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Seabirds at sea in the influence area of the Haltenbanken oil fields Results from 1991

Tor Egil Kaspersen

NINA

NORSK INSTITUTT FOR NATURFORSKNING

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Adress:
NINA
v/Information Division
Tungasletta 2
N-7005 Trondheim
Telephone +47 7 58 05 00
Telefax +47 7 91 54 33

Abstract

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The influence area of the Haltenbanken oil fields contains important seabird localities. In 1991 seabird observers participated in 11 open sea surveys in the area. Seabirds were counted in accordance with internationally recommended methods. 50268 birds were recorded. The Fulmar was the most numerous species, but also Kittiwake, Herring Gull, Puffin, Black-backed Gulls, Little Auk, Common Guillemot, Gannet and Razorbill were frequently recorded.

The distributional patterns changed throughout the year. Some species left the area in the autumn (Lesser Black-backed Gull, Gannet, skuas). Others are regular winter visitors (Little Auk, Glaucous Gull), while the recorded densities of Puffin and Razorbill changes totally in the autumn. In November Razorbill was the most numerous alcid in the influence area while Puffin was the less numerous. This is reverse of spring/summer records.

The frontal system between Atlantic water and the Coastal current seems to attract some species part of the year (Fulmar, Kittiwake, Glaucous Gull, Pomarine Skua, Long-tailed Skua), while others were observed while searching for their prey in local fronts or eddies (Little Auk).

Marine biological data gathered during one survey were coupled to parallel seabird data. Statistical testing indicates positive numerical correlation between Puffins and potential prey.

Important features of seabirds distribution remains to be answered after 10 months of registration. Further research is therefore recommended. Verification of existing data is also necessary.

Besides a further mapping of the general seabirds distribution, the studies should focus the Auk post-breeding migration, the movements of Puffins and Razorbills in autumn and spring, and the relations between the observed distribution and marine biological, hydrographical and behavioral components.

Key words: Seabirds - open sea - distribution - Haltenbanken.

Tor Egil Kaspersen, Norwegian Institute for Nature Research, Tungasletta 2, N-7005 Trondheim.

Referat

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Risikoområdet for oljefeltene på Haltenbanken omfatter viktige lokaliteter for sjøfugl. I 1991 deltok sjøfuglornitologer på 11 tokt innen dette området. Sjøfugler ble registrert i henhold til internasjonalt anerkjente metoder. 50268 fugler ble bestemt til art. Havhest var mest tallrik, men også krykkje, gråmåke, lunde, svartbak, sildemåke, alkekonge, lomvi, havsule og alke ble registrert relativt ofte.

Fordelingsmønsteret varierte gjennom året. Noen arter forlot området om høsten (sildemåke, havsule, joer), andre arter synes å være faste overvintringsgjester (polarmåke, alkekonge). For lunde og alke registrerte vi en tetthetsendring om høsten i forhold til om våren og sommeren. Fra å være den minst registrerte alkefuglen i vår/sommermånedene, var alke den mest registrerte i november. Det motsatte var tilfelle for lunde.

I enkelte perioder synes noen arter (havhest, krykkje, polarmåke, polarjo, fjelljo) å følge frontsystemet mellom kyststrømmen og Atlanterhavstrømmen. Andre arter (alkekonge) ble ofte registrert under næringssøk i mer lokale front/strøm områder.

Marinbiologiske data samlet på et tokt ble koplet mot parallelle sjøfugldata. Statistisk testing ga positiv korrelasjon mellom antall lunder og mengden av mulige byttedyr.

Mange viktige spørsmål er ubesvarte etter 10 måneder med registreringer av sjøfugl i risikoområdet. Det anbefales derfor at arbeidet videreføres. Supplerende undersøkelser vil være nødvendig for å verifisere eksisterende data.

I tillegg til fortsatt kartlegging av den generelle fordeling, bør videre studier særlig vektlegge alkefuglers svømmetrekk, bevegelsene til lunde og alke om høsten og våren, og sammenhengen mellom observerte fordelingsmønstre og marinbiologiske, hydrografiske og adferdsmessige komponenter.

Emneord: Sjøfugler - åpent hav - fordeling - Haltenbanken.

Tor Egil Kaspersen, Norsk Institutt for Naturforskning, Tungasletta 2, N-7005 Trondheim.

Preface

The project 'Seabirds at sea in the influence area of the Heidrun oil field' was initiated by Conoco in 1991. Norsk Hydro, Saga Petroleum, Norske Shell and Statoil later joined the project which was renamed 'Seabirds at sea in the influence area of the Haltenbanken oil fields'.

The priority this first year has been to the build up an operative open sea database through intensive field work and construction of necessary data programs. We thank Lars Kvenild for his help with the data programs, and also thank all the people involved in the field work.

Observations were mainly made from research vessels belonging to the Institute of Marine Research. The observations would not have been possible without the help of their captains, crew and scientific staff who are gratefully thanked. We thank specially Hein-Rune Skjoldal, Thor Knudsen and Kjell Nedreås for their efforts to provide us with integrator data.

Arne Follestad has been project leader at NINA for this project.

Trondheim February 1992

Tor Egil Kaspersen

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1 Introduction

Oil spill drift modelling indicates that the maximum extent of the coastline which might be contaminated with oil from a spill in the Heidrun field is from Fræna to Senja. The region from Frøya to Andøya is defined as the impact zone (CONOCO 1989, p. 38).

The Heidrun Environmental Impact Assessment (EIA) stated that the data base on distribution and abundance of seabirds at sea was poor in this area (CONOCO 1989, p. 82). As a consequence the project 'Seabirds at sea in the influence area of the Haltenbanken oil fields' was initiated in 1991.

The main objectives in this project are:

a) To determine feeding areas of seabirds and their general patterns of distribution offshore, with particular emphasis on those species especially vulnerable to oil pollution.

b) To attempt to interpret the relationship between distribution of seabirds at sea and meteorological, oceanographic and marine biological factors.

Since little information was available for these offshore areas, data gathering was given highest priority in 1991. From March to November seabird observers participated in 11 open sea surveys. Seabirds were recorded along 11805 nautical miles of transectline, and 81317 birds were identified to 58 different species. To a certain extent, parallel marine biological data collected by the Institute of Marine Research (IMR) were made avaliable for us. Thus, it was possible to make a first attempt to interpret the relationship between seabird and marine biological factors in this area.

This first year with open sea surveys has given us useful, but yet very uncomplete and general information on seabirds distribution in the influence area. The results and conclutions are to be read with this in mind.

2 Methods

2.1 Area covered

This report comprises geographical areas between 62°N and 69°N, and thus includes both the Heidrun impact zone and the main feeding areas offshore the bird cliffs of Runde (**Figure 1**).

2.2 Survey methods

Seabird observers were positioned at the bridge on IMR research vessels. The method employed for counting seabirds follows the recommendations of Tasker et al. (1984). Numbers of birds seen within a fixed sea area (a 90° sector with a radius of 300 m) were recorded from the moving ship. Distances were judged by eye with regular verification using a rangefinder (Heinemann 1981). During most cruises two observers were on board, and watch was kept around the clock, except during dark hours.

2.3 Data handling

Information related to each bird or group of birds seen was recorded on a Husky field-computer together with geographical position and meteorological data.

Before analysis can be carried out, the position for each observation has to be calculated. A FORTRAN program (CONV) has been constructed for this purpose. The data were checked for logical errors, and the resulting ASCII-files were converted into system database files. These are stored in the NINA Marine Resource Database for retrival when needed.

2.4 Data analysis and presentation

Analysis were carried out on a VAX 3100 computer by using a map-drawing program - SUPERMAP (Kvenild & Strand 1984), a statistical program - SPSSx, and a graphical program - SPSS Graphics. Computer-drawn distributional maps were produced for most of the seabird species. Our material represents 8 months in 1991. We found it convenient to amalgamate months for this report. The maps show single birds observations as plots. Monthly

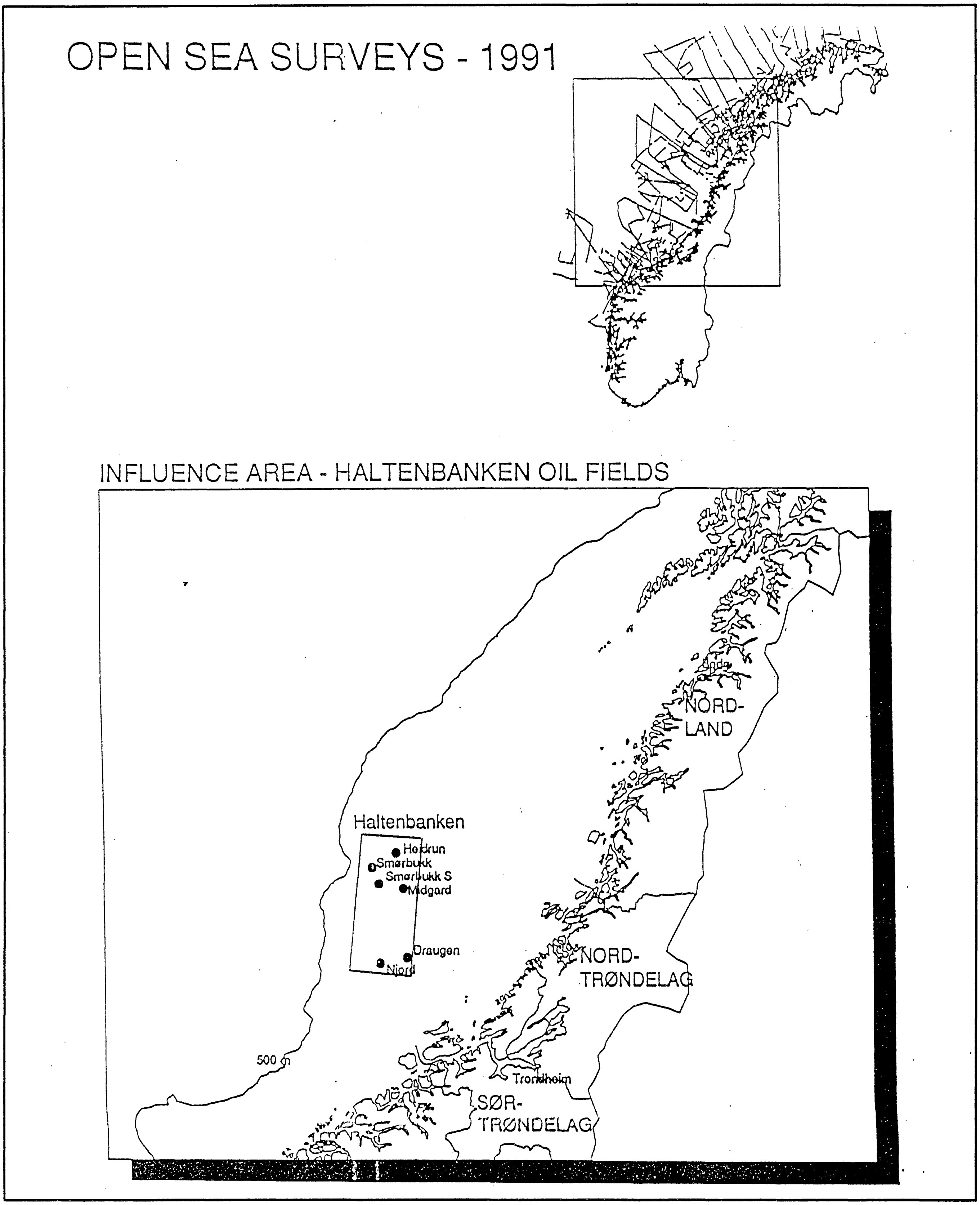


Figure 1 **Area covered in 1991. Survey routes are shown as lines on the map (upper right).**

density (birds seen per square kilometre surveyed) is presented graphically extrapolate. We have chosen not to numbers of birds seen to greater areas till a better coverage is present and the data are verified through additional records.

For species where certain identification occationally have proved difficult (Guillemot and Razorbill, skuas except Great Skua, immature stages of great gulls, and the terns), the density might have been higher than suggested in **Table 1**. Two other and probably more important factors which might influence the density figures are:

Table 1. Summary of birds seen in 1991 during 11 open sea surveys within the influence area of the Haltenbanken oilfields. Totals for the whole area covered in parantheses.

Species	Tot. no.		Mean no./km²	
Fulmar (*Fulmarus glacialis*)	25 385	(42.879)	5.78	(6.55)
Kittiwake (*Rissa tridactyla*)	6 218	(9.799)	1.42	(1.50)
Herring Gull (*Larus argentatus*)	6 004	(9.647)	1.37	(1.47)
Puffin (*Fratercula arctica*)	4 152	(7.455)	0.95	(1.14)
Great Black-backed Gull (*Larus marinus*)	3 495	(3.893)	0.80	(0.59)
Lesser Black-backed Gull (*Larus fuscus*)	1 044	(1.060)	0.24	(0.16)
Little Auk (*Alle alle*)	718	(1.100)	0.16	(0.17)
Common Eider (*Somateria mollissima*)	617	(1.338)	0.14	(0.20)
Common Guillemot (*Uria aalge*)	572	(786)	0.13	(0.12)
Gannet (*Sula bassana*)	273	(299)	0.06	(0.05)
Razorbill (*Alca torda*)	252	(354)	0.06	(0.05)
Long-tailed Duck (*Clangula hyemalis*)	176	(375)	0.04	(0.06)
Commorant (*Phalacrocorax carbo*)	158	(159)	0.04	(0.02)
Pomarine Skua (*Stercorarius pomarinus*)	110	(123)	0.02	(0.02)
Common Gull (*Larus canus*)	99	(123)	0.02	(0.02)
Arctic Skua (*Stercorarius parasiticus*)	90	(141)	0.02	(0.02)
Arctic Tern (*Sterna paradisaea*)	90	(167)	0.02	(0.03)
Shag (*Phalacrocorax aristoelis*)	87	(105)	0.02	(0.02)
Glaucous Gull (*Larus hyperboreus*)	82	(270)	0.02	(0.04)
King Eider (*Somateria spectabilis*)	81	(93)	0.02	(0.01)
Great Skua (*Stercorarius skua*)	68	(96)	0.02	(0.01)
Common Scoter (*Melanitta nigra*)	67	(161)	0.01	(0.02)
Black-headed Gull (*Larus ridibundus*)	49	(50)	0.01	(0.01)
Common Tern (*Sterna hirundo*)	45	(45)	0.01	(0.01)
Long-tailed Skua (*Stercorarius longicaudus*)	33	(57)	0.01	(0.01)
Black Guillemot (*Cepphus grylle*)	25	(48)	0.01	(0.01)
Brünnich's Guillemot (*Uria lomvia*)	18	(363)	<0.01	(0.06)
Velvet Scoter (*Melanitta fusca*)	9	(9)	<0.01	(<0.01)
Scooty Shearwater (*Puffinus griseus*)	2	(3)	<0.01	(<0.01)
Storm Petrel (*Hydrobates pelagicus*)	2	(2)	<0.01	(<0.01)
Manx Shearwater (*Puffinus puffinus*)	1	(2)	<0.01	(<0.01)
Leach's Petrel (*Oceanodroma leucorhoa*)	1	(1)	<0.01	(<0.01)

1 Variability in detection between different species (auks on the water are often difficult to spot, specially Little Auk) (Tasker et al. 1987).

2 The IMR research vessels attracts some species (Fulmar, Gannet, gulls, skuas), most predominant when trawling.

Trawling intensity varies a great deal within and between the IMR surveys, and this is probably reflected in density figures and distributional maps. Other species (mainly auks) may dive or change flight direction away from the vessels, and thus avoid detection. These effects are not quantified.

2.5 Marine-biological registrations

The IMR research vessels are equipped with instruments for echo-integration. Echo-integration is a method for making quantitative acoustic/trawl survey estimates of the densities of different fish species and plankton. The integrator values are assigned different species or categories on basis of characteristic echo-traces, which are verified by trawl net samples. It is possible to assign the registrated values to different depths (Erikstad et al. 1990). IMR has kindly given us access to integrator-data for a couple of surveys on which we participated.

A special FORTRAN computer program for matching integrator data with the bird observations is recently constructed, and the first experimental analysis of correlations between bird- and prey abundance is executed. Aggregation unit on this specific survey was 5 nautical mile. Marine organisms were divided into 88 different species-depth cathegories and integrator values were assigned these cathegories every 5 n.m. Seabird observations were aggregated along the same 5 n.m. units, and bird abundance was regressed on values of all marine biological cathegories.

3 Results and discussion

3.1 Summary of observations

As observations mainly were made from IMR research vessels, we had no means of influencing survey route or areas covered. The researched area thus extends both south and north of the impact area of the Haltenbanken oil fields. For the whole area covered, 81317 birds were identified to 58 species. Fulmar, Kittiwake, Herring Gull and Puffin accounts for 86% of these birds. Within the geographical area this report comprise, 50286 birds were recorded along 7913 n.m. of transectline. 53 different species were identified.

Species of no relevance for this study are omitted from further analysis (passerines, e.g.). The small discrepancies between the figures in **Table 1** and the 'Densitiy-Numbers' histograms in the appendix are caused by minor variations in the selection criteria.

3.2 Species account

The most vulnerable seabird species are those which remain on the sea surface for much of their lives (Tasker et al. 1987).

The auks are highly vulnerable to oil pollution (Anker-Nilssen 1987), and this study particularly emphasis these species.

Since the dynamics of an ecosystem are governed by a multitude of factors, we have tried to incorporate both marine biological and oceanographic factors in our study. Likewise it may be nessesary to study other bird species than the auks in order to understand the main features of the auk distribution, abundance and habitat use. If is known that the time required to discover a patch of food may decrease when many individuals are searching (Krebs & Davis 1884, p. 128). In this multispecies community it is highly possible that location of food by individuals of one species also alerts individuals of other species even if their favoured prey is different.

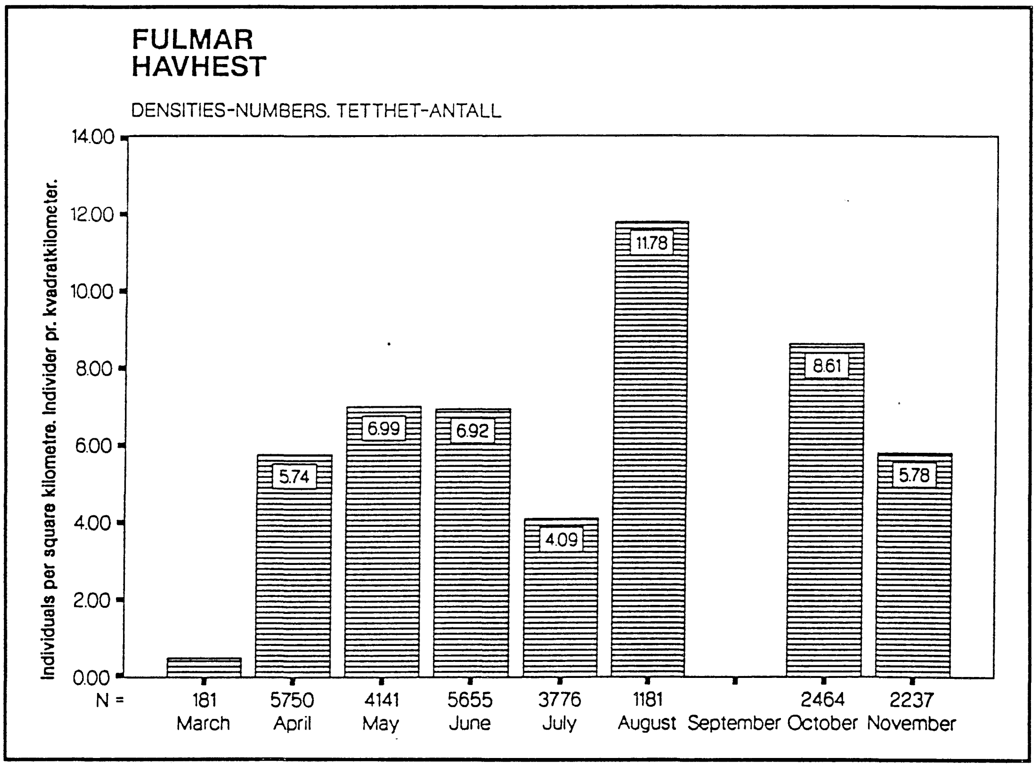
The species are discussed in accordance to their relative abundance (Table 1). Species which are recorded at very low densities (e.g. Storm Petrel), and species of little relevance for the study (e.g. Common Tern) are omitted from this account. The Long-tailed Skua is discussed in some detail since the records seem to reveal some new features of this little studied species.

Fulmar (Havhest)

Particularly high concentrations are often related to commercial fishing activity, where Fulmars will feed on offal (Tasker et al. 1987). Fishing activity from the IMR research vessels varies a great deal, and some of the density figures are probably influenced by ship activity **(Figure 2)**.

The Fulmar was abundant in most pelagic regions covered, specially near Runde. In early spring and late autumn the highest densities were found along the edge of the continental shelf. Thus, periodically Fulmars may have distributional patterns related tofrontal systems between cold coastal and warm Atlantic water **(Figure 3)**.

Figure 2 Fulmar. Monthly densities and numbers.



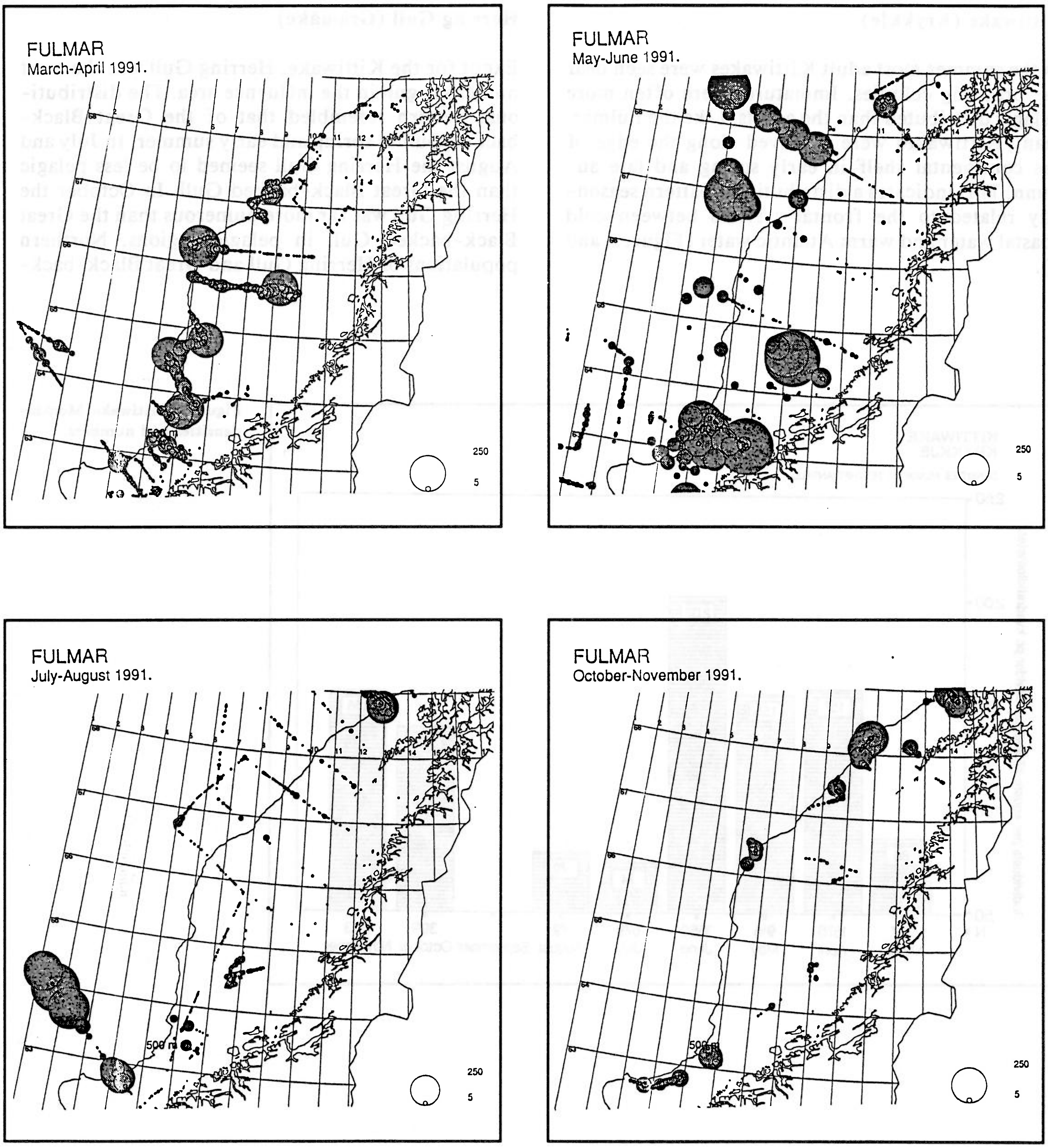


Figure 3 Fulmar. Monthly distribution. Circle diameter represents number of individuals.

Kittiwake (Krykkje)

In the summer most adult Kittiwakes were seen near the breeding colonies. Immatures were often more pelagic distributed than the adults. Like the Fulmar, many Kittiwakes were observed along the edge of the continental shelf in early spring and late autumn. This indicates a distributional pattern seasonally related to the frontal systems between cold coastal water and warm Atlantic water **(Figure 4 and 5)**.

Herring Gull (Gråmåke)

Exept for the Kittiwake, Herring Gull was the most numerous gull in the influence area. The distributional pattern resembled that of the Great Black-backed Gull in spring and early summer. In July and August the Herring Gull seemed to be less pelagic than the Great Black-backed Gull. In October the Herring Gull was far more numerous than the Great Black-backed Gull in pelagic regions. Northern populations of Herring Gull and Great Black-back-

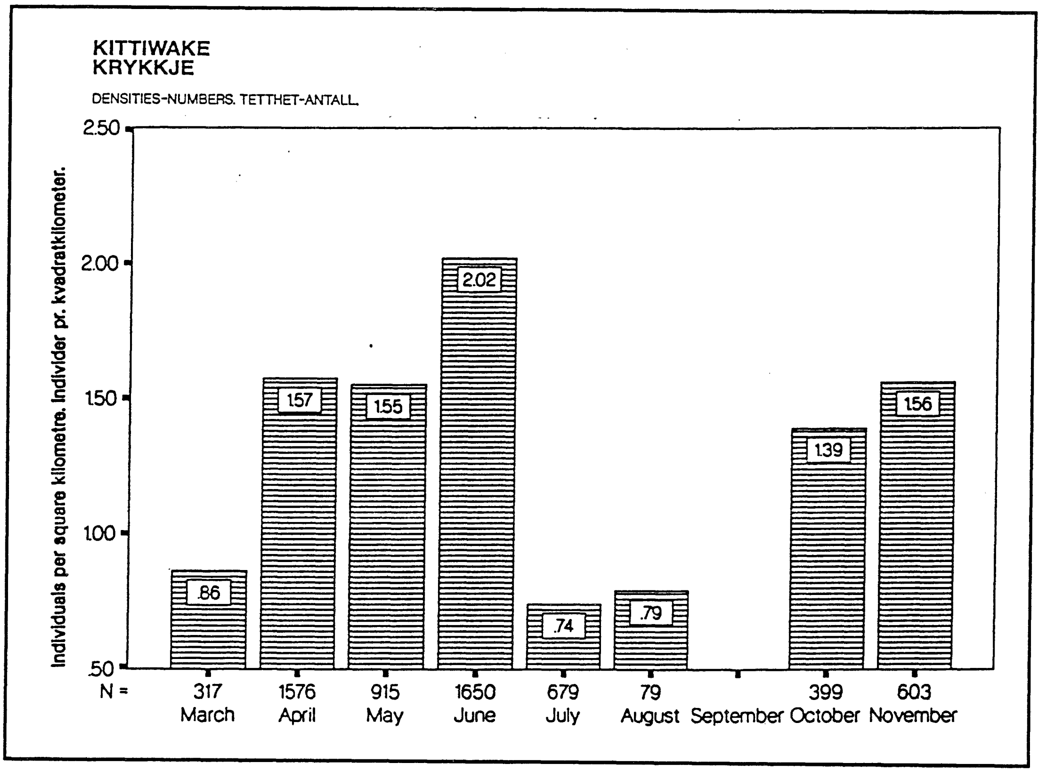


Figure 4 **Kittiwake. Monthly densities and numbers.**

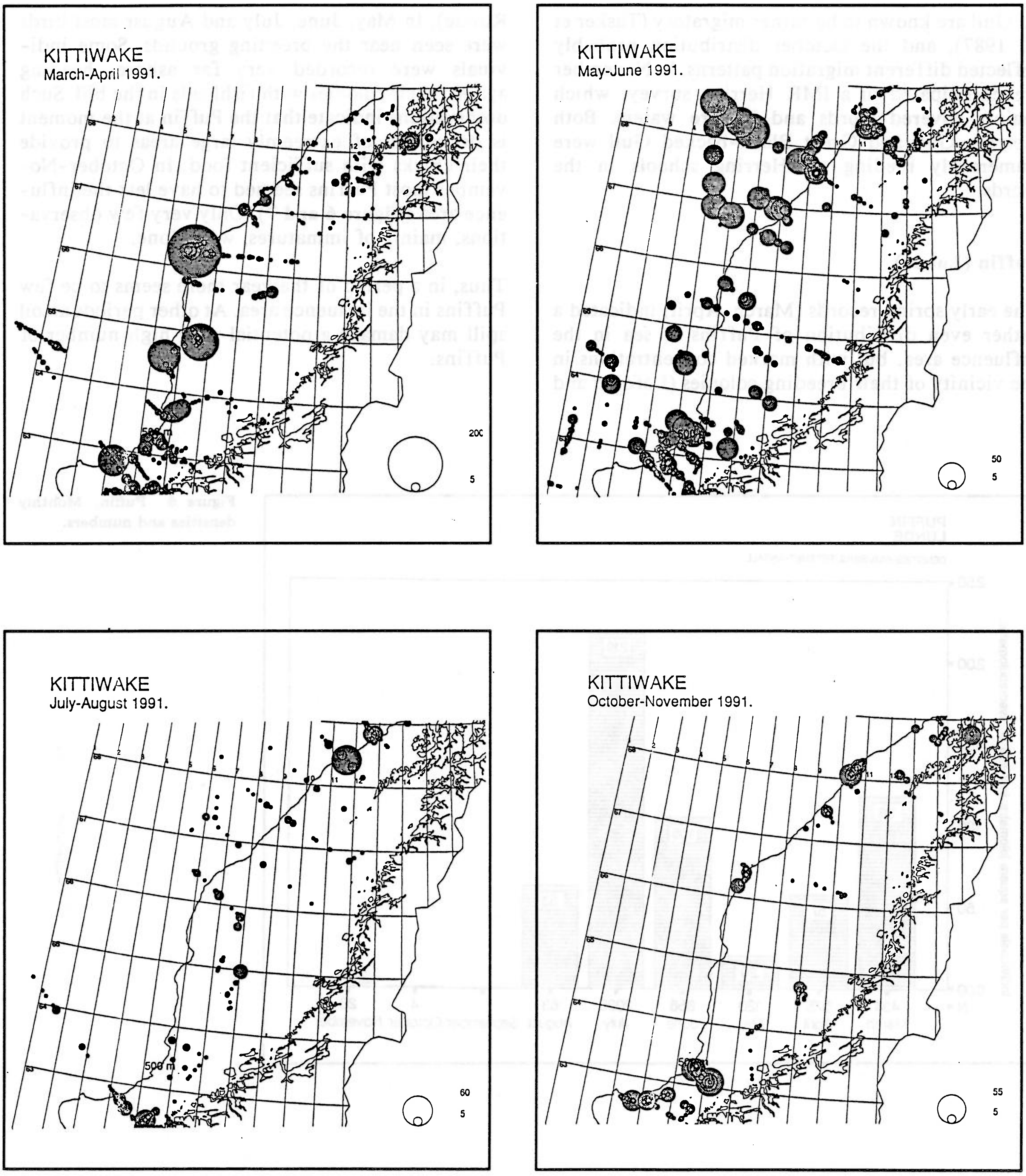


Figure 5 Kittiwake. Monthly distribution. Circle diameter represents number of individuals.

ed Gull are known to be rather migratory (Tasker et al. 1987), and the October distribution probably reflected different migration patterns. In November we participated in a IMR Herring survey, which mainly covered fjords and inshore waters. Both Herring Gull and Great Black-backed Gull were numerously feeding on Herring schools in the fjords.

Puffin (Lunde)

The early spring records (March-April) indicated a rather even distribution of Puffins at sea in the influence area, but with marked concentrations in the vicinity of their breeding colonies (Lofoten and Runde). In May, June, July and August most birds were seen near the breeding grounds. Some indiviuals were recorded very far ashore, heading against their colonies with fishloads in the bill. Such observations indicate that the Puffin at the moment is dependent of extreemly large areas to provide their chicks with sufficient food. In October-November most Puffins seemed to have left the influence area **(Figure 6 and 7)**. Only very few observations, mainly of immatures, were done.

Thus, in a period of the year there seems to be few Puffins in the influence area. At other periods an oil spill may damage a potential very high number of Puffins.

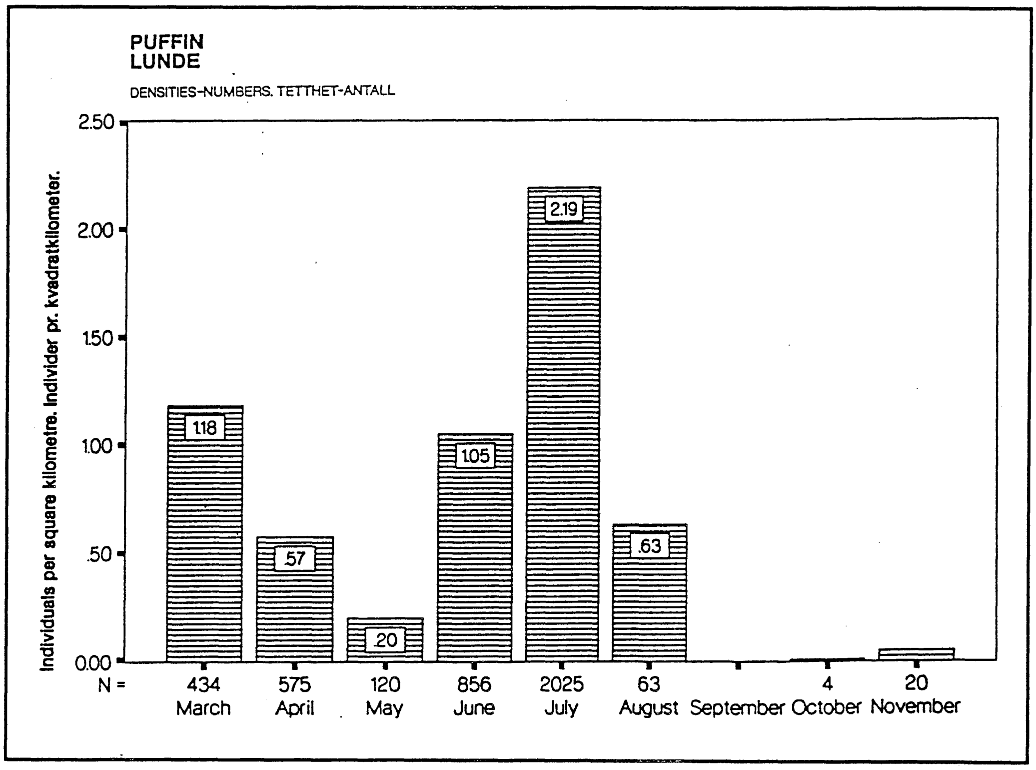


Figure 6 **Puffin. Monthly densities and numbers.**

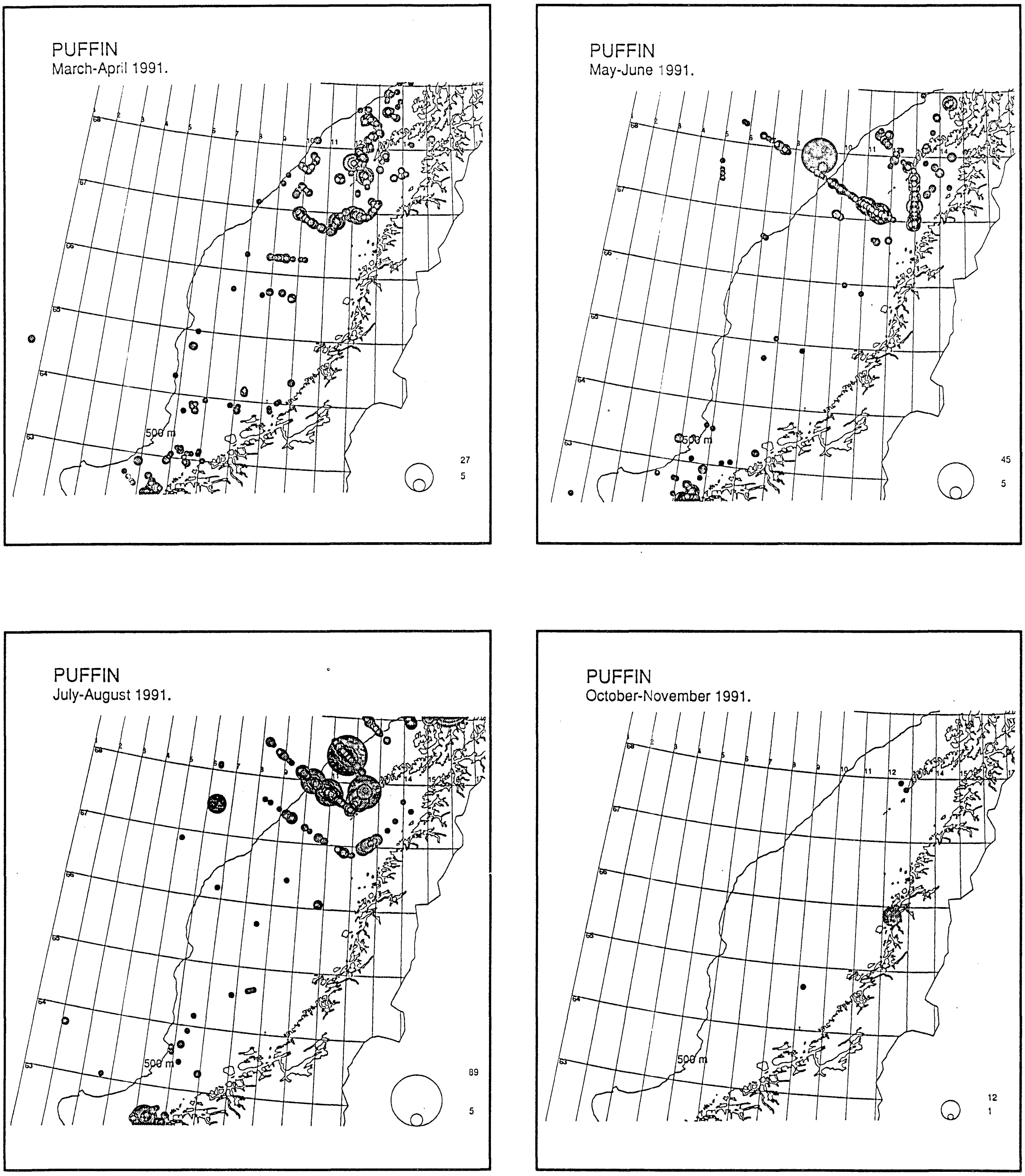


Figure 7 Puffin. Monthly distribution. Circle diameter represents number of individuals.

Great Black-backed Gull (Svartbak)

See Herring Gull

Lesser Black-backed Gull (Sildemåke)

The Lesser Black-backed Gull is principally a summer vistor to our waters (Tasker et al. 1987). There are two breeding subspecies of Lesser Black-backed Gull in Norway, whereof the Norwegian population of *Larus fuscus fuscus* is pointed out as threatened (Lorentsen 1991). Most of the recorded Lesser Black-backed were of the sub-species *Larus fuscus fuscus*. There was an increase in density from March which peaked in June. The reduced number in July may correspond to the start of the autumn passage. In October-November very few birds were left.

Little Auk (Alkekonge)

The Little Auk is a high arctic breeder and a regular winter visitor in the influence area. Little Auks are sometimes observed in immense numbers along the coast of central Norway in the winter and early spring (Follestad 1990).

The 1991 records show concentrations near Lofoten and Runde in March-April. Thereafter the Little Auk disappeared from the area. In October it returned as the most numerous alcid in the influence area **(Figure 8 and 9)**. Little Auks were recorded in most pelagic regions covered, sometimes concentrated along fronts (visible foam and eddies), e.g. the Moskenes current.

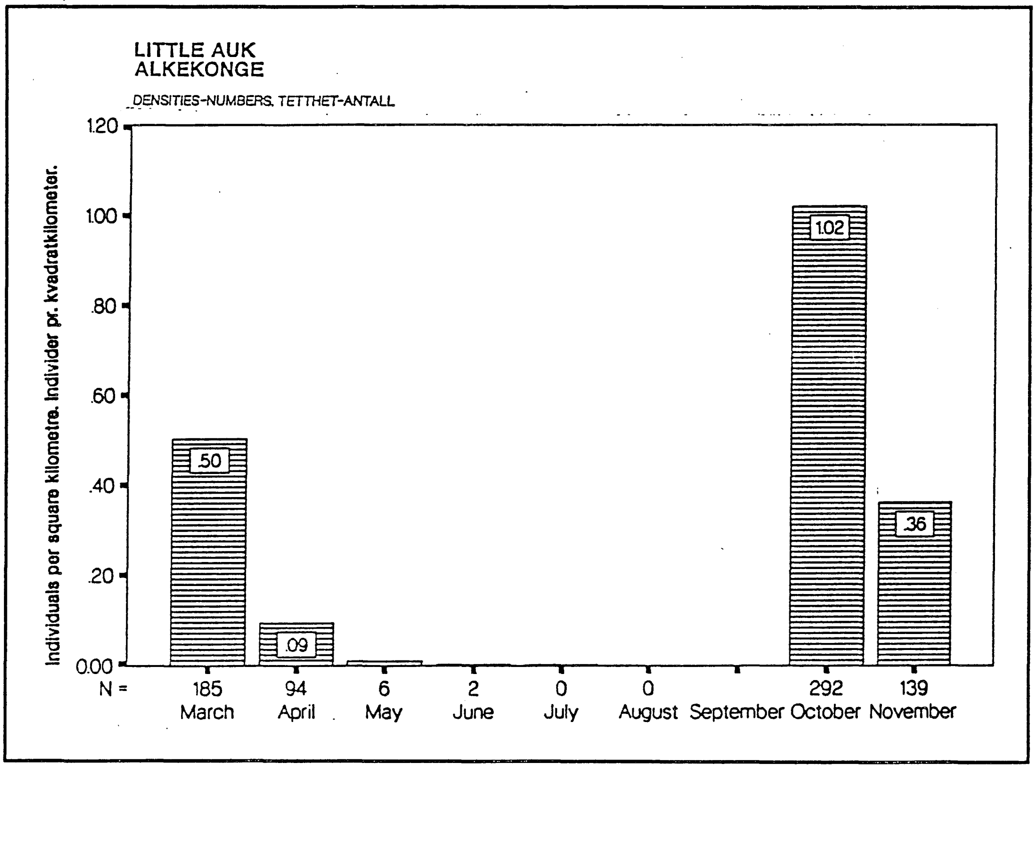
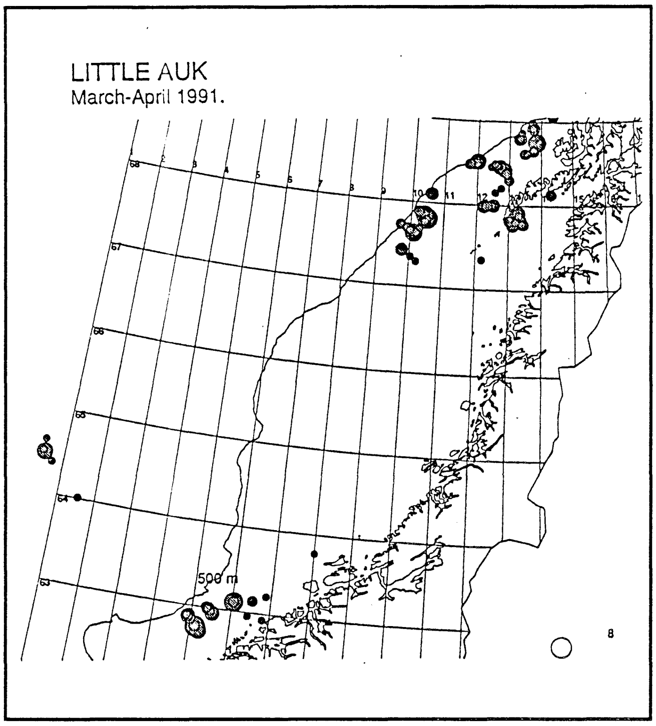


Figure 8 Little Auk. Monthly densities and numbers.



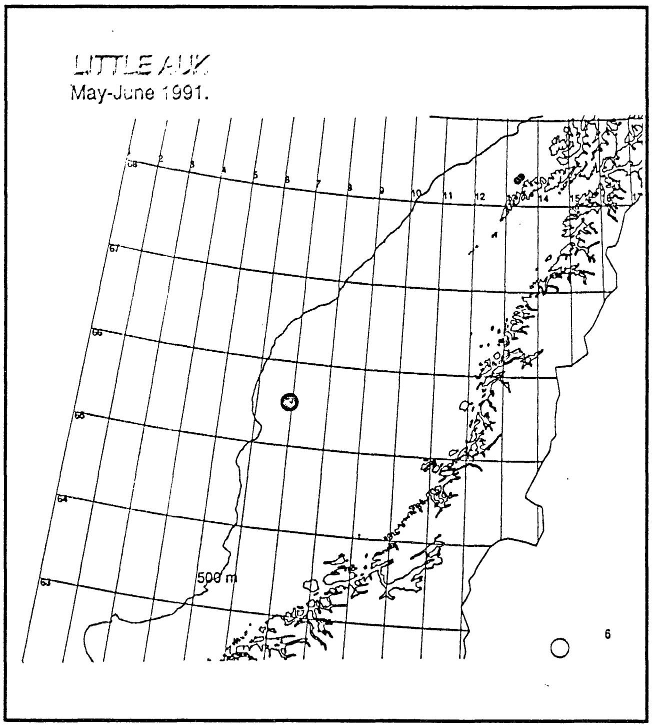
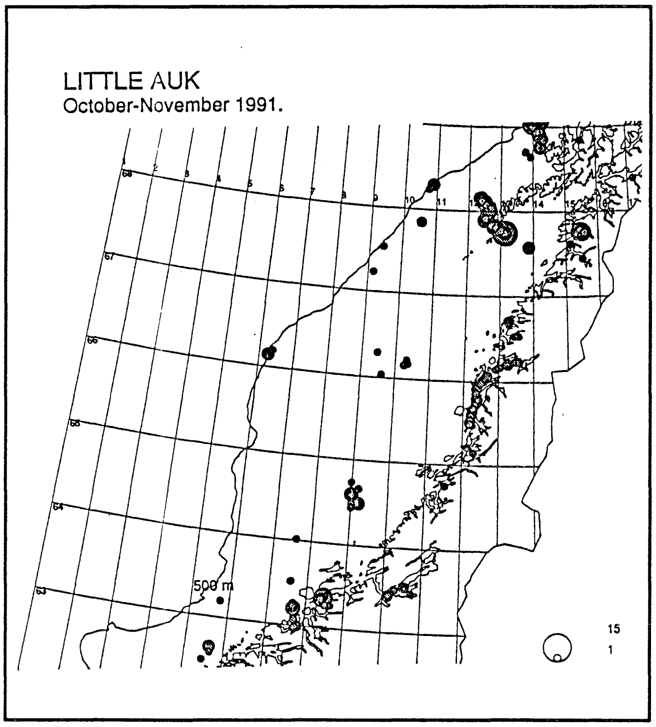


Figure 9 Little Auk. Monthly distribution. Circle diameter represents number of individuals.



Common Guillemot (Lomvi)

The Common Guillemot is pointed out as a particularly threatened species in Norway (Follestad 1989). Detailed knowledge of distribution, abundance and habitat use throughout the year is critical for a sensible management of this species.

The recorded offshore densities were highest in the pre-breeding season (April) and after the exodus (August). In late spring and early summer most Common Guillemots were recorded near their breeding colonies. In July-August there were still marked concentrations near Runde, but the records also indicated a more scattered offshore distribution, with many observations near the edge of the continental shelf **(Figure 10 and 11)**.

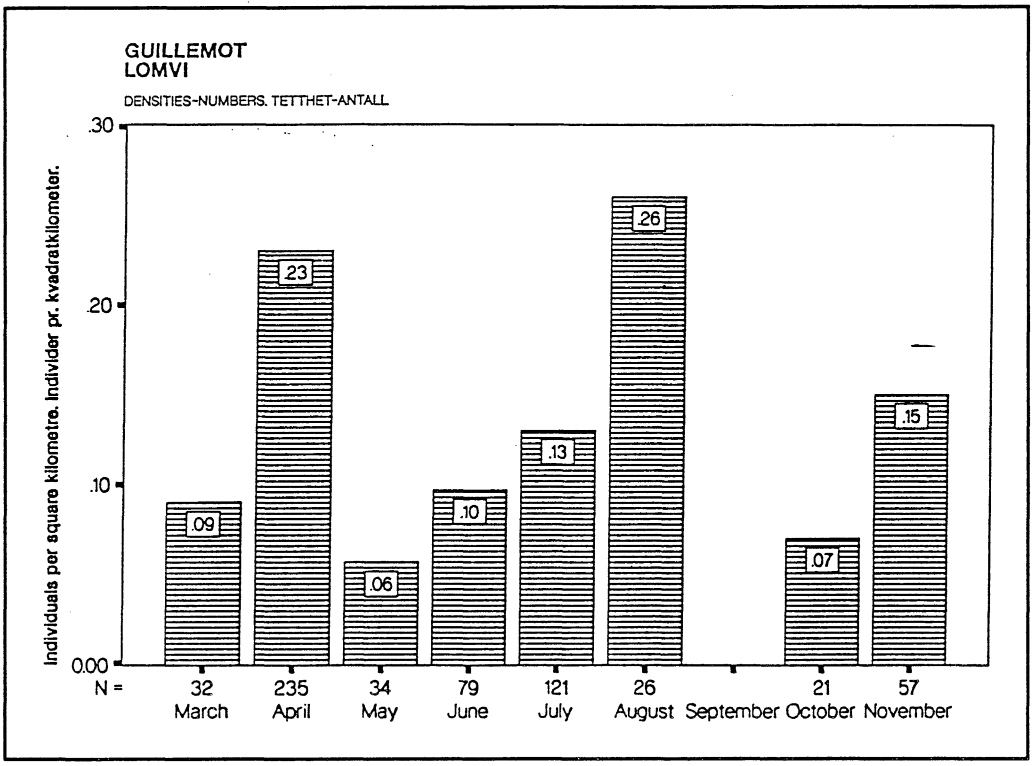


Figure 10 Common Guillemot. Monthly densities and numbers.

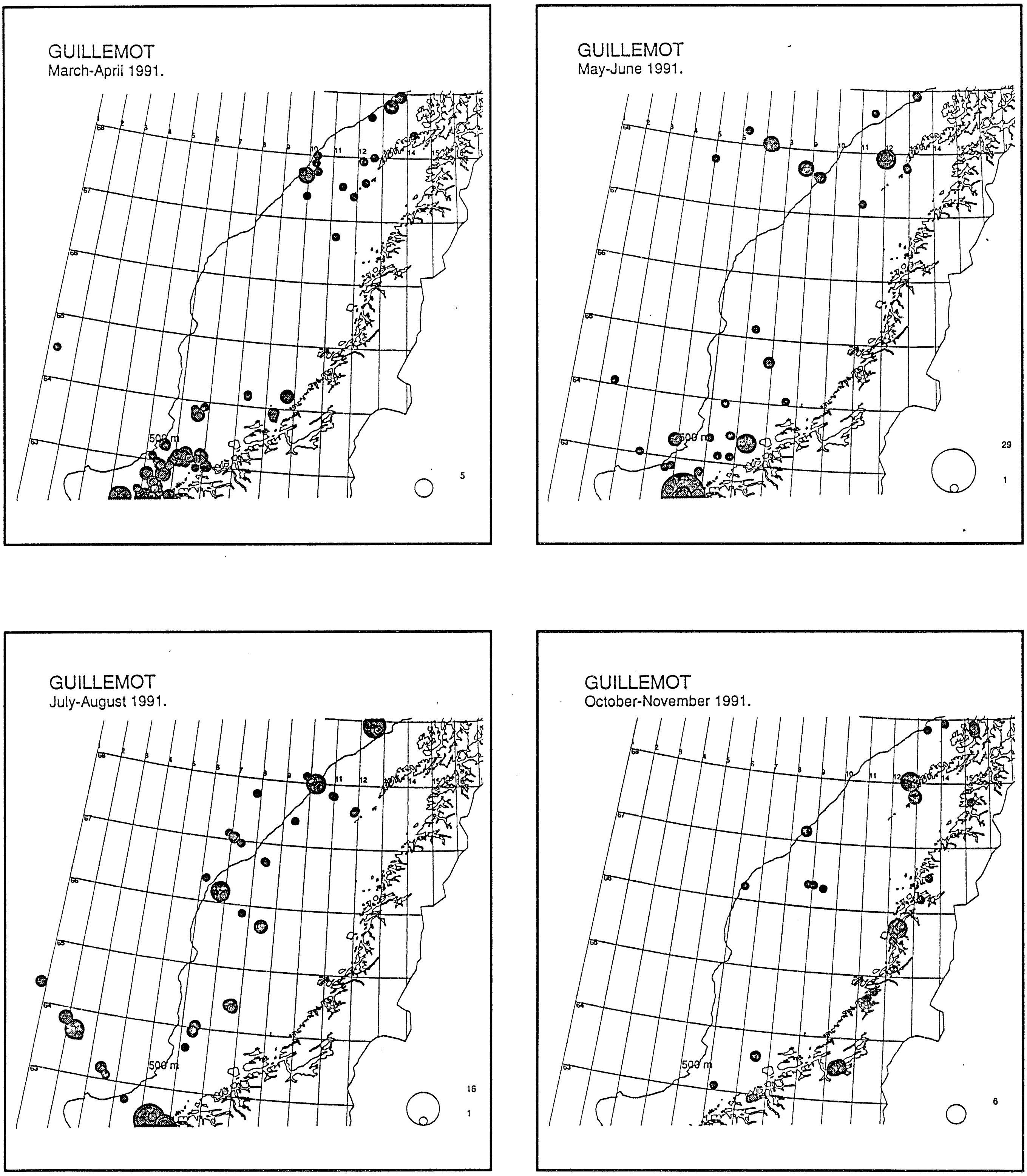


Figure 11 Common Guillemot. Monthly distribution. Circle diameter represents number of individuals.

During the post breeding movements in late July/ August the Guillemots are extreemly vulnerable to oil contamination (Follestad 1989). The survey coverage in late July and in August was poor, but a few parent/child observations were made on Haltenbanken in August. It is reasonable to suggest that these birds came from Runde. It is notable that the highest monthly density of the Common Guillemot was registrated in August when the only survey was made on Haltenbanken.

There were no September observations. In October-November very few Guillemots were sighted at sea. Most records came from nearshore waters.

Gannet (Havsule)

Most Gannets are supposed to be migrants (Tasker et al. 1987). Runde supports the largest breeding colony in Norway (Lorentsen 1991). From March there were increased densities in the offshore areas close to the breeding colonies. The peak in April was probably a consequence of the rather limited area covered during the earliest April survey. Highest densities were found near Runde, but in summer Gannets were recorded in most pelagic regions covered. All October-November observations were of immatures in the vicinity of Runde **(Figure 12 and 13).**

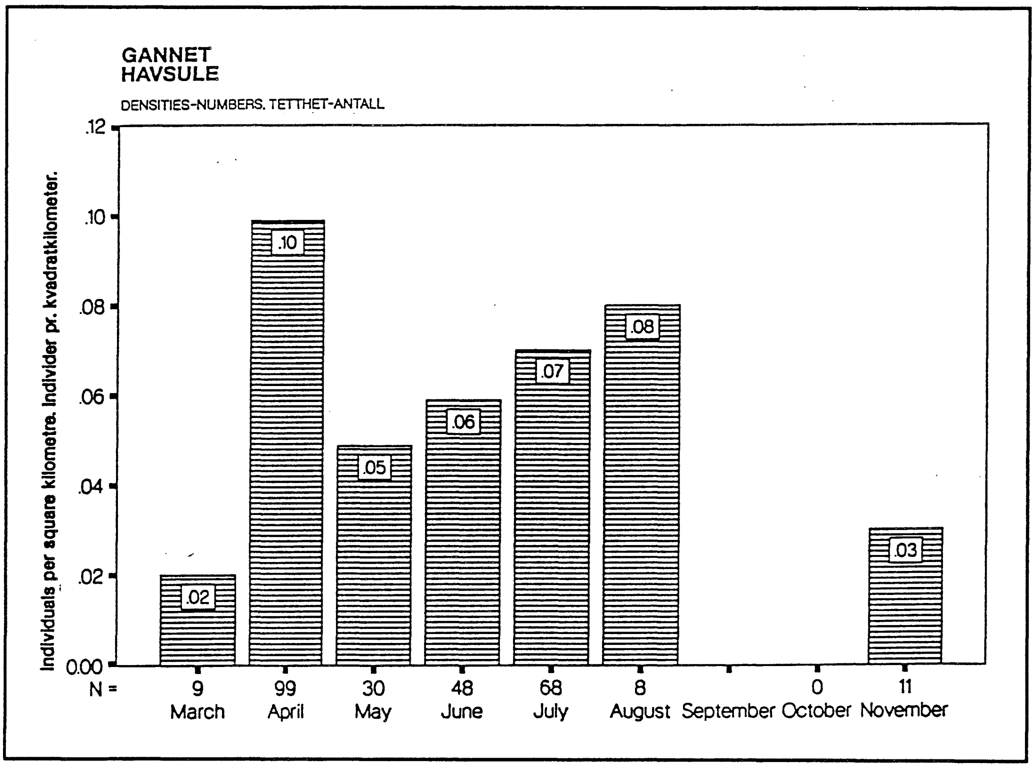


Figure 12 Gannet. Monthly densities and numbers.

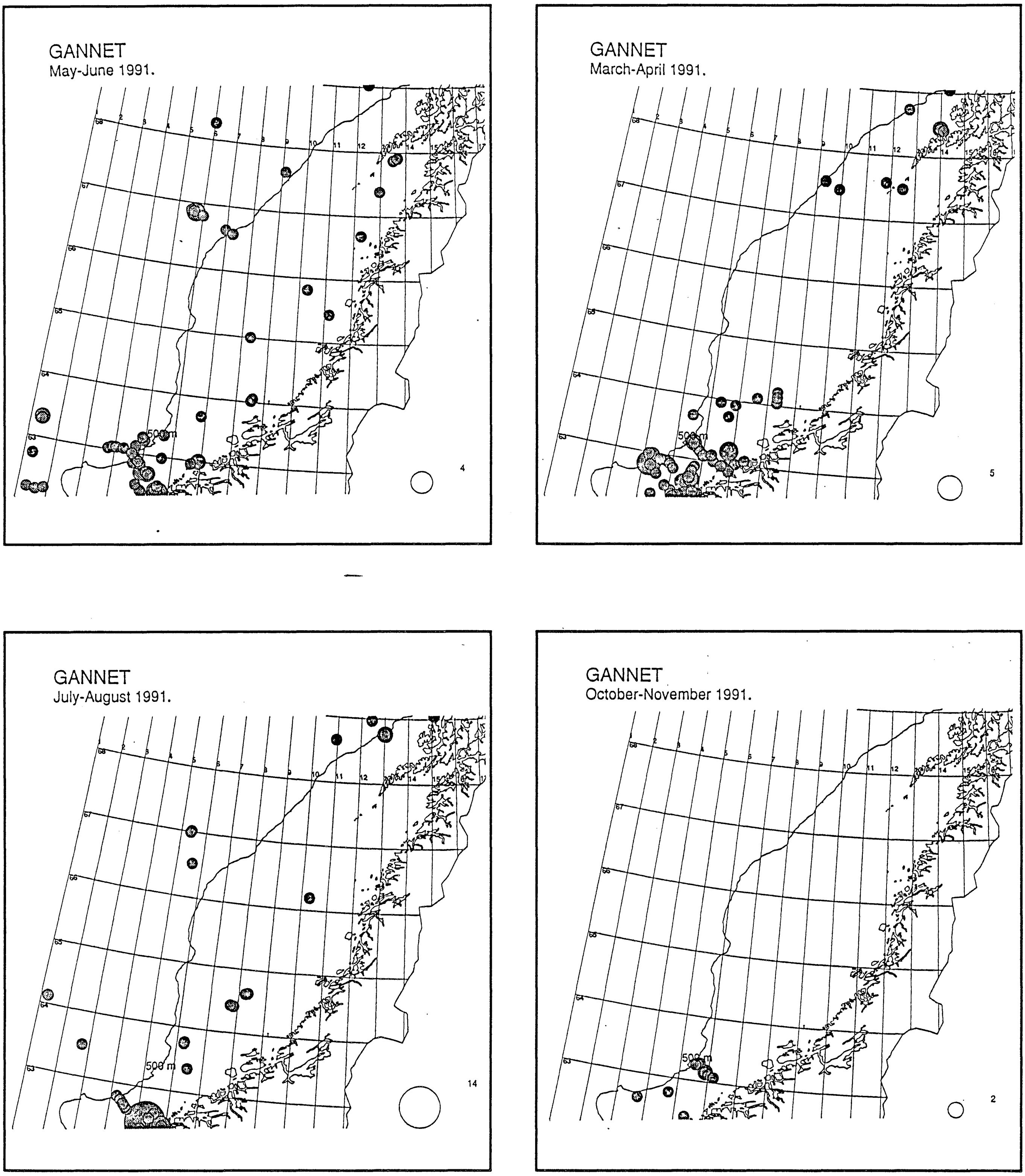


Figure 13 **Gannet. Monthly distribution. Circle diameter represents number of individuals.**

Razorbill (Alke)

Most of the year the surveyed area held few Razorbills. In the spring (March-April) highest densities were recorded near Runde. Later on the densities in the Lofoten area increased. Peak numbers were present in November, when Razorbill was the most frequently recorded alcid **(Figure 14 and 15)**.

The bulk of the November observations were made between isle of Vega and Tjøtta at the Helgeland coast. Periodic, this may be an important feeding area for Razorbills, probably from North Norwegian (and/or Russian) colonies. The importance of this area is confirmed by records from previous years (NINA seabird database, unpubl.). Many Razorbill observations in October-November compared to Puffin and Guillemot suggest quite different migration patterns or habitat use.

Long-tailed Duck (Havelle)

Unlike other seaducks, the Long-tailed Duck is quite pelagic outside the breeding season. This is reflected in relatively many sightings offshore in October-November.

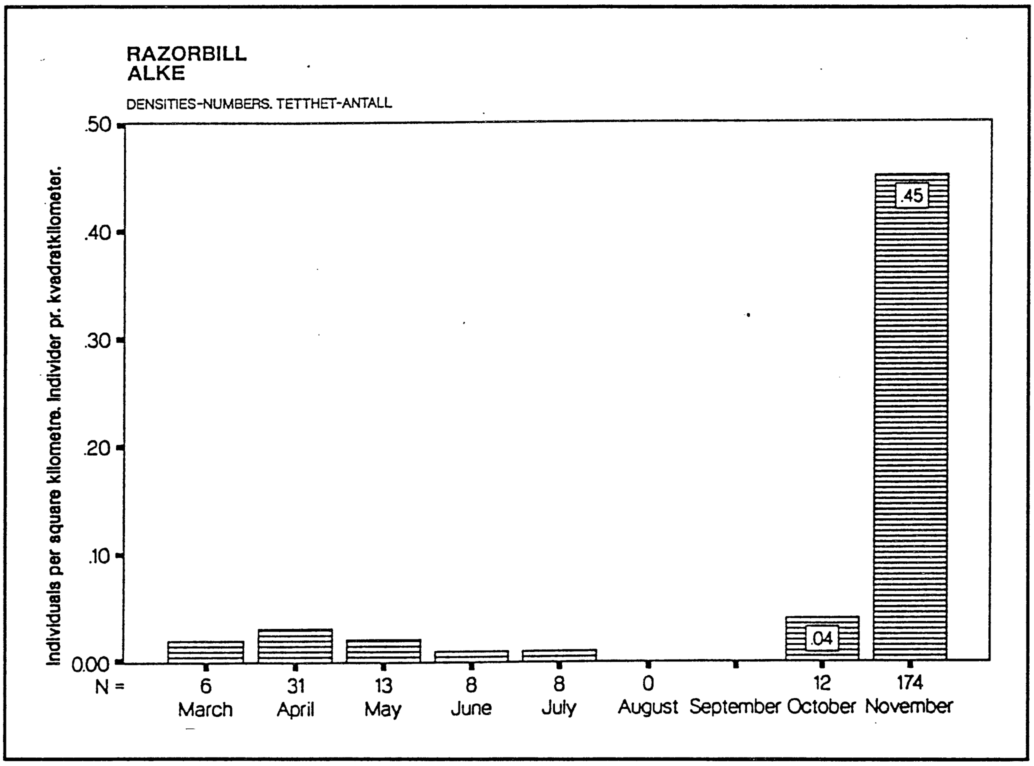


Figure 14 Razorbill. Monthly densities and numbers.

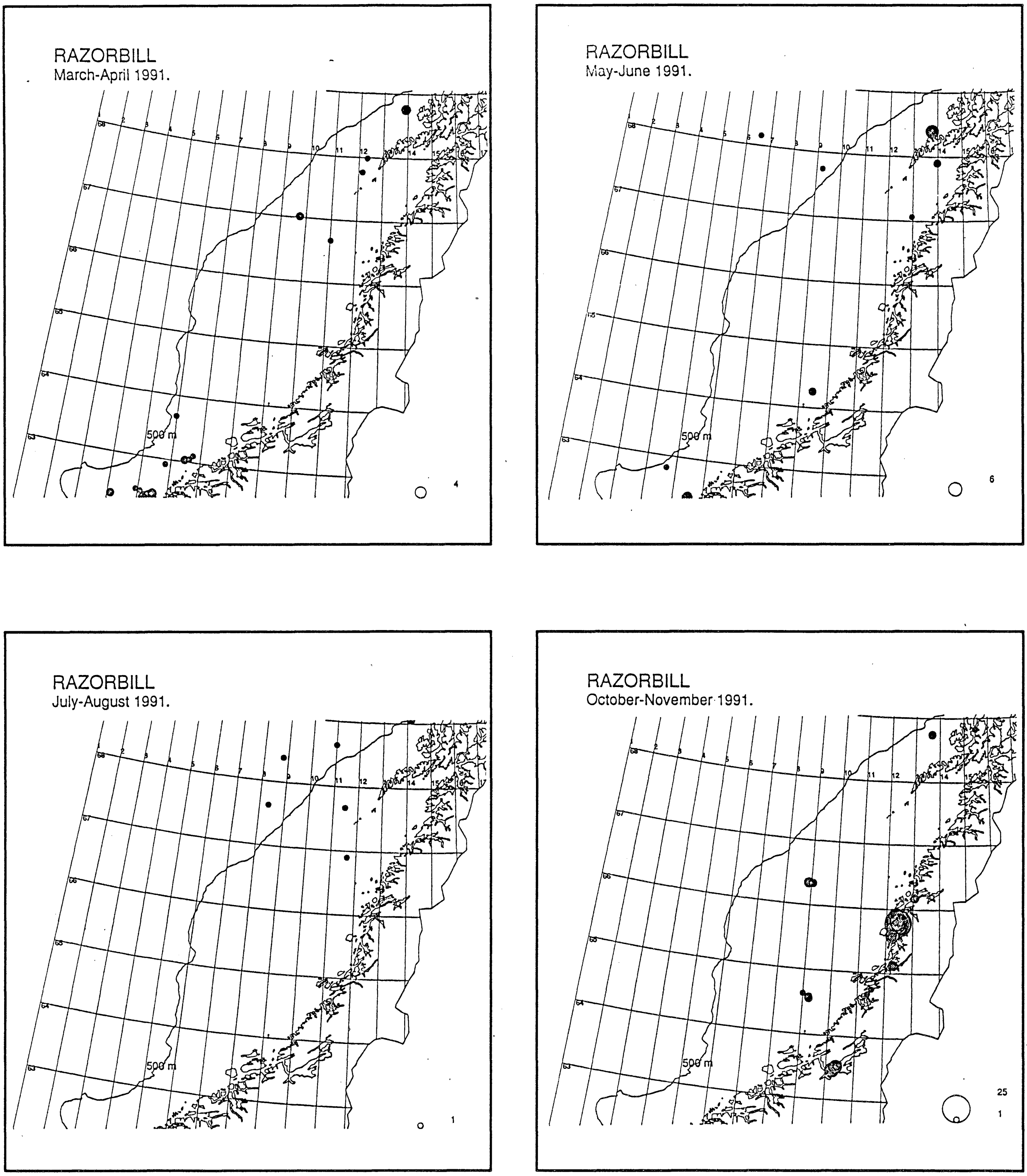


Figure 15 Razorbill. Monthly distribution. Circle diameter represents number of individuals.

Pomarine Skua (Polarjo)

The Pomarine Skua breeds in the arctic, but spends the winter in low-latitude tropical areas (Cramp & Simmons 1985). Pomarine Skuas are recorded in Norwegian waters during migration. Almost all sightings were made in May. The observations indicate two alternative migration corridors. Some birds seem to follow the frontal system along the edge of the continental shelf on their way to the breeding grounds while others follow the Norwegian coastline.

Arctic Skua (Tyvjo)

The Arctic Skua is a holarctic species (Cramp & Simmons 1985). The first observation in 1991 was made in April. In May-June Arctic Skuas were recorded regularly but scattered over most the surveyed area. The peak in May is probably corresponding to the return to the breeding colonies. Late October there were still some induviduals left in the area.

Arctic Tern (Rødnebbterne)

Summer guest. Most observations in inshore waters but regularly recorded pelagic.

Glaucous Gull (Polarmåke)

Glaucous Gulls are regular winter visitors in Norwegian waters.

The majority of sightings in the influence area were made in October-November along the edge of the continental shelf. Most of the recorded birds were immatures. Very few Glaucous Gulls were observed between June and August inclusive.

Great Skua (Storjo)

The first sightings of the Great Skua were made in April. A slight increase in numbers was recorded in May before it peaked in June. In May-June Great Skuas were rather uniformly distributed over the surveyed area. In July and August Great Skuas were regularly observed. Exept for some aggregations near the bird cliffs at Runde, the Great Skua operated highly pelagic. No records were made in October-November.

Long-tailed Skua (Fjelljo)

Long-tailed Skuas breed circumpolar holarctic. Though supposed to be highly oceanic, little is known about summer distribution outside the breeding areas. The migratory routs are imperfectly known. It is suggested that Long-tailed Skuas fly through the Barents Sea or over the north Norway mountains into the Norwegian Sea, then into the Atlantic west of the British Isles (reversed in spring) (Cramp & Simmons 1985). In 1991 the first sighting of the Long-tailed Skua was made 19 May. A total of 57 Long-tailed Skuas were recorded. All but one north of 66°N. This was probably a southern border for an Atlantic migration corridor leading from the southern hemisphere to the breeding grounds in Fennoscandia and the USSR. It seems that most of the skuas reached the Norwegian waters south of 69°N. The picture is surely not static. In May 1986 13 Long-tailed Skuas were observed heading east along the 71°N (NINA seabird database, unpubl.). Nearly 90% of the Skuas observed in May and June had a northern flight direction **(Table 2 and 3)**.

The birds seemed to follow the edge of the continental shelf from 66°N to 69°N, from where they dispersed either to the breeding grounds, or to feeding grounds in the Norwegian Sea or the Barents Sea. Most of the birds in our study carried an adult plumage (56 out of 57 individuals in 1991). This indicates that we missed the southward migration of first year juvenile, which is not remarkable since we lack data from mid August and later. It also indicates that few immatures reached the studied area during the spring and summer 1991.

Brünnich's Guillemot (Polarlomvi)

There were only few observations of Brünnich's Guillemot in the impact area, and the data is merged with data for the Common Guillemot. This species is more common north of the influence area.

3.3 Bird/prey abundance

For one survey numeric correlations between bird and prey abundance were investigated. Numbers of birds seen (Puffins at sea) were regressed on values

Table 2. Distribution of Long-tailed Skuas in May/June 1991 in relation to flight direction and position.

	Flight direction				
Position	N	E	S	W	Total
66 - 69°N	90% (19)	5% (1)	5% (1)	0	100% (21)
North of 69°N	0	0	0	0	-

Table 3. Distribution of Long-tailed Skuas in July/August 1991 in relation to flight direction and position.

	Flight direction				
Position	N	E	S	W	Total
66 - 69°N	33% (2)	17% (1)	50% (3)	0	100% (6)
North of 69°N	25% (6)	12% (3)	50% (12)	12% (3)	99% (24)

of different marine biological cathegory variables. Since numerical associations may manifest itself only above some treshold (Piatt 1987), two different criteria for selecting 5 n.m. patches for the analysis were used:

1 Numbers of swimming Puffins should exceed a certain minimum. This is supposed to strengthen the non-random distribution pattern.

2 Only areas within a certain distance from the colonies were included. This geographical selection criteria will exclude large geographical areas with low density patches (e.g. all exept the Lofoten area).

Both selection criteria gave significant correlations **(Figure 16)**, and the Pe50 variable (pelagic fish in the upper 50 metre) is the key variable. Thus, there seems to be a numerical correlation between Puffins and their prey when the birds density exceeds a certain treshold. The spatial scale used was 5 n.m., and the temporal scale, less than 40 min. Data gathering was fully syncronized and the aggregated seabird numbers correspond exactly to the aggregated hydroacoustic values.

There were no information on the diett of the Puffins included in the analysis, and the Pe50 cathegory is not exactly defined (T. Knutsen pers. comm). Much of the fish specimens in this category were probably too large for the Puffins to feed on.

The eccosounder on board did not registrate the depth range 0-10 m. Since Puffins are supposed to catch most of their prey near the surface, usually not deeper than 15 m (Cramp & Simmons 1985), integrator data will fail to reflect the prey density in the 0-10 m stratum (see Hunt 1990).

Even if Pe50 not is a suitable Puffin prey, positive correlation between Pe50 and Puffins can be explained if the Pe50 cathegory consists of predatory fish (e.g. Saithe), mainly feeding on suitable Puffin prey in the upper 10 m. Figure 16 shows that other prey cathegories also are put into the equation which may explain some features of the Puffin distributional pattern, but the many independen variables may also create a correlations coincidences.

The selection criteria limited the number of selected 5 n.m. patches for the correlation analysis severly. No other alcids (e.g. Razorbill, Guillemot) were recorded at the nesessary density to carry out a correlation analysis.

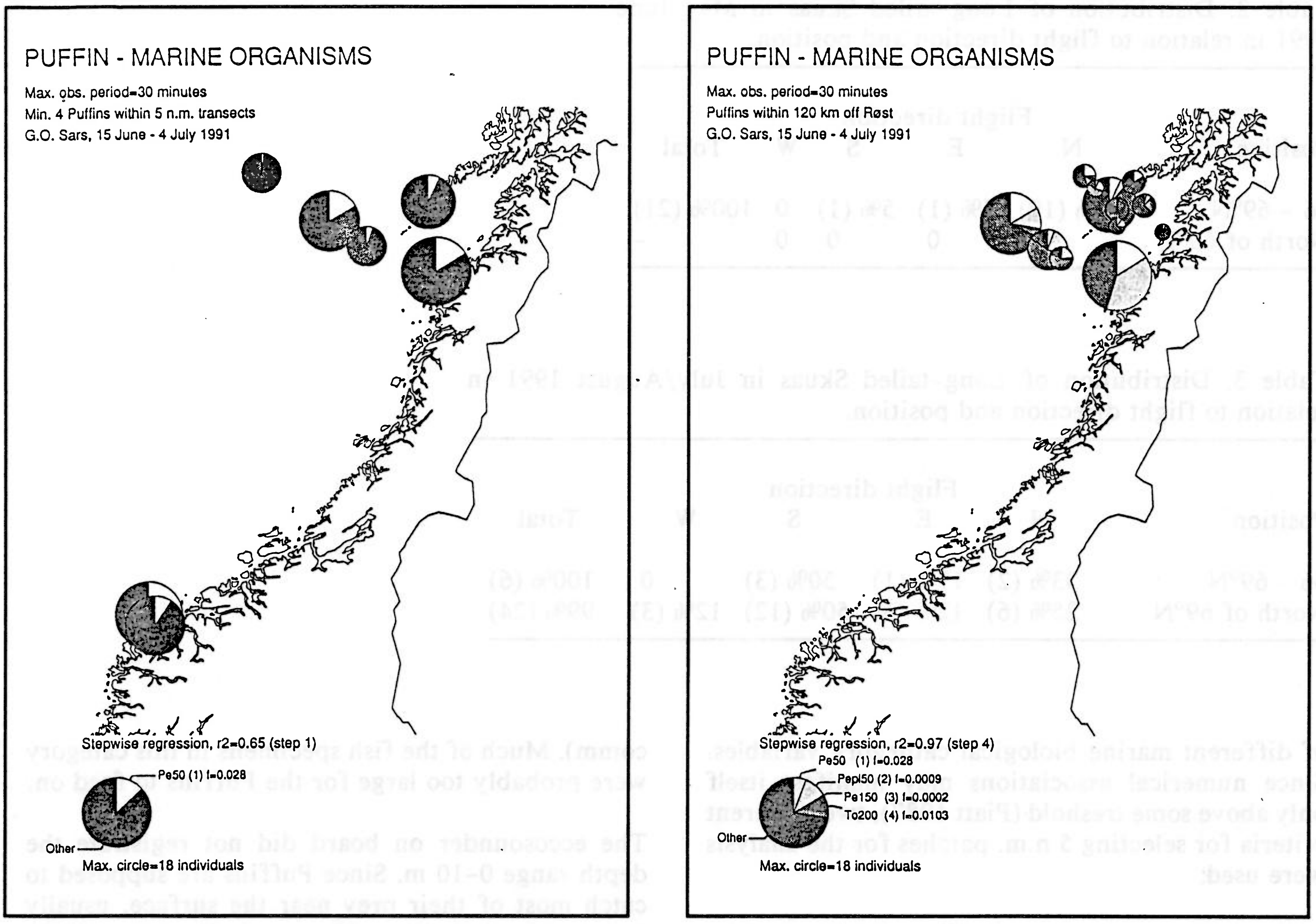


Figure 16 Puffin - marine organisms. Circle diameter represents number of Puffins. Sector size represents the relative amount of marine organisms. Regression statistics is connected to the key circle.

4 Evaluation and further research

4.1 Evaluation

The influence area of the Haltenbanken oil fields covers immense open sea areas. 11 surveys from March to November can by no means give a reliable description of offshore seabird distribution throughout the year. Much of this years efforts were put into general data collection, construction of necessary data programs, establishing routines for collection, handling and transfer (IMR-NINA) of data, exploring, testing, and evaluating methods for explaining and predicting distributional patterns, and defining strategies for a further research.

The influence area includes many important seabird areas. These are more or less permanent. The bird cliffs at Runde, Lovunden, Værøy/Røst and their surroundings are of vital importance for a substantial number of species over many months. Large frontal systems seem periodically to be predictable areas of some importance for several seabird species. Other areas may be charcterized by unstable but sometimes plentiful food resources. These may be exploited dependent on how predictable, detectable and available the resources are (see Hunt 1990).

Through a general mapping of seabirds at sea, this research program has attemted to determine areas of vital importance for seabirds at sea throughout the year. We have also attempted to interpret the relationship between the distribution of seabirds at sea and marine biological factors.

It is clear that several important features of seabird distribution is left to be examined. The general coverage has been constrained by the relatively short period of study. When the matherial is splitted into zones, seasons, behavior, sex and age the picture becomes dangerously unreliable. Trend analysis are not possible, and there is a problem of verification. Attempts to use patch quality to explain observed variations in seabirds density are yet experimental.

Further fundings for a research program over 2-3 years is nessecary to cope with these constraints. Such fundings will give us a possibility to examine seabird biology in the influence area in more detail.

4.2 Five major objectives for further work

1 To examine the general distribution patterns of seabirds offshore throughout the year.

2 To examine wintering areas of Guillemots and Razorbills.

3 To examine the movements and range of auks around Værøy/Røst, Lovunden and Runde, swimming migration included.

4 To examine the great migration movements of the Puffins in autumn and spring.

5 To interpret the relationship between the distribution of seabirds at sea and marine biological and oceanographic factors.

IMR measures the vertical distribution of salinity and temperature, using a CTD (conductivity-temperature with depth) at certain intervals (usually 10 n.m.).

As a first effort to interpret the relationship between seabirds distribution and oceanographic factors at a large scale, we have to some extent interpolated CTD values (surface temperature and salinity) on maps over seabird abundance **(Figure 17).** Since fronts may be very local phenomena, it is important to have access to finer scale registrations than those given by the CTD.

We have discussed the possibility to registrate hydrographical data continously from the research vessels, and this question is concidered by the IMR.

Satelite images of sea surface temperatures (SST) may be another important tool for measuring and interpreting dynamic attributs of seabird environments. Satelite-derived images covering fractions of one survey have already been studied. The major limitation regarding such optical data is the dependence upon weather conditions, but we were able to find satelite images which gave good pictures of the sea surface temperatures for the actual area and periode. A spatial resolution of the NOAA-satelite data of 1 km (Pedersen 1990) gave a far better accuracy than CTD derived data (9-18 km).

The next step is to position analoge thermal infrared satelite data (and weather/light-independent ERS radar satelite images) accuratly. SPACETEC A/S in Tromsø will try to solve these problems. It might then be possible to run correlation analysis between sea surface temperature (or structure) and seabird consentrations. If we through satelite images will be able to derive reliable pictures of seabird distribution, these might become powerful tools for impact analysis, oilspill combating and protection.

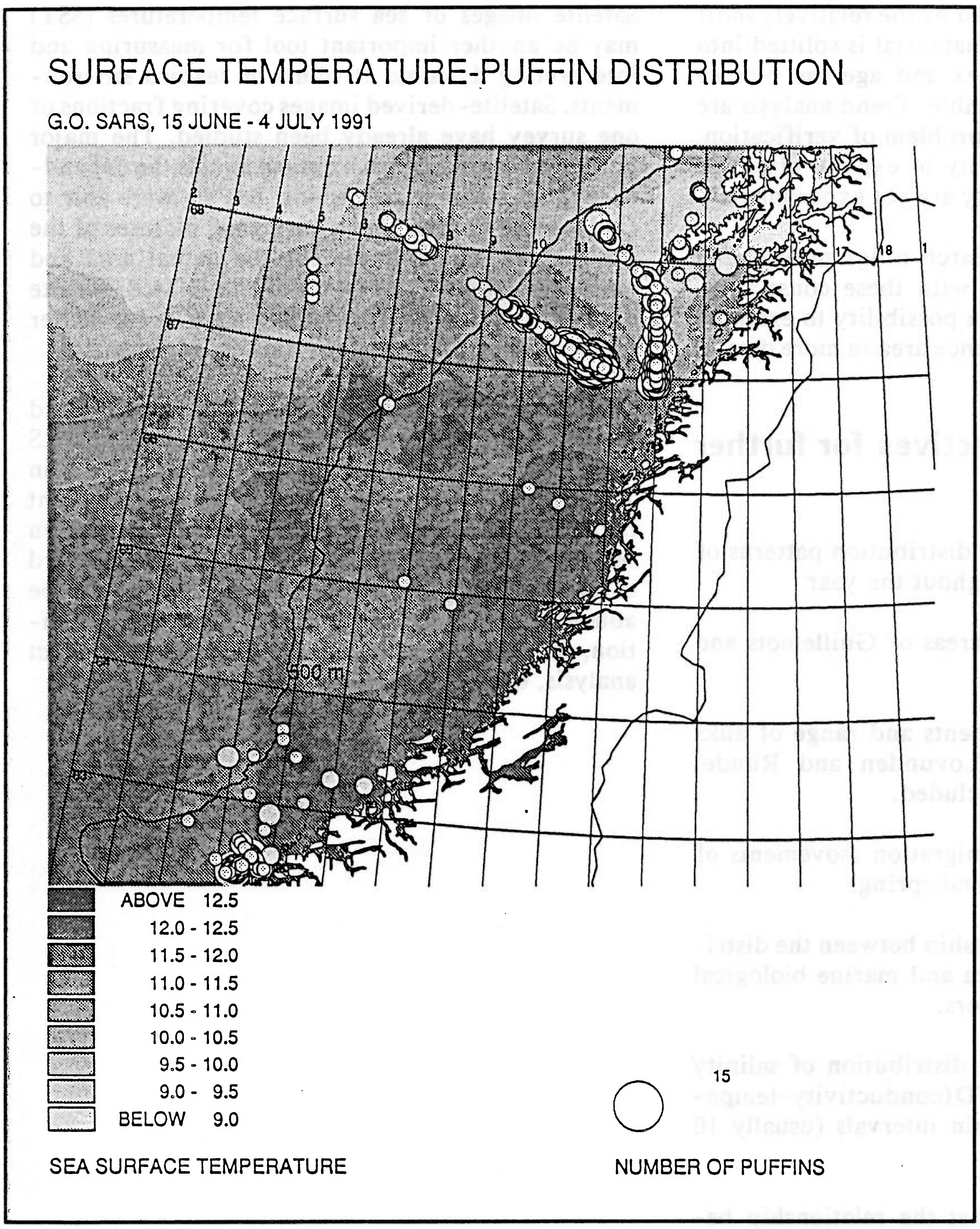


Figure 17 Sea surface temperature - Puffin distribution. Sea surface temperatures measured at CTD stations interpolated on a map over Puffin distribution. Circle diameter represents number of Puffins.

5 Summary

This report is a summary of important features of seabird distribution at sea through the year (1991) in the influence area of the Haltenbanken oil fields. We also point at possible mecanisms behind the observed patterns and try to define major objectives for further research. It is stressed that the data records are limited, and no environmental impact assessment should be carried out on the basis of this report.

Oil spill damage is a serious threat to seabird species in the area. The auks are concidered to be most vulnerable to oil pollution. Largest auk concentrations at sea are generally found offshore close to their breeding colonies. The feeding range in the breeding season is probably detemined by distance to colony and the patch quality. From late July the auks leave their colonies. The Puffins probably move out into the Atlantic Ocean, and in October very few records were made in the influence area. Guillemot and Razorbill post-breeding swimming migration is poorly known, but Haltenbanken may be an important area for Guillemots during this critical flightless period. Monthly records over Guillemot densitiy varied little in 1991, while Razorbill density increased in October-November. Many Razorbills appeared to concentrate in an area north of Vega at the Helgeland coast. At this part of the year rather high densities of Little Auks were recorded. This species was frequently sighted in the surveyed areas, and the highest densities were associated with currents or tidal flows (e.g. Moskenes current). There were no surveys from December to March, and we have no knowledge of seabirds distribution in the influence area in this periode. In March conciderable concentrations of auks were recorded offshore the breeding colonies.

Except for the auks, most of the seabird species in the area are concidered moderate vulnerable for oil pollution at sea. One exeption is the Gannet. Their chicks fledge from the colonies from late August. These birds are flightless and would be vulnerable to oil spills for approximately a week after leaving their nests. The major colones in Norway are situated on Runde.

It is assumed that variations in prey availability is responsible for the observed variations in seabird abundance and density. Thus, we have explored methods for correlating seabird density to prey density. A numerical correlation between number of Puffins and prey density was found.

Oceanographic fronts are sites of enhanced physical and biological activity, including locally concentrated feeding by marine birds. In a future study we intend to use satelite images (from ERS-1 and NOAA satelites) to locate frontal systems in the influence area, and to correlate seabird abundance to the occurance of fronts. If we are able to predict bird density and abundance on basis of prey abundance or the some oceanographic feature, this will be a powerful tool for impact analysis, oil spill combating and protection.

6 Sammendrag

Denne rapporten gir et sammendrag av åpent hav registreringer av sjøfugl innen risikoområdet for oljefeltene på Haltenbanken i 1991. Sjøfuglers ubredelse og antall beskrives, og marinbiologiske faktorer trekkes inn for å forklare numeriske variasjoner i lundefuglenes utbredelsesmønster. Det presiseres at datagrunnlaget for denne rapporten er begrenset og ikke gir grunnlag for konsekvensanalyser. Det legges frem forslag for videre undersøkelser.

Oljesøl er en trussel mot sjøfugler i åpent hav. Alkefuglene vurderes som svært sårbare i denne sammenheng. Gjennom store deler av året finner en de største konsentrasjoner av alkefugl innen risikoområdet utenfor hekkekoloniene ved Runde, Lovunden og Lofoten. Størrelsen på disse områdene antas hovedsaklig å være en funksjon av næringstilgang og avstand til koloni. De fleste alkefuglene forlater koloniene fra slutten av juli. Lundfuglene trekker antagelig ut i Atlanterhavet, og i oktober-november registrerte vi svært få lunder i risikoområdet. Svømmetrekket til lomvi og alke er lite kjent, men Haltenbanken kan være et viktig område for lomvi fra Runde i denne svært sårbare perioden. Den registrerte månedlige tetthet varierte lite for lomvi, mens den økte markert for alke i oktober-november. Særlig mange alker ble registrert i områder nord for Vega på Helgelandskysten. I denne perioden ble det sett ganske mange alkekonger. De største tetthetene ble registrerte i forbindelse med lokale strømsystemer (f.eks. Moskenesstrømmen). Ingen tokt ble gjennomført fra desember til mars og vi mangler helt kjennskap til antall og fordeling av sjøfugler i åpent hav i dette tidsrommet. I mars ble det igjen registrert betydelige mengder alkefugl i havområdene utenfor hekkekoloniene.

Bortsett fra alkefuglene, karakteriseres de fleste av sjøfuglene i området som moderat utsatte for oljesøl. Havsulen er et unntak. Når ungene forlater reiret fra slutten av august, er de ikke flyvedyktige og vil derfor være svært sårbare ved et eventuelt oljesøl. De betydeligste havsulekoloniene i Norge ligger på Runde.

Ofte forutsetter man at det er variasjoner i tilgang på byttedyr som forårsaker de observerte variasjoner i sjøfuglenes utbredelse og tetthet. Vi har derfor forsøkt å relatere sjøfugltetthet til byttedyrstetthet. Ut fra gitte kriterier var vi i stand til å påvise en statistisk sammenheng mellom antall lundefugler og mengden av byttedyr.

Oceanografiske frontsystem er områder med stor fysisk og biologisk aktivitet, og ofte med ansamlinger av beitende sjøfugl. Ved en eventuell fortsettelse av prosjektet vil vi forsøke å bruke satelittbilder (fra ERS-1 og NOAA satelitter) til å lokalisere frontsystemer. Vi vil deretter lete etter sammenhenger mellom sjøfuglers utbredelse og frontsystemer.

Dersom vi blir i stand til å forutsi utbredelse og tetthet av sjøfugl ut fra byttedyrstetthet eller oceanografiske forhold, vil dette bli viktige redskap ved forebyggende-, skadebegrensende- eller beredskapsmessige tiltak i tilknytning til oljeforurensing.

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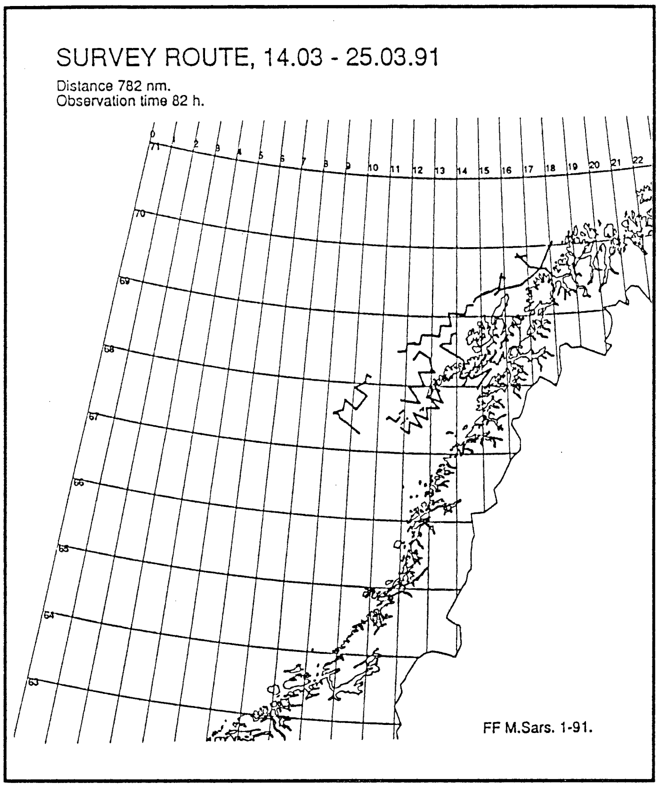
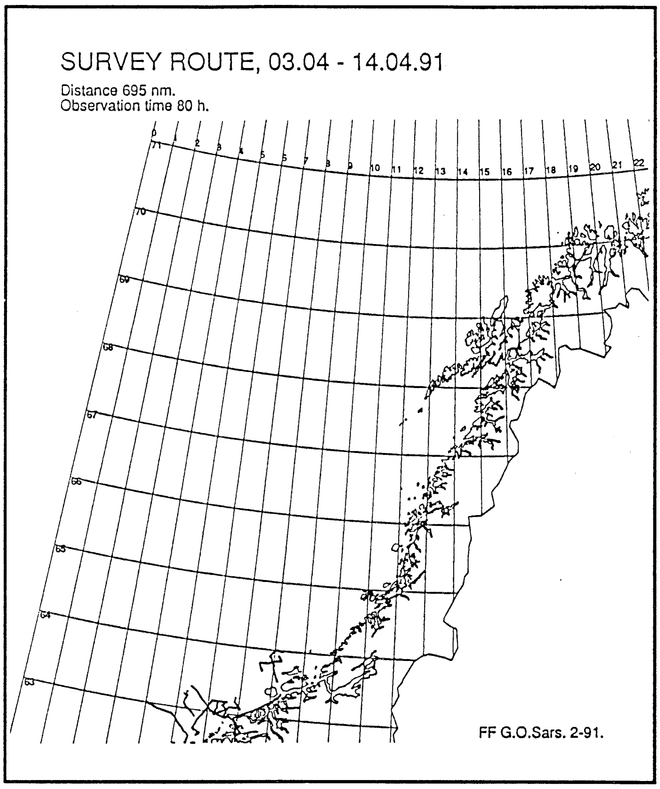
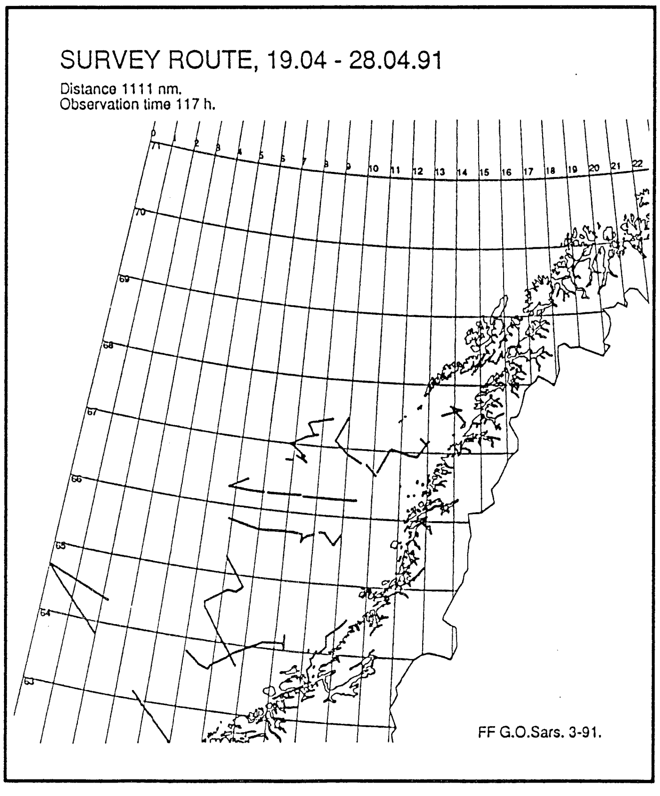
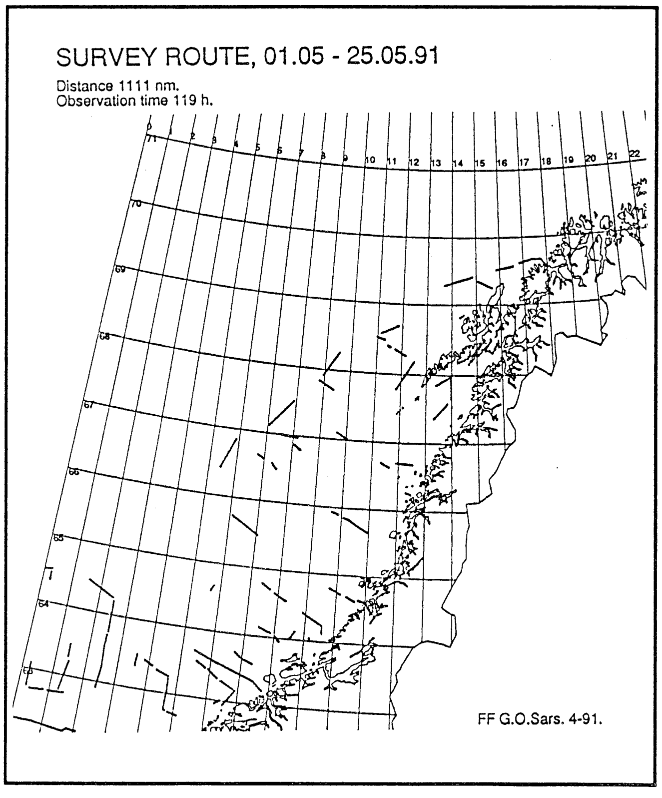
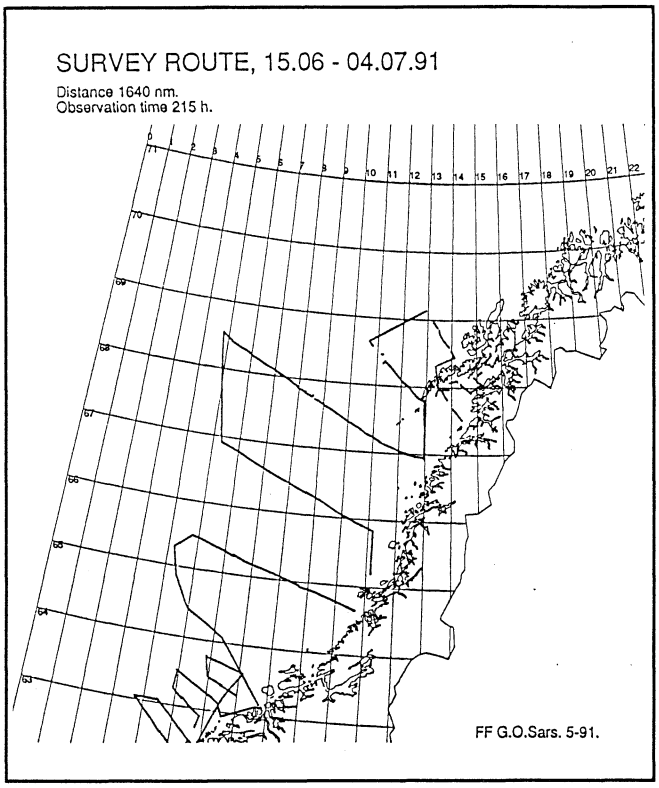
Appendix 1 Survey routes 1991.







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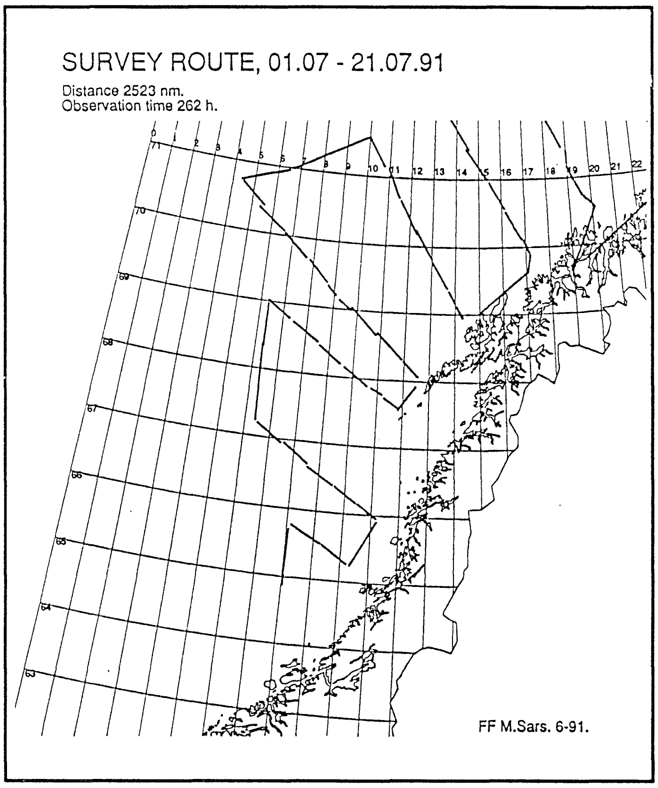
FF G.O.Sars. 5-91.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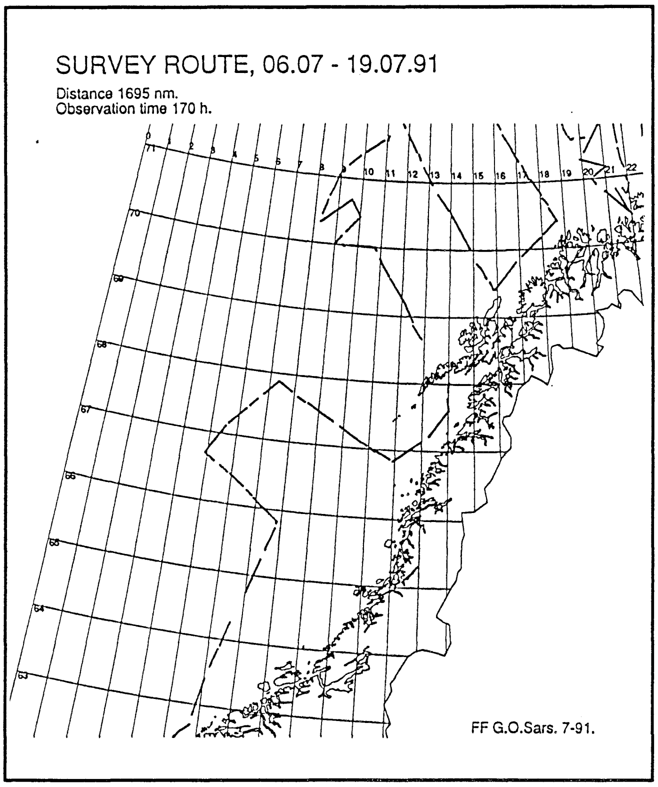
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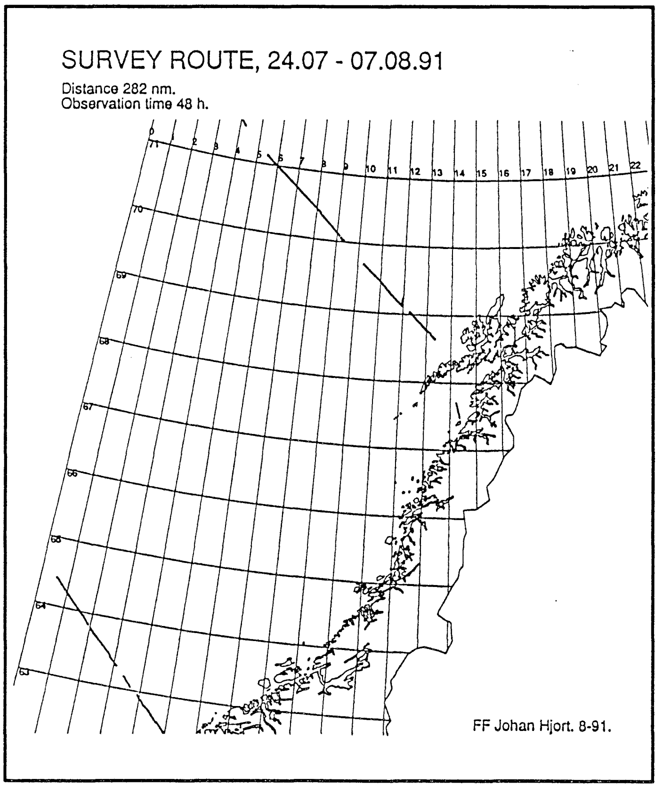
Distance 1695 nm.
Observation time 170 h.
FF G.O.Sars. 7-91.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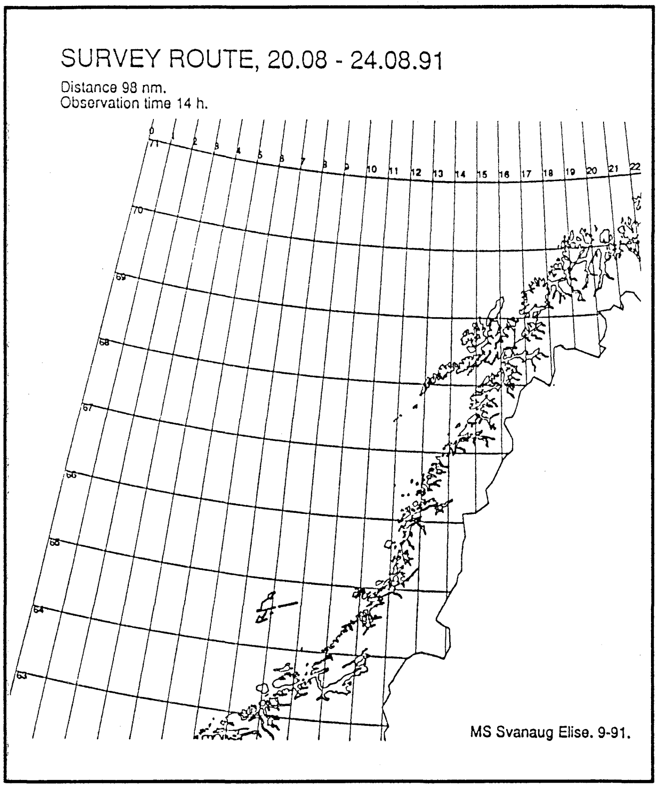
FF Johan Hjort. 8-91.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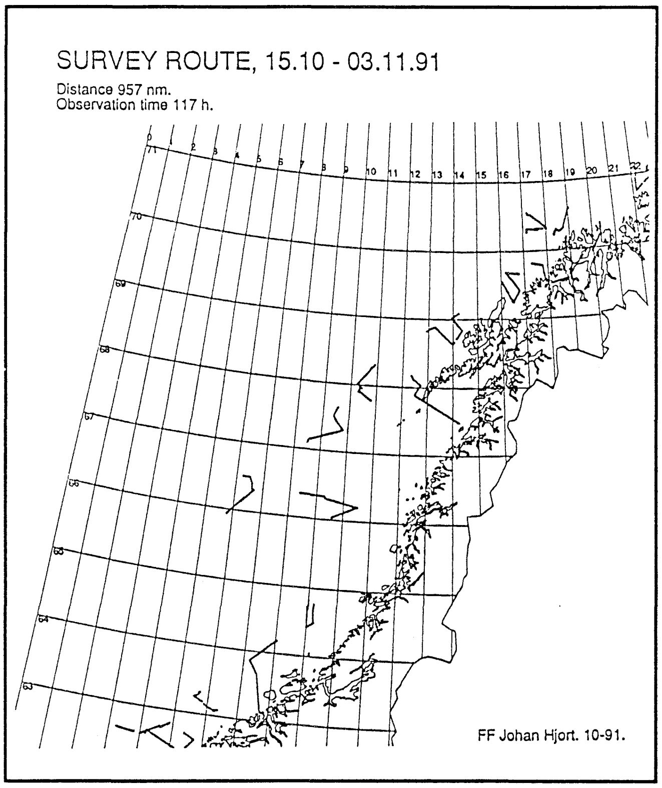
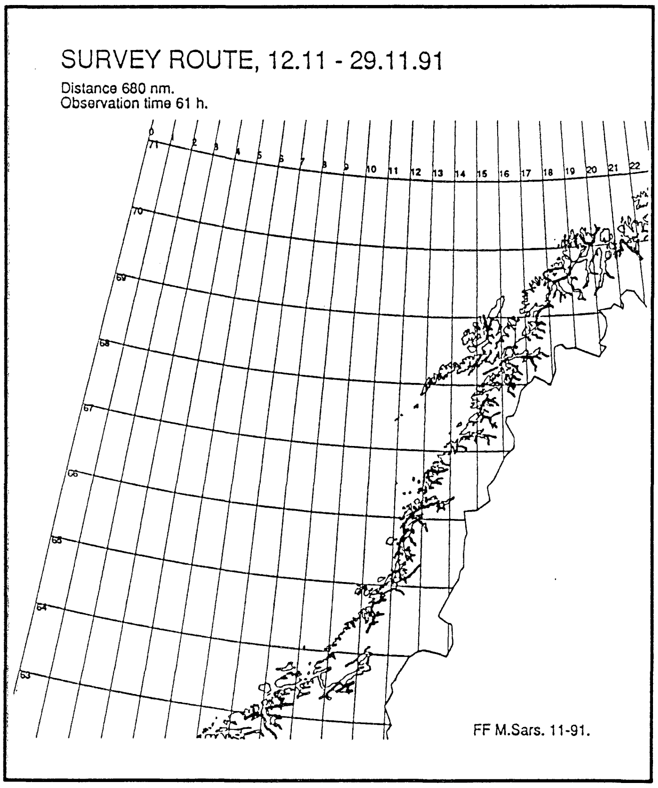
MS Svanaug Elise. 9-91.


SURVEY ROUTE, 15.10 - 03.11.91
Distance 957 nm.
Observation time 117 h.
FF Johan Hjort. 10-91.


SURVEY ROUTE, 12.11 - 29.11.91
Distance 680 nm.
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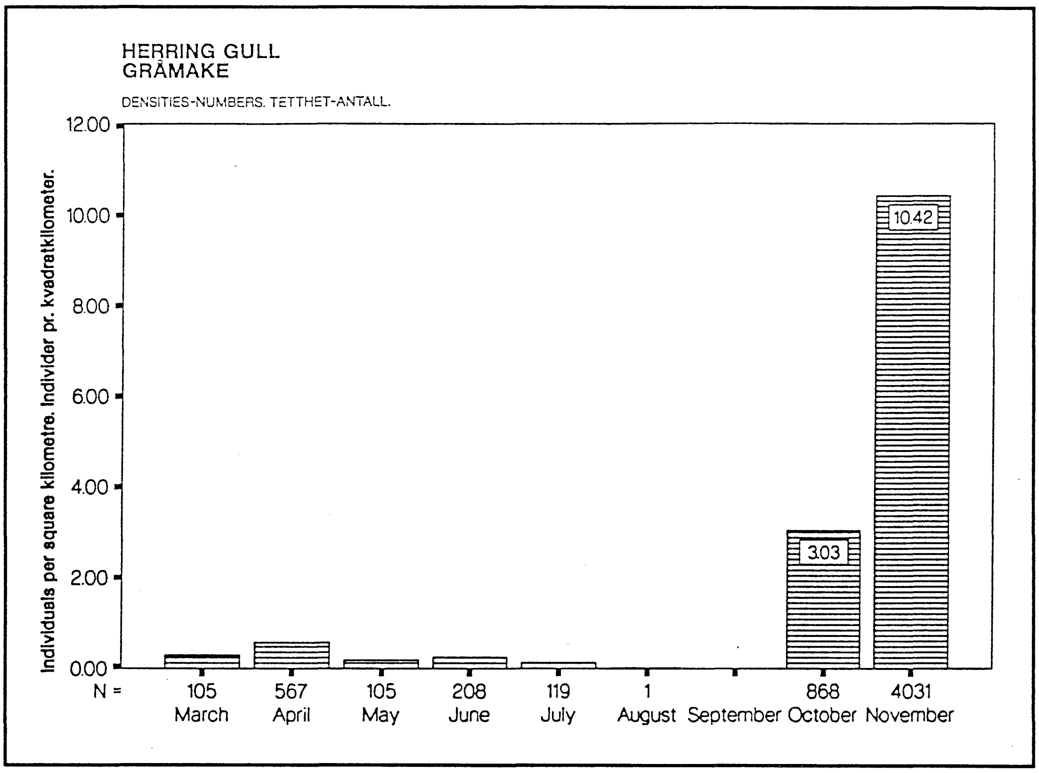
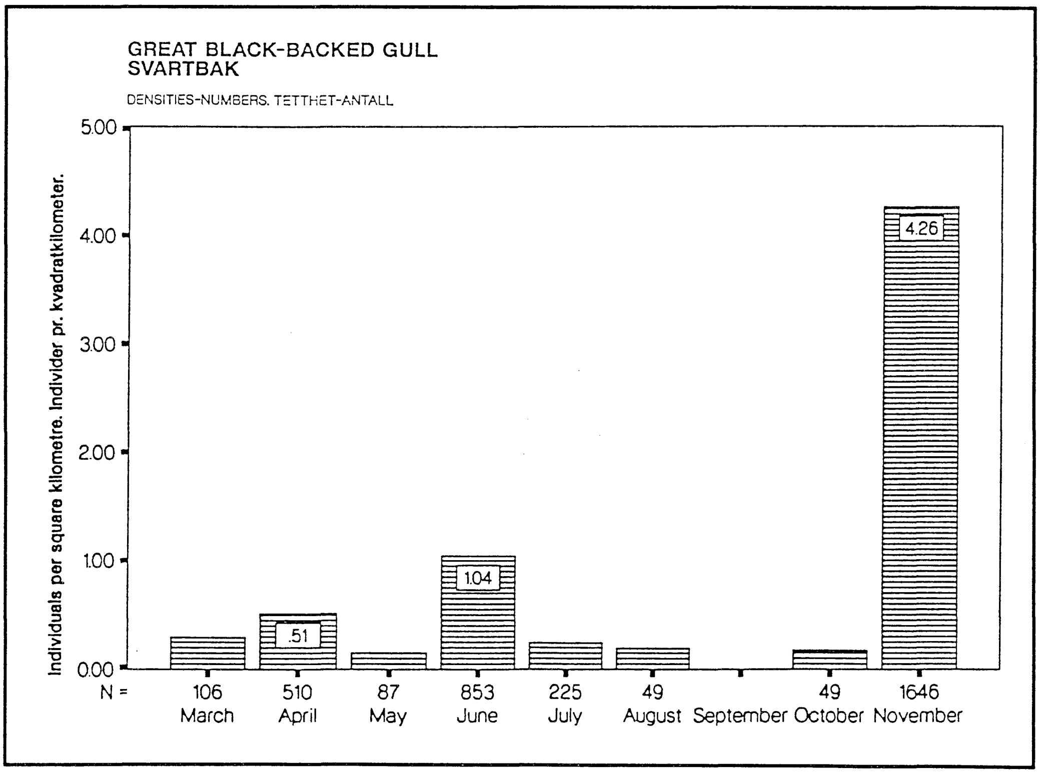
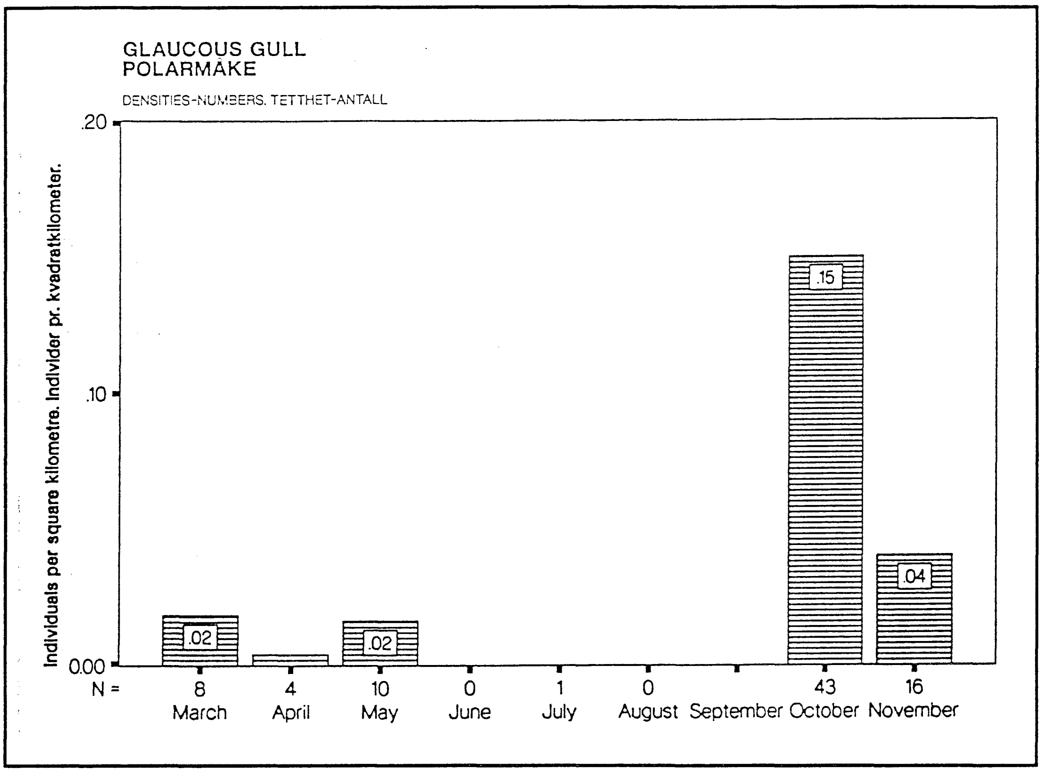
Appendix 2 Species account.

Appendix 2.1 Herring Gull. Monthly densities and numbers.

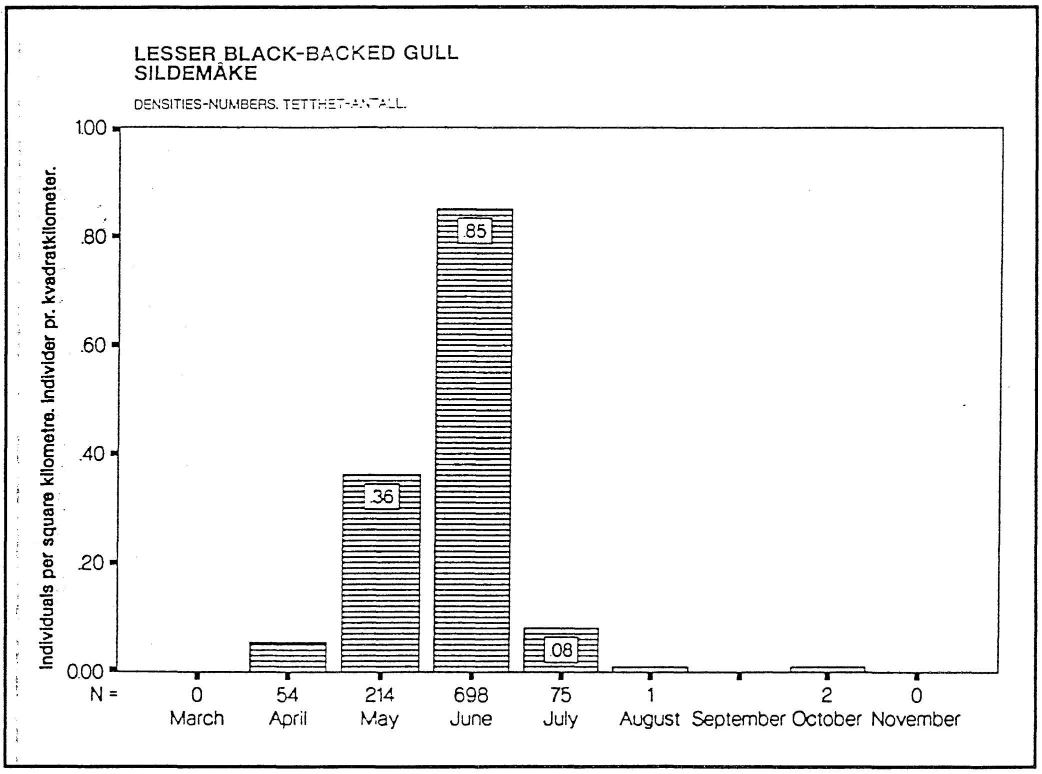


Appendix 2.2 Great Black-Backed Gull. Monthly densities and numbers.



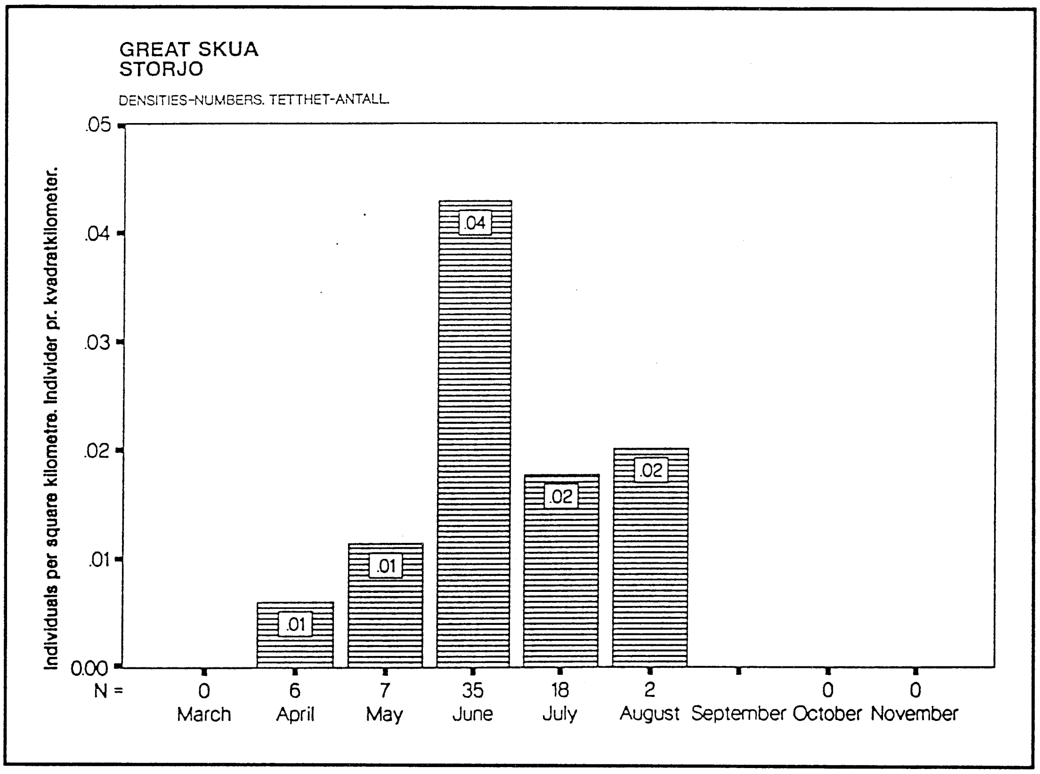


Appendix 2.3 Glaucous Gull. Monthly densities and numbers.

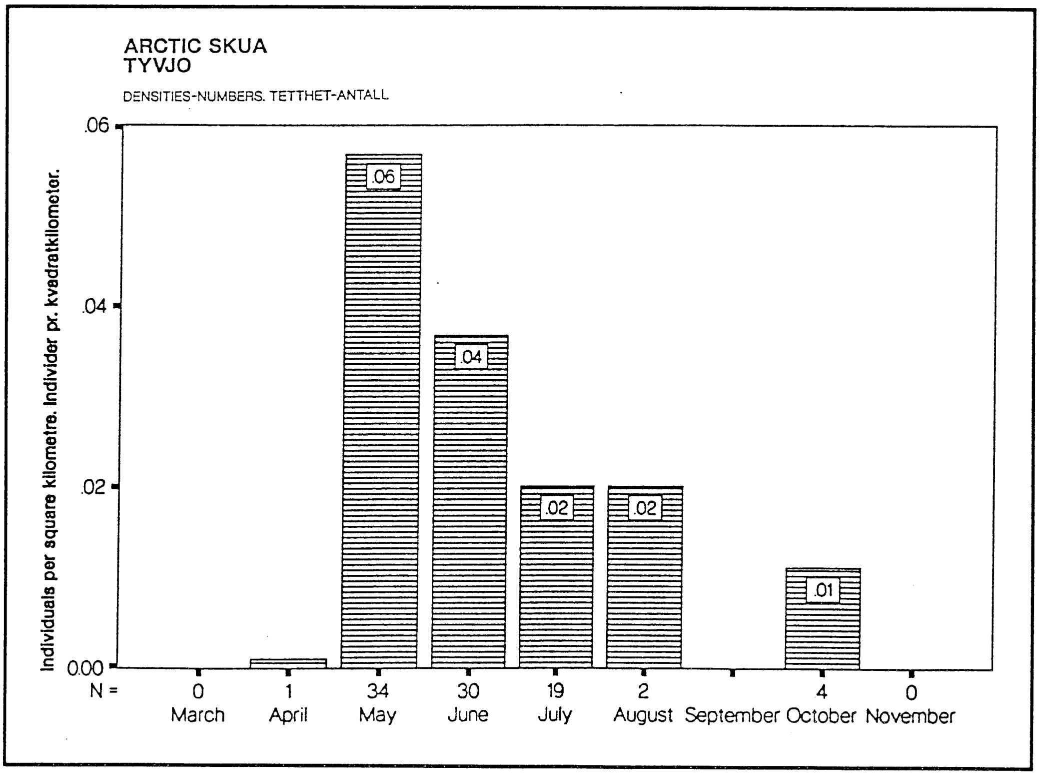


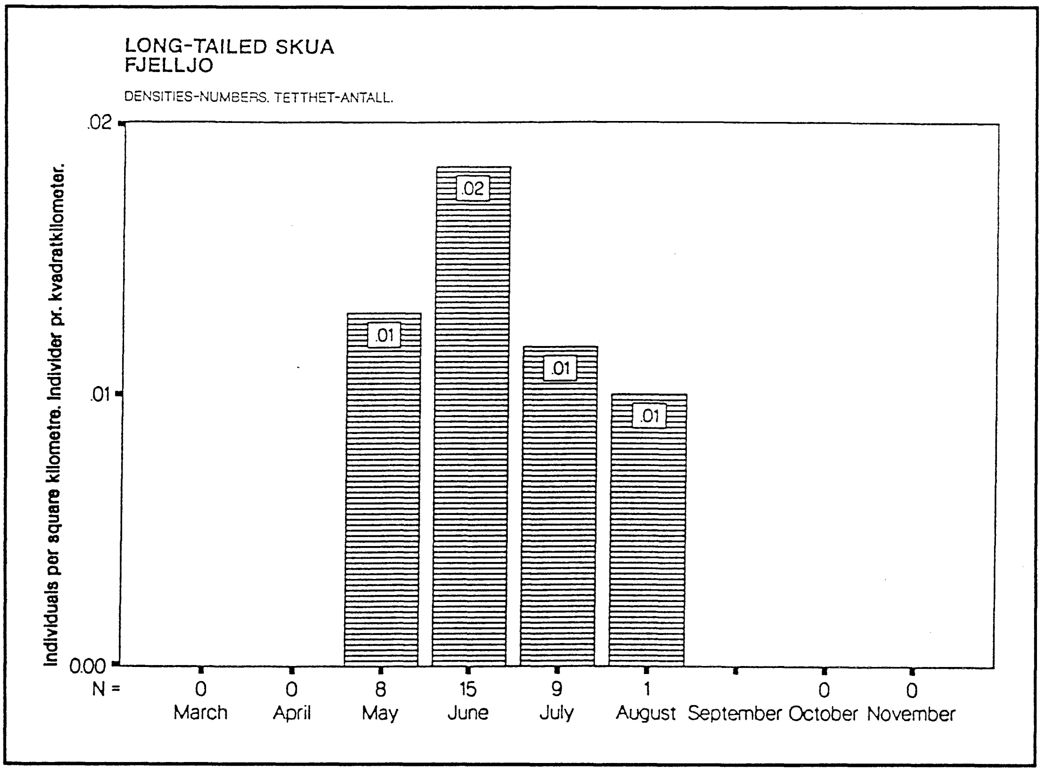
Appendix 2.4 Lesser Black-backed Gull. Monthly densities and numbers.

Appendix 2.5 Great Skua. Monthly densities and numbers.

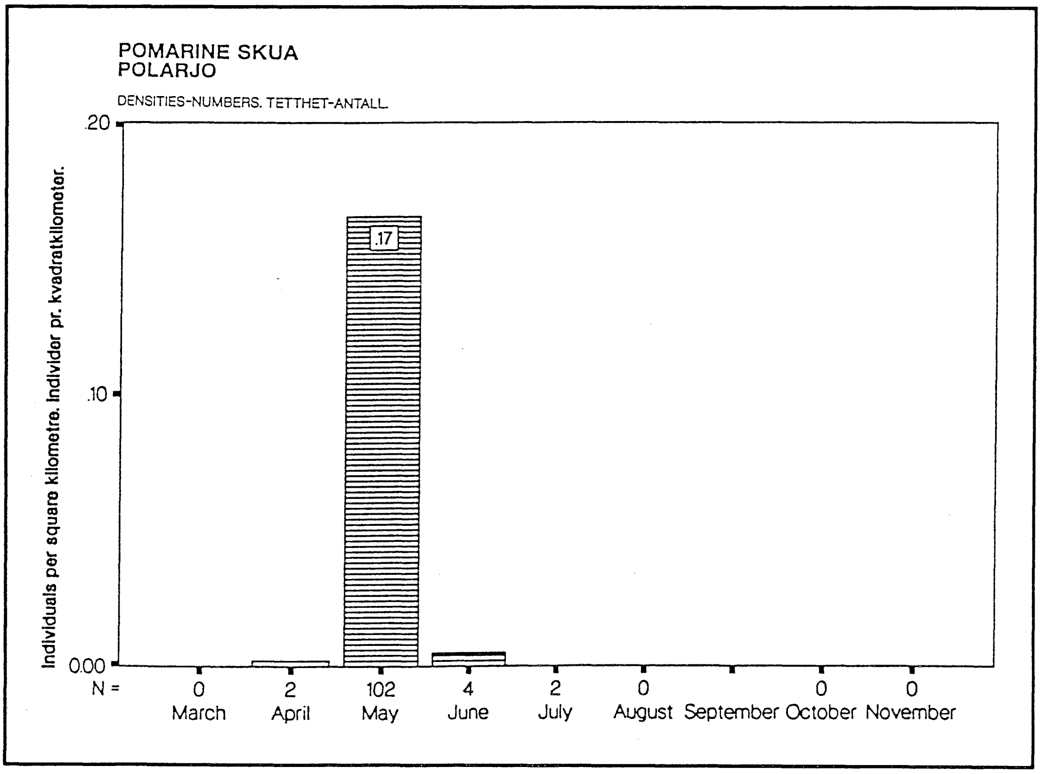


Appendix 2.6 Arctic Skua. Monthly densities and numbers.

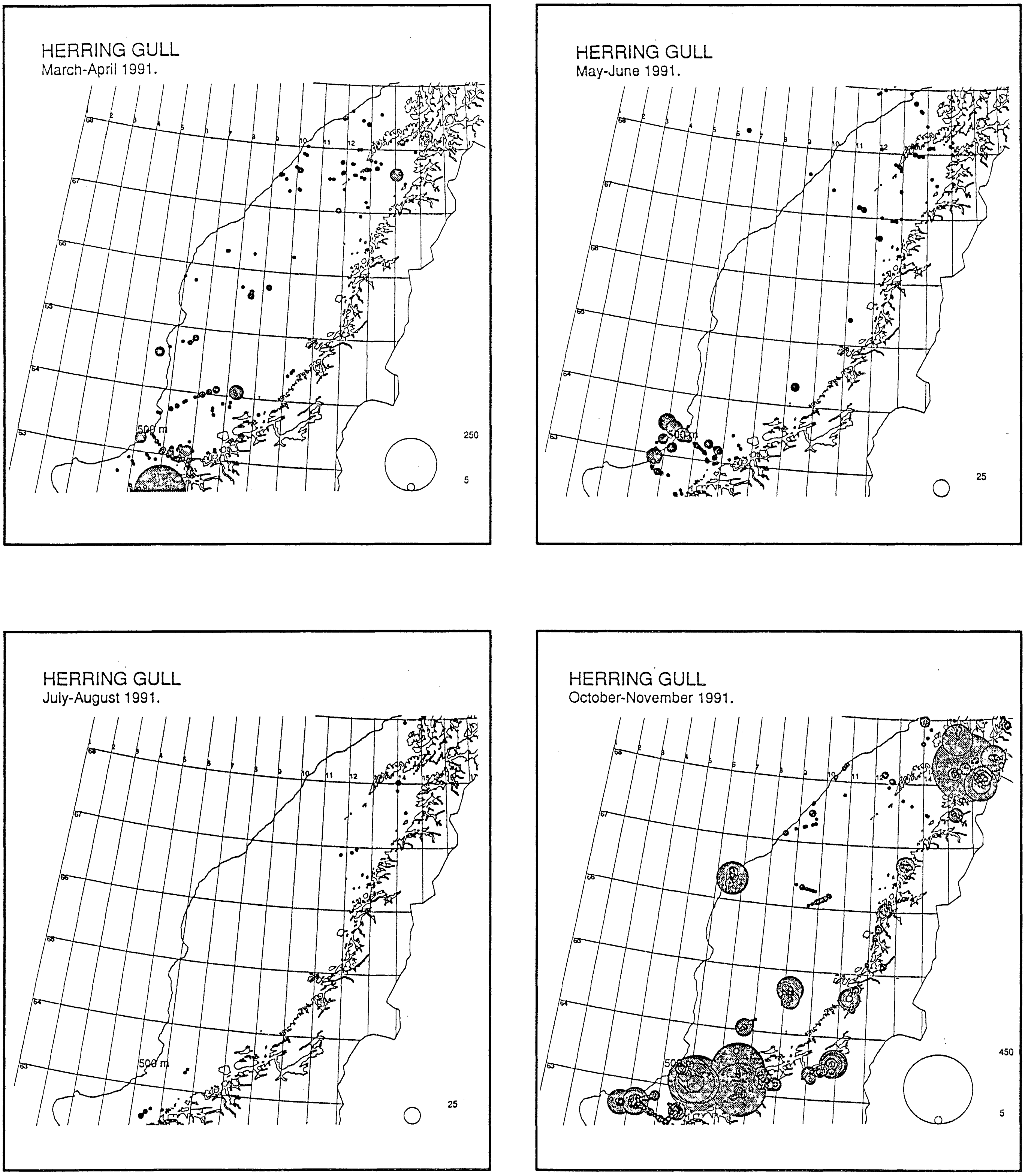




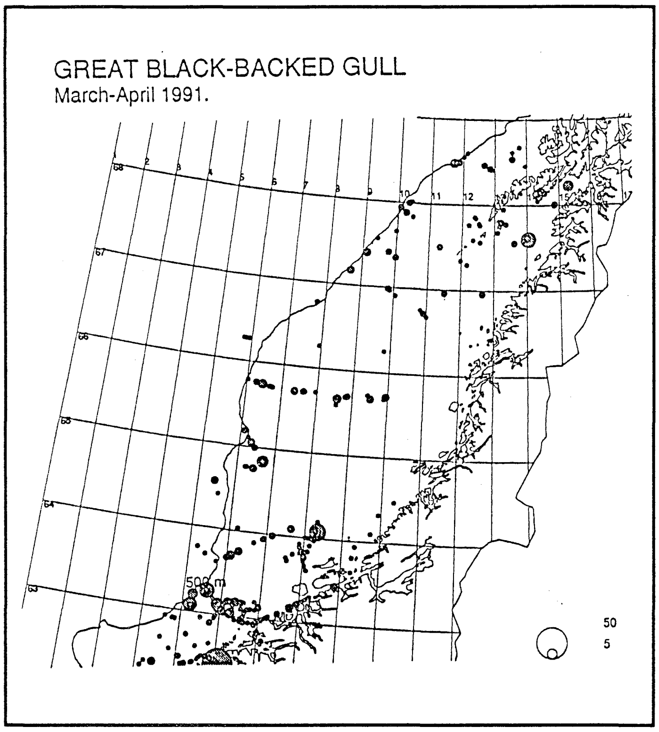
Appendix 2.7 Long-tailed Skua. Monthly densities and numbers.

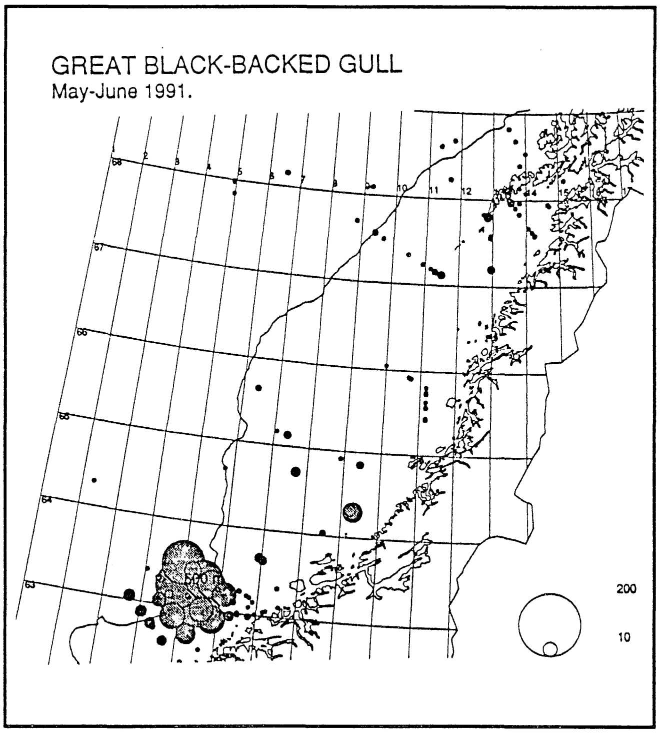


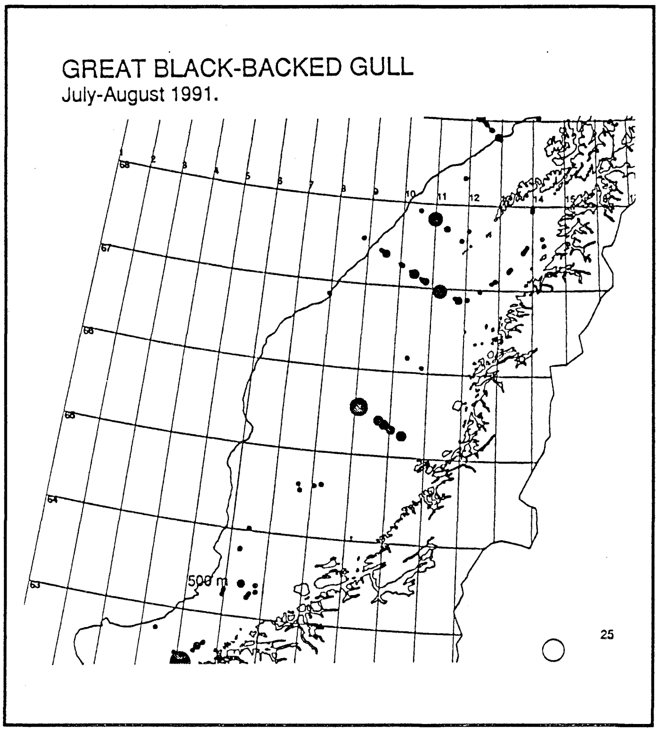
Appendix 2.8 Pomarine Skua. Monthly densities and numbers.

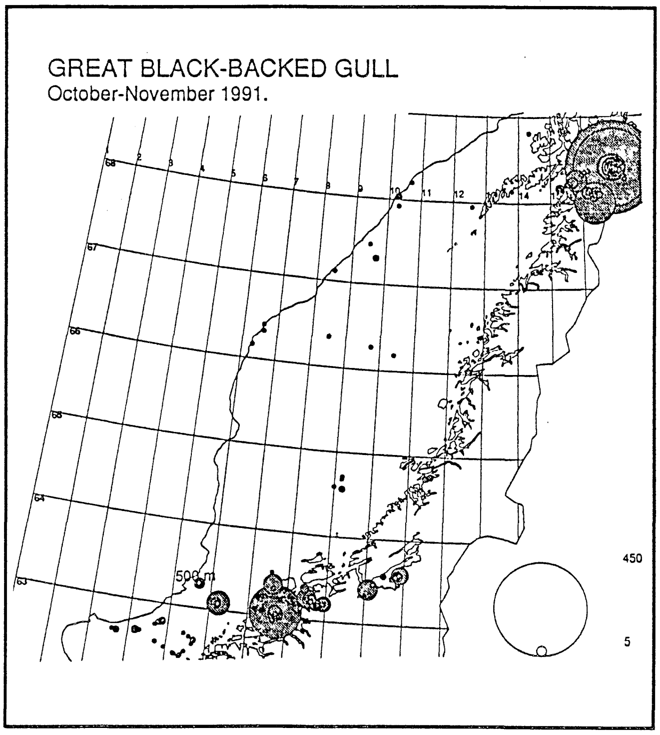


Appendix 2.9 Herring Gull. Monthly distribution. Circle diameter represents number of individuals.

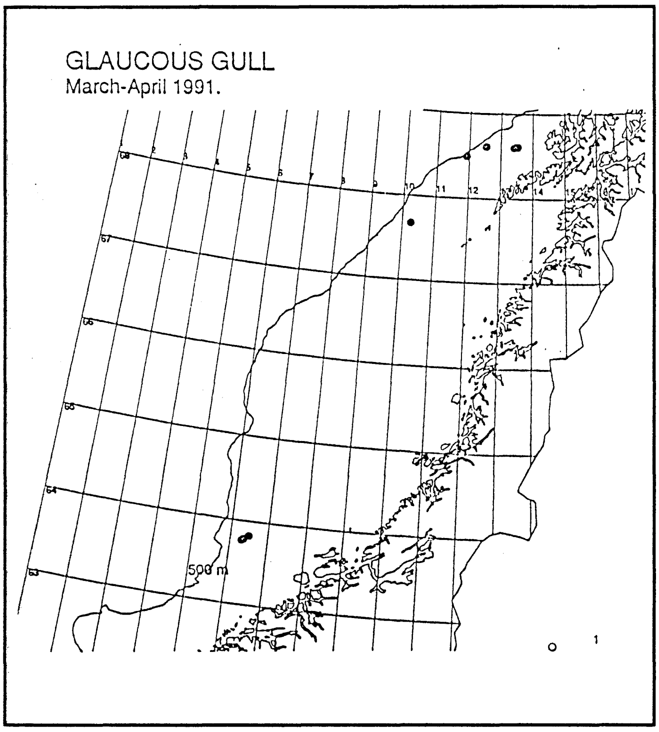


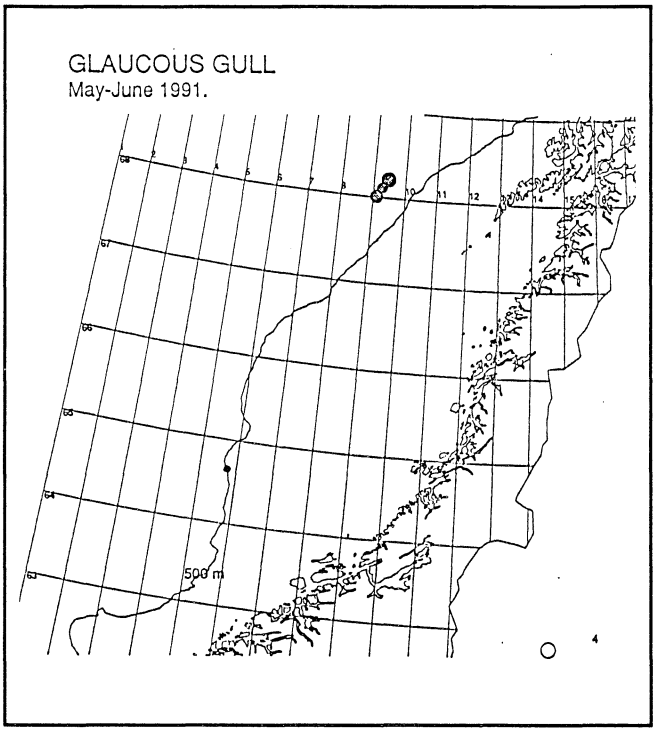




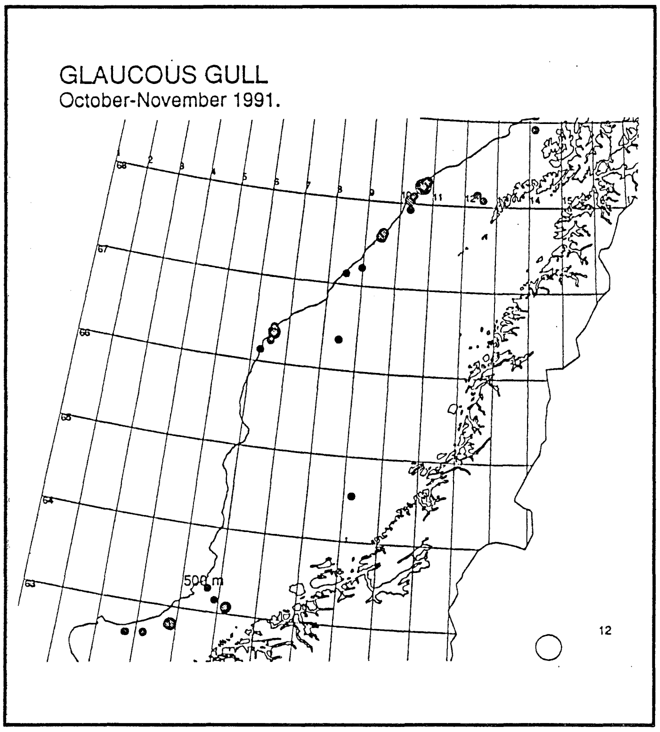


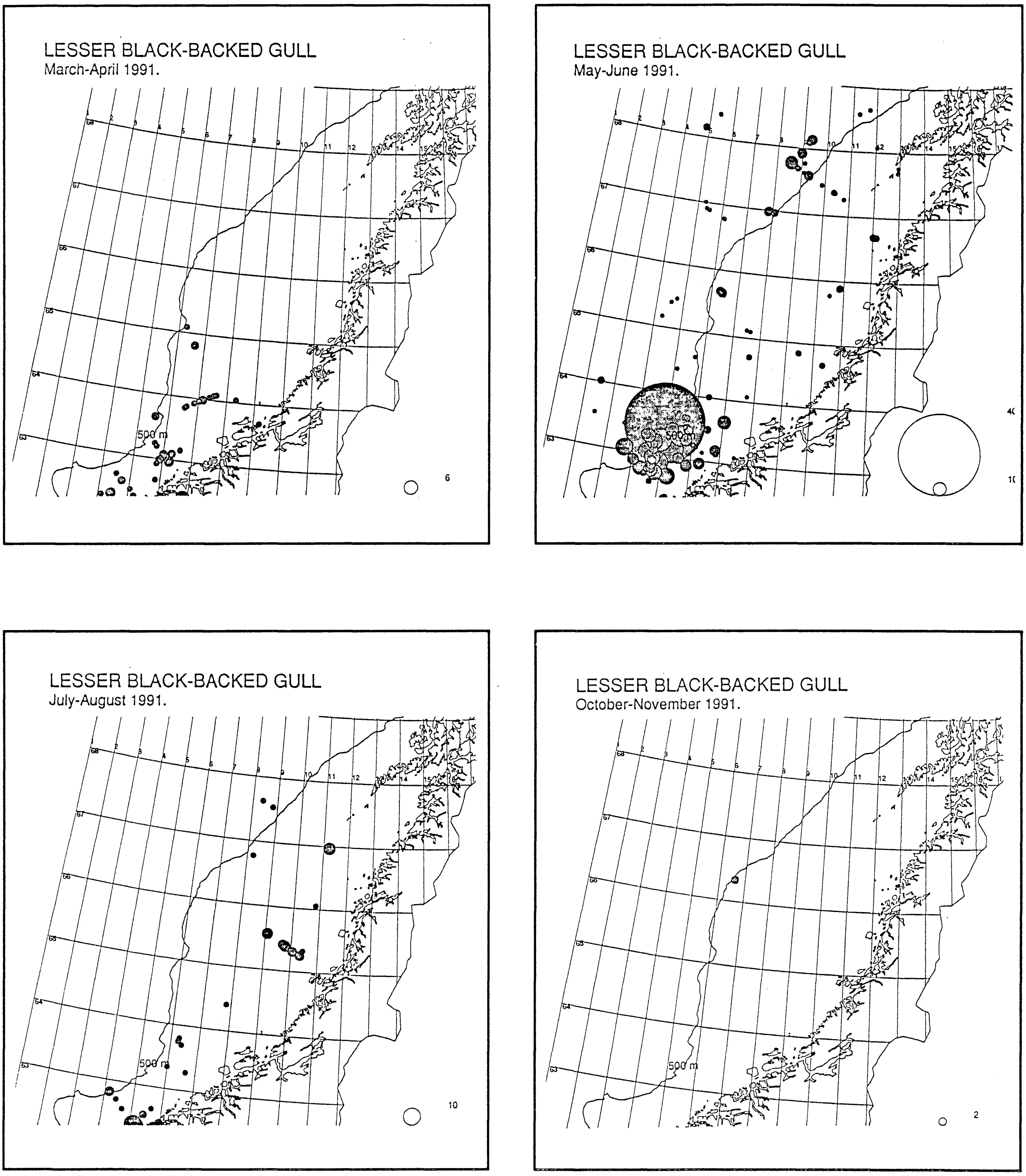
Appendix 2.10 Great Black-backed Gull. Monthly distribution. Circle diameter represents number of individuals.



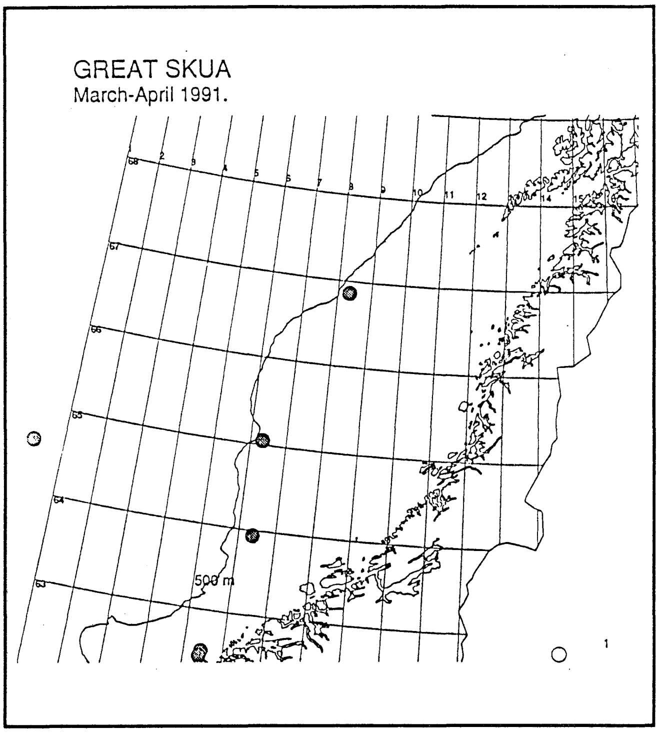


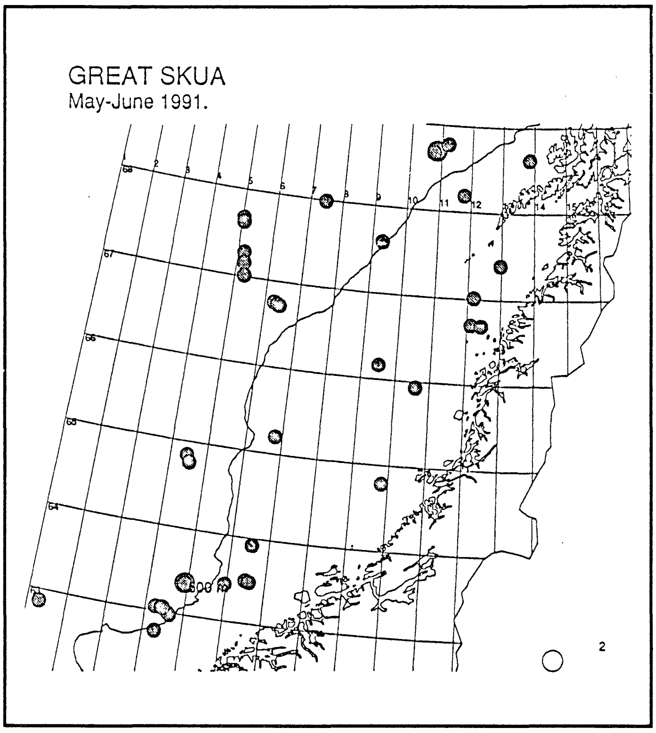
Appendix 2.11 Glaucous Gull. Monthly distribution. Circle diameter represents number of individuals.



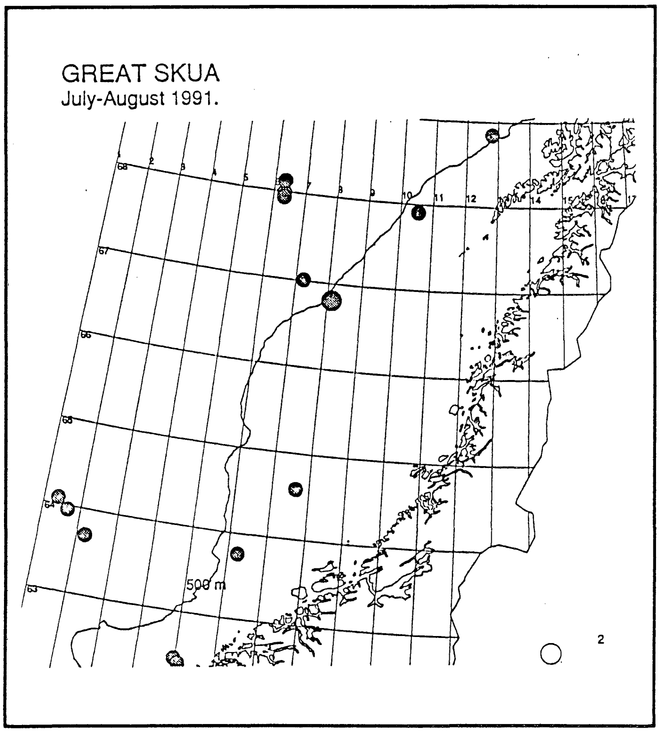


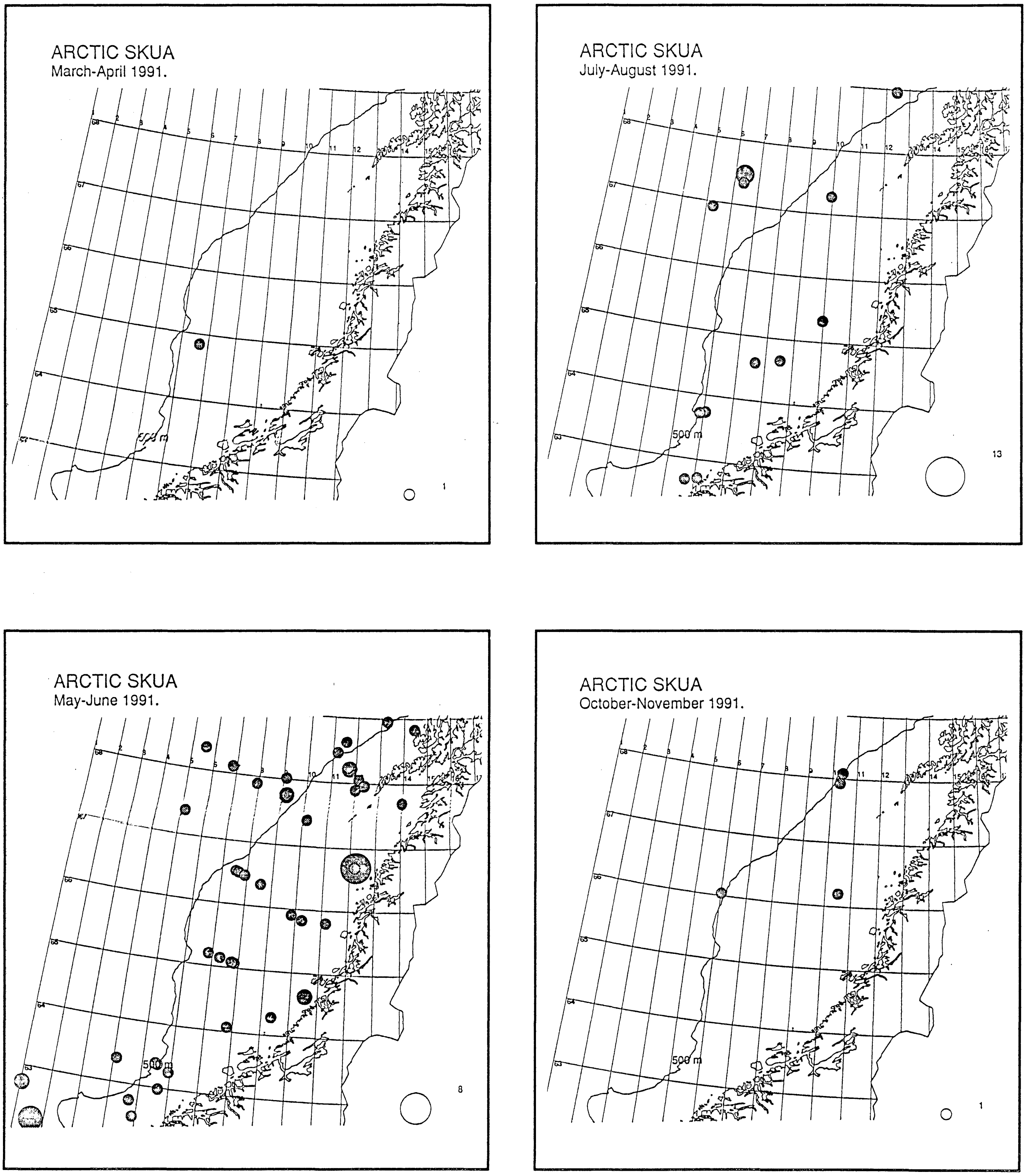
Appendix 2.12 Lesser Black-backed Gull. Monthly distribution. Circle diameter represents number of individuals.



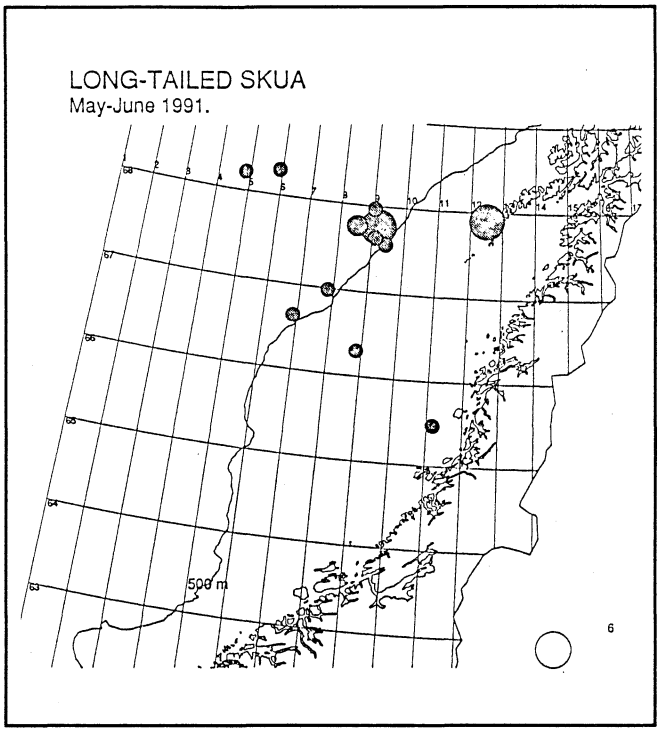


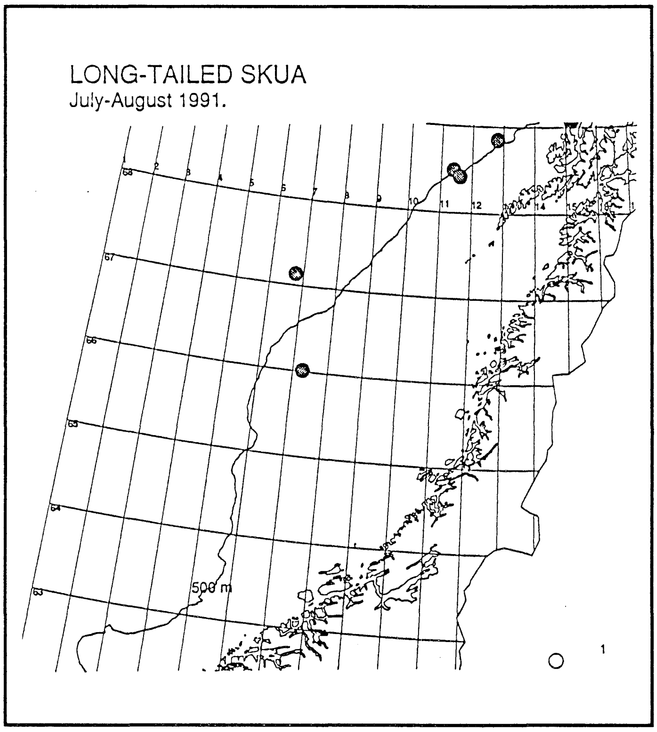
Appendix 2.13 Great Skua. Monthly distribution. Circle diameter represents number of individuals.



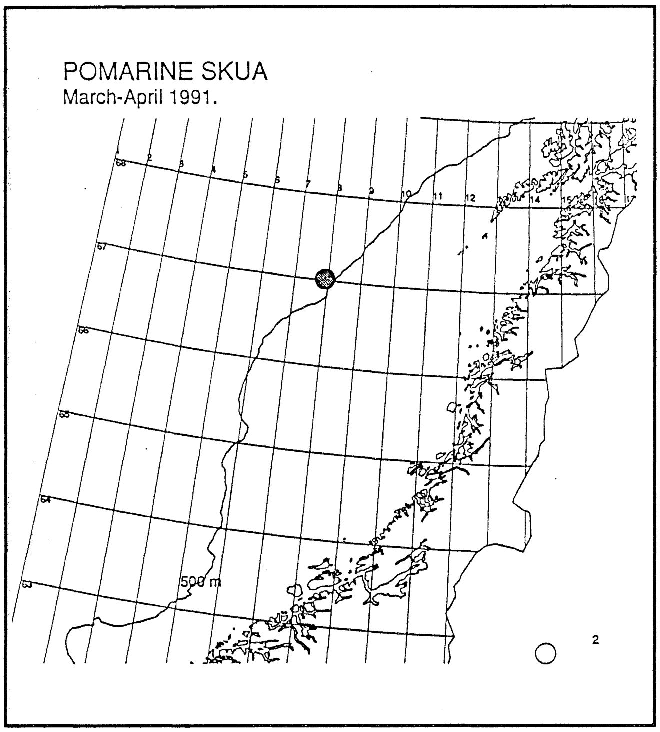


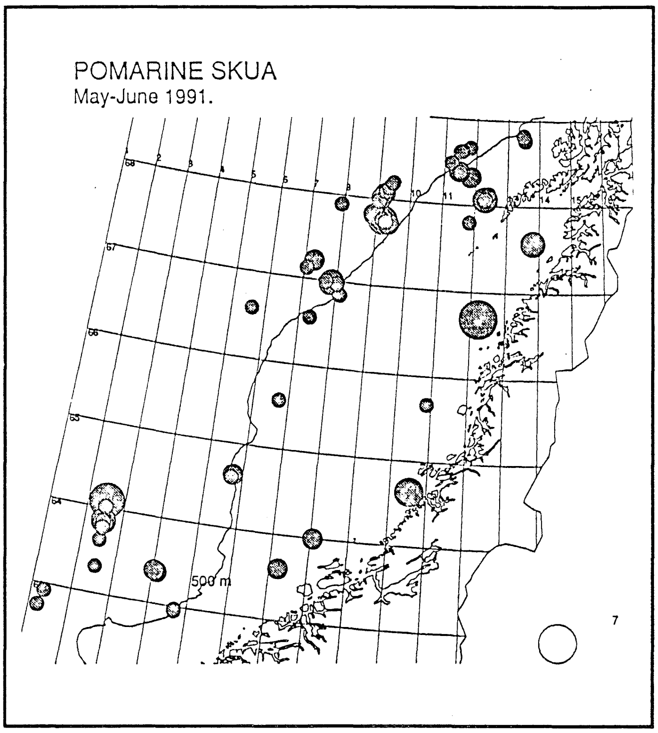
Appendix 2.14 Arctic Skua. Monthly distribution. Circle diameter represents number of individuals.



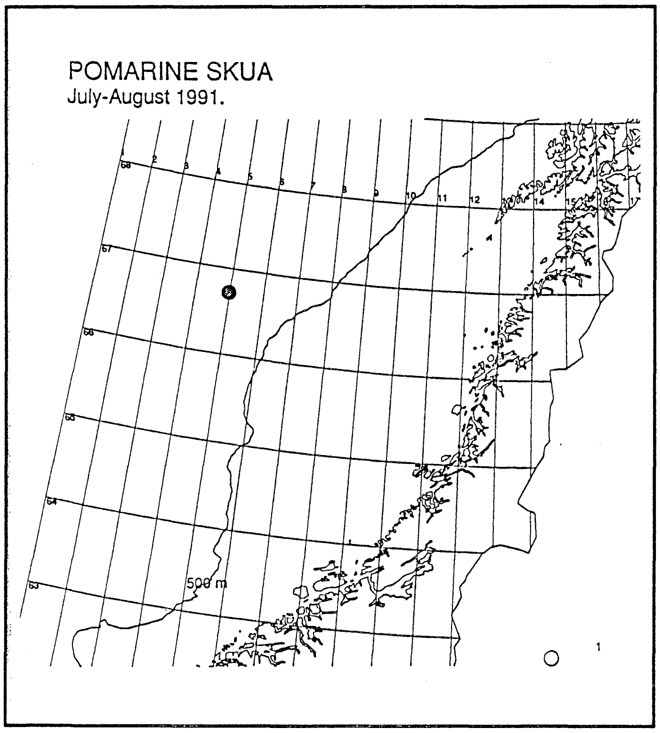


Appendix 2.15 Long-tailed Skua. Monthly distribution. Circle diameter represents number of individuals.





Appendix 2.16 Pomarine Skua. Monthly distribution. Circle diameter represents number of individuals.



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nina oppdrags-melding

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Norsk institutt for naturforskning
Tungasletta 2
7005 Trondheim
Tel. (07) 58 05 00