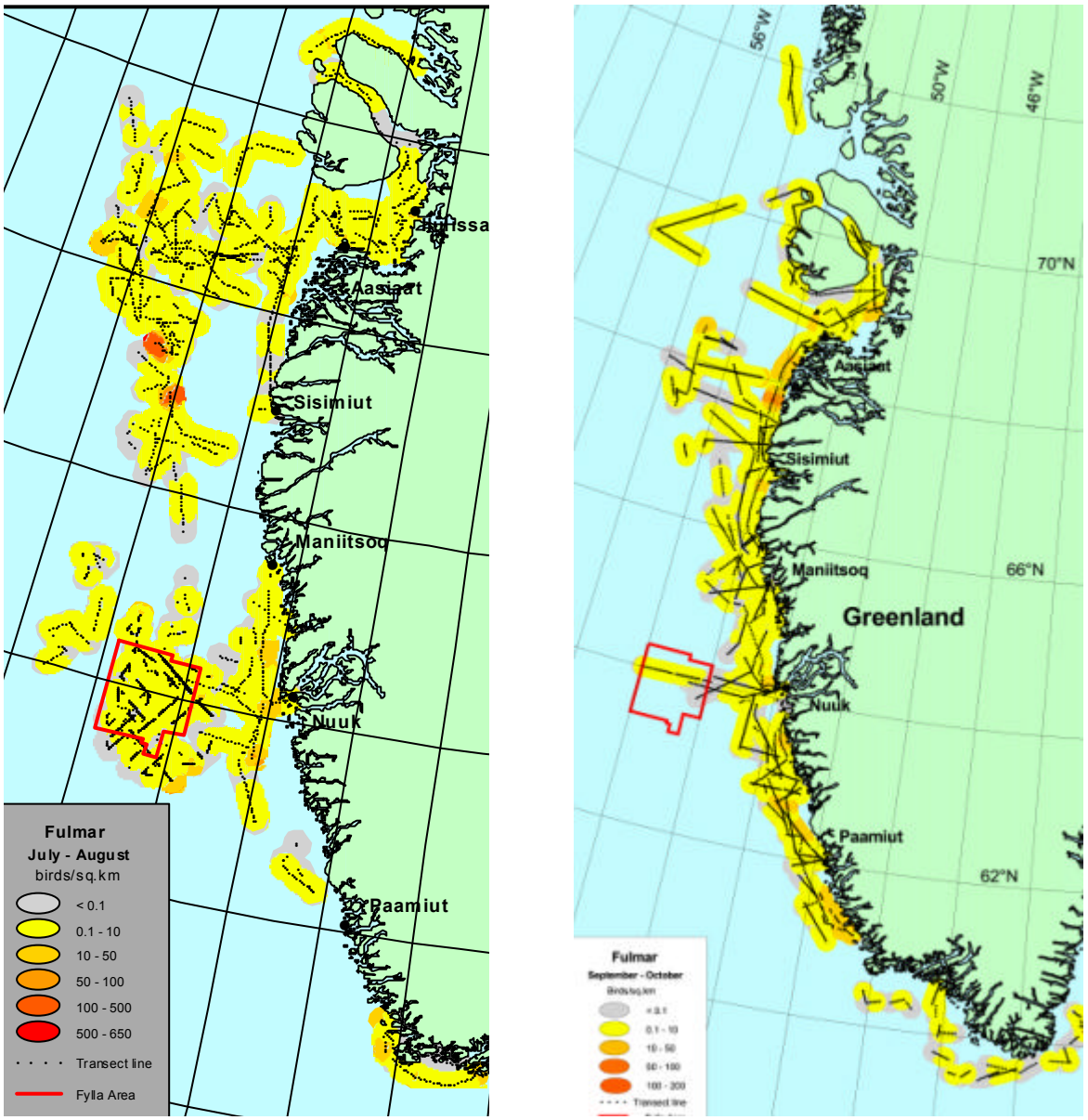
Map 2. The transects sailed during the surveys in 1993 and.1994. The oil exploration drill sites of 1977 indicated.



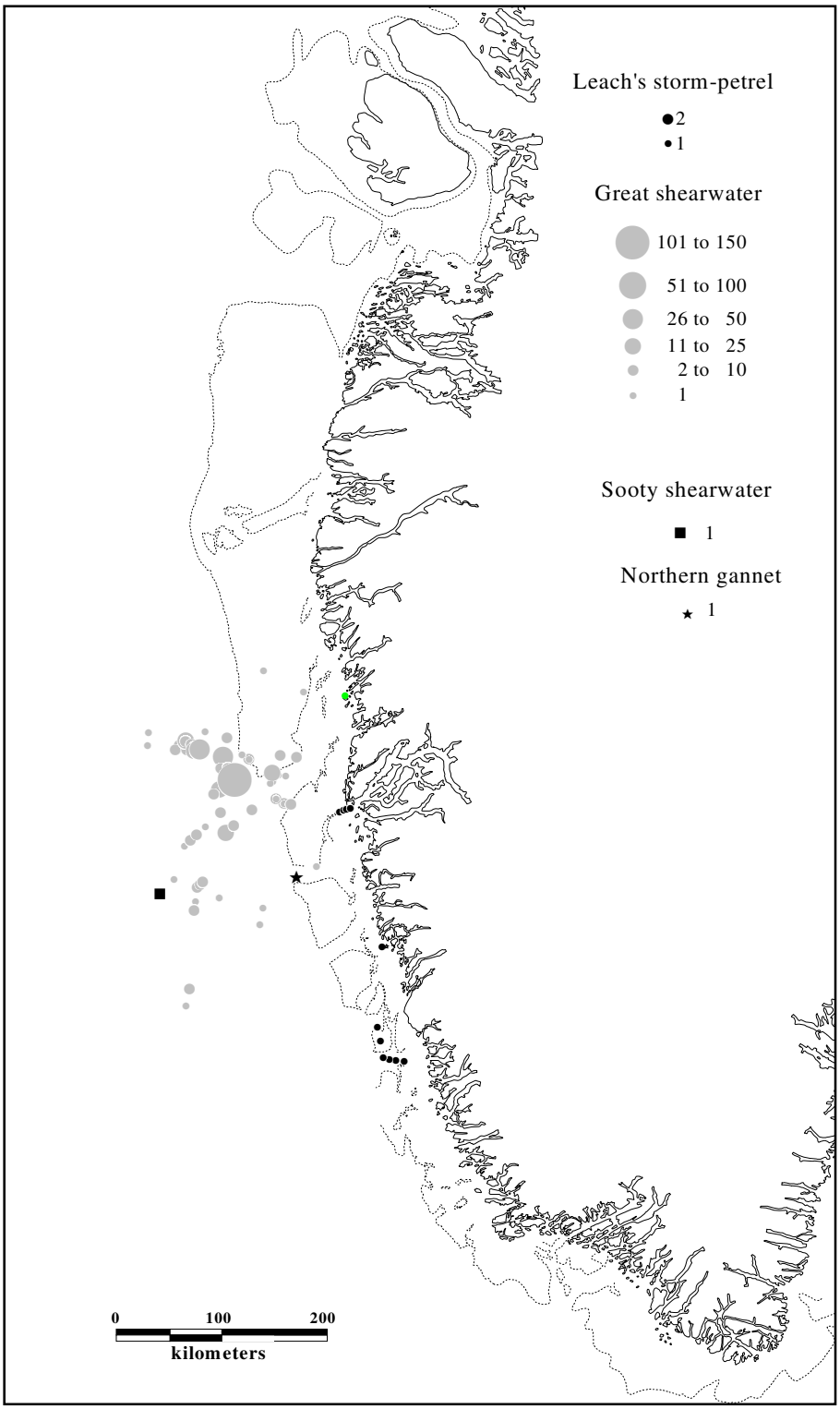
Map 3. The transects sailed during the surveys in 1998, 1999 and 2000.



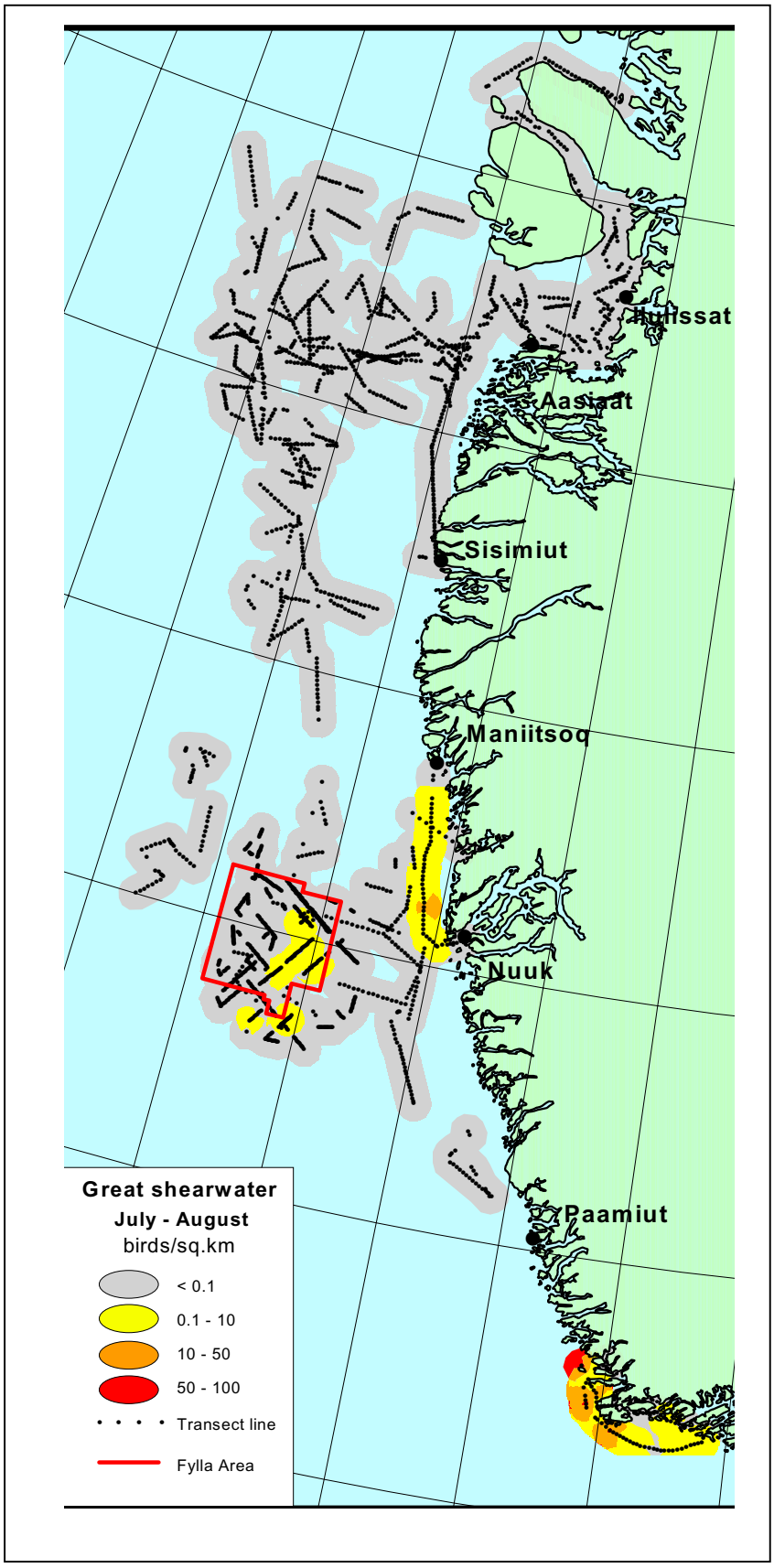
Map 4. Distribution of observations of great northern diver and great cormorant during the NERI 1992-2000 surveys.



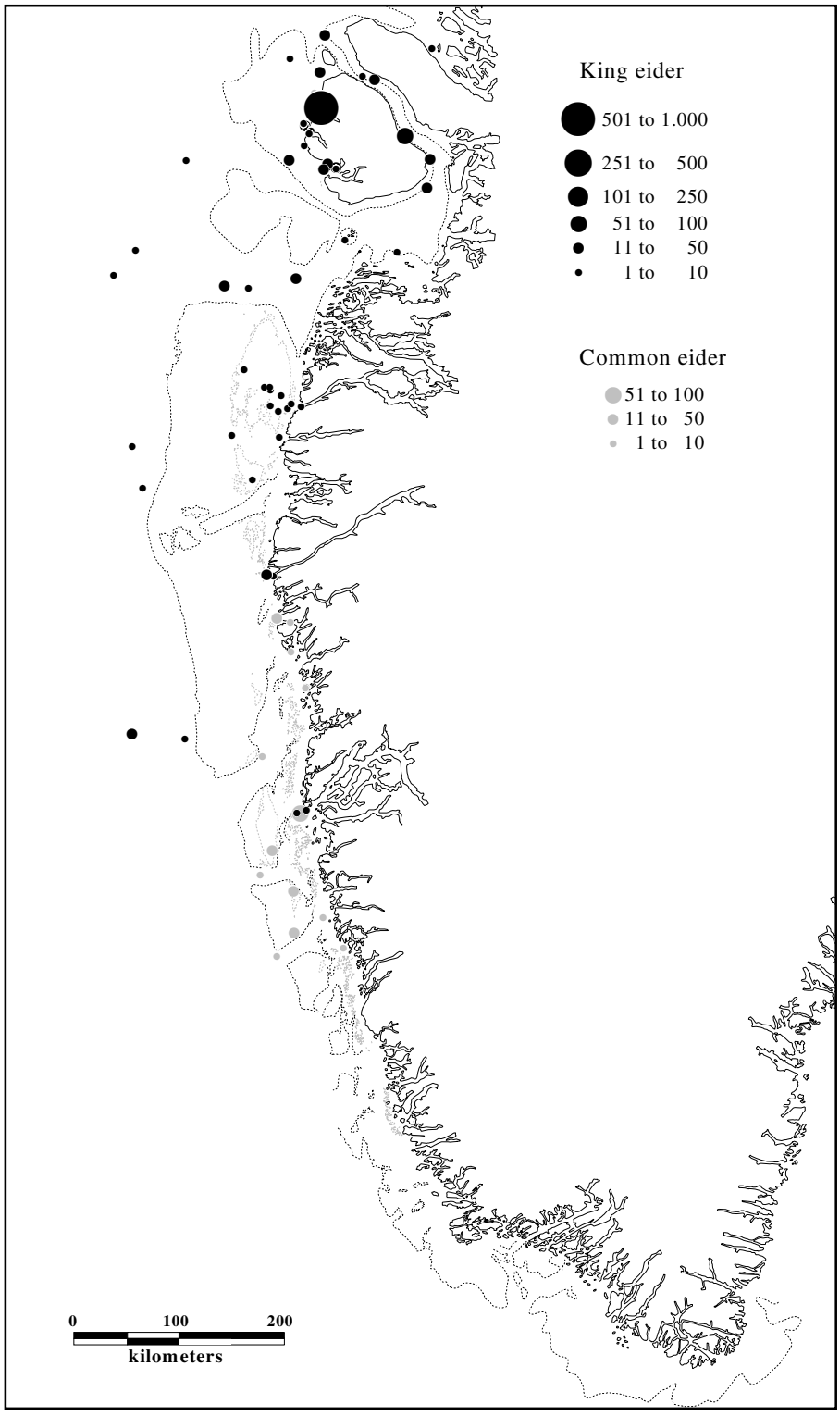
Map 5. Densities of northern fulmar recorded by NERI in 1992-2000 and Ornis Consult in 1988, in summer (July and August) and in autumn (September and October). See text for explanation of calculation method. Area framed with red is the Fylla oil exploration license area.



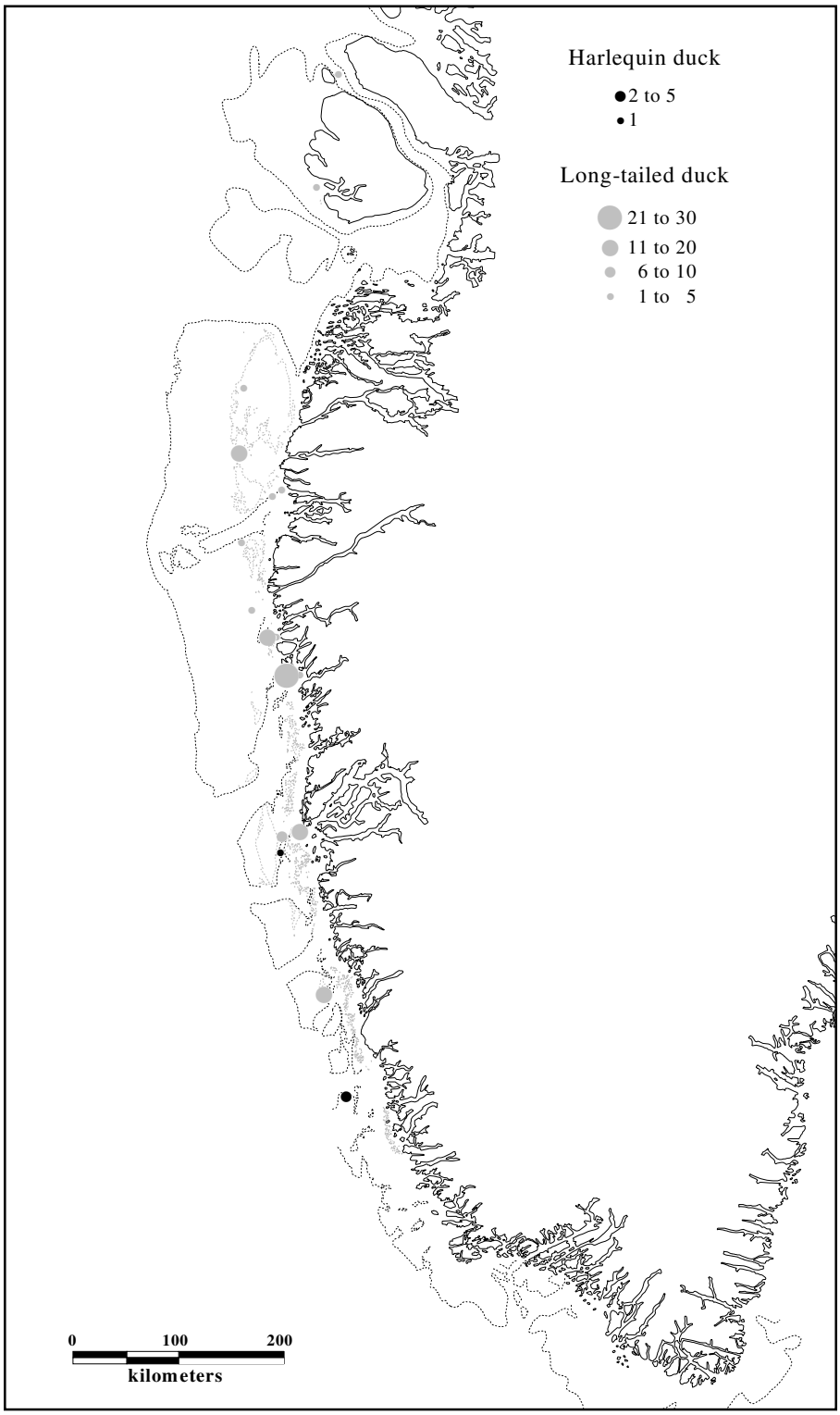
Map 6. Distribution of observations of shearwaters, Leach's storm-petrel and northern gannet during the NERI 1992-2000 surveys.



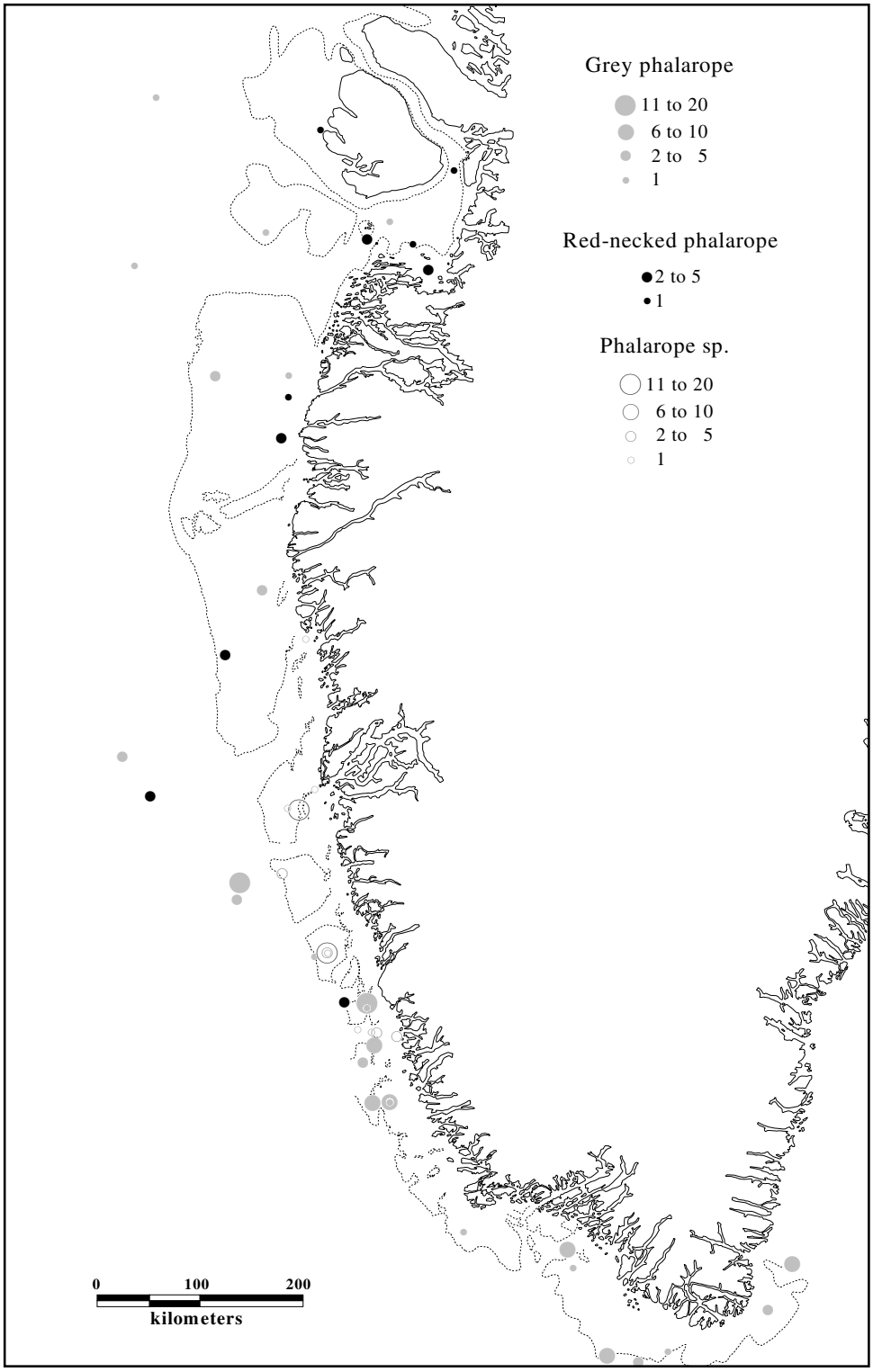
Map 7. Density of great shearwaters in July-August during the NERI 1992-2000 surveys. Area framed with red is the Fylla oil exploration license area.



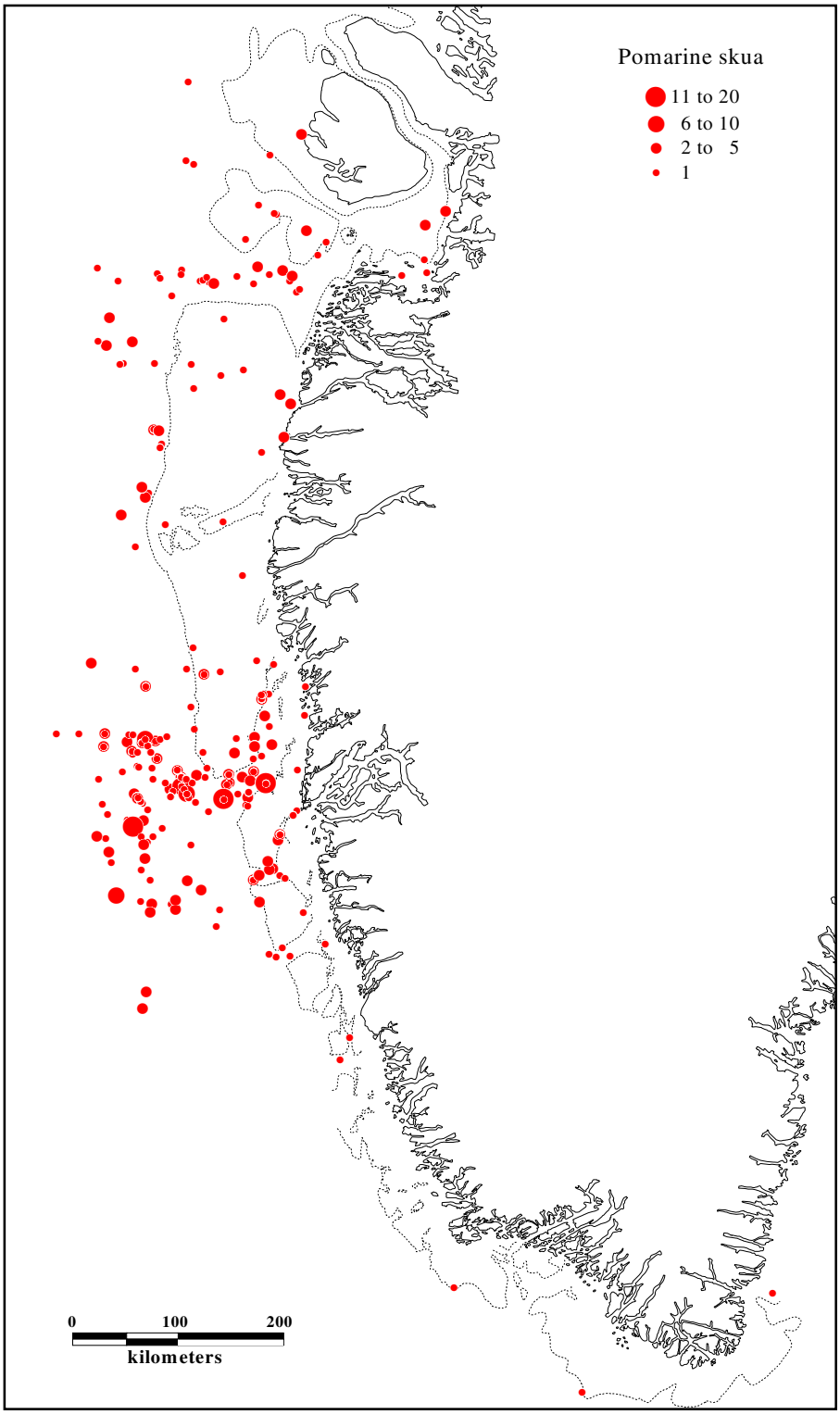
Map 8. Distribution of observations of common eider and king eider during the NERI 1992-2000 surveys.



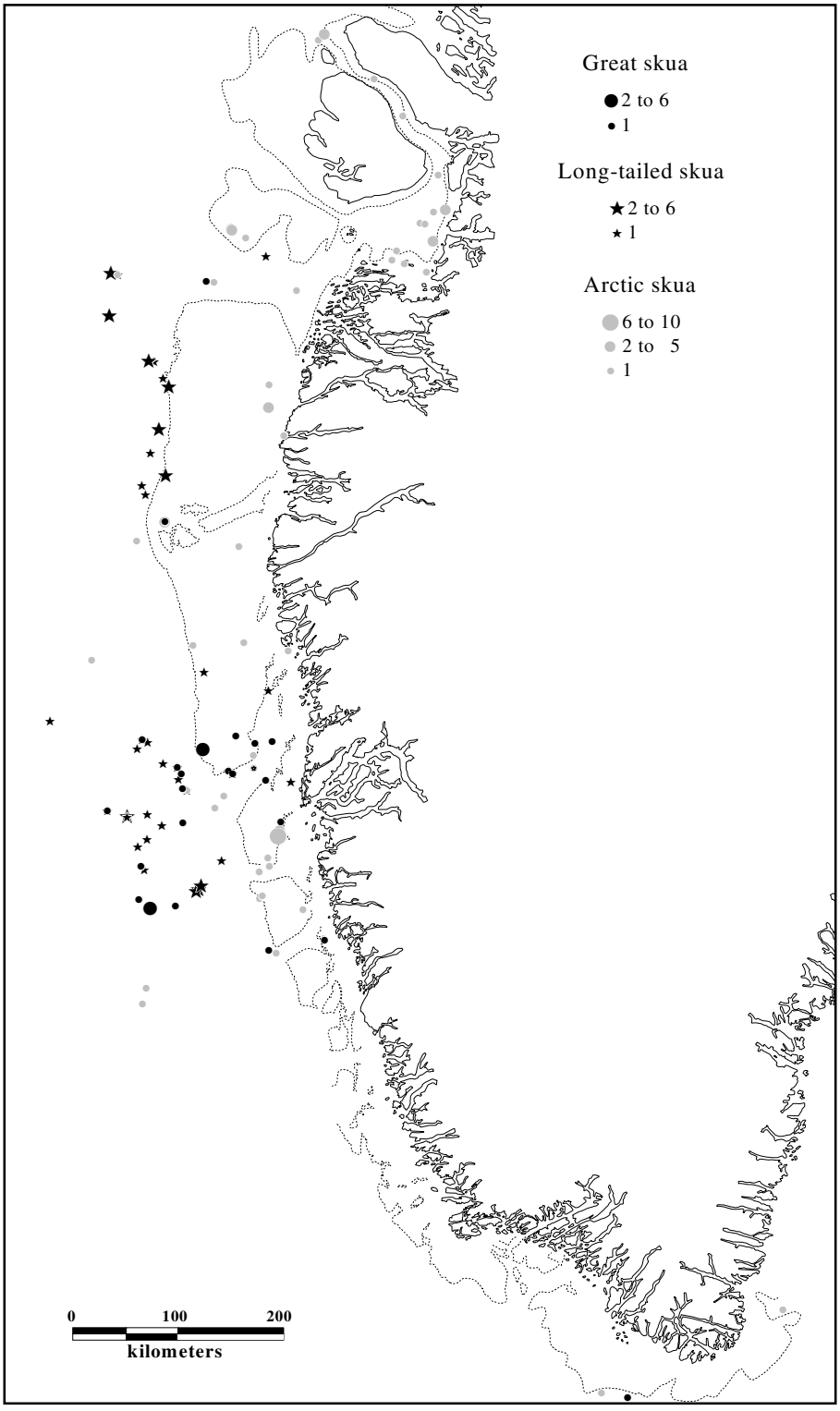
Map 9. Distribution of observations of long-tailed duck and harlequin duck during the NERI 1992-2000 surveys.



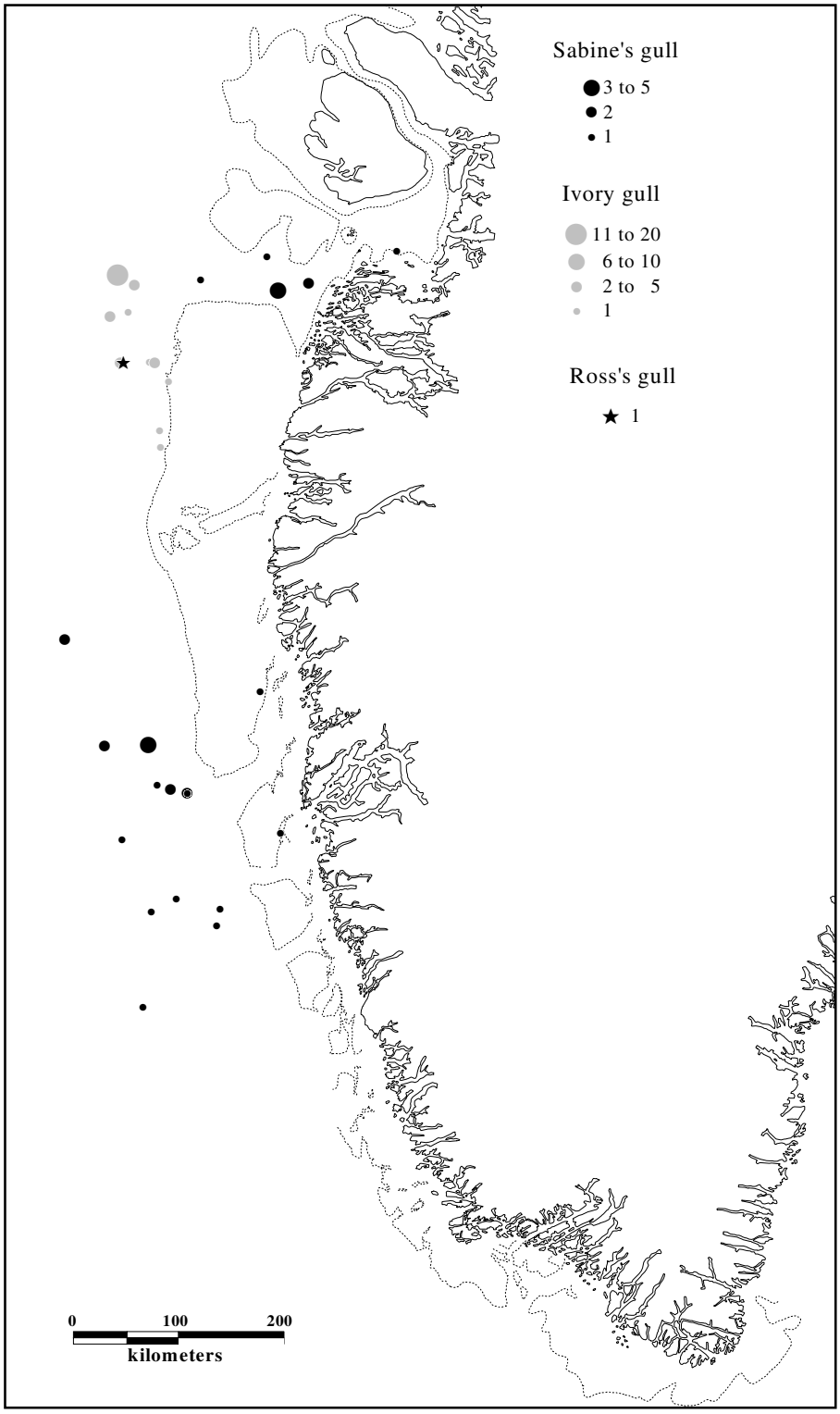
Map 10. Distribution of observations of phalaropes during the NERI 1992-2000 surveys.



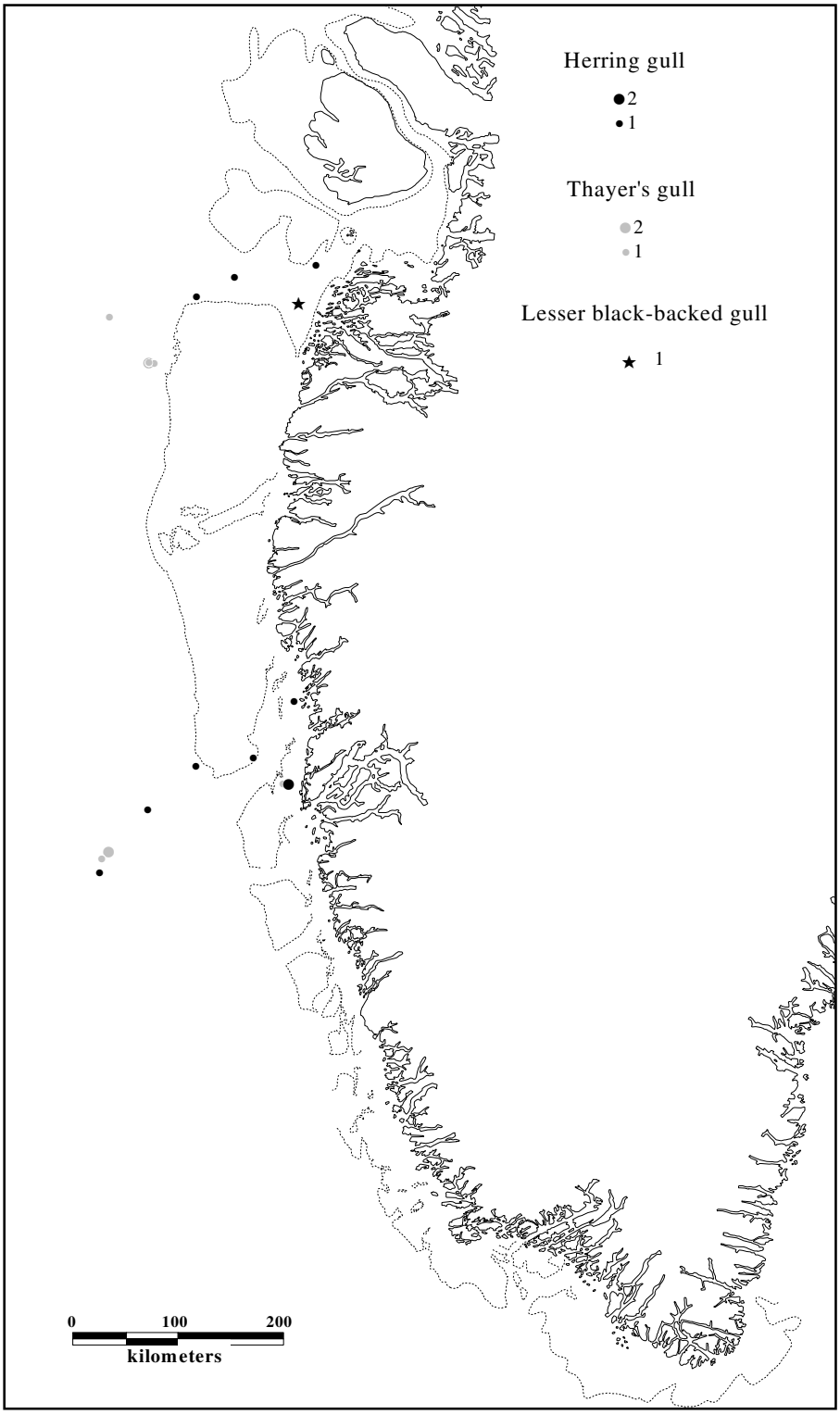
Map 11. Distribution of observations of pomarine skuas during the NERI 1992-2000 surveys.



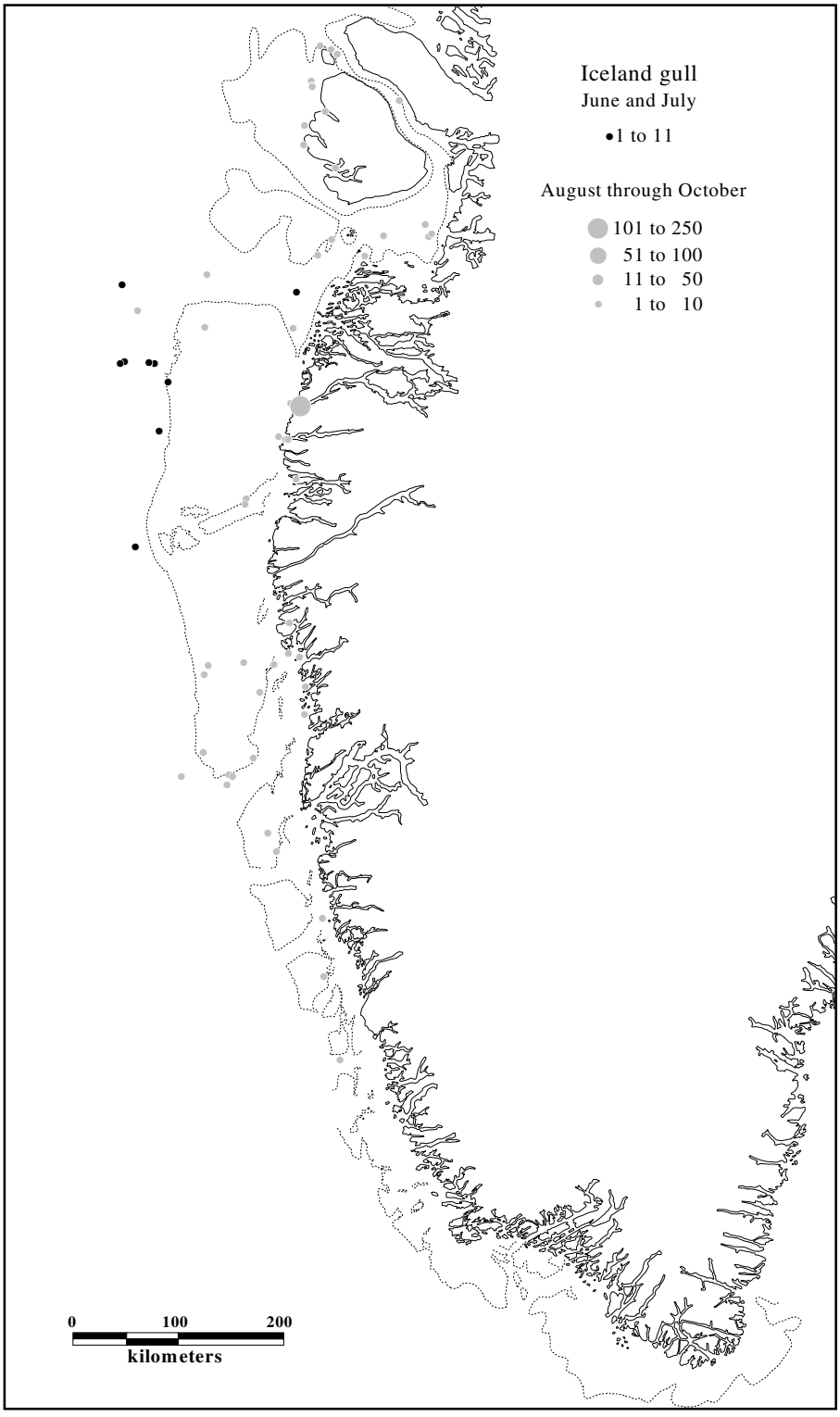
Map 12. Distribution of observations of arctic, long-tailed and great skua during the NERI 1992-2000 surveys.



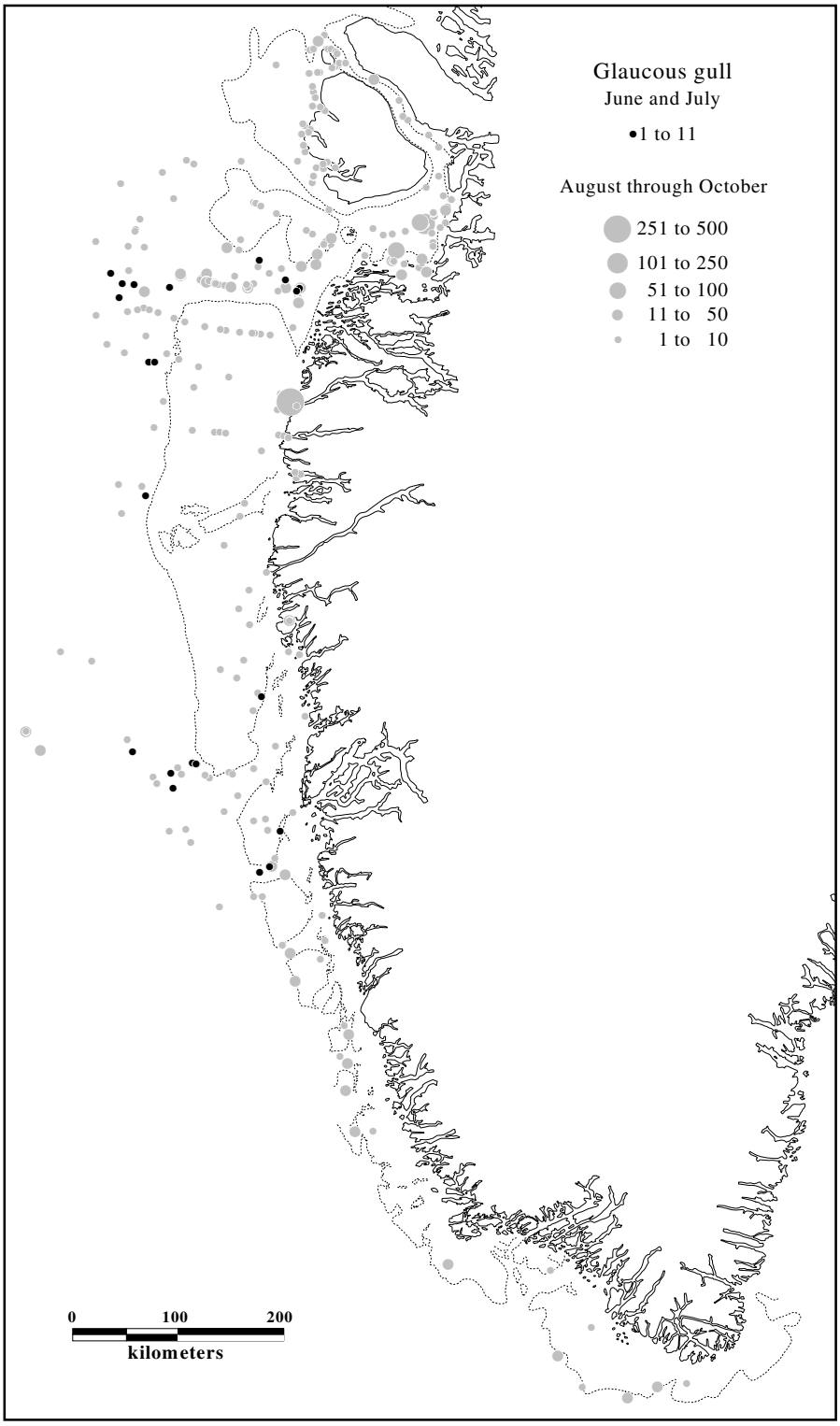
Map 13. Distribution of observations of Sabine's, ivory and Ross's gull during the NERI 1992-2000 surveys.



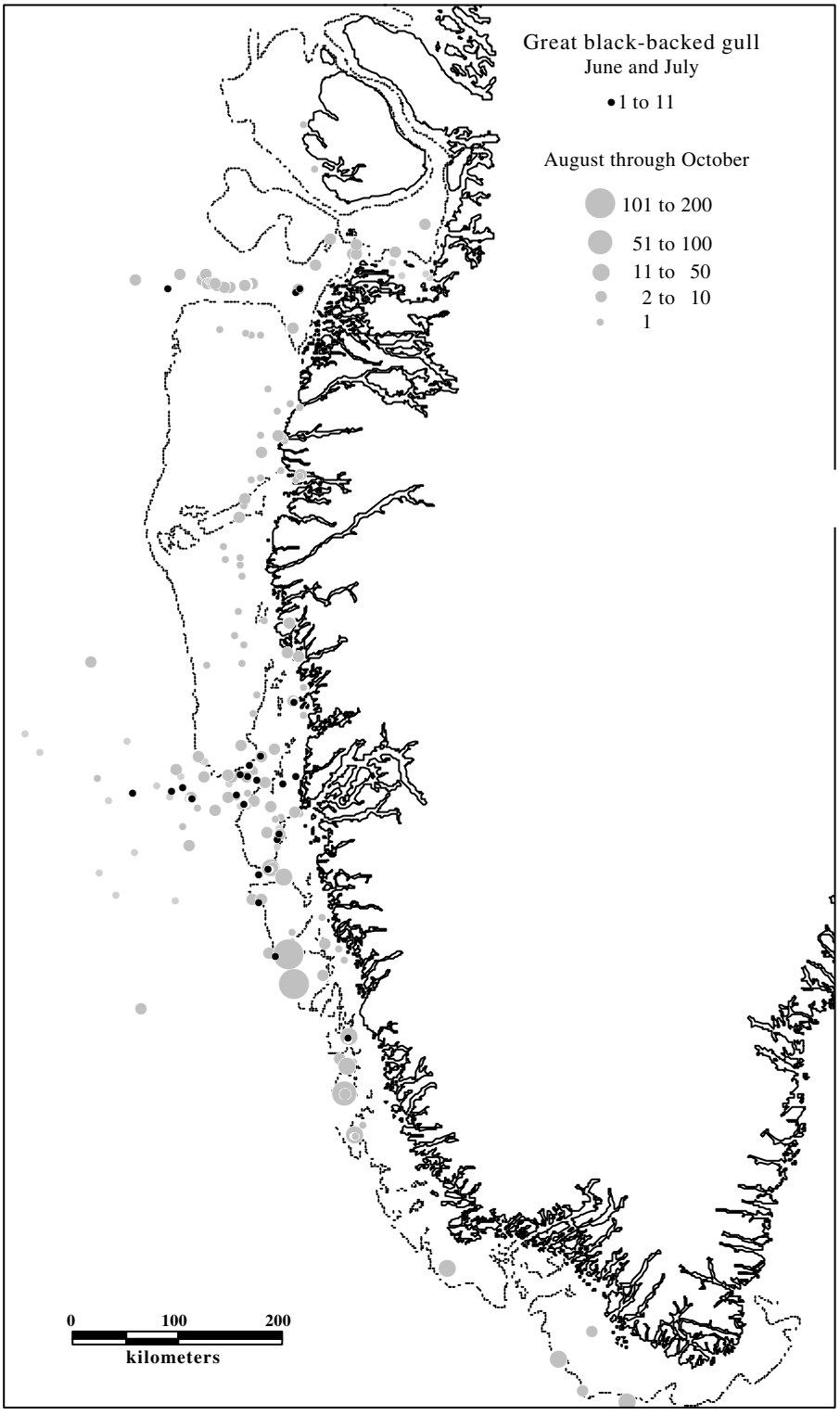
Map 14. Distribution of observations of some rare *Larus*-gulls during the NERI 1992-2000 surveys.



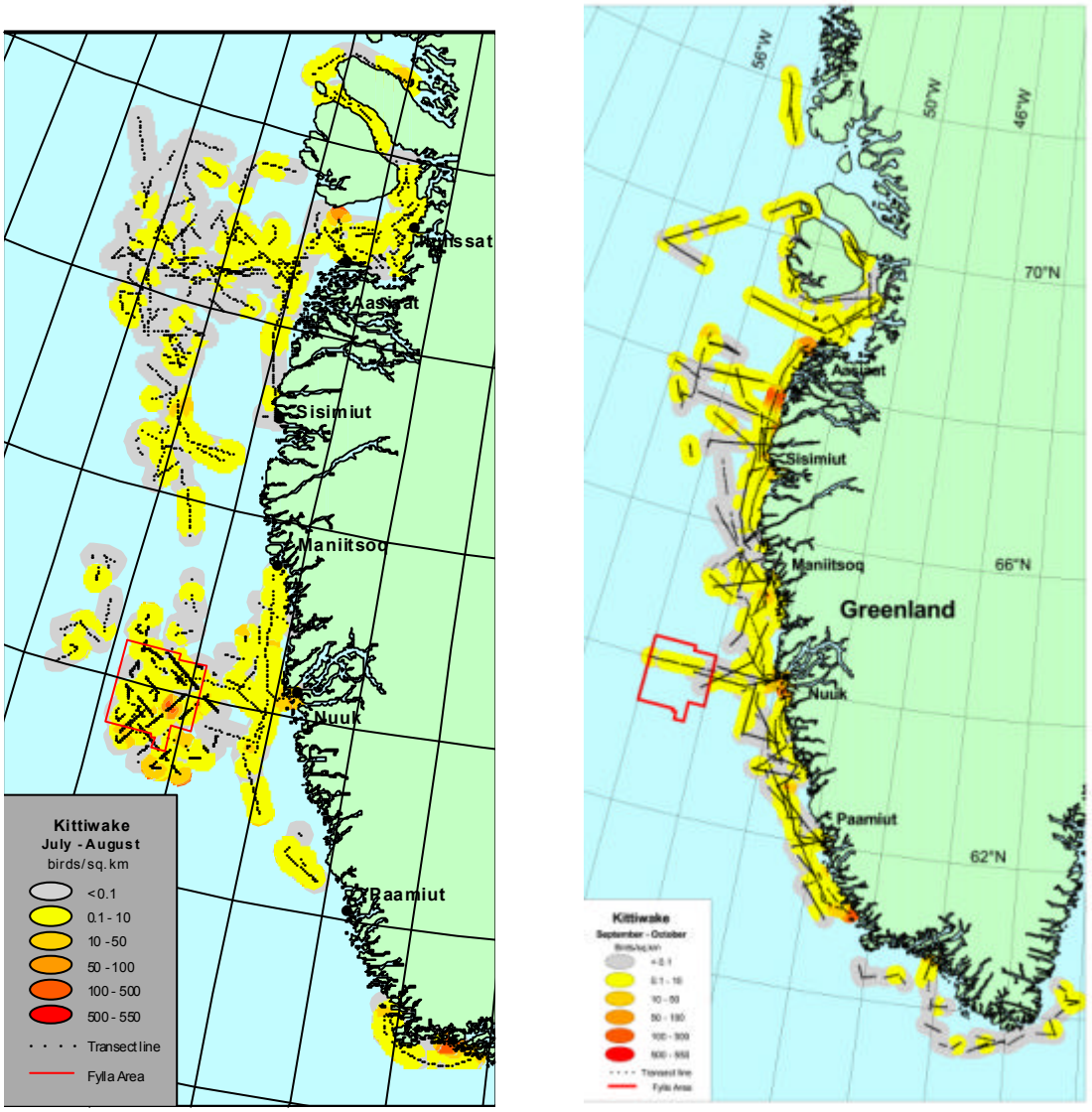
Map 15. Distribution of observations of Iceland gull during the NERI 1992-2000 surveys.



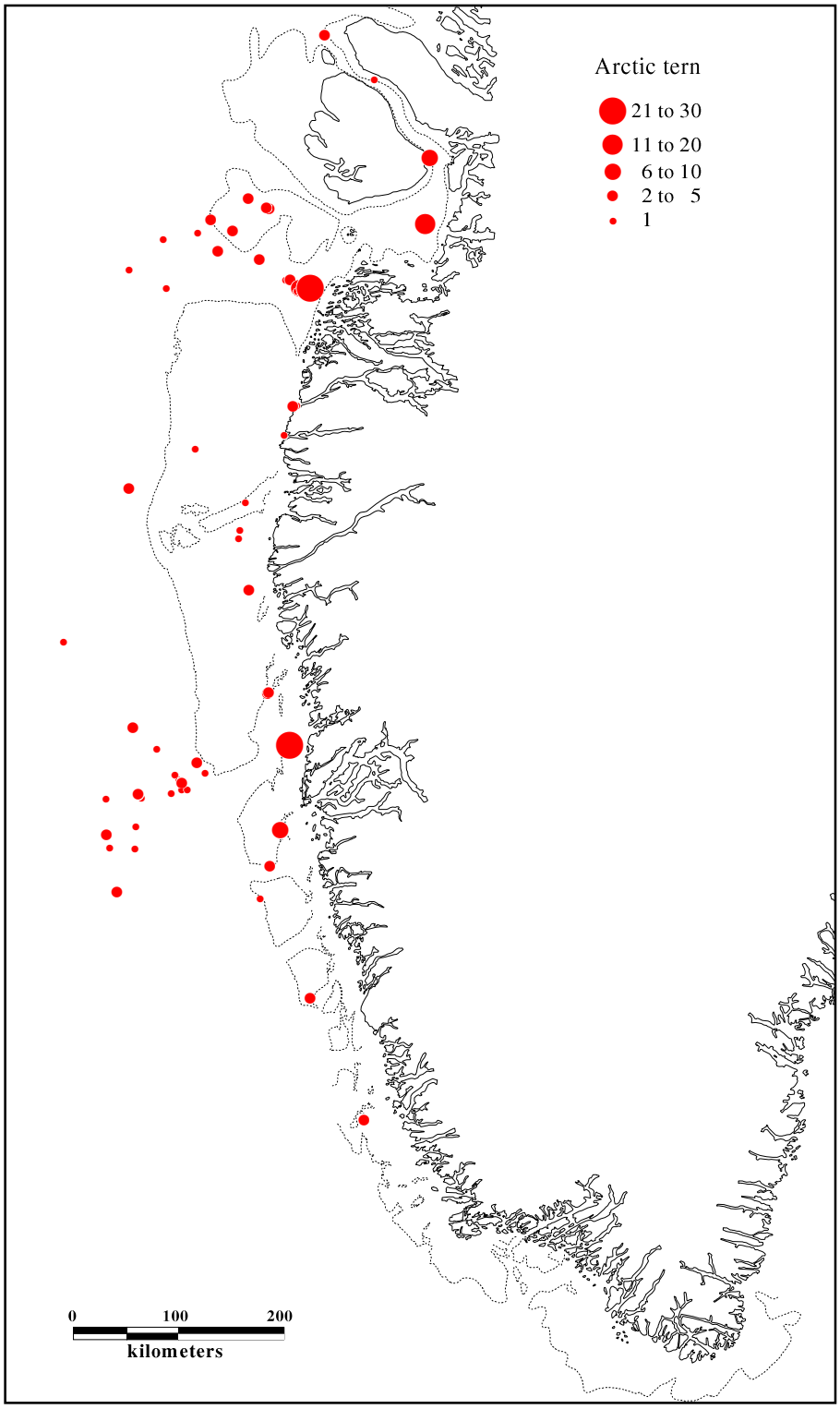
Map 16. Distribution of observations of glaucous gull during the NERI 1992-2000 surveys.



Map 17. Distribution of observations of great black-backed gull during the NERI 1992-2000 surveys.

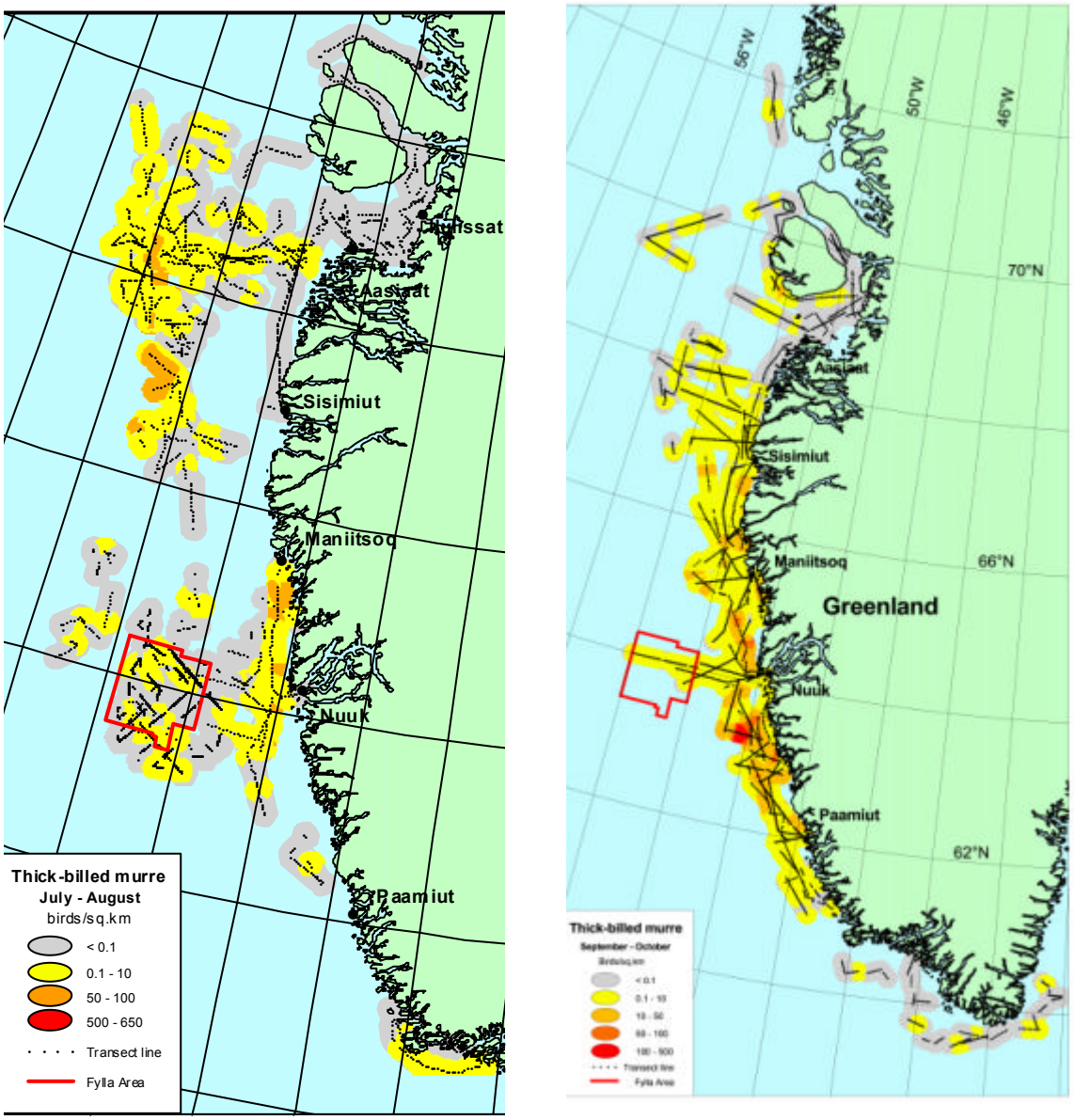


Map 18. Densities of kittiwakes in summer (July-August) and autumn (September-October) during the NERI 1992-2000 surveys and the Ornis Consult surveys in 1988. Area freamed with red is the Fylla oil exploration license area.

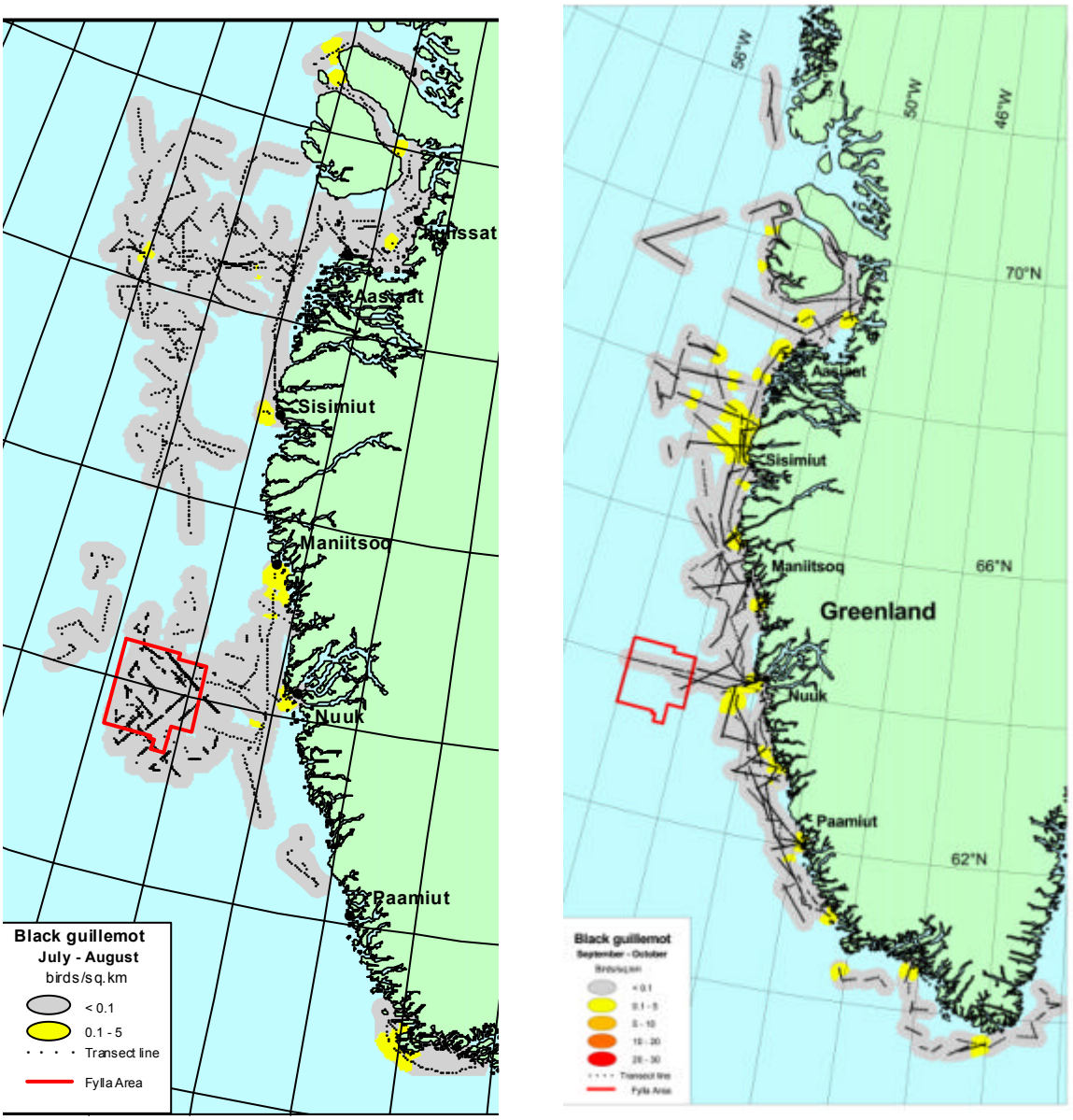


Map 19. Distribution of observations of arctic tern during the NERI 1992-2000 surveys.

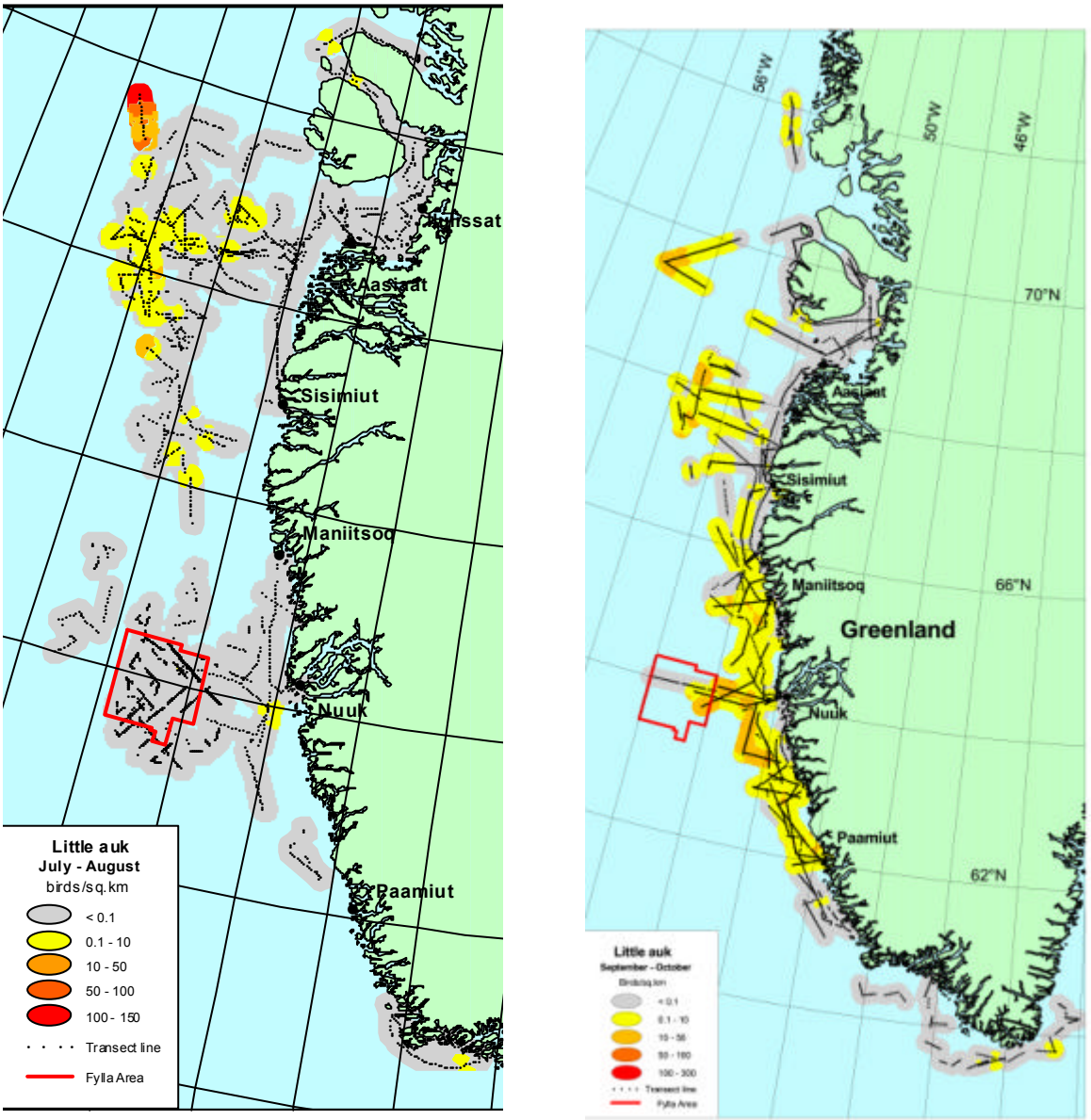
Map 20. Distribution of observations of common guillemot and razorbill during the NERI 1992-2000 surveys.



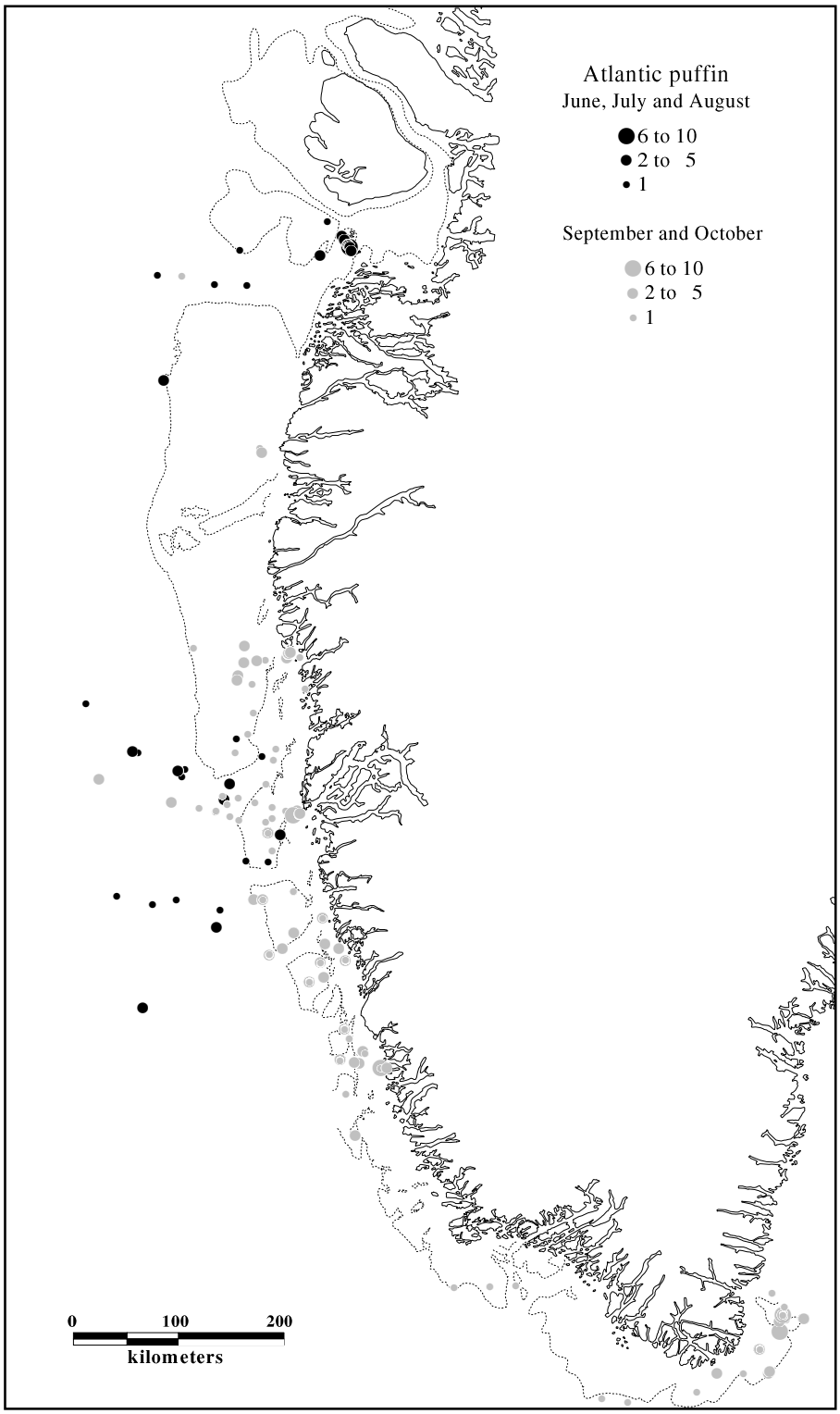
Map 21. Densities of thick-billed murre in summer (July-August) and autumn (September-October) during the NERI 1992-2000 surveys and the 1988 Ornis Consult surveys. Area freamed with red is the Fylla oil exploration license area.



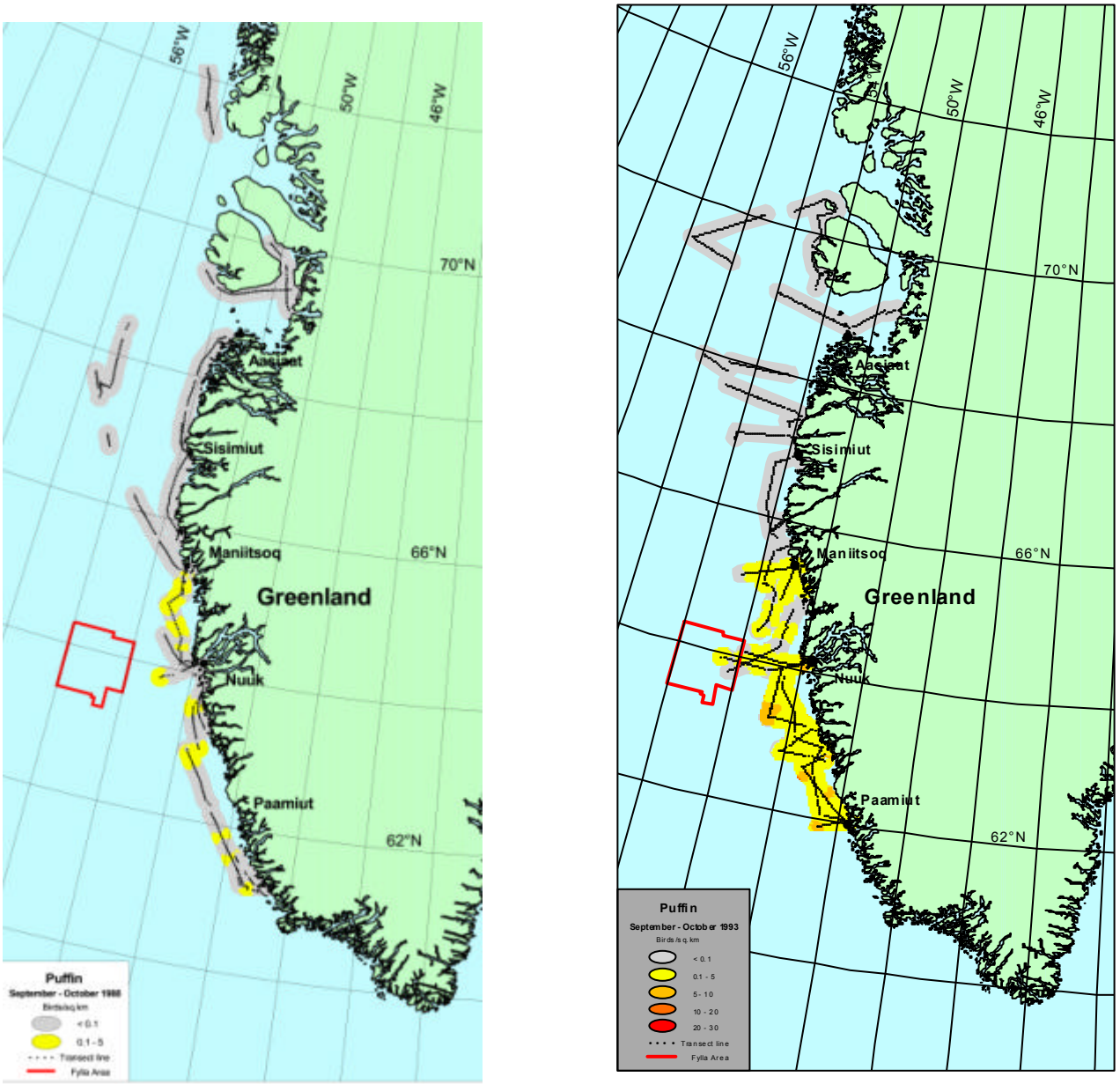
Map 22. Densities of black guillemot in summer (July-August) and autumn (September-October) during the NERI 1992-2000 surveys and the 1988 Ornis Consult surveys. Area freamed with red is the Fylla oil exploration license area.



Map 23. Densities of little auk in summer (July-August) and autumn (September-October) during the NERI 1992-2000 surveys and the 1988 Ornis Consult surveys. Area freamed with red is the Fylla oil exploration license area.



Map 24. Distribution of observations of Atlantic puffin during the NERI 1992-2000 surveys.



Map 25. Densities of Atlantic puffin two different autumns (September-October) 1988 and 1993. Area freamed with red is the Fylla oil exploration license area.

References

Boertmann, D. 1979. Ornithological observations in West Greenland, 1972-77. - Dansk Orn. Foren. Tidsskr. 73: 171-176. (Danish, with English summary).

Boertmann, D. 1994. An annotated checklist to the birds of Greenland. Meddr. Grønland, Bioscience 38, 63 pp.

Boertmann, D. 2000. Togtraport: Havfugle-observationer i Davis Stræde 29. juli til 14. august 2000. Danmarks Miljøundersøgelser, upubliseret rapport.

Boertmann, D & A. Mosbech 1999. Bemærkelsesværdige fugleobservationer fra Vest- og Nordgrønland, 1992-1998. - Dansk orn. foren, tidsskr. 93: 145-152.

Boertmann, D., Mosbech, A., Falk, K. & K. Kampp 1996. Seabird colonies in western Greenland. - NERI Technical Report 170: 148 pp.

Brown, R.G.B. 1986. Revised Atlas of Eastern Canadian Seabirds. 1 Shipboard Surveys. - Canadian Wildlife Service: 111 pp.

Brown, R.G.B., Nettleship, D.N., Germani, P., Tull, C.E. & Davis, T. 1975. Atlas of eastern Canadian seabirds. - Canadian Wildlife Service: 220 pp.

Durinck, J. & K. Falk 1996. The distribution and abundance of seabirds off south-western Greenland in autumn and winter 1988-1989. - Polar Research 15 (1): 23-42.

Falk, K. & Kampp, K. 1992. Havfugle ved Vestgrønland - en opdateret oversigt. - Unpubl. report, Ornis Consult/Zoological Museum, Copenhagen: 24 pp. + maps.

Falk K. & K. Kampp 1997. Langsigtet moniteringsplan for lomvier i Grønland. - Teknisk Rapport nr. 18, Pinngortitaleriffik, Grønlands Naturinstitut, 26 pp.

Falk. K, & K. Kampp in prep. Lomvien i Grønland: mulige effekter af forskellige bestandspåvirkende faktorer, og praktiske grænser for ressource udnyttelse. – Teknisk rapport, Pinngortitaleriffik, Grønlands Naturinstitut.

Falk, K., Benvenuti, S., Dall'antonia, L., Kampp, K. & A. Riboloni 2000. Time allocation and foraging behavior of chick-rearing Thick-billed murres *Uria lomvia* in high-arctic Greenland. - Ibis 142: 82-92.

Franeker, J.A. van & Wattel, J. 1982. Geographical variation of the fulmar *Fulmarus glacialis* in the North Atlantic. - Ardea 70: 31-44.

Kampp, K. & Kristensen, R.M. 1980. Ross's Gull Rhodostethia rosea breeding in Disko Bay, West Greenland, 1979. - Dansk Orn. Foren. Tidsskr. 74: 65-74.

Huettmann, F. & A.W. Diamond 2000. Seabird migration in the Canadian northwest Atlantic Ocean: moulting locations and movement patterns of immature birds. - Canadian Journal of Zoology 78: 624-647.

Mosbech, A. 2000. Predicting impacts of oil spills - Can ecological science cope?. A case study concerning birds in Environmental Impact Assessments. - National Environmental Research Institute, Denmark. 126 pp.

Mosbech, A., Dietz, R., Boertmann, D. & P. Johansen 1996. Oil exploration in the Fylla Area. - NERI Technical Report 156, 90 pp.

Mosbech, A., Boertmann, D., Nymand, J., Riget, F. & M. Acquarone 1998. The marine environment in Southwest Greenland. - National Environmental Research Institute, Department of Arctic Environment, 178 pp. + 3 apps.

Mosbech, A. & D. Boertmann 1999. Distribution, abundance and reaction to aerial surveys of post-breeding king eiders (*Somateria spectabilis*) in western Greenland. – Arctic 52: 188-203.

Mosbech, A. & S. Johnson 1999. Late Winter Distribution and Abundance of Sea-Associated Birds in Southwest Greenland, Davis Strait and Southern Baffin Bay. – Polar Research 18: 1-17.

Phillips, R.A., Petersen, M.K., Lilliendahl, K., Solmundsson, J., Hamer, K.C., Camphuysen, C.J., & B. Zonfrillo 1999. Diet of the northern fulmar Fulmarus glacialis: reliance non commercial fisheries? - Marine Biology 135: 159-170.

Salomonsen, F. 1967. Fuglene på Grønland. - Rhodos, København: 341 pp.

Salomonsen, F. 1990: Fugle. Pp. 131-360 in Salomonsen, F. (ed.): Grønlands Fauna (2. udg.), Gyldendal , København. 464 pp.

Skov, H., Durinck, J., Leopold, M.F. & M.L. Tasker 1995. Important bird areas for seabirds in the North Sea. - BirdLife International, Cambridge. 156 pp.

Tasker, M.L. Jones, P.H., Dixon, T, & B.F. Blake 1984. Counting seabirds from ships: a review of methods employed and suggestion for a standardized approach. - Auk 101: 567-577. 1984

Webb, A. & J. Durinck 1992. Counting birds from ship. Pp. 24-37 in Komdeur, J., Bertelsen, J. & G. Cracknell (eds), Manual for aeroplane and ship surveys of waterfowl and seabirds. - IWRB Special Publication No. 19. Slimbridge.

Appendix

5 day periods

Period no. dates

1:	1 - 5 Jan.
2:	6 - 10 Jan.
3:	11 - 15 Jan.
4:	16 - 20 Jan.
5:	21 -25 Jan.
6:	26 -30 Jan.
7:	31 Jan. -4 Feb.
8:	5 - 9 Feb.
9:	10 - 14 Feb.
10:	15 - 19 Feb.
11:	20 - 24 Feb.
12:	25 Feb. - 1 Mar. (incl. 29 Feb.)
13:	2 - 6 Mar.
14:	7 - 11 Mar.
15:	12 - 16 Mar.
16:	17 - 21 Mar.
17:	22 - 26 Mar.
18:	27 - 31 Mar.
19:	1 - 5 Apr.
20:	6 - 10 Apr.
21:	11 - 15 Apr.
22:	16 - 20 Apr.
23:	21 - 25 Apr.
24:	26 - 30 Apr.
25:	1 - 5 May
26:	6 - 10 May
27:	11 - 15 May
28:	16 - 20 May
29:	21 - 25 May
30:	26 - 30 May
31:	31 May - 4 Jun.
32:	5 - 9 Jun.
33:	10 - 14 Jun.
34:	15 - 19 Jun.
35:	20 - 24 Jun.
36:	25 - 29 Jun.
37:	30 Jun. - 4 Jul.
38:	5 - 9 Jul.
39:	10 - 14 Jul.
40:	15 - 19 Jul.
41:	20 - 24 Jul.
42:	25 - 29 Jul.
43:	30 Jul. - 3 Aug.
44:	4 - 8 Aug.
45:	9 - 13 Aug.
46:	14 - 18 Aug.
47:	19 - 23 Aug.
48:	24 - 28 Aug.
49:	29 Aug. - 2 Sep.
50:	3 - 7 Sep.
51:	8 - 12 Sep.
52:	13 - 17 Sep.
53:	18 - 22 Sep.
54:	23 - 27 Sep.
55:	28 Sep. - 2 Oct.
56:	3 - 7 Oct.
57:	8 - 12 Oct.
58:	13 -17 Oct.
59:	18 - 22 Oct.
60:	23 - 27 Oct.
61:	28 Oct. - 1 Nov.
62:	2 - 6 Nov.
63:	7 - 11 Nov.
64:	12 - 16 Nov.
65:	17 - 21 Nov.
66:	22 - 26 Nov.
67:	27 Nov. - 1 Dec.
68:	2 - 6 Dec.
69:	7 - 11 Dec.
70:	12 - 16 Dec.
71:	17 - 21 Dec.
72:	22 - 26 Dec.
73:	27 - 31 Dec.

National Environmental Research Institute

The National Environmental Research Institute, NERI, is a research institute of the Ministry of Environment and Energy. In Danish, NERI is called *Danmarks Miljøundersøgelser (DMU)*.
NERI's tasks are primarily to conduct research, collect data, and give advice on problems related to the environment and nature.

Addresses:

URL: http://www.dmu.dk

National Environmental Research Institute
Frederiksborgvej 399
PO Box 358
DK-4000 Roskilde
Denmark
Tel: +45 46 30 12 00
Fax: +45 46 30 11 14

Management
Personnel and Economy Secretariat
Research and Development Section
Department of Atmospheric Environment
Department of Environmental Chemistry
Department of Policy Analysis
Department of Marine Ecology
Department of Microbial Ecology and Biotechnology
Department of Arctic Environment

National Environmental Research Institute
Vejlsøvej 25
PO Box 314
DK-8600 Silkeborg
Denmark
Tel: +45 89 20 14 00
Fax: +45 89 20 14 14

Environmental Monitoring Co-ordination Section
Department of Lake and Estuarine Ecology
Department of Terrestrial Ecology
Department of Streams and Riparian areas

National Environmental Research Institute
Grenåvej 12-14, Kalø
DK-8410 Rønde
Denmark
Tel: +45 89 20 17 00
Fax: +45 89 20 15 15

Department of Landscape Ecology
Department of Coastal Zone Ecology

Publications:
NERI publishes professional reports, technical instructions, and the annual report. A R&D projects' catalogue is available in an electronic version on the World Wide Web.
Included in the annual report is a list of the publications from the current year.

[Blank page]

This report presents the phenological and distributional results from ship based seabird surveys off West Greenland performed by NERI in the summers and autumns of 1992 to 2000. The results are compared with seabird counts carried out from offshore stationary platforms in 1977.

DANCEA
Danish Cooperation for Environment in the Arctic
Ministry of Environment and Energy

Ministry of Environment and Energy
National Environmental Research Institute

ISBN 87-7772-634-8
ISSN 0905-815x
ISSN (electronic) 1600-0048