JOINT NATURE CONSERVATION COMMITTEE

THE DISTRIBUTION OF SEABIRDS AND CETACEANS

AROUND THE FAROE ISLANDS

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This report should be cited as:
Taylor, S J, & Reid, J B
The distribution of seabirds and
cetaceans around the Faroe Islands

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ISBN 1 86107 532 4

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Summary

- Surveys were conducted in the waters around the Faroe Islands between 1979 and 1999, to gain information on the distribution and abundance of seabirds and cetaceans.
- A total of 37 bird, and 15 cetacean species was recorded within the area.

Seabird species present throughout the year:

- Northern fulmars were the most abundant seabird species in the region, with very high densities found over the Faroese shelf and Faroe Bank throughout the year, with peaks in July and August. Slightly fewer were recorded between April and June.
- Peak northern gannet densities occurred during June, just to the east of the only colony on the islands at Mykineshólmur. Northern gannets were most widely distributed in August.
- Herring gulls were restricted to coastal waters during the breeding season, after which low numbers dispersed to deeper waters.
- Great black-backed gulls were more numerous in Faroese waters during the winter than during the summer, and were often recorded around fishing vessels at the shelf edge.
- Black-legged kittiwakes were abundant throughout the year, but particularly so during May and June when many were close to the islands, and over the slope to the south. Between July and September black-legged kittiwakes were distributed at low densities over much of the study area. There was also a number of high density patches over the shelf and slope. During October and December, black-legged kittiwakes were far less abundant within the study area.
- The highest common guillemot densities were in the vicinity of the breeding colonies on the southern Faroe Islands during May and June. During July and August, high densities were found over the Faroe Bank, and south of Suðuroy, while moderate common guillemot densities were found over the banks to the east of the islands during September and November.
- Razorbills were less abundant than common guillemots, but localised concentrations were noted over the shelf during May and June, with some post breeding concentrations to the south-west during July and August. The highest densities were seen to the north-east of the islands in November.
- Between May and August, high, often very high, densities of Atlantic puffins were present over most of the Faroe plateau, including the Faroe Bank Channel, the Faroe Bank and the banks to the east of the islands. Atlantic puffin concentrations were found at up to 90 km from the nearest colony during June. Dispersion was more contracted during July, when very high densities were found close to the colonies. Birds were found further from the islands during the winter, when moderate concentrations were over the offshore banks to the east of the islands.

Summer seabird visitors:

- Most Manx shearwaters were found over the western part of the study area. The Faroe Bank in particular held high numbers of Manx shearwaters between March and August, with the highest numbers during July and August.
- With 250,000 pairs the Faroe Islands hold a large proportion of the total European Storm-petrel population. High densities were present during July and August, particularly over the outer shelf and shelf break.
- Leach's storm-petrels were most numerous at the shelf edge to the south-west of Mykines, and over the Wyville Thomson Ridge at the southern edge of the survey area, during July and August. They were less common elsewhere, and at other times of the year.
- Small numbers of Arctic skuas were found in the vicinity of the colonies, and higher numbers were over the outer shelf to the north of the islands during June.
- Low numbers of great skuas were dispersed throughout the survey area, with higher densities recorded scavenging behind fishing vessels to the north of the islands during June.

- Peak numbers of lesser black-backed gulls were recorded during June and July, when they were scattered over the Faroese shelf and slope, often scavenging at fishing vessels.
- Most Arctic terns were seen in May and June close to the islands, where they breed in small numbers. Thereafter birds began to disperse to the south and south-west.

Winter seabird visitors:

- Glaucous gulls were frequent winter visitors, particularly during November, when most were recorded over the slope to the east of the islands and over the Faroe-Shetland Channel.
- Most little auks were seen during November over the banks to the east of the islands. Fewer birds were recorded closer to shore, and over the Faroe-Shetland Channel to the east.

Migrant seabirds:

- Thirteen great shearwaters were seen, most were over deep water to the south-east of the Faroe Bank during August.
- Sooty shearwaters were seen between July and September; the highest densities were seen over the Faroe Bank and the southern Faroese shelf during August.
- Pomarine and long-tailed skuas were seen in small numbers as they migrated to and from their northern breeding grounds.

Inshore seabird species:

- European shags were largely limited to coastal waters, especially during the breeding season. Some birds were seen over deep water at other times of year.
- All common eiders were seen very close to the coast.
- Common and black-headed gulls were mostly close inshore, but there were a number of records over deep water to the south, and south-east of the islands.
- Black guillemots were also found close to the coast, and may be more abundant than the observations made during this survey would suggest.

Cetaceans:

- There were two peaks in fin whale sightings, occurring during May and August. All sightings recorded in May occurred near the 1,000 m contour around the Faroe Bank Channel, Faroe Shetland Channel and to the north-east of the islands. All but three of the August sightings were recorded over shallower water at the edge of the banks and along the shelf break to the east of the islands.
- Almost as many sei whales as fin whales were seen. All but one of these sightings were during August.
- Minke whales were seen less frequently than either fin or sei whales. Most were over offshore banks or at the shelf edge.
- Two humpback whales were seen in the Faroe-Shetland Channel in July 1988.
- Sperm whales were recorded over continental slope waters, often in water deeper than 1,000 m.
- One Sowerby's beaked whale was observed, and a further five beaked whales were seen but could not be identified to species level.
- Killer whales were only seen ten times and all sightings were, at or beyond, the shelf edge.
- Long-finned pilot whales were the second most abundant cetacean species within the survey area, particularly during August in slope waters.
- Atlantic white-sided dolphins were the most abundant cetacean species, and large pods were seen in deep water. There was also a late summer movement into shallow shelf waters.
- There were two sightings of white-beaked dolphins on the Scottish side of the Faroe-Shetland Channel, but none on the Faroese side.
- Common dolphins were observed once, and Risso's dolphins twice.
- Four bottlenose dolphin pods were recorded over the Wyville Thomson Ridge.
- 60% of all harbour porpoise sightings were made during August. Although most were seen over the shelf, or at the shelf edge, 26% were in deeper water.

1. Introduction

1.1 Background

The Seabirds at Sea Team (SAST) of the Joint Nature Conservation Committee (JNCC) has been surveying seabird abundance and distribution and also cetacean distribution in British, and adjacent waters, since 1979. With the commencement of oil development in the North Sea during the 1970s the need for data on seabird dispersion at sea in the oil interest areas became apparent. This resulted in the formation of SAST with funding from the UK government and the oil and gas industry. This survey work continued as the oil industry expanded into new areas. The data obtained from 20 years of surveying by SAST and from other similar European organisations have been incorporated into the European Seabirds at Sea (ESAS) database. This database presently contains over 1.5 million seabird, and over 10,000 cetacean records, which have been used to produce a number of atlases on seabird distribution and abundance (e.g. Webb *et al.* 1990; Stone *et al.* 1995; Bloor *et al.* 1996; Pollock *et al.* 1997; Pollock *et al.* 2000). Other publications have included those focusing on seabird vulnerability to surface pollutants (e.g. Tasker *et al.* 1990; Carter *et al.* 1993; Webb *et al.* 1995; JNCC 1998).

Oil licensing in Faroese waters took place during 2000. Although no blocks have been licensed as yet, the area of interest to the oil industry is expected to be the deep waters to the eastern side of the study area (Figure 1). One of the licensing requirements is that information is presented on the importance of the licence blocks for seabirds and cetaceans. This information is required to complete Environmental Impact Assessments and form oil spill contingency plans. The UK oil industry funded work to satisfy these requirements in the Atlantic Frontier (Pollock *et al.* 2000). The UK process has served as a model for ensuring that seabird surveys were conducted in Faroese waters before the first Faroese licensing round.

1.2 Previous work and current objectives

Although seabird and cetacean survey coverage was obtained within the project boundary between 1979 and 1999, few data were collected before 1994, and almost none between the months of October and February. Even during the months of June to August data were limited, and most survey effort had been achieved in the south-eastern part of the survey area in Scottish waters (Stone *et al.* 1995). Ornis Consult Ltd. collected much of the seabird dispersion data during the late 1980s and early 1990s (Danielsen *et al.* 1990; Skov *et al.* 1994, 1995a) and vulnerability analysis has been undertaken for the waters south and west of Britain, and Faroese waters (Webb *et al.* 1995). In 1994, the JNCC obtained oil industry funding for a two year project focusing on the Faroe-Shetland area (Bloor *et al.* 1996). Consequently survey coverage was increased, especially between May and September, but was still not extensive enough to make a full assessment of the area's importance for seabirds and cetaceans. From July 1997, a consortium of oil and gas industry companies, Geotechnical Environmental Metocean (GEM), have funded survey work in the waters around the Faroe Islands. This collaborative venture between the Joint Nature Conservation Committee (JNCC), Ornis Consult Ltd. (OC), and Fiskirannsóknarstovan (Faroes Fisheries Lab) resulted in two special charters and a series of other surveys between August 1997 and September 1999. The current objective is to gain information on seabird and cetacean dispersion in Faroese waters with particular emphasis on deep waters to the south and south-east of the islands. The data collected during this project, and data from the period 1979 - 1996, have been analysed and the results are presented in this report.

1.3 The marine environment

The survey area contains a complex array of current systems, topography, inorganic nutrients and all the living components of the marine ecosystem, all of which interact to create a heterogeneous environment that varies through space and time in its suitability for seabirds and cetaceans. This variation can ultimately be traced back to fluctuations

in physical parameters such as seabed topography and current flow. Different hydrographic regimes and water masses vary in their nutrient content, and thus suitability for primary production and subsequent higher trophic level energy flow. Differences in diet and foraging behaviour result in the segregation of seabirds and cetaceans into different ecological niches in the marine environment. Several features of this environment that influence seabird and cetacean distribution are discussed below.

1.4 Bathymetry

The study area is dominated by the Faroe plateau, consisting of the main Faroese shelf, the banks to the east of the islands and the Faroe Bank to the south-west (Figure 1). The extreme south-eastern corner of the project area encloses a small part of the outer Scottish shelf. The Faroese shelf is widest in the north, and narrowest in the south, which is where the shelf edge is closest to the islands. To the east of Suðuroy, the 200 m contour is only 10 km from shore. The shelf topography is more uniform to the west of the islands, and more variable to the east, where there are a series of shallow banks shoreward of the 100 m contour from Eysturoy (Figure 2). Further east, the 200 m contour is convoluted into a series of banks also running north - south.

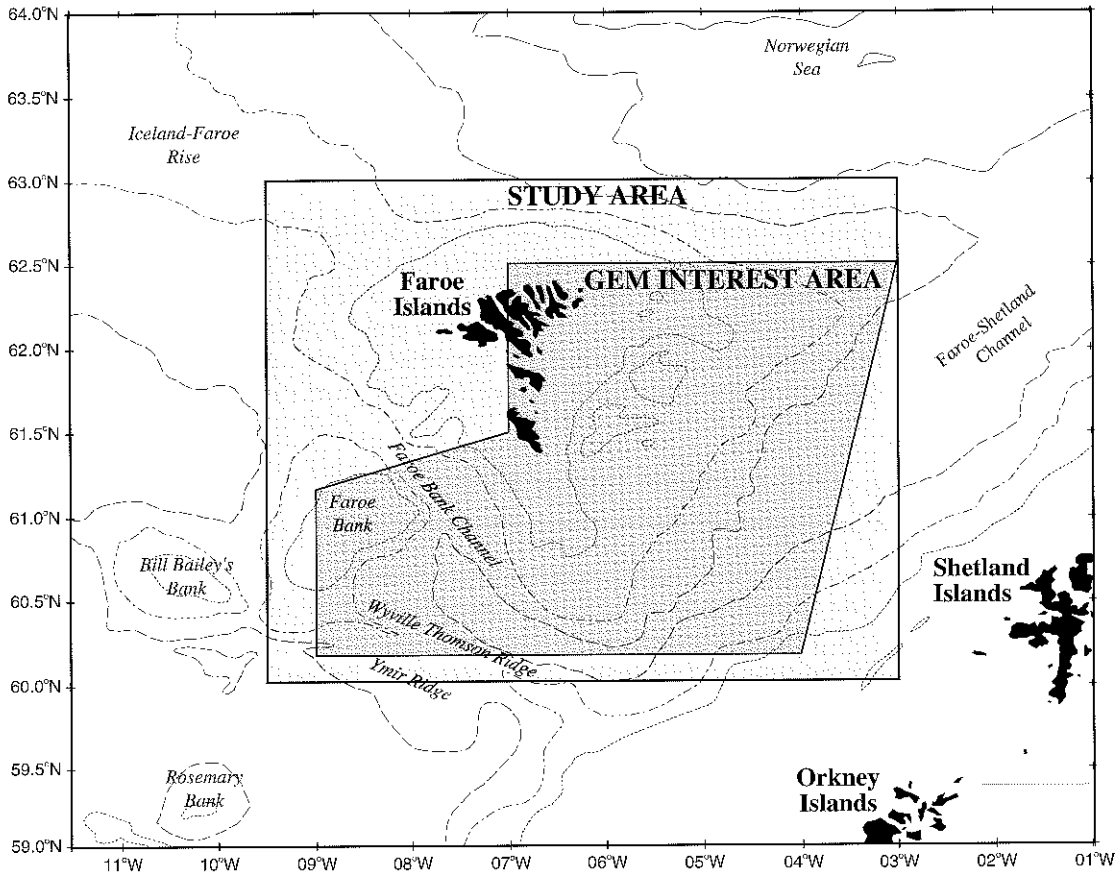


Figure 1 The study area showing place names and bathymetry
Bathymetry: dot (200 m isobath); dot dash (500 m isobath); short dash (1,000 m isobath); long dash (2,000 m isobath); solid (3,000 m isobath)

The Faroe Bank is the largest of a group of three banks stretching to the south-west of the Faroe Islands. Its north-eastern edge is approximately 73 km to the south-west of Suðuroy. Most of the bank is more than 100 m below the surface but in places the water depth is less than 80 m. Between the Faroe plateau and the Scottish shelf is the Faroe-Shetland Channel, and to the south-west is the Faroe Bank Channel. Within the study area water depth reaches 1,500 m in the central Faroe-Shetland Channel, and 1,100 m in the eastern Faroe Bank Channel. The Faroe Bank Channel becomes shallower and narrower towards the north-west as it passes between the Faroese shelf and the Faroe Bank. The southern side of the Faroe Bank Channel forms the northern edge of the Wyville Thomson Ridge which then adjoins the Ymir Ridge to the south.

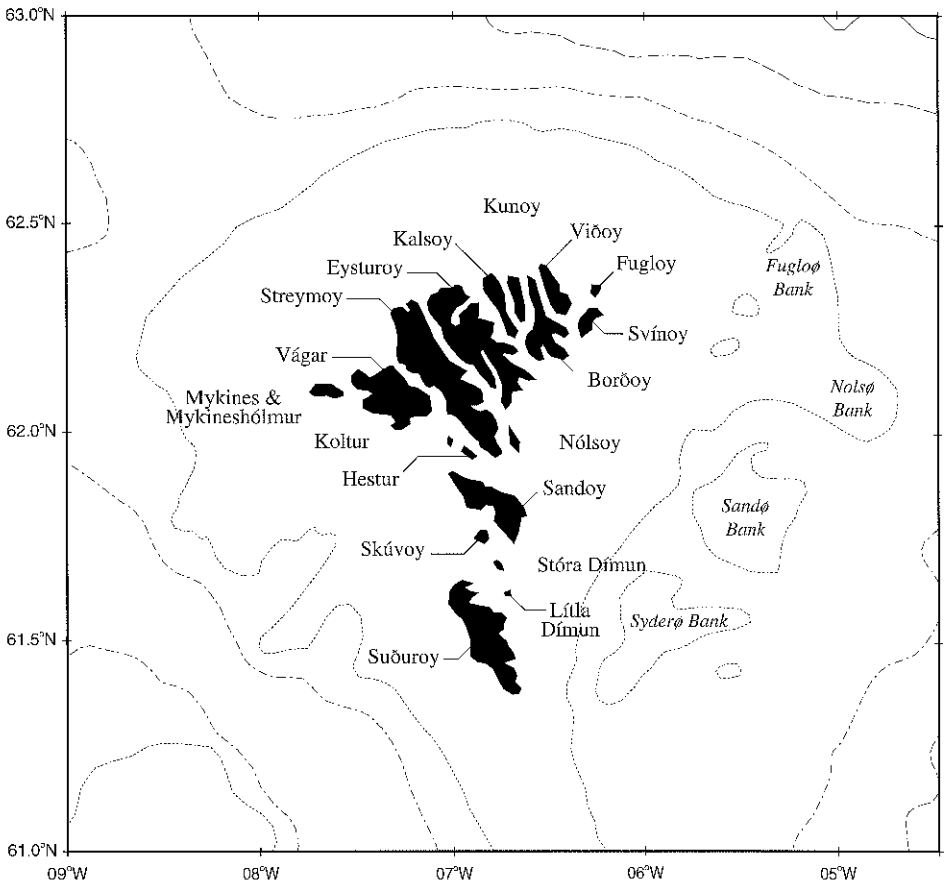


Figure 2 Faroe Island place names and banks
Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)

More than half of the Ymir Ridge lies outside the study area. The Faroe Bank Channel, Wyville Thomson and Ymir Ridge area contains the steepest and most varied topography within the study area. The next steepest slope area is to the north of the islands, over the southern edge of the Norwegian Basin, where only 22 km of horizontal distance separates the 200 and 1,000 m contours. The slope over the sides of the Faroe-Shetland Channel is more gentle, especially over the north-western side, where these same two depth contours are separated by 132 km of horizontal distance. The slope is also gentle over the Iceland-Faroe Rise, which separates the Iceland and Norwegian Basins. The south-eastern corner of the Rise lies within the study area, and is to the north-west of the islands.

1.5 Hydrography; currents and water properties

The area is subject to a milder maritime climate than would be expected from its latitude, due to warm North Atlantic water, which flows between Shetland and Iceland from the south (Figure 3). One branch (Faroes Current) flows from the west of the Rockall Plateau and continues northwards over the Iceland-Faroe Rise, before flowing eastwards over the slope to the north of the Faroes. It then continues along the eastern edge of the Norwegian basin in a north-easterly direction (Hansen 1985). Another more southerly branch of Atlantic water flows from the south-west around Bill Bailey's and the Faroe Banks, before flowing as a variable anticyclonic gyre around the edge of the Faroe plateau (Figure 3). The exact course of this branch is variable, but it is thought to turn to the east on reaching the south-eastern corner of the Faroese shelf, and then flow into the Norwegian Sea along the eastern side of the Faroe-Shetland Channel (Aken & Eisma 1987). A third branch of Atlantic water flows in a north-easterly direction into the southern Faroe-Shetland Channel. It may then mix to some extent with the Atlantic stream of the anticyclonic gyre, as it turns east across the Faroe-Shetland Channel (Hansen 1985). The Scottish Slope Current is a narrow and fast flowing current of warm Atlantic water which flows north-eastwards adjacent to the Scottish shelf edge over the eastern side of the Faroe-Shetland Channel. An offshoot of this oceanic water mixes with coastal water over the outer shelf, before flowing east past Orkney and into the North Sea (Dooley 1974).

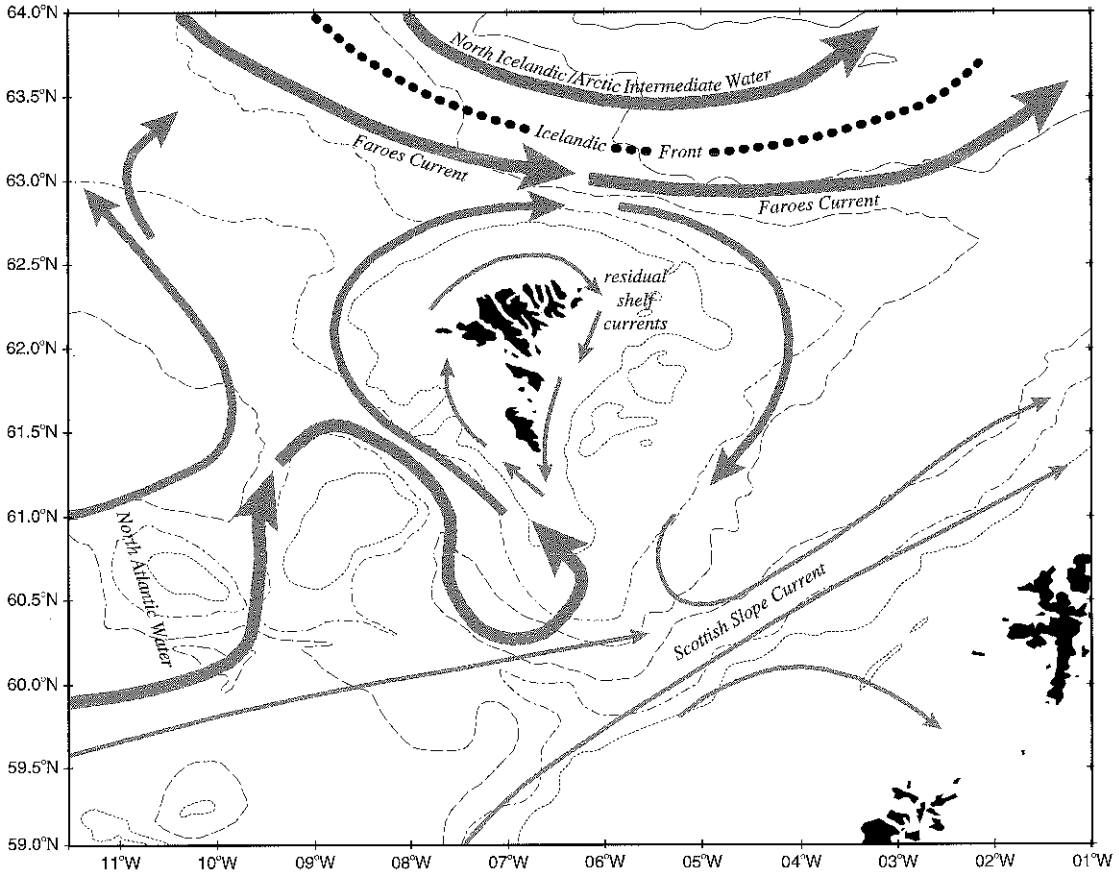


Figure 3 Water types and current flow paths around the Faroe Islands
Bathymetry: dot (200 m isobath); dot dash (500 m isobath); short dash (1,000 m isobath); long dash (2,000 m isobath); solid (3,000 m isobath)

Tidal flow is strong over the Faroese shelf, particularly close to shore, where eddies and tidal races form at many locations (Hansen 1992). In addition, residual anticyclonic currents circle the shelf over the 100 m contour (Davidsen & Hansen 1981). Faroese coastal water receives input from more oceanic water through wind driven upwelling at the shelf edge. Eddies also bring water from beyond the shelf edge over the shelf (Huthnance 1985). Most surface flow is northerly and is balanced by a predominantly southerly flow at depth. Cold, deep Norwegian Sea water flows south-westwards out of the Norwegian Basin and along the Faroe-Shetland Channel below 500 m. Some of this water is forced up into the overlying Atlantic water during overflow events, when water flows west through the shallower western Faroe Bank Channel (Fiskirannsóknarstovan 1995), or south over the Wyville Thomson Ridge (Ellett & Roberts 1973). At the Icelandic Front to the north of the islands, cool water of Icelandic and Arctic origin sinks below the surface layer of modified Atlantic water, and spreads over the slope and into the western Faroe-Shetland Channel. This cooler mixed water may periodically extend upwards over the outer northern Faroese shelf and upper slope (Meincke 1978). All these current systems are subject to changes in flow path and volume, which results in marked inter-annual variation in water temperature and salinity in the Faroe-Shetland area (Dooley *et al.* 1984; Hansen 1985). Nevertheless, characteristic temperature and salinity values can be assigned to each water mass. The Scottish Slope Current contains the warmest and most saline waters (9°-11°C, 35.25-35.45 Practical Salinity Units (psu)). The main branches of the North Atlantic Current further west are slightly cooler, and less saline, at between 7° and 9°C, 35.15-35.35 psu. The cooler water is generally found to the north of the islands where it has been modified by interaction with East Icelandic and Arctic Intermediate Waters. East Icelandic water is a lot colder than Atlantic water at 2°- 4°C, 34.7-34.9 psu, as is Arctic Intermediate Water at between 0° and 2°C, 34.72-34.98 psu. Waters over the Faroese shelf are between 6° and 10°C, 35.05-35.25 psu. The Deep Norwegian Sea Water is the coldest at between 0°C and -1°C, 34.9 psu (Aken & Eisma 1987; Jákupsstovu 1999).

1.6 Hydrographic conditions associated with seabird and cetacean distribution

Seabird and cetacean distribution is heavily influenced by the location of favourable feeding areas. Feeding areas are most commonly found in the vicinity of hydrographic features which will either concentrate passively drifting prey items, or contain favourable conditions for *in situ* prey production. Favourable feeding conditions are frequently found at the transition zone between two water masses, where salinity and water temperature change over a small horizontal distance. Such an area occurs over the slope to the north of the islands where fronts form as warm North Atlantic water meets cooler Norwegian Sea water (Meincke 1978). Fronts also occur where there is sharp change in current speed, or along the margins of upwelling such as around banks, reefs, shoals, in the lee of islands, and along the shelf edge (Fearnhead 1975; Fournier 1978; Huthnance 1985; Aken *et al.* 1987). Most Faroese shelf waters are well mixed by wind and tidal action, especially during the winter, with no thermal stratification in the upper 100 m. However, some shelf water does become stratified with the decline in wind speed during the summer (Aken & Eisma 1987). Tidal fronts may develop at the boundary between this stratified water and the well-mixed water (Fearnhead 1975; Pingree & Griffiths 1978). Fronts, or adjacent waters, are favoured as feeding locations by several trophic levels, either due to passive advection of prey items into the frontal region, or to high *in situ* primary and secondary production (Cushing 1971; Kiørboe & Johansen 1986). High phytoplankton growth may occur in the vicinity of the front if there is sufficient nutrient renewal and stabilisation of surface layers (Lalli & Parsons 1993). Zooplankton, squid, fish, seabirds and cetaceans have all been found in increased numbers at frontal systems (Schncommon eider 1982; Kiørboe & Johansen 1986; Begg & Reid 1997; Raid 1989; Schncommon eider 1990; Skov & Durinck 1995; Follestad 1991). Zooplankton concentrations have also been found at convergences (Pingree *et al.* 1974), surface eddies (Pingree 1978), in the vicinity of strong tidal currents over topographic irregularities (Alldredge & Hammer 1980; Braune & Gaskin 1982), and downstream from headlands and islands (Savidge & Lennon 1987).

1.7 Seabird and cetacean diet; trophic interactions

In the study area, seabirds and cetaceans feed on prey over a range of trophic levels and sizes, from Calanoid copepod crustaceans to marine mammals. On occasion, some killer whales *Orcinus orca* will prey upon other marine mammals such as long-finned pilot whales *Globicephala melas* (Bloch & Lockyer 1988), while the large sei whale *Balaenoptera borealis* and the tiny little auk *Alle alle* often feed on copepods (Jonsgård & Darling 1977; Bradstreet & Brown 1985; Sigurjónsson, 1995). These zooplankton eaters require high concentrations for efficient foraging, such as those found at frontal systems and upwelling zones (Brodie *et al.* 1978; Brown 1988a, b). Zooplankton abundance varies temporally, over diurnal and seasonal time scales. Many zooplankter spend the day deep in the water column and come to surface waters to feed during the night (Bollens & Frost 1991). Other zooplankter such as *Calanus finmarchius*, overwinter in large numbers at depth feeding on phytoplankton, and then return to the surface during the summer (Colebrook 1986). Planktivorous seabirds exploit such periods of peak abundance by feeding and breeding when crustaceans are most abundant at, or near, the sea surface. For example Leach's storm-petrels, in common with many other Procellariiformes, feed more at night than during the day (Watanuki 1985; Prince & Morgan 1987). Over a longer time scale, most Faroese seabirds breed during the period of peak primary and secondary productivity (Salomonsen 1955). In Faroese waters peak primary production occurs around early May, but varies according to environmental conditions (ERT 1997). Chain forming diatoms dominate in shelf waters, and in early spring in the open ocean (>800 m), while dinoflagellates and coccolithophores predominate over the shelf break and slope. In the open ocean most primary productivity is attributed to micro and dinoflagellates (Zeitzschel 1986). After May there is a succession of key herbivore and predatory zooplankton, which exploit this seasonal abundance in phytoplankton during the following four to five months (ERT 1997). These include copepods, fish larvae and the larvae of benthic invertebrates over the shelf; copepods are also present at the shelf break and in deeper water (Zeitzschel 1986; Jákupsstovu 1999). Although euphausiids are found over the shelf, most are over the shelf break and slope, while salp (Chordata) and cilliate (Protozoa) distribution in Faroese waters, may be centred further offshore in deep oceanic water (Zeitzschel 1986). Squid and fish may aggregate to feed and spawn in areas of elevated zooplankton abundance (Kiørboe & Johansen 1986). Mackerel *Scomber scombrus* and herring *Clupea harengus* feed on the abundant *C. finmarchius* population after it rises into surface layers in the spring (Bainbridge & Forsyth 1972; Colebrook 1986). Mackerel, herring, and sprat *Sprattus sprattus* are characteristic of the schooling, lipid-rich pelagic fish, preferred as prey by most seabirds in the study area (Hunt *et al.* 1996).

Seabird distribution has been correlated with fish availability during both the breeding season (Crawford & Shelton 1978; Springer *et al.* 1986), and the non-breeding season (Jensen *et al.* 1994).

Seabird and cetacean diets are determined by their foraging method, and preferred foraging location within the water column, as these both govern the prey species available to them (Vermeer *et al.* 1987; Burger *et al.* 1991; Jensen *et al.* 1994). The pursuit-diving common guillemot *Uria aalge* can dive to 180 m (Piatt & Nettleship 1985), although usual foraging depths are less than this, which allows it to take gadoid species less readily available to shallower diving species such as the Atlantic puffin *Fratercula arctica* (Blake 1983, 1984; Harris 1984). In contrast, northern gannets *Morus bassanus*, which plunge dive from a height, and Manx shearwaters *Puffinus puffinus* which shallow plunge dive, depend on finding fish close to the sea surface, such as mackerel, herring or sprat (Wanless 1984; Brooke 1990). Northern fulmars *Fulmarus glacialis*, and European *Hydrobates pelagicus* and Leach's *Oceanodroma leuchorhoa* storm-petrels usually feed at the sea surface on fish, cephalopods and crustaceans (Watanuki 1985; Prince & Morgan 1987), although on occasion northern fulmars will dive to at least ten metres depth (Bourne 1997).

As would be expected, seabird and cetacean diet varies with location, and with season (Furness & Todd 1984). Falk *et al.* (1992) discovered that in the Norwegian Sea, Atlantic puffins fed almost exclusively on lantern fish *Benthosema glaciale* and *Gonatid* squid, while over the Faroese shelf they ate euphausiids, sandeels *Ammodytes* spp. and capelin *Mallotus villosus*. In Scottish waters, the proportion of clupeoids and gadoids in the diet of common guillemots increased from the summer to the winter (Blake *et al.* 1985; Halley *et al.* 1995). More generally, there is a lack of information on diet away from the coast and in winter (Jensen *et al.* 1994). Seabird diet during the breeding season is better known; sandeels and clupeoids such as sprat and herring are important prey for many species of seabird in the north-east Atlantic, including auks (Blake *et al.* 1985; Wright & Bailey 1991), terns (Monaghan & Uttley 1991), black-legged kittiwakes *Rissa tridactyla* (Hamer *et al.* 1993), Arctic skuas *Stercorarius parasiticus* (Furness 1990) and European shags *Phalacrocorax aristotelis* (Harris & Riddiford 1989; Harris & Wanless 1991). Their distribution at sea can be positively correlated with sandeel density (Camphuysen 1990; Furness 1990; Wright & Bailey 1991; Wright & Begg 1997). Partial or complete breeding failure may occur if sandeel stocks are low (Uttley *et al.* 1989). Although a number of north-east Atlantic seabirds eat cephalopods, especially the procellariiforms (mostly *Ommastrephid* squid), (Watanuki 1985; Falk *et al.* 1992; Bourne 1997), cephlapods appear to be of greater importance in the diet of odontocete cetaceans (Clarke 1980; Furness 1994). Cephalopods comprise a high proportion of the diet of sperm whales *Physeter macrocephalus* (Rice 1989) and northern bottlenose whales *Hyperoodon ampullatus* (Clarke & Kristensen 1980), and probably in that of Sowerby's beaked whales *Mesoplodon bidens* (Ostrom *et al.* 1993). Squid also feature to a variable, and perhaps lesser extent, in the diet of long-finned pilot whales (Desportes & Mouritsen 1993), Atlantic white-sided dolphins *Lagenorhynchus acutus* (Couperus 1997), bottlenose dolphin *Tursiops truncatus* (Barros & Odell 1990), and harbour porpoise *Phocoena phocoena* (Pierce & Santos 1996). Pelagic clupeoids and gadoids comprise a variable, and often high proportion, of the odontocete diet, including herring, mackerel, blue whiting *Micromesistius poutassou*, and Norway pout *Trisopterus esmarkii* (Desportes & Mouritsen 1993; Hoydal & Lastein 1993; Rogan *et al.* 1997; Couperus 1997). For example, the predominantly coastal white-beaked dolphin *Lagenorhynchus albirostris* and harbour porpoise, eat a wide range of fish species including sandeels, whiting *Merlangius merlangus*, haddock *Melanogrammus aeglifinus*, poor cod *Trisopterus minutus*, Norway pout *T. esmarkii*, pollack *Pollachius pollachius*, and also herring for the harbour porpoise (Evans 1990; Martin 1995), and including herring, haddock, and whiting for the white-beaked dolphin (van Bree & Nijssen 1964; Santos *et al.* 1994).

Euphausiids are the primary prey of fin whales *Balaenoptera physalus* in the Faroes area, with herring a second choice (Jonsgård 1966; Mitchell 1974). Sei whale diet in Faroese waters is less certain, but in most areas they specialise on copepods with euphausiids as a second choice, although in Icelandic waters they eat more euphausiids than copepods (Sigurjónsson 1995; Horwood 1987). Unlike sei whales, fin whales will eat a range of fish species in addition to crustaceans, including blue whiting, capelin *Mallotus villosus*, herring, mackerel and sandeels (Jonsgård 1966; Mitchell 1974; Sigurjónsson 1995). Minke whales *Balaenoptera acutorostrata* eat a wide range of prey species including euphausiids, gadoids, sandeels, herring and capelin, although herring and capelin predominate (Jonsgård 1982; Sigurjónsson 1995; Skaug *et al.* 1995; Haug *et al.* 1996).

1.8 Fisheries, and interaction with seabirds

Fisheries have the potential to both adversely, and positively, affect seabirds and cetaceans. Three main species of pelagic fish are caught in Faroese waters, namely blue whiting, herring, and mackerel. Blue whiting are fished with pelagic trawls, towed at 300 - 400 m depth just beyond the shelf break, mainly during late April and May. This is when they migrate into the Norwegian Basin from their spawning areas over the Wyville Thomson Ridge and further south (Hansen & Jákupsstovu 1992). The largest catches are taken by Russian factory trawlers over the upper slope to the south of the Faroes (Jákupsstovu 1999). Three herring groups can be identified in Faroese waters: those which spawn in small numbers very close to shore, the Norwegian spring spawners and the Shetland autumn spawners. The last two

are targeted by the larger purse seine vessels. The Norwegian spring spawners spawn along the Norwegian west coast, before migrating to the southern and central Norwegian Sea. In some years the autumn Shetland spawners reach the banks to the east, and south of the Faroes, during feeding migrations (Jákupsstovu 1999). Mackerel spawn to the south of Ireland and are fished in Faroese waters using purse seines and pelagic trawls between June and September as they migrate into, and through, the survey area. The highest Russian catches have been in the deep waters of the Faroe-Shetland Channel in June (Jákupsstovu 1999). The mackerel make a return southward migration in the winter, and are caught at this time in Scottish waters, but not further west in Faroese waters (Saville 1985).

A range of demersal fish are trawled, but the most significant fishery is for gadoids. Cod *Gadus morhua*, saithe *Polachius virens* and haddock, comprised the greatest landing weights in 1996. Other demersal fish landed, in order of abundance during 1996, were: greater silver smelt *Argentina silus*, redfish *Sebastes* spp., Greenland halibut *Reinhardtius hippoglossoides*, ling *Molva molva*, tusk *Brosme brosme*, monkfish *Lophius piscatorius* and blue ling *Molva dipterygia* (Jákupsstovu 1999). Sandeels are locally abundant, but have never been fished commercially, as patches of suitable habitat are too small for long tows (H. Jákupsstovu, pers. comm.). Demersal fish are targeted with a range of fishing gear types and vessel sizes, ranging from small set-netters to large trawlers, and long-liners greater than 40 m in length. Most of the large demersal trawler fishing effort is concentrated between 300 and 600 m along the slope to the east, and north-east of the Faroe plateau, and also over the south-eastern side of the Iceland-Faroe Rise (Jákupsstovu 1999). These areas over the upper slope may hold the greatest potential for seabirds exploiting discarded bycatch. Demersal trawls generate the largest amount of discards; Hudson (1986) found that demersal trawlers from Shetland on average discard 27% by volume of their catch. The large quantities of discards available can be important for seabirds, but their importance also depends on the availability of alternative sources of natural food (Garthe *et al.* 1996; Camphuysen *et al.* 1995; Hamer *et al.* 1991).

Hydrography is a better predictor of northern fulmar distribution than fisheries (Camphuysen & Garthe 1997). This means that northern fulmars make use of areas where natural feeding opportunities are good; if these areas coincide with fishing vessels, then they will also eat fishing discards when they are available. There is little empirical information on fishery-seabird interactions in Faroese waters, but large numbers of seabirds were seen feeding around fishing vessels during this survey, for example during late April and early May, when large numbers of Russian factory ships target blue whiting over the slope to the south of the Faroes.

Northern fulmars, black-legged kittiwakes and great black-backed gulls *Larus marinus* were the commonest fishing vessel associates, although northern gannets, great skuas *Catharacta skua*, European storm-petrels and herring *L. argentatus*, Iceland *L. glaucoides*, glaucous *L. hyperboreus* and lesser black-backed gulls *L. fuscus* were also frequent ship associates. There is some evidence to suggest that fishing vessel discards comprise a higher proportion of seabird diet during the winter than during the summer, at least in the North Sea (Camphuysen *et al.* 1993, 1995).

Not all fishery-seabird interactions benefit seabirds. Some fishing gears can result in high levels of seabird mortality, and fisheries may cause reductions in the abundance of seabird prey. The greatest direct mortality is thought to be due to entanglement in gill nets and other fixed nets. Auks are especially prone due to their foraging behaviour below the surface (Oldén *et al.* 1988; Bibby 1972), but long lines are also a potential problem, especially for Procellariiformes. Interaction at the ecosystem level is most significant when birds are feeding in the same area as fishing operations, and are consuming fish of the same size as that targeted by the fishery (Wright *et al.* 1998), a prime example being the industrial fishery for sandeels in the North Sea. Sandeel landings from the Wee Bankie, off the east coast of Scotland, have been correlated with years of low breeding success in the surface feeding black-legged kittiwake (Harris & Wanless 1997). However, natural fluctuation in sandeel recruitment, and variation in current flow patterns, may prove more significant in other areas. There is no sandeel fishery in the Faroes, but in some years (e.g. 1988 - 1992) there has been almost complete breeding failure in the archipelago's Atlantic puffin colonies; these years can be at least partly explained by natural variations in sandeel abundance (B. Olsen & H. Jákupsstovu, pers. comm.).

1.9 Breeding seabirds

The Faroe Islands hold large numbers of breeding seabirds; the populations of 13 out of the 19 breeding seabird species exceed 1% of the total European populations (Table 1). Northern fulmar, storm-petrel and black-legged kittiwake numbers exceed 10% of the European total, and Manx shearwater and Atlantic puffin numbers are just less than 10%. At an international level, European storm-petrel numbers are very important; the islands probably hold about 40% of the world population, with one island, Nólsoy, probably containing 17% of the world population at 100,000 pairs (J-K Jensen & T. Martin unpublished ringing data; B. Olsen pers. comm.). Northern fulmars and Atlantic puffins are the most numerous breeders, followed by European storm-petrels and black-legged kittiwakes (Table 2). The breeding common guillemot population is only about a third of the size of the Atlantic puffin population, while that of razorbills *Alca torda*

and black guillemots *Cepphus grylle* is much lower. The distribution of seabird breeding colonies influences seabird dispersion at sea during the breeding season, as the adults are constrained by the need to return to their nest site. For example northern fulmars have been found foraging 100 km away, and northern gannets between 150 km and 320 km, away from the nearest colony (Furness & Todd 1984; Tasker *et al.* 1985; Camphuysen *et al.* 1995).

Table 1 Pairs of breeding seabirds in the Faroe Islands (placed in a European context)

Species	*Total for study area*	*European population*	*% of European population in study area*
Northern fulmar	800,000	5,840,000	13.69
Manx shearwater	25,000	306,000	8.17
European storm-petrel	Approximately 250,000 a	Uncertain, but probably < 580,000	Probably about 40%
Leach's storm-petrel	1,000	60,600	1.65
Northern gannet	2,000	223,600	0.89
European shag	1,500	125,000	1.20
Arctic skua	1,300	17,500	5.14
Great skua	450	13,600	3.31
Black-headed gull	250	1,200,000	0.02
Mew gull	1,000	488,000	0.20
Lesser black-backed gull	9,000	187,000	4.81
Herring gull	1,500	978,000	0.15
Great black-backed gull	1,200	83,100	1.44
Black-legged kittiwake	230,000	1,740,000	13.21
Arctic tern	2,000	278,000	0.72
Common guillemot	175,000 b	3,000,000	5.83
Razorbill	4,500 b	612,000	0.73
Black guillemot	3,500	100,000	3.50
Atlantic puffin	550,000	6,890,000	7.98

Many of these figures , especially the petrel and shearwaters numbers, are only approximate. Sources: Grimmet & Jones (1989); Bloch et al. (1996a); Lloyd et al. (1991); B. Olsen pers. comm.

a Lloyd et al. (1991) estimated an upper world total of 380,000 pairs, which assumed that the Faroes contained at most 100,000 pairs. A decade of ringing has revised the estimated Faroese population upwards to 250,000 pairs. The colony on Nólsoy alone is thought to contain approximately 100,000 pairs, which would make it the largest colony in the world (J-K. Jensen & T. Martin unpublished ringing data; B. Olsen pers. comm.)

b Numbers of individuals multiplied by 0.55 to obtain pair estimates (B. Olsen pers comm.)

Table 2 Relative abundance of seabird species at Faroese colonies

Seabird colony	*Relative abundance of the more numerous species - listed in order of decreasing abundance*
Mykines and Mykineshólmur	P, SP, F, K, Gu, MS, Ga, R, LP
Vágar	F, P, K, SP, Gu, LP, MS, BG, R
Streymoy	F, P, K, Gu, SP, R, MS, BG
Eysturoy	F, P, Gu, K, MS, SP, BG, R
Kalsoy	P, F, K, Gu, SP, MS, BG, R
Kunoy	F, P, Sp, MS, BG
Borðoy	F, P, SP, BG
Viðoy	F, P, K, G, SP, MS, BG
Fugloy	SP, F, P, Gu, K, R
Svínoy	F, SP, P, MS
Nólsoy	SP, P, F, K, MS
Koltur	P, F, SP, MS
Hestur	P, K, F, SP, Gu, MS,
Sandoy	P, F, SP, K, Gu, MS, BG, R
Skúvoy	Gu, F, P, K, SP, MS, R
Stóra Dímun	P, K, Gu, SP, R, R
Lítla Dímun	P, K, SP, Gu, F
Suðuroy	F, K, P, Gu, SP,

Species key: F = northern fulmar, MS = Manx shearwater, LP = Leach's storm-petrel, SP = European storm-petrel, Ga = northern gannet, K = black-legged kittiwake, Gu = common guillemot, R = razorbill, BG = black guillemot, P = Atlantic puffin. For species population estimates for each island refer to Grimmett and Jones (1989) or ERT (1997). For place names of colonies see Figure 2.

2. Methods

2.1 The study area

The study area was centred on the Faroe Islands, but extended as far south as the Wyville Thomson Ridge (Figure 1). The study area includes licence blocks 204, 205 and 213, which were registered in the 16th and 17th UK offshore oil licensing rounds. The area covered during this report is shown by the box in Figure 1, and is delimited by the following co-ordinates: 63°00'N 9°30'W, 63°00'N 3°00'W, 60°00'N 9°30'W, 60°00'N 3°00'W.

2.2 Survey methodology

Surveys were conducted from ships using methodology for counting seabirds at sea, as described by Tasker *et al.* (1984) and Webb & Durinck (1992). A range of 'vessels of opportunity' were used for surveys, including research vessels, fishery protection vessels, seismic vessels and ferries, in addition to two dedicated charters. Data were collected when the vessel was steaming at speeds greater than 5 knots. The vessel's position, speed and course were recorded using a Global Positioning System (GPS). Environmental data such as wind direction and force, sea state, swell height and visibility were recorded every 90 minutes, or more frequently, if environmental conditions had changed.

All seabirds on the water, and within 90° of the ship's trackline out to a perpendicular distance of 300 m, were recorded. Birds on the water were assigned to one of four transect bands (A = <50 m, B = 51-100 m, C = 101-200 m, D = 201-300 m) according to their perpendicular distance from the ship's track. A 'snapshot' technique was used to sample flying birds, so as to minimise the biases arising from the movement of flying birds relative to the movement of the ship. The frequency of 'snapshots' was determined by the speed of the vessel and the distance in front of the vessel at which flying birds could be detected. During JNCC surveys, observers used the naked eye to detect birds, and binoculars to confirm species identification if necessary. During Ornis Consult Ltd. surveys, binoculars were used to scan the 300 m band transect in order to detect seabirds. Other pertinent details such as associations between species and feeding behaviours were also noted. Birds associated with fishing vessels were counted and noted as such.

Cetacean observations were recorded concurrently with seabird surveys, using the same distance bands as for birds. In addition, they were also recorded at greater distances from the survey vessel outwith the transect bands. Information noted included species, number and age of animals (where possible) and behaviour.

2.3 Data analysis

2.3.1 Data preparation

Data collected during seabird surveys were recorded on paper forms while at sea. Data were later transcribed onto a computer database, and coded data were checked manually by an independent observer.

Data were grouped in preparation for map production, to give a total number of birds per 10 min period of the survey. These totals were used to calculate densities, and prepare sightings and abundance maps. During production of seabird density maps, only those birds on the water within the 300 m band transect, or flying 'in snapshot' were included.

2.3.2 Correction factors

Correction factors were applied to birds on the water to account for variations in detectability at different distances from the ship's trackline (Table 3). As stated above, birds on the water were recorded in one of four distance bands (A = <50 m, B = 51-100 m, C = 101-200 m, D = 201-300 m). Correction factors were calculated using the following formula:

$$\frac{(nA + nB) \times 3}{(nA + nB + nC + nD)}$$

where nA, nB, nC and nD equal the number of birds recorded on the water in the respective transect bands (Tasker *et al.* 1987). Correction factors were not calculated for uncommon species (those with a sample of less than 1,000 birds recorded on the water within transect), and the correction factors found in Stone *et al.* (1995a) were applied instead. Correction factors were only applied for birds on the water for which density was to be calculated. Species that were closely related, and similar in size and appearance (e.g. common guillemot and razorbill), were grouped together when calculating the correction factors, as their detection rates are very similar. Certain species groups, such as auks and petrels, became more difficult to detect as sea state increased. For these species, correction factors were calculated taking sea state into account. Correction factors were applied to the data collected in each survey period, and location, by multiplying the number of birds recorded for a species by its correction factor to give a corrected value with which to calculate density (the corrected number of seabirds recorded per km^2 survey coverage).

Table 3 Correction factors used during data preparation

Species group	*Sea state*	*Correction factor*
Northern fulmar	All	1.2
Shearwaters	All	1.1
European/Leach's storm-petrel	0-2	1.3
European/Leach's storm-petrel	≥3	1.6
Northern gannet	all	1.0
European shag	all	1.1
Skua	all	1.3
Small gull	all	1.2
Large gull	all	1.0
Terns	all	1.7
Common guillemot/Razorbill	0-2	1.3
Common guillemot/Razorbill	≥3	1.6
Black guillemot	all	1.4
Atlantic puffin/little auk	≥3	1.4
Atlantic puffin/little auk	≥3	1.7

Cetacean data were not used to produce density or abundance maps, since the opportunistic methods used for recording them do not include measurements of angle, or distance, at first sighting, and so are likely to under-record cetaceans in the area. Instead, cetacean sightings data have been presented either as number of animals seen per km of survey trackline, or the location of each sighting has been plotted (see below).

2.4 Data presentation

Seabird and cetacean species accounts are presented in taxonomic order, except for a summary list of rare seabirds, which comes after the main seabird accounts. Monthly distribution maps for each species were generated using Dmap for Windows version 6.5b (Morton 1998). Where consecutive maps showed a similar pattern in both distribution and density, they were grouped together.

Data shown in density and abundance maps are presented in ¼ International Council for the Exploration for the Sea (ICES) rectangles, which measure 15' latitude by 30' longitude. The method of mapping differs between species, according to how numerous they were within the survey area:

Density maps: Maps of seabird density are presented if more than 150 birds were seen of a given species. The number of birds seen has been divided by the total survey coverage in each ¼ ICES rectangle to give the number of birds per square km (birds/km^2).

Abundance maps: For common cetacean species, of which more than 1,500 animals were recorded, distribution is depicted as the number of animals per km travelled. Only long-finned pilot whale and Atlantic white-sided dolphin came into this category.

Sightings maps: Maps showing the location of sightings were produced for uncommon seabirds, with between 20 and 150 records, and for cetaceans with less than 100 records.

2.5 Limitations and variation within survey data

The data used in this report were collected by a number of observers from a variety of survey platforms. Large vessels provide a higher observer eye height which may result in improved visibility. Smaller vessels afford a more detailed look at seabirds on the water, but are more affected by adverse weather conditions, making it difficult to carry out observations during the winter. In addition, fewer vessels of opportunity were available for surveying during the winter, so significantly less survey coverage was achieved during the winter than during the summer (Figure 4). The use of fishery protection vessels, and fishery research vessels, can result in high densities of seabirds associating with the observation platform. Variation in eye height, vessel speed and stability of the platform may induce biases during adverse weather conditions. Survey tracks were not determined by the observers, with the exception of the two dedicated surveys. The use of ferries, seismic vessels and hydrographic cruises in particular, involves steaming along pre-determined fixed routes, resulting in uneven survey coverage. In order to assess the seabird distribution in parts of the study area that are representative of the whole study area, the survey tracks should ideally be selected at random. Again, this was not possible on non-dedicated survey cruises. Variation in weather conditions between surveys is another source of variation, as seabird and cetacean detectability varies with the weather conditions experienced during each survey. High sea states, swell height, and wind speeds affect survey coverage for much of the year, but particularly during the winter. Almost 60% of all cetacean sightings in the ESAS database were made between June and August, when sea conditions were calmer, and the day length longer. This seasonal increase in number of sightings is partly due to an increase in cetacean numbers and survey effort, but the more favourable observing conditions are also likely to be responsible.

High sea states result in biases towards larger, more conspicuous species. For example, large pale birds flying high above the water are more readily detectable in rough weather than small predominately dark species such as the storm-petrels or auks. However, correction factors have been used in an attempt to correct for observations made over a range of sea states (see above). Similarly the size and behaviour of cetacean species affects the likelihood of their detection. Species that surface inconspicuously, such as the beaked whales, and small species such as the harbour porpoise, show significant reductions in sighting rate with increasing sea state (Clarke 1982; Palka 1996). The behaviour of cetaceans also influences their sighting rate, since some species such as common dolphins approach vessels to ride the bow wave, increasing their chances of detection.

OC and the JNCC both used the same surveying methodology, with the exception of the continuous use of binoculars by OC in order to detect birds ahead of the ship, and within the band transect. This leads to a bias towards species which are wary of the approaching survey vessel, such as divers, and also to species such as auks, which may dive before the approach of the survey vessel. However, the continuous use of binocular scans within the band transect is likely to under-record cetaceans, since many are detected at some distance from survey vessels using cues such as distant splashes or blows.

3. Survey Coverage

This report summarises all ESAS data collected in the study area between 1979 and May 1999.

Figure 4 depicts monthly effort as km^2 surveyed, and Table 4 as tabulated monthly totals. Survey effort and coverage was greatest during summer and least during the winter, when reduced day length, strong winds and increased swell heights, restricted both ship speeds and days suitable for surveying.

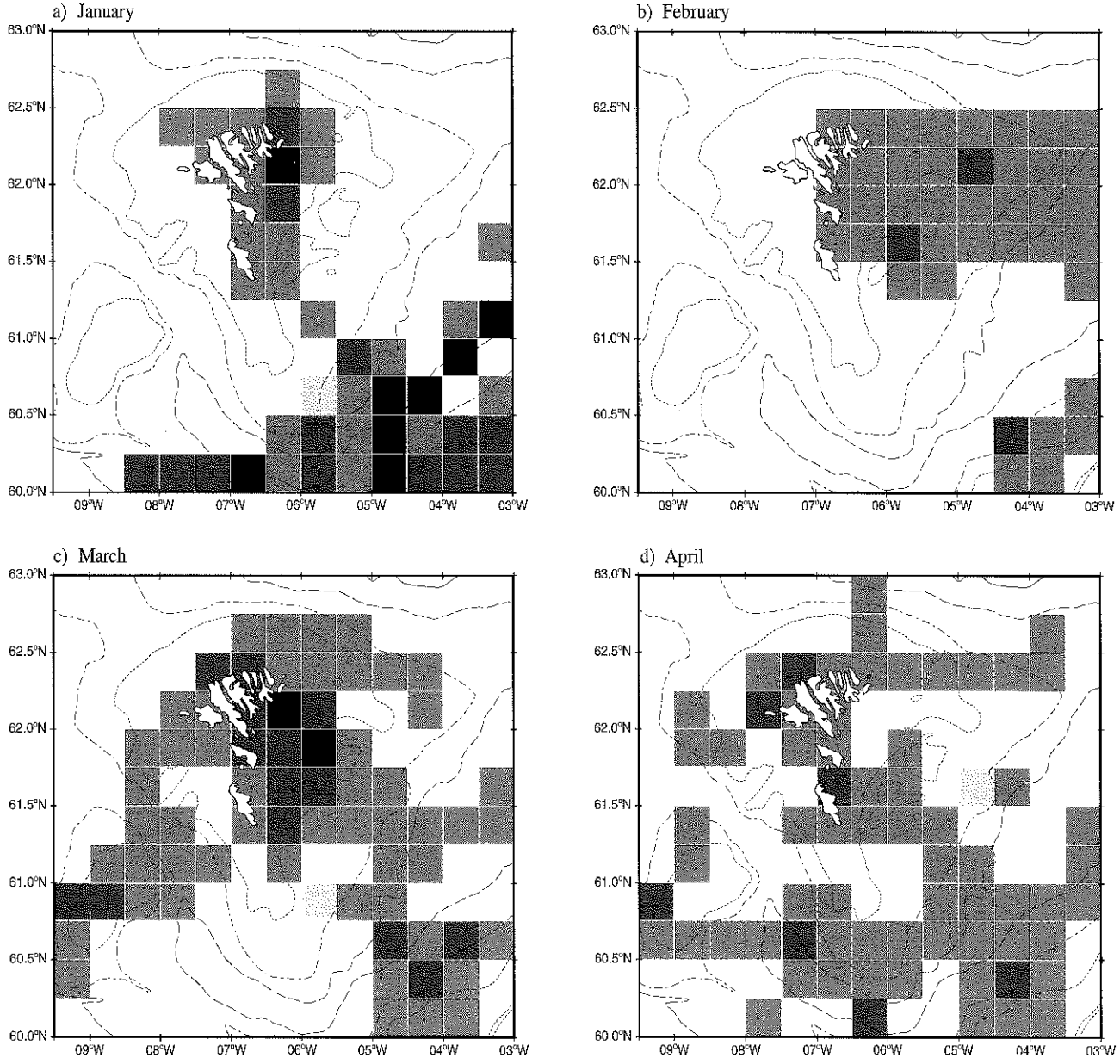


Figure 4 Monthly survey effort (km^2) achieved in the survey area, 1979 - 1999

Blank = No coverage | 0.01-0.99 | 1.00-9.99 | 10.00-19.99 | 20.00+

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)

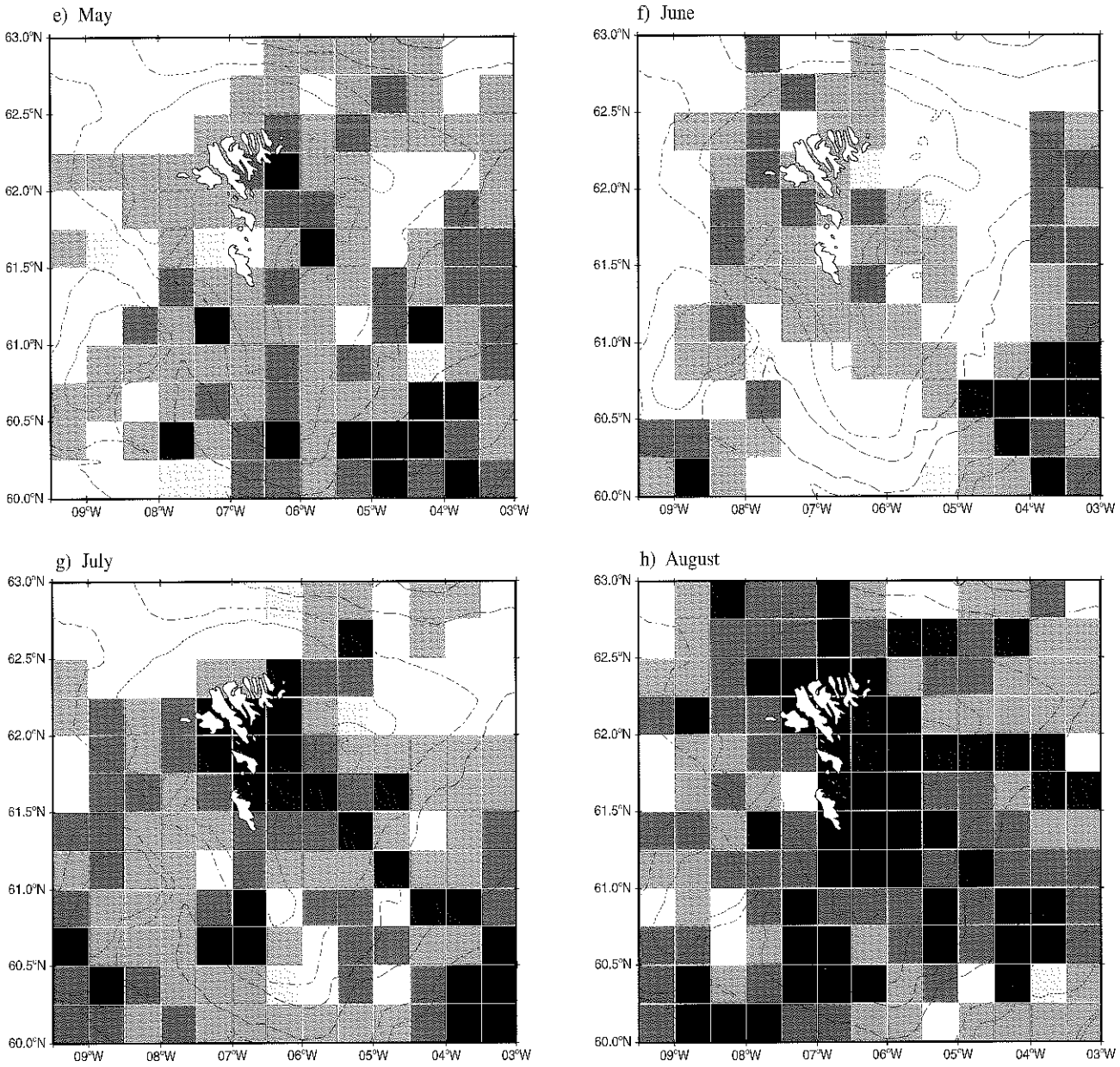


Figure 4 Monthly survey effort (km²) achieved in the survey area, 1979 - 1999

Blank = No coverage 0.01-0.99 1.00-9.99 10.00-19.99 20.00+

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)

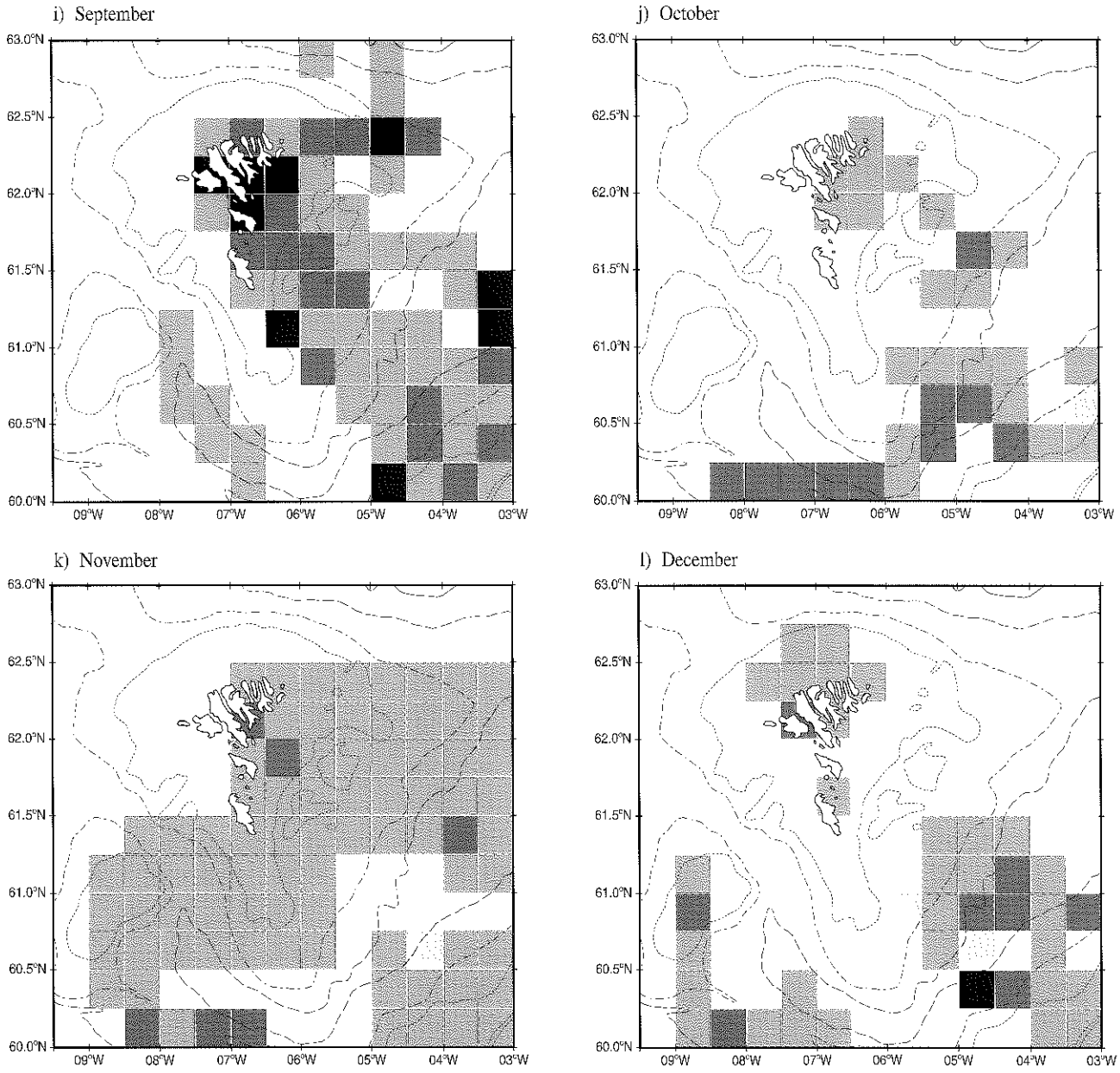


Figure 4 Monthly survey effort (km²) achieved in the survey area, 1979 - 1999

Blank = No coverage 0.01-0.99 1.00-9.99 10.00-19.99 20.00+

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)

Table 4 Monthly survey effort: 1979 - 1999

Month	*Survey effort (km²)*	*% Survey effort*
January	461	4.6
February	276	2.8
March	510	5.1
April	411	4.1
May	1,164	11.6
June	846	8.5
July	1,601	16.0
August	2,918	29.2
September	689	6.8
October	237	2.4
November	591	5.9
December	298	2.9
Total effort	10,003	100

4. Seabird distribution

4.1 Northern fulmar *Fulmarus glacialis*

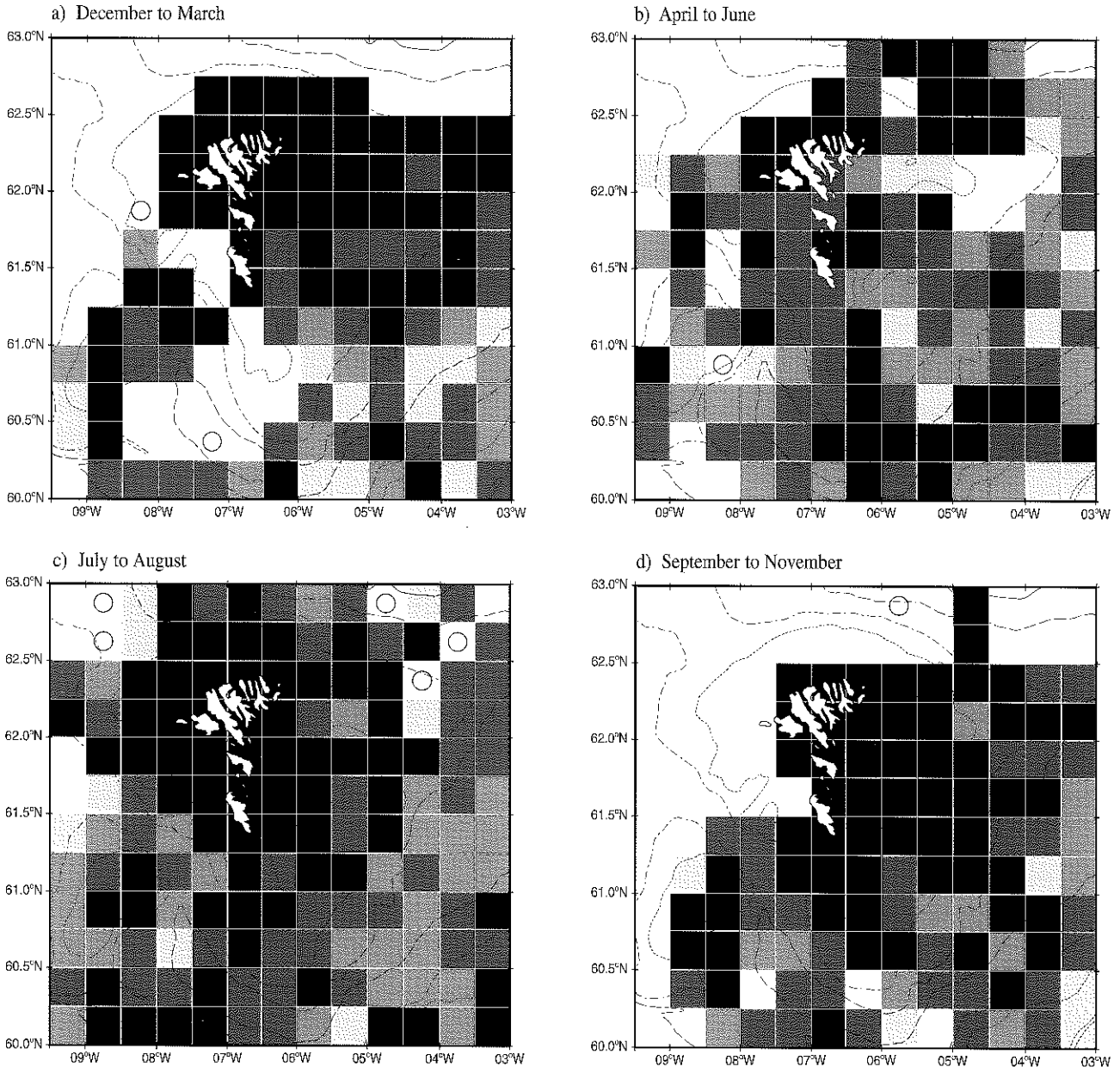


Figure 5 The seasonal distribution and density of northern fulmar

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)

Key: Density (birds/km²)

No birds | 0.01-0.99 | 1.00-1.99 | 2.00-4.99 | 5.00+

Northern fulmars were by far the most numerous bird species within the project area, and were found in high numbers during every month of the year. Over 800,000 pairs breed in the Faroe Islands (Grimmett and Jones 1989; B. Olsen pers. comm.), and over 235,000 pairs breed in Shetland colonies (Lloyd *et al.* 1991). Breeding northern fulmars first started returning to their colonies in November, but the peak period of return was during December. By January the breeding ledges were fully occupied, and numbers were further swelled by large numbers of non-breeders and immature birds (Salomonsen 1955; Sigfússon 1990). Densities were very high in shelf waters at this time, especially close to large colonies, such as Vágar which holds over 100,000 pairs (B. Olsen pers. comm.). Large numbers were also present over the Faroe Bank and northern Faroe Bank Channel, but fewer birds were present over the Faroe-Shetland Channel (Figure 5a). In the following few months, numbers were lower over the Faroe Bank, and higher over the southern Faroe-Shetland Channel (Figure 5b). Densities were lower around some of the islands during April, and this could be due to the pre-laying exodus, when breeding males leave the colony for about nine days, and females for about 20 days, during late April (Macdonald 1977).

During July and August high northern fulmar densities were recorded over most of the shelf and slope areas, with the exception of the Faroe-Shetland Channel (Figure 5c). Faroese northern fulmar chicks hatch around the beginning of July, and from then through to August, high demands are placed on parent birds as they feed their growing chicks. Offshore northern fulmar concentrations were closer to the breeding islands during July than during August, with most less than 150 km from the nearest colony. This is less than the potential maximum reported by Dunnet & Ollason (1982) of 466 km. From August, northern fulmars were less tied to their colonies, and there was greater dispersal away from the islands to the slope south of the islands, and to the Faroe Bank Channel. Densities over the shelf, and over the eastern and south-western banks, remained very high throughout late autumn. The Faroe Bank, and the slope to the south-east of the islands, held the highest densities at this time (Figure 5d).

Many northern fulmars do not disperse too far from their breeding colonies during the winter (Coulson & Horobin 1972; Macdonald 1980). Survey coverage was less extensive away from the islands during the winter, but densities remained high in most areas surveyed between December and March (Figure 5a).

Over deep waters, most birds scavenging for fishing vessel discards are northern fulmars (Camphuysen *et al.* 1993; Garthe *et al.* 1996). In Faroese waters, large numbers were seen scavenging behind discarding fishing vessels, from close in shore to deep slope waters. However, fewer fishing vessel associates were seen over the Faroe Bank than over other shelf edge/bank waters. Hydrography is likely to be a better predictor of northern fulmar distribution than the location of fisheries (Camphuysen & Garthe 1997). Northern fulmars probably go to areas where natural feeding opportunities are good, and if these areas coincide with fishing vessels, then they will also exploit discards as an additional food source.

4.2 Sooty shearwater *Puffinus griseus*

Sooty shearwaters breed in the southern hemisphere, and during the non-breeding season migrate in large numbers to the north Atlantic (Richdale 1963). Lesser numbers arrive in Faroese waters from July onwards. Low densities were distributed throughout the survey area, but the highest densities were over the western Wyville Thomson Ridge, the Faroe Bank and the southern Faroese shelf, especially during August (Figure 6). Some of the shearwaters over the Wyville Thomson Ridge, were scavenging at fishing vessels, as were a few over the northern edge of the Faroe Bank. By October numbers had declined, and there was only one November record, which was over the Faroe Bank.

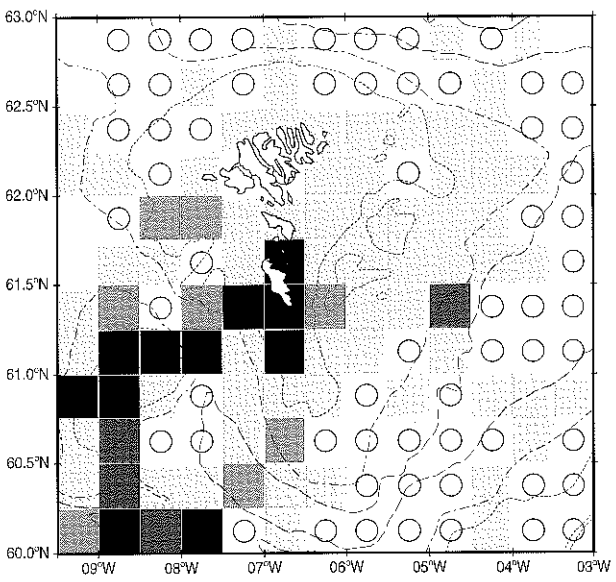


Figure 6 The distribution and density of Sooty shearwater, July to October

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)

Key: Density (birds/km²)

No birds
0.01-0.49
0.50-0.99
1.00-1.99
2.00+

4.3 Manx shearwater *Puffinus puffinus*

Manx shearwaters breed in the Faroe Islands and winter in the south Atlantic off Brazil and Argentina (Brooke 1990). During their arrival in March and April they were restricted to the waters of the Faroe Bank. They were not seen nearer their breeding colonies until May (Figure 7a). During the breeding season, Manx shearwaters were dispersed over most of the Faroese shelf, and also over much of the deep water beyond the shelf edge. Approximately 25,000 pairs of shearwaters breed in the Faroes, 90% of them on the west side (Grimmett & Jones 1989). All at-sea concentrations, and high density areas were to the west of the islands, and over shelf or bank waters. During July, large numbers were seen to the west of Sandoy and Skúvoy (Figure 7b), which hold the largest Faroese shearwater colonies (Grimmett & Jones 1989). The Faroe Bank retained its importance as a feeding area for this species throughout the summer, with large numbers seen plunge-diving over the central bank during July and August. This part of the bank is approximately 120 km from the colonies on Sandoy and Skúvoy, and so well within the 360 km postulated by Brooke (1990), as being the maximum effective foraging range for birds feeding chicks. Skov *et al.* (1993) showed that Manx shearwater distribution in the north-east Atlantic is centred over warmer water than that of northern fulmar distribution. The water surrounding the Faroe Bank is often warmer than the water over the north-east Faroese shelf (Hansen 1985). This may have influenced the observed distribution during this study, where Manx shearwaters were much less common over the north-east Faroese shelf, than they were to the south-west of the islands.

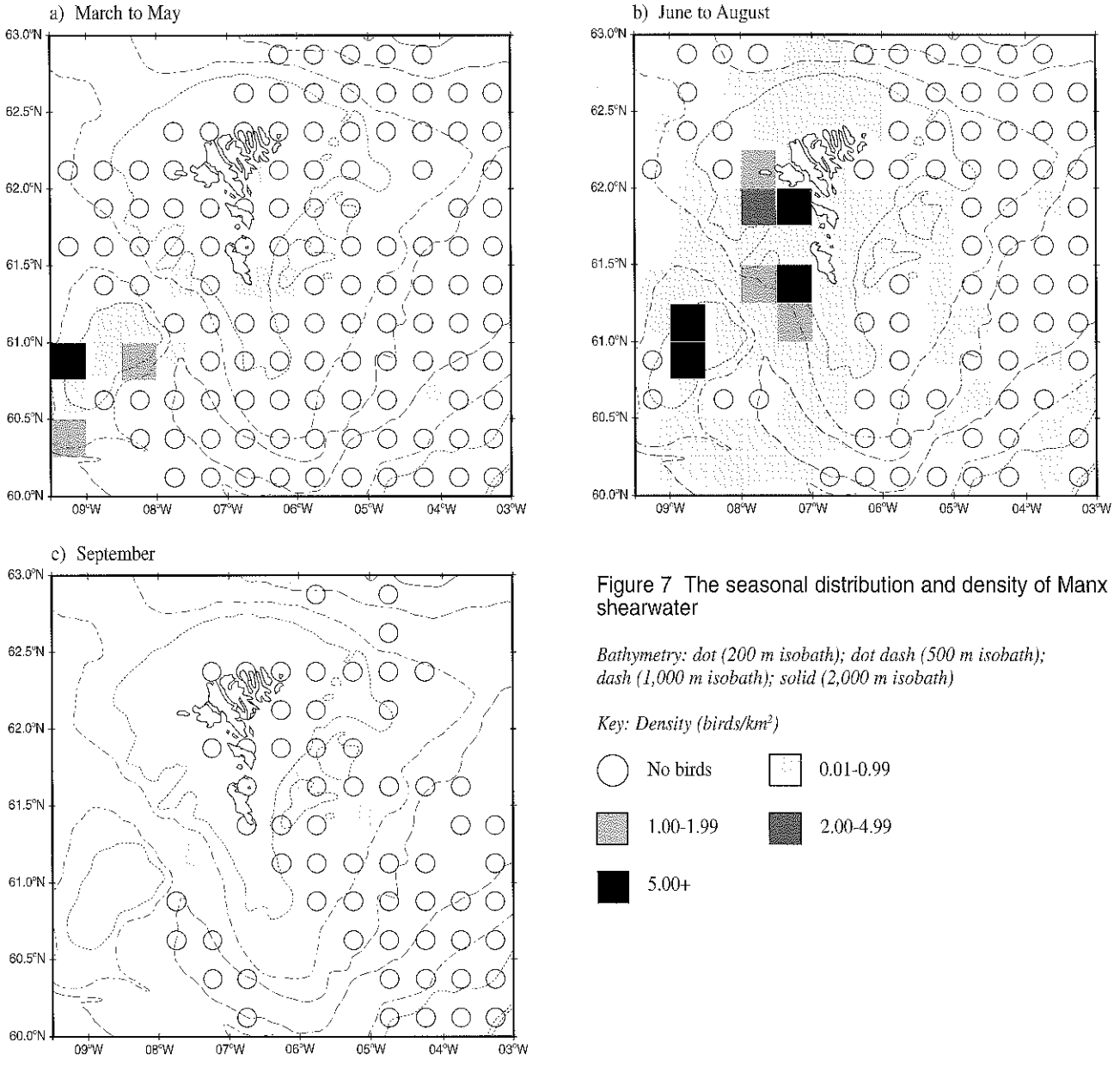


Figure 7 The seasonal distribution and density of Manx shearwater

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)

Key: Density (birds/km²)

The number of birds at the colonies decreases through August, and into September (Figure 7c), as the adults depart for their wintering grounds (Salomonsen 1955). The fledgling shearwaters leave shortly afterwards to fly south, and probably spend little time in Faroese waters (Brooke 1990). Nevertheless moderate concentrations of shearwaters may remain over the Faroe Bank during September (pers. obs.). Manx shearwaters were not recorded in the study area between October and February.

4.4 European storm-petrel *Hydrobates pelagicus*

At the end of May storm-petrels return to their colonies from the wintering grounds off west and south Africa (Salomonsen 1955; Cramp & Simmons 1977). The Faroe Islands probably hold 40% of the world population, the eastern island of Nólsoy alone has 100,000 pairs, probably 17% of the world population (J-K Jensen & T Martin unpublished ringing data; B. Olsen pers. comm.; Table 1). The island of Sandoy just to the south may hold an additional 50,000 pairs. The importance of these two islands for breeding birds was reflected in storm-petrel offshore distribution during June, when the two 1/4

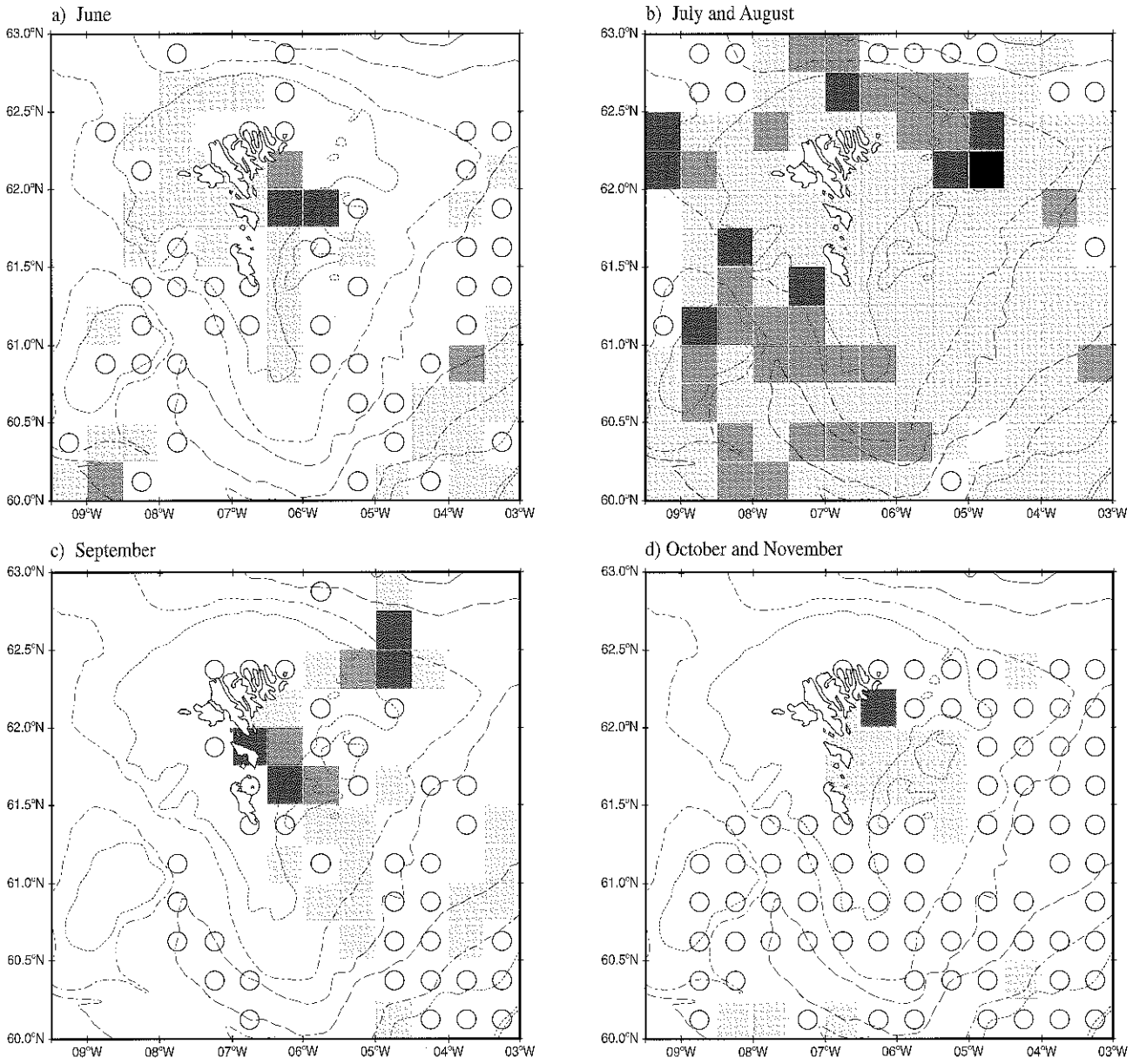


Figure 8 The seasonal distribution and density of European storm-petrels

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Density (birds/km²)

No birds | 0.01-0.99 | 1.00-1.99 | 2.00-4.99 | 5.00+

ICES rectangles to the east of Nólsoy and Sandoy, held the highest densities in the study area (Figure 8a). Although numbers of birds present at the breeding colonies may peak in September, the highest at-sea densities were recorded during July and August, when numbers of birds at sea were swelled by immatures and non-breeders (Scott 1970; Fowler *et al.* 1982). There is some evidence to suggest that storm-petrels favoured the shelf edge and slope, with moderate densities over the Faroe Bank and Faroe Bank Channel, as well as over the slope to the west and north-east of the islands (Figure 8b). The highest densities were over the slope to the north-east during July, and over the eastern edge of the Nolsø bank, to the east of the islands, during August. Storm-petrels were also distributed at lower densities throughout the rest of the study area at this time. Hatching takes place from the end of July onwards (Salomonsen 1955), and the main fledging period is from late October to early November (B. Olsen pers. comm.). During September two local concentrations were present, one in the vicinity of the breeding colonies and to the south-east of the islands, and another just beyond the shelf edge to the north-east of the islands (Figure 8c). Fewer birds were seen during October and November than during September (Figure 8d). Storm-petrels were not recorded between November and May.

4.5 Leach's storm-petrel *Oceanodroma leucorrhoa*

Much fewer Leach's storm-petrels breed in the Faroes than in Scotland. A few hundred pairs breed on Mykines and Mykineshólmur, where as there are between 3,200 and 6,400 occupied burrows on St Kilda (Lloyd *et al.* 1991). Birds were first recorded returning from their tropical wintering grounds (Brown 1979) during June, when there were a few records close to the colony, at the shelf edge and over the Wyville Thomson Ridge (Figure 9a). Peak abundance was not reached until July and August, when numbers are likely to have been augmented by non-breeders as is the case in North American colonies, and in Faroese European storm-petrel colonies (Huntington *et al.* 1996; Salomonsen 1955).

Leach's storm-petrels favoured deep water with sharp topographic relief, as found over the Wyville Thompson/Ymir Ridge system in the far south-west of the study area (Figure 9b). The high densities over the ridge also extended further to the south towards the St Kilda breeding colonies, especially during August (Pollock *et al.* 2000). Approximately 97% of the Leach's storm-petrels seen by Skov *et al.* (1994) were on water between 400 m and 1,500 m deep, with very few birds seen in shallower, or deeper water. More birds were associated with waters of transitional temperature, than with either warm, or cold water. This may indicate a preference for mixed waters, as found in areas of high topographic relief, such as over the Wyville Thompson Ridge and shelf break. The highest densities close to the colonies were seen at the shelf edge to the south-west of Mykines during July. Survey coverage was low in the west, and south of the survey area during September, with only one record in the Faroe Bank Channel. Most adults and young begin to leave their nest sites during September. There were no records between October and May.

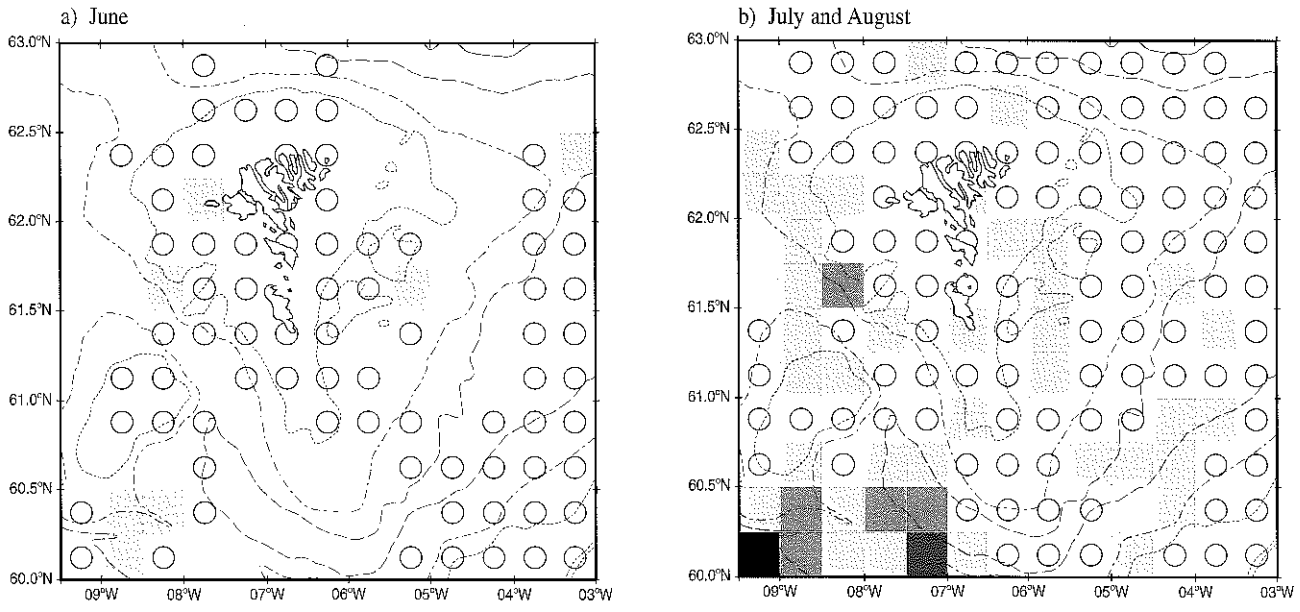


Figure 9 The seasonal distribution and density of Leach's storm-petrel

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Density (birds/km²)

No birds | 0.01-0.49 | 0.50-0.99 | 1.00-1.99 | 2.00+

4.6 Northern gannet *Morus bassanus*

Mykineshólmur, in the west of the islands, is the only Faroese northern gannet colony. It holds approximately 2,000 pairs, which return to their nest sites during February (Olsen & Permin 1974). Few northern gannets were seen during the winter months (Figure 10c). Numbers did not increase until March, when moderate densities were seen over the outer shelf to the south-west of Mykines (Figure 10a). Peak densities were reached in June, with most birds recorded just to the west of Mykineshólmur (Figure 10b). High densities were also found approximately 60 km from the colonies, at the shelf edge to the north, and to the south-west of the colony. Lower densities occurred over the banks to the east of the islands, up to a maximum of 160 km away from Mykineshólmur. In Shetland, Tasker *et al.* (1985) recorded northern gannets feeding up to 150 km from the colony, and most remained within 37 km.

Northern gannets were absent from most of the area to the south of the islands including the Faroe Bank. However, between the middle of July and early August, the breeding population is swelled by the arrival of non-breeders (Salomonsen 1955). This, coupled with the dispersal of breeding adults during August and September, leads to a much wider spread of records over most of the Faroes plateau during these months (Figure 10b). Areas of locally high abundance were found over the 1,000 m contour during August, with noteworthy concentrations to the north, and east of the islands, and also over the Faroe Bank Channel. Northern gannets were seen scavenging behind fishing vessels throughout the year, but especially during July and August. The breeding area is deserted by early October (Salomonsen 1955), and birds were recorded only occasionally in Faroese waters, between then and February (Figure 10c). Larger numbers were present on the Scottish side of the survey area, particularly in January, when 180 were seen scavenging at a fishing vessel over the shelf edge.

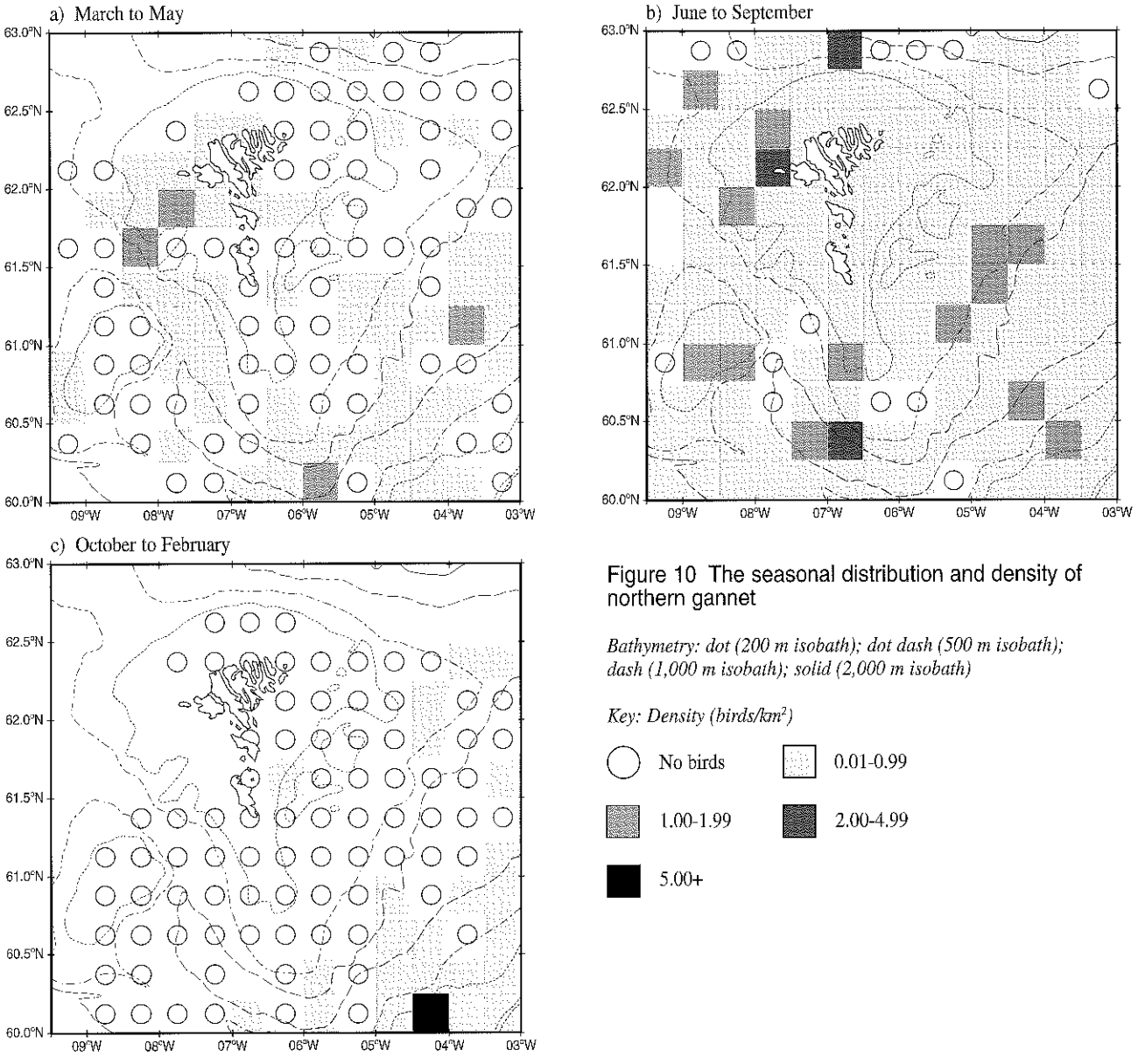


Figure 10 The seasonal distribution and density of northern gannet

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)

Key: Density (birds/km²)

4.7 European shag *Phalacrocorax aristotelis*

Low densities of European shags were found close to the islands, which hold between 1,500 and 2,000 breeding pairs (Bloch *et al.* 1996). European shags are usually restricted to coastal waters as they prefer to forage in waters of between 15 m and 40 m depth (Barrett & Furness 1990; Wanless *et al.* 1993). Densities may be higher than the distribution map indicates (Figure 11), as little survey work was conducted close inshore. Some northern populations move up to several hundred kilometres (Johansen 1975), while other populations are thought to be more sedentary (Cramp & Simmons 1977). All records away from the coast, were during the non-breeding season, with two records over the shelf to the east of the islands in August and October. Another bird was seen over the Scottish shelf, in the south-eastern corner of the project area, during September. There were three other sightings in September and January over deep water just to the south of the survey area.

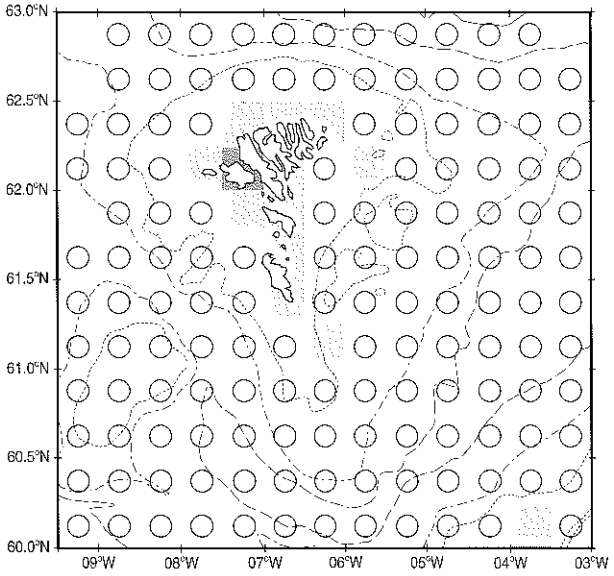


Figure 11 The distribution and density of European shags throughout the year

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)

Key: Density (birds/km²)

No birds
0.01-0.99
1.00-1.99
2.00-4.99
5.00+

4.8 Common eider *Somateria mollissima*

With approximately 3,500 breeding pairs in the Faroes, common eiders are not uncommon, but there were only 47 sightings during this project. This is because they prefer to feed in water less than 4 m deep (Pethon 1967), and few survey tracks were in shallow water close to shore. None were seen away from the coast, and there was no seasonal trend in the number of sightings.

4.9 Arctic skua *Stercorarius parasiticus*

Arctic skuas are summer visitors from their wintering areas in South African and Argentinean waters (Summerhayes, *et al.* 1974; Cramp & Simmons 1983). They return to the Faroese colonies from the end of April onwards (Salomonsen 1955). In May and June, low densities were found over the Faroe plateau, and at the shelf edge adjacent to the Shetland (Figure 12a). The Faroes hold 900 apparently occupied territories, and Shetland has 1,900 AOT (Lloyd *et al.* 1991). Few birds were seen at sea, but moderate densities were present over the outer shelf to the north of the islands in June. Birds from the north-eastern island of Fugloy, which holds 65 pairs (Grimmett & Jones 1989), may have contributed to this. Slightly lower densities were recorded in the ¼ ICES rectangle containing Vágar, and in the rectangle due south of Suðuroy. Fifty pairs breed on Mykines and Mykineshólmur, just to the west of Vágar (Grimmett & Jones 1989). Arctic skuas leave their breeding colonies from late July onwards (Furness 1987). From July until August Arctic skuas were more widely distributed throughout the study area, as they were less constrained by the need to return to their breeding islands (Figure 12b). Birds migrating to their winter quarters from more northerly colonies probably pass through Faroese waters during September. There were no records between October and April.

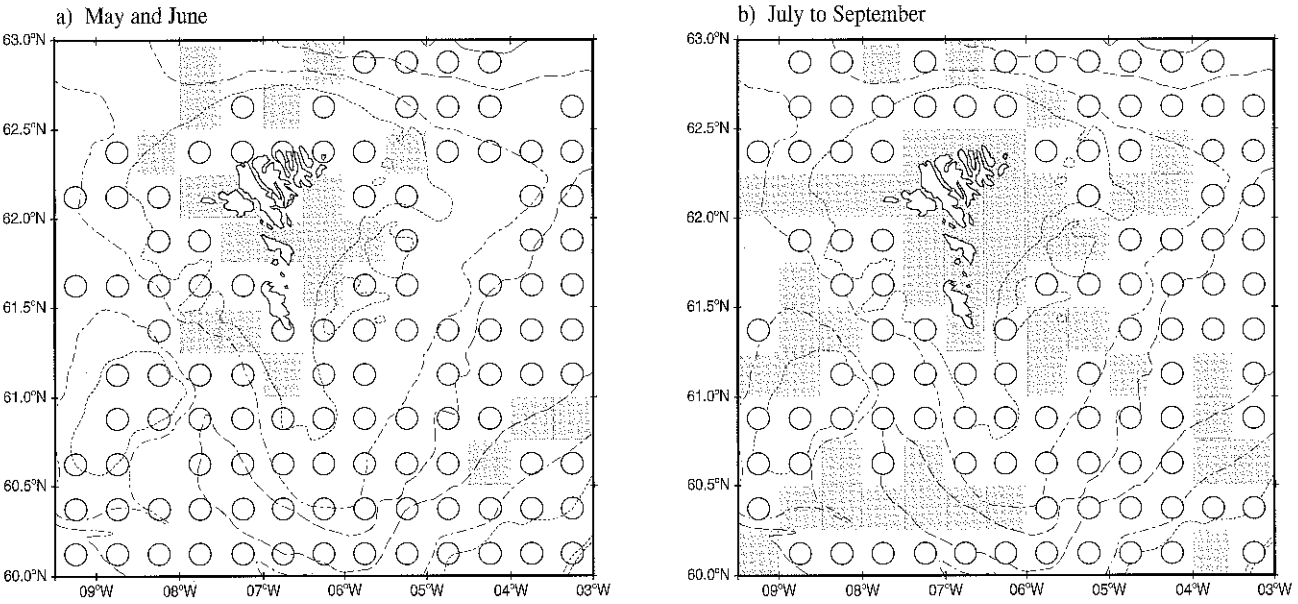


Figure 12 The seasonal distribution and density of Arctic skua

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Density (birds/km²)

No birds | 0.01-0.49 | 0.50-0.99 | 1.00-1.99 | 2.00+

4.10 Pomarine skua *Stercorarius pomarinus*

Pomarine skuas have a circumpolar, high Arctic breeding distribution, from which they migrate to their west African wintering areas (Furness 1987). There were 17 sightings in May, eight in June, 11 in July, a peak of 28 in August, but only a few in September and October. The most common group size was one, with 88 birds seen in total. The sightings appeared to be randomly distributed throughout the survey area (Figure 13).

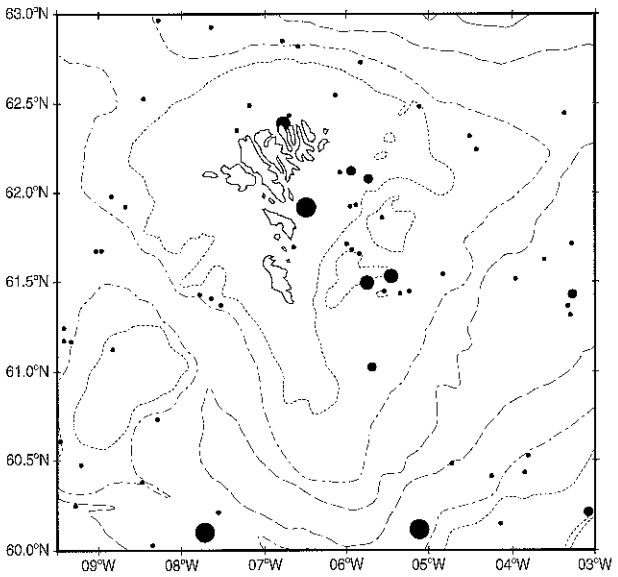


Figure 13 Sightings of pomarine skua

Bathymetry: dot (200 m isobath); dot dash (500 m isobath) dash (1,000 m isobath); solid (2,000 m isobath)
Key: Number of Individuals

• 1 | • 2 | ● 3 | ● 4+

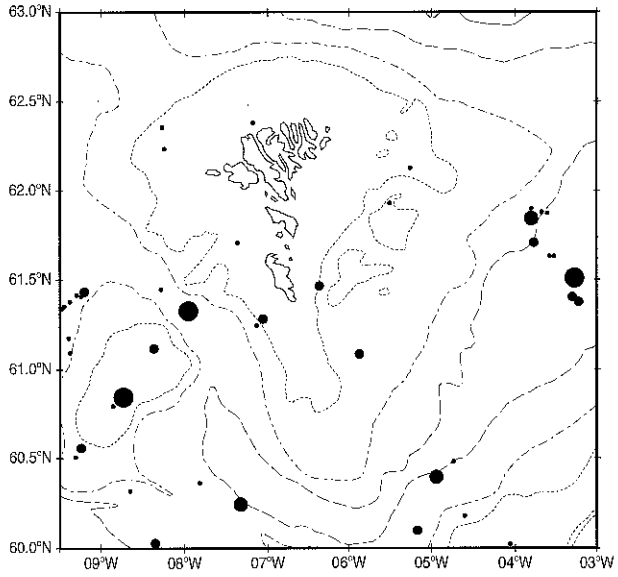


Figure 14 Sightings of long-tailed skua

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Number of Individuals

• 1 | • 2-3 | ● 4-5 | ● >6

4.11 Long-tailed skua *Stercorarius longicaudus*

Long-tailed skuas pass through the study area when travelling between their west African wintering grounds, and their mainly low Arctic breeding grounds (Furness 1987). Eighty eight birds were seen in total (equal to the pomarine skua total), but group size tended to be larger, with up to eight in a group. There were also more pronounced May and August sightings peaks than was the case with Pomarine skua (Figure 14).

4.12 Great skua *Catharacta skua*

During March and April and prior to the breeding period, great skuas were found in isolated patches over the slope, mainly to the south of the islands. None were seen over the shelf (Figure 15a). The skuas return to their colonies at the end of April or early May (Salomonsen 1955; Furness 1987). As the breeding season progresses the number of birds at the colonies increases, and peaks in July, with the arrival of non-breeders. Densities at sea peaked in June, with the highest densities noted at the shelf edge to the north of the islands (Figure 15b) Densities were lower around the islands,

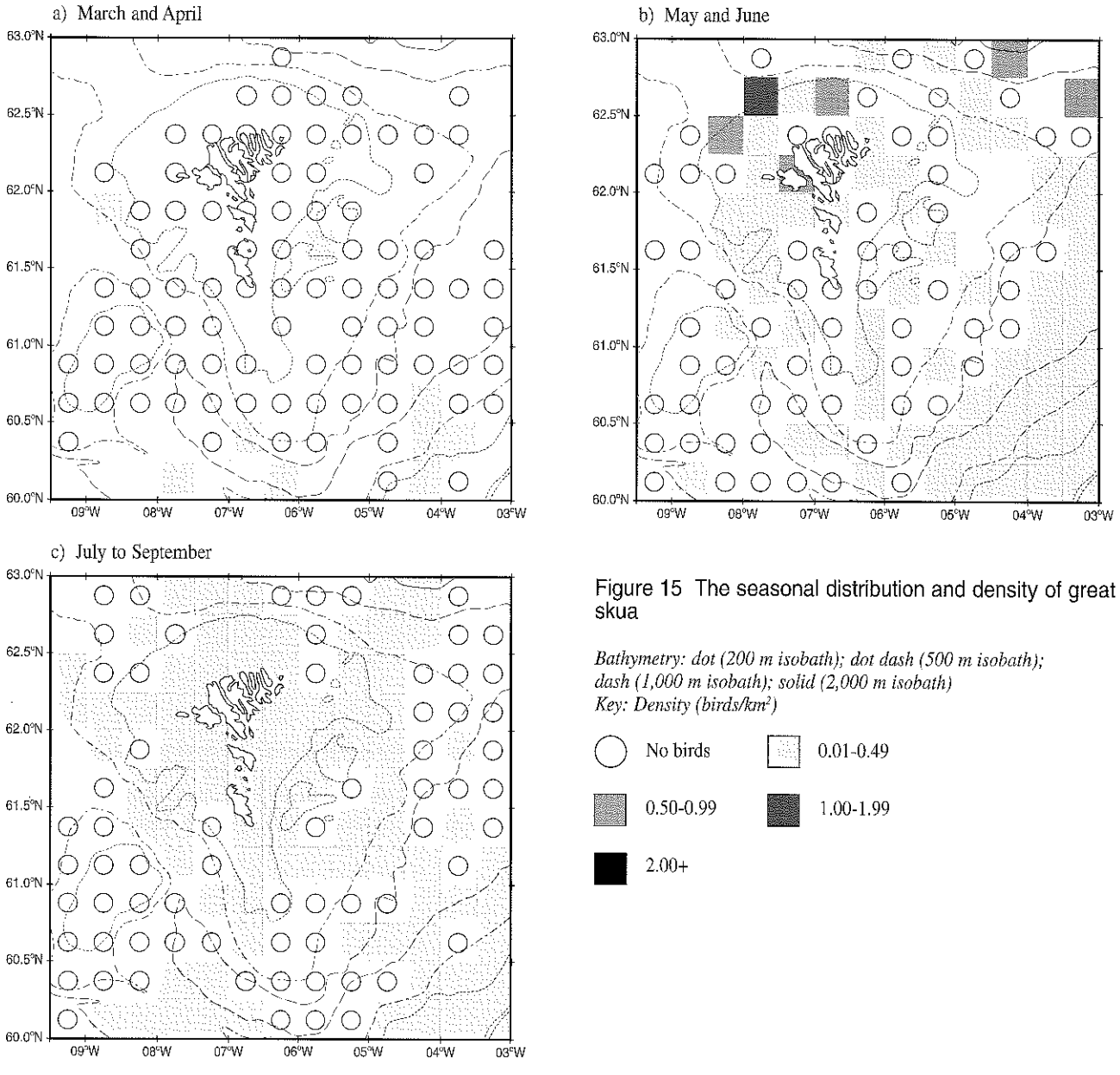


Figure 15 The seasonal distribution and density of great skua

with the possible exception of the Vágar/Streymoy area, on the western side of the islands. Great skuas are uncommon breeders in the Faroes, with possibly as few as 450 pairs (Bloch *et al.* 1996), where as Shetland colonies hold 5,650 pairs (Bayes *et al.* 1964a; Lloyd *et al.* 1991). During the breeding season, low densities were found over much of the Faroe-Shetland Channel area. These are probably from the large Shetland colonies to the east, such as Foula, and are likely to include non-breeders. This is because many of the birds were further from their breeding colonies than their maximum estimated foraging range of 60 km (Furness & Hislop 1981). High numbers of non-breeders are present at the colonies, and at sea during this period (Klomp & Furness 1990).

Great skua diet is varied and includes other bird species (Bayes *et al.* 1964b), but fishing vessel discards are an important source of food (Hudson & Furness 1988). During June, July and August, skuas were regularly seen scavenging behind fishing vessels. A high proportion of birds, seen over the northern shelf edge during June, were associated with fishing vessels. Numbers at the colonies decline through August as birds finish breeding. At-sea distribution is more widespread between July and September, with birds scattered over much of the Faroese shelf and slope (Figure 15c). By the end of September, few birds remain in the area. There was only one October record, which was in the Faroe-Shetland Channel.

4.13 Black-headed gull *Larus ridibundus*

Black-headed gulls are uncommon breeders with 250 pairs nesting in the islands (Bloch *et al.* 1996). They were only recorded 13 times, nine of these sightings were beyond the shelf edge (Figure 16). These deep water sightings were made during April, August, October and November, and may have included Icelandic birds wintering in Scottish and Irish waters (Horton *et al.* 1984).

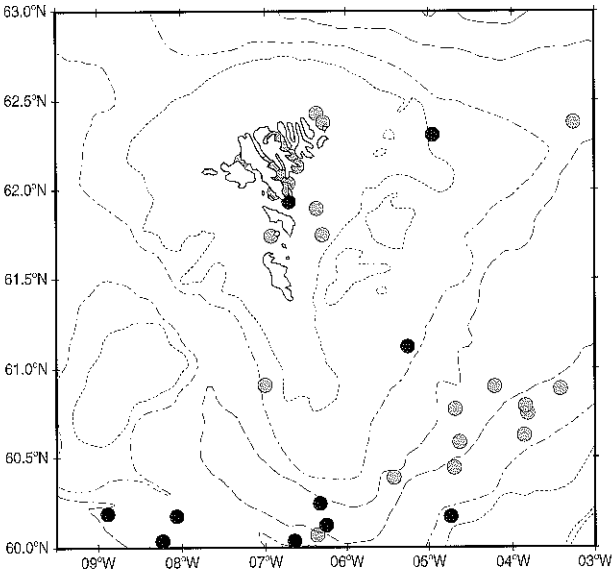


Figure 16 Sightings of black-headed and mew gulls

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key:

Black-headed gull

Mew gull

4.14 Mew gull *Larus canus*

Mew gulls were mostly seen during the summer, close to shore and close to their colonies, which hold 1,000 pairs (Bloch *et al.* 1996). The 12 offshore sightings did not show any seasonal trend, being evenly spread between May and December (Figure 16).

4.15 Lesser black-backed gull *Larus fuscus*

Lesser black-backed gulls are summer visitors from southern England and further south (Baker 1980). They were first seen within the study area during March, but numbers remained very low until April and May, when observations may have included Icelandic breeders returning to their colonies (Figure 17a). Densities did not exceed 0.99 birds per km^2, with the exception of one 1/4 ICES rectangle over the eastern Faroe Bank Channel, which held birds associating with a fishing vessel. Higher densities were not recorded until June and July, when the Faroese population of approximately 9,000 pairs, were breeding (Lloyd *et al.* 1991). During these months lesser black-backed gulls were widely scattered throughout the project area. Most birds were seen close to the islands, or over the outer shelf, but two other concentrations were up to 100 km from the islands (Figure 17b). These may have been breeding birds, despite the distance from the islands; Camphuysen (1995) recorded birds feeding 135 km from a colony in the North Sea. July and August were the peak months for the number of sightings of fishing vessel associates. By August, the breeding season is over and most birds migrate south to their wintering areas again. Densities were again below 0.99 birds per km^2, except for one rectangle at the shelf edge to the north-east of the islands (Figure 17c).

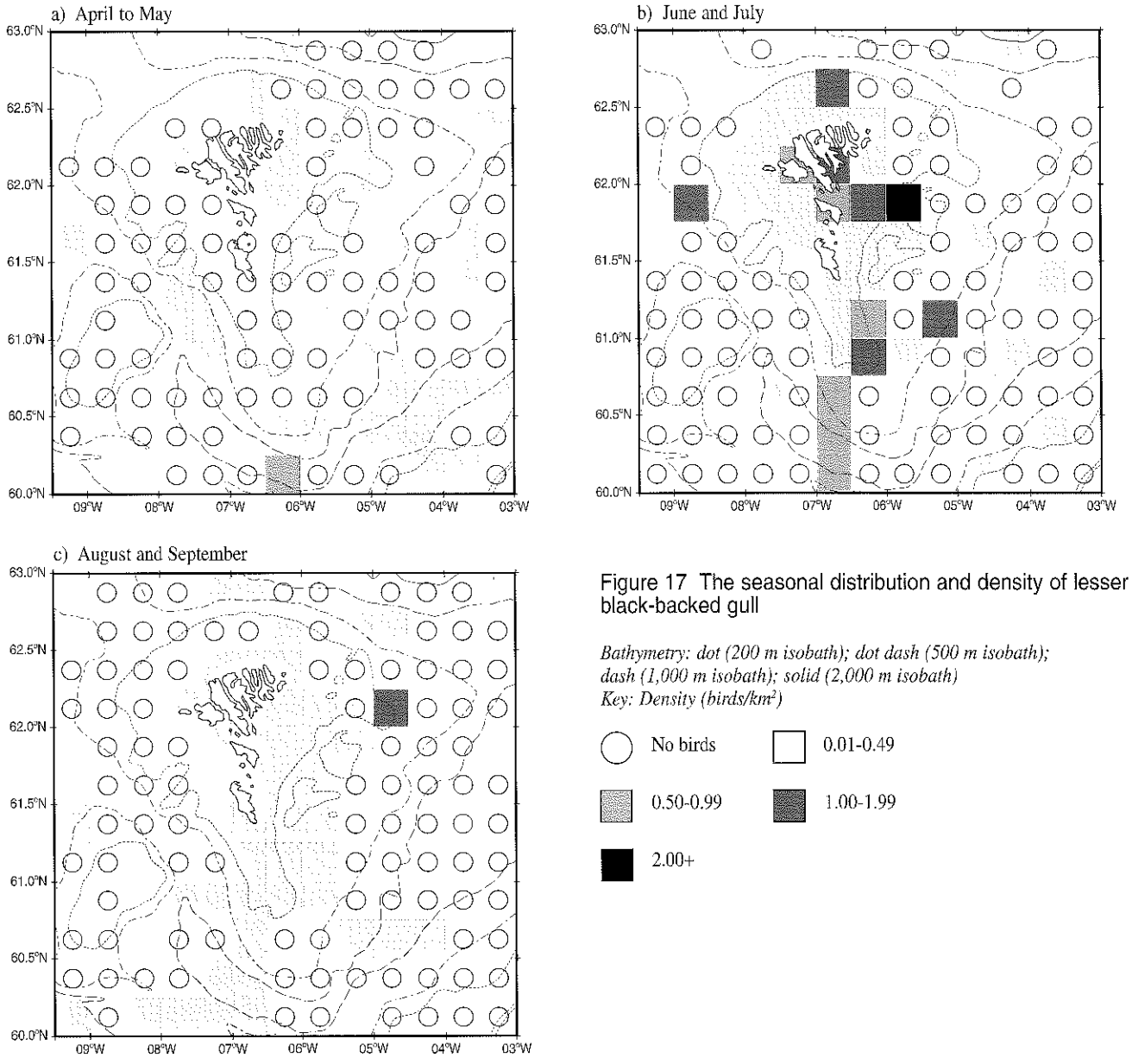


Figure 17 The seasonal distribution and density of lesser black-backed gull

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Density (birds/km^2)

No birds
0.01-0.49
0.50-0.99
1.00-1.99
2.00+

4.16 Herring gull *Larus argentatus*

One thousand five hundred pairs of herring gulls breed in the islands (Lloyd *et al.* 1991). During the summer, most birds were seen around the islands, and close to their colonies (Figure 18a). Herring gulls are less pelagic than lesser black-backed gulls, and feed closer inshore when breeding (Camphuysen 1995). Inshore densities may have been underestimated in this study as few surveys were conducted close inshore among the fjords. Herring gull numbers increased during the winter, when more birds were seen over deep water away from the islands, than during the summer (Figure 18b). These winter observations may include immigrant birds from other breeding areas, as the Faroese birds are thought to be mostly sedentary (Cramp & Simmons 1983). Herring gulls were seen at fishing vessels in July and January away from islands; the two sightings in July were over the slope to the west of the islands.

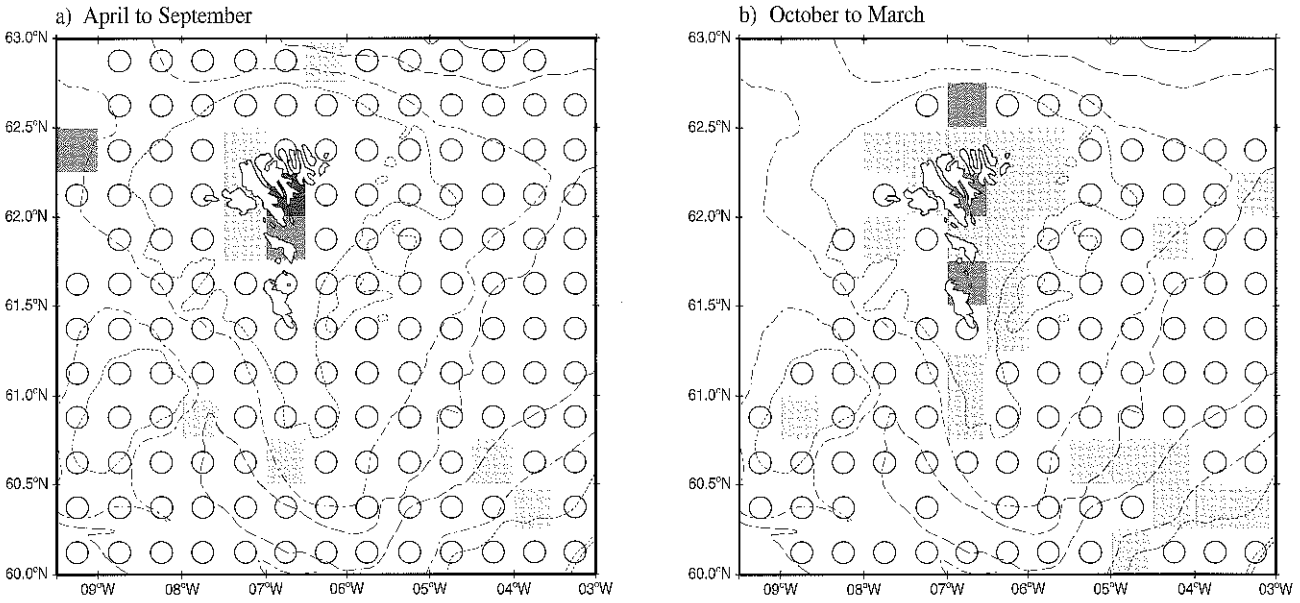


Figure 18 The seasonal distribution and density of herring gull

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Density (birds/km²)

No birds | 0.01-0.49 | 0.50-0.99 | 1.00-1.99 | 2.00+

4.17 Glaucous gull *Larus hyperboreus*

Glaucous gulls are winter visitors to the study area from Arctic breeding colonies, possibly those in east Greenland (Cramp & Simmons 1983). They are most numerous between November and January, when the largest concentrations were found over the slope to the east of the islands, and over the Faroe-Shetland Channel. One ¼ ICES rectangle to the south-east of the Faroe-Shetland Channel, consistently held birds scavenging at fishing vessels between November and January (Figure 19a). Fewer birds were seen closer to the islands especially later in the winter (Figure 19b).

4.18 Great black-backed gull *Larus marinus*

Great black-backed gulls are the least numerous gull species breeding in the islands (1,200 pairs) (Bloch *et al* 1996a). Shetland to the east holds about 2,100 pairs (Lloyd *et al.* 1991). During the breeding season this species was sparsely distributed around the islands, and over the offshore banks, with low concentrations over the Faroe Bank Channel. These gulls often scavenge at fishing vessels in the North Sea (Garthe *et al.* 1996), and they were frequently recorded scavenging in the study area. The concentration at the shelf edge to the south-east of Suðuroy during May, included many fishing vessel associates (Figure 20a).

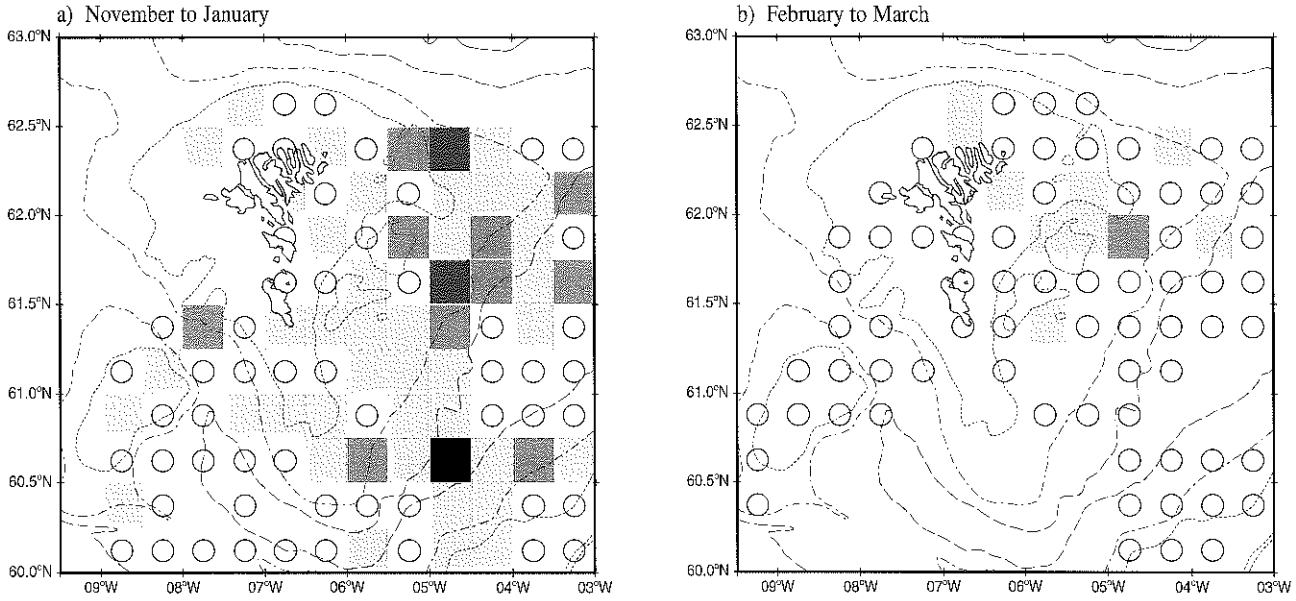


Figure 19 The seasonal distribution and density of glaucous gull

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Density (birds/km²)

No birds | 0.01-0.49 | 0.50-0.99 | 1.00-1.99 | 2.00+

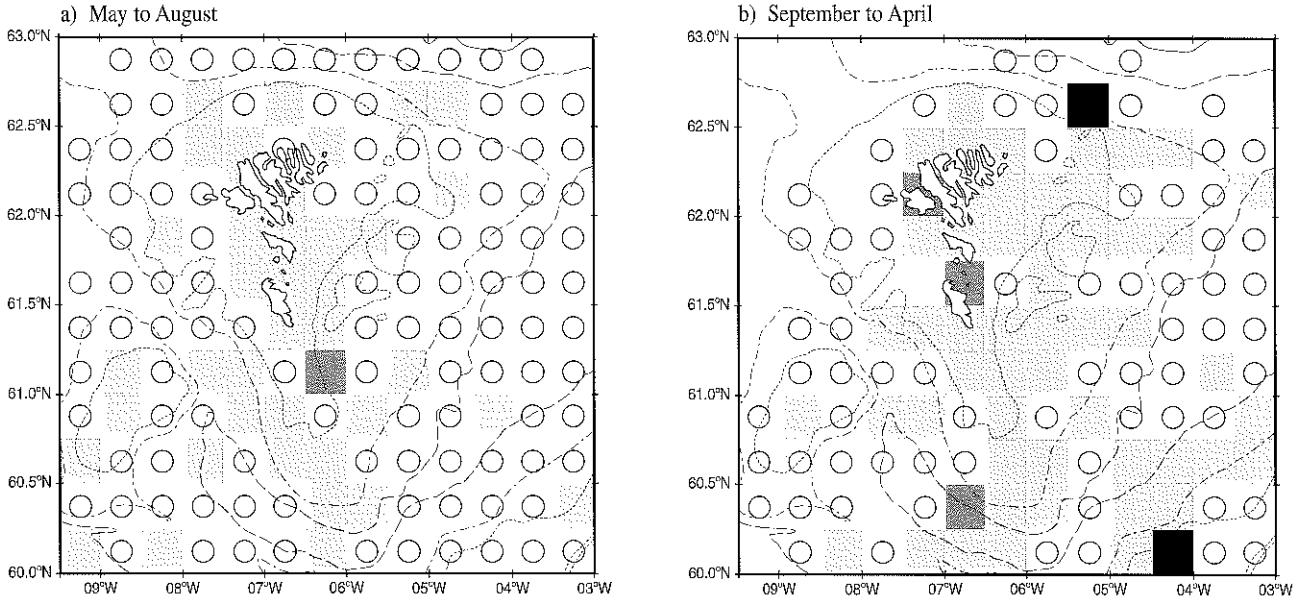


Figure 20 The seasonal distribution and density of great black-backed gull

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Density (birds/km²)

No birds | 0.01-0.49 | 0.50-0.99 | 1.00-1.99 | 2.00+

Higher densities were present during the winter and spring, than during the summer (Figure 20b), with notable concentrations at the shelf edge to the north-east of the islands in March, and over the Scottish shelf edge in January, and also over the Faroese shelf in December (Figure 20b). It is possible that these winter concentrations contain birds from Icelandic or Norwegian colonies. Norwegian and Russian ringed birds have been seen in Britain during the winter (Coulson *et al.* 1984). Some Faroese birds move south into Scottish waters during the winter, while Shetland birds are not thought to move further than 100 km from their breeding colonies (Harris 1962).

4.19 Black-legged kittiwake *Rissa tridactyla*

Black-legged kittiwakes were the most widespread and abundant gull species, and were present in every month of the year. Prior to and during the early breeding period (January to April), numbers increase at the colonies. At this time moderate concentrations were scattered throughout the survey area, over both shallow, and deep water. The highest concentrations were over the eastern Faroe Bank Channel, and over the Scottish shelf edge, on the Scottish side of the Faroe-Shetland Channel. Many birds in the latter area were associated with fishing vessels. Over the Faroese shelf high numbers were seen to the south of Vágar (Figure 21a). During the main breeding period (May to July), the Faroe Islands have held as many as 230,000 pairs, but numbers may have been lower in recent years (Bloch *et al.* 1996a; B. Olsen pers. comm.). This abundance is reflected in the at-sea distribution which was highly concentrated around the islands, although moderate densities were also present elsewhere, such as over the slope to the south (Figure 21b). Large

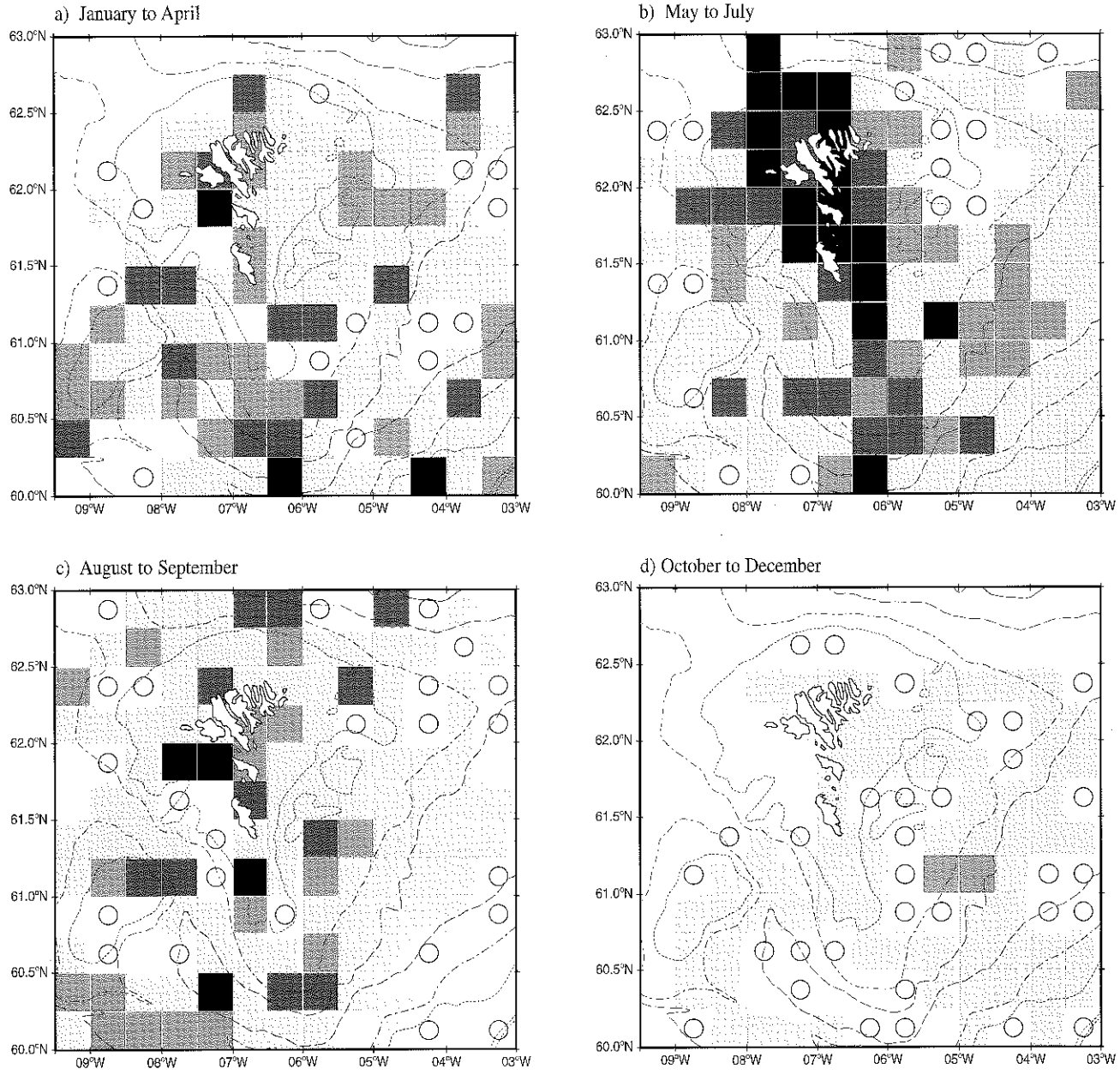


Figure 21 The seasonal distribution and density of black-legged kittiwake

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Density (birds/km²)

No birds | 0.01-0.99 | 1.00-1.99 | 2.00-4.99 | 5.00+

numbers were seen associating with fishing vessels over the eastern Faroe Bank Channel in May. In addition to the numbers of adults foraging at sea to feed their chicks, there is a significant influx of non-breeders and immature birds from May onwards (Salomonsen 1955; Cadiou 1992).

Chicks fledge in late July and early August (Salomonsen 1955), and this period signals a general dispersal of both adult, and juvenile birds, away from the breeding colonies to feeding areas at the shelf edge, and beyond. During August and September birds were widely scattered throughout the survey area, with notable concentrations in the two ¼ ICES rectangles to the west of Sandoy (Figure 21c). Shetland colonies probably hold less than 20,000 pairs (Richardson 1985), some of which may disperse east into the study area, further swelling numbers. Most of the black-legged kittiwakes recorded at sea between Shetland and Iceland area during August and September, by Danielsen *et al.* (1990), were juveniles. Between October and December black-legged kittiwake numbers dropped considerably, but birds were still scattered throughout the survey area at low densities (Figure 21d).

4.20 Arctic tern *Sterna paradisaea*

Arctic terns migrate north from the Southern Hemisphere to arrive in Faroese waters during May, when small numbers were present over the Faroe-Shetland Channel, and also closer to the islands (Figure 22a). High densities were not seen until June, when peak numbers were recorded close inshore (Figure 22b). Moderate numbers were also present at the

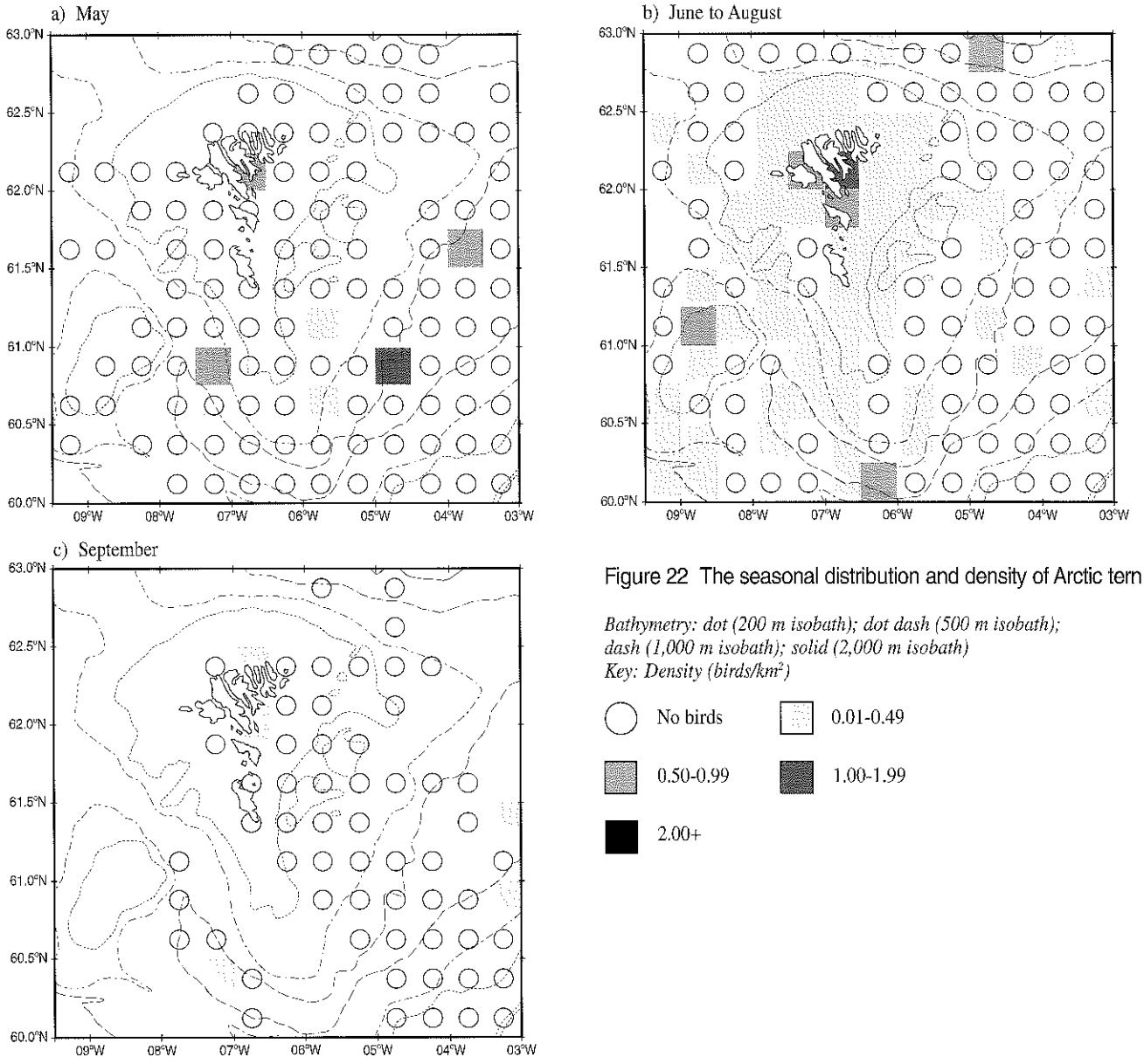


Figure 22 The seasonal distribution and density of Arctic tern

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Density (birds/km²)

shelf edge to the west of Suðuroy. In July, birds were more widely scattered throughout the survey area, but the core area of higher abundance around the islands remained.

In August, the centre of abundance shifted away from the breeding islands to the Faroe Bank, and eastern Faroe Bank Channel, although moderate densities remained around the islands. It is likely that birds from the larger colonies in Iceland and Shetland pass through the area on their way south during August. The Faroe Islands hold only 2,000 pairs (Bloch *et al.* 1996), while Iceland has more than 100,000 pairs, and Shetland approximately 32,000 (Lloyd *et al.* 1991). The Faroese breeding colonies are not completely vacated until late August (B. Olsen pers. comm.), and birds were still present around the islands in September, albeit in reduced numbers (Figure 22c). The only other records during this month were on the Shetland side of the Faroe-Shetland Channel, and over the Faroe Bank Channel. No Arctic terns were seen in the study area between October and April.

4.21 Common guillemot *Uria aalge*

Approximately 175,000 pairs of common guillemots nest in the islands (Bloch *et al.* 1996a). Few were seen during January. In February and March moderate densities were observed throughout most of the Faroe plateau, including the Faroe Bank (Figure 23a). Fewer birds were seen over the Faroe-Shetland Channel. At this time observations may have included birds on their way to Icelandic, or more northerly colonies.

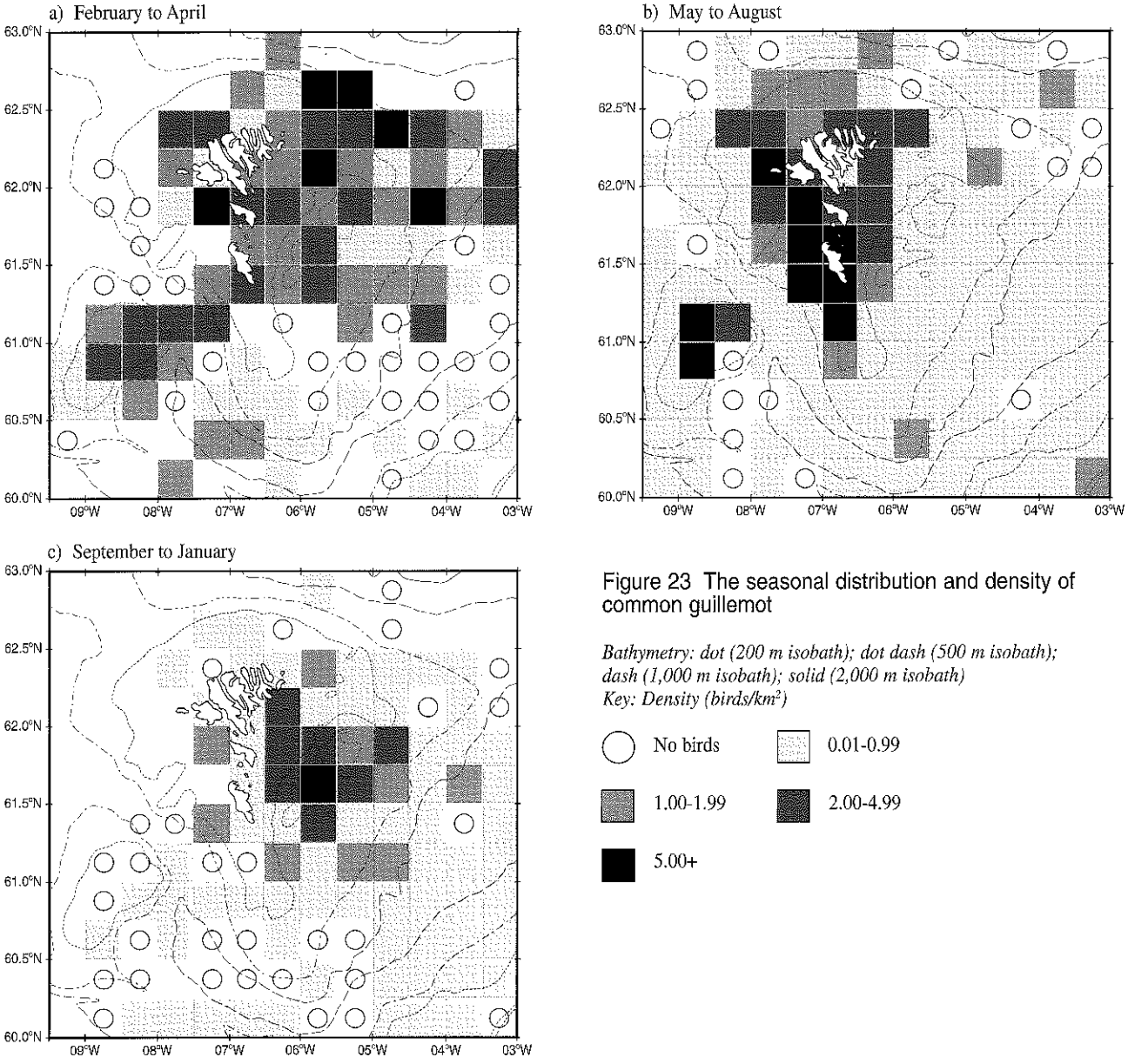


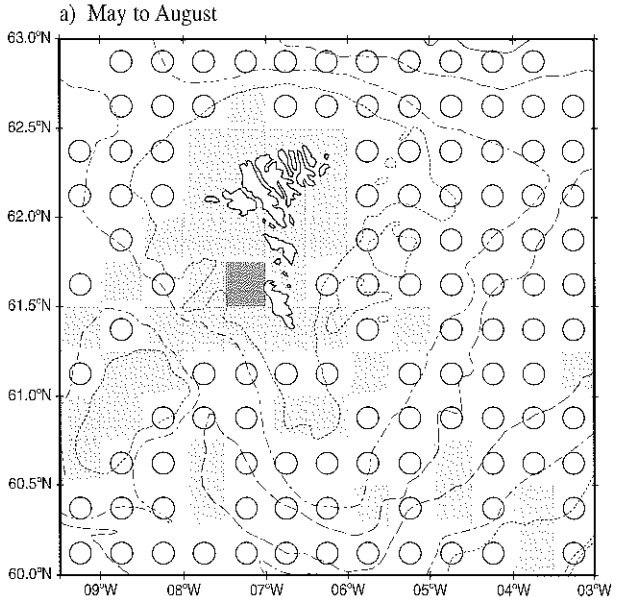
Figure 23 The seasonal distribution and density of common guillemot

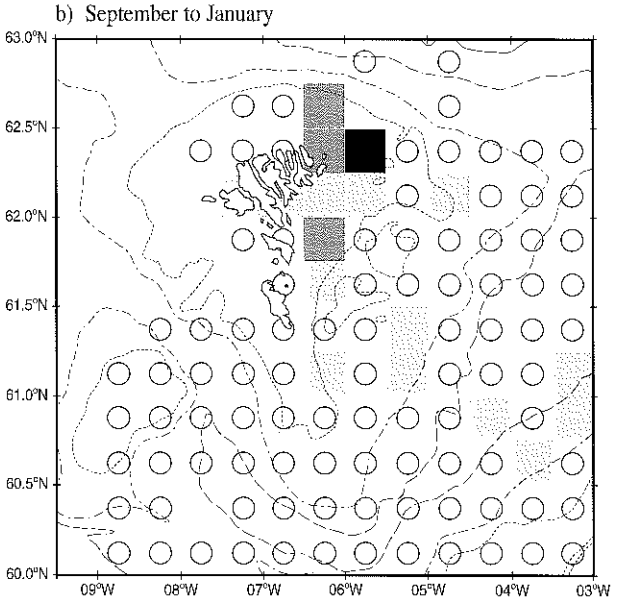
Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Density (birds/km²)

It was not until May, when both breeders and non-breeding immature birds were at the colonies, that there was a significant increase in at-sea densities (Figure 23b). Common guillemots were then present throughout most of the study area, but were most concentrated in the vicinity of the breeding colonies. The greatest densities were recorded to the south-west of the southern islands of Sandoy, Skúvoy, Stóra Dímun and Suðuroy (see Figure 2), which contain the largest breeding colonies in the islands (Dyck & Meltofte 1975).

During June high densities were also present to the north and west of Mykines, which also holds high numbers of breeding birds. During June, no patches of high density were seen further than 60 km from the breeding colonies. Birds from the Scottish colonies of St Kilda and Handa do not usually forage further than 60 km from their breeding colonies (Webb *et al.* 1990). Faroese common guillemots fledge, and leave their colonies, under the care of their fathers from late June onwards (Nørrevang 1958; Tasker *et al.* 1986). Many probably disperse to the Faroe Bank and the other offshore banks. The highest densities were found over the Faroe Bank, and south of Suðuroy, during July and August (Figure 23b). During surveys in 1987 and 1988, low chick densities were also present on the Iceland-Faroe Rise (Danielsen *et al.* 1990). Both adults and chicks are flightless at this time, as the adults undergo a post-breeding primary moult, and the chicks are not yet able to fly (Harris & Wanless 1990).

The banks to the east of the islands held many birds during September and November (Figure 23c). Survey coverage in October, December and January was too low to assess the importance of this area during these months, but high numbers during September, November and February, suggest that common guillemots are abundant here during the remainder of the autumn and winter (Figure 23c). Lack of survey coverage over the Faroe Bank during most of the autumn and winter precludes an assessment of this area. Ringing recoveries indicate that some Faroese common guillemots disperse to the North Sea, and west Norwegian waters, during the winter (Olsen 1982; Baillie 1982). Common guillemots are seen back at the breeding colonies from early February onwards (Salomonsen 1955).





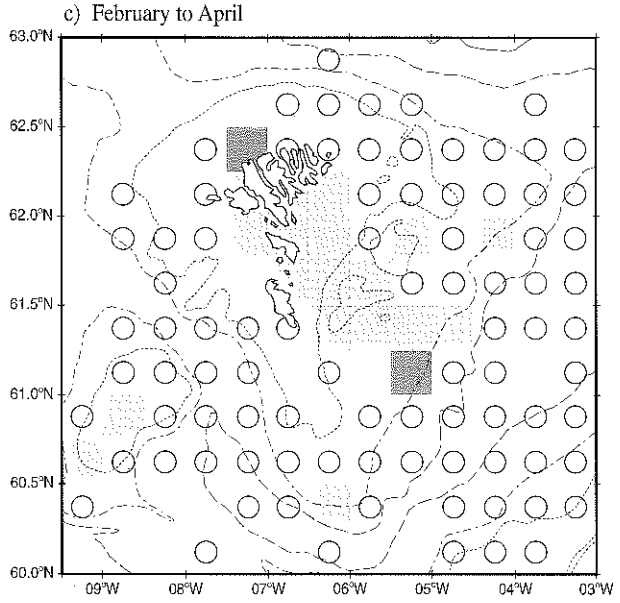


Figure 24 The seasonal distribution and density of razorbill

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Density (birds/km²)

No birds
0.01-0.99
1.00-1.99
2.00-4.99
5.00+

4.22 Razorbill *Alca torda*

There are 4,500 pairs of breeding razorbills in the Faroes (Bloch *et al.* 1996a). During the breeding period, between May and August, birds were present at low densities over much of the Faroese shelf (Figure 24a). Localised patches of higher density were recorded to the north-west of the islands in May, to the south of Suðuroy in June, and to the north-west of Suðuroy and south-west of Skúvoy in July. Skúvoy holds the largest Faroese breeding colony with 2,300 birds (Grimmett & Jones 1989). Most razorbills breeding on St Kilda, Scotland, foraged within 38 km of their breeding colonies (Leaper *et al.* 1988). This suggests that many of the razorbills seen away from the islands, especially those over deep water, are likely to have been non-breeders. Immature birds ringed at Scottish colonies have been recovered in Faroese waters during the summer (Jensen & Fritze 1992).

There is some post-breeding dispersal from the end of July, and into August, when some birds move towards the south, or south-west to the Faroe Bank. During July and August the adults undergo a post breeding moult, and are potentially vulnerable to surface pollutants, as they cannot fly (Jensen & Fritze 1992). Distribution to the south and west of the islands, in September and October, needs to be clarified as survey coverage was poor at this time (see Figure 4i, j). Nevertheless no large concentrations were seen during September and October. High densities were recorded in coastal waters just to the north-east of the islands during November, and at lesser densities to the south, in this month and during January (Figure 24b). It is likely that Icelandic birds significantly contribute to these concentrations as ringing recoveries have shown them to winter in this area (Jensen & Fritze 1992). In addition, Iceland holds the largest razorbill colonies in the world, estimated at 450,000 pairs (Lloyd *et al.* 1991). The ¼ ICES rectangle to the south-east of Boroy retained high densities into February. Local breeders return to their colonies in March (B. Olsen pers. comm.). The high winter concentrations to the north-east were no longer present in March, but scattered areas of low density were found in coastal waters, and over the banks to the south-east (Figure 24c).

4.23 Black guillemot *Cepphus grylle*

Black guillemots breed on many of the Faroe Islands (Table 2), with a total population of approximately 3,500 pairs (Bloch *et al* 1996). Low densities were seen when survey vessels ventured close to shore, with moderate densities observed around the eastern sides of Streymoy and Eysturoy (Figure 25). Black guillemots sometimes forage within 500 m of their nest, or at other times up to 4 or 5 km away (Ashbirk 1979). Black guillemots have therefore been under-recorded, as most surveys were too far offshore to accurately estimate their abundance. No seasonal trend was apparent, as would be expected from a largely sedentary species; most Shetland birds winter within 15 km of their breeding colonies, and those in Orkney, within 50 km (Ewins 1988; Ewins & Kirk 1988). The only two records away from the coast were during July, both less than 20 km to the east of Suðuroy.

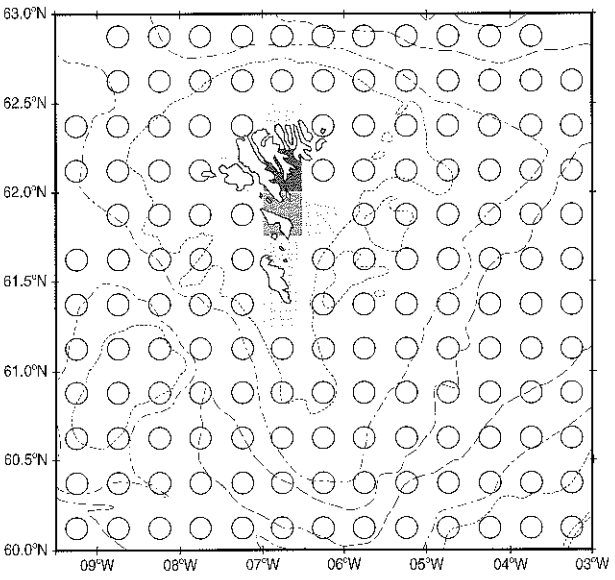


Figure 25 The year-round distribution and density of black guillemot

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Density (birds/km²)

No birds
0.01-0.49
0.50-0.99
1.00-1.99
2.00+

4.24 Little auk *Alle alle*

Little auks breed in the high Arctic, and fly to more temperate waters to winter. The exact origin of those wintering in these waters is as yet unknown (Camphuysen *et al.* 1996). They generally do not arrive in Faroese waters until November, although a few scattered individuals were seen earlier in the autumn (Figure 26a). Most were seen during November, when they were found at high densities over the banks to the east of the islands, as well as over parts of the shelf (Figure 26b). Little auks are zooplankton eaters, and require high plankton concentrations for efficient foraging (Bradstreet & Brown 1985). Elsewhere, their distribution has been correlated with that of high sub-surface crustacean concentrations, found at the edges of banks and the shelf edge (Brown 1988).

In this study, although the highest concentrations were found over the outer shelf and banks, moderate concentrations also stretched east over the Faroe-Shetland Channel. Far fewer were seen after November, and no large concentrations were noted, with the exception of one close inshore during December and another in February. Little auks are known to leave their wintering grounds as early as February (Isaken & Bakken 1996). It is likely that those wintering in Faroese waters also start to move northwards at this time, as few birds were seen after the end of February.

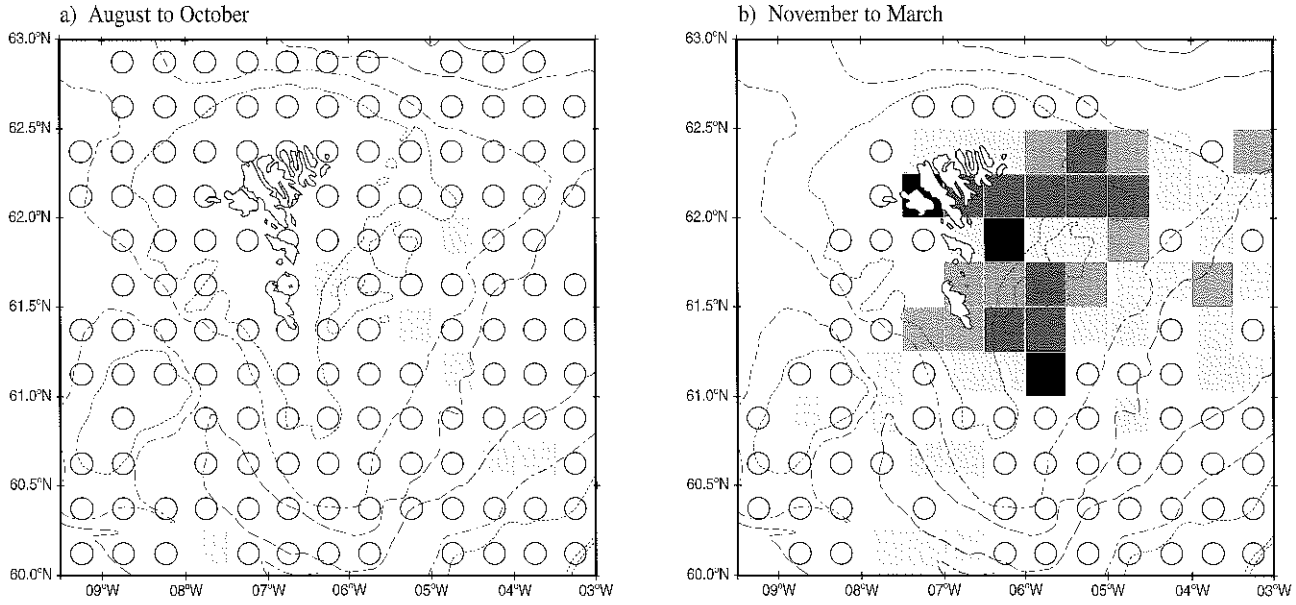


Figure 26 The seasonal distribution and density of little aukl

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Density (birds/km²)

No birds | 0.01-0.49 | 0.50-0.99 | 1.00-1.99 | 2.00+

4.25 Atlantic puffin *Fratercula arctica*

Faroese Atlantic puffins return to their breeding colonies from mid-April (Salomonsen 1955). At-sea density increased, and distribution was more widespread from March to April, particularly close to the islands. During April, densities were high around the islands, especially the southern ones, which have the largest colonies. As the breeding season progressed into May, high densities were reached over most of the shelf. High density patches were also present over the banks to the east, and south-west, as well as over the Faroe Bank Channel and the south-west Faroe-Shetland Channel (Figure 27a). Few birds were seen over the rest of the Faroe-Shetland Channel. The Faroes hold at least 550,000 pairs of Atlantic puffin and these are swelled by non-breeders from the end of June (Grimmett & Jones 1989; Bloch *et al.* 1996).

Very large numbers of Atlantic puffins were observed close to the islands between June and August, while further from the coast, densities remained high (Figure 27b). If foraging conditions are good, birds will feed within a few kilometres of the colonies (Wanless *et al.* 1990). However, in this study high density areas were found to extend to at least 40 km from the colonies, such as to the east of the colonies on Suðuroy during July, and over Syderø bank. During this period high densities were recorded over most of the Faroese shelf, with fewer birds over the Faroe Bank and Faroe-Shetland Channel, than during May. High densities were also observed to the north-west of the islands during June,

with birds seen up to 90 km from the closest colonies. These may have been non-breeding birds, but Norwegian breeders have been found further than 130 km from the nearest colony (Anker-Nilssen & Lorentsen 1990). From the end of July, chicks are fledging, and moving away from the islands towards the offshore banks (Danielsen *et al.* 1990). Atlantic puffin densities over the northern edge of the Faroe Bank peaked during August. At the same time Atlantic puffins also dispersed towards the Iceland-Faroe Rise, with high densities observed to the north of the islands in August. Fewer birds were seen over the deeper waters away from the offshore banks and ridges. Numbers decreased drastically by September, when most birds have left the coastal waters (Figure 27c). The western end of the Faroe Bank Channel held higher numbers of Atlantic puffins during this month than anywhere else in the study area.

The Faroese shelf and banks to the east of the islands, may be locally important during the winter months, with moderate densities observed during November and February (Figures 27c, d). These wintering birds are thought to include birds from more northerly colonies, as birds ringed in Norwegian colonies have been recovered here during the winter (Jensen 1986; B. Olsen pers. comm.). Limited survey work during the late winter suggests that Atlantic puffins are present in low numbers over the shelf and slope, with some areas of higher density found at the shelf edge to the north, and east during March (Figure 27, d).

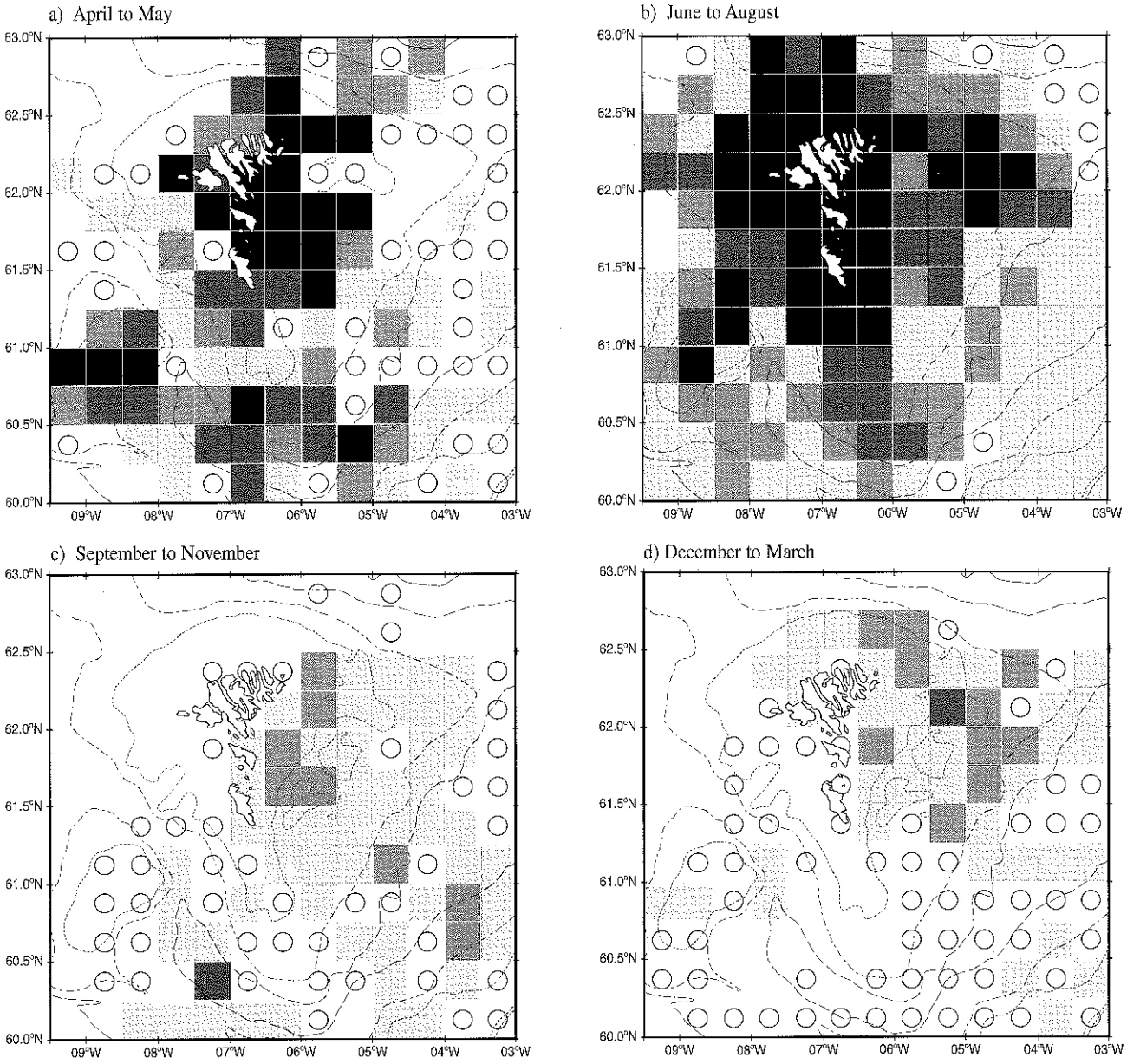


Figure 27 The seasonal distribution and density of Atlantic puffin

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Density (birds/km²)

No birds | 0.01-0.99 | 1.00-1.99 | 2.00-4.99 | 5.00+

4.26 Rare species

The following species were recorded less than 20 times.

4.26.1 Red-throated diver *Gavia stellata*

Two red-throated divers were to the north of Suðuroy in March, and another was over the Faroe-Shetland Channel in July. Despite being common breeders in Iceland and Scotland, only 15 pairs breed in the Faroe Islands (Bloch *et al.* 1996).

4.26.2 Great northern diver *Gavia immer*

One great northern diver was seen over the Faroe-Shetland Channel in June, and another in November. Four other solitary individuals were seen close to the islands during May. Great northern divers are frequently seen from shore, as they pass through the islands, *en route* to their Canadian and Icelandic breeding grounds.

4.26.3 Great shearwater *Puffinus gravis*

Large numbers of great shearwaters migrate from their south Atlantic breeding islands to the western side of the north Atlantic in the spring (Voous & Wattel 1963). As autumn approaches numbers increase over the eastern side of the Atlantic, with a few recorded in the study area. All 13 sightings were in August, apart from one in September, and almost all were of single birds. Every sighting was over water deeper than 500 m. There was a distinct cluster of sightings south-east of the Faroe Bank, and over the Wyville Thomson Ridge.

4.26.4 Cory's shearwater *Calonectris diomedea*

One was seen over Fuglø Bank to the north-east of the islands, 44 km east of Fugloy, on 7 July 1988. Cory's shearwaters disperse widely over the north Atlantic away from their Mediterranean and Macaronesian breeding colonies during the non-breeding season.

4.26.5 Soft-plumaged petrel sp. *Pterodroma* sp.

A petrel of the soft-plumaged group, probably Fea's petrel *Pterodroma feae*, was seen over the Shetland side of the Faroe-Shetland Channel (209 km south-east of Sandoy) on 25 June 1996. Fea's petrels breed on the Desertas Islands, Madeira, and in the Cape Verde archipelago off north-west Africa.

4.26.6 Great cormorant *Phalacrocorax carbo*

Four great cormorants were seen just to the south of Sandoy in August 1987. Great cormorants are only rarely seen in the Faroe Islands (Bloch *et al.* 1996).

4.26.7 Red-necked phalarope *Phalaropus lobatus*

Four red-necked phalaropes were seen to the west of the islands, during the space of two weeks, on one sea trip at the end of July and beginning of August 1997. Two were over the shelf to the north west of Mykines in the west, one was over the shelf edge due south west of Mykines, and another was over the north eastern edge of the Faroe Bank. Approximately 50 pairs breed in the islands, but the above sightings may have been from other, more northerly colonies, as red-necked phalaropes migrate south from their breeding colonies between the end of June (females) and August (juveniles) (Cramp & Simmons 1983).

4.26.8 Grey phalarope *Phalaropus fulicaria*

One was seen over the slope, 74 km north west of Mykines, on 12 August 1988. Grey phalaropes migrate from their breeding grounds on the Arctic tundra to their wintering areas in upwelling zones off the west coast of Africa (Griffiths & Sinclair 1982).

4.26.9 Common tern *Sterna hirundo*

All nine sightings of common terns were made during three days in late August 1997. They were over shallow waters to the east of the islands, except for one which was over the slope due east of Sandoy.

4.26.10 Iceland gull *Larus glaucoides*

Most Iceland gulls do not travel far from their breeding areas in Greenland, but small numbers disperse as far as continental Europe during winter (Grant 1982). Iceland gulls were much rarer than glaucous gulls with only 15 records. All were seen between November and April. There was no obvious pattern to dispersion, but there were a number of records over the Faroe-Shetland Channel.

4.26.11 Sabine's gull *Larus sabini*

One juvenile Sabine's gull was seen over the northern edge of the Faroe Bank Channel, to the south of Suðuroy, on 29 August 1997.

4.26.12 Brünnich's guillemot *Uria lomvia*

All four sightings were in coastal waters. One was seen in July, 24 km to the south of Mykines, and another in August, close to Eysturoy in the north of the islands. The other two sightings were in January, the first 8 km to the north of Eysturoy, and the second, 22 km to the east of Sandoy. Iceland has approximately 700,000 pairs of Brünnich's guillemots, but only small numbers have been recorded in the Faroe Islands and Shetland (Bloch *et al.* 1996; Johnston 1999).

5. Cetacean distribution

5.1 Fin whale *Balaenoptera physalus*

Fin whales are the most abundant large baleen whale species in the north-east Atlantic (Sigurjónsson 1988; Buckland *et al.* 1992; Sigurjónsson 1995), and were encountered in small numbers during this study. There were two distinct peaks in the number of sightings, the first in May with 13 sightings (36 animals), and the second in August with ten sightings (25 animals). There was one sighting in June, one in July, three in September and one in November. All the May sightings were in the vicinity of the 1,000 m contour over the Faroe Bank Channel, the Faroe Shetland Channel, and to the north-east of the islands (Figure 28). In contrast, all but three of the August sightings were over the edge of the banks, and shelf edge to the east of the islands. This seasonal difference in sighting locations may suggest a seasonal difference in favourable foraging location. In the spring, the best feeding conditions may have been over deep water, and later in the year at the shelf edge. Alternatively, the whales may have made a relatively rapid transit through the survey area in May on their way to favourable feeding locations elsewhere, followed by a return to favourable feeding locations at the Faroese shelf edge later in the year. During years of high prey abundance, greater numbers of fin whales probably remain in Faroese waters throughout the summer. (Degerbøl 1940).

Although fin whales are undoubtedly less abundant during the winter months (Bloch 1998; Degerbøl 1940), they are not completely absent, as acoustic work has shown them to be present throughout the year (Clark & Charif 1998). The main wintering area for those summering in the west Norway to Faroes area, is as yet unknown (Christensen *et al.* 1992).

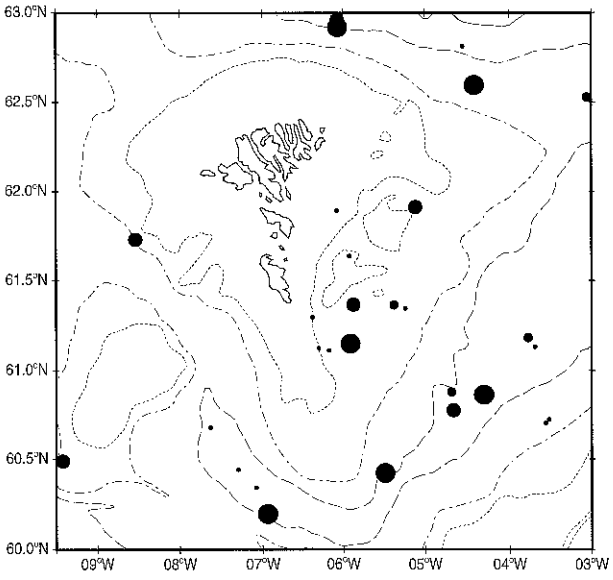


Figure 28 The locations of all fin whale sightings

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Number of Individuals

• 1 • 2 ● 3 ● 4+

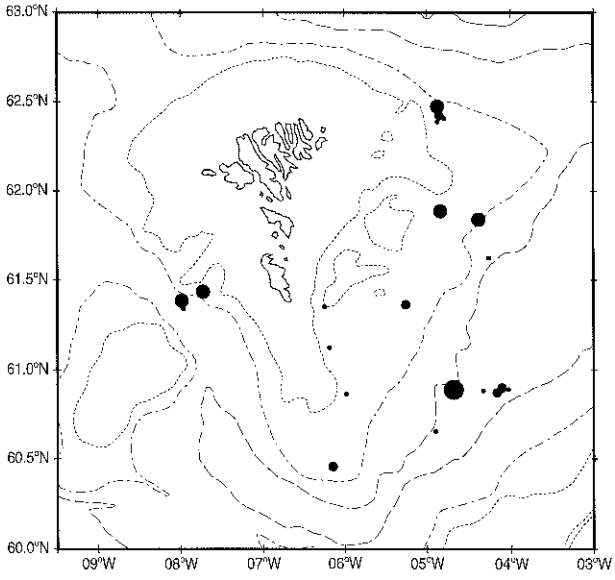


Figure 29 The locations of all sei whale sightings

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Number of Individuals

• 1 • 2-3 ● 4-5 ● >6

5.2 Sei whale *Balaenoptera borealis*

Sei whales are thought to favour more temperate and oceanic waters than the other large rorquals, especially during their northward migration (Jonsgård & Darling 1977; Mizroch *et al.* 1984). Their occurrence in European coastal waters is less predictable than that of fin whales. They appear in large numbers during some years, while in others, very few will appear (Jonsgård & Darling 1977). Recent years have been characterised by larger than usual numbers in Faroese waters (D. Bloch pers. comm.), and almost as many sei whales as fin whales were seen during this study.

All but one of the 23 sightings (59 individuals) were in August; the other was in May. All sightings were at the shelf edge, or in deeper water further offshore, with most sightings to the east, and south-east of the islands (Figure 29). It is possible that most sei whales travel to the west of the Faroes during their spring northward migration, and then move into Faroese waters later in the season, maybe from Icelandic or Norwegian waters. They are known to leave Norwegian coastal waters during August (Christensen *et al.* 1992). In six years of sightings west and south-west of Iceland, almost no sei whales were seen during June and July, but numbers increased during August to reach a peak during September (Sigurjónsson 1995). In this study the modal group size was one, but on one occasion eight animals were seen together.

5.3 Minke whale *Balaenoptera acutorostrata*

Minke whales are abundant in some areas of the north-east Atlantic during the summer months, especially in coastal waters (Evans 1992; Schweder *et al.* 1993). However, in this study area they were seen less frequently than fin whales, with only 19 sightings (23 animals) in total. Every sighting was in the period April to September, with 11 in August (48%). All but three sightings were in the vicinity of the shelf break, or beyond, with no animals seen close to shore (Figure 30). Minke whales are seen feeding between the islands every summer (Bloch 1998), so the lack of sightings during this study is probably an artefact of low survey effort close inshore. Minke whales feed on a wide range of prey species, including various gadoids, mackerel, sandeels and herring (Sigurjónsson, 1995; Skaug *et al.* 1995; Haug *et al.* 1996). However, young herring comprises a high proportion of the diet when they are available (Haug *et al.* 1995; Linstøm *et al.* 1998). Minke whales are thought to feed on Scottish spawning herring during August (Evans 1980). These Scottish herring periodically travel west across the Faroe-Shetland Channel to the southern and eastern Faroese banks (Jákupsstovu 1999). Most of the minke whales seen during this study were over these same banks.

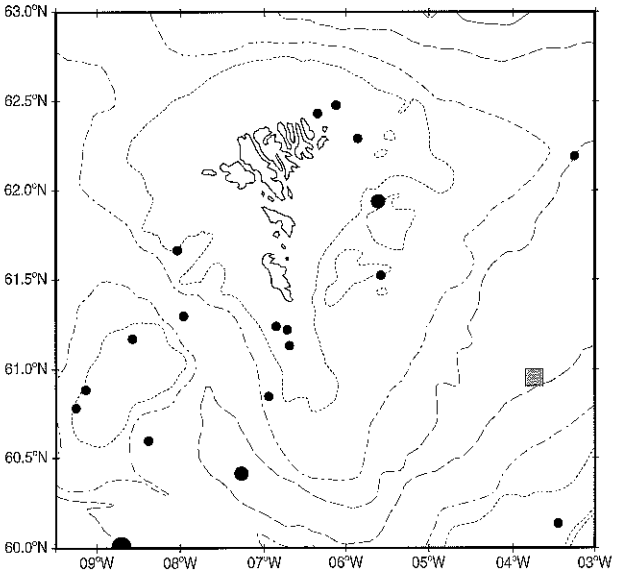


Figure 30 The locations of all minke and humpback whale sightings

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Number of Individuals

Minke whale • 1 ● 2 ● 3

Humpback whale ▒ 2

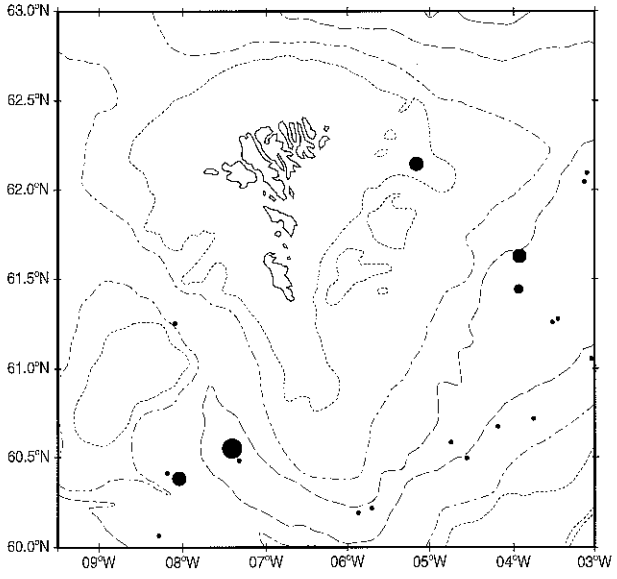


Figure 31 The locations of all sperm whale sightings

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Number of Individuals

• 1 • 2 ● 3 ● 4+

5.4 Humpback whale *Megaptera novaeangliae*

Two humpback whales were seen over the eastern side of the Faroe-Shetland Channel in July 1988 (Figure 30). Four were seen in a similar location from seismic vessels during 1997 (Stone 1998). In the Iceland-Faroe Rise/Shetland area as a whole, acoustic monitoring has detected a minimum of between two, and ten singing males, at any one time between November 1996 and March 1997 (Clark & Charif 1998).

5.5 Sperm whale *Physeter macrocephalus*

A total of 31 sperm whales was recorded on 21 occasions over the deep waters of the Faroe Bank Channel and Faroe-Shetland Channel (Figure 31). Only on one occasion were sperm whales seen away from deep water, when two were seen over the north-eastern Faroese shelf. None were seen within the survey area to the north-east of the islands, possibly due to low survey effort (see Figure 4).

There were 21 sightings of sperm whales between January and July, and one during both September and October. The month with most sightings was June, although most individuals (ten) were seen in May. Nearly all sightings were of solitary individuals, blowing at the surface between dives, but 3 whales were seen in close proximity to each other on two occasions. Most of the stranded and inshore sightings around Britain and Ireland have been of sub-adult and mature males (Berrow *et al.* 1993). Most of the whales in this study were also identified as males due to the very small group sizes, the northerly latitude, and the size of the individuals involved. Almost all sightings were over the slope, and most were in water deeper than 1,000 m. This preference for deep water may be explained by their diet of Histioteuthid and Cranchiid squid, which inhabit mesopelagic depths (200-1,000 m) (Clarke 1980; Rice 1989).

5.6 Northern bottlenose whale *Hyperoodon ampullatus*

Bottlenose whales are thought to be migratory, present in greatest numbers to the north of Iceland and west of central Norway, from April until July (Benjaminsen & Christensen 1979). During this survey there were five sightings: three in May, one in April, and one in October (Figure 32). Three sightings were of single individuals, two of two, and one of six which were seen during May. None was recorded during August and September, when most are stranded in the Faroe Islands (Bloch *et al.* 1996). This is also when the whales are thought to be migrating south from more northerly feeding areas (Benjaminsen & Christensen 1979). Bottlenose whales forage at, or close to the sea floor, and may dive on occasion to over 1,400 m in depth (Hooker & Baird 1999). The bottlenose whales in the Gully, Nova Scotia are never seen in water less than 1,000 m deep (Whitehead *et al.* 1997). All bottlenose whales seen in the survey area were over the 1,000 m contour. All sightings, but one, were over the Faroe Bank Channel, the other sighting was over the Faroe-Shetland Channel. The southern most Faroese island of Suðuroy is the closest island to the Faroe Bank Channel, and is where 72% of bottlenose whales stranded/landed in the Faroes have been found (Bloch *et al.* 1996b).

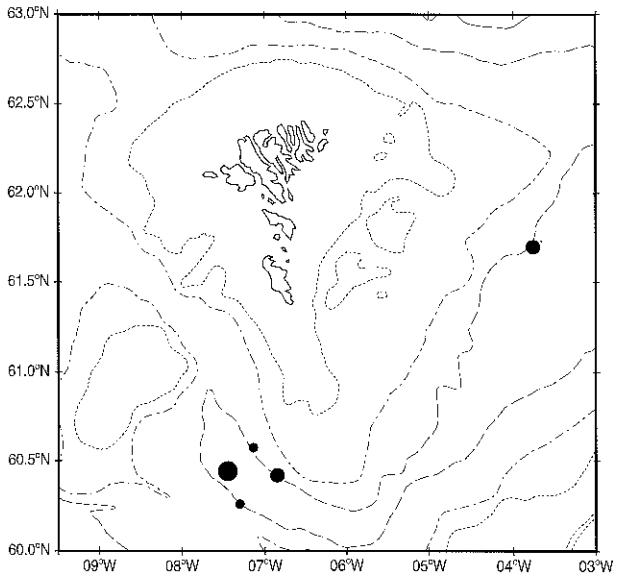


Figure 32 The locations of all northern bottlenose whale sightings

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Number of Individuals

• 1 ● 2 ● 6

5.7 Sowerby's beaked whale *Mesoplodon bidens* and unidentified beaked whales *Mesoplodon* spp.

Beaked whales of the genus *Mesoplodon* are seen only infrequently due to their preference for deep water, and because they spend only a short time at the surface between long dives (Hooker & Baird 1999). In addition, they often show rapid, elusive surfacing behaviour, and indistinct blows which renders them inconspicuous. There was only one sighting of a beaked whale that was positively identified as a Sowerby's and a further five sightings were thought to be Sowerby's, but species identification could not be confirmed. The positively identified whale was to the west of the Faroe Bank in over 500 m of water, whereas the others were over the Faroe Bank and Faroe-Shetland Channel in 1,000 m of water, or deeper (Figure 33). Sowerby's beaked whale was also positively identified during another survey within the study area. This sighting was over the eastern Faroe-Shetland Channel in the same location as the easternmost record in Figure 33 (ERT 1999). Five of these seven records were of solitary individuals; the other two records were of two animals together. There was one sighting for April, June and November, and two for August and September. A further 14 *Mesoplodon* sightings were made just to the south of the study area, to the south of the Wyville Thomson Ridge (Pollock *et al.* 2000).

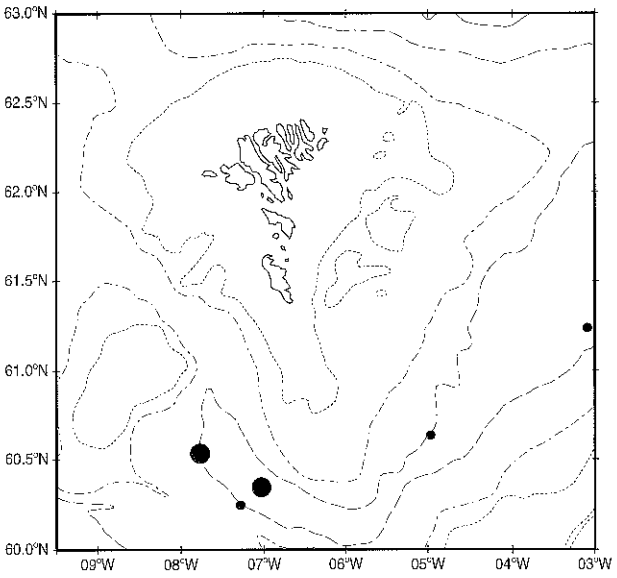


Figure 33 The locations of all *Mesoplodon* beaked whale sightings

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Number of Individuals

• 1 ● 2

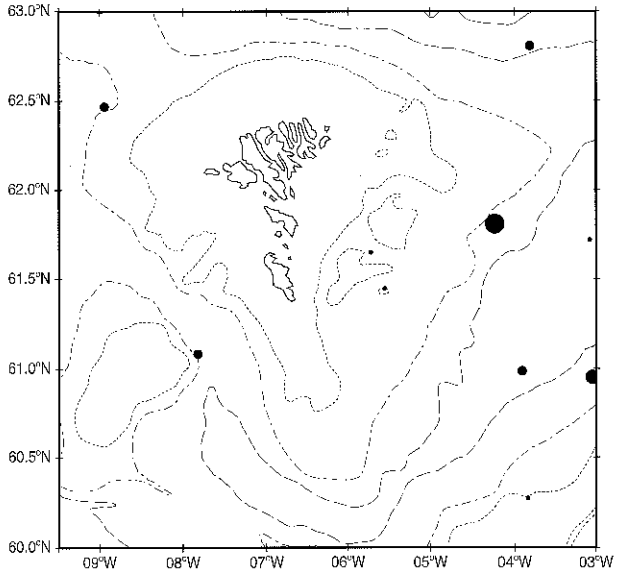


Figure 34 The locations of killer whale sightings

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Number of Individuals

• 1-4 • 5-9 ● 10-14 ● 15-20

5.8 Killer whale *Orcinus orca*

Killer whales were seen ten times between March and August, with two records in March, three in May, two in June and three in August. There were no records between September and February. Two sightings were over the edge of Syderø bank to the east of the Faroes, one was over the edge of the Faroe Bank, and another was over the Scottish shelf edge. All the rest were over deeper slope waters, mostly over the Faroe-Shetland Channel (Figure 34). The absence of records from the Faroese shelf should not be taken as a true absence, as they are frequently sighted in Faroese coastal waters during the summer months (Bloch & Lockyer 1988). Pod size ranged from one to 17 whales, with a mean of 6.0.

5.9 Long-finned pilot whale *Globicephala melas*

Long-finned pilot whales are one of the most abundant and widespread cetacean species in the north-east Atlantic (Buckland *et al.* 1993). They were seen in low numbers throughout much of the project area, but most were at or beyond the shelf edge, with a distribution biased towards the south and south-west (Figure 35). Most sightings were during the summer, especially during August when 1,091 animals (n = 14) were seen. These sightings comprised 69.5% of the total number seen for all months (n = 63). The mean pod size of 24 was heavily skewed by two large pods seen during August in the Faroe Bank Channel, which contained 400, and 500 animals respectively. Many pods were subdivided into a number of smaller pods, spread over several kilometres of ocean. This seasonal increase in the number of whales seen offshore is reflected in the July to September peak in the number of schools stranded close inshore (Zachariassen 1993). Although large pods are regularly recorded close to shore in the Faroese fjords (Bloch *et al.* 1996), most of the large pods seen during this survey were in deep water beyond the shelf edge. This is where squid *Todarodes sagittatus*, and blue whiting migration is most concentrated (Hoydal & Lastein 1993; Jákupsstovu 1999). Other favoured pilot whale prey, especially when *T. sagittus* is less abundant, include another squid (*Gonatus* sp.). These squid are most abundant over the slope to the north of the islands (Desportes & Mouritsen 1993), and the concentrations of pilot whale recorded seaward of the 500 m contour to the north of the islands, may have been feeding on them.

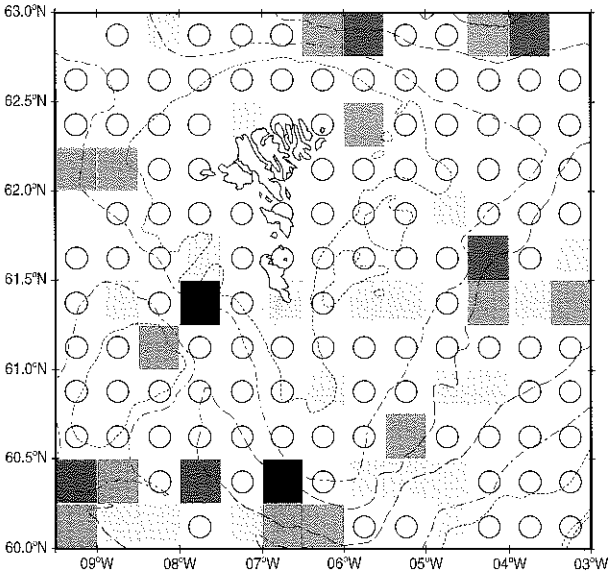


Figure 35 Density of long-finned pilot whales throughout the year

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Abundance (individuals/km)

No animals
0.01-0.09
0.10-0.49
0.50-0.99
1.00+

5.10 Atlantic white-sided dolphin *Lagenorhynchus acutus*

The Atlantic white-sided dolphin was the most numerous cetacean with 2,791 individuals recorded. There were only a few scattered sightings between December and May. All were over the shelf edge, or over deeper water (Figure 36a). There were both more sightings and more dolphins per sighting during June and July, when all sightings but two were over the slope. The other two sightings were at the Scottish shelf edge to the south-east of the survey area. Peak abundance was not reached until August, when large pods were seen along the length of the Faroe Bank Channel, and the central Faroe-Shetland Channel (Figure 36b). Only one large pod was seen over the shelf, to the north-west of the islands, but several smaller pods were seen to the east of the islands. This was the only month when white-sided dolphins were seen shoreward of the outer shelf. This seasonal venture into shelf waters is also common elsewhere (Selzer & Payne 1988; Evans 1992; Gowans & Whitehead 1995).

Within the survey area, the Faroe Bank Channel and western Ymir Ridge, have the highest sea floor relief. This, coupled with the overflow of deep Norwegian Sea water, leads to increased nutrient flux into the upper ocean (Meincke 1978; Hansen 1985), which is likely to enhance its suitability as a feeding area (Selzer & Payne 1988). Mean group size was 22.9 animals, although many groups contained fewer than 12 animals. These small groups, were often loosely associated with a number of other groups, to form a diffuse aggregation of dolphins spread over several kilometres. It is likely that the large pods of travelling dolphins occur when a number of small pods have coalesced into one large one (Gaskin 1992). By September numbers of white-sided dolphins had declined again, and all dolphins were seen over deep water to the south of the islands. There was only one sighting in October. In November, dolphins were seen over the central Faroe-Shetland Channel, southern Faroe-Bank Channel and one pod was seen over the shelf edge to the south-east of Suðuroy.

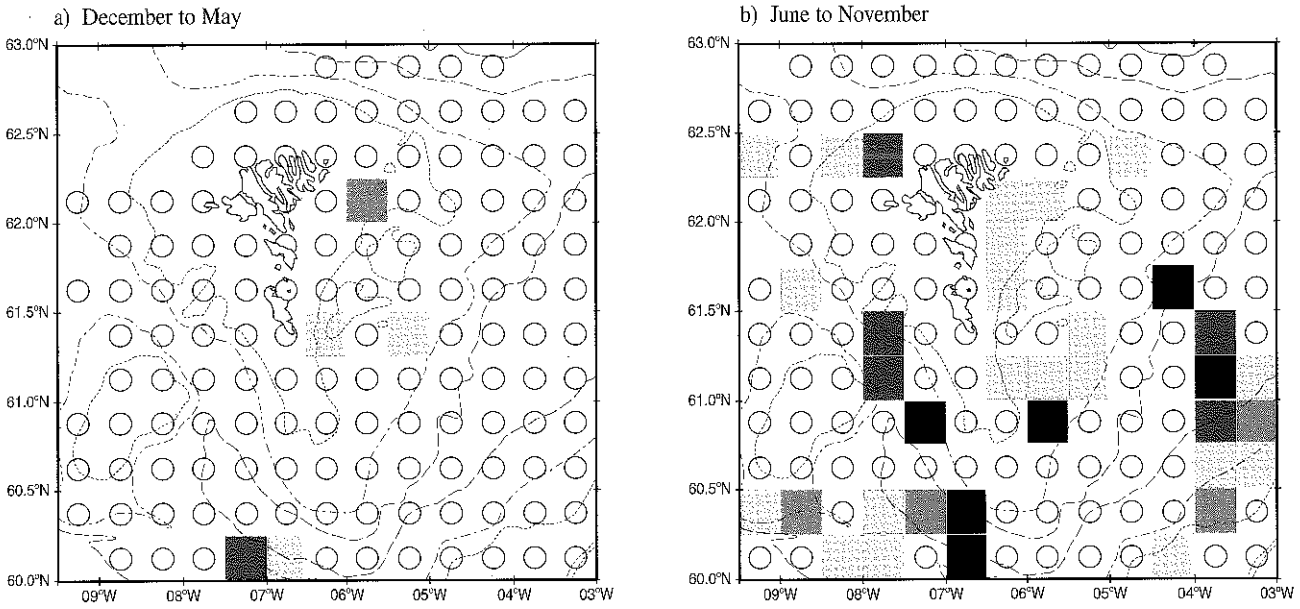


Figure 36 Seasonal density of Atlantic white-sided dolphins

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Abundance (individuals/km)

No animals | 0.01-0.09 | 0.10-0.49 | 0.50-0.99 | 1.00+

5.11 White-beaked dolphin *Lagenorhynchus albirostris*

Despite its abundance in north-west Scottish waters (Evans *et al.* 1993; Pollock *et al.* 2000) this species is rare in the study area. Four were seen in December over the Scottish side of the Faroe-Shetland Channel, and three in September over the Scottish shelf, to the south-east of the study area (Figure 37). None were recorded over the Faroese shelf, but they are occasionally stranded in the islands (Bloch 1998).

5.12 Common dolphin *Delphinus delphis*

There was only one sighting of common dolphins during this study of four dolphins in November 1997 over the eastern side of the Faroe-Shetland Channel. However, this species has been commonly recorded in waters south of the Wyville Thomson Ridge, to the south of the Atlantic study area (Pollock *et al.* 2000). In another study, common dolphins were found in warmer and more saline water than Atlantic white-sided dolphins (Selzer & Payne 1988). The Atlantic waters to the south of the ridge, and along the Scottish slope, are warmer and more saline than the waters over the Faroe plateau (Jákupsstovu 1999), and this may have contributed to the difference in occurrence between the two species.

5.13 Risso's dolphin *Grampus griseus*

There were only two sightings of Risso's dolphins, and they were both over the Scottish side of the Faroe-Shetland Channel. Three were over the shelf in November 1997, and one was over the slope in December 1998 (Figure 38).

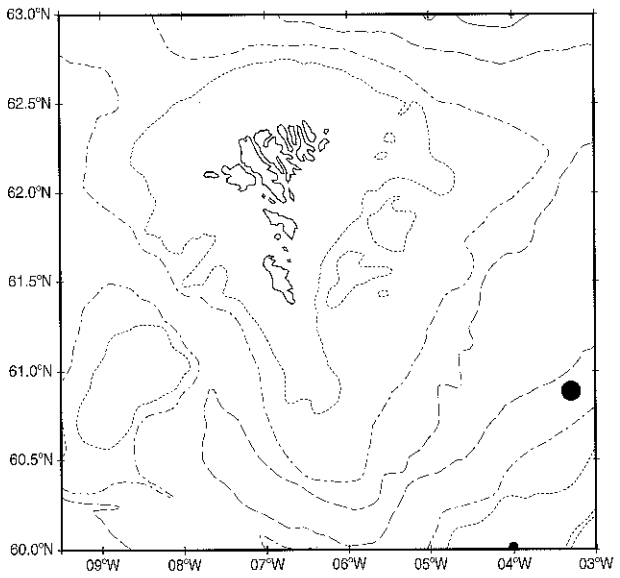


Figure 37 The locations of all white-beaked dolphin sightings

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Number of Individuals

• 3 ● 4

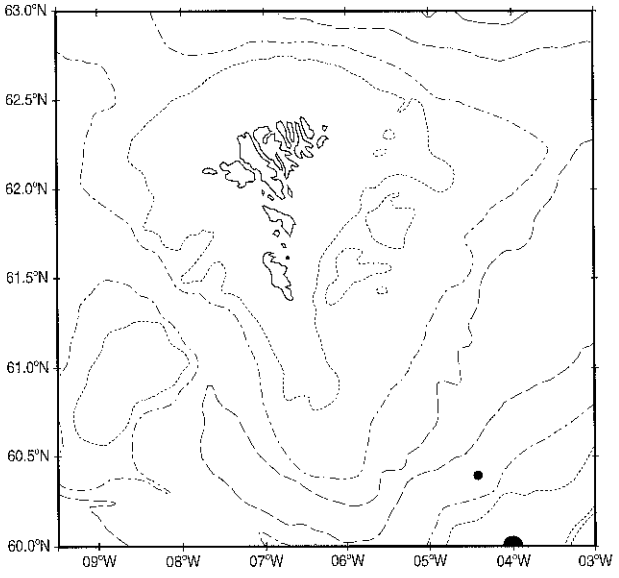


Figure 38 The locations of all Risso's dolphin sightings

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Number of Individuals

• 1 ● 3

5.14 Bottlenose dolphin *Tursiops truncatus*

Four of the five bottlenose dolphin pods recorded, were near the 1,000 m contour over the Faroe Bank Channel and Wyville Thomson Ridge, (Figure 39) during May, September and October. The other sighting was of two animals over the 100 m contour to the north-east of the islands (east of Fugloy) in July. There were a further five sightings just to the south of the study area between September and March (Pollock *et al.* 2000). They were not seen to associate with any other cetacean species, except on one occasion in September 1995, when ten white-sided dolphins were associated with 23 bottlenose dolphins over the Faroe Bank Channel. None were recorded with pilot whales, although they are sometimes seen with pilot whale pods (Bloch *et al.* 1993; Gowans & Whitehead 1995).

5.15 Harbour porpoise *Phocoena phocoena*

Porpoise abundance is known to vary on a seasonal basis, with a summer increase in northern coastal waters, which may be due to a seasonal offshore to inshore movement (Northridge 1996; Rosel 1997). During the winter and spring, harbour porpoises were only rarely encountered in Faroese waters. No sightings were made in February, and only a few between March to June. From June onwards, numbers increased with a distinct peak in numbers during August, when over 60% of the sightings were made. Numbers declined rapidly after August, and by October few porpoises were seen, with only four sightings during November. Most sightings were over shallow water close to the islands, or at the shelf edge to the south, and east of the islands (Figure 40). However 26% of sightings were seaward of the shelf edge, mostly in the vicinity of the Faroe Bank Channel and the Faroe Bank.

Porpoises may make greater use of deep water than the number of sightings alone would suggest. This is because the water is often rough over the deep water to the south of the Faroes, even during the summer. Porpoises become harder to detect in sea states greater than two (Palka 1996; Teilmann 1995). The modal group size was 1.0, although the mean was skewed to 1.9 individuals by a few large counts, including one group of 10 and another of 25. These two pods were seen over the slope to the south of the islands during November. The peak calving period in British waters is during June and July (Lockyer 1995); it is possible that porpoises move closer to the islands during late summer in order to exploit good feeding conditions, and/or to protect the young and vulnerable calves (Evans and Gilbert 1991; Evans *et al.* 1993b).

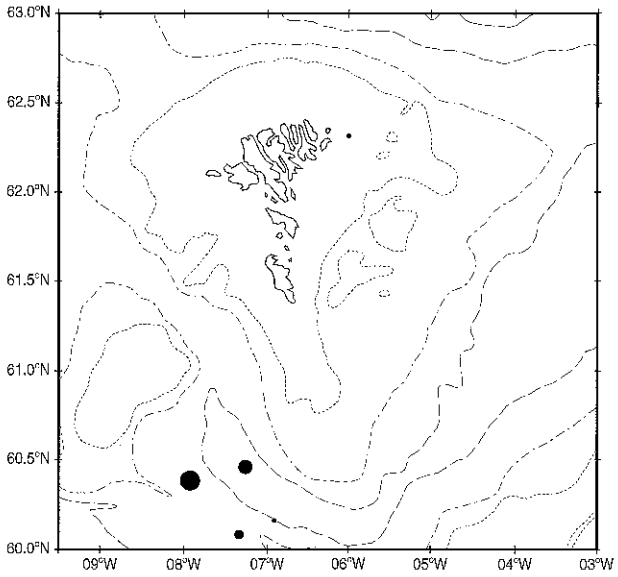


Figure 39 The locations of all bottlenose dolphin sightings

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Number of Individuals

• 1-3 • 4-8 ● 9-20 ● 21+

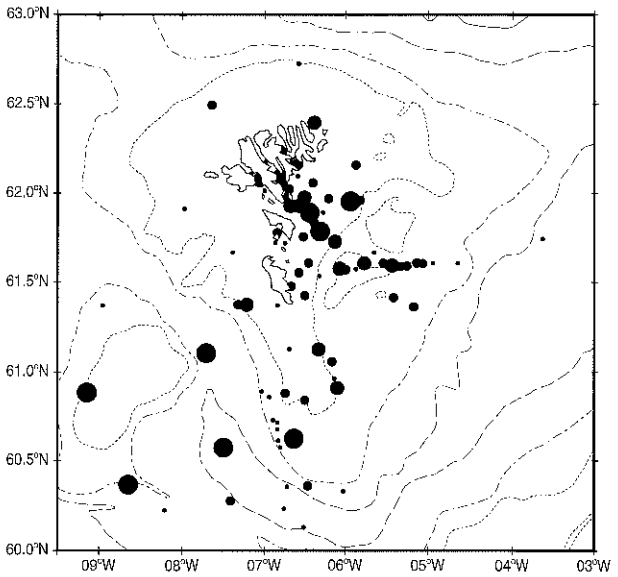


Figure 40 The locations of all harbour porpoise sightings

Bathymetry: dot (200 m isobath); dot dash (500 m isobath); dash (1,000 m isobath); solid (2,000 m isobath)
Key: Number of Individuals

• 1 • 2-3 ● 4-5 ● >6

6. Potentially vulnerable concentrations of seabirds and cetaceans

6.1 Important areas for seabirds

There were several locations within the study area, which consistently held high densities of seabirds. These were: the Faroe Bank, the southern Faroese shelf, the Faroe Bank Channel, the banks to the east of the islands, and coastal areas close to seabird colonies (see Figures 1 and 2 for place names). In addition, other areas occasionally held high seabird densities, but less consistently so, namely the Wyville Thomson Ridge and sections of the Faroe-Shetland Channel. The species and times, for which each of these areas are most important are discussed below; a detailed analysis of the vulnerability to surface pollution of seabirds in Faroese waters appears in Skov *et al.* (2001).

6.1.1 Faroe Bank and northern Faroe Bank Channel

The Faroe Bank, and the narrow section of the northern Faroe Bank Channel between the Faroe Bank and the south-west Faroese shelf, were especially important for common guillemots and Atlantic puffins. The highest densities of common guillemots were present during March, July and August, and the highest Atlantic puffin densities during April, May and August. Numbers were highest at the end of the breeding season, when the adults and fledglings disperse away from the colonies (Nørrevang 1958). The Faroe Bank held large numbers of Manx shearwaters in March, prior to their arrival in coastal waters, closer to their breeding colonies. The Bank continued to hold variable, but often high, numbers of Manx shearwaters between April and August. The Faroe Bank was also important for sooty shearwaters from July to September. This area held some of the highest recorded storm-petrel densities in Faroese waters, especially during July.

6.1.2 Southern Faroese shelf

The southern part of the Faroese shelf tended to hold the same species, at the same times of year, as the Faroe Bank. It is quite likely that some seabirds, such as the Manx shearwaters, were exploiting similar feeding habitats on both sides of the northern Faroe Bank Channel. Both Manx and sooty shearwaters, were abundant between July and September, with most recorded in August. The waters around Suðuroy held large numbers of auks during the summer, especially Atlantic puffins in July, and common guillemots in August. Little auks were abundant around Suðuroy in November.

6.1.3 Wyville Thomson Ridge and southern Faroe Bank Channel

The deep water of the southern Faroe Bank Channel held moderate to high densities of Atlantic puffins during April and May, but not later in the year when higher densities were recorded in coastal waters. In August, the southern Faroe Bank Channel held moderate densities of Leach's storm-petrels, as did the adjacent Wyville Thomson Ridge. More generally, seabird densities were lower than those found over inshore waters, and the offshore banks, but higher than those found over most of the Faroe-Shetland Channel.

6.1.4 The outer shelf and banks to the east of the islands

The eastern shelf edge and adjacent series of banks to the east of the islands, held large numbers of auks, both in summer and winter. Running north to south they are: Fuglø Bank, Nolsø Bank, Sandø Bank and Syderø Bank (see Figure 2).

Atlantic puffin densities were highest in May and June over Fuglø, Sandø and Syderø Banks, and over Nolsø and Syderø Banks in November. Common guillemot densities were high in April, September and November over Syderø Bank. High little auk densities were seen during November over the outer shelf, and over Sandø and Syderø Banks. Razorbills were less numerous than the other auks, but were seen in significant numbers over the eastern banks, especially over the western side of Nolsø during January. During the winter, the banks were favoured by glaucous gulls, with most seen over the outer edge of Nolsø Bank. European storm-petrels foraged over these banks in moderate to high densities during late summer. Most were seen in July and August, over Fuglø and Nolsø, but densities remained high over the outer shelf, and upper slope to the north-east of the islands, and also close to Fuglø Bank in September. In June, European storm-petrels were concentrated from the eastern side of Sandoy eastwards to the shelf break.

6.1.5 The Faroe-Shetland Channel

Seabird densities were generally low in the Faroe-Shetland Channel, with the exception of Atlantic puffins, which were numerous over the southern Channel in May, and the upper slope along the western side of the central Channel in March, and glaucous gulls in the southern Channel in December and January. The southern Faroe-Shetland Channel, and the adjacent eastern Faroe Bank Channel, generally held more seabirds than the north-east Faroe-Shetland Channel.

6.1.6 Coastal areas

Although many species were seen close to shore around the colonies, some species bred in much larger numbers than others, and consequently showed higher seasonal abundance in coastal waters. The most noteworthy concentrations of coastal birds were: high densities of common guillemots and Atlantic puffins, situated just offshore from most of the islands, especially between May and August; black-legged kittiwakes between May and July; northern gannets around Mykines, the westernmost island in the archipelago between June and August; Arctic terns were common around the eastern side of the central islands in June and July, and black guillemots were widespread close to shore, around most of the Faroese coastline.

6.2 Important areas for cetaceans

Cetaceans would appear more able to cope with the immediate effects of an oil spill than do seabirds. Once oiled, seabird plumage can very easily lose its insulative properties, and become water-logged, whereas cetacean skin is very impermeable (Geraci 1990). There is no evidence that oil or tar balls significantly foul the feeding apparatus of baleen whales, although the long term effects of pollutant accumulation in toothed whales might prove significant in some instances (Geraci 1990; Kiceniuk *et al.* 1997). The sound generated by seismic surveys have the potential to disturb cetaceans (Turnpenny & Nedwell 1994; Stone 1998), and so it is useful to outline the high use areas for cetaceans within the project area. Cetaceans showed an opposite trend to seabirds in their habitat use, with most seen in deep water, whereas most seabirds were seen in shallow water. Cetaceans were seen more frequently in some areas than in others, such as over the Wyville Thomson Ridge, the southern Faroe Bank Channel, the Faroe-Shetland Channel, the shelf edge and banks to the east, and the south-east of the islands.

6.2.1 The Wyville Thomson Ridge, southern Faroe Bank Channel and the Faroe-Shetland Channel

Several of the odontocetes favoured deep water, such as long-finned pilot whales, which were widespread over the entire area, but were most numerous in August. White-sided dolphins were also widespread between June and November. Harbour porpoises were not infrequently seen over the deep water of the Faroe Bank Channel. The distribution of sperm whales, northern bottlenose whales and unidentified beaked whale species, was centred over the 1,000 m contour, particularly in the southern Faroe Bank Channel. Most fin and sei whales were seen over shallower water, and there was a number of sightings of Sei whales over the southern Faroe Bank Channel, and the central Faroe-Shetland Channel, in August and September.

6.2.2 The Faroe Bank, northern Faroe Bank Channel and the southern Faroese shelf

Although not common, minke whales were the numerous baleen whale species seen over this area of predominately shallow water. Harbour porpoises were also frequently seen over the shelf break to the south of the Faroes.

6.2.3 The shelf edge and banks to the east of the islands

Most of the fin whales sighted in the project area were over the banks to the east of the islands, especially around Syderø Bank. Most sei whale sightings were also in the vicinity of the eastern banks, and western Faroe-Shetland Channel. The Syderø and Sandø Banks held higher numbers of harbour porpoises in August than the surrounding waters.

6.2.4 Coastal areas

Several species were encountered in coastal waters, but the only one with a predominantly coastal distribution was the harbour porpoise. Most were recorded between June and August.

7. Concluding comments

This report has significantly added to knowledge on the distribution of seabirds and cetaceans in the Faroes area, and should help aid future strategic environmental assessment. A report on the year-round at-sea distribution of seabirds in Faroese waters has not been possible until now because of a the lack of survey coverage outside the summer months. Although Bloor *et al.* (1996), did consider Faroese waters, the limited survey coverage precluded full assessment of seabird and cetacean dispersion.

An assessment of the vulnerability to surface pollution of seabird concentrations in Faroese waters appears in Skov *et al.* (2001); the data on which that vulnerability atlas is based include those used in the present report, but with the addition of data collected after compilation of the present report. Whereas Webb *et al.* (1995) published seabird vulnerability maps for the period March to September for Faroese waters, Skov *et al.* (2001) covers the entire year. In addition, Skov *et al.* (2001) present modelled seabird dispersion patterns that allow seasonal estimates of the absolute numbers of seabirds using the waters around the Faroe Islands to be made.

8. Acknowledgements

This work was sponsored by Geotechnical Environmental Metocean (GEM). We thank John Spink and Anne Walls of Amerada Hess for co-ordinating the project steering group. Jennifer Bracey also gave positive support. During 2000 funding was provided by: Agip UK Ltd.; Amerada Hess Ltd.; Anadarko North Sea Company; BP Amoco Exploration; Conoco (UK) Ltd.; Dansk Olie-Og Gasproduktion A/S; Enterprise Oil; Exxon Mobil Exploration and Production UK Ltd.; Marathon International Petroleum; C Murphy Petroleum Ltd.; Phillips Petroleum Company Ltd.; Saga Petroleum Faroes AS (Norsk Hydro); Statoil UK Ltd.; Texaco Ltd.; TotalFina Elf; Veba Oil and Gas Veba Oil and Gas Ltd. In previous years funding was also provided by: Amoco Faroes (now part of BP Amoco); Arco British Ltd.; BHP Petroleum (Exploration) Inc.; Deminex (now Veba Oil & Gas); Elf Exploration UK plc (now part of TotalFina Elf); Fina Petroleum Development Ltd. (now part of TotalFina Elf); LASMO (ULX) Ltd.; Mærsk Olie og Gas AS and Shell Expro UK Ltd. Fiskirannsóknarstovan (Faroese Fisheries Laboratory-FFL) and the Ministry of Petroleum (Tórshavn) were observers. We wish to thank Hjalti Jákupsstovu, (Fiskirannsóknarstovan) for co-ordinating the Faroes Fisheries Laboratory (FFL), Ornis Consult (OC) and the Joint Nature Conservation Committee (JNCC) during this project.

Thanks to Ornis Consult Ltd. for allowing us to use ESAS data which they have collected, and especially to Henrik Skov for getting the data into a format suitable for analysis.

We are indebted to many observers who collected data in the survey area over the last few years. In particular we thank Per Andoll (OC), Phil Bloor (JNCC), Kim Christensen (OC), Ciarán Cronin (JNCC), Jan Durinck (OC), Jes Graugaard (OC), Thomas Johansen (OC), Mardik Leopold (Institute for Forestry and Nature Research, Netherlands (IBN/DLO), Rogvi Mouritsen (FFL), Henrik Skov (OC), Dylan Walker (JNCC), and Richard White (JNCC).

The survey work could not have been achieved without the help of a number of organisations, especially the following, who kindly allowed us to place surveyors on their vessels: Faroese Coastguard and Fisheries Protection (*FPV Tjaldrid*), Danish navy, Faroes Command, (*HDMS Beskytteren*), Faroes Fisheries Laboratory (*R/V Magnus Heinason*), Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD) Marine Laboratory, Aberdeen (*R/V Scotia*), Institute of Marine Research, Bergen, (*R/V Johan Hjort*), Smyril lines (*Noronna*). We are very grateful for the kindness and co-operation shown by the captains and crews of these vessels.

We would like to especially thank Bergur Olsen, Fiskirannsóknarstovan, and Dorete Bloch, Føroya Náttúrugripasavn (Faroes Museum of Natural History), Tórshavn, Faroe Islands for their valuable advice during the writing of this report, including comments on an earlier version. We thank Sharon Robertson (JNCC), for administrative support, and all staff employed on the SAST Phase 5 programme of work. In addition to the above sponsors, SAST 5 was sponsored by Esso Petroleum Co. Ltd., Department of Transport (Marine Pollution Control Unit) and BG plc. We are grateful to Caroline Weir and Roddy Mavor who worked on a JNCC sister project in the Atlantic Frontier; Caroline's help proved invaluable in the preparation of the report. Andy Webb provided crucial data specialist skills and Andrew Upton commented on an earlier draft. Thanks also to Janet Ford and Linda Porter of JNCC for formatting the report.

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Appendix I.

Scientific, English, Faroese and Danish names of seabirds and cetaceans mentioned in the text

Latin name	*English name*	*Faroese name*	*Danish name*
Seabirds			
Gavia stellata	Red-throated diver	Lómur	Rødstrubet lom
Gavia immer	Great northern diver	Havgás, Imbrimil	Islom
Fulmarus glacialis	Northern fulmar	Havhestur, Náti	Mallemuk
Pterodroma sp.	Soft-plumaged petrel sp.	Skurvutur marjallur	Blød petrel
Calonectris diomedea	Cory's shearwater	Nevgulur skrápur	Kuhls skråpe
Puffinus gravis	Great shearwater	Stórskrápur	Storskråpe
Puffinus griseus	Sooty shearwater	Gráskrápur	Sodfarvet skråpe
Puffinus Puffinus	Manx shearwater	Skrápur	Alm. skråpe
Hydrobates pelagicus	European storm-petrel	Drunnhvíti, Havtyrðil	Lille stormsvale
Oceanodroma leucorhoa	Leach's storm-petrel	Sýldur drunnhvíti	Stor stormsvale
Morus bassanus	Northern gannet	Súla	Sule
Phalacrocorax carbo	Great cormorant	Hiplingur	Storskarv
Phalacrocorax aristotelis	European shag	Skarvur	Topskarv
Somateria mollissima	Common eider	Æða	Ederfugl
Phalaropus lobatus	Red-necked phalarope	Helsareyði	Odinshane
Phalaropus fulicarius	Grey phalarope	Sundgrælingur	Thorshane
Stercorarius pomarinus	Pomarine skua	Jói	Mellemk jove
Stercorarius parasiticus	Arctic skua	Kjógvi	Almindelig kjove
Catharacta skua	Great skua	Skúgvur	Storkjove
Larus sabini	Sabine's gull	Ternumási	Sabinemåge
Larus ridibundus	Black-headed gull	Fransaterna	Hættemåge
Larus canus	Mew gull	Skatumási, Válkur, Lortumási	Stormmåge
Larus fuscus	Lesser black-backed gull	Likka	Sildemåge
Larus argentatus	Herring gull	Fiskimási	Sølvmåge
Larus glaucoides	Iceland gull	Lítil valmási	Hvidvinget måge
Larus hyperboreus	Glaucous gull	Valmási	Gråmåge
Larus marinus	Great black-backed gull	Svartbakur, Bakur	Svartbag
Rissa tridactyla	Black-legged kittiwake	Ryta	Ride
Sterna hirundo	Common tern	Kriterna	Fjordterne
Sterna paradisaea	Arctic tern	Terna	Havterne
Uria aalge	Common guillemot	Lomvigi, Lomviga	Lomvie
Uria lomvia	Brünnich's guillemot	Íslands lomvigi, Íslands lomviga, Stuttvigi	Polarlomvie
Alca torda	Razorbill	Álka	Alk
Cepphus grylle	Black guillemot	Teisti	Tejst
Alle alle	Little auk	Fulkubbi	Søkonge
Fratercula arctica	Atlantic puffin	Lundi	Lunde
Cetaceans			
Balaenoptera physalus	Fin whale	Nebbafiskur	Finhval
Balaenoptera borealis	Sei whale	Seiðhvalur	Sejhval
Balaenoptera acutorostrata	Minke whale	Sildreki	Vågehval, Sildepisker
Megaptera novaeangliae	Humpback whale	Kúlubøka	Pukkelhval
Physeter macrocephalus	Sperm whale	Avgustur	Kaskelot
Hyperoodon ampullatus	Northern bottlenose whale	Døglingur	Døgling
Mesoplodon bidens	Sowerby's beaked whale	Nevhvalur	Næbhval
Orcinus orca	Killer whale	Mastrarhvalur	Spækhugger
Globicephala melas	Long-finned pilot whale	Grindahvalur	Grindehval
Lagenorhynchus acutus	Atlantic white-sided dolphin	Skjórutur springari	Hvidskæving
Lagenorhynchus albirostris	White-beaked dolphin	Kjafthvítur springari	Hvidnæse
Grampus griseus	Risso's dolphin		Halvgrindehval
Tursiops truncatus	Bottlenose dolphin	Hvessingur	Øresvin
Delphinus delphis	Common dolphin	Vanligur springari	Alm. delfin
Phocoena phocoena	Harbour porpoise	Nísa	Marsvin

The Joint Nature Conservation Committee is the forum through which the three country nature conservation agencies — the Countryside Council for Wales (CCW), English Nature (EN), and Scottish Natural Heritage (SNH) — deliver their statutory responsibilities for Great Britain as a whole and internationally. These responsibilities, known as the special functions, contribute to sustaining and enriching biological diversity, enhancing geological features and sustaining natural systems. The special functions are principally:

- to advise ministers on the development of policies for, or affecting nature conservation in Great Britain and internationally;
- to provide advice and knowledge to anyone on nature conservation issues affecting Great Britain and internationally;
- to establish common standards throughout Great Britain for the monitoring of nature conservation and for research into nature conservation and the analysis of the results;
- to commission or support research which the Committee deems relevant to the special functions.

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COVER PHOTOGRAPHS
Northern fulmar *Fulmarus glacialis*, Ian C Carter/JNCC
Atlantic puffin *Fratercula arctica*, Mark L Tasker/JNCC

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