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Seabird resources in the influence area of the Midgard field at Haltenbanken

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Abstract

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In this report data on seabirds in the influence area of the Midgard field is compiled. The assessment covers both onshore and off-shore seabird distribution and a summary of the impact of oil and oil activities on seabirds.

The impact region of the coast contains several of the most important seabird localities in Norway. For several species the area holds a significant portion of the total European population.

The region contains the main breeding locations for Eiders, Cormorants (the Froan and Helgeland archipelago), and auks (e.g. the bird cliffs on Røst, Værøy, Lovunden and Runde).

The populations of moulting Eiders at Froan and Velvet Scoters at Ørland are very large. Moulting populations of several waterfowl species at Froan and Vega would be very vulnerable in the event of an oil spill from the Midgard field.

Some of the most important wintering locations are found in the region. More than 50 % of the total Norwegian population of Divers, Eiders, Velvet Scoter, Long-tailed Duck and Red-breasted Merganser are wintering here. For Grebes and Black Guillemots the wintering populations constitute nearly 80 % of the national population. Principal wintering areas are Smøla, Frøya, Ørland, the Helgeland coast including Vega and the Røst area.

Knowledge on off-shore distribution of seabirds is fragmentary. The most important feeding areas in the breeding season are within 100 km from the main bird cliffs. Evidence shows that many seabirds in spring aggregate in fronts and upwelling areas where there is high production, e.g., in the frontal system between Atlantic water and the Coastal Current. Auks perform regular post-breeding swimming migrations which may result in aggregations of birds off-shore.

Hence, the Midgard impact area holds large populations of both national and international importance. At any time of the year, an oil spill may threaten large numbers of vulnerable species both off-shore and inshore.

Key words: Seabirds - distribution - oil spills - environmental impact assessment - Midgard field.

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Referat

Follestad, A. Sjøfuglressursene innen influensområdet for oljesøl fra Midgard-feltet på Haltenbanken. - NINA Oppdragsmelding 90: 1-66.

Denne utredningen gir en oversikt over sjøfuglbestandene innen influensområdet for oljesøl fra Midgard-feltet på Haltenbanken, som omfatter både kystnære og åpent hav bestander, og en oppsummering av mulige effekter av oljesøl og oljerelaterte aktiviteter.

Influensområdet for oljesøl fra Midgard-feltet har flere av de viktigste sjøfuglområdene i Norge. For flere arter finnes her en betydelig andel av den europeiske bestanden.

Området har de viktigste hekkelokalitetene for ærfugl, storskarv (Froan og Helgeland) og alkefugl (f.eks. fuglefjellene på Røst, Værøy, Lovunden og Runde).

Fjærfellingsbestandene av ærfugl i Froan og av sjøorre i Ørland er meget store. Mytebestandene for flere arter vil være meget sårbare for oljesøl dersom et oljesøl skulle ramme Frøya eller Vega.

Noen av våre viktigste overvintringsområder finnes innen influensområdet. Mer enn 50 % av hele den norske bestanden finnes her for lommer, ærfugl, sjøorre, havelle og siland. For dykkere og teist utgjør overvintringsbestanden innen området nær 80 % av den nasjonale bestanden. Viktige overvintringsområder er Smøla, Frøya, Ørland, Helgelandskysten med Vega og Røst.

Vår kunnskap om fordeling og antall av sjøfugl i åpent hav i det aktuelle området er mangelfull. De viktigste områdene for næringssøk i hekketiden ligger innenfor en avstand av 100 km fra de store fuglefjellene. Noen data viser at sjøfugler ofte samles i frontsystemer og områder med upwelling der det er høy produksjon, f.eks. i frontsystemet mellom atlanterhavsvann og kyststrømmen. Noen alkefugler har et svømmetrekk etter at ungene hopper på sjøen, og dette kan også gi samlinger av fugl i åpent hav.

Influensområdet til Midgard har således sjøfuglbestander av både nasjonal og internasjonal betydning. Uansett årstid vil et større oljeutslipp fra Midgard kunne skade et stort antall av flere svært sårbare arter både til havs og i kystnære områder.

Emneord: Sjøfugl - fordeling - oljesøl - konsekvensvurdering - Midgard-feltet.

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Preface

The present document summarizes data on seabirds and gives an assessment of the potential impact on seabirds of the development of the Midgard oil and gas field at Haltenbanken, Block 6507/11, 6407/3 and 6407/3.

The report has been prepared by Norwegian Institute for Nature Research (NINA) as a data base report for the seabird section in **"Midgard miljøutredning"** prepared by Cooperating Marine Scientists (CMS) on behalf of Saga Petroleum a.s. This report is based on a similar data base report for **"Heidrun Field: Environmental Impact Assessment"**, prepared by Norwegian Institute for Water Research (NIVA) on behalf of CONOCO Norway Inc (Follestad 1989).

Data on the distribution and abundance of breeding, moulting, wintering and open sea populations are comprised of existing information stored in the seabird data bank at NINA. This report is an updated version of the report to Conoco.

Trondheim 9 Jan. 1992

Arne Follestad

Contents

1 Introduction

1.1 Species and geographical area covered

The category seabird includes species which depend on the sea for the bulk of their nutrient resources (see Folkestad 1979). These species fall naturally into two major groups according to their chosen lifestyle; typical or seasonal seabirds. Typical seabirds include the following species: Fulmar, Gannet, Cormorant, Shag, the auks, most seagulls and some marine ducks. Seasonal seabirds include divers, grebs, several duck species and some gulls.

Greatest emphasis is placed here on species which are vulnerable to oil contamination according to a number of criteria, such as individual vulnerability to oil contamination, population size of vulnerable species, congregations of birds during critical periods, and localities particularly exposed to oil contamination from oil fields, e.g. outlying coastal archipelagos and skerries.

It it stressed that certain species and localities are discussed here on the basis of criteria associated with an oil spill situation. Large numbers and concentrations of other seabird species also merit evaluation in association with other problems.

The geographical area comprises the coastline between Hitra (63°30'N) and Bodø (67°20'N), but some data from Runde in Møre & Romsdal county and Røst/-Værøy in Nordland county, is included.

1.2 Seabird ecology

The most typical seabirds are restricted to marine areas on a year-round basis and is the largest and most important group of seabirds in Norway. Seasonal seabirds usually breed near freshwater, but relay on the sea during the remainder of the year.

A characteristic of typical seabirds is their low rate of reproductive capacity. They become sexually mature at an age of 3 to 7 years (even up to 10 years for the Fulmar), and in some species (e.g. most auks) the female produces only one egg per year. This low reproductive rate coincides with a low natural mortality of the adults, which are in general longlived. In such a situation, even a slight increase in mortality of adult birds, e.g. by oil pollution, may result in severe consequences for the population, due to their low rate of reproductive capacity and long recovery period.

1.3 Annual life cycle of seabirds

Abundance and distribution of seabirds vary seasonly. Some species, which breed in large concentrations, later spread out over larger geographical areas. On the other hand, some species with a scattered breeding pattern, congregate in large flocks during migration, while moulting, and/or throughout the winter. Environmental impact analyses as well as contingency planning connected with oil spill combating and protection must take this into consideration.

The following table provides a rough outline of the most important periods in the annual life-cycle of seabirds:

	J	F	M	A	M	J	J	A	S	O	N	D
Breeding				...	...	...	...	...	...			
Post breeding movements by auks						...	...	...	...			
Moulting ducks					...	...	...	...	...			
Migration/-resting areas		...	...	...	...		...	...	...	...	...	
Wintering	...	...	...								...	...
Open sea	...	...	...	...	...				...	...	...	...

1.4 Seasonal variation in seabird distribution

Typical seabirds, as most of the cliff nesting birds, may occur in large concentrations of hundreds of thousands or even millions of individuals within a restricted area. In contrast other species are more scattered along the coast, while other breeds inland far away from the sea in individual pairs or small colonies.

The distribution pattern of seabirds during the breeding season when they are largely confined to land, is often very different from that which they exhibit during the rest of the year.

Typical cliff nesting birds, which may occur in large concentrations at a restricted area in the breeding season, may occur more or less spread out over large areas at other times of the year.

For other species, a contrasting situation is common, where birds breeding in individual pairs or small colonies may congregate in dense concentrations outside the breeding season.

2 Material and methods

2.1 Data base

A review of the work on mapping of seabirds in Norway is given by Follestad & Nygård (1984), Follestad (1986) and Anker-Nilssen (1987).

Information about seabird distribution is compiled on the basis of data stored by the Norwegian Institute for Nature Research (NINA). The data has been obtained from several sources, including projects carried out for the Royal Norwegian Ministry of Environment, the Royal Norwegian Ministry of Petroleum and Energy, the Directorate for Nature Management, several oil companies (some through Operatørkomite Nord, OKN), the Environmental Conservation Division of Fylkesmannen in Møre & Romsdal as well as data from the Norwegian Ornithological Society and private individuals.

Little is known about spring migrations, but occasional observations indicate that large concentrations of divers, grebes and ducks are found in certain coastal areas from the end of March until the beginning of May. However, these occurrences are not indicated on maps because the available information is deficient and may easily present a completely distorted picture of the actual situation.

Information about seabird roosting places is lacking. We do know that some species congregate in large and dense flocks at night, but these flocks have not been mapped. This type of mapping is time consuming and expensive, but should be conducted for the most important seabird wintering localities.

Some of the material presented here has only been briefly analysed, and results should therefore be regarded as preliminary.

2.2 Methods for counting seabirds

Breeding. Most counts are carried out according to standard methods for mapping breeding seabirds (Nordic Minister Council 1983). The majority of the field work is conducted in June and July, and yields material of varying quality, which is often determined by when in the breeding cycle each individual species is most effectively appraised. Data on Greylag Geese and Red-breasted Mergansers is generally poor because these species should usually be counted in early May. Estimates on the numbers of individuals at the large bird colonies at Runde, Lovunden and Røst are also poor.

Moulting. Most counts were made from the shore, but boats were used to transport several field workers to suitable observation posts on land. Areas in the vicinity of these posts were scanned with telescopes and binoculars. Some counts were also made from boats. Some sections of the area were surveyed from a helicopter, and our experience with this technique was very positive (Follestad et al. 1986).

Moulting ducks are very shy, and often quickly vanish when observed from a boat. Therefore field work was restricted to periods of good weather and tranquil seas, when large flocks could be relatively accurately counted from the shore.

Winter. Counts were largely carried out using standard methods for mapping seabirds during winter (Statens Naturvårdsverk 1978, Nordic Minister Council 1983). The sea is thoroughly scanned with a telescope or binoculars from chosen observation posts. Helicopters were used in some areas in 1986, to transport field workers to counting localities and to cover areas which were impossible to observe from land. Our experience with this method was very positive, and we highly recommend the use of helicopters in future mapping projects.

The distribution of the sexes within a given population was established by discriminating between "adult males" and "adult females and young". Further divisions are possible for some species, but are time consuming and are not a regular part of inventories. Only a few individuals were aged in the field for species such as swans and gulls.

Some species were difficult to distinguish from each other, and were often classified as "unidentified diver/s" "Great Northern/White-billed Diver", or "unidentified cormorants". Combined results are presented for several species in order to reduce the numbers of maps.

Open sea. Counts are made from a boat using standard methods. Observations are recorded in ten minute intervals or, by using a Husky field computer, with "exact" time. Density calculations are made on the basis of positions plotted on squares of unlimited sizes. Squares of 20x20 km (400 km^2) have been used in this report.

A more detailed review is given by Anker-Nilssen (1987).

2.3 Inaccurate sources

When studying the results and conclusions presented in this report, one must also consider the weaknesses and limitations of the data included. Please refer to Follestad et al. (1986) and Anker-Nilssen (1987) for more detailed discussions. In many cases, results presented here should be regarded as representing minimum statistics.

2.4 Data treatment and map projection

All mapping data is plotted on coded charts and stored in the data bank at NINA. Counting zones and observation posts are recorded on maps which is kept at NINA, and this assures that future counts will be based on corresponding subdivisions of localities.

Distribution maps are drawn using the Seabird Project's mapping program SUPERMAP (Kvenild & Strand 1984). Data is thereby easily accessible for later updating, future use in impact analyses, and to assist planning of protective measures in critical oil spill situations.

When several counts of wintering seabirds are made in one area, only the results of the most recent observations in a given area are referred to in this report. Only one count has been made in most areas.

Winter data from Møre & Romsdal has been treated in a special manner, as different locality subdivisions have been used from year to year in some areas. Statistics represented on municipality maps are based on data arranged in 1 km squares. The data program summarizes the total of individuals in each square for each month, every year. Average monthly numbers are calculated for each square, and the highest resulting figures from the months between December and March, are combined with the averages.

Fylkesmannen in Møre & Romsdal (1985) has combined the maximum numbers of individuals per locality in periods between December and February. This method may exaggerate statistics on species which wander, or which occur in varying numbers from place to place, or from year to year. In this report average calculations are chosen in order to obtain data which is more readily comperable with figures from other counties. March data has also been included in our calculations because only data from that month is available for some counties farther north. In certain situations this may have resulted in that only courting aggregations of some species are represented, and that average calculations may yield higher than maximum numbers. Comparisons of the results of these different methods are given for some species in Table 1.

Winter data from Vega are also treated separately, because count areas were slightly different from year to year in certain regions (Follestad et al. 1986).

Different symbol ranking is used for each species or group of species represented on the map. A ranking factor is provided in SUPERMAP and is used to construct the diameter of symbols. For comparable species of similar abundance, equivalent ranking factors are used to obtain the same drawing on several maps. In most cases, diameter is proportional to the number of birds registered, but diameter may be constant on a few maps.

When comparing maps of birds with low numbers like grebes and divers with those of more abundant species like Cormorant and Eider, one should be awere of ranking factor differences which are intended to provide the best possible visual projection of observations.

Table 1. Comparison of two methods for calculating population estimates for three groups of wintering seabirds in Møre og Romsdal County (refer to the text). Method 1 = Maximum number for each locality from December to February. Method 2 = Maximum average for one month, December to March.

Municipality		Species group/method					
		Divers		Grebes		Cormorants	
		1	2	1	2	1	2
11	Vanylven	1	1	3	4	300	561
14	Sande	20	23	110	122	1150	1325
15	Herøy	4	4	20	15	950	481
16	Ulstein	18	7	20	9	2700	2500
17	Hareid	2	1			93	38
19	Volda	1	1			11	10
20	Ørsta					5	4
31	Sula			12	9	55	30
04	Ålesund	1		1		340	302
32	Giske	30	21	73	85	700	305
34	Haram	27	16	27	23	630	680
45	Midsund	33	54	86	184	660	742
02	Molde	5	5	8	8	200	109
46	Sandøy	50	45	250	113	3900	1970
47	Aukra	18	12	180	244	960	1267
48	Fræna	24	7	54	31	2350	1010
51	Eide	2	3	16	4	170	71
54	Averøy	11	8	13	15	3800	3000
56	Frei	2	3	15	17	92	82
57	Gjemnes					13	12
60	Tingvoll	1	1			4	4
03	Kristiansund	3	2	5	4	360	106
69	Aure	7	12	35	38	42	210
72	Tustna	2		9	7	46	32
73	Smøla	350	267	700	518	7200	4679
Total (ca)		610	500	1640	1450	26700	19600

2.5 Evaluation of the data base

Møre & Romsdal County

Breeding - material based on investigations over a period of several years, regarded as good. Meanwhile, some material from the 1970's resulted from unsatisfactory methods.

Moulting - surveys carried out in 1985 and 1990, considered good but still with inadequate coverage of mergansers.
Winter - comprehensive material from several years, but structured such that comparisons with data sets representative for seabird populations in other counties are difficult.

Sør-Trøndelag County

Breeding - most of the data for several species is from the 1970's, but very accurate numbers are avai-lable for Cormorants in recent years. Estimates on Eider and Black Guillemot are based on surveys in 1988.
Moulting - surveys conducted in 1985, 1986 and 1990. Adequate data for several species.
Winter - the entire county was investigated in 1985-1986, with the exception of a few extremely exposed areas.

Nord-Trøndelag County

Breeding - most of the data was collected after 1980, and much of the material on many species is considered as good.
Moulting - surveys conducted in 1985. Good data on Eider, uncertain for Velvet Scoter. Surveys began too late for Red-breasted Merganser, and too early for Greylag Geese.
Winter - surveys conducted in 1984 and 1986. Good data, but lacking for some outlying areas including some localities in outer Vikna.

Nordland County

Breeding - most of the data has been collected after 1980. The data on several species, particularly Cormorants, is good.
Moulting - surveys conducted in 1985 and 1988, and several years at Vega. Data on Eider is good, but less accurate for Velvet Scoter. Surveys were started too early to include Red-breasted Merganser, and too late for Greylag Geese, apart from the populations in Vega (surveyed each year as part of a monitoring program).
Wintering - surveys conducted between 1983 and 1988. Good data from several areas. Data is particularly lacking in some outlying and exposed areas with ectensive shallows. There are few counting stations in these areas. Information for some areas varies considerably from year to year.

Open sea (off-shore)

Open sea areas are poorly investigated, and data is only available from a few periods of the year.

3 Seabird vulnerability to contamination by oil

3.1 Vulnerability of seabirds to oil pollution

When the plumage of a seabird is soiled by oil, it no longer serves an isolating function and many seabirds die of hypothermia. Birds may also suffer internal damage through ingestion of oil during feeding, or while preening oiled plumage.

Several factors determine species vulnerability to oil contamination. These factors includes several aspects of their behaviour, season, diet, population status and recovery periods:

Behaviour. Several species exhibit pronounced social behaviour, and therefore occur in large concentrations within a limited area. In such cases, even relatively small oil leakages may effect considerable numbers of birds. Species which are largely confined to the surface of the sea during winter (or night time), are particularly exposed. There is a continual risk for considerable losses of colonially breeding species like auks and cormorants, as long as large numbers of these birds congreate on the sea in the vicinity of colonies.

Season. Because wintering seabirds spend most of their time on the water during predominantly dark periods where chances for discovering an oil slick are minimal, they are more directly threatened by contamination. An oil slick at sea may be especially dangerous prior to the start of the breeding season, when tens of thousands of seabirds congregate on the water in the vicinity of breeding cliffs.

Diet. Seabird species which graze on land to a large extent, are not as subject to oil contamination of their plumage or reduced access to nutrient resources as species which are entirely dependent upon the sea.

Population status. The impact of oil contamination will be greater for species which are few in number, or which are affected by several other negative factors.

Recovery periods. There are considerable differences in the lengths of time required to restore a population to normal levels following extensive oil damage. The reproductive capacity of auks is extremely limited, and great losses of sexually mature birds will result in severe consequences for the population.

The species are often divided into three categories of vulnerability: very high, high and moderate. Divers, grebes, marine ducks and auks are considered to be the most vulnerable seabird groups to oil pollution (for a more detailed index of vulnerability, see Anker-Nilssen 1987).

3.2 Critical oil spill situations

Critical periods for seabirds, where the consequences of an oil spill can be much more serious than at other times of the year, varies between species. Folkestad (1983) summarized the following critical situations in the event of an oil spill:

* concentrations of flightless birds
  - moulting grounds/moulting flocks
  - post breeding movements of auks
  - areas with large numbers of young birds
* concentrations at roosting areas
* periods with poor light conditions at night, particularly during winter in northern areas

Post breeding movements of auks is added in the list as this is a combination of moulting adult birds and assemblages of young birds. Moreover, only one sex of the adults (the male) will be affected, and this will increase the effects of an oil spill.

In addition, in the event of an oil spill, vulnerability is increased in all areas where birds are concentrated at feeding areas, breeding grounds, and during migration.

3.3 Seasonal variation in vulnerability of seabirds to oil pollutition

Breeding season. The breeding season varies in time among seabirds as among other bird groups, and it is thus not possible to give any exact outline of the duration of this period. For example, Puffins appear to breed relatively early and may lay their eggs in April, while the Storm Petrel lay their eggs in August/September - or even later.

An even more complicating factor in a description of the breeding season, is a period of colony attendance prior to egglaying. This is a regular feature of the breeding biology of many species, but its length varies both within and between species. For example, in some auk populations, the first adult birds return to their breeding sites about 3-4 months before egg-laying, and even 6 months is known in the Guillemot (Nettleslip & Birkhead 1985).

At this time large congregations of seabirds may be found on the sea close to their breeding sites. In general, seabird vulnerability to oil spills is high during winter, and their early appereance at colonies together with their behaviour and age composition (adult and sexually mature birds), makes them highly vulnerable to oil spill. Great losses of reproductive birds can result in an instant drop in the population size.

Post breeding movements by auks. Consideration of the post breeding movements of auks away from their colonies, is critical to evaluation of the impact of major oil spills or leakages of a more chronic nature associated with oil installations. These data are therefore treated separately, although data from Norwegian coastal and off-shore areas is scarce.

Following a period of twenty days confined to the breeding ledge, young Razorbills and Guillemots, which are as yet incapable of flying, take to the sea accompanied by one of their parents, usually the male. Together they embark on a swimming migration to wintering areas. They may take to the sea early in July at Runde, and somewhat later, in August, in northern Norway. The actual point in time, and the series of events associated with jumping were investigated in colonies at Runde (Follestad 1988a).

Adult birds start moulting abruptly and lose all of their remiges (large feathers in the wing) simultaneously. This temporarly loss of flight ability is compensated by complete renewal of feathers later. The entire moulting process usually lasts about 40-50 days (Birkhead & Taylor 1976). Young birds are able to fly at about the same time as adults. Throughout this period, young are fed by their parents, and the actual point in time when young become independent is unknown. It is assumed that they are gradually weaned throughout the autumn and winter, before adult birds return to their breeding colonies.

Moulting season. Like auks, waterfowl renew all large wing feathers simultaneously, during the course of a 3-4 week period between June and September. The actual point in time varies from species to species, and with the sex and age of individual birds. Waterfowl are incapable of flying during moult, and form large flocks, often in exposed areas off the skerries of the outer archipelago. Such flocks are therefore extremely vulnerable to oil spills at this time.

Divers and grebes also moult their remiges simultaneously, but little is known about their distribution during their moulting periods (autumn, Red-throated Diver and grebes; spring, other divers). Like other seabirds temporarily incapable of flying, divers and grebes must be regarded as highly vulnerable to oil spills during the moulting periods.

The four main waterfowl species within the influence area of Midgard moult at different times, and it has been difficult to cover the actual moulting period for each species throughout the entire survey area. Results therefore represent minimum numbers of birds, particularly for Greylag Geese and Red-breasted Mergansers.

Migration. The extent to which different seabird species wander in search of food outside the breeding season is variable. It depends among other factors on the predictability of the food, and this will vary between species, from those feeding on benthos (e.g. mussels) with a reasonable good predictability, to those feeding on pelagic zooplankton or fish, with a very low predictability.

Present knowledge is largely confined to ringed birds, but resent research based on biometrics of dead birds may add new information on the origin of our wintering populations. Knowledge of the migrational movements of seabirds may be critical for evaluations of which seabird populations may be affected by an oil spill in a given area.

A better understanding of the winter and spring distribution of seabirds off central Norway, will require detailed studies of their diet in different areas at different times of the year. Future studies on seabirds at sea, as well as inshore, should therefore give priority to oceanographic and biological factors that may influence the distribution of the bird at sea.

Winter. When interpreting the results one must acknowledge that some of the limitations of this material have resulted from varying coverage of some geographical areas, methodological problems, and that in many cases results only represent a temporary situation when large areas were only investigated on one single occasion.

Open sea. There is little available data on seabirds at open sea in areas of the Norwegian sector which may be affected by oil contamination from the Midgard field. Limited information has been collected through some studies conducted on post breeding movements of auk species origination from colonies which may be affected by oil spill from Midgard: Runde, Røst, and colonies in the British Isles and on the Faroe Islands.

Comprehensive seabird mapping at sea has been accomplished in Great Britain. Data from these investigations are only superficially treated in this report, and only in association with the Guillemot post breeding migration.

Typical seabirds such as Fulmar, Gannet, Kittiwake, Guillemot, Brünnichs Guillemot, Razorbill, Puffin and Little Auk, mainly winter on the open sea. Some concentrations have been found near land, and are probably the result of unusually rich sources of food in these areas. Mapping of these species at sea should be undertaken before the consequences of an oil spill can be fully understood.

4 Vulnerable seabird populations in the influence area

4.1 Inshore seabird populations

Breeding season. Between 2 and 3 million pairs of seabirds annually breed along the coast of Norway, representing breeding populations comparable in size with that of Great Britain, Ireland and Iceland (Røv 1984). The cliff-breeding species are most numerous, but the main part of the population is outside the influence area of Midgard (when Røst and Værøy is not included). The influence area is, however, the main breeding area in Norway for several other species, which may be scattered along the coast or concentrated in a number of colonies.

The most important breeding areas for the Cormorant is in the outer archipelagos in Trøndelag and on the coast of Helgeland. About 70 % of the Norwegian population of approximately 21,000 pairs breeds in the influence area.

Coastal areas of Trøndelag and Helgeland are the most important breeding grounds of the Common Eider in Norway. The Eiders are associated with the sea throughout the year, and are among those seabird species which are highly vulnerable to oil contamination.

The auks are one of the most specialized groups of seabirds, but are also the seabirds most vulnerable to man's activities, especially oil pollution and fishing nets. Rough estimates of the numbers of auk species in colonies of cliffbreeding seabirds that might be directly or indirectly influenced by an oil spill from Midgard, are given in Table 2.

Table 2. Rough estimates of the number of breeding auks (pairs) that might be directly or indirectly influenced by an oil spill from Midgard (from Røv 1984, the estimate for Guillemots on Runde is corrected based on data from Lorentsen 1991).

Colony	Razor-bill	Guille-mot	Puffin
Runde	3 200	6 000	75 000
Lovunden			60 000
Fugløy			10 000
Røst	4 000	<1 000	700 000
Værøy	800	2 000	70 000

Heavy population declines in northern Norway during recent years, particularly for the Guillemot and the Puffin, imply that these populations must at present be regarded as extremely vulnerable to additional losses of adult birds.

Moulting. The Norwegian coast is an important moulting area for waterfowl (Greylag Goose and seaducks), and for some species, it holds a significant part of the European population.

Existing information on moulting seabirds is mainly based on single counts, and variations from year to year may bias conclusions. For further comments, see Follestad et al. (1986).

Current knowledge of the status of some moulting seabird populations in the influence area of Midgard, is given in Table 3 (Seabird project, NINA, unpubl. data). This does not include the auk species with a considerable part of the population off-shore during moult, or divers and grebes.

Table 3. Estimates of the number of moulting waterfowl species within the Midgard influence area.

County	Greylag Goose	Eider	Velvet Scoter	Red-breasted Merganser
Møre & Romsdal	900	13 000	550	1 300
Sør-Trøndelag	6 700	52 500	8 700	4 750
Nord-Trøndelag	1 900	7 500	260	750
Nordland (south)	8 800	24 000	1 600	2 800
Total	18 300	97 000	11 000	9 600

Migration. The data base for this section is partially based on a coarse analysis of results on ringed seabirds retrieved (Fylkesmannen i Møre & Romsdal 1985). This material includes recoveries of birds ringed in Sogn & Fjordane, Møre & Romsdal and Sør-Trøndelag counties, here referred to as central Norway, and are summarized in Table 4.

A rough comparison of recoveries of ringed seabirds indicates that birds from several populations winter within the influence area. Existing material is not, however, adequate for evaluating the composition of these seabird populations, or the extent to which certain populations may be affected in the event of an oil spill.

Wetlands. Wetlands are important for species other than typical seabirds, and large numbers of species often exploit such localities. They are also often areas which contain unusual biotopes which should be protected. Localities associated with marine habitats are empha-

Table 4a. Recoveries of ringed seabirds in central Norway (Sogn og Fjordane, Møre og Romsdal and Sør-Trøndelag) according to where they are found.

	Northern Norway Entire year	Nov.-Feb.	Central Norway Entire year	Nov.-Feb.	Southern Norway Entire year	Nov.-Feb.	Other Countries Entire year	Nov.-Feb.
Gannet	1		1				2	
Cormorant	1		16	6	8	4	16	4
Greylag Goose			8				10	4
Eider	1		26	3				
Guillemot	62	46	36	19	43	32	11	9
Razorbill			2		5		7	4
Black Guillemot			30	4	1			
Puffin	3	1	8				8	6

Table 4b. Recoveries of ringed seabirds in central Norway (Sogn og Fjordane, Møre og Romsdal and Sør-Trøndelag) according to where they are ringed.

	Northern Norway Entire year	Nov.-Feb.	Central Norway Entire year	Nov.-Feb.	Southern Norway Entire year	Nov.-Feb.	Other Countries Entire year	Nov.-Feb.
Gannet			1				3	1
Cormorant	139	49	16	6			1	
Greylag Goose	16		8		2		1	
Eider	13	4	26	3				
Guillemot	17	13	36	19			97	51
Razorbill	6	3	2				25	2
Black Guillemot	2	2	30	4				
Puffin	9	5	8				4	1

sized. Freshwater areas are not included, even when freezing of these areas during winter may force birds into nearby shoreline habitat where they may be exposed to oil contamination.

Several wetland areas are protected, or have been proposed included under regulation for environmental protection. Some seabird areas are already protected, including the following: Runde in Herøy (Møre & Romsdal), Froan in Frøya (Sør-Trøndelag), Grandefjæra in Ørland (Sør-Trøndelag), and Røst (Nordland). Data from several localities are given in discussions of each species, under comments on breeding, moulting and/or wintering.

Winter. The Norwegian coast is an important wintering area for many seabirds, and for several species, it holds a significant part of the European population (for waterfowl, see Nygård et al. 1988).

Table 5. Estimates of the number of some wintering seabirds within the Midgard influence area

Species or systematic group	Møre & Romsdal	Sør-Trøndelag	Nord-Trøndelag	Nordland	% of total population in Norway*
Divers	600	575	300	600	69
Grebes	1 650	650	180	300	79
Cormorants	19 000	18 000	6 000	13 000	62
Eider	25 000	50 000	33 000	160 000	65
King Eider	100	700	1 000	25 000	38
Velvet Scoter	4 500	8 000	3 200	5 000	69
Long-tailed Duc	8 000	11 000	4 500	20 000	51
Red-breasted Merg.	6 000	3 500	1 500	3 500	52
Black Guillemot	2 000	6 000	2 000	10 000	77

* Estimates for winter populations in Norway are given in Nygård et al. (1988).

Counting of seabirds in Norway during the winter, with rough sea conditions, low temperature and short daylight hours is difficult. Thus existing information on wintering seabirds is mainly based on single counts, and variations from year to year may bias our conclusions. For further comments, see Follestad et al. (1986).

Current knowledge of the status of some wintering seabird populations in the influence area of Midgard, is given in Table 5 (Seabird project, NINA, unpubl. data). This does not include species with a considerable part of the population off-shore during winter.

4.2 Off-shore seabird populations

Observations of seabirds at sea off the coast of Central Norway have occasionally been made over the last few years, but the coverage is poor. A brief summary of the current state of knowledge is presented here. Emphasis is placed on the distribution of seabirds related to the frontal system along the Norwegian coast between the warm and saline Atlantic water, and the cold and less saline Norwegian coastal stream.

Available information is inadequate for evaluating the species distribution throughout the year, but some are commented on to illustrate differences in the distribution patterns of some species.

It is stressed that the majority of open sea data are from areas between 62°N and 64°N. The effects of small oil spills on seabirds present in the vicinity of the Midgard field may therefore not be properly evaluated.

Generally, seabirds at sea are not distributed at random. They usually concentrate where food resources are abundant, and this may some times be related to oceanographic factors like salinity and temperature. Fronts between differnt currents often coincide with regions of increased primary production, and the effects of fronts on seabird distribution are well known from several areas.

Spring distribution. The following comments are based on presently available data which includes information on the most common seabird species at sea within the influence area in spring.

Gannets seems to be spread in a belt along the coast, and they have not been observed at Haltenbanken. Gannets dive after relatively large prey, and may occur in high numbers in areas with concentrated access to fish.

Fulmars appear to be abundant throughout all of the area investigated. Particularly high concentrations are often related to commercial fishing activity, where Fulmars will feed on offal. They wander extensively over large open sea areas, mainly feeding on plankton, smaller fish and crustaceans. Some distributional patterns may thus be related to frontal systems.

Kittiwakes distribution is similar to that of the Fulmar, but their numbers are in general smaller. High densities may occur near their breeding colonies, from the time when they take up occupation.

Razorbills occurs in smaller numbers than other species, and most individuals have been observed near the bird cliffs at Runde. Some feeding areas north of Runde may be important to both the local population at Runde and immature birds from other breeding populations.

Guillemots appears to have the same distribution pattern as Razorbills, but they occur in larger numbers, possibly reflecting the larger numbers of the Guillemot at the breeding colony at Runde. One can expect that most of the larger auks near Runde in spring originate from the breeding populations there. The majority of auks from Great Britain and the Faroe Islands will already have returned to their respective colonies by this time. Guillemots visit the cliffs at 3 to 5 day intervals, and between visits they remain at sea.

Guillemots have been observed far out at sea in spring, and some birds appear to concentrate in the frontal system at the continental shelf.

Puffins also congregate near the breeding colonies. Large concentrations may, however, be found north of Runde in late winter and spring. Densities of up to about 1,200 birds/km² are recorded (at Buagrunnen, 63°05'N 6°30'E, 27 February 1989). Large numbers are also found close to the coast in several areas, north to Froan (data are lacking farther north). Data also indicate that Puffins may concentrate in the eddy at Haltenbanken, but further data are needed on this phenomenon.

Little Auks are sometimes observed in immense numbers, even inshore, for example on 26 January 1986 5,000 to 15,000 Little Auks were recorded between the islands of Hitra and Frøya. They migrate northwards to their breeding grounds in March/April, and resent data indicate that they may occur in very high numbers off central Norway at this time (see below). Little Auks are seldom observed off the coast of central Norway during the last half of April.

The frontal system off Central Norway. Seabirds associated with fronts or upwelling areas are often plankton feeders such as the Little Auk. Results from a survey of seabirds at sea in March and April 1988, shows that some of the pelagic distributional patterns of the Little Auk, as well as other seabirds, may in spring be related to the frontal system between Atlantic water and the coastal stream off Central Norway (Follestad 1990).

Little Auks and Puffins were present in a non-random pattern of distribution mainly south of 64°N (Figure 1).

Two different patterns of Little Auk distribution seemed to occur in March/April 1988. In the warm and saline Atlantic water, Little Auks were more or less evenly distributed in smaller numbers all the way out to the Greenwich meredian. Most Little Auks were, however, recorded on the continental shelf in the cold and less saline coastal stream, or close to the frontal system between the two water masses. Their distribution here was more patchy, sometimes present in very high numbers.

In the coastal stream, large concentrations of up to 300-400 Little Auks pr. km² were found near shore on 4-6 March 1988. When areas north to 69°N were surveyed in the middle of March, only a few Little Auks were observed, and no particular concentrations were evident. At the end of March and in early April, however, very high densities of Little Auk, between 900 and 1,500

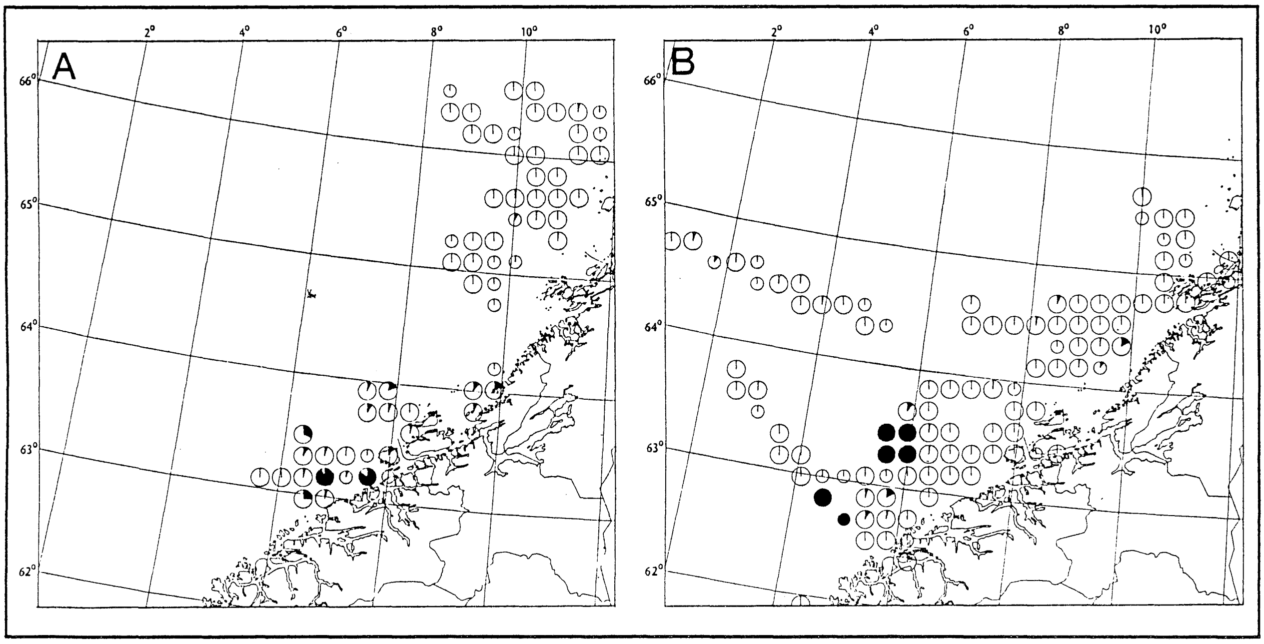


Figure 1. (A) Distribution of Little Auks before 15 March 1988. Size of plots is 20x20 km. Filled symbols indicates a density of at least 200 birds/km². Small symbols represent transect lines that were less than 6 km long. (B) Distribution of Little Auks after 15 March 1988. Note that very large consentrations of birds can occur at or close to the frontal system at the continental edge between atlantic and coastal water, and that distribution and abundance of seabirds at sea can be quite unpredictable, as it is probably related to unpredictable food resources. There is a possibility of injuring a very high number of birds even within a restricted area in the event of an oil spill.

birds pr. km², were recorded in two areas on the continental shelf between 62°30'N and 63°30'N.

On 23 March 1988, on a transect from the Greenwich meridian to the coastal areas near Svinøy (62°20'N 5°16'E), salinity and temperature were measured at certain intervals. Close to the edge of the continental shelf there was a front between the Atlantic and coastal water and a rapid change in temperature and salinity was recorded (Figure 2). The numbers of Little Auks observed in each 10-minute period along this transect increased very rapidly at the frontal area, from almost zero to 900-1,200 birds (Figure 2). At ship speeds of 11-12 knots and a transect width of 300 m, these numbers are almost equal to densities given as birds pr. km².

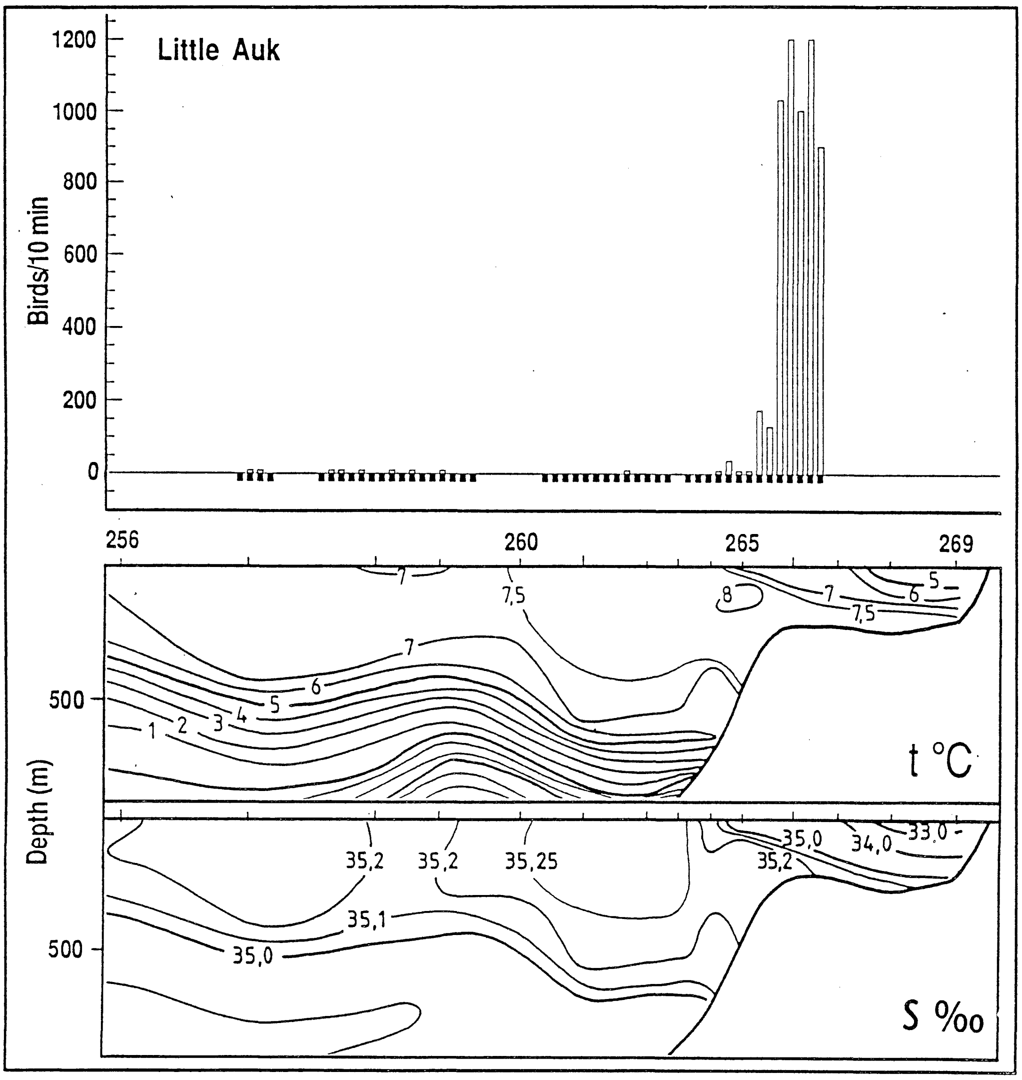
High densities were also recorded in March 1989. About 2,300 Little Auks pr. km² were recorded close to the coast on 22 March (63°20'N), but at the same time more than 1,000 Little Auks pr. km² were recorded in some areas on the continental shelf or over the continental slope.

The normal winter range of Little Auks in the eastern Atlantic extends south to the North Sea and Skagerrak areas, as shown by surveys of seabirds at sea and by their presence among seabirds found dead after the oil spill in Skagerrak 1980/81 (Anker-Nilssen et al. 1988b). Little Auks are commonly found in the North Sea, but according to recent research, only in small numbers (Tasker et al. 1987).

Densities of 1,000-1,500 Little Auks pr. km² (observed in two areas in 1988), are exceptionally high compared to those found in the western part of the North Sea, where mean densities above 2 birds pr. km² rarely occur (Tasker et al. 1987). At such densities even a small oil spill may damage a very large number of Little Auks.

More data should be collected on the distributional patterns of Little Auks along the coastline, to see if they move from inshore areas to the front at certain times. The reason for the high concentrations of Little Auks associated with the frontal system off the coast of central Norway is not clear. Fronts in the North Sea often coincide with regions of increased primary

Figure 2. Densities (counts/10 minutes) of Little Auks alongside a transect from about 2°E of the Greenwich Meridian (CTD st.no. 256) to Svinøy (CTD st.no 269) 23 March 1988 in relation to temperature (t in °C) and salinity (S in ‰). Black squares beneath the line in the Little Auk figure indicate the 10-minute intervals covered. CTD st.no. are given at the top of the temperature figure.



production. In water off Central Norway phytoplankton production in spring will at first increase at the front and in the mixed coastal water masses. During the survey in 1988, however, no data on plankton or fish were collected with the exception of observations on sonars, indicating that Little Auks were concentrated where food was abundant.

We do not know if these concentrations of Little Auks stay on Haltenbanken or at feeding grounds farther north on their migration northwards to their breeding sites, or if their distribution patterns are related to fronts or other oceanographic factors.

Little Auks feed where prey is most concentrated, and a better understanding of the winter and spring distribution of Little Auks, as well as other seabirds, off Central Norway, is neccessary to evaluate the impact of oil spills from the Midgard field. In general, improved coverage of the seas off Central Norway will be essential to complete an accurate description of the distribution of seabirds normally occuring in larger numbers off shore in the influence area of Midgard.

4.3 The species account

Distribution maps from Sør-Trøndelag to Lofoten are enclosed in an appendix. Maps for the whole influence area includes data also from Møre & Romsdal and Vesterålen. Maps have been drawn only for the most vulnerable species to oil contamination.

Divers *Gavia* sp.

This group includes two species breeding in Norway, the Red-throated Diver and the Black-throated Diver, and to high arctic breeders, the Great Northern Diver and the White-billed Diver.

Breeding. The Red-throated Diver is the most abundant and widespread diver species, and breeds regularly up to the coast of Helgeland. It may here search for food at sea in the vicinity of their breeding localities, and they could thus possibly be affected by contamination from an oil spill in the breeding season. It is however, uncertain if this will happen in such an extent to influence the population development on a long time scale.

Neither the Great Northern Diver nor the White-billed Diver are breeding in Norway. The breeding population of the Great Northern Diver at Island, is estimated to about 500 pairs (RSPB and ICBP 1981), but is a more common species in Greenland and North-America. The White-billed Diver is everywhere present in apparent low numbers.

Winter. Divers and grebes are, compared with most other seabird species, present in low numbers, but the wintering populations of some species in Norway are nevertheless outstanding in Europe.

The Red-throated Diver winters regularly in the influence area of Midgard, north to the coast of Helgeland. The most important winter sites are Hitra, Frøya and Vega. The Black-throated Diver migrates out of the country, and only single individuals winter along the Norwegian coast.

The Great Northern Diver winters regularly in the influence area of Midgard. The most important winter sites are Ørlandet and Storfosna, Tarva in Bjugn, Linesøya in Åfjord, Bispøyan in Hitra, outer parts of Vikna, and Vega.

In Europe, the White-billed Diver winter regularly only in Norway, where it is found most commonly from Sør-Trøndelag and northwards. This species is often found on other localities than the Great Northern Diver, but the reason to this is unknown.

These species are usually solitary, dive frequently, and are difficult to observe on the water. Results therefore represent minimum numbers.

Grebes *Podiceps* sp.

This group includes mainly two species, the Slavonian Grebe and the Red-necked Grebe.

Breeding. The Slavonian Grebe breeds inland, and the population size in Norway is estimated to about 500 pairs (Fjeldså 1973).

The Red-necked Grebe breeds among others in Sweden and Finland, and it is thought to be birds from these populations that winter along the Norwegian coast (see Follestad et al. 1986).

Winter. The Red-necked Grebe is the most numerous Grebe during the winter. The influence area of Midgard holds a significant proportion of the Norwegian winter population of this species, estimated to 2,700 individuals by Nygård et al. (in manus). Important winter sites are Bispøyan in Hitra, Ørlandet and Storfosna in Ørland, outer parts of Vikna, and Vega.

The Slavonian Grebe is a less numerous species in winter, but a significant proportion of the Norwegian winter population of about 800 individuals (Nygård et al. in manus), winter within the influence area of Midgard.

Gannet *Sula bassana*

Breeding. Gannets breed at Runde which supports the largest concentration of this species in Norway, at Hovsflesa in Vågan at Skarvklakken in Andøy and at Syltefjordstauran in Finnmark (Røv 1984).

Migration. Four ringed Gannets from Runde were recovered in northern Norway, at Runde, in the Netherlands and in Germany. Three foreign Gannets (two British and one Irelandic) were found in the investigation area. These recoveries demonstrate that Gannets wander along the coast of northern Europe and at open sea, but we are unable to provide more detailed information on their migration patterns.

Young Gannets are fed by their adults until they leave the colony. The newly fledged juvenile swims away from the colony. It cannot, for a week or two, raise itself from the surface, mainly because it has too much fat. Also, its wings are not quite grown. During this period young Gannets are vulnerable to contamination from oil spills. The main migration route is probably southwards, and only birds from the northern colonies are likely to be threathened by oil spills from Midgard. As the Gannet population has increased in later years, losses of young Gannets one year, should not affect the population development at a long time scale.

Cormorant *Phalacrocorax carbo*

Breeding. The most important breeding areas for Cormorants are primarily located in the outer archipelago in Trøndelag and the coast of Helgeland (Table 6). Over 70 % of the entire Cormorant population in Norway breeds within the influence area for the Midgard field. Population numbers have increased sonce 1980. Recent population figures indicate approximately 21,000 breeding pairs of Cormorants in Norway today. Estimates are very accurate and are based on surveys of nests in colonies or aerial photographs.

Cormorants breed in dense colonies of up to several hundred pairs, and these are often located on small islands and skerries which are exposed to weather - and oil. They are easily disturbed during the breeding season, and quickly abandon the nesting area if humans approach, as would be the case in a clean-up operation after an oil spill. This may result in enormous losses of eggs and young by gulls staying near the colony.

Cormorants spend much of the day at resting or roosting localities, and are therefore considered less vulnerable to oil contamination than many other seabirds. But, they may become susceptible if they are driven off the skerries into an oil slick, as for example during the night.

Table 6. Geographical distribution of the breeding population of Cormorants in Norway around 1985 (Røv & Strann 1987).

Area	Year	Number of pairs
Sula	1986	680
Froan	1986	3 000
Vikna	1985	1 820
Sklinna	1985	1 100
Sør-Helgeland	1985	2 300
Vega	1985	3 000
Nord-Helgeland	1982	1 600
Træna-Myken	1982-85	1 250
Salten	1982	125
Vestfjorden	1982-85	350
Mosken	1985	85
Lofoten, nord	1985	450
Vesterålen	1983-85	600
Andøya	1983	200
Troms	1982-83	145
Vest-Finnmark	1983-84	1 800
Øst-Finnmark	1981-85	2 650
Total, rounded off		21 000

Migration/Winter. Outside the breeding season, Cormorants are common along the entire coast of southern and central Norway. Ringing recoveries indicate that a large proportion of the population migrates south, to some extent also out of the country. Several birds recovered in central Norway, were originally ringed in northern Norway. Most recoveries were made in September-October, although there are several for the winter period from November to February. The material suggest that the influence area is an important wintering area for some segments of the North Norwegian Cormorant population.

Shag *Phalacrocorax aristotelis*

Breeding. A significant breeding population of Shags is found in the influence area. There is a considerable breeding population at Froan, which includes several smaller colonies. This population has remained stable during recent years. Sklinna is another important area where Shags breed in scree slopes and in the mole at Heimøya. If an oil slick drifts towards Sklinna, the harbour area and the breakwater may trap the oil in the vicinity of these colonies. Shags is also breeding at several localities in Vega, Træna, Rødøy and Røst.

Shag nests are much more concealed than those of Cormorants. They are often located under boulders and in rocky crevices, and are therefore less frequently disturbed. As with Cormorants, Shags spend part of the day at resting places, and are therefore considered less vulnerable to oil contamination than many other marine seabird species.

Migration/Winter. Only a few, if any, Norwegian Shags migrate out of the country during the autumn. Today the most concentrated wintering grounds appear to be located in outer coastal areas of Nordmøre and Sør-Trøndelag, where Shags from Sunnmøre, Trøndelag and Nordland congregate.

More than 20 % of all Shags which are ringed, are recovered, and recovery material for this species is more extensive than for any other seabird species in Norway, because this species is often hunted or drowned in fishing tackle. The winter population on the coast of Sunnmøre and Romsdal is mainly comprised of birds from the colonies at Sunnmøre. The coast of Nordmøre and Trøndelag south of the Trondheimsfiord, is a major wintering area for Shags from Sunnmøre, and colonies from northern Norway.

Winter populations found along the coast north of the Trondheimsfiord, appear to originate from colonies in northern Norway. All recoveries in Norway of foreign Shags have been made south of Stadt. Therefore all Shags found in the influence area of the Midgard field probably are from Norwegian populations.

Shags from Runde winter in areas between the Trondheimsfiord and the Sognefiord. Recoveries suggests that on this coastal stretch, large concentrations of wintering Shags are found near Smøla, Hitra and Frøya, and these areas are regarded as the most important Shag wintering sites in Norway. The wintering area of the population at Runde appears to have been displaced northward after the 1950's, simultaneous with serious declines in the herring population.

The principal midwinter concentrations of Shags, and in smaller numbers, Cormorants, are found in the archipelagos of Smøla, Hitra ane Frøya. Of the total winter population of cormorants in these municipalities, as well as the influence area as a whole, Shags makes up about 70 %. The Cormorant prefer shallow inshore water, and are rarely found far out at sea, as may to a greater extent be the case with the Shag.

Greylag Goose *Anser anser*

Breeding. Greylag Goose breed along the coast from Vestlandet to as far north as Finnmark. The greatest numbers are found in Møre & Romsdal, Trøndelag and at the coast of Helgeland. After the turn of the century, the population sharply declined, but has increased more recently.

Froan and Vega are two important breeding areas. There are also several other areas with good breeding populations within the area currently under discussion.

Moulting. Although Greylag Geese are less vulnerable to oil contamination than many other species during most of the year, they are particularly exposed during moulting, when they are not able to fly.

A summary of present knowledge on the number and distribution of moulting, non-breeding greylags in Norway, is given by Follestad et al. (1988). The most important moulting areas for Greylags are Frøya, including the Froan Nature Reserve, and the Helgeland coast, including the island of Vega. A significant population of Greylag Geese would be threatened if an oil spill struck the coast near Froan or Vega during the moulting period. In Frøya the moulting population of Greylag Geese has been about 5,200 individuals, and in Vega about 6,000. The moulting population is probably mainly comprised of Norwegian birds, but may also include geese from other countries.

Migration/winter. Greylags migrate south during the autumn, and winter in central and southern Europe. Occasionally a few Greylags winter in central Norway.

Eider *Somateria mollissima*

Breeding. Eiders breed along the entire Norwegian coast, and the total population may roughly be estimated to be in the order of size 150,000-200,000 pairs. Data from a mapping project of breeding Eiders in Trøndelag and southern parts of Nordland in 1988 is given by Follestad (1988b). The results from this project showed a breeding population in the surveyed area of about 30,000 pairs, when one adult male is thought to represent one breeding pair. The total number is above previously known estimates for this region, but the breeding poplulation in Nord-Trøndelag seems, however, to have declined since 1982-83.

Eider eggs and down have been exploited at nesting localities in a multitude of coastal villages in Norway. Today, this practice is no longer common, but still exists on the Helgeland coast. Until about 1970, the breeding population experienced obvious declines, but increases have been reported more recently (Røv 1984).

Coastal areas of Trøndelag and Helgeland are the most important breeding grounds in Norway.

Moulting. Froan Nature Reserve is without doubt the most important moulting area for Eider in Norway. A total of 36,000 and 29,000 Eiders, mostly adult males, was recorded in Frøya municipality in 1985 and 1986 respectively. These numbers are considerably higher than that potentially recruited from the local breeding population, but the extent of Norwegian and/or birds originating from other countries, is unknown.

Flocks of moulting Eider at Froan are shown on a map indicating shallows in the area (Figure 4 and Table 7). These maps indicate that population distribution varied from 1985 to 1986. About 25,000 Eiders congregated within a restricted area in the most exposed part of the archipelago in 1986.

Table 7. Moulting Eiders at Frøya in 1985 and 1986. Figure 3 indicate areas which were investigated during this period.

	1985		1986		
	Beg. of July	Mid. August	Beg. of July	End July	Mid. August
1	1 335	6 035	13 300	14 940	14 670
2	3 050	6 200	7 700	8 965	9 300
3	490	145	325	380	?
4	2 570	3 285	2 000	1 265	1 640
5	850	2 900	2 035	875	945
6	845	5 135	1 500	1 655	500
7	185	970	?	?	?
8	1 185	635	475	?	311
9	3 000	4 350	1 050	?	550
10	445	3 850	135	?	100
11	90	275	?	?	?
12	25	80	?	?	?
13	?	1 270*)	?	?	?
Total	14 070	35 130	28 520	27 980	28 520

*)End of July

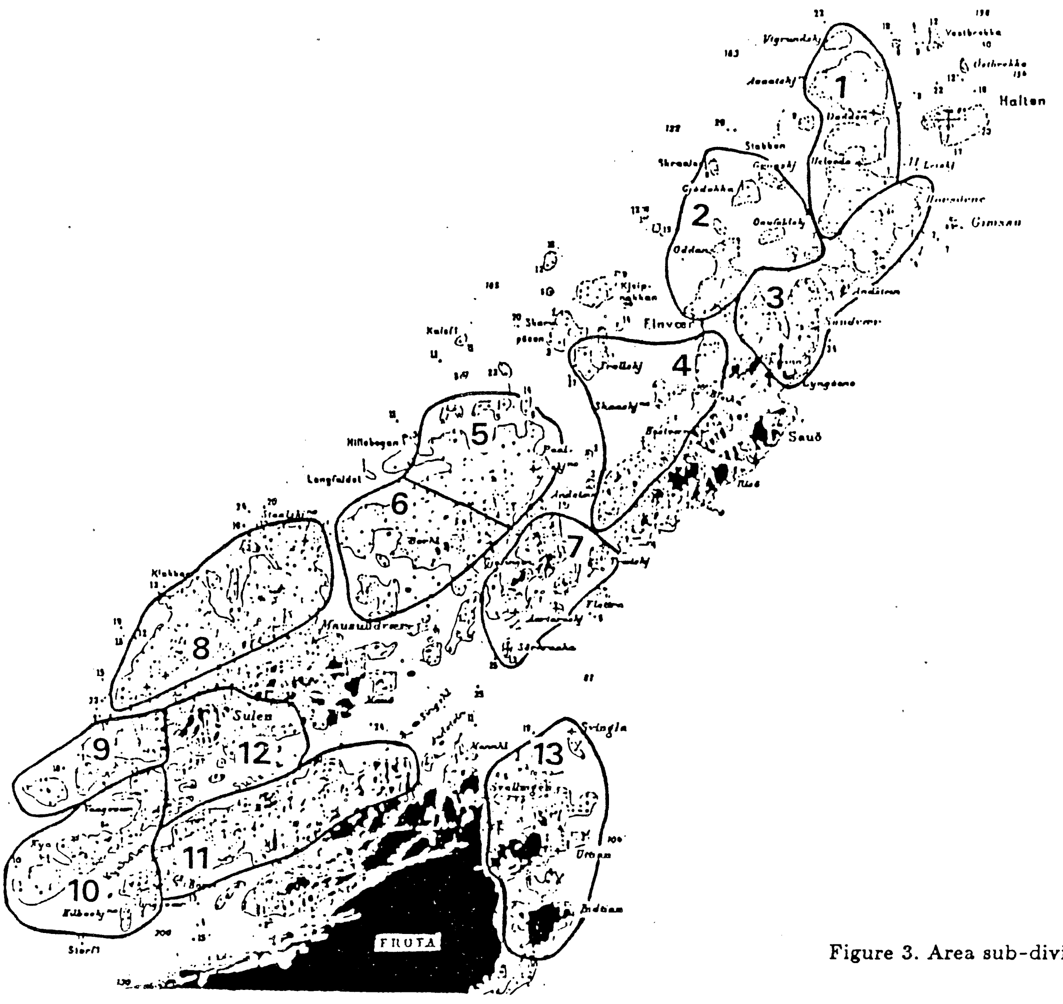


Figure 3. Area sub-divisions for table 7.

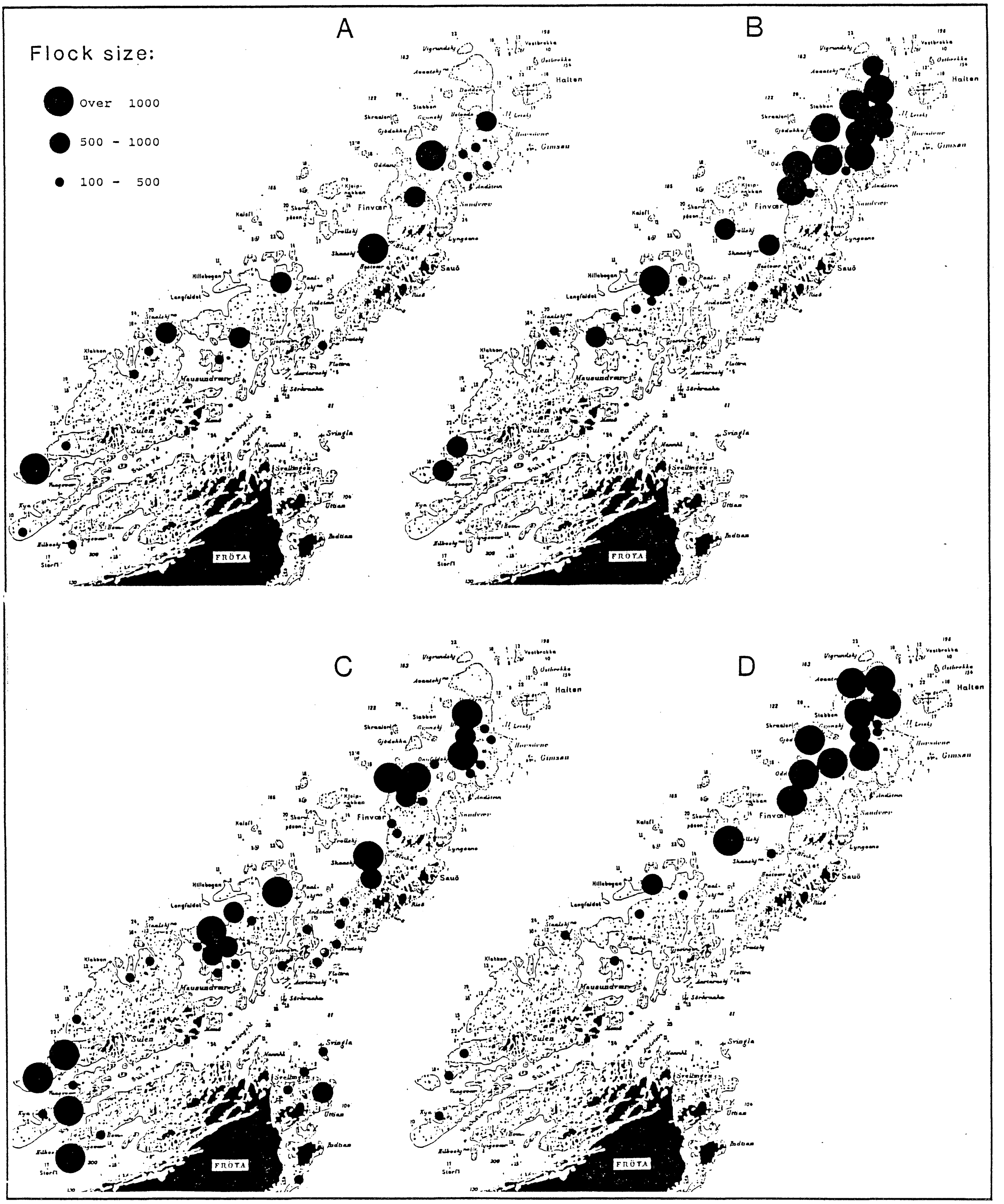


Figure 4. Distribution of flocks of moulting Eiders, mainly adult males, at Frøya in the beginning of July 1985 (A) and 1986 (B) and in the middle of August 1985 (C) and 1986 (D). Note that the main part of the population is located in the most exposed parts of the shallow areas in the archipelago north of Frøya, including the nature reserve of Froan, and that distribution patterns may vary quite a lot from one year to another.

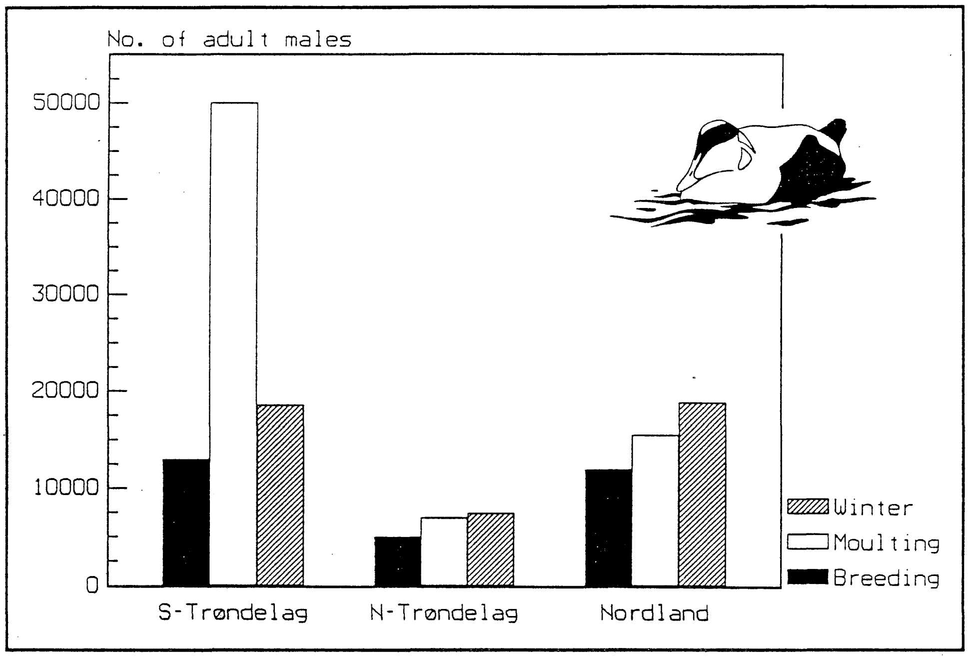


Figure 5. Breeding, moulting and wintering populations of adult male Eiders in Sør-Trøndelag, Nord-Trøndelag and southern parts of Nordland (data from Follestad 1988b). Note the large moulting population in Sør-Trøndelag.

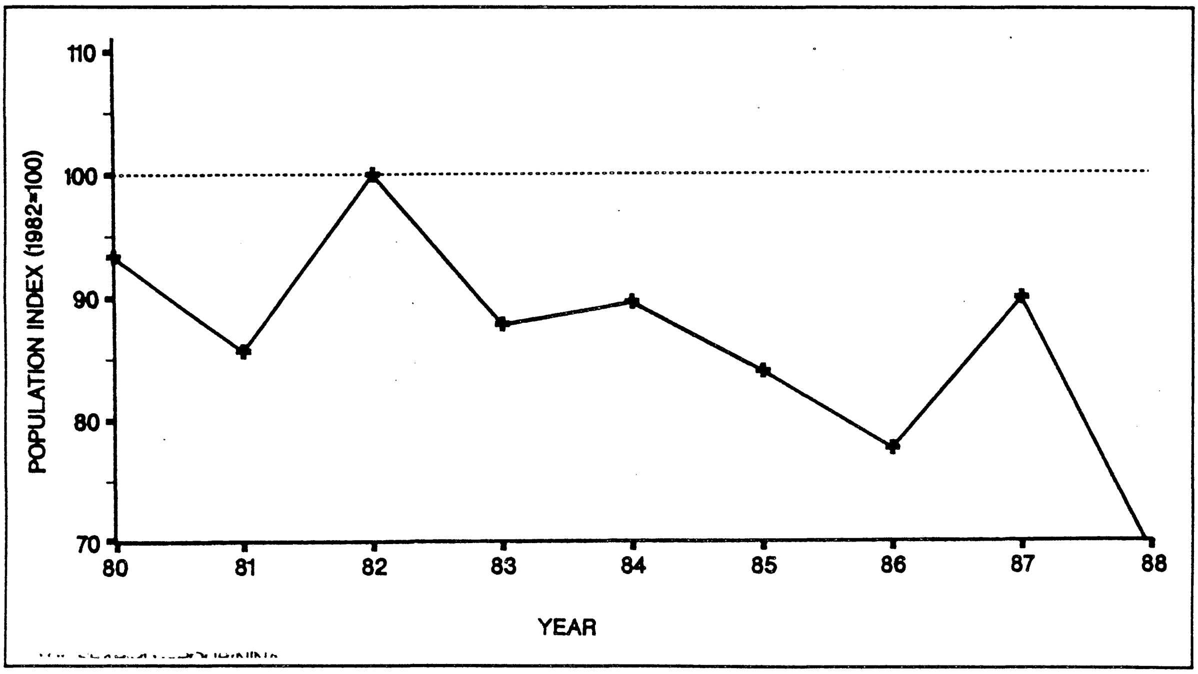


Figure 6. Population development among Eiders in Norway from 1980 to 1988, based on annual midwinter counts in fixed areas (NINA, unpubl. data).

At the present time we have no adequate general picture of the population structure of Eider in Norway, a factor which makes it difficult to evaluate whether the entire moulting population along the coast is recruited from local breeding populations, or if they include breeding populations from more northerly or easterly areas.

The number of moulting Eiders in Sør-Trøndelag is exceptional high compared to both the breeding and wintering population (Figure 5). This is diffcult to explain without suggesting a migration of males from other areas. From where do these birds originate? There may also be some influx of birds in Nordland during moulting and winter, as compared with the breeding population. Some birds here may belong to the Svalbard population.

Eiders are extremely vulnerable to oil contamination during moulting. To evaluate what may happen if an oil spill struck for example the Froan area during the moulting season, the following investigation should be given priority:

a) monitoring and ringing of moulting Eider
b) measures which may be employed to lead or frighten Eider away from the most exposed areas in the event of an oil spill.

Migration. Eider recoveries have been made in Central Norway. 26 of these were originally ringed in the same area, while 13 others were ringed in Nord-Trøndelag (in the Trondheimsfiord). Recovery material only indicates local migrations, suggesting that the Eider populations in these areas remain in the same district throughout the year. None of the recoveries indicate the origin of moulting Eider at among other places, Froan.

Winter. The Eider is assosiated with sea throughout its life cycle, and is the most abundant coastal seabird species in Norway during the winter. Counts within the survey area revealed numbers of about 160,000 individuals. The Eider is distributed along the whole coastline, and is particularly numerous in Vega (winter population about 25,000), and at Froan, Ørlandet and outer Vikna.

A large winter population has been documented in the survey area. Their distribution contrast with that of the moulting period, emphasizing the inadequacy of our current knowledge about Eider populations found along the coast at different times of the year. Further research is required in order to carry out comprehensive consequence analyses.

Population Variations. Annual mid-winter counts of the same areas along the coast indicate a recent decline in the Eider population (NINA, unpubl. data). The reasons for this decline are unknown. The large, year round population of Eiders is in many ways characteristic for the area under discussion. Increased drilling activity will necessitate accurate monitoring of the further development of this population.

King Eider *Somateria spectabilis*

Winter. The King Eider is a high arctic species which does not breed in Norway. This species winters in northern Norway, and may regularly winter as far south as Sør-Trøndelag county. The survey area lies on the outer limits of the normal winter distribution of this species, although they may occur to a varying degree from year to year.

Røst, Værøy and some other localities in Lofoten and Vesterålen are important winter sites.

Common Scoter *Melanitta nigra*

This is an abundant sea duck, but there are no internationally important winter sites for this species along the Norwegian coast.

Bispøyan in Hitra seems to be a regular winter site in Sør-Trøndelag, but it is not known to what breeding populations these birds belongs, and thus it is impossible to evaluate the consequences of an oil spill in this area on this species.

Velvet Scoter *Melanitta fusca*

Breeding. The breeding range extends from Norway and eastwards in the Palearctic, and the species is an inland breeder in our country. Breeding numbers in the western Palearctic are everywhere quite low. It is one of the least abundant of the sea ducks, and is considered extremely vulnerable to the effects of oil pollution.

Moulting. The moulting population of Velvet Scoter in the survey area is outstanding in Europe, and is comprised of a minimum of 11,000 individuals. Ørlandet, with 7,000 individuals recorded in 1985 and a minimum of 5,000 in 1986, is the most significant area for Velvet Scoter in Norway. Their numbers in this area appear to have increased considerably (Follestad et al. 1986). Vega is the most important moulting area for Velvet Scoter in Nordland county, although the population there seems to have declined. A concentration of about 500 individuals has been recorded on Smøla.

Winter. The Velvet Scoter is a marine species outside the breeding season, during which it exhibits flocking behaviour and has a very localised distribution. The most important wintering areas are Ørlandet, Smøla, parts of Frøya, Tarva in Bjugn, outer Vikna and Vega.

A significant increase in numbers of wintering Velvet Scoters in Sør-Trøndelag county was demonstrated from 1977 to 1985/86 (Follestad et al. 1986). The reasons for this increase are unknown, but must be regarded in the context of an increase in the moulting population. This species should be monitored over a larger area if the extent of the wintering area has altered during recent years.

Long-tailed Duck *Clangula hyemalis*

Breeding. The Long-tailed Duck is breeding inland, but some non-breeding birds stay at sea during summer.

Winter. The Long-tailed Duck is distributed throughout the whole influence area, but have only occasionally occured in large concentrations. Large flocks may, however, bee found during spring migration. Long-tailed Ducks are often found far out to sea, and even large concentrations may have been overlooked during counts.

Red-breasted Merganser *Mergus serrator*

Breeding. Red-breasted Merganser breed in freshwater habitats, but are also commonly found along the coast. We have little information on breeding populations found in the area discussed in this report, because most seabird investigations are conducted in June and July. Breeding Red-breasted Mergansers should be counted early in May, while males are still in the breeding area.

Moulting. Mapping of moulting Red-breasted Mergansers was only given priority in Frøya. The total number is therfore an absolute minimum. Their documented numbers are, however, among the highest in Europe, with a moulting population of approximately 10,000 individuals. Birds congregating within this area, probably originate from a substantial part of their breeding range in Fennoscandia.

Frøya is the most important moulting area, but recent data from Sør-Helgeland emphasizes the importance of this region also for moulting Red-breasted Mergansers.

Existing data indicates considerable variation between the results from 1974-1980 and those from 1985, suggesting a significant population decline.

Winter. The winter population constitutes a sizable part of the European population. The origins of those populations occuring along the Norwegian coast are unknown (cfr. Follestad et al. 1986).

Sea Eagle *Haliaeetus albicilla*

Although the Sea Eagle is not considered a true seabird, in Norway this species is entirely dependent on the sea for food. Fish and seabirds make up most of its diet. Through consumption of oiled seabird carcasses, Sea Egles may be exposed to internal damage and poisoning.

Breeding. The vast majority of all European Sea Egles are breeding in Norway, and the population has approached 1,500 pairs. A very large percentage of these breed within the influence area of the Midgard field.

Sea Eagles nest at several locations on small islands and islets in the outermost archipelago, and disturbance, like that associated with clean up efforts after an oil spill, should be avoided in the vicinity of Sea Egle nests.

Winter. The influence area of Midgard is the main wintering area of Sea Eagles in Norway. The winter population is probably composed mainly of Norwegian birds.

Waders *Charadriidae*

Waders include several species, all of which are considered less vulnerable to oil contamination. Conflicts with oil slicks may take place when oil is washed ashore in zones where waders search for food. Wetlands are important wader habitats, for example the wetland system at Ørlandet. The winter population of Purple Sandpipers is of international importance, and may indirectly be influenced by an oil spill if feeding areas in the tidal zone of exposed skerries are contaminated.

Kittiwake *Rissa tridactyla*

Breeding. One of the the largest colonies in Norway, with an estimated 60,000 pairs, is located at Runde. Farther north, large colonies are found on the islands Røst and Vedøy, comprising 23,000 and 19,000 pairs respectively. Several smaller colonies are located within the area under discussion, and many have experienced serious population declines or reproductive failure in recent years.

Kittiwakes are not considered particularly vulnerable to oil contamination. However, because the population has declined after 1970, and the present population at Runde is only about 40 % of what it was fifteen years ago, they are mentioned in this report. The colony at Halten has also experienced a serious reduction in numbers of nests from 1,666 in 1974 to 105 in 1986 (Lorentsen 1986). In the given situation, additional damage related to oil contamination may reinforce an increasingly negative trend.

Guillemot *Uria aalge*

Breeding. Runde is the only large Guillemot colony in southern Norway, and represents a population of about 8-10,000 pairs. Heavy population declines in northern Norway during recent years have resulted in that the colony at Runde may be the only large colony in Norway which still supports a stabilized population.

Larger colonies farther north are first found on Røst and Værøy, which support populations of about 1,000 and 2,000 pairs respectively. Elsewhere in the influence area, the species is only found in limited numbers. At Sklinna the population is estimated at between 30 and 40 pairs.

Guillemots assemble in breeding colonies long before the start of egg-laying, and on certain days (often at 3 to 5 day intervals) large flocks of Guillemots and other auk species may congregate just outside the colony. Most of these individuals are sexually mature birds and represent the most vulnerable segment of the population. Their whereabouts during interim periods, or whether they congregate within the influence area of the Midgard field en route to the colony, are factors about which little is known.

Young birds jump into the sea when they are only three weeks old, before they are able to fly. They then begin a swimming migration (post breeding movements), see separate section about these movements.

Migration/winter (based on ring recoveries). A total of 152 recoveries of Guillemots ringed at Runde were reported as of 1985, and yield considerable information about migration patterns. Most recoveries are made along the Norwegian coast during autumn and winter. Only eleven recoveries were made in foreign countries. Recoveries show that the Guillemot population at Runde spreads along the entire Norwegian coast from Troms to Rogaland during the autumn, and it appears that more birds migrate north than south (Haftorn 1971). Several recoveries were also made along the coast of Sørlandet and Østlandet, later in the winter. All eleven recoveries made in foreign countries were reported from coastal areas along the North Sea.

Several birds ringed in other areas, including northern Norway and the Murmansk region, have also been recovered. However, most of these stem from breeding areas to the west including the Faroe Islands, Shetland and the rest of Great Britain, and some from Helgoland.

Recoveries clearly demonstrate that the coast and nearer open sea areas off central Norway and Helgeland are used by part of the wintering population from Runde. Although little is known about the composition of the wintering population, the area is also used by birds from some Guillemot populations from northern Norway, northern Russia, Great Britain and the Faroe Islands.

The migration pattern of Guillemots is partially illuminated by recoveries of ringed Guillemots at several different location in Europe (Mead 1974, Baillie 1982). These recoveries demonstrate that ringed Guillemots from Helgoland, eastern England and the northern parts of Scotland occur in southern Norway. A large number of birds also originate from colonies in the Faroe Islands (Olsen 1982).

Post breeding movements from the colony at Runde. Follestad (1988a) summarizes the results from a project on the post breeding movements of Guillemots and Razorbills after taking to sea from the breeding colonies on Runde outside Ålesund in 1988, including some of the results from a similar study in 1985.

Field work both in 1985 and 1988 was divided into three phases: (a) date of departure and extent of young birds taking to sea, (b) dispersal of young and adult birds away from the colony, and (c) distribution and density at sea.

Very few young Guillemots were seen at sea north of Runde in 1988 compared with 1985, when several young Guillemots were observed near land, many during the course of other field work. This is particularly evident in results from transects at sea from Kristiansund to Haltenbanken (Table 8). As young Guillemots left the colonies later in 1988 than in 1985, the two first transects in 1985 may be compared with the transects in 1988. 102 young Guillemots were observed on these two transects in 1985, against only 3 in 1988.

Table 8. Numbers of young Guillemots and Razorbills at sea in transects from Kristiansund to Haltenbanken in 1985 and 1988.

Year	Dates	No. of observers.	No. of young Guillemots	No. of young Razorbills
1985	19-23.7	2	21	-
	3- 5.8	2	81	-
	18-19.8	1	6	-
	11-12.9	1	-	-
1988	26-27.7	2	1	-
	8- 9.8	2	2	-

When the young Guillemot take to sea, it weigh only about 200-300g, or 20-25 % as compared to the adults. Three young Guillemots observed between Kristiansund and Haltenbanken in 1988, were rather large and almost at the same size as the adults. They were so large that it would have been difficult to distinguish them from adults at some distance. This indicate that they were not from the birds taking to the sea on Runde in the middle of July or later. We cannot exclude the possibility that young Guillemots from Scotland or the Faroe Islands may reach our coast at the same time or shortly after that young have taken to sea at Runde, and this make it difficult to interpret some of the observations at sea.

Haltenbanken appeared to be a very important area for Guillemots in 1985, where densities between 2 an 5 young Guillemots/km^2 were observed in August. In that hardly any birds at all were seen in the area between Haltenbanken and the mainland, the tendency by young Guillemots to remain at Haltenbanken for some time was conspicious. Meanwhile, several young Guillemots were observed near land during the course of other fieldwork. We are unable to ascertain whether both groups originated from Runde, or if this distribution pattern is associated with dispersal patterns found at Runde, where some birds migrated towards open sea while others moved into the fiords.

Haltenbanken seemed, however, to be of no importance to young Guillemots in July and August in 1988. As practically no young Guillemots were seen north to norteast of Runde this year, and some were seen southwest of the island, the migration pattern seemed to differ quite well from previous years.

It seems reasonable to assume that the post breeding movements in 1988 has been directed at first to west or south west, and then possibly more to the south. We have, however, little documentation of this, even if lack of observations may be a strong indication.

In 1988 a series of transects close to Runde were surveyed to find the feeding areas for seabirds on Runde during the chick rearing period. During the breeeding season most of the birds migrated to west or southwest, at the coast south to areas round Svinøya or to the islands and fiords against south or southeast. Early in July huge numbers of auks were reported between Voksa and Kvamsøy and in Vanylven all the way in to Fiskå and Åheim.

On the other hand, very few birds were observed at all in directions dominating earlier years, in the sectors towards north and northeast against Breisundet and Giske/Haram. Birds actually seen in these areas in 1988 were probably most young and non-breeding birds.

Later in the observation period less migration were observed to the south, as the activity was greater in the sector to southwest or northwest.

Important in understanding these migration patterns, and probably also the post breeding movements, is the fact that 1988 was the best spawing year for the Herring after the collapse in the stock in the late 1960s. From the end of May it was evident that Herring larvae dominated the food habits close to Runde. Particularly high concentrations were found in the sectors S-SE, between the islands and in the fiords. Herring larvae was the main food for Puffins, and it was found Puffin chicks filled with Herring larvae. At the same time the supply of other fish species was good, and several of these also fed on Herring larvae: Saithe, Mackerel, Sandeel, sprat and 1-group Herring.

The marked change in feeding areas compared with earlier years may thus have been caused by the high concentrations of Herring larvae and other fish species close to and south or west of Runde in 1988. We do not know, however, if this also explain the change in the post breeding movements of Guillemots.

Such changes in both feeding areas and post breeding movements makes an evaluation of the environmental impact of oil spills much more complicated, and it will also be more difficult to know what will be the best strategy in plans of oil spill combating and protection.

Post breeding movements from colonies in the British Isles. On the basis of comprehensive mapping of seabirds at open sea in Britain, Blake et al. (1984) contends that there is no direct evidence to support suggestions by Mead (1974) that young birds incapable of flying accompanied by one of their parents, swim across the northern part of the North Sea from colonies in England and Scotland in an enormous migration to southwestern Norway. The highest numbers of recoveries of Guillemots which are ringed in England or Scotland, are recorded in Norway in October and November. In the light of these recoveries, Blake et al. (1984) assume that Guillemots first leave Great Britain in September.

Surveys in July 1985 and 1986, showed that significant numbers of adult Guillemots with their youngs were found in several areas in the North Sea, indicating that large migrations of Guillemots with young across the North Sea occur shortly after they leave their colonies. Further mapping is needed to evaluate the degree to which an oil slick from Midgard may affect the post breeding movements of auks from Great Britain and the Faroe Islands. In July and August, adult birds have moulted their primary feathers and are incapable of flying. They are therefore extremely vulnerable to oil contamination during this period.

Razorbill *Alca torda*

Breeding. The only substantial colony of Razorbills in southern Norway is on Runde, where the population is about 3,200 pairs. Larger colonies farther north are first found on Røst and Værøy, which support populations of 4,000 and 800 pairs respectively.

Razorbills also congregate at colonies prior to egglaying (see section about Guillemots).

Migration/winter (based on ring recoveries). Only 14 recoveries have been made of young Razorbills ringed at Runde. Two of these recoveries are from central Norway (June, September), one from southern Norway, three in Denmark, and seven further south (Ireland, East Germany, the Netherlands and France). Although recoveries are few, they do indicate that the breeding population at Runde migrates south during the winter. No young Razorbills was observed at Haltenbanken in 1985 and 1988 (Table 8).

On the other hand, in that 6 recoveries of Razorbills ringed in northern Norway have been made in the influence area between October and March, the area appears to be important for wintering birds from northern Norway. We have no information about the number of birds which may winter in the influence area. Several Razorbills ringed in Great Britain have also been recovered in the influence area, as well as some birds from Sweden and the Soviet Union.

Black Guillemot *Cepphus grylle*

Breeding. The Black Guillemot breeds in single pairs, or in small and loose colonies in outlying coastal areas. The largest colonies are found in the most isolated islands and skerries, a factor related to the abundance of mink, which is a serious predator (Folkestad 1982).

Few reliable figures are available for breeding populations of Black Guillemots in Norway, and considerable methodological problems are encountered in evaluating the abundance of this species (see Munkejord 1983). The entire population is estimated at between 11,000 and 19,000 pairs (Evans 1984).

Froan supports by far the largest numbers of Black Guillemot in the Trøndelag counties, with an estimated population of about 2,000 pairs. The Black Guillemot is also found in greater numbers on the coast of Helgeland, especially on some localities in Vega.

Migration. Most Black Guillemot recoveries are of birds ringed on Grasøyane in Ulstein, and 26 of 31 were recovered along the coast of Møre & Romsdal. Three recoveries were made in Sør-Trøndelag, one in Sogn & Fjordane and one at Hordaland, indicating that the Black Guillemot may disperse along the coast outside the breeding season, although long migrations are uncommon. Two Black Guillemots from northern Norway (Andøya and Senja) have been recovered in the influence area. None of the Black Guillemots ringed in Norway have been recovered in foreign countries and vice versa.

Winter. The Black Guillemot is, unlike other auk species, associated with coastal areas during winter. Several locations within the influence area of Midgard are among the most important wintering grounds for the species, particularly Froan and Vega.

Experiences from previous oil spills along the Norwegian coast (Helgeland coast, Røv 1982) indicate that the Black Guillemots is extremely vulnerable in the event of an oil spill.

Puffin *Fratercula arctica*

Breeding. The Puffin is the most abundant seabird species in Norway, with a total population of more than one million pairs. They breed along the entire coast from Rogaland and northward, usually in very large colonies.

The far largest Puffin colonies in Norway are, however, found at Røst and Værøy, with a total of about 700,000 and 70,000 pairs respectively.

The colony at Runde is the largest in southern Norway, and is roughly estimated at 75,000 pairs. Two large colonies are located within the influence area: 60,000 pairs at Lovunden, and 10,000 pairs at Fugløy in Gildeskål (Røv 1984). Some smaller colonies are also found.

In common with other auk species, the Puffin is extremely vulnerable to oil contamination. During the spring, before the start of the breeding season, large flocks congregate on the sea near the colony. An oil spill at this time would mainly strike sexually mature individuals (see also comments on Guillemots).

Systematic investigation of population dynamics and reproductive biology has been carried out at Runde and Røst (Røv 1984), and also to a certain extent at Sklinna. A significant declining trend is indicated by figures from Røst, and suggest serious reproductive failure. It is difficult to make any concrete statement about Runde and Sklinna, but developments appear to have stabilized in both areas. Sharp declines are reported for Lovunden.

Migrations/winter. In contrast with Guillemots and Razorbills, young Puffins are able to fly when leaving the colony at the end of the breeding season. They thus do not perform a post breeding movement by swimming as in the two other species.

Nineteen Puffins ringed at Runde have been recovered. These recoveries indicate that birds from Runde may disperse at sea after the breeding season, but more detailed conclusions are impossible. Four Puffins ringed in Great Britain have been recovered in central Norway, indicating that other Puffin populations are also found in the area.

Apart from during the breeding season, little is known about distribution of Puffins. However, there are several indications that a significant number of Puffins from Røst and Runde may live within the influence area of the Midgard field during short or longer periods in the year.

Little Auk *Alle alle*

The Little Auk is a high arctic breeder, and is only found within the influence area outside the breeding season.

Winter/spring. Se section 4.2.

4.4 Important seabird localities

Particularly important seabird localities are described here only briefly. Emphasis is placed on species most vulnerable to oil spills.

Runde, Lovunden and Røst/Værøy are the three largest bird cliffs which may directly or indirectly be affected by oil spills from Midgard. Directly by oil spill present in the vicinity of the colonies during the breeding season, and indirectly by oil spills that may threaten auks on their post breeding movements, like Guillemots from Runde moving north towards Haltenbanken.

Giske and Haram support significant populations of divers, grebes and cormorants. Relatively large numbers of Red-breasted Merganser have been observed at Giske, and good populations of other marine ducks have been found in both municipalities.

Outer coastal areas of Romsdal are important for several species. Large numbers of divers, grebes, cormorants and Red-breasted Merganser have been observed in the municipalities Midsund, Sandøy, Aukra and Fræna, as well as significant populations of Common Eider, Long-tailed Duck and Velvet Scoter. A large population of Whooper Swans is also found in the Fræna/Eide area.

High numbers of cormorants and Red-breasted Mergansers have been observed in the vicinity of Averøya.

Smøla is clearly the most important coastal wintering area in Møre & Romsdal county. Significant numbers of several species have been observed here, especially populations of divers and grebes, which are among the largest in the country. The populations of the Red-throated Diver and the Great Northern Diver, which are predominant among the divers, and the Red-necked Grebe are of European importance. Smøla is also an important moulting area for Greylag Geese, Common Eiders and Veltet Scoters.

Froan and Vega are two of our most important seabird areas on a year-round basis. There are important breeding localities for the Black Guillemot in Norway, and an oil spill here may have drastic consequences for the population size of this species. The breeding populations of the Cormorant and the Eider are also outstanding.

Froan and Vega are the most important moulting sites in Norway for Greylag Goose and Eider, probably also for Red-breasted Merganser, with about 35,000 male Eiders in Froan. Both are also the most important wintering areas for several species. An oil spill at any time of the year may kill several thousands or tens of thousands seabirds in both Froan and Vega.

Ørlandet is an important moulting area for Velvet Scoter and Eider, and a wintering area for several species. The wetlands of Ørlandet is unique in this region, and is an important area for several dabbling ducks and waders. Some localities are protected according to the Ramsar Convention.

Outer Vikna is an important wintering site for several species.

Sklinna is an important breeding area for Cormorants, Shags, Puffins and Black Guillemots. Due to a mole oil may be 'trapped' just outside the breeding sites.

The coast of Helgeland south of Vega has important moulting and wintering areas for several species.

Røst is also an important wintering area, particularly for Common and King Eiders.

4.5 Further research and monitoring

In order to fully understand the long term consequences of oil pollution for seabird populations, increased knowledge about the population dynamics of each species is essential. Therefore basic biological research is vital to analyses of the impact of oil pollution on seabirds.

This report hopefully provides a fundation on which to build further research and establish monitoring programs, which will be useful in interpreting problems encountered as a result of developments within the petroleum industry. We wish to emphasize that the population composition of several species should be thoroughly investigated, and that ringing is vital to this type of research.

Chronic oil pollution, which to a certain extent is associated with drilling activities and the petroleum industry in general, can result in damages to seabirds. Investigations of the extent of this type of pollution should be initiated.

Enormous seabird resources would be exposed to oil contamination in the event that an oil spill stranded in the impact area. Research and development of methods for preventing seabirds from coming into contact with oil on the surface of the sea, should be given priority.

5 Impact assessment

5.1 Analysis model on the impact of oil contamination

Oil constitute a serious and well documented danger for seabirds, and many millions have been killed after large and small oil spills. Of the three main factors contributing to the risk for local seabird populations, i.e. the probability of an oil spill event, the dispersal of the oil over the area, and the numbers, distribution and vulnerability of seabirds in the area, only the last is amenable to analysis by ornithologists.

An analysis of the impact of oil spills on seabird populations, should, ideally, provide information on the short and long term effects at population levels of all vulnerable seabirds within a given area. An impact analysis thus involves evaluations of vulnerable seabird populations in inshore and off-shore areas during the year, degree of vulnerability, population stability, potential risk, criteria for evaluating the importance of conservation effects concerning a particular population, effects of different types of oil and components (raw oil etc.) and measures for restricting damage from oil contamination.

A new oil vulnerability index for seabirds which differentiate between individual vulnerability and population vulnerability, and between different seasons, recognize 17 criteria, 9 at the individual level and 8 at population level, that the vulnerability of seabirds to oil is dependent on (see Anker-Nilssen 1987). In the lack of vital biological data, we are at present unable to construct realistic calculations concerning the number of birds which may be damaged or killed as a result of oil contamination. Neither are we able to predict the length of time required before an effected population may recover.

Without digitalized oil drift simulations, necessary for applying the analysis model described by Anker-Nilssen (1987), this analysis system can not be entirely carried through. Only a qualitative evaluation, based on descriptions of assumed vulnerable seabird populations relative to statistics on direction and drift obtained through simulation of oil spills, is therefore presented here.

However, for several species and populations within the impact area for the Midgard Field, the extent of the effects of oil contamination may be regarded as more or less similar to those for seabirds populations in the Barents Sea. The following discussion is partly based on calculations made in an impact analysis constructed for the southern Barents Sea (Anker-Nilssen et al. 1988a). It should be emphasized that the data base concerning seabirds at open sea is poor. Several simulation experiments demonstrate that these populations would be jeoparidized in the event of an oil spill at Midgard.

In the following analysis we have distinguished between consequences of oil pollution and consequences related to other conditions categorized as physical encroachment factors.

This summary only discusses species which are assumed to be highly vulnerable to oil contamination.

5.2 Long term effects of oil contamination

Seasonal variation in the impact on different groups of seabirds

Typical seabirds are most vulnerable to oil contamination. The largely pelagic life cycle of petrels and auks affords them little protection, particularly outside the breeding season when birds are not associated with colonies.

Cormorants and Shags breed in highly vulnerable localities, which renders them much more exposed during the summer. In the winter, the Shag is more exposed than the Cormorant which at least partly remains in more protected coastal areas.

Ducks represent a moderately exposed group. However, extensive or significant effects may be expected for Eiders throughout the year, for Velvet Scoter and Red-breasted Merganser during the moulting season and in the winter, and for Long-tailed Duck during the winter.

The long term effects on most coastal gull populations are likely to be moderate. However, breeding populations of Lesser Black-backed Gull are particularly exposed because the species is somewhat pelagic, and the population has declined drastically in recent years.

Other seabird groups are less exposed, and significant long term effects are only anticipated for moulting Greylag Geese.

The effects of drilling during different seasons

Spring. In March-April, large pelagic populations mainly of Little Auk may be vulnerable to oil spills from the Midgard field. Considering the densities of 1,000-1,500 Little Auks/km^2 found in some areas at the end of March/beginning of April in 1988 and 1989, one may expect comprehensive damage even from smaller spills. Chronic spillage from normal platform activities in this area, could in time result in extensive damage.

Divers, grebes and ducks may congregate in large flocks before and during spring migration along the coast line, and as this will mainly be adult birds, oil spills may result in negative effects on a long time scale.

Breeding season. In summer (April-August/September), the effects may be considerable in the event of an oil spill affecting breeding populations of cormorants, Eiders and auks in the influence area.

Oil drift simulation experiments indicate that the coast from Trøndelag to Helgeland is most exposed to potential stranding of oil from the Midgard field. Several seabird colonies, some with very large breeding populations of vulnerable species, may be exposed to oil spills. Potential damage to auks in particular may be considerable, but the extent of damage may vary according to time of the year, stages in the breeding cycle, weather conditions etc.

Prior to the start of the breeding season, large and dense flocks of auks often congregate on the sea just outside the colony. Most of these birds are reproductively active adults. If these individuals are hit by an oil spill, the long term effects for the population will be serious. Although actual figures are not avialable, it is roughly estimated that if half of the breeding population of Guillemot is lost, 50 years may elapse before the population approaches normal levels.

Later in the breeding season, young or non-reproductive individuals may reside near the colony, while breeding birds occupy the cliffs, or are away in search of food. The extent to which breeding birds may be affected by oil contamination depends on the size of the area in the vicinity of a colony through which an oil spill may pass.

Population developments have been negative for all of the auk species in Norway, but particularly for Puffins at Røst and for Guillemots in Troms and Finnmark. Røst/Verøy supports by far the largest seabird colonies in Norway. The Puffin population here has been reduced by one-half from 1979 to 1989 due to failed reproduction. The Puffin colony at Lovunden also appears to have declined radically. In such a situation it is of prime importance that oil contamination to these populations is prevented in the future.

Black Guillemots breed more dispersed than other auk species. They are often preyed upon by the Mink, and therefore mainly nest in out-lying coastal areas, where they ufortunately are exposed to stranded oil. The greatest numbers of this species within the influence area for Midgard, are found at Froan and Vega. Oil which strands in these areas could damage a large proportion of the total population of Black Guillemots in Norway.

At Sklinna, a mole between two islands may act as a kind of oil trap, and lead to extensive damage to birds on the water in the vicinity of the colonies.

Moulting period. An oil spill occurring during the moulting season for ducks (July-September/October) would affect large numbers of birds. The populations of moulting Eiders at Froan and Velvet Scoters at Ørland are very large. Moulting populations at Froan and Vega would be very vulnerable in the event of an oil spill from Midgard field.

Moulting seabirds often congregate in dense concentrations in particular areas. Greylag Geese, Eiders and mergansers assemble in exposed areas of the archipelago. They are unable to fly and are therefore highly vulnerable to contamination from oil spills. Velvet Scoter usually flock in less exposed areas, but are nevertheless a highly vulnerable species to oil spills.

Damage to moulting duck populations may be considerable when oil strands in areas including Froan, Ørlandet and Vega. Today, these regions are internatinal important areas for moulting waterfowl.

The composition of moulting flocks along the coast is unknown. Damage to moulting waterfowl populations (local as well as foreign populations, possibly including Fennoscandian breeding populations) may have serious long term consequences for breeding populations.

During moult and the swimming migration period for Razorbills and Guillemots (July-September), the effects of an oil spill would be considerable, particularly if striking Razorbills or Guillemots with their young en route from their colonies. During the post breeding migration, adults and young are incapable of flying for more than two months. The direction of the Guillemot migration from Runde probably varies from year to year, thus complicating evaluations of the potential impact of an oil spill.

Winter. An oil spill in the winter could result in serious consequences. Coastal populations of Red-throated Divers, White-billed Divers, Great Northern Divers, Red-necked Grebes, Cormorants, Shags, Eiders, Velvet Scoters, Red-breasted Mergansers and Black Guillemots are especially vulnerable. Significant populations of Razorbill, Guillemot and Little Auk are probably spread along the entire coast where they are largely pelagic. Existing data suggests that the influence area for Midgard contains important winter habitat for several pelagic seabird populations.

Computer simulation of oil drift and stranding reveals that potential for stranding in large areas of Sør-Trøndelag, Nord-Trøndelag and Helgeland is highest during the winter. The risk of oil contamination during the winter is higher because of the low number of daylight hours and reduced visibility, and decreased survival after even small oil damages related to lower temperatures.

The influence area of the Midgard Field is the most important wintering area for most of the seabird species which are considered vulnerable to oil contamination, in all of Norway. A significant weakness of the available material on these species is the lack of information concerning which populations winter in the area. Evaluation of the impact of damages related to oil spills, is largely limited to the number of birds which may be affected, and to a lesser degree the long term consequences for different populations.

Divers and grebes are highly vulnerable to oil contamination. These species breed in small numbers throughout their entire distributional range. Therefore, a relatively significant number of birds winter in coastal regions of the influence area. Oil stranding may lead to high losses of certain species and significant reductions of the breeding population.

Experiance from England demonstrates that species like the Great Northern Diver are exceptionally vulnerable. During one oil spill, the number of carcasses of Great Northern Divers found dead as a result of oil contamination exceeded the total number of individuals previously though to be living in the area. The above illustrates the extreme difficulties in properly surveying these species. Information on the size of the breeding population of several of these species is limited, and it is difficult to make conclusions concerning populations in different areas.

Cormorants winter along the coast in the entire area, with the largest concentrations at Froan. Damages to cormorants here would probably affect birds originating from several areas along the coast, thereby reducing the total extent of damage to a single population. Shags are more often found in outlying coastal areas, and are therefore more vulnerable to oil contamination than the Cormorant. Reduction in the number of adult Shags at the colony at Runde, which have undergone serious declines and poor reproductive success in recent years, would have particularly serious consequences.

Eiders are found in both inner and outer coastal areas, with the largest concentrations in areas highly exposed to oil contamination. Oil stranding in Froan, Vikna, Vega or at Røst could injure large wintering populations. We have no information on which populations would experience greatest losses. Serious losses may intensify negative developments already seen in wintering populations of Eiders in recent years.

Velvet Scoter are highly vulnerable to oil contamination as documented during the occurrence of several oil spills in foreign countries. Heavy losses of Velvet Scoter may be expected in the event of an oil spill stranding at Frøya/Ørlandet, Vikna or Vega. We have no information on which populations may be involved.

Long-tailed Ducks are often found in areas which are exposed to oil spills. The species is relatively abundant and evenly distributed throughout the area. The consequences for breeding populations and potential losses resulting from oil contamination, are unknown.

Mergansers are highly vulnerable to oil contamination, but often occur in areas which are less exposed, such as between islets and skerries. They are highly mobile, and may follow schools of fish. At present we have no information on which populations may be affected in the event of an oil spill.

The auks species are highly vulnerable to oil contamination. Although they may occur in varying numbers along the coast, all species but the Black Guillemot, are most abundent at open sea (see following section). Experiences from earlier oil spills has shown that the Black Guillemot is highly vulnerable to oil spills, but even if long term effects on local populations could be expected whenever large numbers of Black Guillemots are killed, we lack reliable data on population development of this species in Norway.

Off-shore seabird populations. Although our data base is poor concerning the distribution and abundance of seabirds at sea, we have data that may indicate the possibility of an oil spill to injure a very high number of seabirds, particularly the auk species, even within a restricted area. Concentrations of Little Auks and Puffins as high as 1,000 birds/km^2 or more have been found off the coast of Møre & Romsdal and Sør-Trøndelag in spring. Such concentrations are most probably related to food resources, but they are with our present knowlegde, highly unpredictable in time and location.

We do not know wether or not these birds also winter in this area, but if they do so, the short term effects of even a small oil spill may be great with a large number of birds killed. The long term effects at population level, however, can not be evaluated properly with our present knowledge of their origin and how their distribution and abundance is related to food resources.

Effects on particularly vulnerable and endangered species

Regardless of the season, many populations which are already threatened, would be in danger in the event of an oil spill.

Almost half of the populations treated in this analysis are internationally important. During all seasons, populations which are concentrated in small areas are vulnerable. Even a single oil spill may under such conditions, exterminate an entire population.

Negative population trends are found for several of the most significant and vulnerable seabird populations in Norway. Factors including lack of food, oil contamination, and drowning in fishing gear appear to account for a steadily increasing mortality among many threatened seabird populations, including populations which are otherwise expected to be exposed to potential oil spill in the influence area. Many of the most vulnerable populations are typical seabirds with long life expectancy, slow sexual maturation and low annual reproduction. Such characteristics result in slow restitution following a crisis. Long-lasting negative population dynamics indicate that the vulnerability of many species has already approached an alarmingly high level. Under the existing circumstances, it is not adviseable to introduce yet another potential source of environmental stress.

5.3 Immediate effects of an oil spill

The immediate effects of oil contamination on seabird populations are apparent within a relatively short time period after a spill has occurred. These are conspicuous, easily registered and include dead birds washed ashore and oil contaminated individual birds. Immediate effects of oil contamination are often the source of great public concern, and media coverage.

Immediate damage potential is particularly high during the winter. Folkestad (1983) documented that the most frequent and worst damage to seabirds in association with oil spills occurred during the darkest time of the year. One may assume that these factors are related to limitation of the chances that birds will discover an oil spill under poor light conditions and low temperatures.

The vulnerability of an entire population is generally higher than for single individuals in breeding autumn and spring populations, but about the same in moulting and winter populations. In other words: if a certain number of individuals in a population are affected by oil contamination, the long term damage will be greater in breeding, autumn or spring populations than when affecting a moulting or winter population.

5.4 Indirect effects of oil

Seabirds may also be indirectly affected by an oil spill in several ways. Destruction of habitat, changes in social structure in cases where one age group or sex category are hardest hit, disturbance related to clean up efforts and other activities are some examples. Comprehensive investigations of such situations are lacking, and it is impossible to evaluate their significance.

This chapter briefly outlines some of the most important types of indirect effects, and their relative significance for different seabird populations in the influence area. Evaluations are based on the most characteristic differences in each groups biology, and are presented in Table 9. Categories of effects are discussed in the same order as presented in the table.

Table 9. Indirect effects of an oil spill on the seabird populations in the impact area of the Midgard field, divided on different systematic groups. The expected negative effects are given on a scale 0-3, where 0 = insignificant, 1 = small or moderate, 2 = considerable and 3 = very considerable. Effect categories: A = Contamination of the breeding area, B = Disturbance in breeding areas, C = Deterioration of available food resources, D = Socially determined effects, E = Temporarily reduced reproduction in damaged individuals, F = Reduced reproduction in non-contaminated individuals.

Systematic group	Effect category					
	A	B	C	D	E	F
Divers	1	2	1	1	*	1
Grebes	0	0	3	1	*	3
Petrels	0	1	2	3	3	3
Gannets	3	3	3	3	*	3
Cormorants	3	3	3	3	*	3
Swans	0	0	3	2	3	3
Geese	2	3	2	1	3	2
Dabbling ducks	2	2	3	1	3	2
Diving ducks	3	3	3	2	*	2
Mergansers	3	3	3	1	*	2
Phalaropes	2	2	2	1	3	2
Skuas	2	2	1	1	3	3
Gulls	3	2	2	2	3	3
Terns	3	3	3	3	3	3
Auks	2	2	3	3	*	3

* See explanation in text.

It should be emphasized that the occurrence of several simultaneous effects will amplify the magnitude of damage considerably.

Contamination of breeding areas (A), when breeding grounds or the immediate vicinity are soiled with oil. The immediately surrounding area often includes roosting areas, feeding grounds and approaches to nests. This may result in that the area is inaccessable or unusable for seabirds.

Cormorants often have roosting areas on small, low islets and skerries where oil strands easily. Geese and ducks pass through shore areas on their way to and from land, and their breeding behaviour may be altered if oil accumulates on the shoreline. These species also rely on rich feeding areas near land. The White-tailed Eagle and many gull species are carrion feeders, and may be poisoned through feeding on oil damaged prey species.

Disturbance in breeding areas (B), resulting from clean up activities or other activities. Few species tolerate abnormally high disturbance over extended periods of time. However, some species are more vulnerable than others. During clean up activities, species nesting nearest the shore are most directly affected. Clean up activities may last for several days and stress may result in negligible reproductive success for some species.

If Cormorants are frightened away from nests, eggs and young are very conspicuous and easy prey for opportunistic predators like ravens, crows and gulls. Sea ducks and mergansers are not easily scared away from their nests, but once frightened may avoid the nest later. Because terns nest in colonies on the shoreline, any clean up action would expose all eggs and young simultaneously, resulting in considerable damage over a short time period. Unnecessary disturbance of White-tailed Eagle breeding habitat is not recommended.

Deterioration of available food resources (C) through damage to food organisms caused by oil dispersion agents, or that important feeding areas become inaccessible related to oil contamination of the surface of the sea or the sea-bottom.

The effects of oil contamination are largely determined by what different species eat and where most of their food is found. Divers such as Gannet and terns are entirely dependent on visually locating their prey from the air. Even a thin oily film on the sea surface reduces visibility, causing difficulties for birds attempting to locate prey. Cormorants, ducks and Black Guillemot forage in shallows near land. Sinking oil deposited on the sea bottom will limit availability of organisms on which these seabirds depend for food. Auks are particularly vulnerable. All species dive in their search for food, often to great depths. Prey are mostly small fish and crustaceans. Comprehensive contamination of these species may have serious consequences for auks, which are often specialized feeders and experience difficulties in finding alternative sources of food.

Socially determined effects (D). Population declines may result in alterations of the social behaviour of remaining individuals, and reduced reproduction capacity or survival. Colonially breeding birds are particularly vulnerable. Effects of this kind within the influence area would have significant consequences for auks. Social stimuli between individuals may influence breeding progress. In many species, synchronized egg-laying increases breeding success. The social structure within a colony is a determining factor for egg-laying synchronization. If the number of individuals is reduced, reproduction declines or in some cases fails completely. At other times of the year, social aspects are also important for several different species, as illustrated by behavioural signalling of discovery of food or the approach of predators.

Temporarily reduced reproduction in damaged individuals (E) which survive oil contamination. This may result from handicaps which prohibit breeding, or because oil on their plumage contaminates their eggs or young thereby reducing survival (e.g. Clark 1984). Oil contamination particularly affecting one sex will result in the most serious negative consequences.

The extent of effects is dependent on when oil contamination occurs, and the length of time required for restitution. Little is known about the chances of survival for oil contaminated birds. Relatively large birds have better chances of maintaining body temperature, and those feeding on land or on the shoreline have better chances for survival. One may therefore reasonably assume that geese and large gulls have high potential for restitution. Birds feeding exclusively from the surface of the sea have lower survival chances, but better than those for divers. Generally complicating factors are potential physiological damage and behavioural alterations related to soiled plumage (e.g. through preening).

Most seabirds have a high rate of energy consumption, and are not able to fast over long time periods without experiencing serious deterioration of their physical condition. Those entirely dependent on diving for their food usually die following extensive oil contamination. Reduced locomotor capacity and higher energy consumption associated with rapid decline in body temperature quickly results in serious obstacles for oil contaminated individuals. Divers, cormorants, diving ducks, mergansers and auks all belong to this category of seabirds. These groups are indicated with an asterix in Table 9, to indicate that effect type E is highly unlikely.

Reduced reproduction in non-contaminated individuals (F), related to mortality of mates during the breeding season. Groups given the highest values in Table 9 are comprised of species where both sexes contribute equally to bringing up young. Effects are of course dependent upon when during the breeding season a mate is killed and which of the sexes is affected. Oil contamination affecting only one of the sexes will result in most comprehensive consequences for a population.

When both sexes brood and participate in bringing up young, the loss of one of the adult birds usually results in negligible reproductive success. Greater damage to one sex may result in a serious lack of mates. This may occur among ducks and auks.

5.5 Effects of physical encroachment factors

Platforms. The most important physical encroachment factors are oil platforms and activities carried out in their immediate surroundings causing noise or light disturbance. The physical presence of oil platforms prevents or restricts seabird activity in the area. Investigations of physical encroachment by oil installations are inadequate, and it is therefore difficult to quantify the direct effects. However, one may reasonably assume that these are less significant than the effects of oil contamination.

Certain species may migrate to and concentrate in areas where the risk of oil contamination is high. Other species may be excluded from important feeding grounds. It is impossible to predict the extent of the consequences for vulnerable seabird populations.

Helicopter routes. Normal helicopter and supply base activities seems to have no important effects on seabirds in any of the suggested alternatives for helicopter and supply base. Helicopter flights at low altitudes should be avoided in the vicinity of Cormorant colonies in the breeding season.

Production Operations, Aqueous Emissions. Discharged water with residual oil which result in small oil slicks or blue shine in the vicinity of the platform, may injure seabirds at sea, particularly the auk species. In the North Sea auks tends to avoid platform constructions, but we don't know how they will behave in situations where very large numbers of birds may be present in spring.

5.6 The total significance of effects

Any conclusion concerning a seabird/oil impact analysis should consider the long term effects of oil contamination and damage on population levels, and present a total picture of the degree of damage. Thus far, analysis has shown that extremely serious consequences for seabirds in the influence area for Midgard field may be expected if the planned oil related activities are initiated and lead to significant oil spills. In the light of our knowledge of the significance of coastal and open sea areas of central Norway for seabird populations, and background concerning the significant consequences oil contamination represents for seabirds, these findings are not surprising.

The influence area is large, and no complete mapping of all seabird resources in the area has been conducted. Therefore the data base is by no means adequate. A general lack of information about the ecology of each population, limits the grade of precision in this analysis. In addition, little or nothing is known about reactions by seabirds to oil contamination or restitution potential under natural conditions

The negative population dynamics of several of the most vulnerable seabird species have recently been the object of considerable attention. Guillemot has been pointed out as a particularly threatened species which should not be exposed to additional environmental stress. Guillemots from the northern breeding population may winter in significant numbers in the influence area.

The effects of small oil spills or leakages from Midgard should be monitored in periods where the Haltenbanken area is likely to hold a substantial number of seabirds vulnerable to oil contamination, particularly the auks.

6 Summary

This report has been prepared as a data base report for "**Midgard miljøutredning**", prepared by Cooperating Marine Scientists on behalf of Saga Petroleum a.s. The seabird section in Saga's report is an extended summary of this report. Only a brief summary is therefore given here.

Oil spill damage is a serious threat to most seabirds through heavy smothering or hypothermia due to loss of plumage insulation. Birds may also suffer internal damage through ingestion of oil. Species are often divided into three categories of vulnerability: very high, high and moderate. Of the seabirds, divers, grebes, marine ducks and auks are considered to be the most vulnerable to oil pollution.

Oil drift simulation experiments indicate that coastal areas of Trøndelag and Helgeland are likely to be most severely impacted by oil from Midgard. Several seabird colonies, some with very large breeding populations are present in the region and damage to auks in particular may be considerable. It is roughly estimated that if half of the breeding population of Guillemot was lost, 50 years might elapse before the population approached normal levels.

Population developments have been negative for all of the auk species in Norway. In such a situation, it is of prime importance that oil contamination to these populations is prevented in the future.

Black Guillemots nest in out-lying coastal areas, where they would be among the first to be exposed to stranded oil. The greatest numbers are found at Froan and Vega and an oil spill here could damage a large proportion of the total population in Norway.

Moulting seabirds often congregate in large numbers. They are unable to fly and are therefore highly vulnerable to oil spills. Damage to moulting waterfowl may be considerable in some areas, including Froan, Ørlandet and Vega. These regions are internationally important for the populations of several waterfowl species.

Oil spill modelling indicates that potential for stranding is highest during the winter. The risk of oil contamination during the winter is higher because of poor light conditions, low temperatures and reduced visibility, factors one may assume will limitate the chances that birds will discover an oil spill, and decreased survival after even small oil damages related to lower temperatures.

The influence area of the Midgard Field is the most important wintering area in all of Norway for the vulnerable species. A significant number of Divers and Grebes winter in coastal regions and oil stranding may lead to high losses. Common Eiders are found in both inner and outher coastal areas. Oil stranding in Froan, Vikna, Vega or at Røst could injure large wintering populations. Heavy losses of Velvet Scoter may be expected if oil comes ashore at Frøya/Ørlandet, Vikna or Vega. Mergansers are highly vulnerable but occur in areas which are less exposed to oil. The Black Guillemot is highly vulnerable to oil but there is insufficient reliable data on population development of this species in Norway to be able to predict the impacts.

Although the data base on seabirds at sea is poor, there is sufficient knowledge to indicate that an oil spill might injure a very high number of birds, particularly of the auk species. Concentrations of Little Auks and Puffins as high as 1,000-1,500 birds/km² have been found off Møre and Trøndelag in spring. If this is the site of wintering auks too, the short-term effects of even a small oil spill may be great, with a large number of birds killed. Minor spills may impact seabirds at sea in the immediate vici-nity of the field installations, particularly the auk species.

Hence, the Midgard influence area holds large populations of both national and international importance. At any time of the year, an oil spill may threaten large numbers of vulnerable species both off-shore and inshore.

7 Sammendrag

Innledning.

Denne utredningen gir en oversikt over sjøfuglbestandene innen influensområdet for Midgard-feltet på Haltenbanken og en oppsummering av mulige effekter av oljeutslipp og oljerelaterte aktiviteter på sjøfugl. Utredningen danner grunnlaget for avsnittet om sjøfugl i SAGA's rapport "**Midgard miljøutredning**".

Geografisk dekker denne rapporten et område fra Ålesund (62°30'N) til Bodø (67°20'N), men en del data fra Runde i Møre og Romsdal og Røst/Værøy i Nordland er inkludert.

Simuleringer av oljedrift indikerer at kyststrekningen Trøndelag-Helgeland vil være mest utsatt for oljeskader etter et utslipp fra Midgard. Mindre oljeutslipp kan først og fremst skade sjøfugl i nærheten av plattformene, og da særlig alkefugl.

Sjøfuglenes sårbarhet overfor oljesøl.

Oljeutslipp utgjør en velkjent trussel for de fleste sjøfugler, først of fremst gjennom tilgrising og avkjøling når fjærdrakten mister sin isolerende evne. De kan også få indre skader når de får olje i fordøyelsessystemet når de pusser fjærdrakten eller eter oljetilsølt næring.

Sjøfuglene blir ofte inndelt i tre grupper etter hvor sårbare de er overfor oljesøl: svært sårbare, middels sårbare og lite sårbare. Lommer, dykkere, marine ender og alkefugler regnes her som de mest sårbare.

Kritiske perioder i tilfelle oljesøl er:

* Samlinger av ikke flygedyktige fugler
  - myteområder/myteflokker
  - svømmetrekk hos alkefugl
  - områder med store samlinger av unger
* Samlinger på rasteplasser
* Perioder med dårlige lysforhold/nattemørke, særlig vinterstid i nordlige områder.

Typisk for sjøfugl er deres lave reproduksjonskapasitet og høye gjennomsnittlige levealder, som viser at de er tilpasset en lav årlig voksendødelighet. Oljeutslipp som fører til økt voksendødelighet, kan derfor få langvarige effekter på bestandsnivå. Dette er en av flere årsaker til at flere sjøfuglarter er særlig sårbare overfor oljeuslipp.

Bestandens sårbarhet enn generelt større enn den individuelle sårbarheten for hekke-, høst- og vårbestandene, men omtrent like store for myte- og vinterbestandene. Eller sagt på en annen måte: Dersom et bestemt antall individer i en bestand blir berørt av et oljesutslipp, vil dette vanligvis representere en større belastning for bestanden på sikt dersom det er en hekke-, høst- eller vårbestand som rammes, enn om det er en myte- eller vinterbestand.

Sjøfuglbestandene i influensområdet.

Innenfor influensområdet for oljesøl fra Midgard-feltet finnes flere av de viktigste sjøfuglområdene i Norge, og for flere arter finnes her en betydelig andel av europeiske bestanden.

Området har meget viktige hekkelokaliteter for ærfugl, storskarv (Froan og Helgelands-området) og alkefugl (f.eks. fuglefjellene på Røst, Værøy, Lovunden og Runde og kolonier av teist i Froan og Vega).

Lomvi og alke foretar et svømmetrekk etter at ungene hopper på sjøen, og dette kan gi samlinger av alkefugl i åpent hav i en periode som strekker seg over to måneder da ungene og foreldrefuglene ikke er flygedyktige og dermed er ekstra sårbare for oljesøl.

Fjærfellingsbestandene av ærfugl (opp til 35,000 voksne hanner i Froan), sjøorre (opp til 7,000 individer i Ørland) og siland er meget store, også i internasjonal sammenheng. Bestandene for flere arter vil være meget sårbare for oljesøl dersom et oljesøl skulle ramme f.eks. Frøya eller Vega i myteperioden.

Noen av de viktigste overvintringsområdene i Norge finnes i influensområdet. For lommer, ærfugl, sjøorre, havelle og siland finnes her mer enn 50 % av hele den norske bestanden. For dykkere og teist utgjør overvintringsbestanden innen området nær 80 % av den nasjonale bestanden. Viktige overvintringsområder er Smøla, Frøya, Ørland, Helgelandskysten med Vega og Røst.

Vår kunnskap om fordeling og antall av sjøfugl i åpent hav i det aktuelle området er meget mangelfull, og kan ikke gi grunnlag for en detaljert konsekvensvurdering.

Noen undersøkelser viser at mange sjøfugler om våren samles i frontsystemer og områder med upwelling der det er høy produksjon, f.eks. i frontsystemet mellom atlanterhavsvann og kyststrømmen. Særlig høye antall er her funnet for alkekonge i slutten av mars.

Effekter av fysiske inngrepsfaktorer.

Viktige fysiske inngrepsfaktorer er selve installasjonene og tilknyttet virksomhet som arealbeslag, borekaks, forstyrrelse og lys. Manglende undersøkelser gjør det ekstra vanskelig å kvantifisere effekter som er direkte forårsaket av fysiske inngrep. Generelt er det imidlertid grunn til å anta at disse er av mindre betydning enn effekter av oljesøl.

Enkelte arter kan trekke til og konsentreres i områdene med størst risiko for oljesøl, mens andre arter står i fare for å bli utestengt fra viktige beiteområder. Det er umulig å forutsi hvor stor effekt dette kan få for de aktuelle sjøfuglbestandene i risikoområdet.

Langtidseffekter av oljesøl.

Sesongvariasjon i effektene for ulike sjøfuglgrupper. De mest typiske sjøfuglene vil være mest utsatt for oljeskade. Stormfuglenes og alkefuglenes sterkt pelagiske livsmønstre medfører at de er lite beskyttet, særlig utenfor hekketiden når fuglene ikke er knyttet til koloniområdene.

Skarvene hekker på svært eksponerte lokaliteter, noe som bidrar til at de er ekstra utsatt sommerstid. Om vinteren finnes toppskarven for en stor del i mer eksponerte lokaliteter enn storskarven, som delvis er knyttet til mer skjermede kystområder.

Endene er en mer moderat utsatt gruppe. Store eller betydelige effekter må likevel forventes for ærfugl gjennom det meste av året, for sjøorre og siland i myteperioden og vinterstid, og for havelle vinterstid.

Langtidseffekter for de mest kystbundne måkebestandene vil være av moderat karaktér. Hekkebestandene av sildemåke er derimot ekstra utsatt, fordi arten delvis forekommer pelagisk, og bestanden dessuten har gått kraftig tilbake.

De øvrige sjøfuglgruppene er vesentlig mindre utsatt, og bare for mytende grågjess kan det påregnes betydelige langtidseffekter.

Effekter ved boring i ulike sesonger. I **vårsesongen** (mars-april) er store pelagiske bestander av først og fremst alkekonge særlig utsatt for utslipp fra Midgard. Med tettheter over 1,000 alkerkonger pr. km^2, som ble funnet i noen områder i slutten av mars og begynnelsen av april 1988 og 1989, må en forvente svært omfattende skader selv av mindre utslipp. Også små daglige utslipp ved normal drift, kan her over noe tid få store følger.

I **sommersesongen** (april-august/september) kan effektene være svært store ved utslipp som vil berøre hekkeforekomstene av skarv, ærfugl og alkefugler i risikoområdet. Flere kolonier med til dels meget store hekkebestander av disse artene er lokalisert innenfor influensområdet til Midgard.

I **mytesesongen** for andefugler (juli-september/oktober) kan utslipp skade et stort antall fugler. Særlig store er mytebestandene av ærfugl i Froan og av sjøorre i Ørland. Mytebestandene i Froan og Vega, med sin eksponerte beliggenhet, vil være særlig utsatt ved et oljesøl fra Midgard.

I myte- og svømmettrekksesongen for alke og lomvi (juli-september) kan effektene være svært store dersom oljesøl rammer alke eller lomvi med unger på vei bort fra koloniene. Under svømmetrekket er både voksne og unger flygeudyktige i omlag to måneder, og er derfor særlig utsatt. Retningen på svømmetrekket for lomvi fra Runde kan trolig variere fra et år til et annet, slik at det her vil være mer komplisert å vurdere konsekvensene av et oljesøl.

I **vintersesongen** (november-februar/mars) vil utslipp gi svært store effekter. Særlig utsatte kystbestander er smålom, gulnebblom, islom, gråstrupedykker, storskarv, toppskarv, ærfugl, sjøorre, siland og teist. Viktige bestander som alke, lomvi og alkekonge er trolig mer jevnt spredt langs hele kyststrekningen, hvor de hovedsakelig opptrer pelagisk. De foreliggende dataene kan tyde på at det innenfor influensområde er meget viktige vinterområder for flere pelagiske sjøfugler.

Effekter for særlig utsatte og verneverdige bestander. Uansett sesong vil svært mange bestander med spesiell verneverdi stå i fare for å bli meget hardt rammet ved oljesøl.

De siste årene har det vært en klar negativ bestandsutvikling for flere av de viktigste og mest sårbare sjøfuglbestandene i Norge. Faktorer som matmangel, oljeskader og drukning i fiskeredskaper ser ut til å bli en stadig større belastning for en rekke av de mest verneverdige sjøfuglbestandene i området, også for de bestandene som må forventes å bli hardest rammet ved et omfattende oljesøl fra utredningsområdet. Mange av de mest utsatte bestandene er typiske sjøfugler, med høy levealder, sen kjønnsmodning og lav årlig reproduksjon, og har således ekstra dårlig restitusjonsevne. Langvarig negativ bestandsutvikling slår fast at belastningsnivået allerede er for høyt for mange bestander, og det er derfor meget betenkelig og svært risikabelt å introdusere ytterligere miljøbelastninger i en slik situasjon.

Øyeblikkelige effekter av oljesøl.

De øyeblikkelige effektene antyder omfanget av sjøfuglskader på individnivå i løpet av en relativt kort tidsperiode (dager-uker-måneder) etter et oljesøl. Dette er de effektene som lettest lar seg registrere, f.eks. i form av ilanddrevne oljeskadde individer, og som derfor har størst publikumsappell.

Det øyeblikkelige skadepotensialet er spesielt stort vinterstid. De fleste og største skadene på sjøfugl som følge av oljesøl, har skjedd i den mørke årstiden. Dette har trolig sammenheng med fuglenes begrensede muligheter til å oppdage oljesøl ved dårlige lysforhold og lave temperaturer.

Indirekte effekter av oljesøl.

Sjøfuglene kan også bli indirekte berørt av oljesøl på flere ulike måter. Eksempler er forringelse av habitat (og dermed reduserte livsbetingelser), sosiale endringer dersom en spesiell aldersgruppe eller det ene kjønnet blir særlig rammet, og forstyrrelser som følge av opprensningsaksjoner eller andre aktiviteter. Inngående undersøkelser av slike forhold mangler, og det er umulig å vurdere betydningen av slike effekter.

Effektenes samlede betydning.

For konklusjonene i en konsekvensanalyse olje/sjøfugl må det tas utgangspunkt i langtidseffektene av oljeskader på bestandsnivå, som gir det mest fullstendige bilde av skadeomfanget. Mulige effekter av fysiske inngrep og indirekte effekter av olje må likevel også drøftes.

Risikoområdet for virksomheten er stort, og det er ikke foretatt en fullstendig kartlegging av samtlige sjøfuglressurser i området. Datagrunnlaget har således betydelige svakheter, særlig for sjøfugl i åpent hav. Den generelle mangelen på kunnskap om sjøfuglbestandenes økologi begrenser presisjonsgraden i analysen. Videre er sjøfuglenes reaksjoner overfor et oljesøl og deres mulighet til å restituere etter en oljeskade nærmest ukjent under ellers naturlige forhold.

Flere av de mest sårbare sjøfuglene har hatt en betydelig negativ bestandsutvikling de siste årene. Lomvi er et eksempel på en spesielt utsatt art som ikke tåler ytterligere, større belastninger. Lomvi fra nordlige hekkebestander, som har opplevd den sterkeste tilbakegangen, kan overvintre i betydelige antall i risikoområdet.

Analysen har vist at det kan forventes svært alvorlige konsekvenser for sjøfuglbestandene i risikoområdet for Midgard, dersom den planlagte petroleumsvirksomheten blir iverksatt og fører til betydelige oljeutslipp. Dette er neppe overraskende med tanke på den betydning kyst- og havområdene utenfor Midt-Norge har for sjøfugl, både i nasjonal og internasjonal sammenheng, samtidig som oljeskader erfaringsmessig er en betydelig negativ faktor for sjøfugler. Uansett årstid vil et større oljeutslipp fra Midgard kunne skade et stort antall av flere svært sårbare arter både til havs og i kystnære områder.

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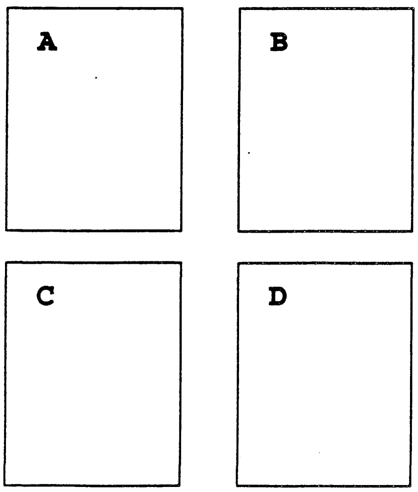
Map appendixes

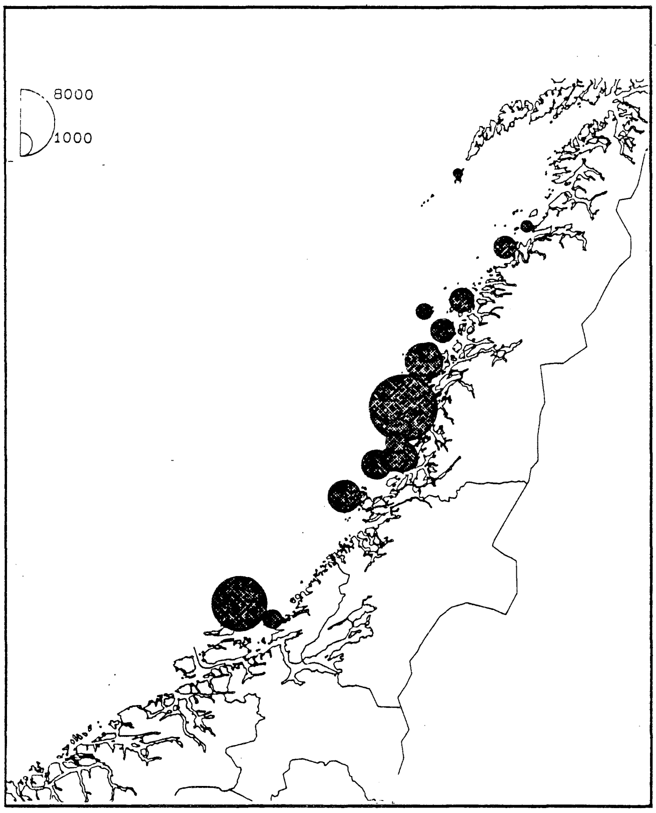
APPENDIX 1

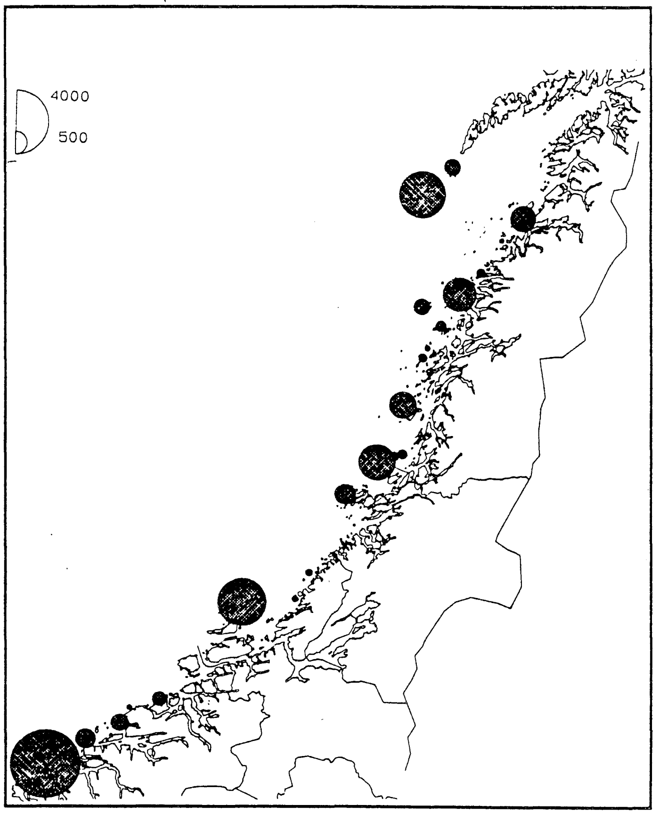
Maps that cover the entire influence area, where data are presented according to municipality.

Breeding	
Cormorant	7 A
Shag	7 B
Black Guillemot	7 C
Moulting	
Greylag Gosse	8 A
Velvet Scoter	8 B
Red-breasted Merganser	8 C
Winter	
Divers	9 A
Grebes	9 B
Cormorants	9 C
King Eider	9 D
Velvet Scoter	10 A
Long-tailed Duck	10 B
Red-breasted Merganser	10 C
Black Guillemot	10 D

All maps in the appendixes are numbered as







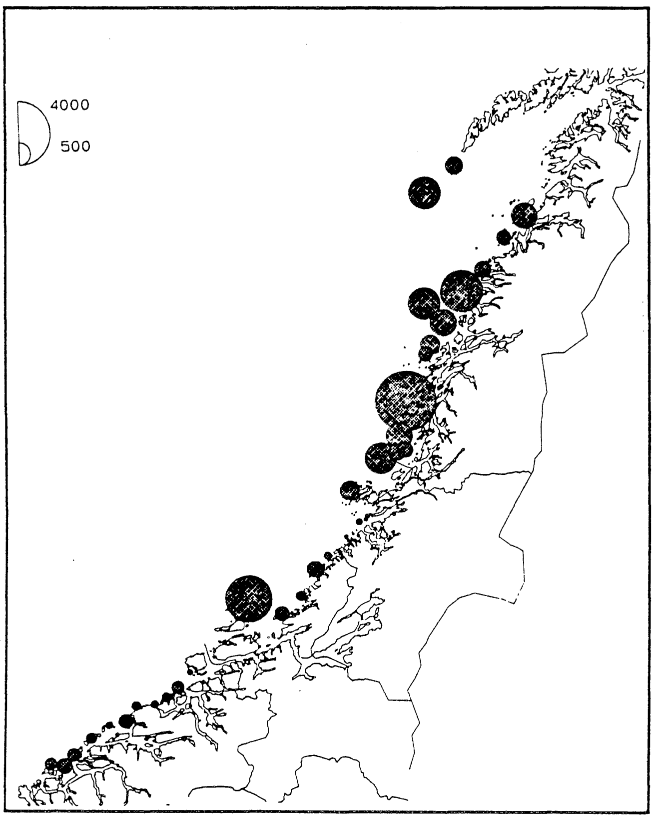


Figure 7. Distribution of breeding (A) Cormorant, (B) Shag and (C) Black Guillemot in the influence area. Scale refers to circle diameter and represents number of individuals.

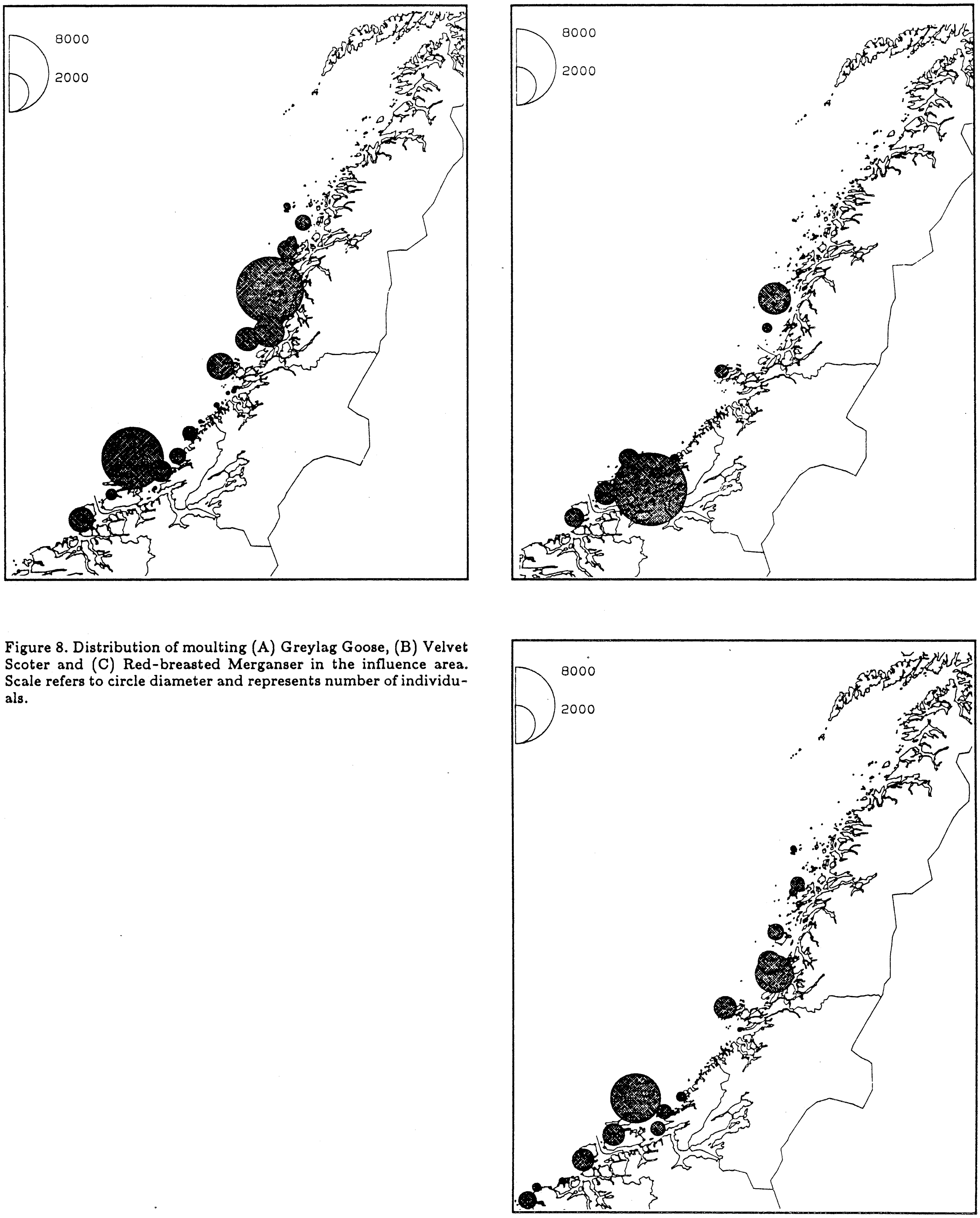


Figure 8. Distribution of moulting (A) Greylag Goose, (B) Velvet Scoter and (C) Red-breasted Merganser in the influence area. Scale refers to circle diameter and represents number of individuals.

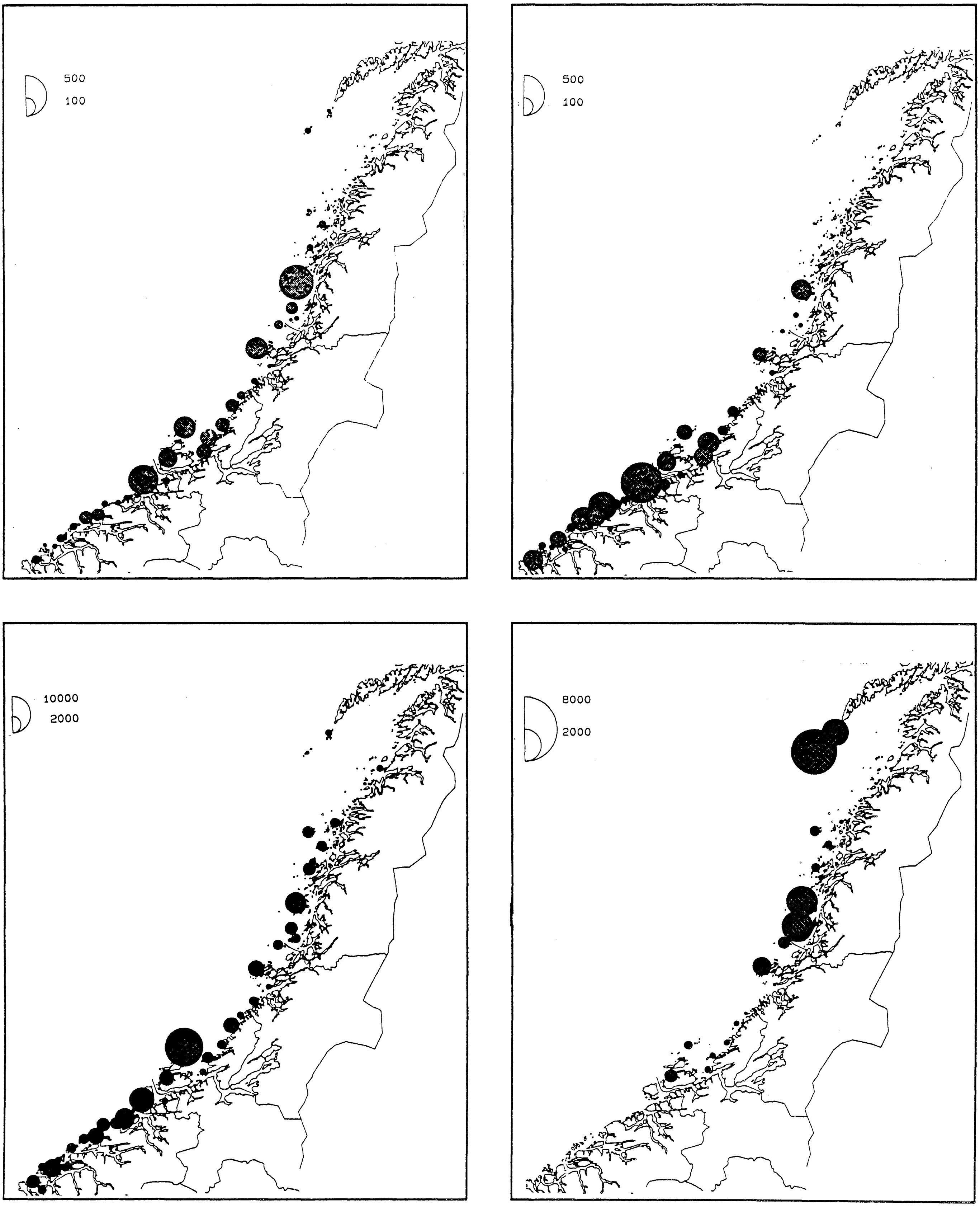


Figure 9. Distribution of wintering (A) divers, (B) grebes, (C) cormorants and (D) King Eider in the influence area. Scale refers to circle diameter and represents number of individuals.

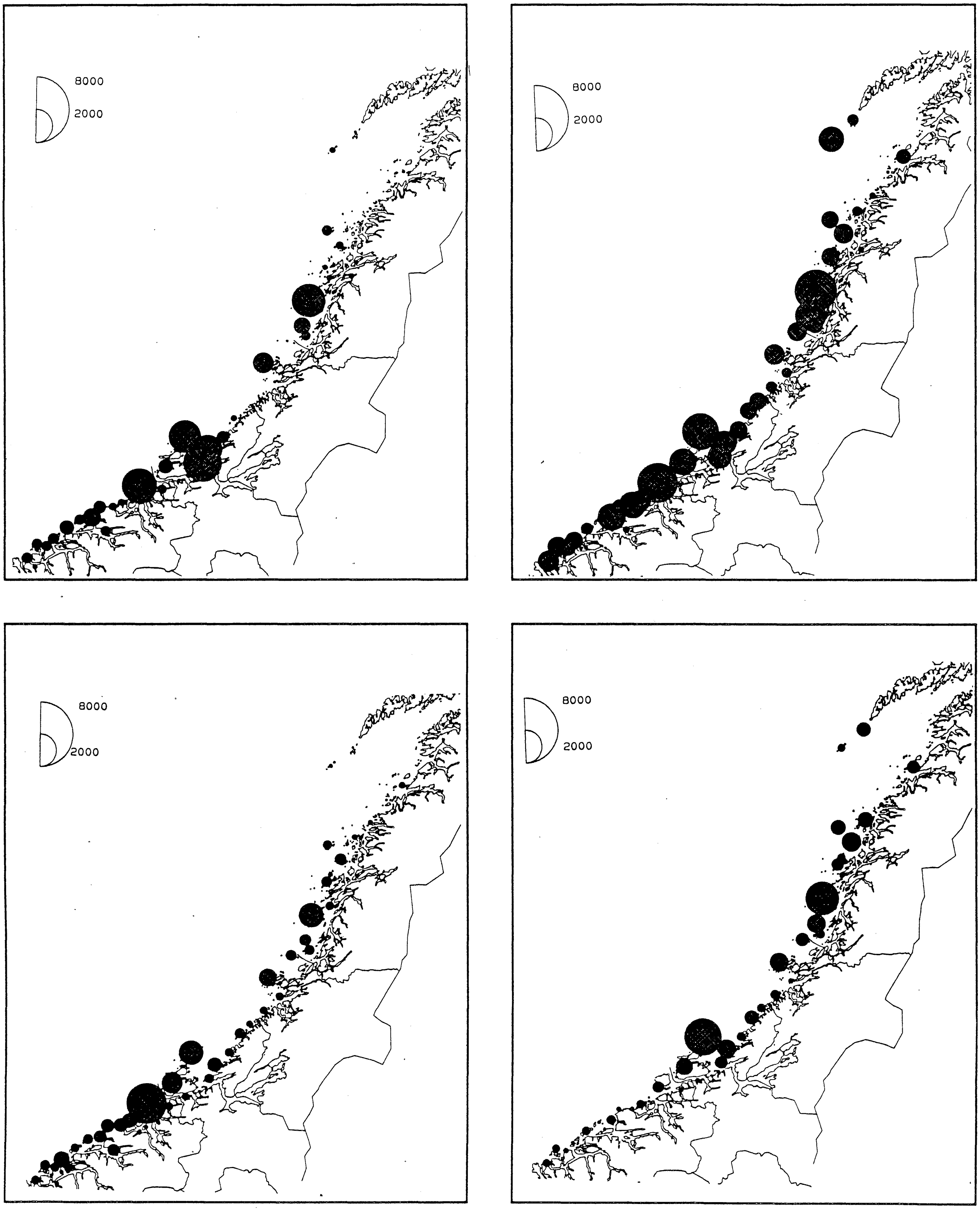


Figure 10. Distribution of wintering (A) Velvet Scoter, (B) Long-tailed Duck, (C) Red-breasted Merganser and (D) Black Guillemot in the influence area. Scale refers to circle diameter and represents number of individuals.

APPENDIX 2

County distribution maps from Møre og Romsdal to Lofoten in Nordland. Numbers in the table refers to figure number.

	Møre og Romsdal	Sør-Tr.lag	Nord-Tr.lag	Nord-land south	Nord-land north
Breeding					
Cormorant		12 A	13 A	14 A	15 A
Shag	11 A	12 B	13 B	14 B	15 B
Eider	11 B	12 C	13 C	14 C	15 C
Black Guillemot	11 C	12 D	13 D	14 D	15 D
Moulting					
Greylag Goose	16 A	17 A	18 A	19 A	20 A
Eider	16 B	17 B	18 B	19 B	20 B
Velvet Scoter	16 C	17 C	18 C	19 C	20 C
Red-br. Merganser	16 D	17 D	18 D	19 D	20 D
Winter					
Divers	21 A	23 A	25 A	27 A	29 A
Grebes	21 B	23 B	25 B	27 B	
Cormorants	21 C	23 C	25 C	27 C	29 B
Eider	21 D	23 D	25 D	27 D	29 C
King Eider					29 D
Velvet Scoter	22 A	24 A	26 A	28 A	30 A
Long-tailed Duck	22 B	24 B	26 B	28 B	30 B
Red-br. Merganser	22 C	24 C	26 C	28 C	30 C
Black Guillemot	22 D	24 D	26 D	28 D	30 D

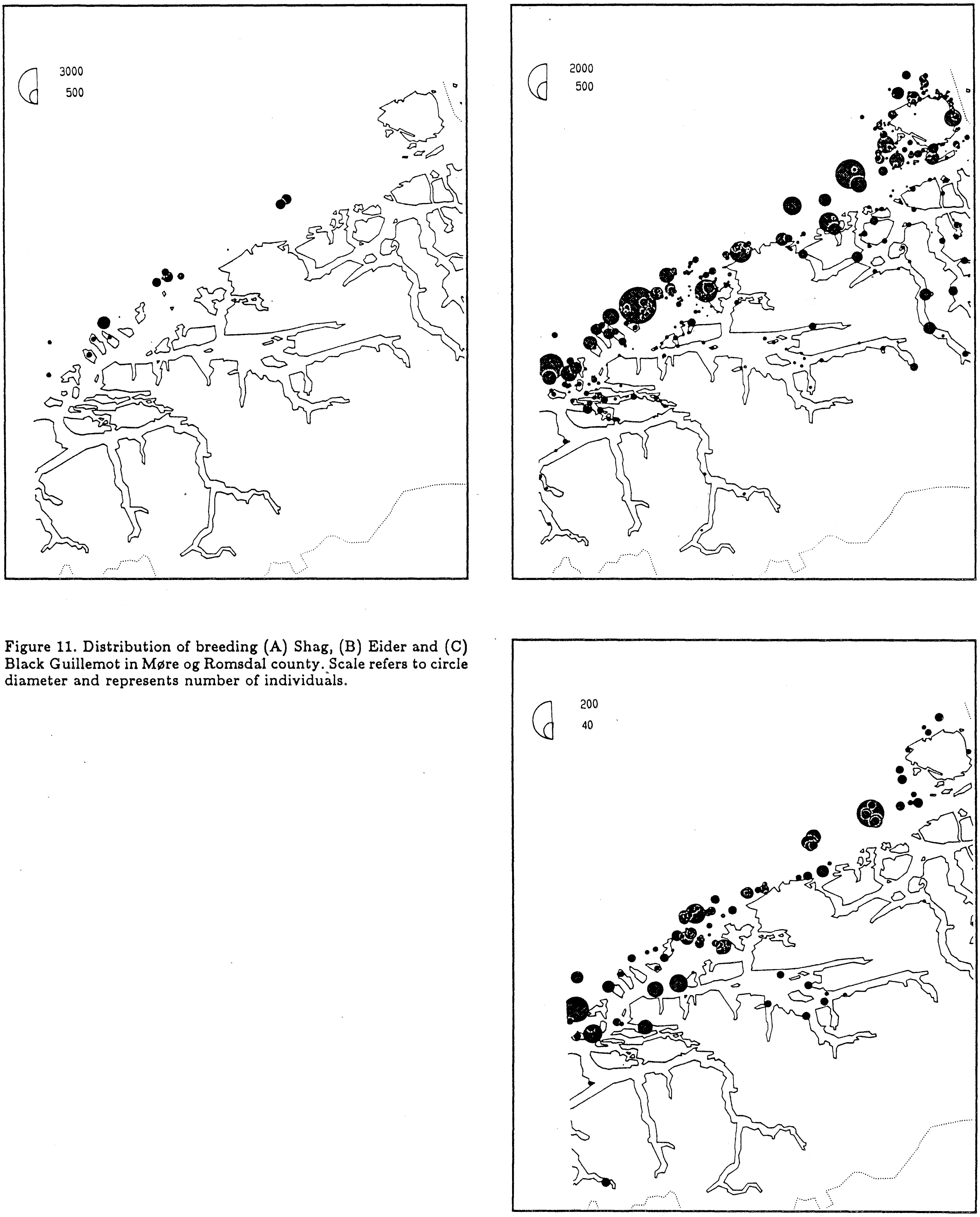


Figure 11. Distribution of breeding (A) Shag, (B) Eider and (C) Black Guillemot in Møre og Romsdal county. Scale refers to circle diameter and represents number of individuals.

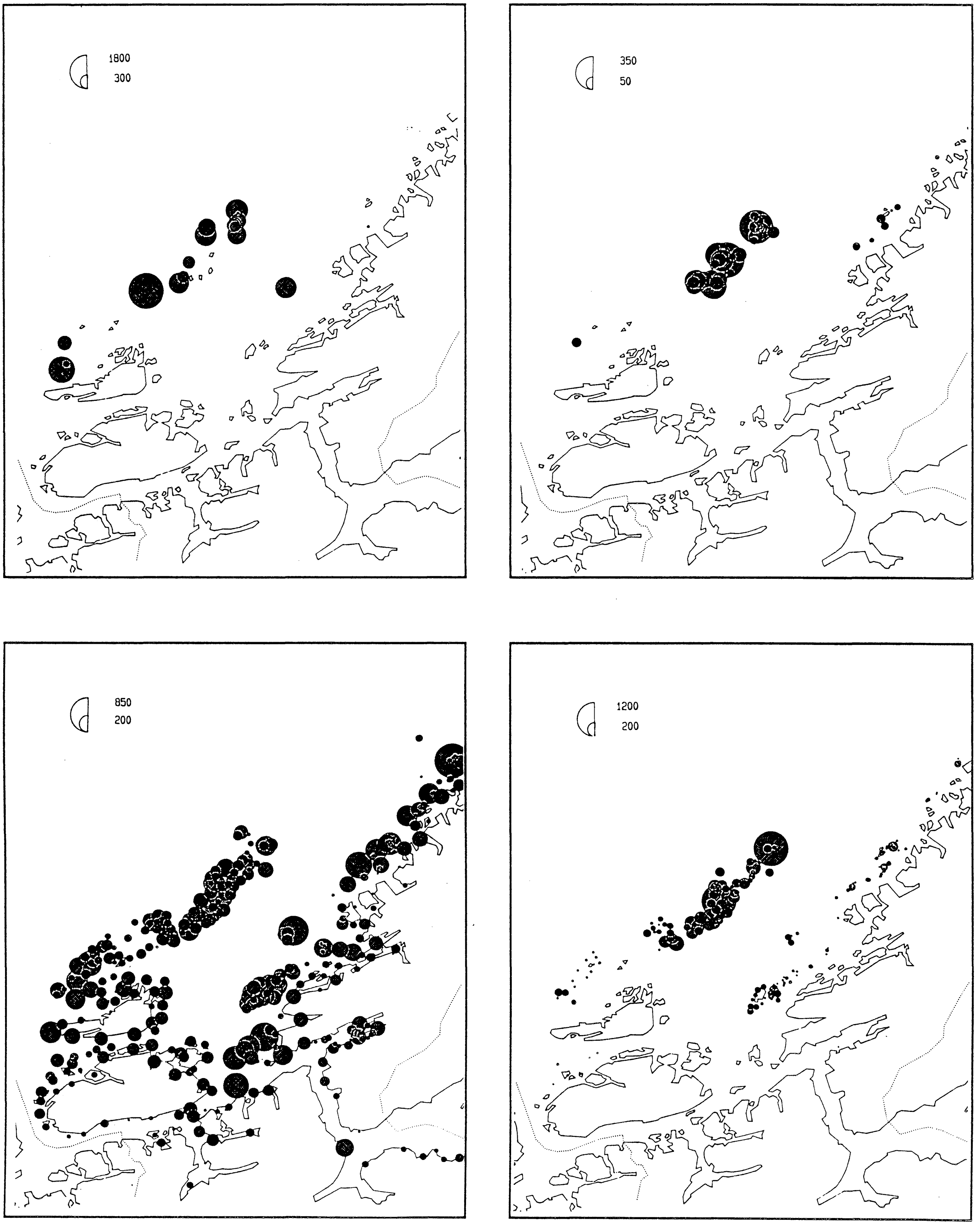


Figure 12. Distribution of breeding (A) Cormorant, (B) Shag, (C) Eider and (D) Black Guillemot in Sør-Trøndelag county. Scale refers to circle diameter and represents number of individuals.

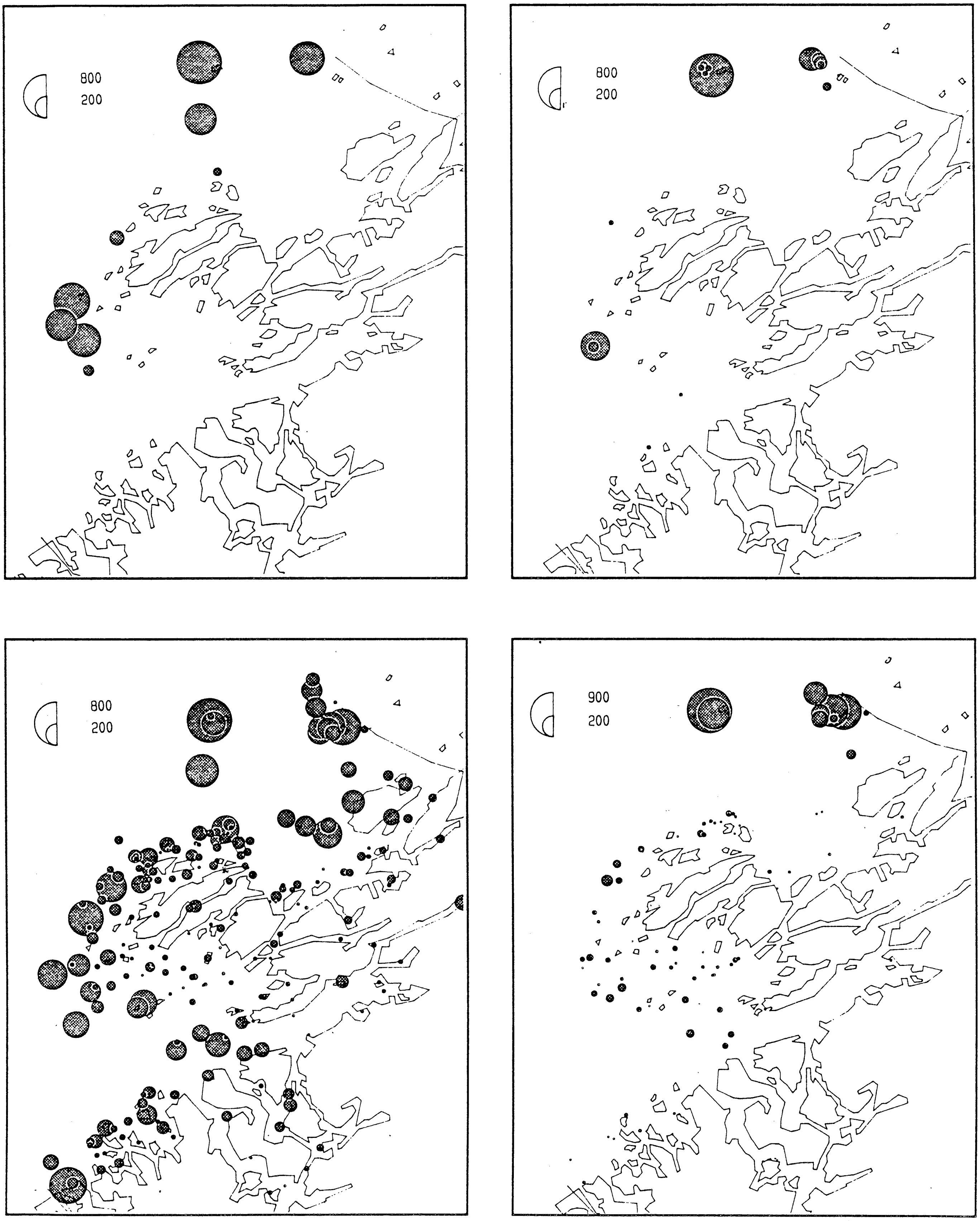


Figure 13. Distribution of breeding (A) Cormorant, (B) Shag, (C) Eider and (D) Black Guillemot in Nord-Trøndelag county. Scale refers to circle diameter and represents number of individuals.

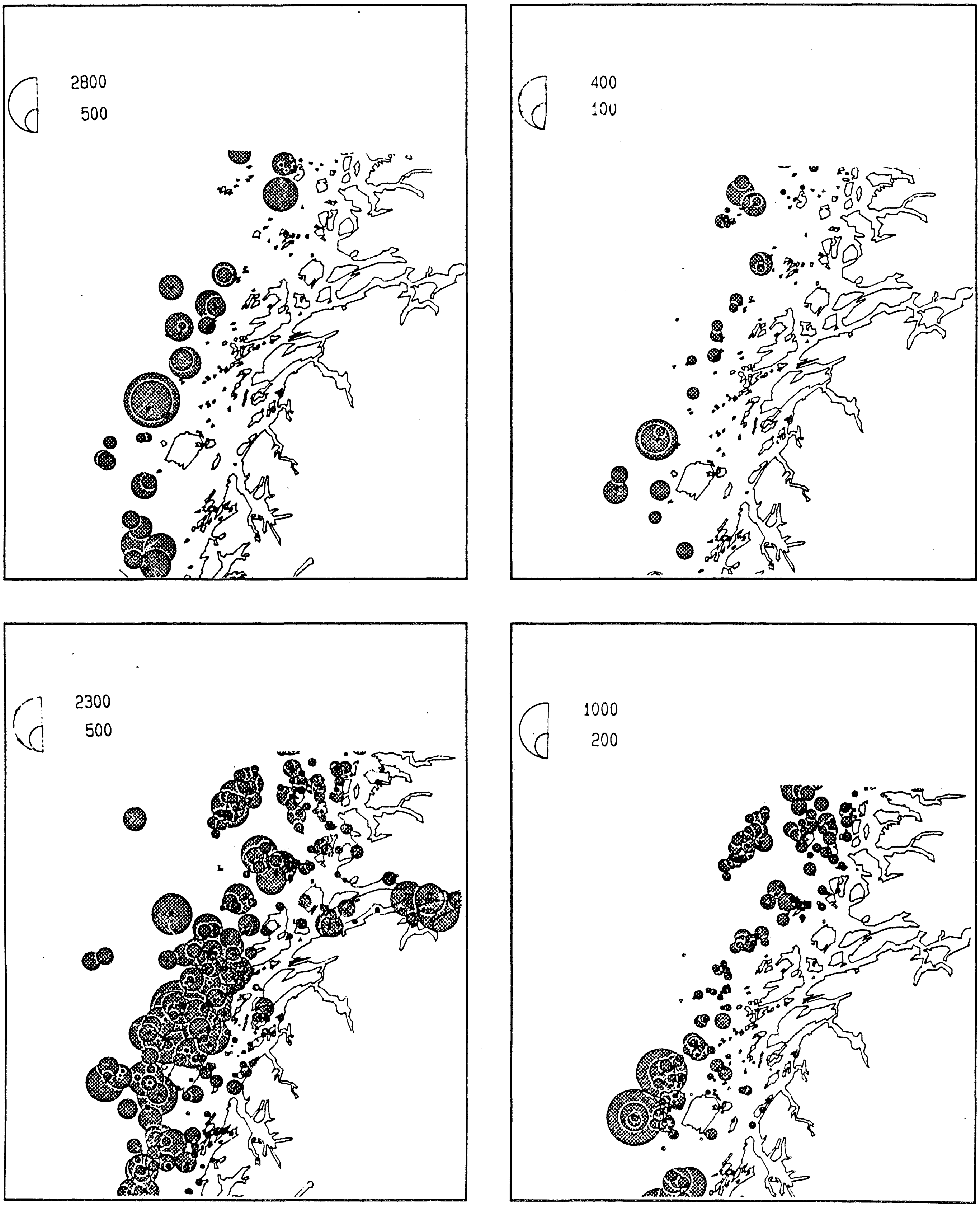


Figure 14. Distribution of breeding (A) Cormorant, (B) Shag, (C) Eider and (D) Black Guillemot in southern parts of Nordland county. Scale refers to circle diameter and represents number of individuals.

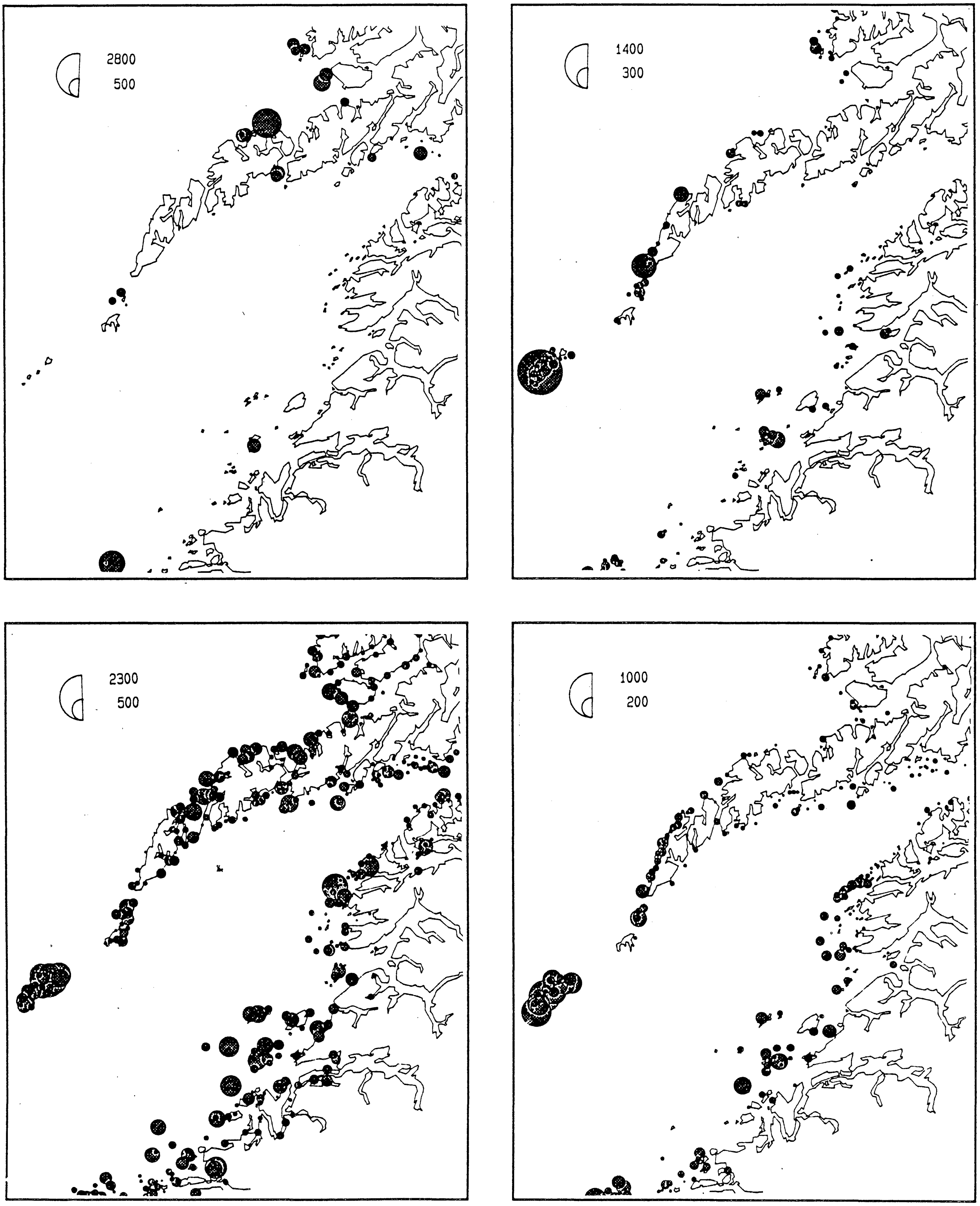


Figure 15. Distribution of breeding (A) Cormorant, (B) Shag, (C) Eider and (D) Black Guillemot in northern parts of Nordland county. Scale refers to circle diameter and represents number of individuals.

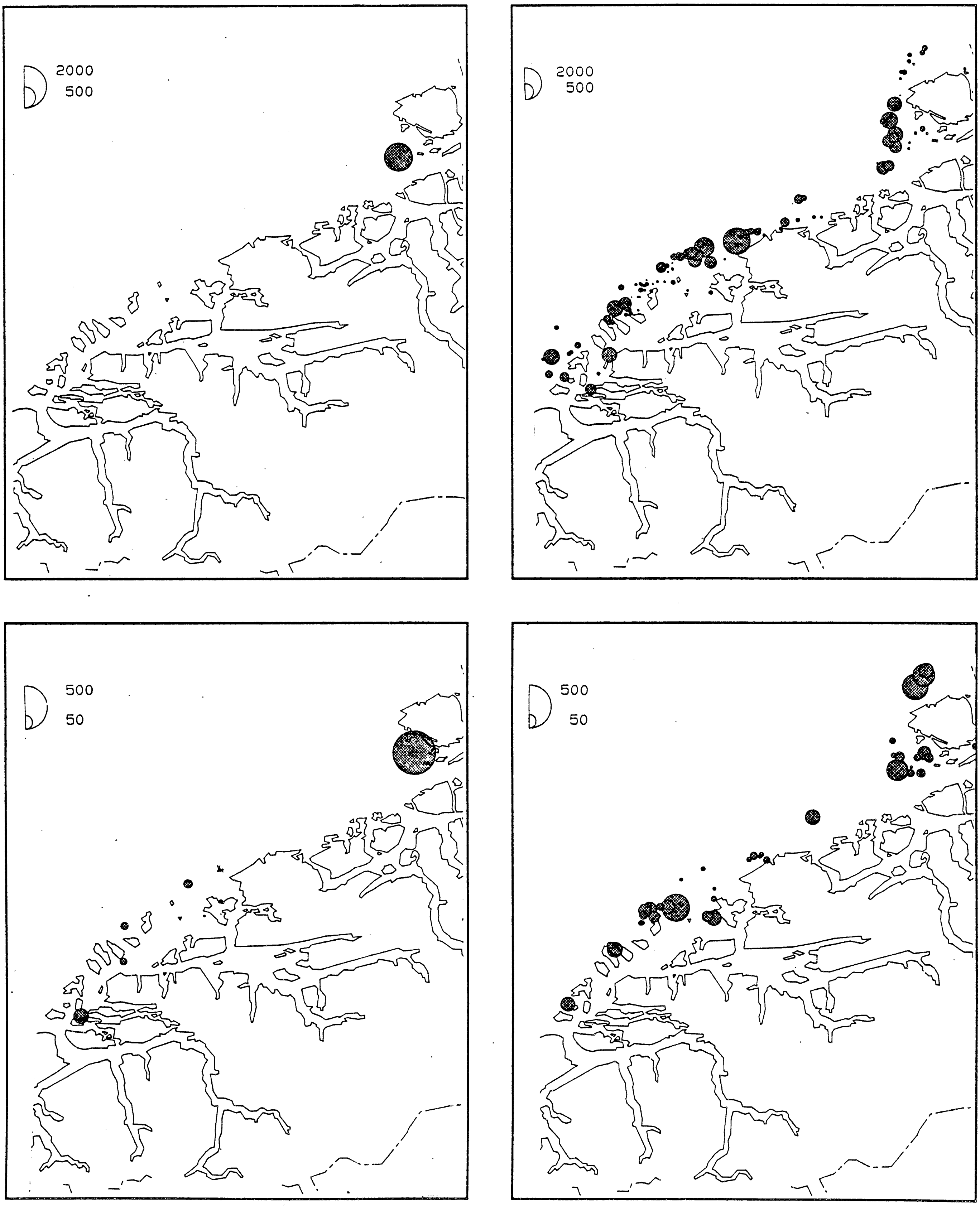


Figure 16. Distribution of moulting (A) Greylag Goose, (B) Eider, (C) Velvet Scoter and (D) Red-breasted Merganser in Møre og Romsdal county. Scale refers to circle diameter and represents number of individuals.

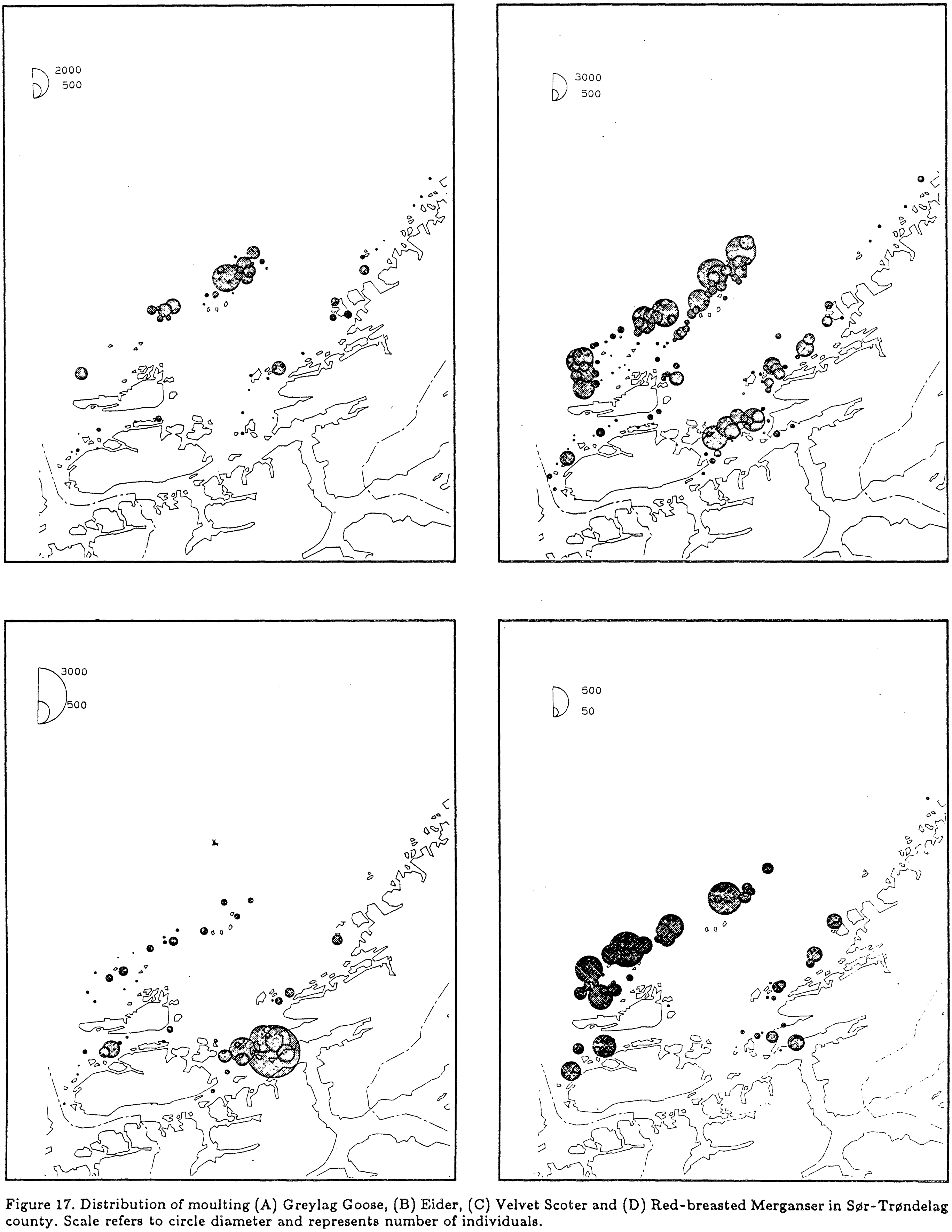


Figure 17. Distribution of moulting (A) Greylag Goose, (B) Eider, (C) Velvet Scoter and (D) Red-breasted Merganser in Sør-Trøndelag county. Scale refers to circle diameter and represents number of individuals.

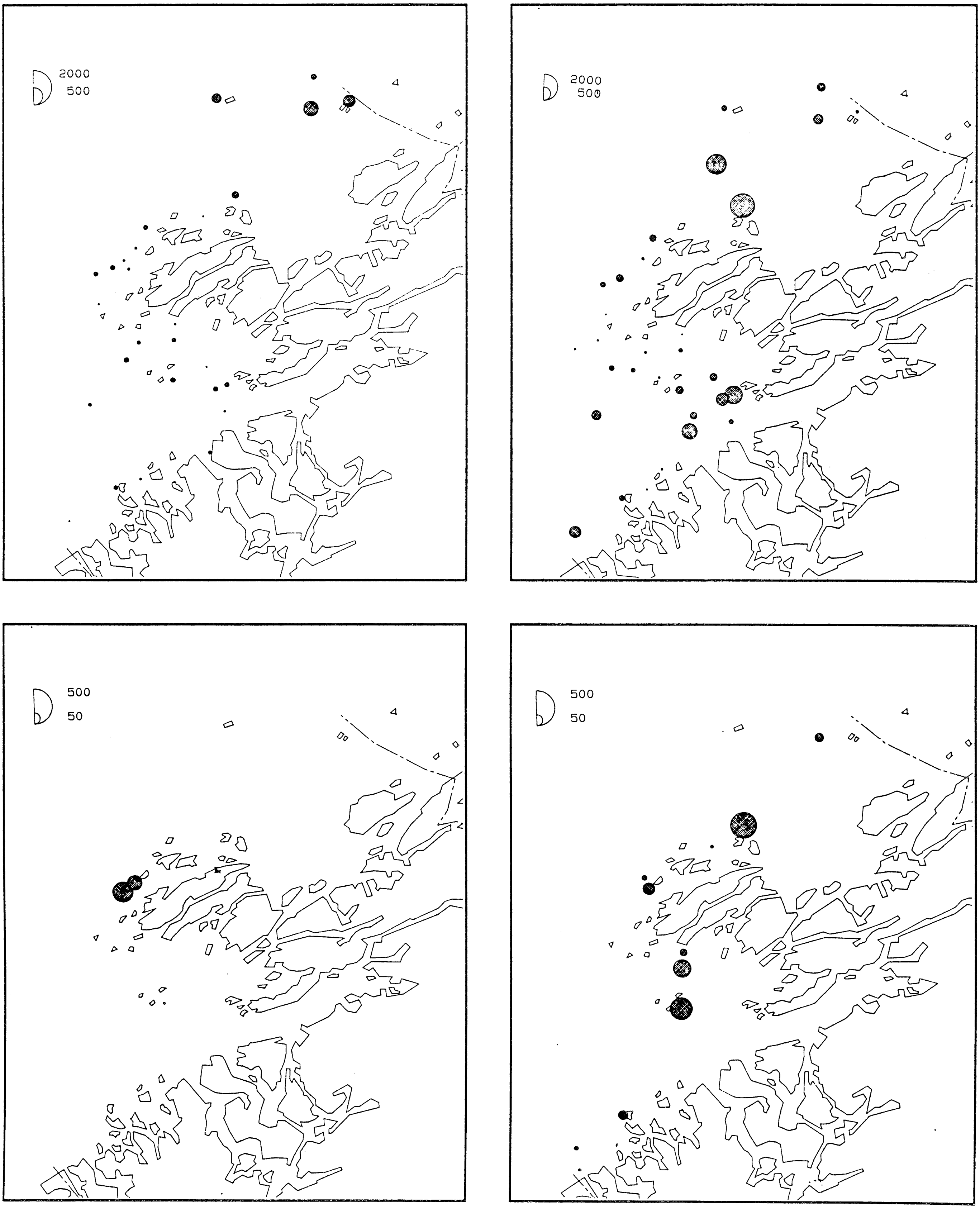


Figure 18. Distribution of moulting (A) Greylag Goose, (B) Eider, (C) Velvet Scoter and (D) Red-breasted Merganser in Nord-Trøndelag county. Scale refers to circle diameter and represents number of individuals.

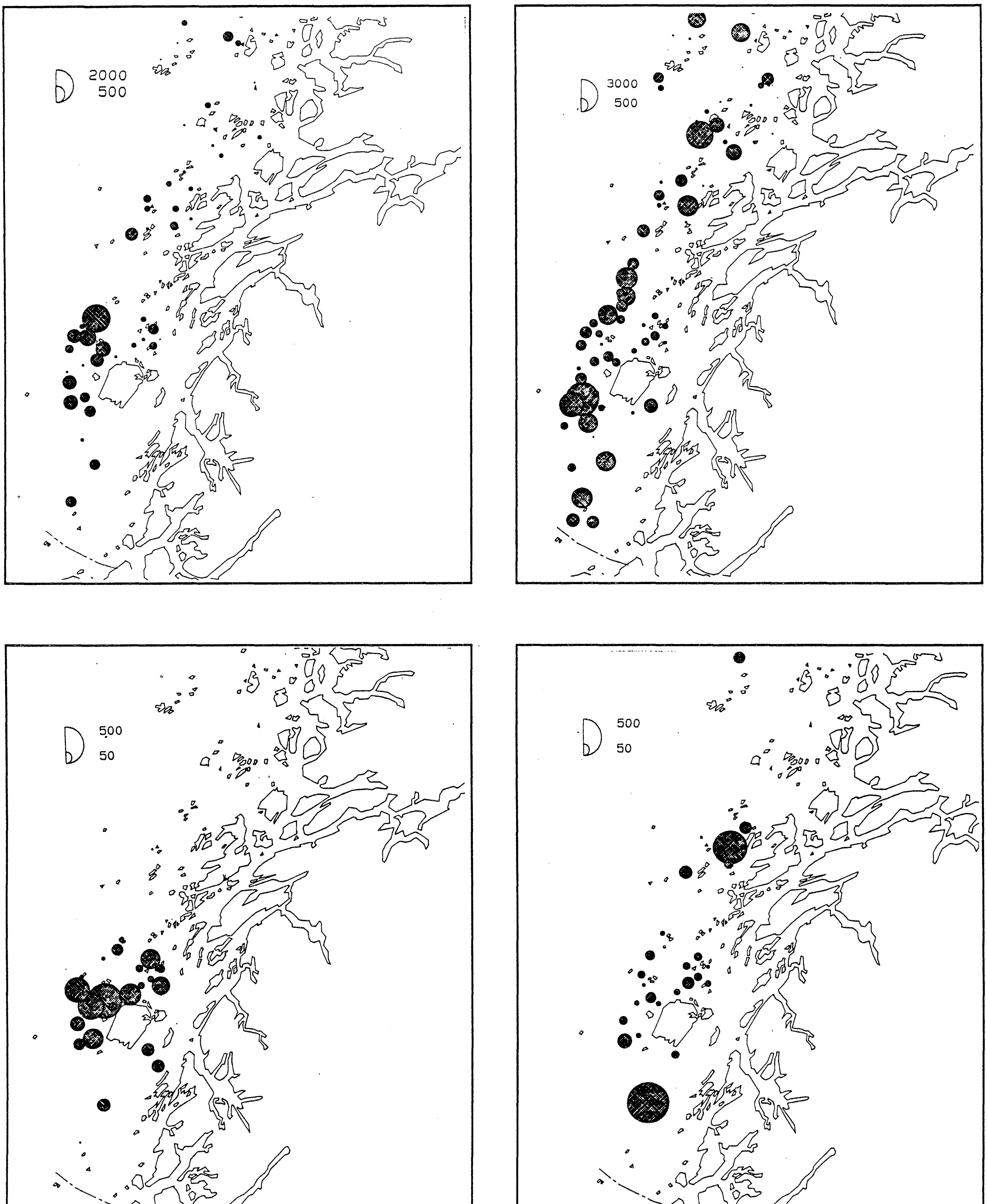


Figure 19. Distribution of moulting (A) Greylag Goose, (B) Eider, (C) Velvet Scoter and (D) Red-breasted Merganser in southern parts of Nordland county. Scale refers to circle diameter and represents number of individuals.

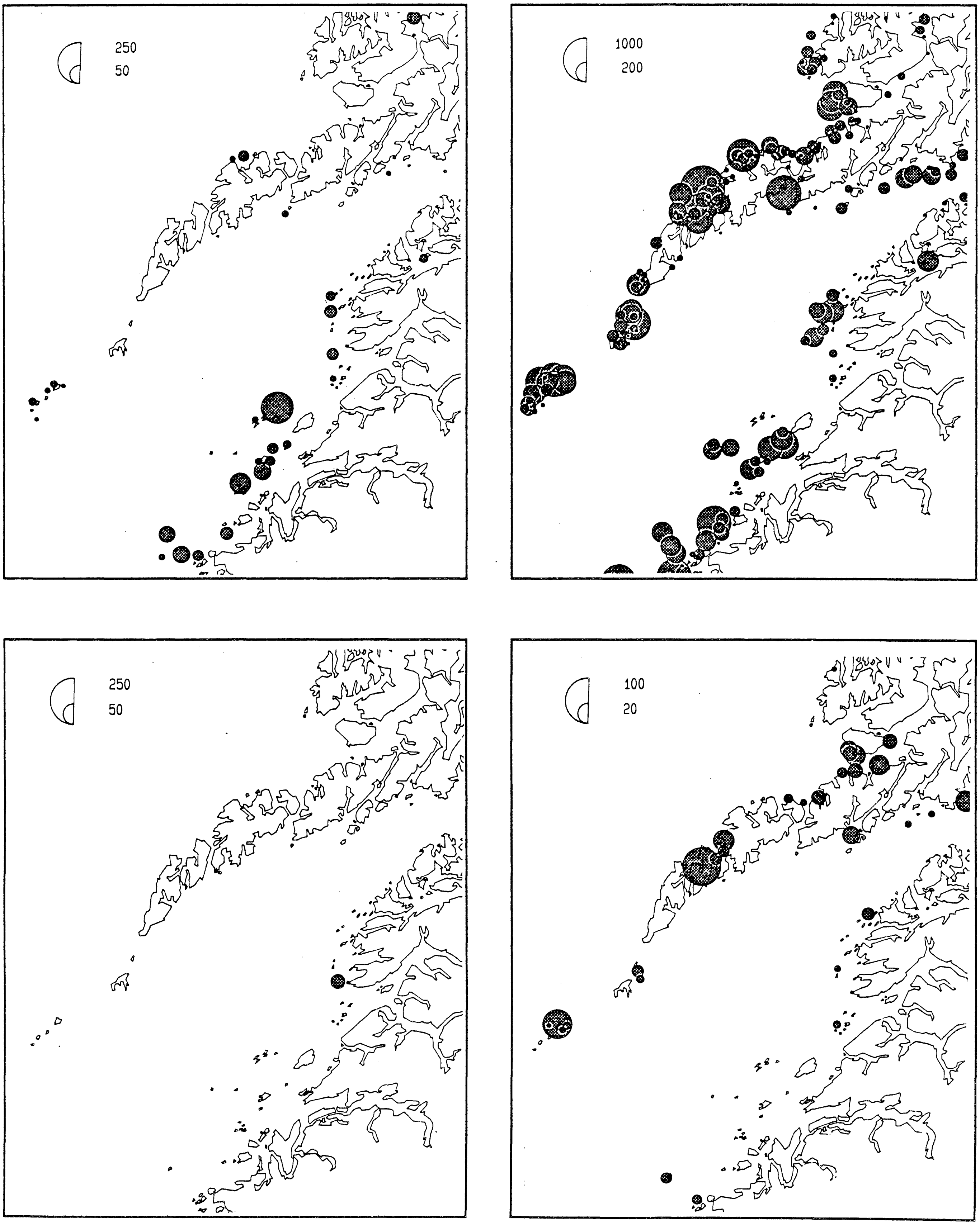


Figure 20. Distribution of moulting (A) Greylag Goose, (B) Eider, (C) Velvet Scoter and (D) Red-breasted Merganser in northern parts of Nordland county. Scale refers to circle diameter and represents number of individuals.

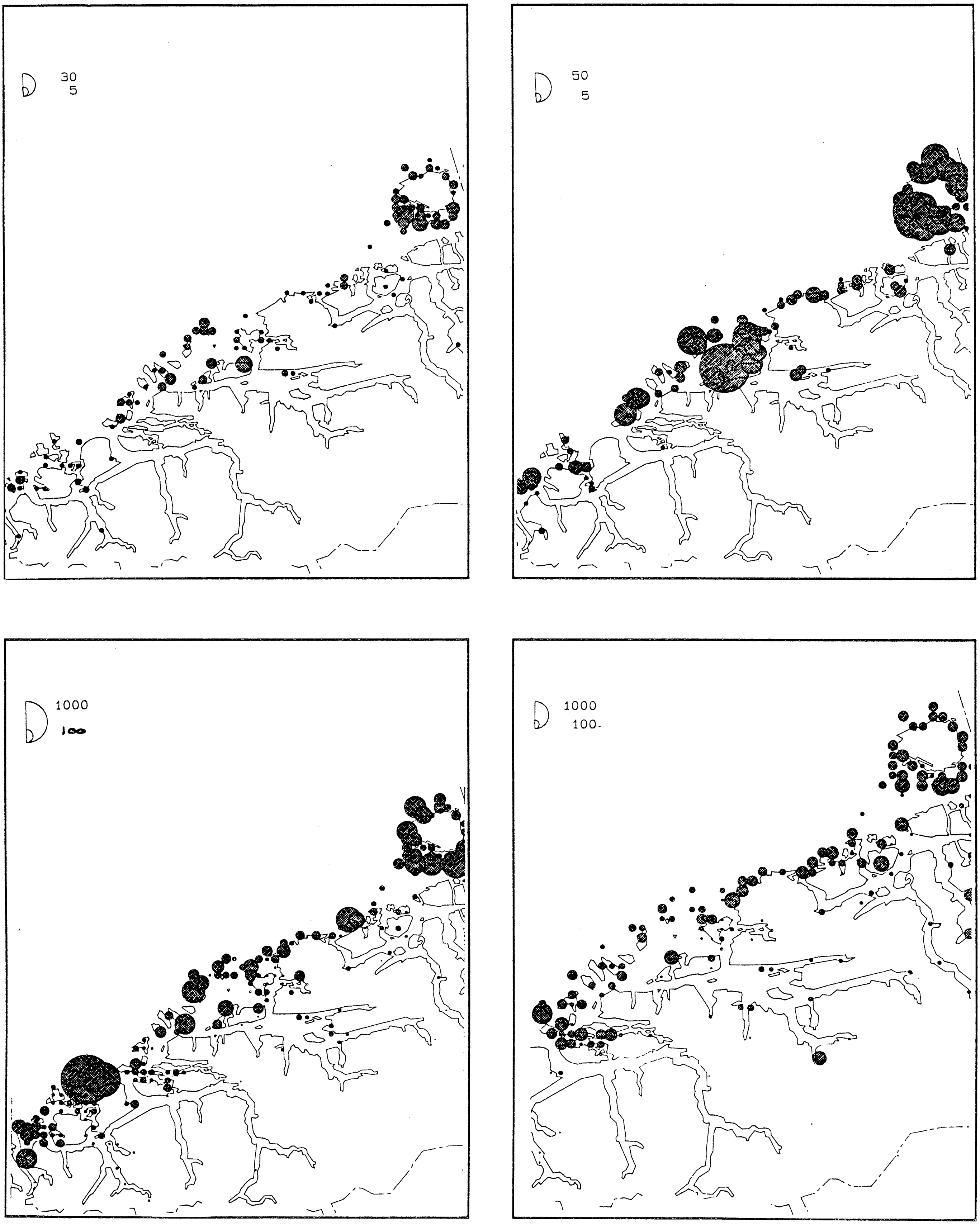


Figure 21. Distribution of wintering (A) divers, (B) grebes, (C) cormorants and (D) Eider in Møre og Romsdal county. Scale refers to circle diameter and represents number of individuals.

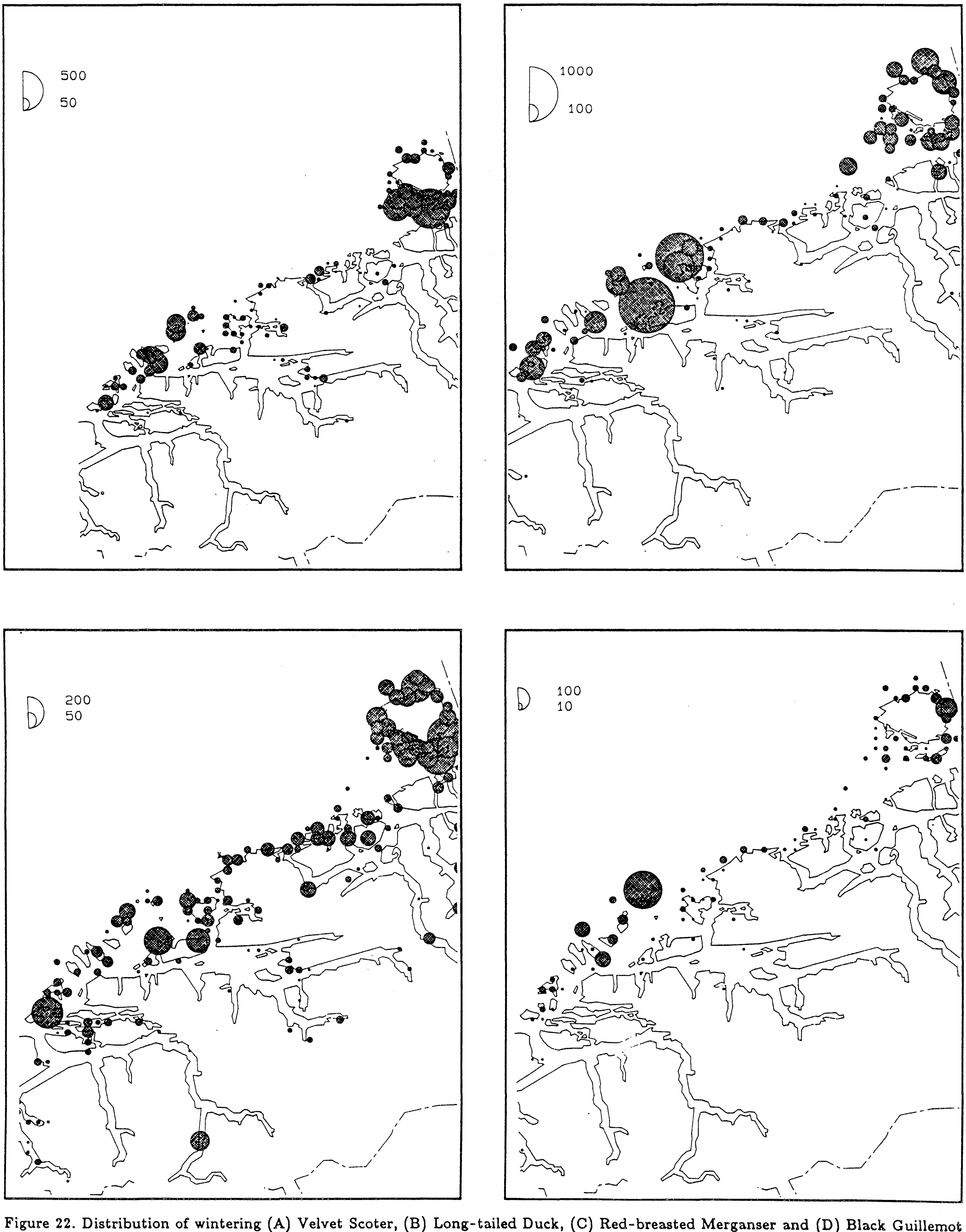


Figure 22. Distribution of wintering (A) Velvet Scoter, (B) Long-tailed Duck, (C) Red-breasted Merganser and (D) Black Guillemot in Møre og Romsdal county. Scale refers to circle diameter and represents number of individuals.

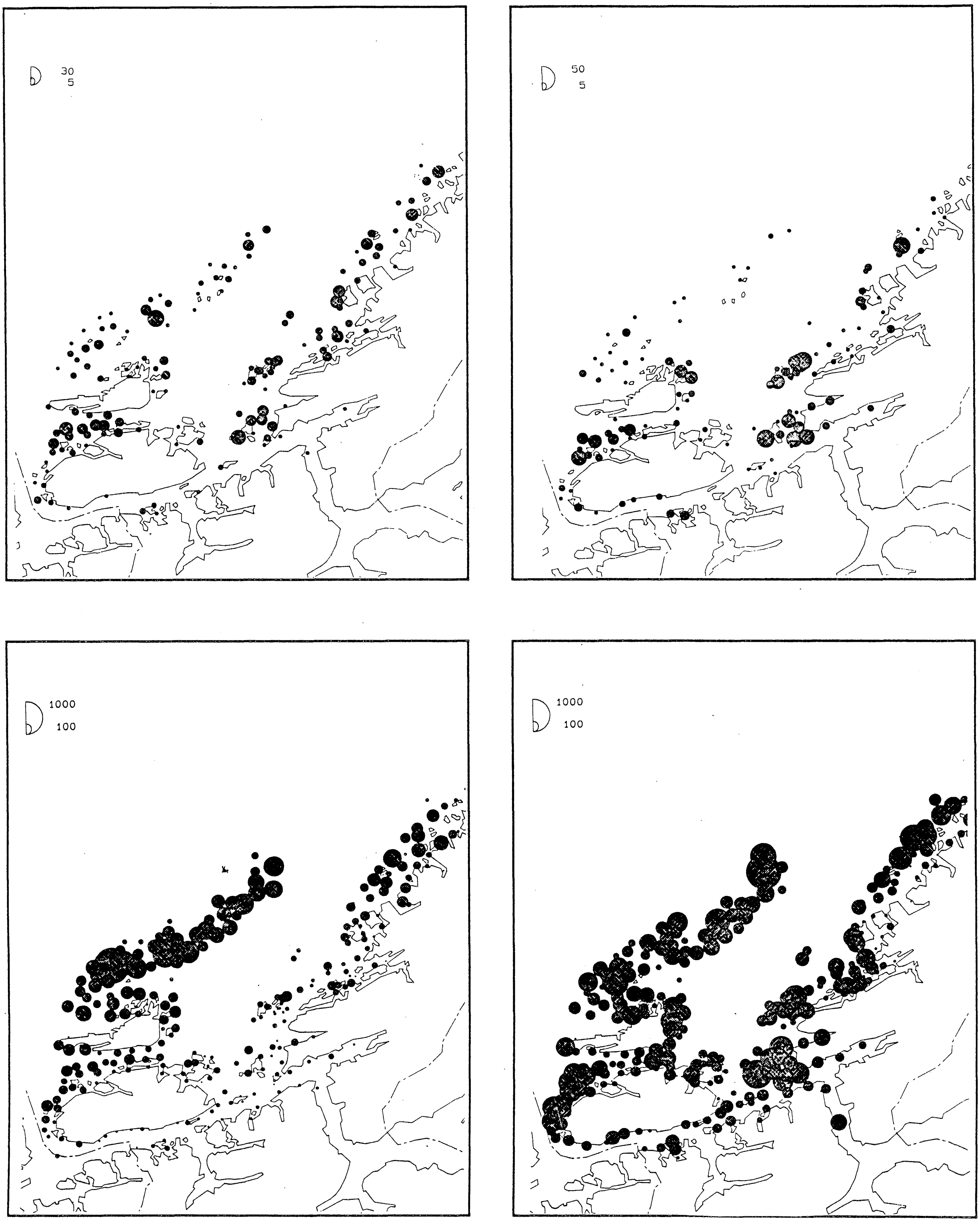


Figure 23. Distribution of wintering (A) divers, (B) grebes, (C) cormorants and (D) Eider in Sør-Trøndelag county. Scale refers to circle diameter and represents number of individuals.

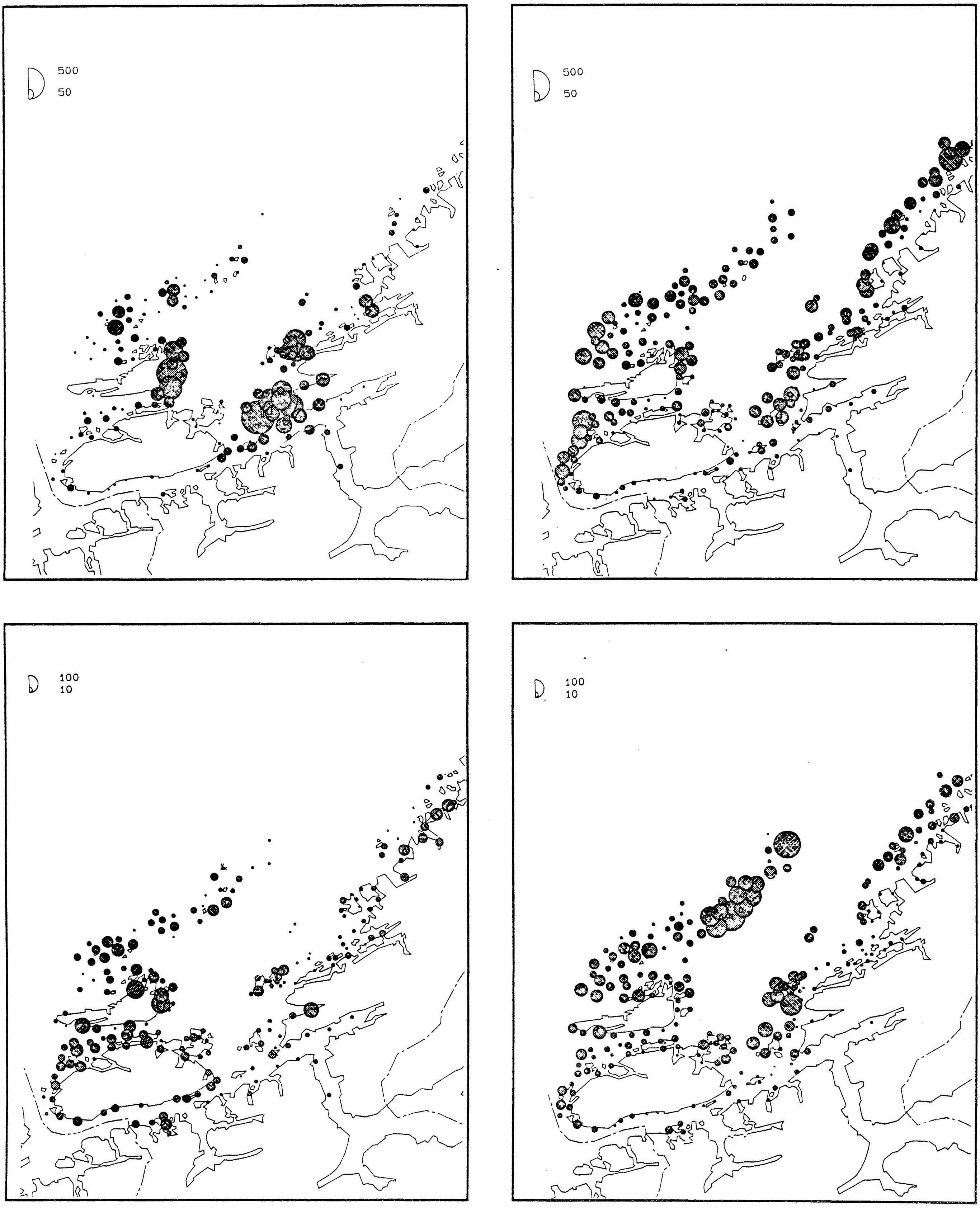


Figure 24. Distribution of wintering (A) Velvet Scoter, (B) Long-tailed Duck, (C) Red-breasted Merganser and (D) Black Guillemot in Sør-Trøndelag county. Scale refers to circle diameter and represents number of individuals.

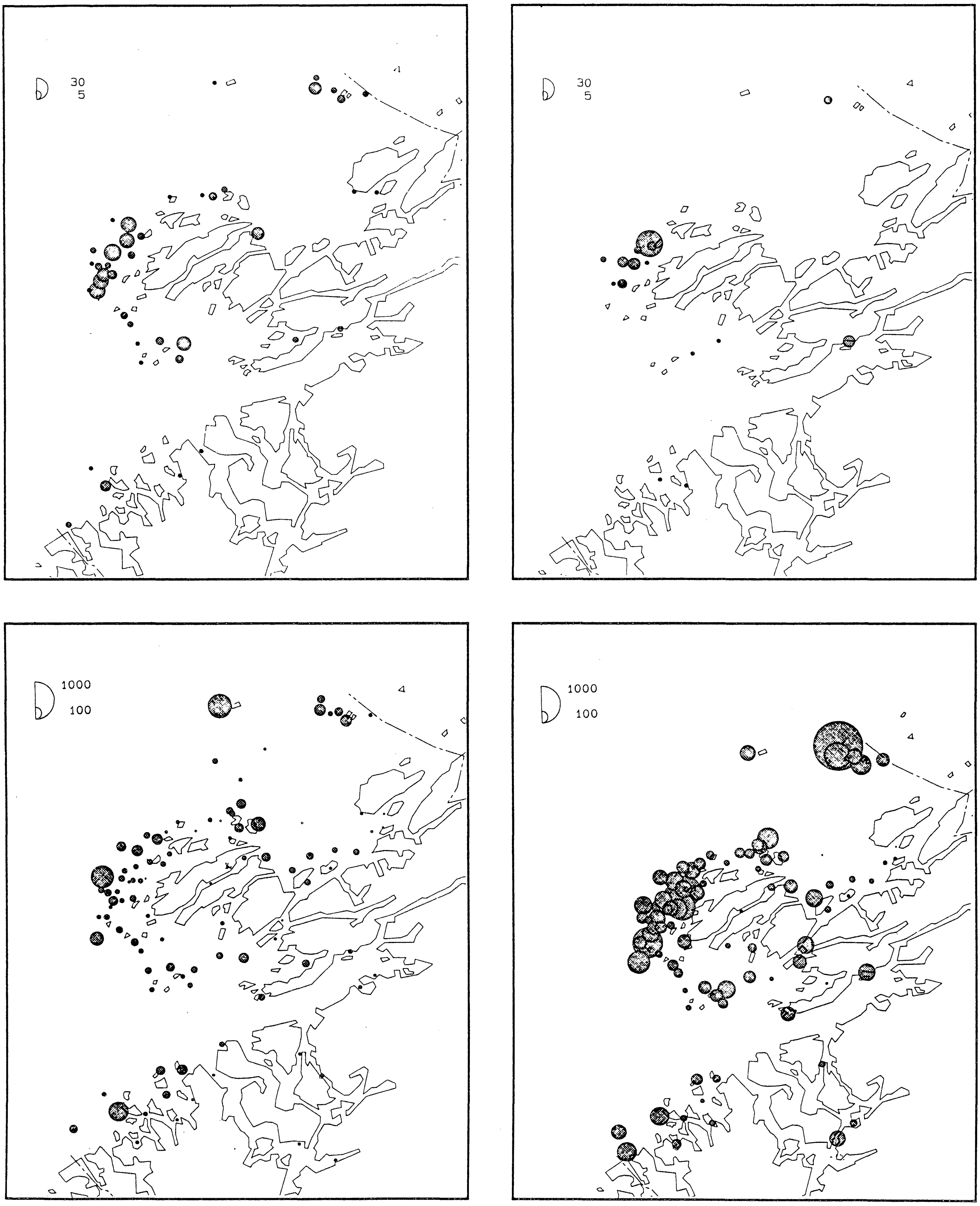


Figure 25. Distribution of wintering (A) divers, (B) grebes, (C) cormorants and (D) Eider in Nord-Trøndelag county. Scale refers to circle diameter and represents number of individuals.

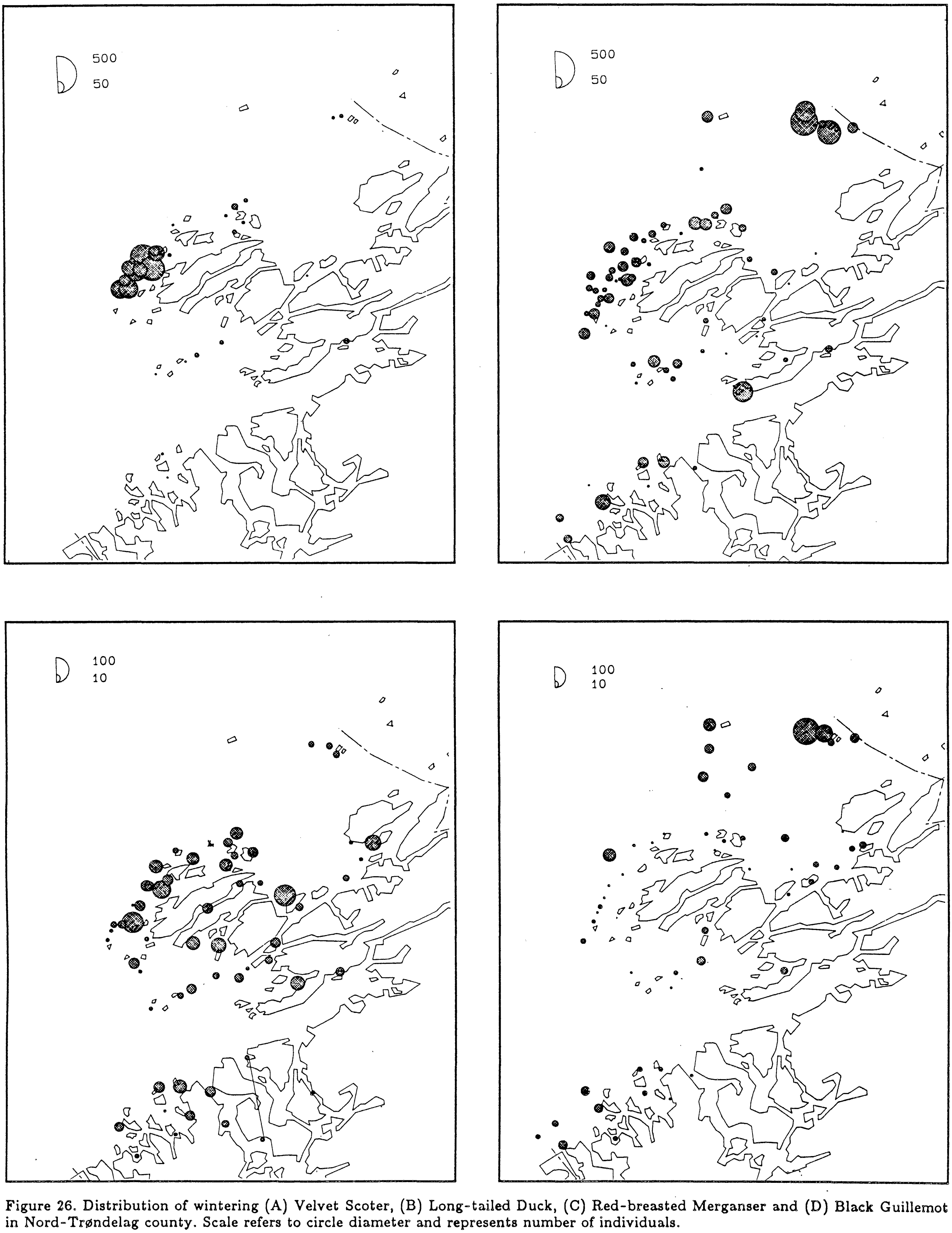


Figure 26. Distribution of wintering (A) Velvet Scoter, (B) Long-tailed Duck, (C) Red-breasted Merganser and (D) Black Guillemot in Nord-Trøndelag county. Scale refers to circle diameter and represents number of individuals.

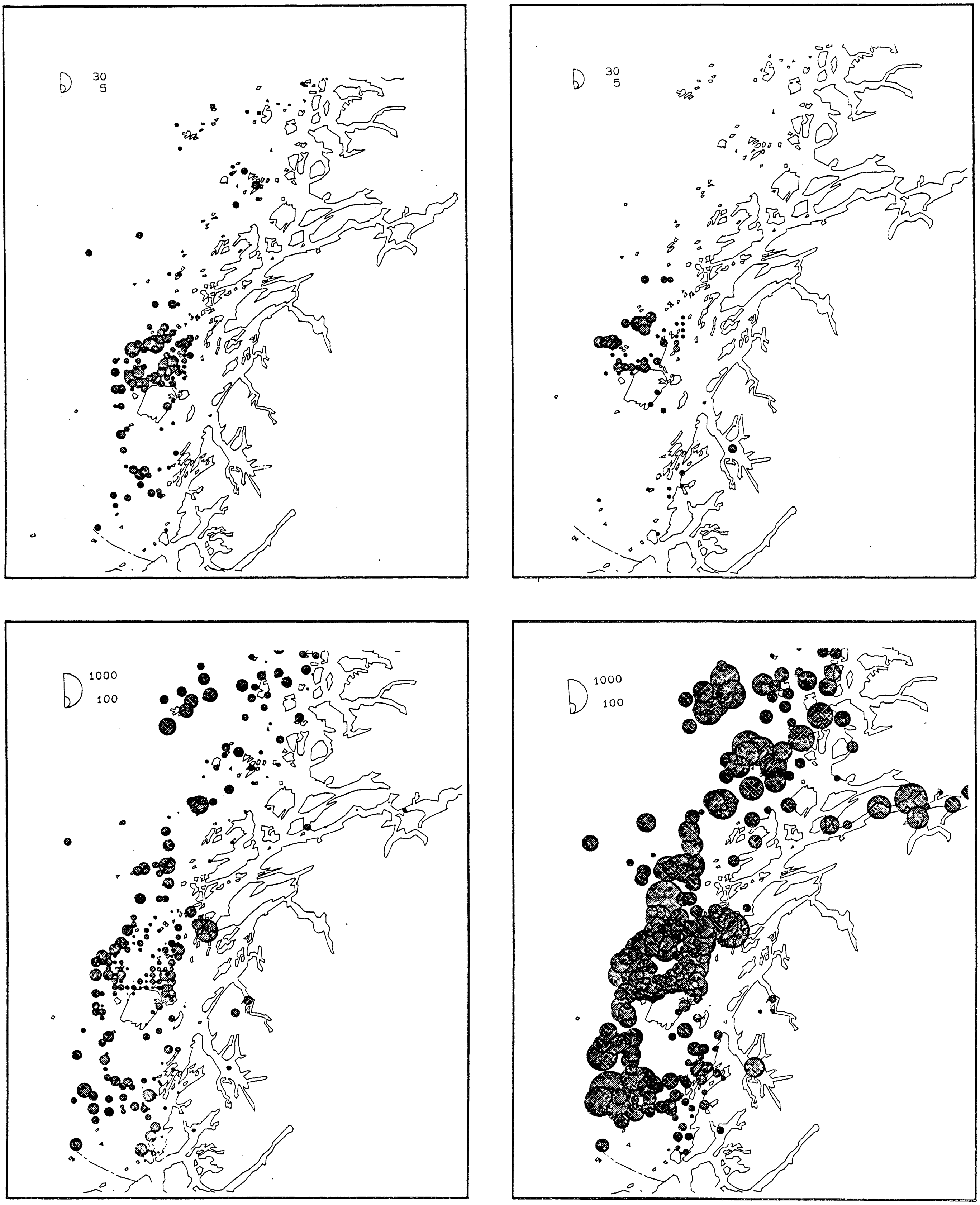


Figure 27. Distribution of wintering (A) divers, (B) grebes, (C) cormorants and (D) Eider in southern parts of Nordland county. Scale refers to circle diameter and represents number of individuals.

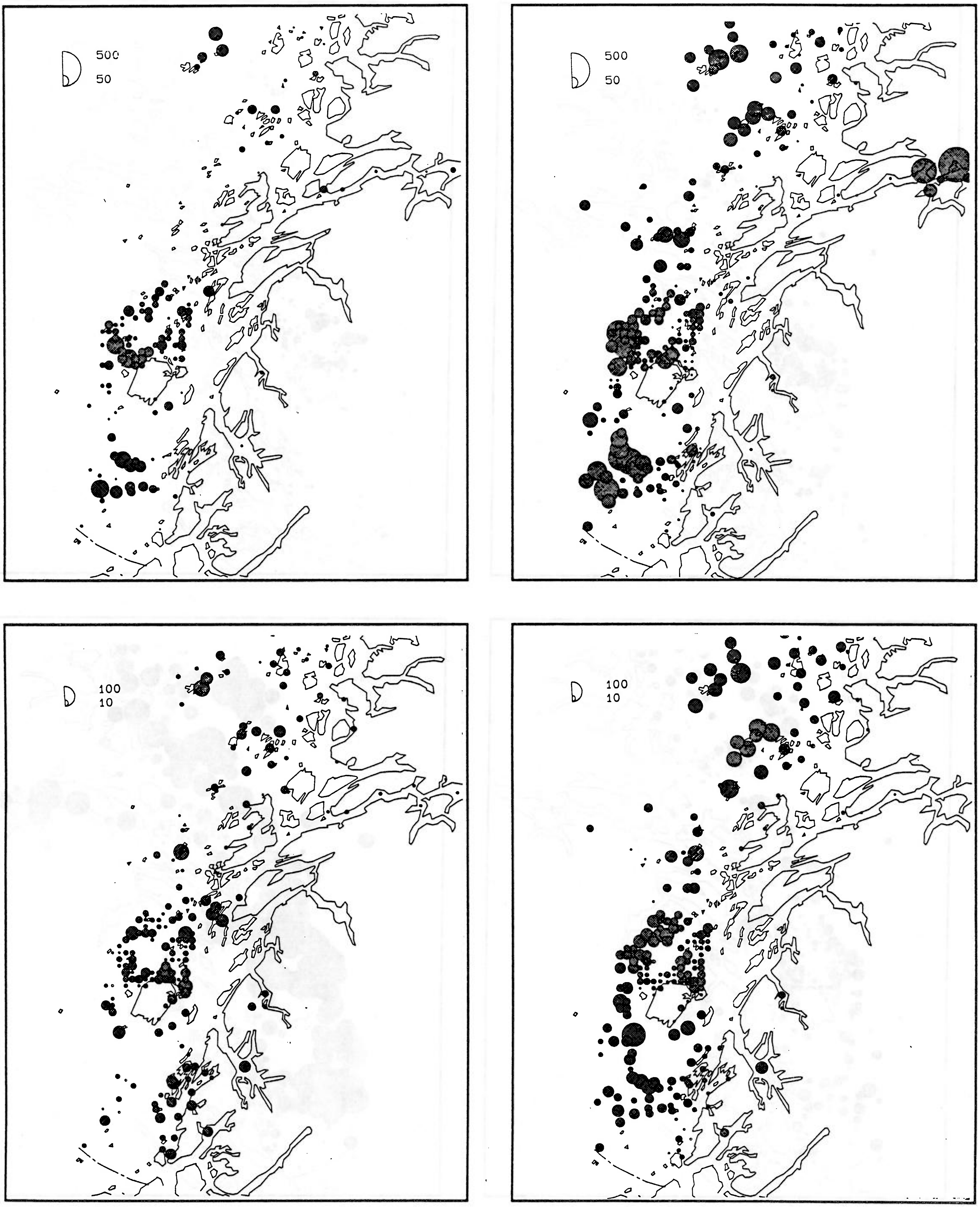


Figure 28. Distribution of wintering (A) Velvet Scoter, (B) Long-tailed Duck, (C) Red-breasted Merganser and (D) Black Guillemot in southern parts of Nordland county. Scale refers to circle diameter and represents number of individuals.

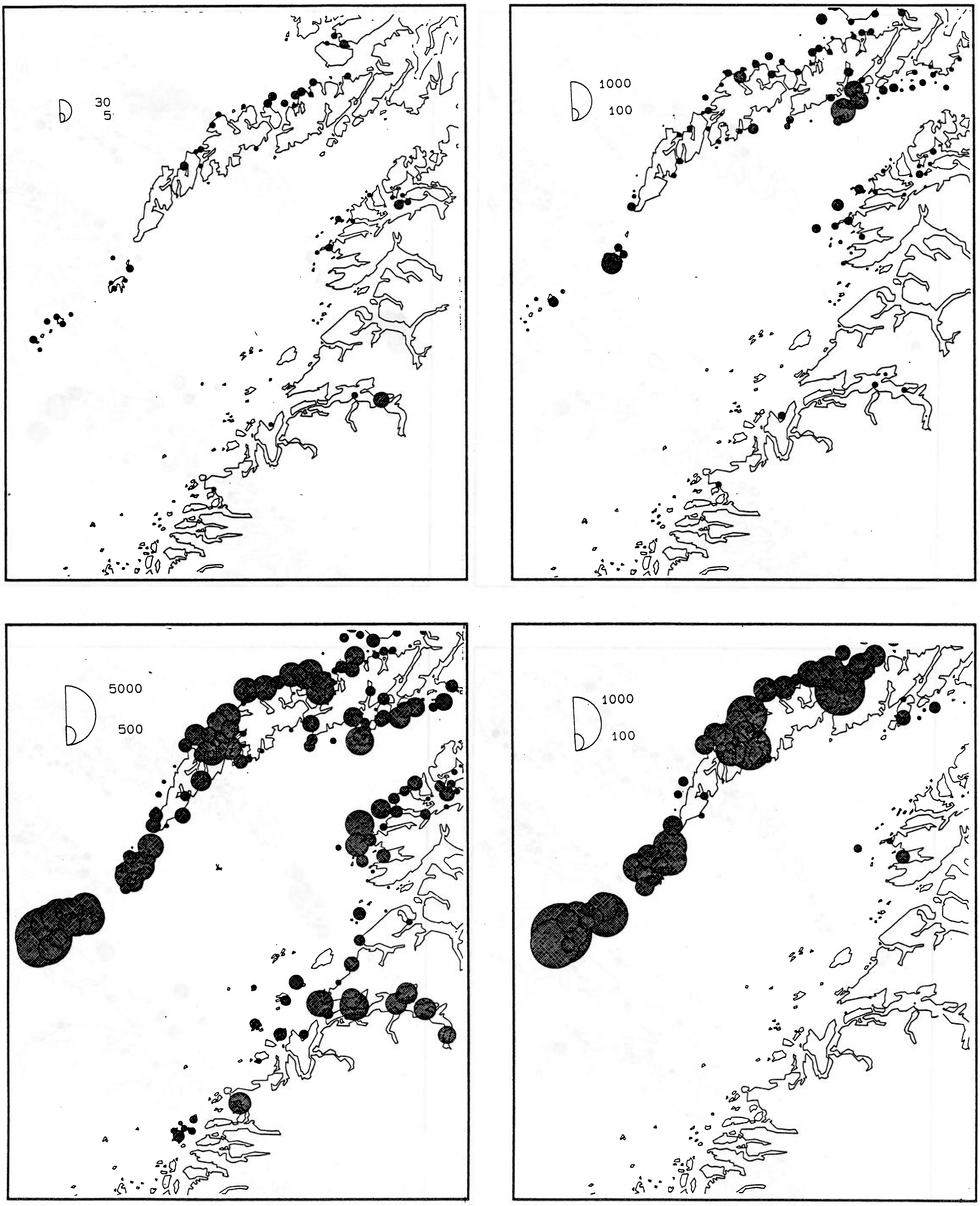


Figure 29. Distribution of wintering (A) divers, (B) cormorants, (C) Eider and (D) King Eider in northern parts of Nordland county. Scale refers to circle diameter and represents number of individuals.

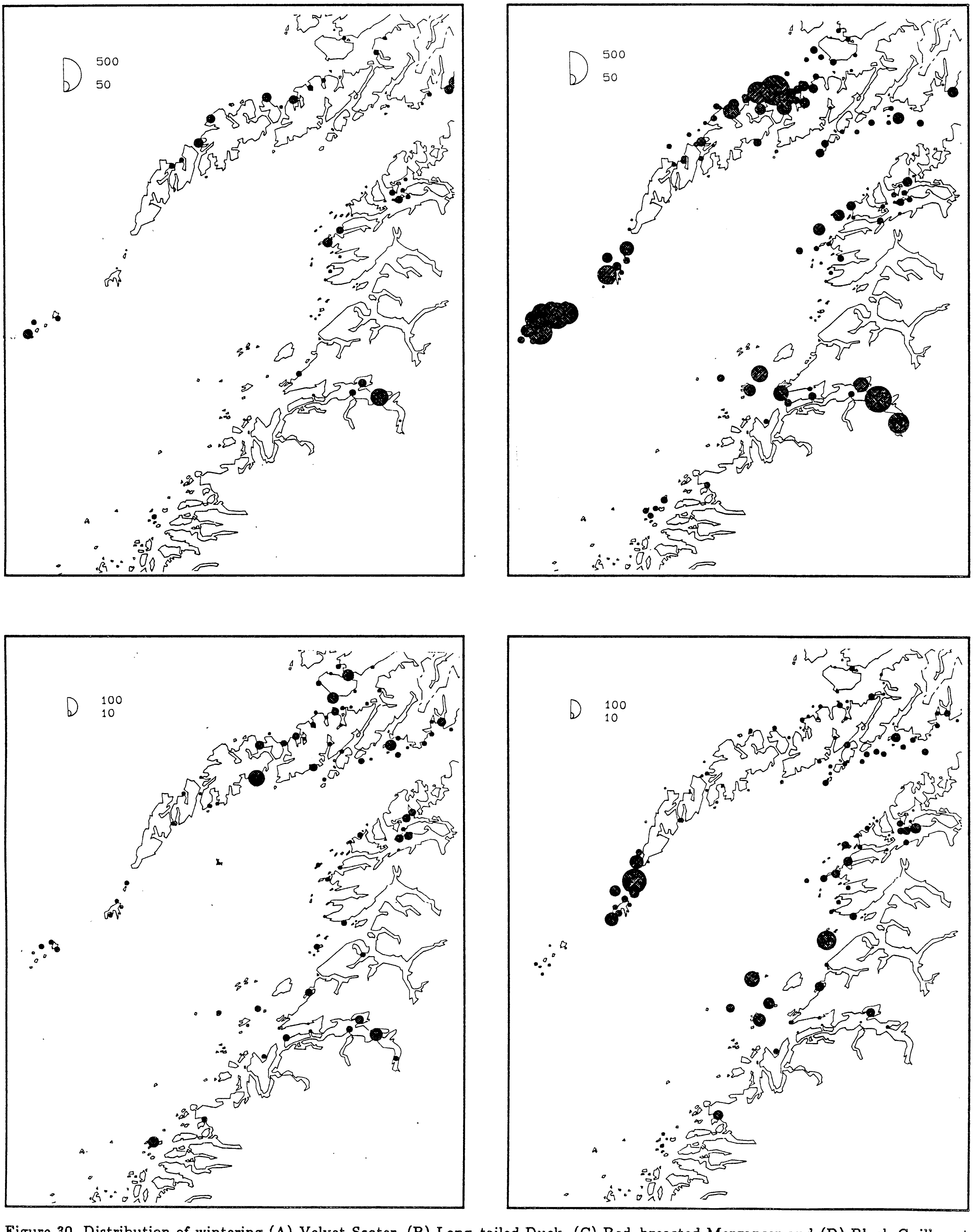


Figure 30. Distribution of wintering (A) Velvet Scoter, (B) Long-tailed Duck, (C) Red-breasted Merganser and (D) Black Guillemot in northern parts of Nordland county. Scale refers to circle diameter and represents number of individuals.

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