MARY BETH DECKER, MARIA GAVRILO, FRIDTJOF MEHLUM AND VIDAR BAKKEN

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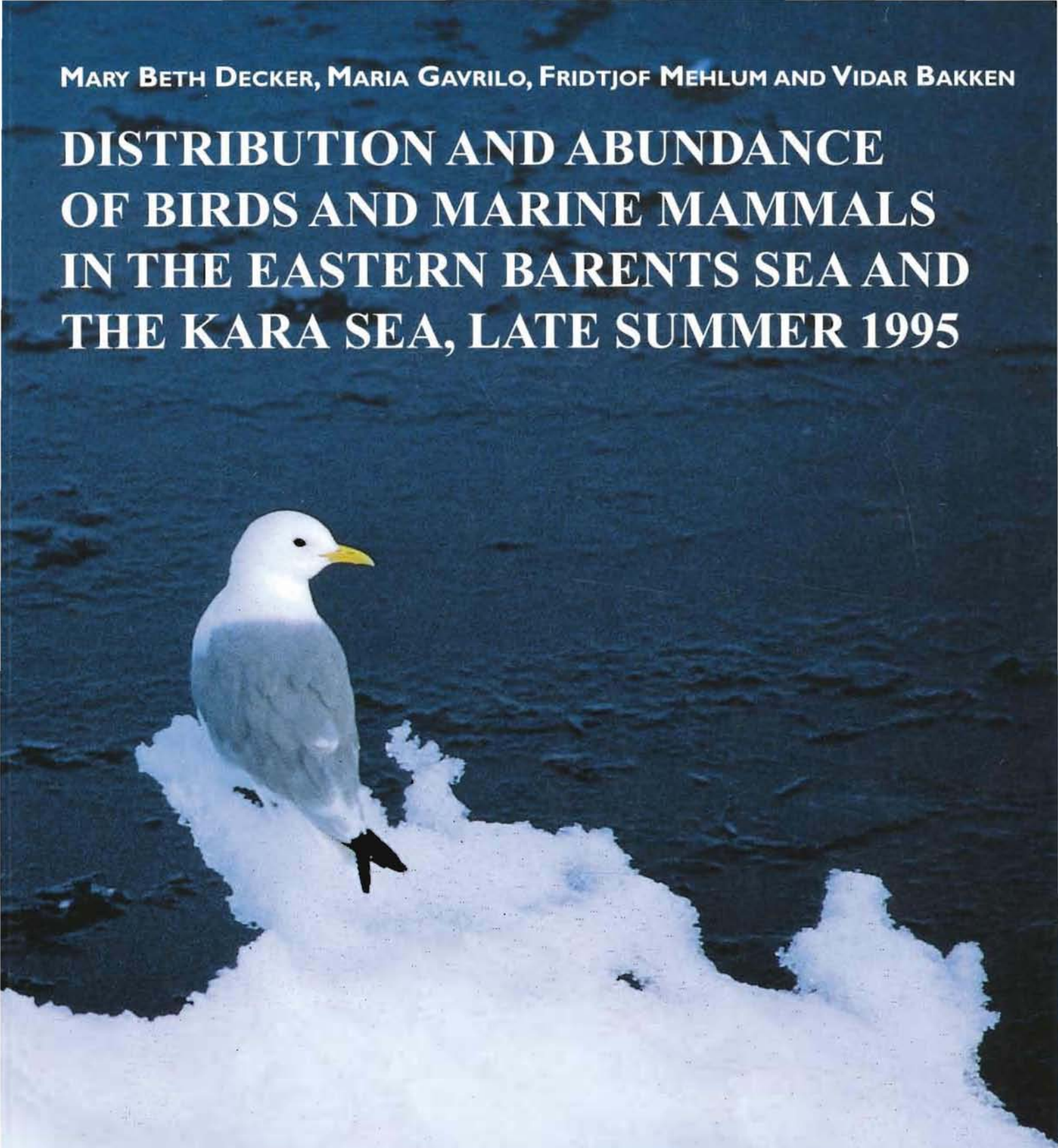

NORSK POLARINSTITUTT

MEDDELELSER NO. 155
OSLO 1998

Meddelelser No. 155

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Cover: Kittiwakes *(Rissa tridactyla)* on ice. Foto: Kjell Isaksen.
Technical editor: Annemor Brekke
Printed by Gjøvik Trykkeri May 1998
ISBN 82-7666-146-7

Contents

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ABSTRACT

Marine bird and mammal surveys were conducted in the Eastern Barents Sea and Kara Sea during the period 3 August to 10 September 1995. We made observations along a total distance of 9336 km. Sea bird and marine mammal abundances were greater in the Barents Sea, while aquatic birds and shore birds were more abundant in the coastal regions of the Kara Sea and in the Ob' and Jenisej Bays. We observed a total of 13,418 birds of 35 species and 457 mammals of nine species throughout the survey. Distribution and abundance maps are presented for 24 of the most numerous species.

INTRODUCTION

We report here on the distribution and abundance of birds and mammals in the Kara Sea and Eastern Barents Sea. Very little is known about the at-sea distribution of birds and mammals in the Kara Sea, however this study compliments other investigations of bird and mammal distributions in the Barents Sea (Mehlum 1989; Bakken & Gavrilo 1995; Isaksen 1995; Krasnov & Nikolaeva 1996a, b). One study of the distribution of seabirds and mammals in the Kara Sea was conducted by Bakken & Gavrilo (1995) in which only the southern parts of the Kara Sea were surveyed.

STUDY AREA

Our survey of birds and mammals covered the eastern portion of the Barents Sea and much of the Kara Sea (Fig. 1). The Barents and the Kara Seas are Arctic seas bordered by the Eurasian continent in the south and by the Arctic Ocean in the north. In addition, the Barents Sea is bordered by the Norwegian Sea in the west. These Arctic seas are largely situated on the continental shelf and have characteristics of the marginal continental seas. In general, the Kara and Barents

Seas are relatively shallow seas that have several deep-water troughs (Baskakov & Shpaikher 1978; Dobrovolskiy & Zalogin 1982).

The thermohaline structure of the Barents Sea is influenced by Atlantic water in the south and Arctic water in the north (Loeng 1991). A principal frontal zone in the Barents Sea, known as the Polar Front, exists between the warm eastern branch of the North Atlantic Current, known as the Nordkapp Current, and cold, less saline Arctic water (Loeng 1989), and large influxes of nutrient-rich Atlantic water into the Barents Sea are related to increased zooplankton and fish production (Sakshaug et al. 1994). Horizontal influx of Atlantic water and vertical mixing near the front are thought to transport nutrients into the euphotic zone and increase production in the Barents Sea.

In the Kara Sea, the thermohaline structure is governed in part by inflow from the Arctic Basin and the Barents Sea. In contrast to the Barents Sea, horizontal influx of nutrient-bearing oceanic water is limited because the Kara Sea is almost entirely surrounded by land masses. However, continental run-off into the Kara Sea via the Ob' and Jenisej Rivers, as well as numerous smaller rivers, is considerable (average 1350 km^3 yr^{-1}). Freshwater outflow into the Kara Sea is 2.8 times greater than that in the Barents Sea, and constitutes almost a half of total river water discharge into the Russian Arctic seas (Ivanov 1996). The freshwater outflow is at present hundreds of kilometers from the river mouths and creates intense vertical stratification throughout a major portion of the Kara Sea.

The Kara Sea is ice-covered from November until June. The sea ice is primarily first-year ice with a maximum thickness of 1.5-2m. Minimum ice cover is typically recorded during the month of September (Faleev 1980). Extensive ice formation during cold periods and intense stratification of the water column during summer strongly influence mixing processes of water masses of the Arctic Ocean, Barents Sea, and of continental origin (Nikiforov & Shpaikher 1980; Pavlov et al. 1996). These physical processes prevent inflow of warmer, nutrient-rich Barents Sea and Atlantic Ocean water into the Kara Sea (Abramov 1985; Matishov et al. 1989). In addition, strong stratification of the water column inhibits vertical mixing and biological production in the upper water column. Therefore, in the Kara Sea considerable amounts of nutrients and organic matter are concentrated in lower water column (Matishov et al. 1989).

Climatic and hydrographic conditions in the Kara Sea in 1995

The summer season of 1995 was characterized by anomalously light ice conditions in the Kara Sea. On our survey, sea ice was only encountered in the Barents Sea south of Franz Josef Land and in the Kara Sea near 80°N (Fig. 1). Factors contributing to the ice conditions included a very mild winter, prevailing off-shore winds and the early onset of ice melt. The south-western part of the Kara Sea was ice-free by late July. Consolidated ice covered only 4% of the northeastern Kara Sea, approximately ten times less than the average ice cover for that region (data from Centre of Ice and Hydrometeorological Information, Department of Long-term Ice Regime and Forecasts, Arctic and Antarctic Research Institute (AARI)).

The distribution patterns for water masses in the Kara Sea during the summer of 1995 were characterized by slight penetrations of the Barents Sea water and of

"eastern-type" river water distribution with an average continental run-off volume (Report on KAREX-95). Hence, Kara surface water prevailed over the Kara Sea.

Many islands and coastal habitats neighbouring the eastern Barents and Kara Seas provide nesting sites for breeding marine and aquatic birds. In particular, extensive colonies of cliff-nesting seabirds are located on the western coast of Novaja Zemlja (mainly Brünnich's guillemots (*Uria lomvia*) and black-legged kittiwakes (*Rissa tridactyla*)) and on Franz Josef Land (mainly little auks (*Alle alle*), Brünnich's guillemots, and kittiwakes) (Barents Sea colony register, Norwegian Polar Institute (NP) and AARI unpublished database). In contrast, breeding populations of cliff-nesting seabirds in the Kara Sea (mainly little auks and kittiwakes) are less numerous, with colonies occupying Severnaja Zemlja and a few small islands (Kara Sea colonies register, NP and AARI unpublished database). The tundra surrounding the southeastern Barents Sea and Kara Sea (Yamal Peninsula, western Taimyr Peninsula, southern Novaja Zemlja and inshore islands) provide favourable breeding habitats for waterfowl and shorebirds. The coastal zones of these areas are of particular importance for non-breeding birds during their molt and migration (Danilov et al. 1984; Mineev 1987, 1994; Estafyev 1991; Rogacheva et al. 1995).

METHODS

We surveyed the distribution and abundance of birds and mammals in the eastern Barents and Kara Seas during the period 3 August to 10 September 1995. Continuous counts of birds and mammals were made from the bridge of the *R/V Ivan Kireev* while the ship was underway and data were entered directly into a pen computer. All birds within an arc from 300-m ahead of the ship to 90° off the port side were recorded using a continuous strip transect method (Tasker et al. 1984). Bird behaviours were recorded as flying, sitting on the water, sitting on ice, or ship following. We counted a ship following bird only once after it was first observed. For birds in flight, we also recorded the compass direction (NN, NE, EE, etc.) in which they were flying. We converted the heading of each individual (or flock) to degrees to compute the average flight direction of migrating species. Marine mammals were recorded using the line transect method (Buckland et al. 1993) and we estimated the animal's distance and compass direction from the ship. We regularly scanned to the horizon to detect marine mammals using 10x binoculars. Environmental data, such as sea state, wind speed and visibility, were updated as conditions changed. Abundance of all birds and mammals is reported as the number of individuals observed per kilometre surveyed.

In order to report abundance estimates of birds and mammals throughout the various habitats traversed during our survey, we divided the area into regions based on geographic location, distance from land, and presence of sea ice. Data are presented separately for the Eastern Barents Sea, coastal Franz Josef Land, western Kara Sea and eastern Kara Sea because these areas are geographically and oceanographically distinct from each other. For the following analyses, we divided the Kara Sea into 'western' and 'eastern' portions at 70° longitude based on properties of distinct water masses occupying the two regions (Nikiforov & Shapaikher 1980) as in Bakken & Gavrilo (1995). Those portions of the survey that were traversed within 50 km of land masses were termed 'coastal' whereas, surveys more than 50 km from shore were categorized as 'pelagic'. 'Ice covered' regions in the Barents and Kara Seas were defined by the presence of sea ice, but

not including large, singular icebergs that were observed far from the ice-edge. Data from the Ob' and Jenisej estuaries are also presented separately.

RESULTS

The total seabird abundance was considerably higher in the eastern Barents Sea than in the the Kara Sea or elsewhere in the study area. We observed the greatest total abundance of seabirds in the ice-covered water of the Barents Sea (Fig. 2). In contrast, aquatic birds (divers, ducks, and geese) were relatively more abundant in the coastal Kara Sea and the Ob' and Jenisej Bays, while shorebirds were most abundant in the eastern Kara Sea, in the ice-covered waters of the Kara Sea and in the estuaries. The highest marine mammal abundance was observed in the pelagic and ice-covered waters of the Barents Sea (Fig. 2). The results of the majority of our sightings are described below. A complete listing of the abundance of all the species we observed can be found in Table 1.

Marine birds in the Barents Sea

Northern fulmars (*Fulmarus glacialis*) were abundant on our survey particularly in the offshore zones of the eastern Barents Sea (Fig. 3, Table 1). Fulmars were distributed throughout the survey area, however we observed the highest abundances of fulmars between 72° 30´ N and 77° 30´ N (Fig. 4). Within this region, many of the fulmars recorded were seen sitting on the water (Fig. 5) and may have been feeding recently. Pomarine skuas (*Stercorarius pomarinus*) were also relatively abundant in the eastern Barents Sea (Fig. 3, Table 1) and most birds were observed west of 46° E and south of 77° 30´ N (Fig. 6). Long-tailed skuas (*Stercorarius longicaudus*) were found in the pelagic waters of the eastern Barents Sea (Fig. 3, Table 1) and the majority of those birds surveyed were found between 75° 30´ N and 78° N (Fig. 7). Small numbers of arctic skuas (*Stercorarius parasiticus*) were found throughout the eastern Barents Sea (Fig. 8).

Black-legged kittiwakes were distributed throughout the eastern Barents Sea (Fig. 9) and the highest overall density of this species (1.03 birds km^{-1}) was found in the ice-covered region (Fig. 3, Table 1). Low numbers of glaucous gulls (*Larus hyperboreous*) were found in coastal zones near Franz Josef Land and the Russian mainland (Fig. 10). Herring gulls (*Larus argentatus*) were also found in low numbers near the Russian mainland coast (Fig. 11). Herring gulls demonstrated a more southern and coastal distribution than glaucous gulls. We observed a few ivory gulls (*Pagophila eburnea*) associated with sea ice near Franz Josef Land (Fig. 12, Table 1). Arctic terns (*Sterna paradisaea*) were observed throughout our survey in the Barents Sea (Fig. 13), however, a large group was observed in the ice-covered region in the eastern Barents Sea (Fig. 3, Table 1). Most terns in the Barents Sea appeared to be migrating toward the west and southwest (Fig. 14).

The most abundant species observed on the entire survey was the Brünnich's guillemot (Fig. 3, Table 1). In the eastern Barents Sea, we observed the highest abundances of Brünnich's guillemots south of Franz Josef Land, south of Novaja Zemlja and to the west of Novaja Zemlja between 71° 30´ and 74° 20´ N (Fig. 15). Many of the guillemots we observed were sitting on the water and may have been feeding in these regions (Fig. 16). We observed numerous adult guillemots with chicks. In addition, many adult Brünnich's guillemots had begun to molt which is an indication that they have commenced migration away from their breeding colonies.

Common guillemots (*Uria aalge*) were much less numerous than Brünnich's guillemots (Fig. 3, Table 1) and were only observed south of 73° 30´ N (Figs. 17 and 18). Little auks were abundant on our survey in the eastern Barents Sea (Fig. 3, Table 1). Specifically, little auks were observed north of 74° N, however the highest abundances of little auks were found in the pelagic waters north of 76° N and near the coast of Franz Josef Land (Fig. 19, Table 1). Black guillemots (*Cepphus grylle*) were present in low abundances near Franz Josef Land in the ice-covered coastal waters (Fig. 3, Table 1) north of 79° N (Fig. 20). The overall abundance of atlantic puffins (*Fratercula arctica*) was relatively low in the eastern Barents Sea (Fig. 3, Table 1), however a relatively large aggregation of puffins was observed in pelagic waters between 69° 30´and 72° 30´ N (Fig. 21). The majority of the puffins we observed were sitting on the water (Fig. 22), therefore, this region may be an important feeding area for this species.

Aquatic birds in the Barents Sea

On this survey, aquatic birds were rare in the Barents Sea (Fig. 23) and were only found in the Barents Sea west of the Kara Gate Strait, in the southeastern part of the Pechora Bay. In this region, several divers (*Gavia* sp.) were seen sitting on the water (Fig. 24). We observed a large group (110 individuals) of geese (*Anser* sp.) flying to the southwest in the pelagic zone southwest of Novaja Zemlja (Fig. 25). One flock of 45 barnacle geese (*Branta leucopsis*) was observed flying south in the same region, but closer to shore. Two groups of three whooper swans (*Cygnus cygnus)* were also observed flying to the south toward the Russian mainland coast.

Shorebirds in the Barents Sea

Shorebirds were relatively rare on our survey of the eastern Barents Sea (Fig. 26, Table 1). However, we did observe small groups of shorebirds (mainly phalaropes, *Phalaropus* spp., and sandpipers, *Calidris* spp.) but only in the near-shore zone north of the Russian mainland.

Marine mammals in the Barents Sea

Marine mammals were relatively abundant in the Barents Sea (Fig. 27). We observed large groups of harp seals (*Pagophilus groenlandicus*) in the eastern Barents Sea, particularly near 76° N 45° E (Fig. 28). These groups of up to 50 individuals were apparently migrating and their orientation was to the west. We estimate the density of harp seals to be 0.1 individuals per kilometre in the pelagic regions of the Barents Sea during the time of our survey (Table 1).

Three bowhead whales (*Balaena mysticetus*) were seen in the northeastern Barents Sea; we observed one individual and two travelling together at approximately 79º 17´ N 40º 11´ E. Several minke whales (*Balaenoptera acutorostrata*) and white-beaked dolphins (*Lagenorhynchus albirostris*) were observed in the southeastern Barents Sea (Fig. 29). We observed one humpback whale (*Megaptera novaeangliae*) feeding with white-beaked dolphins at 70º 30´ N 35º 25´ E. One polar bear (*Ursus maritimus*) approached the ship during the meeting with *R/V Lance* at 80º 18´N 40º 07´E. Another bear was observed swimming near Franz Josef Land at 79º 54´ N 57º 54´E.

Foraging activity in the Barents Sea

In the eastern Barents Sea, from approximately 74° to 70° N en route to Murmansk, we encountered an area that was particularly important to foraging marine birds and mammals (Fig. 29). In this region, fulmars, pomarine skuas, kittiwakes, guillemots and puffins were relatively abundant (Figs. 4, 5, 6, 9, 15, 16, 17, 18, 22) and we observed an active foraging flock of primarily black-legged kittiwakes and pomarine skuas. Within the foraging flock, pomarine skuas were taking fish from black-legged kittiwakes as well as catching fish on the wing from the surface of the water. As the ship steamed through this foraging flock, several birds dropped fish on the deck, which allowed positive identification of the prey as polar cod (*Boreogadus saida*). The location of the foraging flock roughly coincided with the locations of several species of cetaceans and of fishing boats (Fig. 29). Here we observed several minke whales, a humpbacked whale and white-beaked dolphins that appeared to be feeding.

Marine birds in the Kara Sea

In the Kara Sea, the abundance of seabirds was very low compared to what was found in the eastern Barents Sea (Fig. 2). Northern fulmars were relatively abundant and widely distributed throughout the Kara Sea (Fig. 30). One relatively large group of 100 ship following birds was recorded near 78° N 80° E after the ship occupied a hydrographic station for approximately three hours. Fulmar abundance was greatest in the pelagic and ice-covered areas of the Kara Sea (Fig. 3, Table 1). Pomarine skuas were also relatively abundant and evenly distributed in the Kara Sea. Large groups of pomarine skuas were observed near the Yugor Shar Strait and a few birds were also observed near mouth of the Ob' Bay (Fig. 31). In the study area as a whole, the majority (53.3 %) of pomarine skua flocks were flying toward the south, southwest and west (Figs. 32 and 33) and the average flight direction of all birds was to the south (X = 178°). The highest concentration of long-tailed skuas was located in the western Kara Sea, near the Yugor Shar Strait, although some were also observed in the eastern Kara Sea (Fig. 34). The majority (32.9 %) of long-tailed skuas observed during the cruise were flying to the west (Figs. 35 and 36) and the average flight direction of all birds was to the southwest (X = 208°). Small numbers of arctic skuas were found throughout the Kara Sea, and the highest concentrations of this species were found in the western portion (Fig. 37). 41.6 % of all arctic skuas surveyed on this cruise were flying to the east and southeast (Figs. 38 and 39) and the average flight direction of all birds was to the south (X = 146°).

Black-legged kittiwakes were one of the most abundant species in the Kara Sea (Fig. 3, Table 1) and were distributed throughout the region (Fig. 40). The highest concentrations of kittiwakes were found near the Yugor Shar Strait, in the central Kara Sea and west of Severnaja Zemlja. Kittiwakes near the Yugor Shar Strait were feeding along with fulmars and Brünnich's guillemots. Observations of surface water characteristics indicated that these birds were feeding near what appeared to be a tidal front within the Strait.

On our survey, we found low numbers of glaucous gulls in the western and central Kara Sea (Fig. 41). In contrast, herring gulls were relatively abundant in the near-shore zones in the Kara Sea (Fig. 3, Table1) and the highest concentrations of this species were found in the Ob' Bay (Fig. 42). Many of these herring gulls in the Ob' Bay were flying along with the ship while it was underway and were feeding on fish

apparently disturbed by the ship's wake. The herring gulls observed in the White Sea and in the Barents Sea off Kola Peninsula belonged to sub-species *Larus argentatus argentatus*. However, the herring gulls observed in the south-eastern Barents Sea (east of 44° E) and in the Kara Sea were primarily *L. argentatus heuglini* and evidently *L. a. taimyrensis*. These two sub-species of *L. argentatus* are occasionally treated as a separate species *L. heuglini* (Stepanyan 1990). Both sub-species of *L. argentatus* were seen together in the northernmost part of the White Sea.

Ivory gulls were observed north of 77° 30´ N (Fig. 43), although, most ivory gulls were found closely associated with sea ice near Severnaja Zemlja (Fig. 3, Table 1). A small number of Sabine's gulls (*Larus sabini*) were observed flying toward the south and southwest in the Ob' Bay (Fig. 44). We observed arctic terns throughout the Kara Sea (Fig. 45) and, as in the eastern Barents Sea, most birds appeared to be migrating toward the southwest (Fig. 46). For the entire study area, the majority (36 %) of arctic tern flocks were flying toward the west and southwest and the average flight direction of all birds was to the south (X = 178°).

We found very low abundances of Brünnich's guillemots in the Kara Sea. A few individuals were seen near the Yugor Shar Strait and in the western Kara Sea (Fig. 47). No common guillemots were observed in the Kara Sea (Table 1). Little auks were not common in the Kara Sea, however, small groups of little auks were seen in the western Kara Sea as well as on the northern transects near Severnaja Zemlja (Fig. 48). The overall abundance of little auks in the Kara Sea was very low compared to the number of birds we observed in the eastern Barents Sea (Fig. 3, Table 1). Black guillemots were found in the central and eastern Kara Sea. Although, the abundance of black guillemots in the Kara Sea was relatively low (Fig. 3, Table 1), the largest groups were encountered in the vicinity of the ice edge in the northeastern Kara Sea (Fig. 49). No puffins were observed during our survey of the Kara Sea (Table 1).

Aquatic birds in the Kara Sea

Aquatic birds were more numerous on our survey of the Kara Sea than in the Barents Sea (Fig. 2). In particular, divers (*Gavia* sp.) were abundant in the coastal regions of the western Kara Sea and in the Ob' and Jenisej estuaries (Fig. 50). The largest concentrations of divers were encountered in Baidaratskaya Bay and many of these birds were observed sitting on the water (Fig. 51). In addition, a small number of black-throated divers (*Gavia arctica*) were observed in the pelagic region of the Western Kara Sea (Figs. 50 and 51, and Table 1). The average flight direction of all divers was to the southeast (X = 162°) (Fig. 52).

Brent geese (*Branta bernicla*) were relatively abundant in the Kara Sea (Table 1) and concentrations of this species were found in the Ob' and Jenisej estuaries (Fig. 53). In addition, a large flock of geese was observed near the mouth of Ob' Bay and smaller groups were seen west of the Yamal Peninsula. The majority of geese we observed were flying to the southwest (Fig. 54). Long-tailed ducks (*Clangula hyemalis*) were abundant particularly in the Jenisej Bay (Fig. 55), while smaller numbers of this species were seen in the Ob' Bay and in the coastal zone of the western Kara Sea (Fig. 23, Table 1). Long-tailed duck flocks in the Jenisej Bay were observed flying to the east; however, those seen in the Ob' Bay were flying primarily to the west (Fig. 56).

Shore birds in the Kara Sea

Shore bird abundance was greater in the Kara Sea than in the Barents Sea, particularly in the eastern Kara Sea and in the estuaries (Fig. 2). Of the shore birds we observed, *Calidris* species (dunlin (*C. alpina*), curlew sandpiper (*C. ferruginea*), and unidentified *Calidris*) were relatively abundant in the Ob' and Jenisej Bays as well as in the coastal region of the eastern Kara Sea (Fig. 26, Table 1).

Phalaropes (*Phalaropus* spp.) were most abundant in the eastern Kara Sea (Figs. 26, Table 1). We observed concentrations of grey phalarope (*P. fulicarius*) in the northern-most portion of our survey southwest of Severnaja Zemlja (Fig. 57), whereas, red-necked phalarope (*P. lobatus*) had a more southerly distribution and was found near the mainland (Fig. 58).

Marine mammals in the Kara Sea

In general, marine mammals were less abundant in the Kara Sea than in the Barents Sea (Fig. 2), however, the most numerous marine mammal observed in the Kara Sea was the ringed seal (*Pusa hispida*) (Fig. 27, Table 1). We observed ringed seals (primarily solitary individuals) throughout the Kara Sea in both open and ice-covered water (Fig. 59). The highest concentrations of ringed seals were found in the western Kara Sea west of the Yamal Peninsula. In addition, ringed seals were observed in both Ob' and Jenisej Bays. Bearded seals (*Erignathus barbatus*) were found in ice-covered waters west of Severnaja Zemlja, in the Ob' Bay and west of Yamal Peninsula (Fig. 60). Only a few individual harp seals were observed in the western Kara Sea and none in the marginal ice zone in the northernmost part of our survey (Fig. 61).

DISCUSSION

Our pelagic and coastal survey of the Barents and Kara Seas revealed that the total abundance of seabirds and marine mammals was much greater in the Barents Sea than in the Kara Sea (Fig. 2). Bakken & Gavrilo (1995) surveyed the coastal waters of the Barents and Kara Seas and also found that marine bird densities were lower in the Kara Sea than in the Barents Sea. Decreased seabird abundance has been observed in other coastal seas in the Arctic. In pelagic waters of the Beaufort Sea, bird densities are low compared to other seas adjacent to Alaska (Divoky 1984) which may be a reflection of the low annual primary productivity (Schell et al. 1982) and the low prey densities (Horner 1981) of the Beaufort Sea. Similarly, primary production in the Kara Sea is low due to the presence of a strong halocline throughout summer which prevents transport of nutrients into the upper water column and the turbidity of the river-discharged water which restricts light penetration (Matishov et al. 1989; Vedernikov et al. 1994; Pavlov et al. 1996).

It is well known that total pelagic and benthic production are significantly lower in the Kara Sea than in the Barents Sea (Zenkevich & Filatova 1957; Fomin 1989) and that vertebrate marine predators are indirect indicators of secondary and tertiary production (see review by Hunt 1991a). Thus, our observations of decreased densities of birds and mammals in the Kara Sea are a reflection of low production of this sea. In addition, the distribution and size of seabird breeding colonies in the Barents and Kara Seas are also indicative of differences in production of these two ecosystems. Many more colonies are present in the eastern Barents Sea (on Franz Josef Land and on the western coast of Novaja

Zemlja) than in the Kara Sea. Likewise, colony sizes are an order of magnitude greater in the eastern Barents Sea than in the Kara Sea (Barents and Kara Seas colony registers, NP and AARI unpublished databases).

Within wide geographical zones of elevated productivity, higher trophic level predators are attracted to frontal regions because prey availability is often enhanced at smaller-scale physical features (e.g. Brown & Winn 1989; Podesta et al. 1993; Decker & Hunt 1996). In the western Barents Sea, the position of the Polar Front is determined by bathymetry and Mehlum et al. (1997) showed that guillemots use this spatially-fixed frontal region as a feeding site. The Polar Front also extends into the eastern Barents Sea (Loeng 1989). The position of the front in the east varies seasonally and annually and the average range of the Polar Front in the eastern Barents Sea is 35° to 45° E and 71° to 74° N (Terziev et al. 1990). We speculate that the large aggregations of feeding birds, cetaceans and fishing boats present on our survey of the eastern Barents Sea (Fig. 29) may have coincided with the position of the Polar Front. Another frontal system is present between Barents Sea water and colder, less saline Arctic water south of Franz Josef Land at approximately 78° to 79° N. This front is most pronounced at a depth of some tens of meters (Terziev et al. 1990). We observed relatively high densities of diving alcids (guillemots and little auks) south of Franz Josef Land (Fig. 15, 16, 19, 20) that may have been associated with this sub-surface front. Other surveys of the same region from Murmansk to Franz Josef Land in August, 1993 (Iliszko 1995) have also identified these two general areas as important regions for fulmars, kittiwakes, guillemots and little auks. Therefore, we conclude that oceanographic fronts appear to be important feeding sites in the eastern Barents Sea.

In contrast, hydrographic features in Kara Sea are apparently not important sites of energy transfer to higher trophic level predators. River plume fronts are present at the interface between the outflow of the Ob' and Jenisej Rivers and the adjacent Kara Sea waters, however, they are subject to great seasonal and interannual variability (Pavlov et al. 1996). In other areas, river plume fronts have primary production rates greater than adjacent non-frontal areas (Owen 1968). High phytoplankton biomass at estuarine fronts can support enhanced secondary production (Grimes & Finucane 1991; Kingsford & Suthers 1994) which can in turn attract larger predators (Pearcy 1973). Although we hypothesized that predators feed near the estuarine fronts of the Ob' and Jenisej Rivers, we did not observe any obvious patterns in the distribution of seabirds and marine mammals that may have been associated with Ob' and Jenisej outflow. However, tidally-generated processes within narrow straits (specifically on the eastern sides of Kara and Yugor Shar straits) appear to be important to foraging birds in the Kara Sea.

Sea ice is also a feature that influences the distribution and abundance of marine birds in arctic seas (see reviews by Hunt 1991b; Hunt et al. 1996). The marginal ice zone along with associated fronts are areas that often support elevated seabird biomass. During our survey, we encountered the marginal ice zone at approximately 80° N and fulmars, kittiwakes, ivory gulls, phalaropes as well as seals were relatively numerous in these ice-covered areas of the Kara Sea (Fig. 2).

Colonial seabirds depend upon highly aggregated prey such as schooling fishes and densely distributed pelagic invertebrates. Distribution and abundance of prey species were not collected during our survey and the fishes of the Kara Sea have not been as extensively studied previously. Being found much less productive as

compared to the Barents Sea, the Kara Sea and its open zone in particular has been called 'fishless' by Zenkevich & Filatova (1957). Here, we summarize what is currently known about the distribution of fishes in the Kara Sea as reported by Neelov & Chernova (1997) and Antonov & Chernova (1989).

The distribution patterns of fishes in the Kara Sea are typical of coastal arctic seas that are regularly covered by sea ice. Sympagic (under-ice) species such as polar cod are very numerous and found in both coastal and pelagic habitats in the study area. Other sympagic fishes found in the Kara Sea are *Liparis fabricii* (common throughout), *Arctogadus borisovi* (less common and inhabit coastal waters east of Jenisej Bay), and *Eleginus navaga* (rare, but found west of Ob' Bay). Adult *Triglopsis quadricornus* are common and very numerous in coastal waters, bays and brackish habitats. Juvenile *T. quadricornus* are pelagic and are known to be an important prey item of predatory fishes and may also be prey of marine birds and mammals in the Kara Sea. Capelin (*Mallotus villosus*), herring (*Clupea harengus*) and sandeel (*Ammodytes marinus*) migrate into the Kara Sea from the Barents Sea with the warm water currents that pass through the Kara Gate Strait, the Yugor Shar Strait, Matochkin Shar Strait. Occasionally, these species of fish move into the Kara Sea with the Novaja Zemlja Current as it passes Cape Zhelania at the northern end of Novaja Zemlja. Although these species are important prey items in other arctic seas, they are generally not considered important prey species in the Kara Sea, due to the limited penetration of Barents Sea water into the Kara Sea. We require more information on the distribution and abundance of prey if we are to understand how energy is transferred to higher trophic levels in the Kara Sea.

Sympagic fauna is an important link in the food web in northern ice-covered oceans (Gulliksen & Lønne 1989). Young age classes of Polar Cod are important prey of many marine predators in arctic seas (Klumov 1937; Mehlum & Gabrielsen 1993). These fishes feed on sympagic organsims (Gulliksen & Lønne 1989) and are often found in leads and cavities under the ice (Lønne & Gulliksen 1989). As the ice melts, polar cod move into deeper water (Klumov 1937; Ponomarenko 1968) and large aggregations of cod are found within the melt zone (Butorin 1965). We conclude that polar cod is most likely the predominant prey item of marine predators in the Kara Sea.

Sea ice is usually present over much of the Kara Sea during summer. In 1995, sea ice coverage was abnormally low and was the lightest on record since 1940 (data from Centre of Ice and Hydrometeorological Information, Dept. of Long-term Ice Regime and Forecasts, AARI). Since the spatial-temporal distribution of polar cod is strongly affected by sea ice conditions, we would expect to find a greater abundance of marine birds and mammals throughout the Kara Sea during years of increased sea ice coverage. However, in years of very heavy or extensive ice cover, sympagic fauna may be less accessible to feeding birds.

Although the pelagic region of the Kara Sea appears to be unimportant to foraging marine birds and mammals relative to the Barents Sea, the estuaries adjacent to the Kara Sea may be important regions of energy transfer to higher trophic levels. Juvenile whitefish (Coregonidae) use estuaries as nursery areas (Moskalenko 1958; Pirozhnikov 1974). These young fish are very numerous in the Ob' and Jenisej Bays and may be an important prey for piscivorous birds that feed in these estuaries. While in the estuaries, we observed large numbers of herring gulls foraging in the ship's wake. These gulls appeared to be feeding on young whitefish.

In contrast to the low abundance of seabirds and marine mammals found east of Novaja Zemlja, aquatic birds and shorebirds were relatively abundant on our surveys of the Kara Sea and the Ob' and Jenisej estuaries (Fig. 2). Hundreds of thousands of aquatic birds and shore birds breed on the tundra in the surrounding area (Danilov et al. 1984; Mineev 1987, 1994; Estafyev 1991; Rogacheva 1992; Rogacheva et al. 1995). Not only does the Kara Sea provide feeding sites to resident aquatic birds such as divers, but many shore birds migrate from their breeding sites through the Kara Sea and adjacent estuaries at the end of summer. Based on our at sea observations, the Kara Sea, along with its associated bays is an important flyway for migratory birds in the Arctic.

In summary, we observed much greater numbers of seabirds in pelagic regions of the Barents Sea than in pelagic waters of the Kara Sea. Elevated bird abundance appeared to be associated with frontal systems including the Polar Front in the Barents Sea, a tidal front in the Kara Sea and marginal ice-edge fronts in both the Kara and Barents Seas.

ACKNOWLEDGMENTS

We are grateful to Captain Alexander Zhirnov and the crew of *R/V Ivan Kireev* for their support and hospitality. The following scientists from the Arctic and Antarctic Research Institute, St. Petersburg, Russia, provided knowledge in their areas of expertise: Dr. Alexander Egorov (sea ice), Dr. Vladimir Ivanov (river discharge), and Dr. Alexander Korzhikov (climate). Dr. Aleksey Neelov from the Zoological Institute of the Russian Academy of Science, St. Petersburg, Russia, kindly contributed information on fishes of the Kara Sea.

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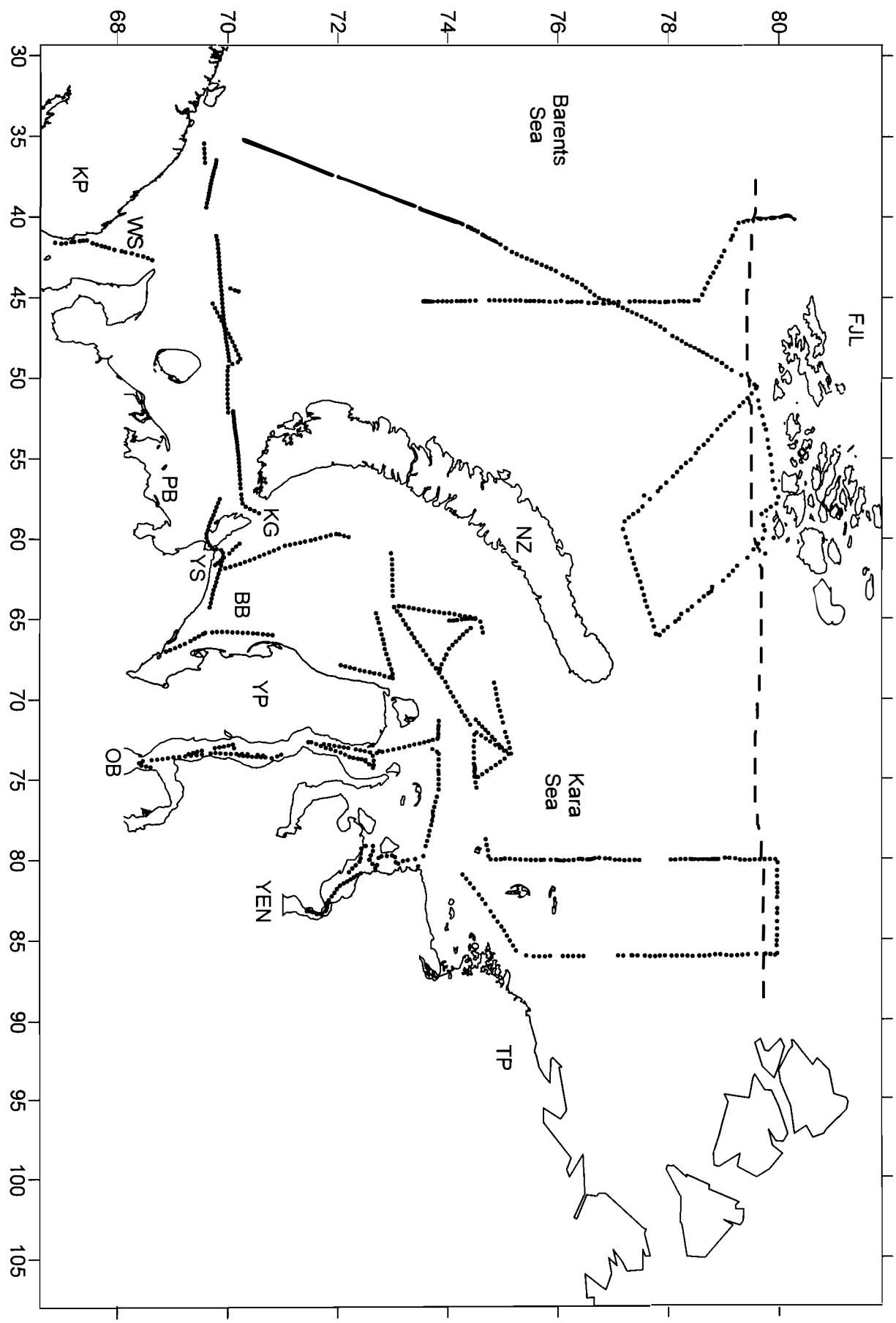
Table 1. *Abundance of animals (inv. km^{-1}) in the different regions in the eastern Barents and Kara* Sea, where BCOA = coastal Barents Sea, BPEL = pelagic Barents Sea, FJL = coastal Franz Josef Land, ICEB = ice-covered regions of the Barents Sea, WKCOA = coastal western Kara Sea, WKPEL = western pelagic Kara Sea, EKCOA = eastern coastal Kara Sea, EKPEL = eastern coastal Kara Sea, ICEK = ice-covered regions of the Kara Sea, OB' = Ob' Bay and River, YEN = Jenisej Bay and River. See text for the geographical definitions of these regions.

Species	BCOA	BPEL	FJL	ICEB	WKCOA	WKPEL	EKCOA	EKPEL	ICEK	OB'	YEN
Distance surveyed (km)	717	2879	327	58	826	998	487	1560	133	825	526
Seabirds											
Alle alle	0.0	0.9364	0.4647	0.9817	0.0012	0.0180	0.0000	0.0013	0.0000	0.0	0.0
Alca torda	0.0	0.0010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cepphus grylle	0.0	0.0024	0.0397	0.1550	0.0	0.0070	0.0	0.0647	0.0375	0.0	0.0
Fratercula arctica	0.0042	0.0834	0.0031	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fulmarus glacialis	0.1561	0.6203	0.1834	0.2411	0.0169	0.0662	0.0021	0.1295	0.1799	0.0	0.0
Larus argentatus	0.0767	0.0021	0.0	0.0	0.1028	0.0030	0.0924	0.0109	0.0	0.4362	0.1501
Larus hyperboreus	0.0195	0.0083	0.0122	0.0	0.0557	0.0211	0.0226	0.0051	0.0	0.0	0.0
Larus marinus	0.0056	0.0014	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Larus sabini	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0073	0.0
Pagophila eburnea	0.0	0.0	0.0183	0.0	0.0	0.0	0.0	0.0045	0.2623	0.0	0.0
Rissa tridactyla	0.2397	0.3775	0.4066	1.0333	0.1452	0.0421	0.0144	0.0487	0.2398	0.0048	0.0
Sterna paradisaea	0.0084	0.0229	0.0489	1.2056	0.0206	0.0221	0.0	0.0199	0.0	0.0	0.0
Stercorarius sp.	0.0028	0.0174	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0012	0.0
Stercorarius longicaudus	0.0056	0.0695	0.0061	0.0344	0.0290	0.0120	0.0041	0.0058	0.0	0.0012	0.0019
Stercorarius parasiticus	0.0125	0.0063	0.0	0.0344	0.0218	0.0130	0.0	0.0038	0.0150	0.0012	0.0
Stercorarius pomarinus	0.2105	0.1757	0.0887	0.2067	0.1694	0.0381	0.0041	0.0160	0.0	0.0085	0.0
Uria aalge	0.0056	0.0229	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Uria lomvia	0.2746	0.3286	1.5104	0.0517	0.0109	0.0010	0.0	0.0	0.0	0.0	0.0
Uria sp.	0.0293	0.0479	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aquatic birds											
Anas acuta	0.0	0.0	0.0	0.0	0.0363	0.0	0.0	0.0	0.0	0.0	0.0
Anser albifrons	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0061	0.0
Anatidae undetermined	0.0	0.0	0.0	0.0	0.0073	0.0	0.0	0.0	0.0	0.0	0.0
Anser sp.	0.0209	0.0382	0.0	0.0	0.0024	0.0	0.0	0.0	0.0	0.0182	0.0912
Aythya fuligula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0019
Branta bernicla	0.0	0.0	0.0	0.0	0.0024	0.0050	0.2053	0.0	0.0	0.0230	0.0513
Branta leucopsis	0.0627	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clangula hyemalis	0.0028	0.0	0.0	0.0	0.0242	0.0030	0.0082	0.0	0.0	0.0885	0.5567
Cygnus cygnus	0.0098	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gavia arctica	0.0167	0.0	0.0	0.0	0.0835	0.0090	0.0	0.0026	0.0	0.0267	0.0152

Gavia stellata	0.0028	0.0	0.0	0.0	0.0665	0.0	0.0	0.0	0.0	0.0024	0.0076
Gavia sp.	0.0084	0.0	0.0	0.0	0.0665	0.0020	0.0103	0.0	0.0	0.0024	0.0228
Melanitta fusca	0.0	0.0	0.0	0.0	0.0073	0.0	0.0	0.0064	0.0	0.0	0.0
Melanitta nigra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0019
Mergus sp.	0.0	0.0	0.0	0.0	0.0012	0.0	0.0	0.0	0.0	0.0	0.0
Mergus serrator	0.0	0.0	0.0	0.0	0.0024	0.0	0.0	0.0	0.0	0.0	0.0
Somateria mollissima	0.0223	0.0014	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Somateria sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0095
Shorebirds											
Calidris alpina	0.0	0.0	0.0	0.0	0.0	0.0	0.0041	0.0	0.0	0.0	0.0475
Calidris ferruginea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2052
Calidris sp.	0.0139	0.0	0.0	0.0	0.0	0.0	0.0370	0.0	0.0	0.0339	0.0304
Phalaropus sp.	0.0558	0.0	0.0	0.0	0.0169	0.0	0.2484	0.0038	0.0075	0.0012	0.0
Phalaropus fulicarius	0.0	0.0	0.0	0.0	0.0	0.0	0.0082	0.1243	0.1049	0.0	0.0
Phalaropus lOb'atus	0.0042	0.0	0.0	0.0	0.0012	0.0010	0.0164	0.0064	0.0	0.0	0.0114
Pluvialis sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0036	0.0
Shorebird undetermined	0.0028	0.0	0.0	0.0	0.0	0.0020	0.0	0.0	0.0	0.0061	0.1140
Marine mammals											
Balaenoptera acutorostrata	0.0	0.0017	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Balaena mysticetus	0.0	0.0003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Delphinapterus leucas	0.0014	0.0	0.0	0.0	0.0	0.0	0.0	0.0006	0.0	0.0	0.0
Erignathus barbatus	0.0	0.0	0.0	0.0	0.0024	0.0	0.0021	0.0	0.0075	0.0024	0.0
Lagenorhynchus albirostris	0.0	0.0153	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Megaptera novaeangliae	0.0	0.0003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pagophilus groenlandicus	0.0014	0.0959	0.0061	0.0861	0.0	0.0020	0.0	0.0006	0.0	0.0	0.0
Phosid undetermined	0.0	0.0021	0.0	0.0	0.0	0.0030	0.0	0.0013	0.0075	0.0012	0.0
Pusa hispida	0.0	0.0003	0.0	0.0	0.0145	0.0241	0.0041	0.0192	0.0300	0.0158	0.0190
Ursus maritimus	0.0	0.0	0.0031	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distance surveyed (km)	717	2879	327	58	826	998	487	1560	133	825	526

Fig. 1. Map of study area indicating place names, survey coverage (dots) and approximate location of marginal ice-edge (dashed-line). Abbreviations for place names are: Franz Josef Land (FJL), Novaja Zemlja (NZ), Severnaja Zemlja (SZ), Kara Gate Strait (KG), Yugor Shar Strait (YS), Pechora Bay (PB), Baidaratskaya Bay (BB), Ob' Bay (OB'), Jenisej Bay (YEN), Kola Peninsula (KP), White Sea (WS), Yamal Peninsula (YP), and Taimyr Peninsula (TP).


Barents Sea
Kara Sea
FJL
NZ
KP
WS
PB
KG
YS
BB
YP
OB
YEN
TP
68
70
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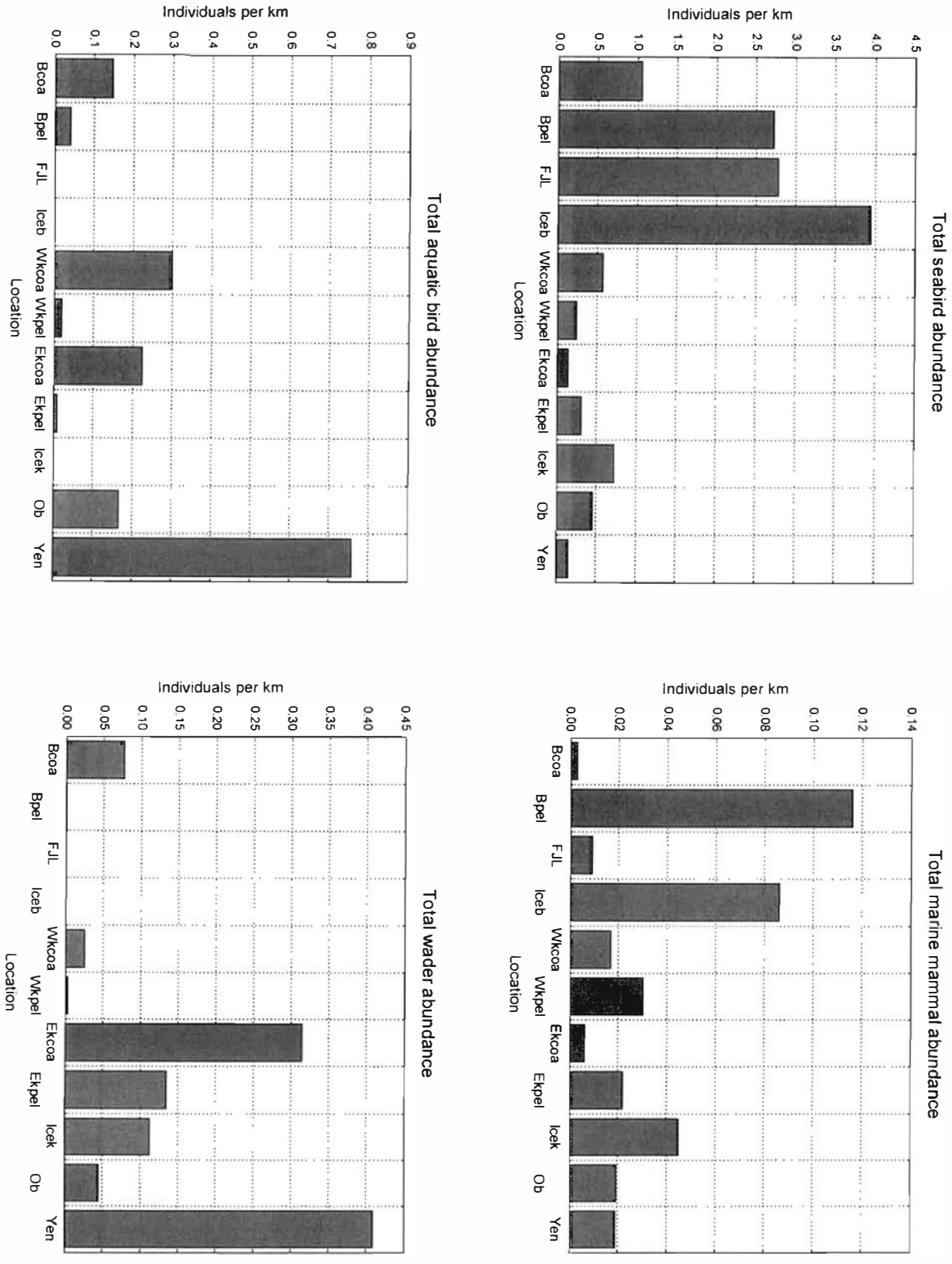


Fig. 2. Total abundance (ind. km^{-1}) of seabirds, marine mammals, aquatic birds (divers, ducks and geese) and shorebirds in the different regions in the eastern Barents and Kara Sea, where BCOA = coastal Barents Sea, BPEL = pelagic Barents Sea, FJL = coastal Franz Josef Land, ICEB = ice-covered regions of the Barents Sea, WKCOA = coastal western Kara Sea, WKPEL = western pelagic Kara Sea, EKCOA = eastern coastal Kara Sea, EKPEL = eastern coastal Kara Sea, ICEK = ice-covered regions of the Kara Sea, OB' = Ob' Bay, YEN = Jenisej Bay. See text for the geographical definitions of these regions.

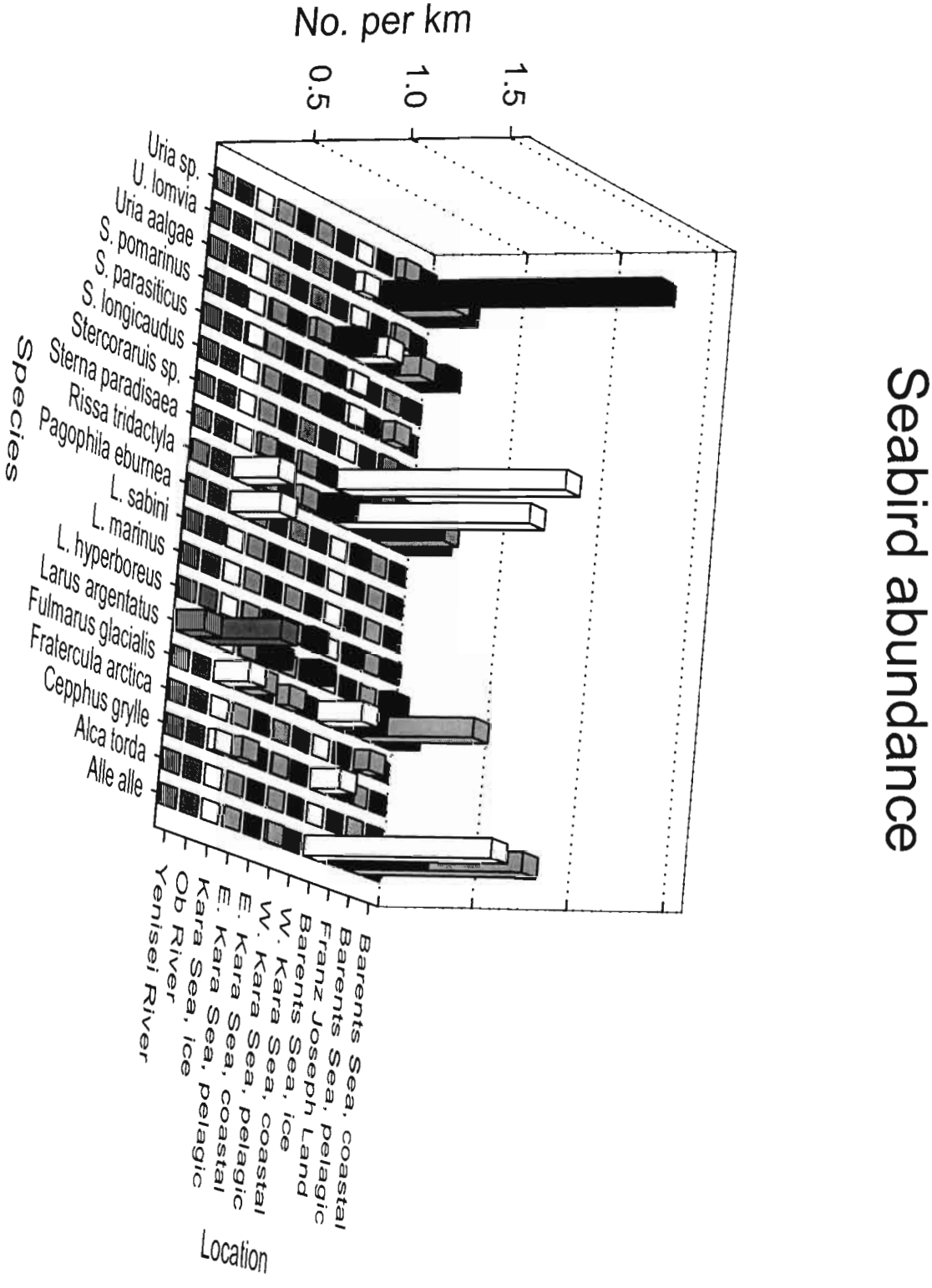
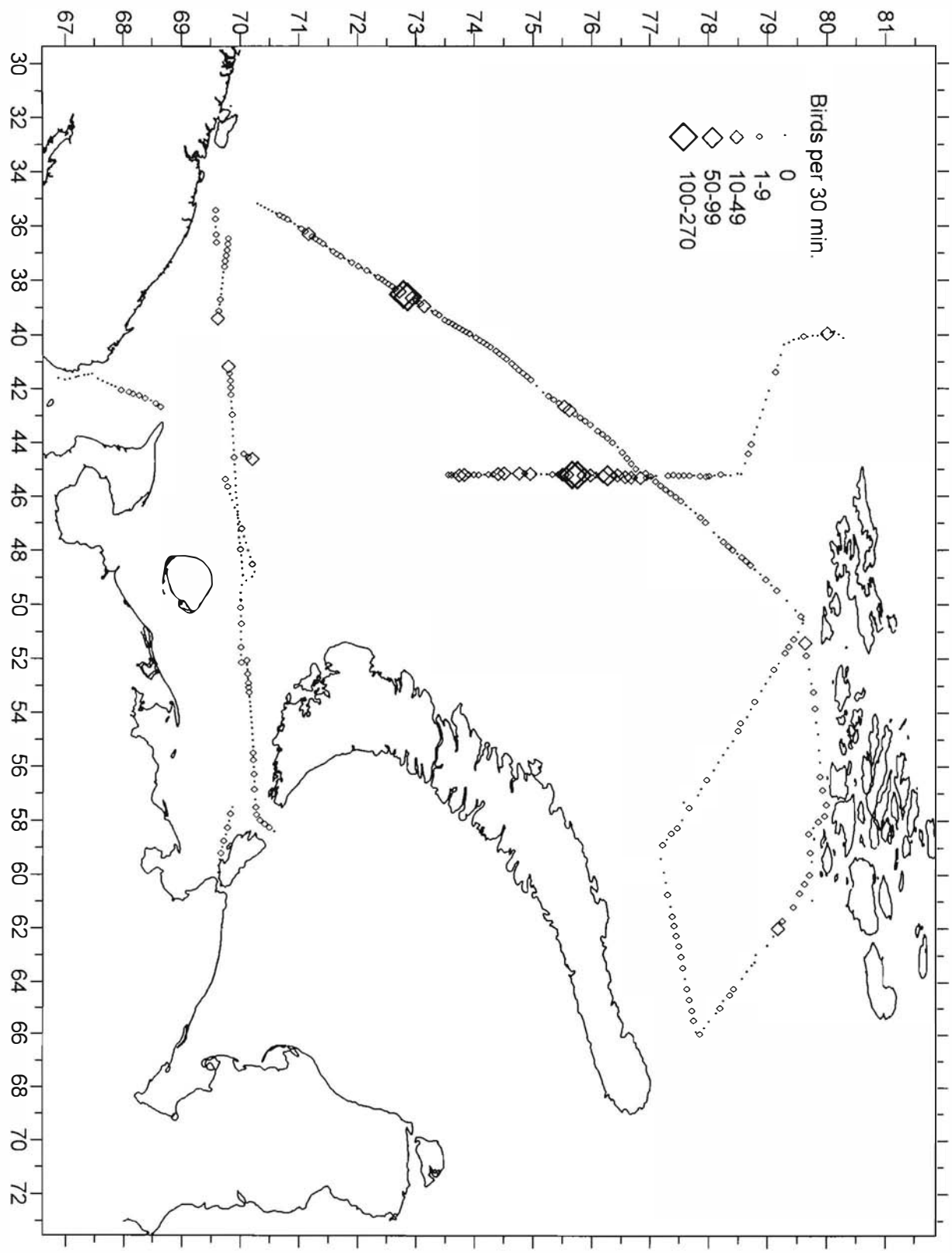


Fig. 3. Abundance (ind. km^{-1}) of selected seabird species in the different geographical regions of the study area.



Fulmarus glacialis

All behaviors

Fig. 4. Distribution of northern fulmars (*Fulmarus glacialis*) (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

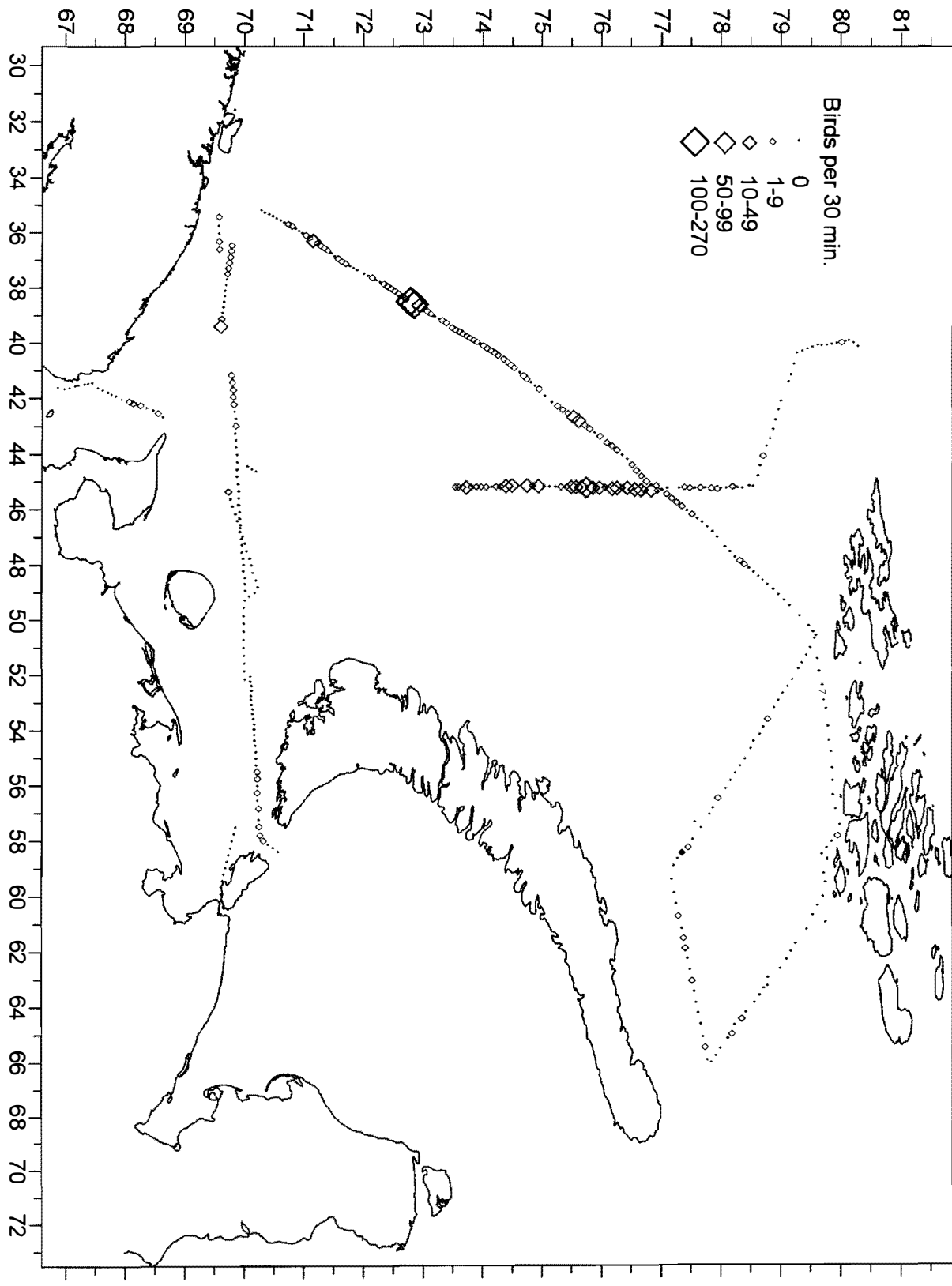


Fig. 5. Distribution of northern fulmars (*Fulmarus glacialis*) on water only (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

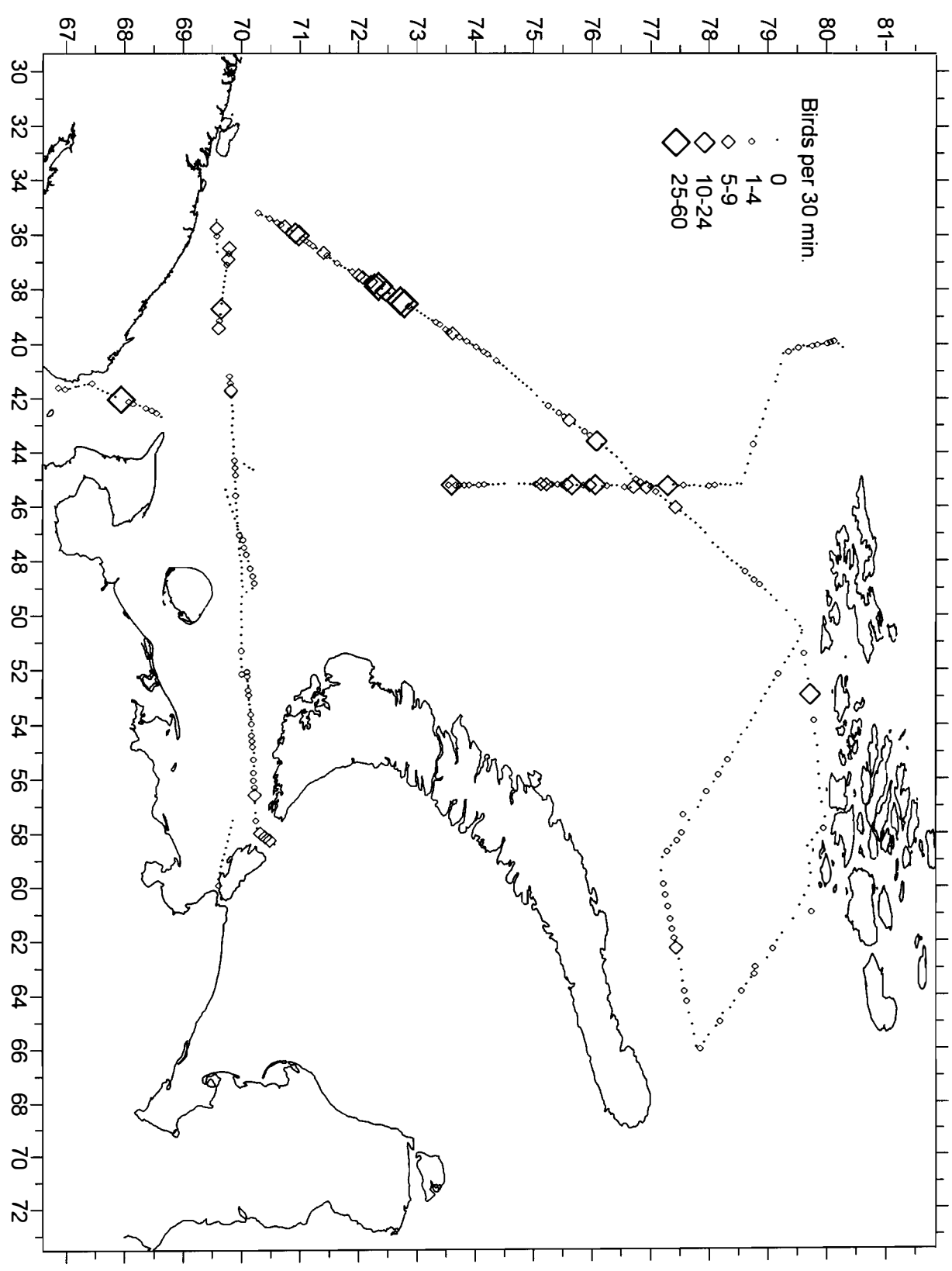


Fig. 6. Distribution of pomarine skuas (*Stercorarius pomarinus*) (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

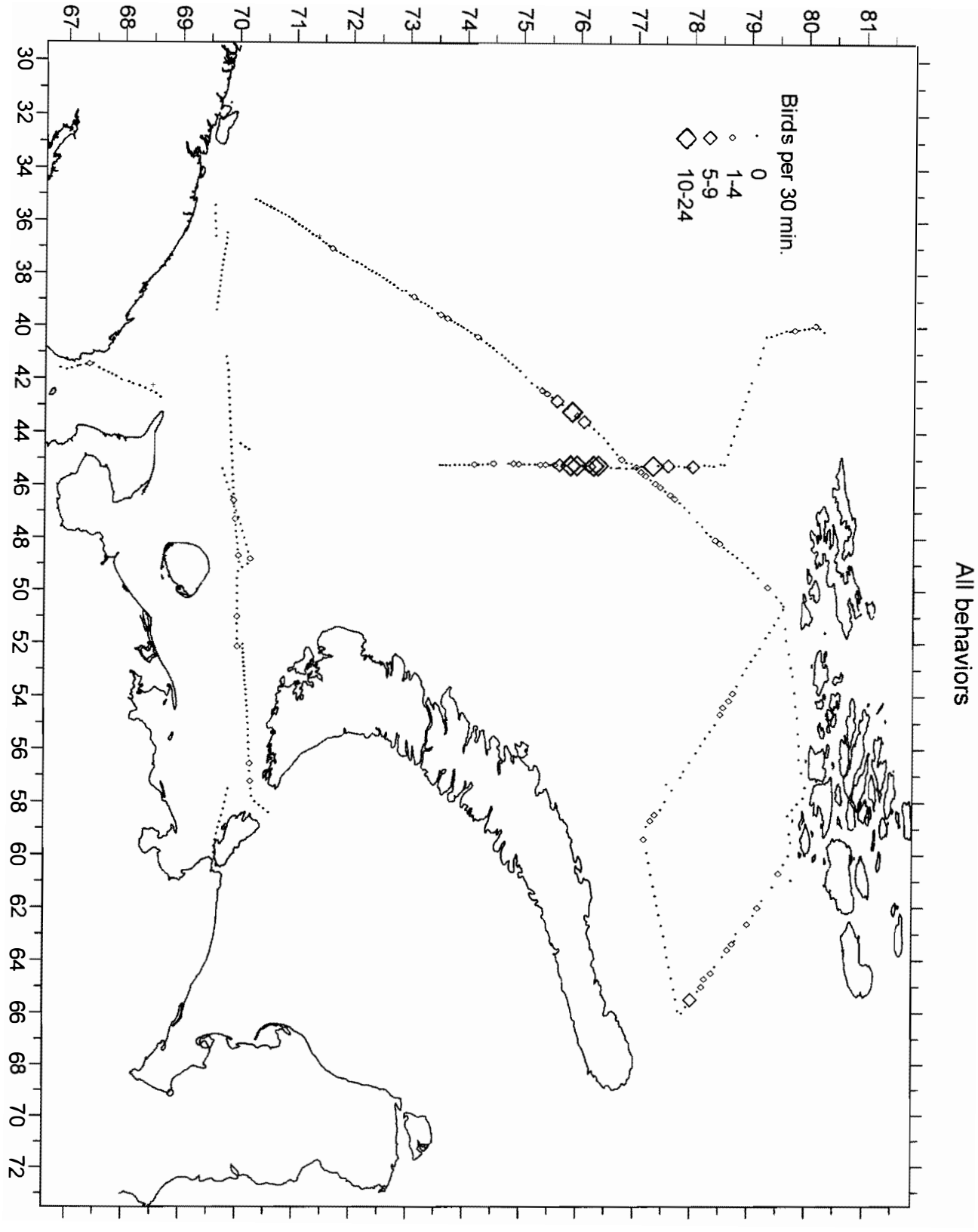


Fig. 7. Distribution of long-tailed skuas (*Stercorarius longicaudus*) (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

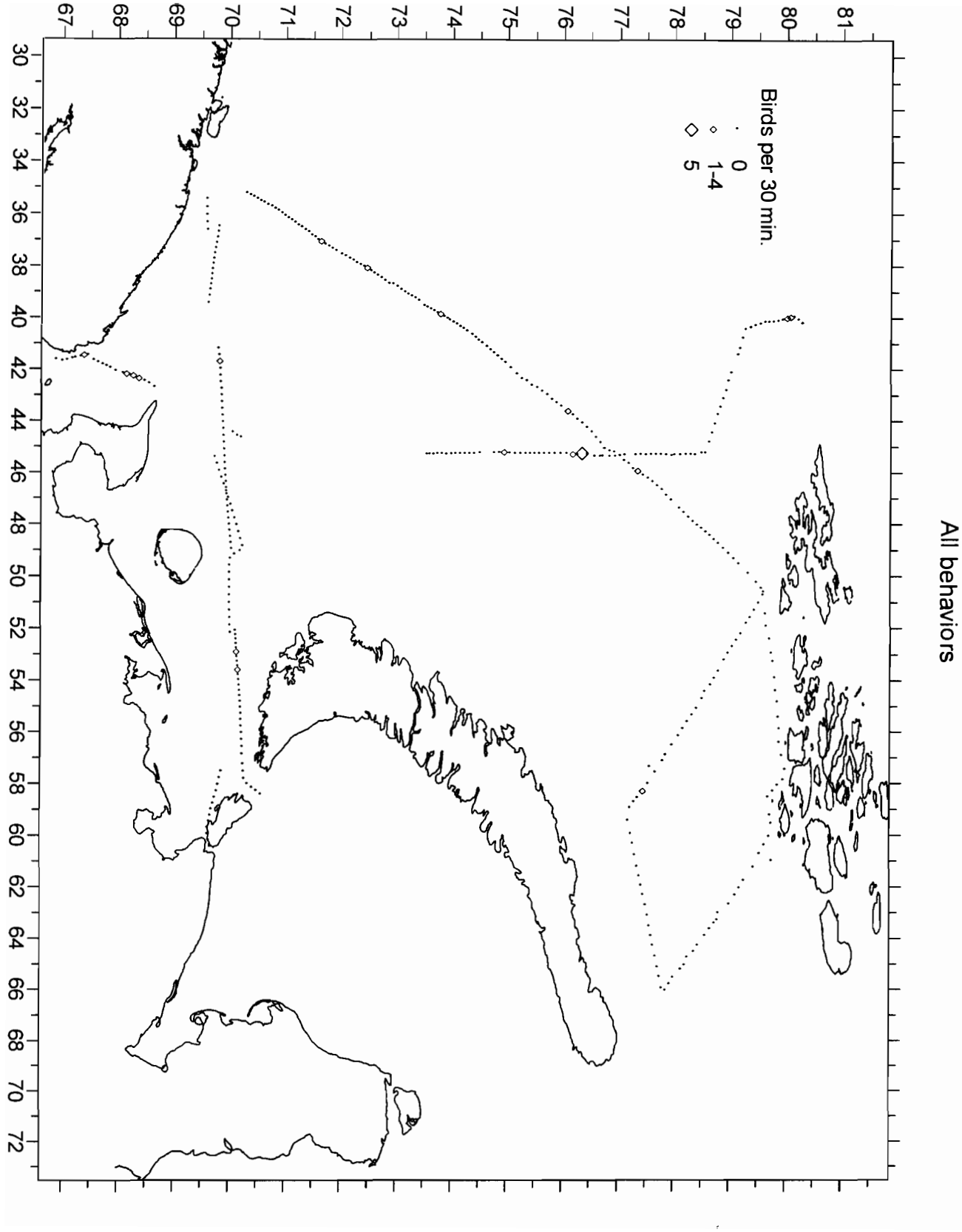


Fig. 8. Distribution of arctic skuas (*Stercorarius parasiticus)* (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

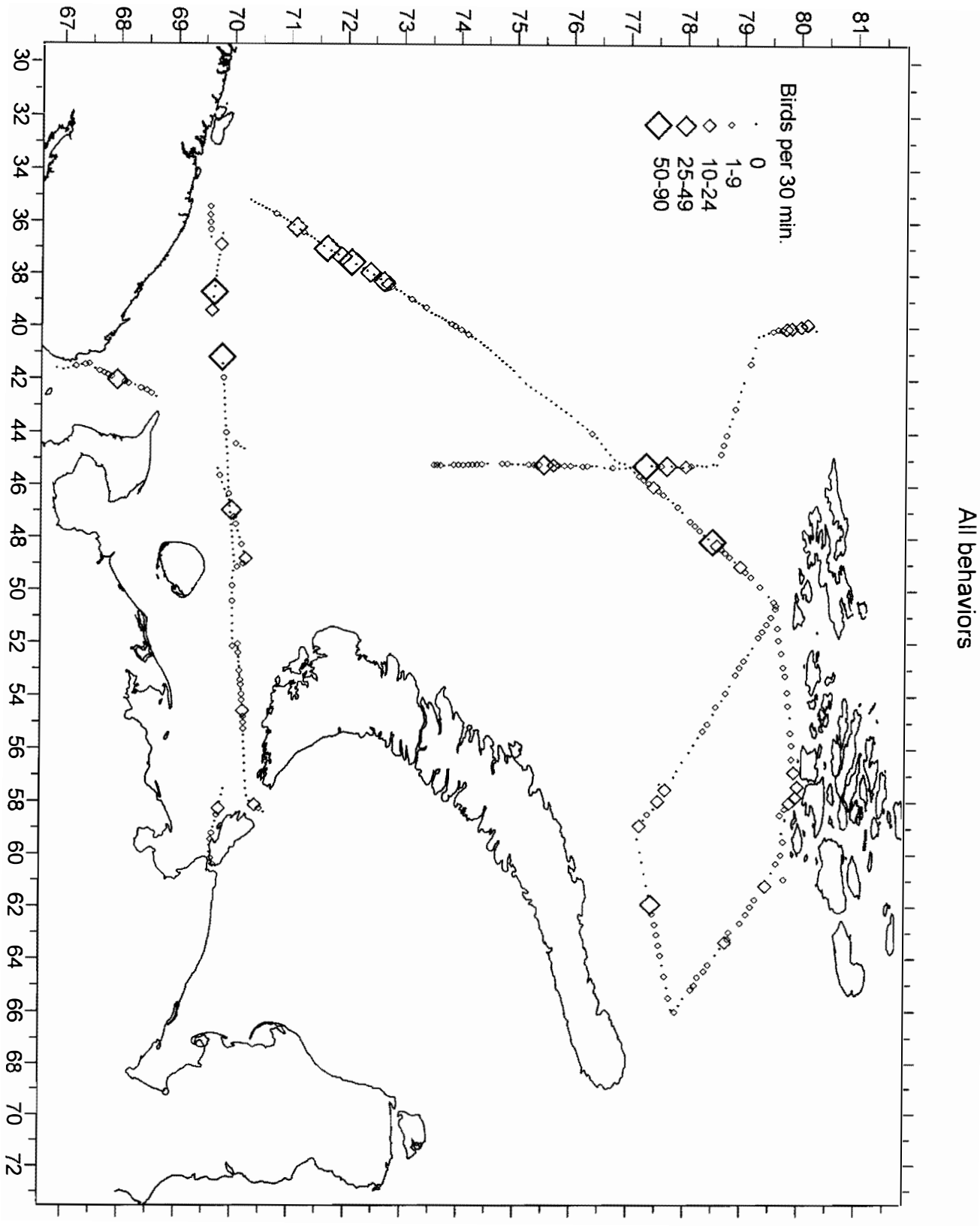


Fig. 9. Distribution of black-legged kittiwakes (*Rissa tridactyla*) (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

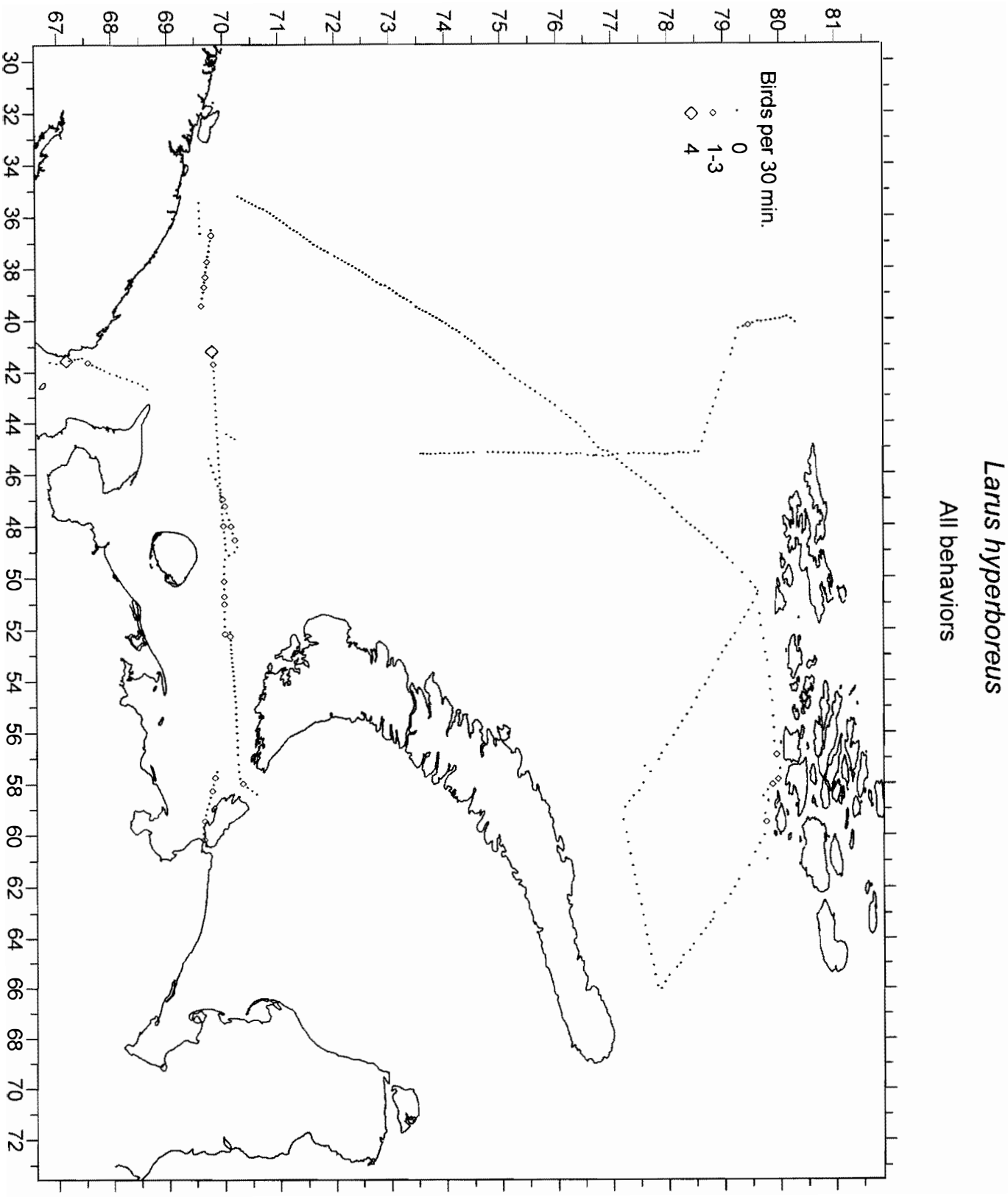


Fig. 10. Distribution of glaucous gulls (*Larus hyperboreous*) (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

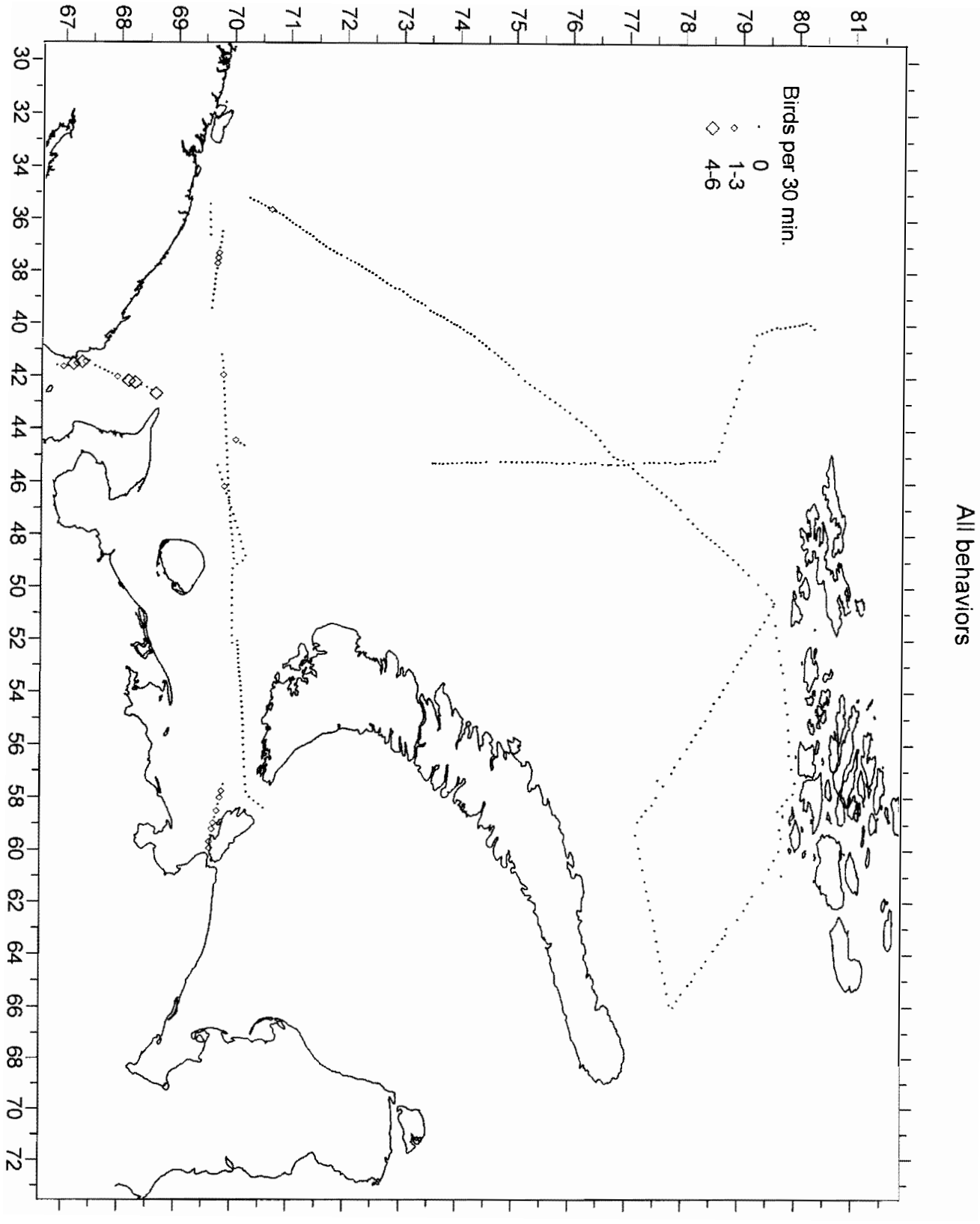


Fig. 11. Distribution of herring gulls (*Larus argentatus*) (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

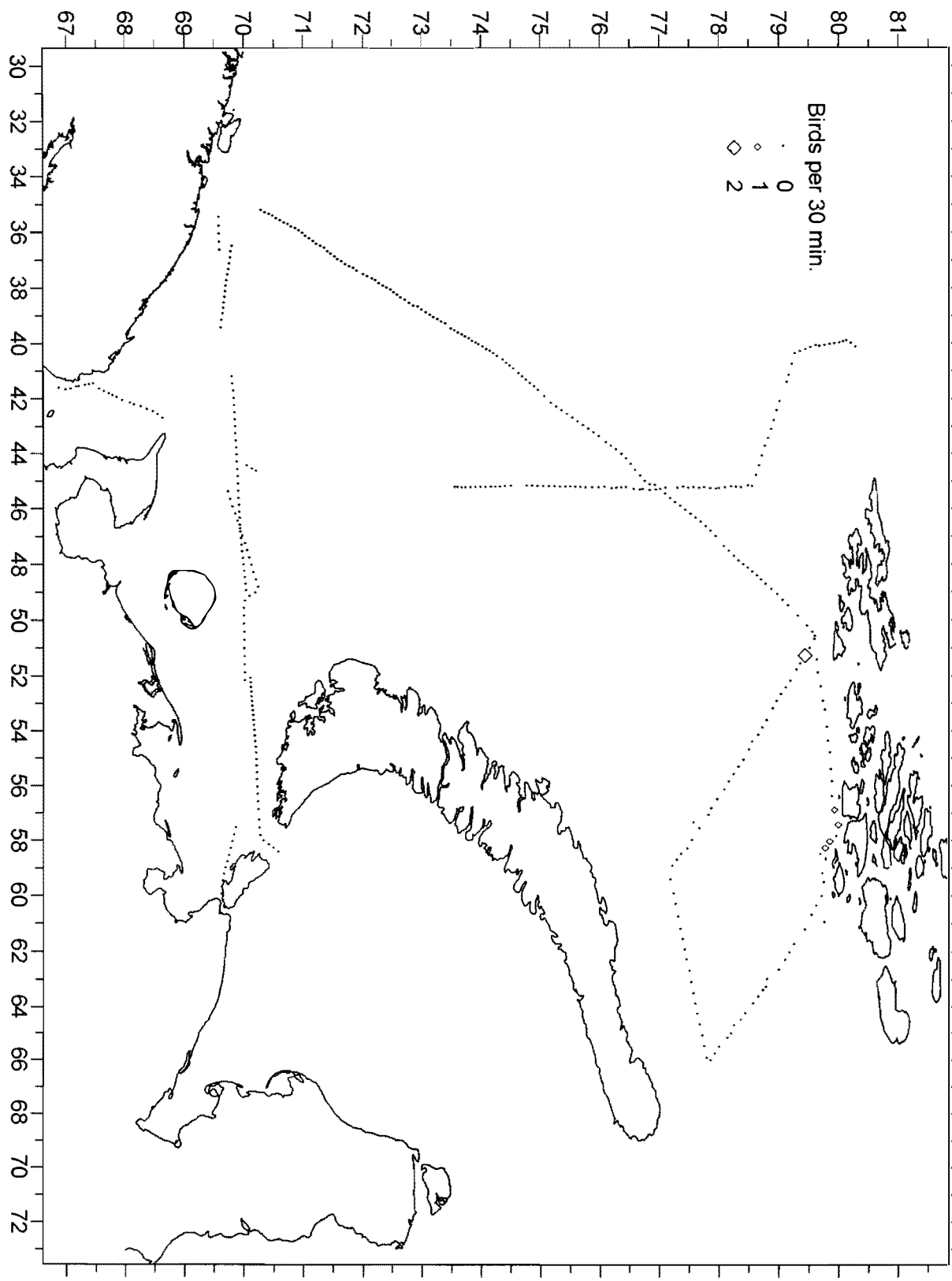


Fig. 12. Distribution of ivory gulls (*Pagophila eburnea*) (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

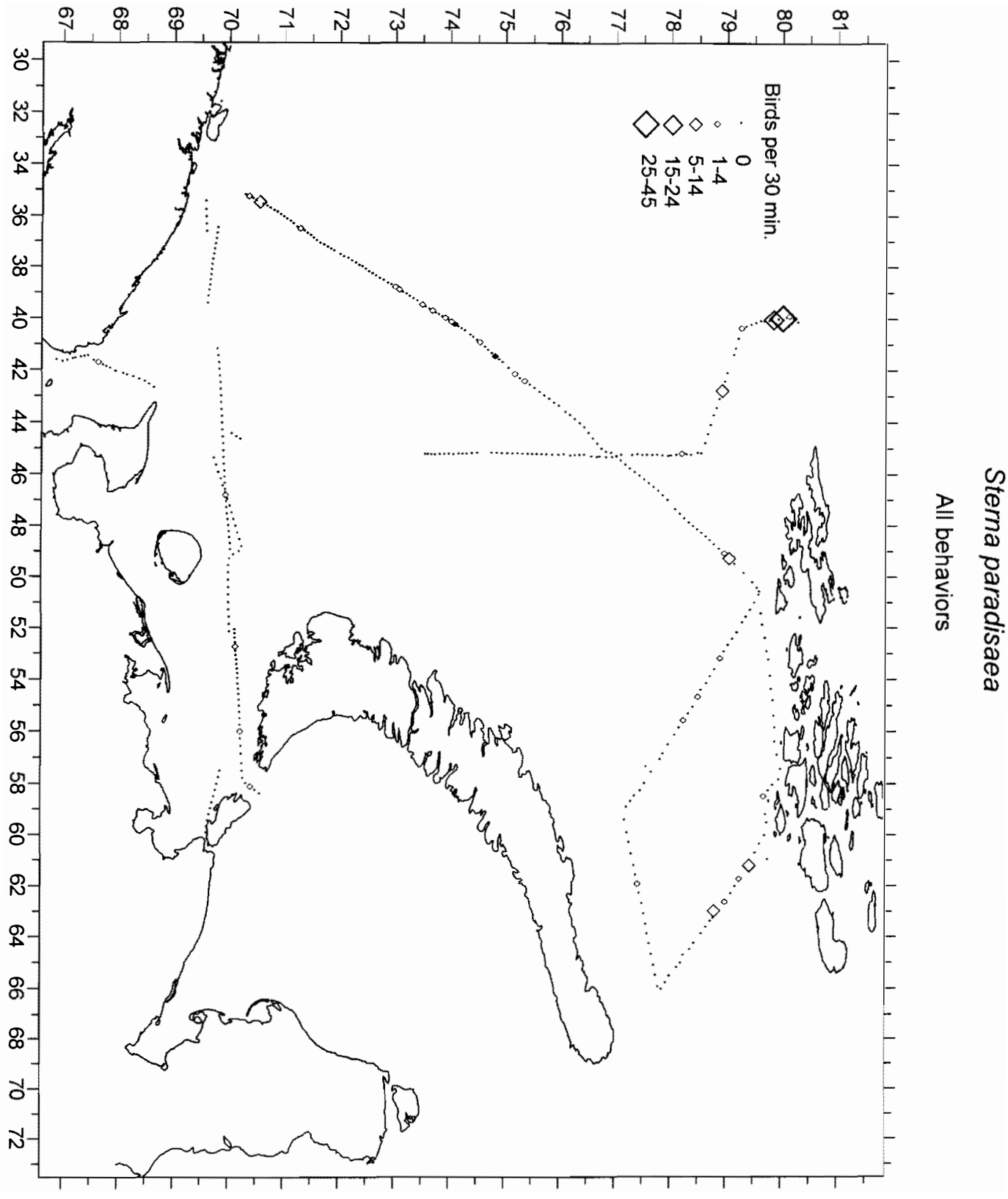


Fig. 13. Distribution of arctic terns (*Sterna paradisaea)* (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

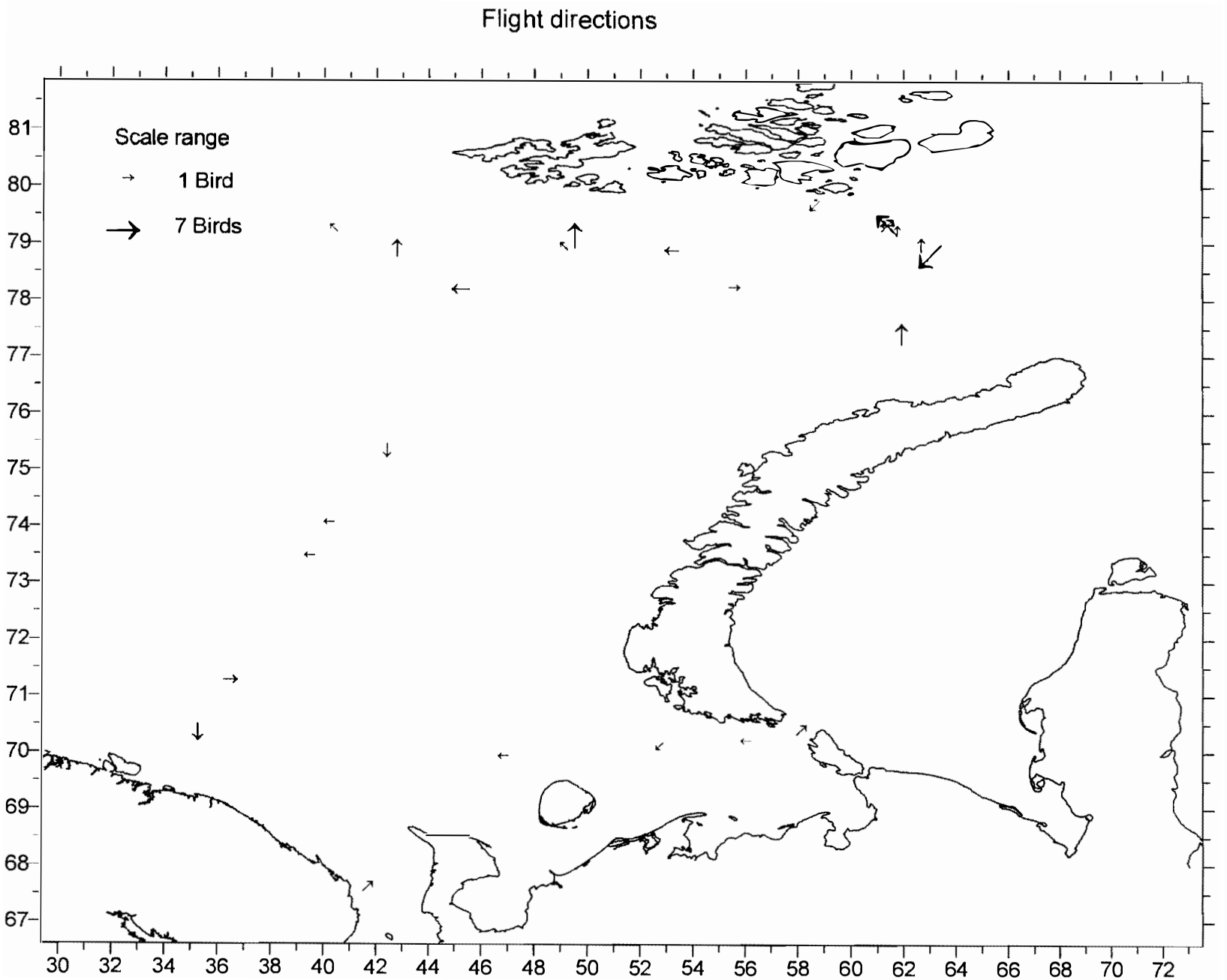


Fig. 14. Flight directions of arctic terns (*Sterna paradisaea)* (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

Uria lomvia

All behaviors

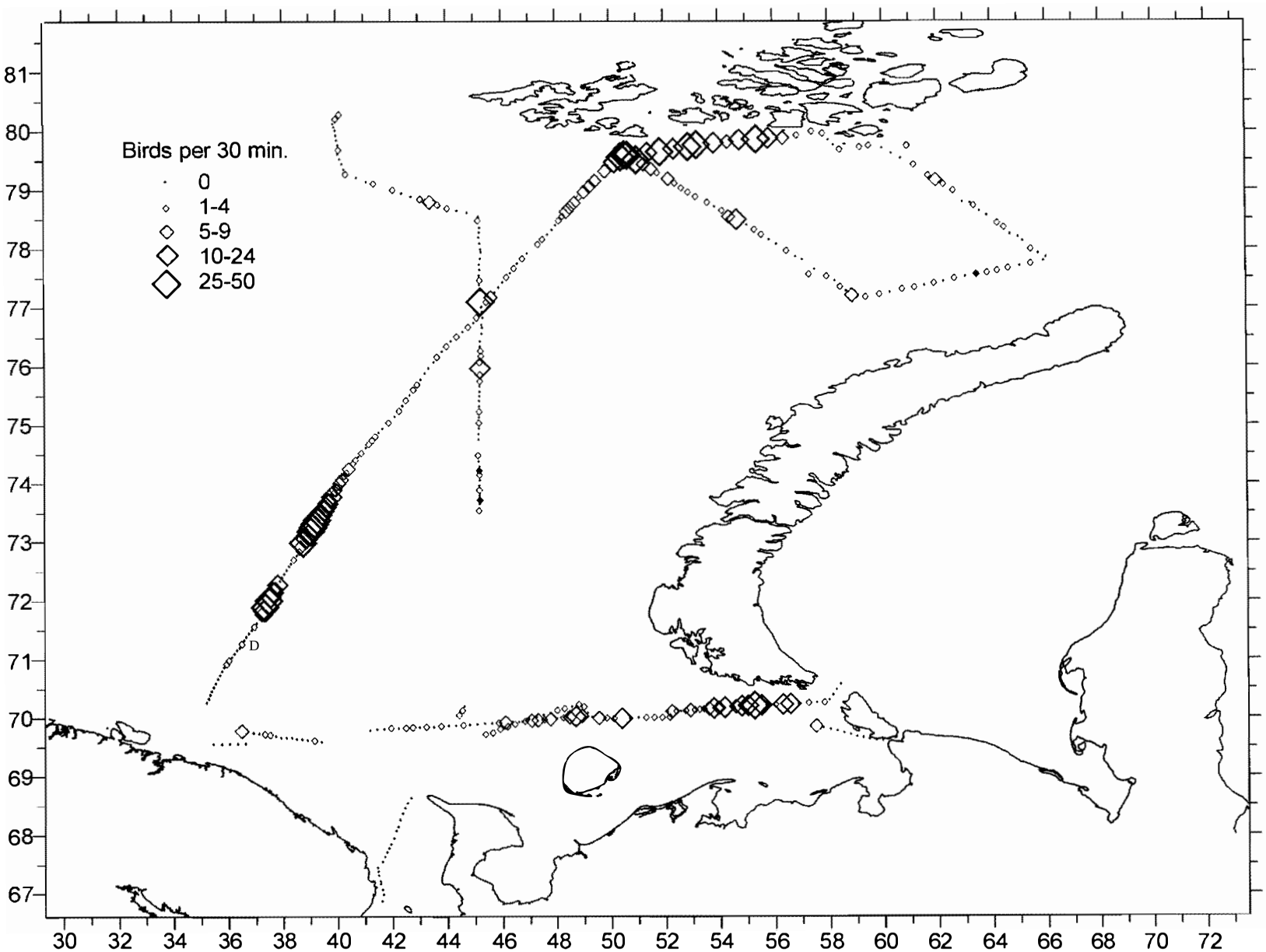


Fig. 15. Distribution of Brünnich's guillemots (*Uria lomvia)* (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

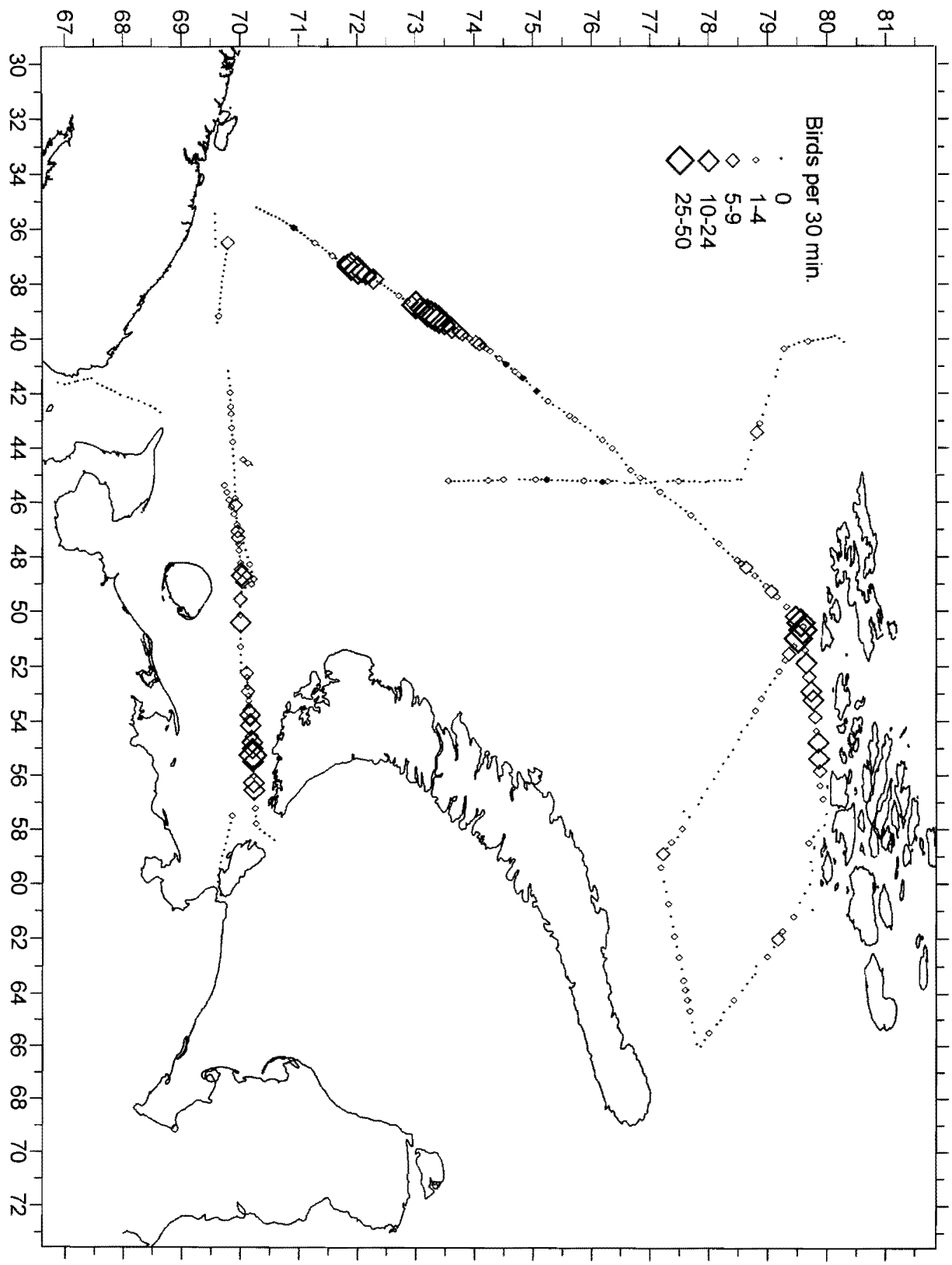


Fig. 16. Distribution of Brünnich's guillemots (*Uria lomvia*) on water only (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

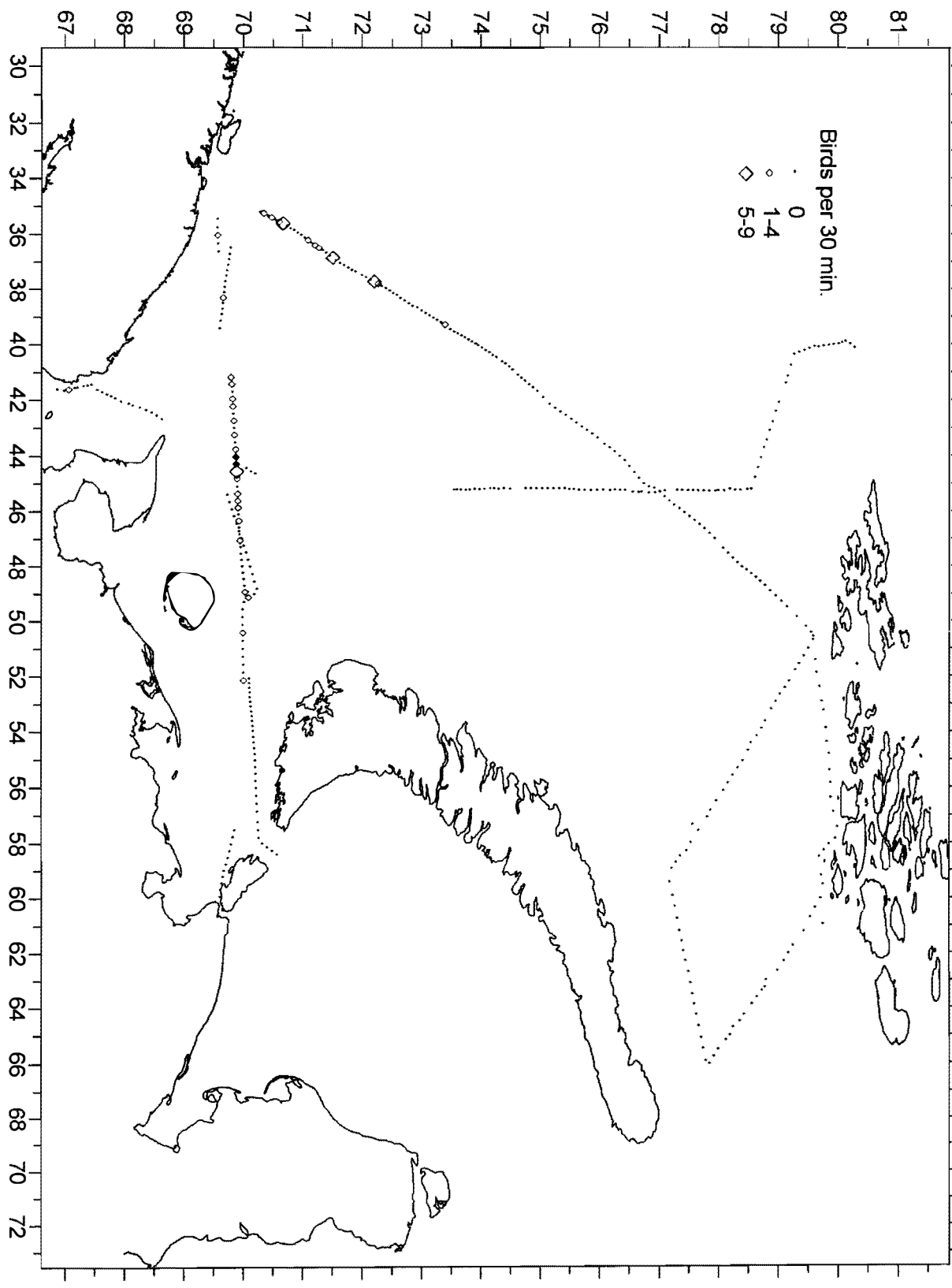


Fig. 17. Distribution of common guillemots (*Uria aalge*) (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

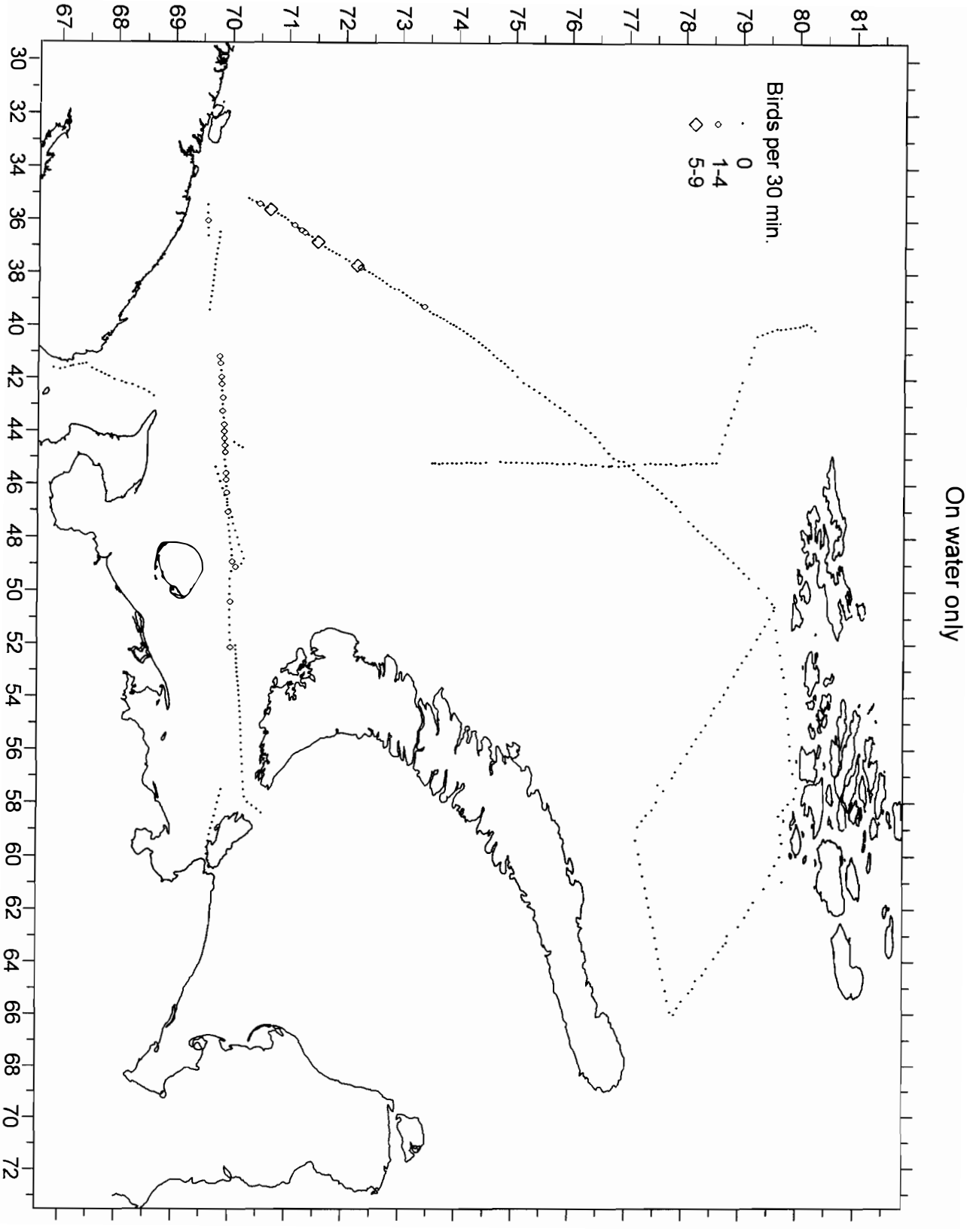


Fig. 18. Distribution of common guillemots (*Uria aalge*) on water only (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

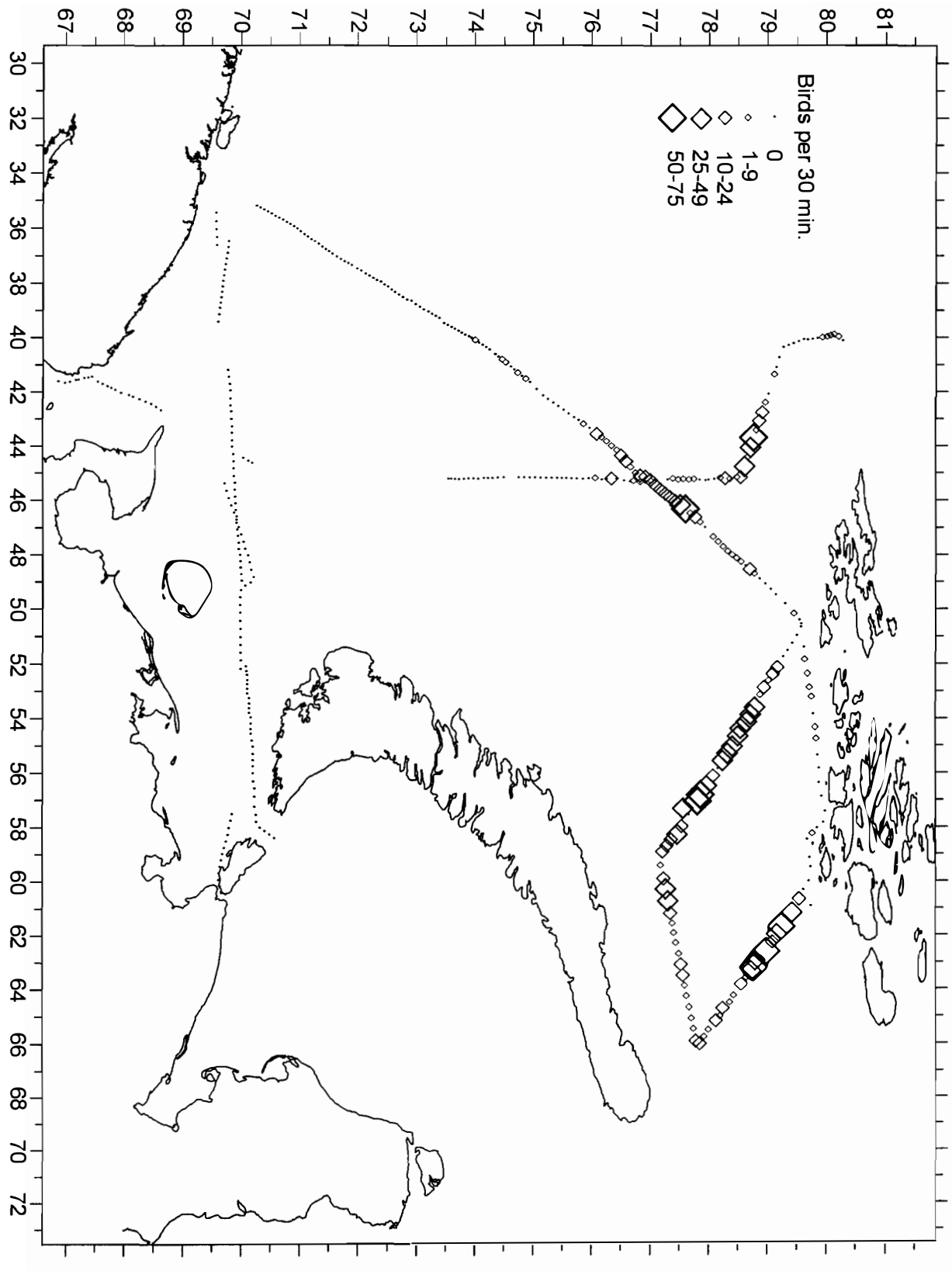


Fig. 19. Distribution of llttle auks (*Alle alle)* (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

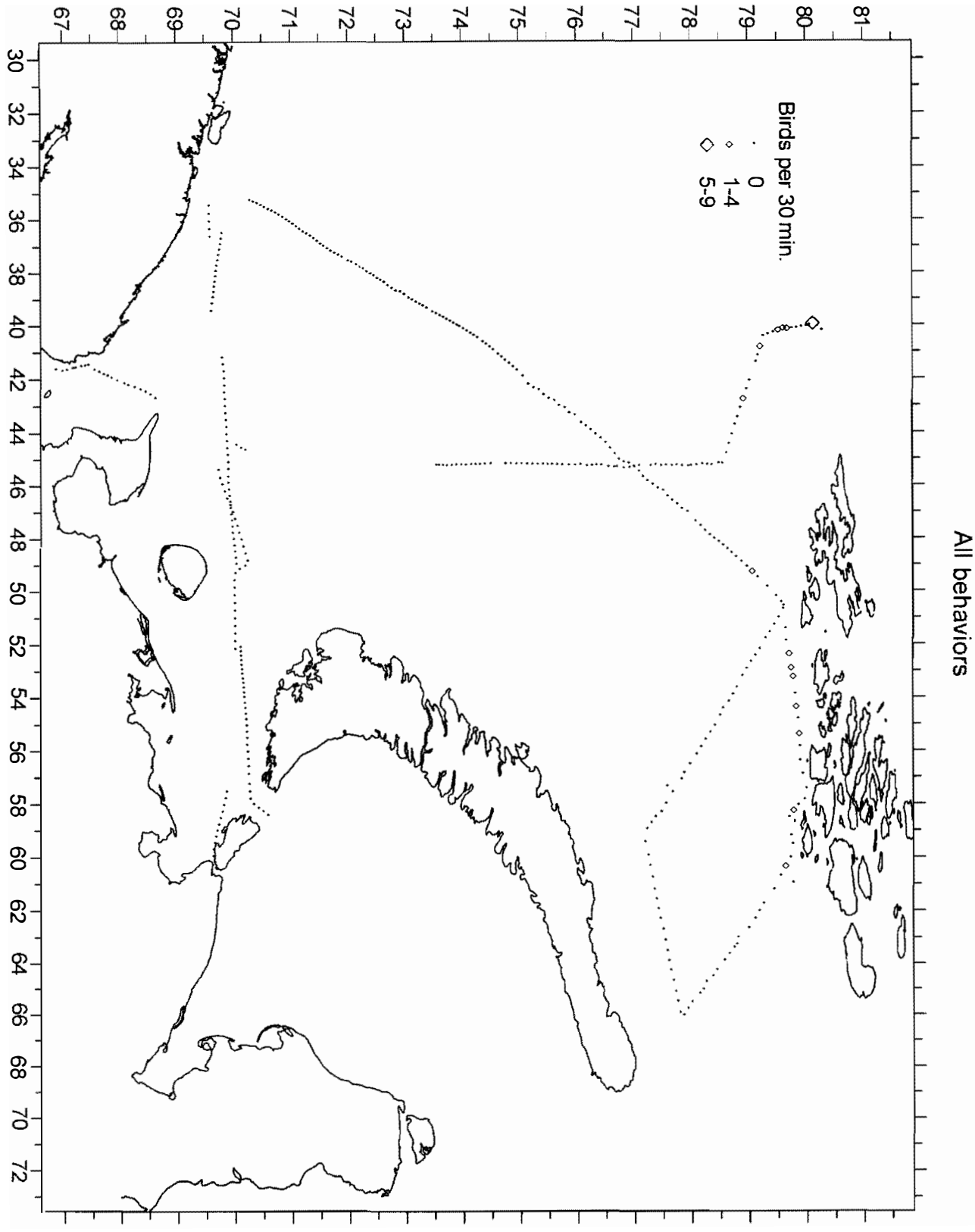


Fig. 20. Distribution of black guillemots (*Cepphus grylle*) (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

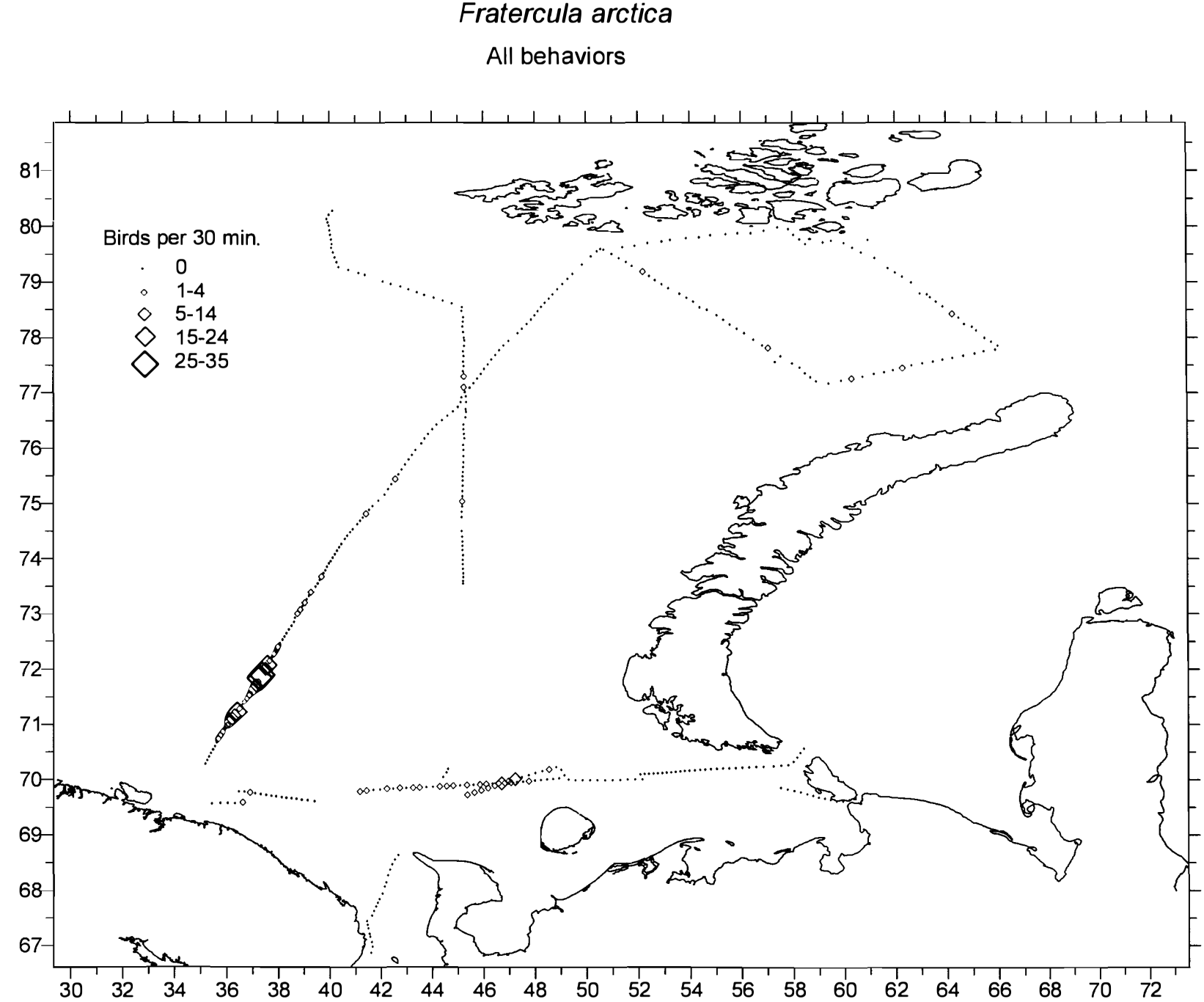


Fig. 21. Distribution of atlantic puffins (*Fratercula arctica*) (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

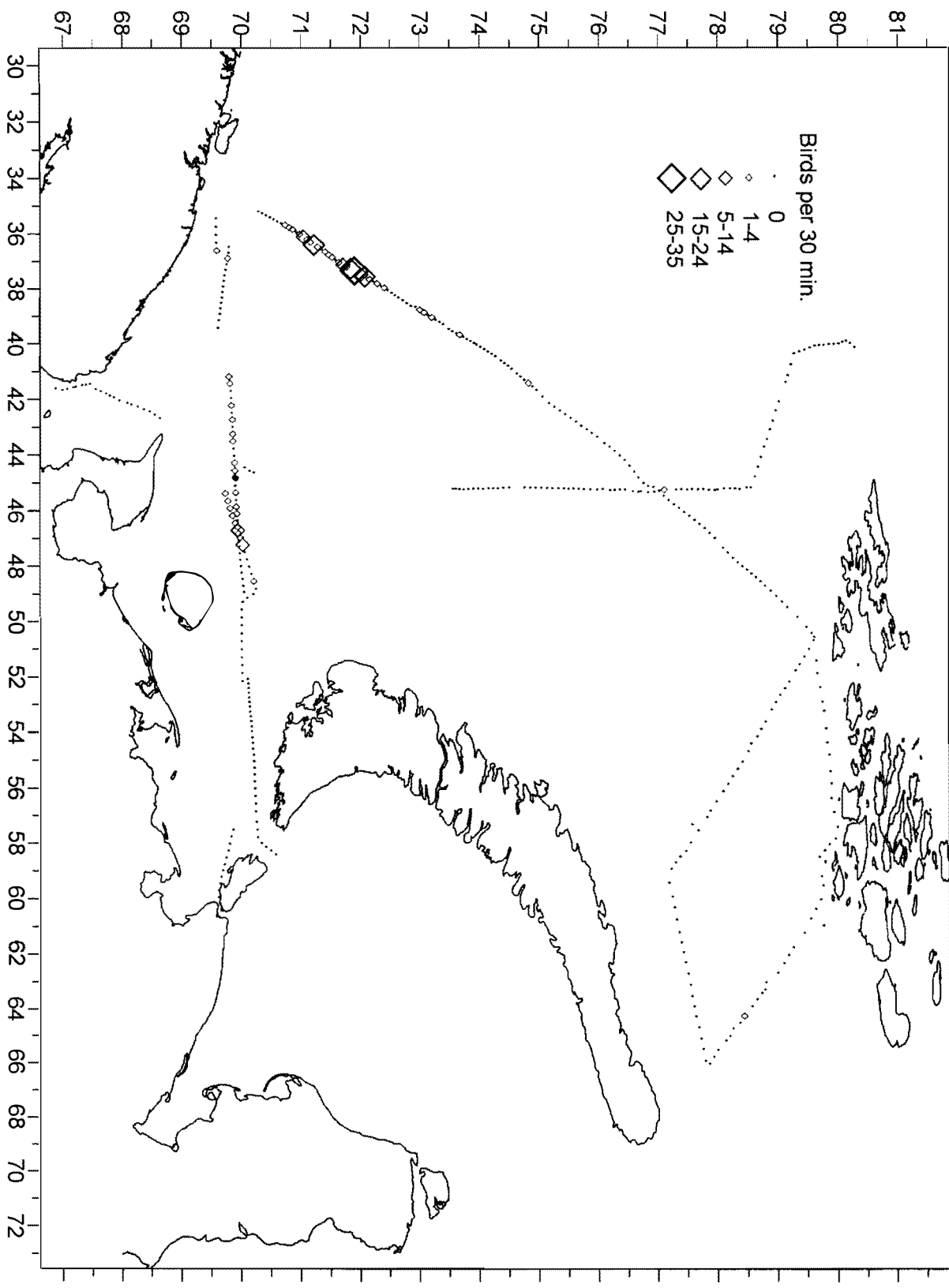


Fig. 22. Distribution of atlantic puffins (*Fratercula arctica*) on water only (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

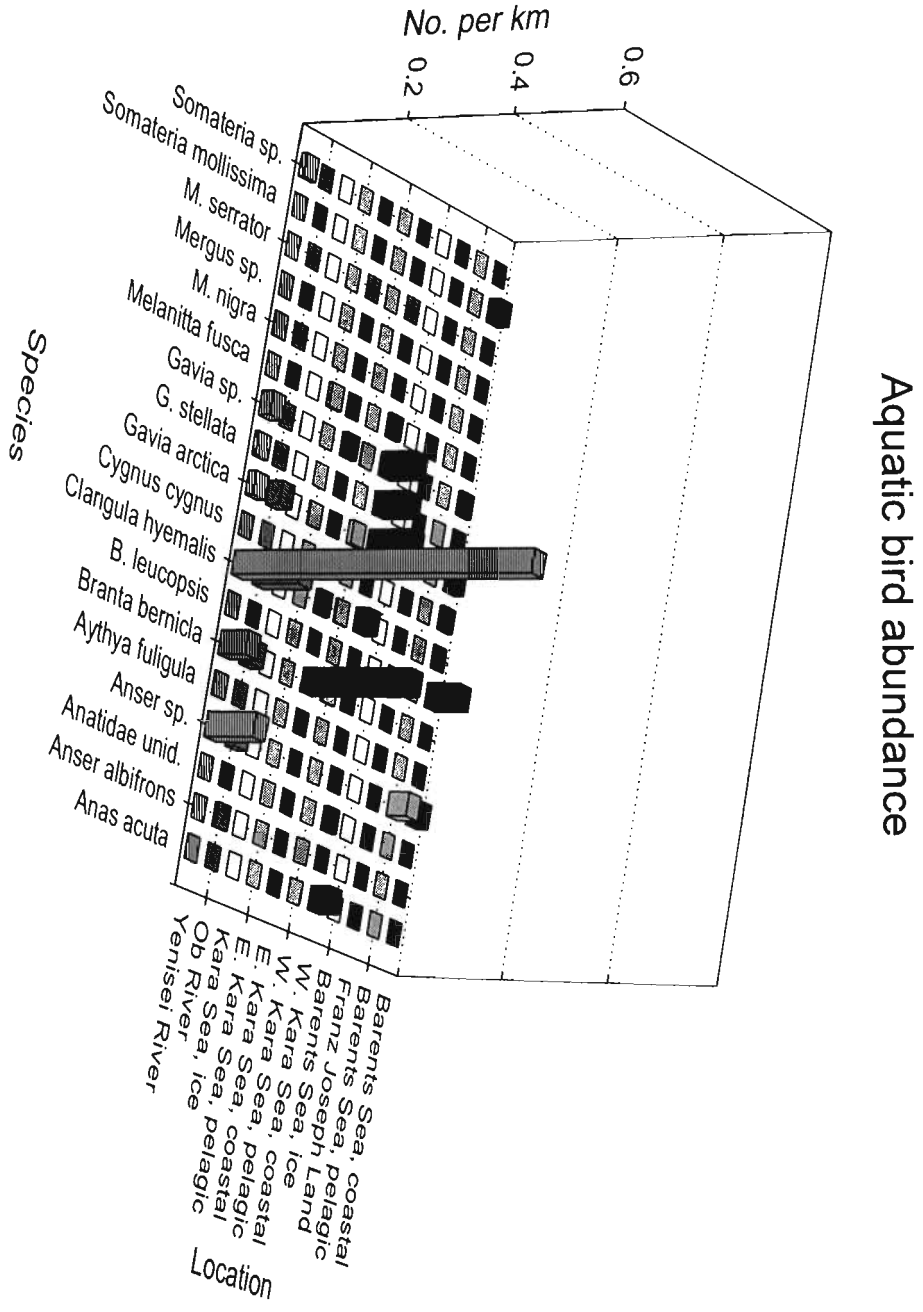


Fig. 23. Abundance (ind. km^{-1}) of selected aquatic bird species in the different geographical regions of the study area.

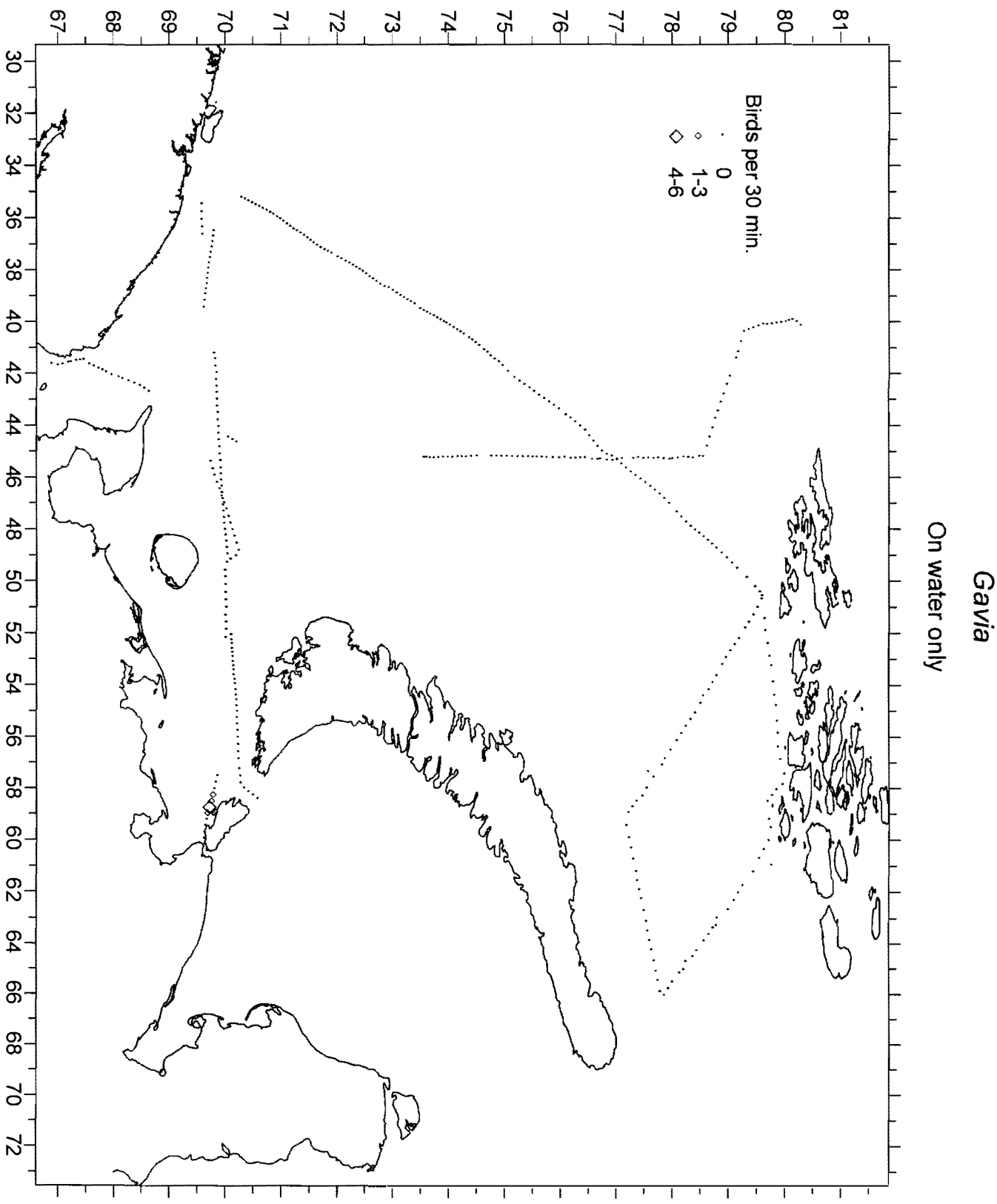


Figure 24. Distribution of divers (*Gavia* sp.) (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

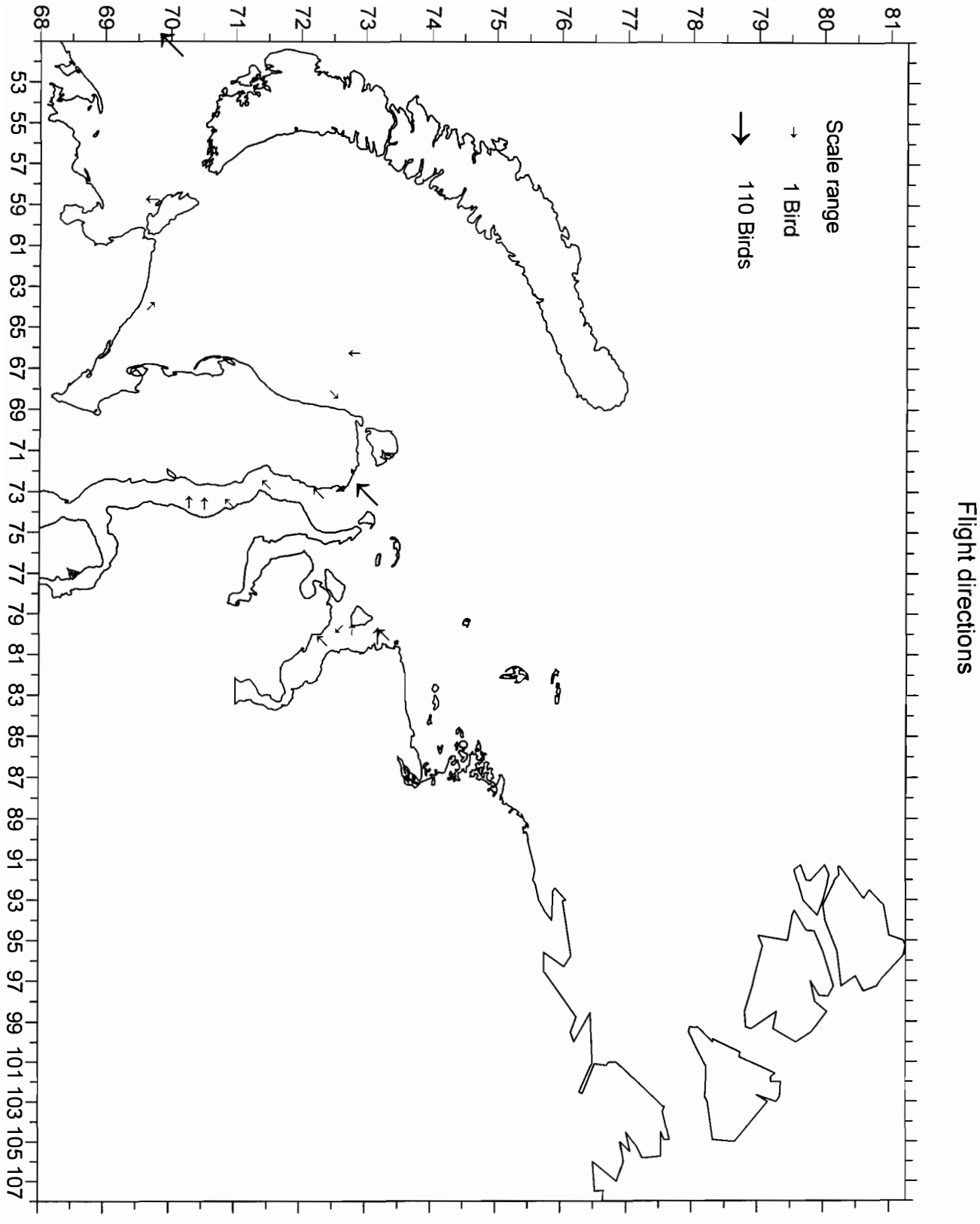


Fig. 25. Flight directions of geese (*Anser* sp.) (ind. per 30 min.) in the Barents and Kara Seas during August 3 - September 10, 1995.

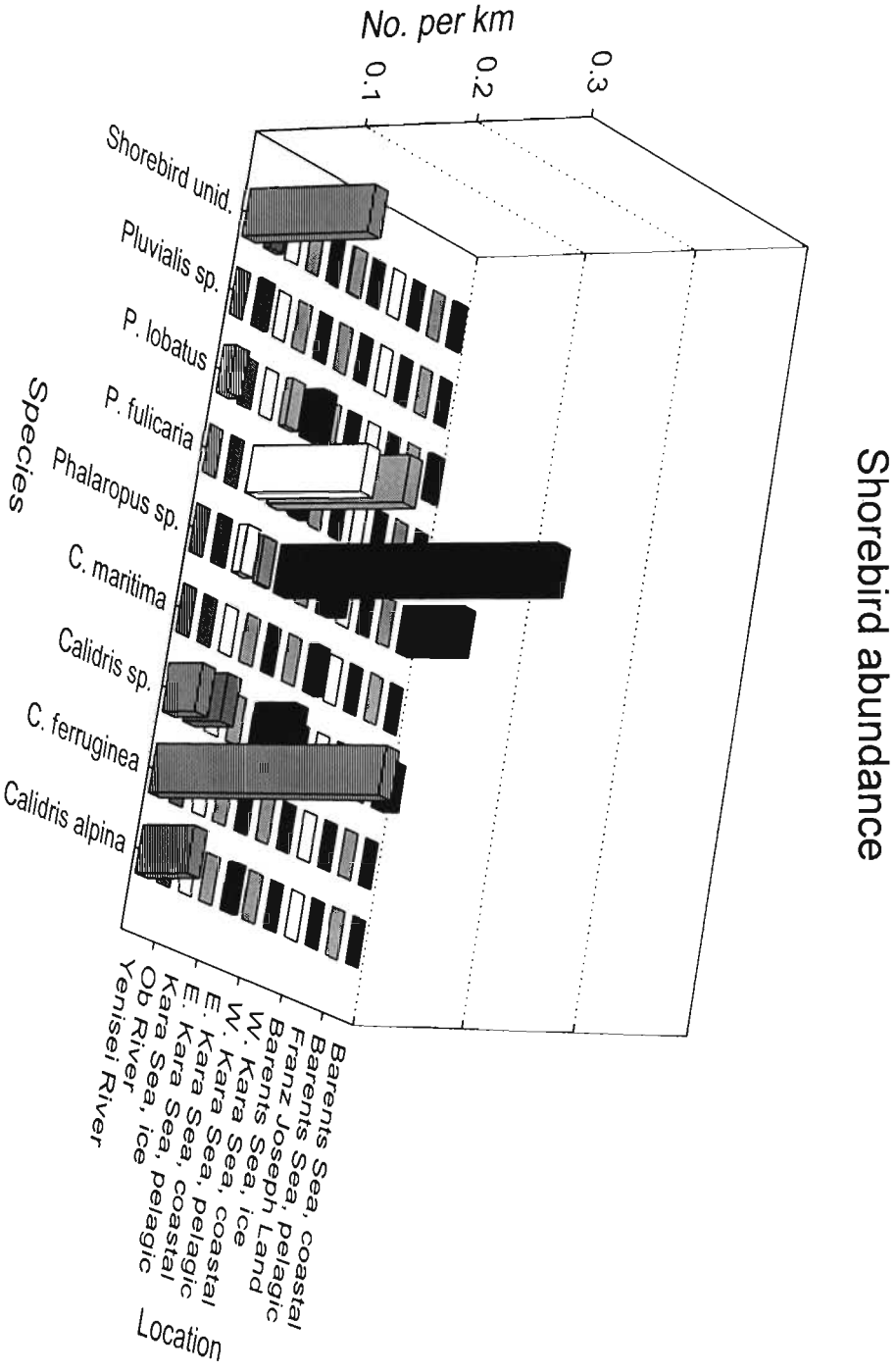


Figure 26. Abundance (ind. km^{-1}) of selected shorebird species in the different geographical regions of the study area.

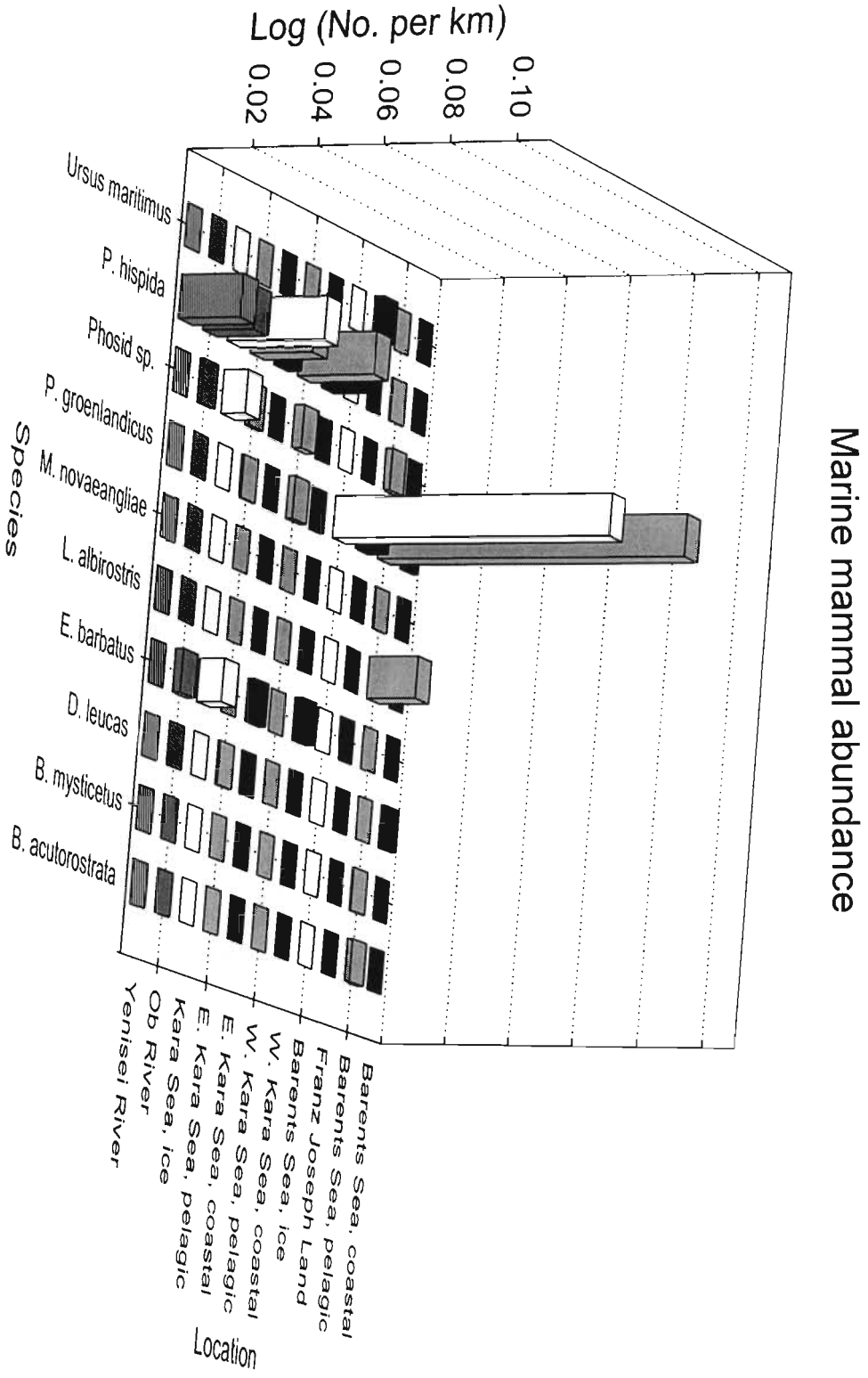


Fig. 27. Abundance (ind. km^{-1}) of selected marine mammal species in the different geographical regions of the study area.

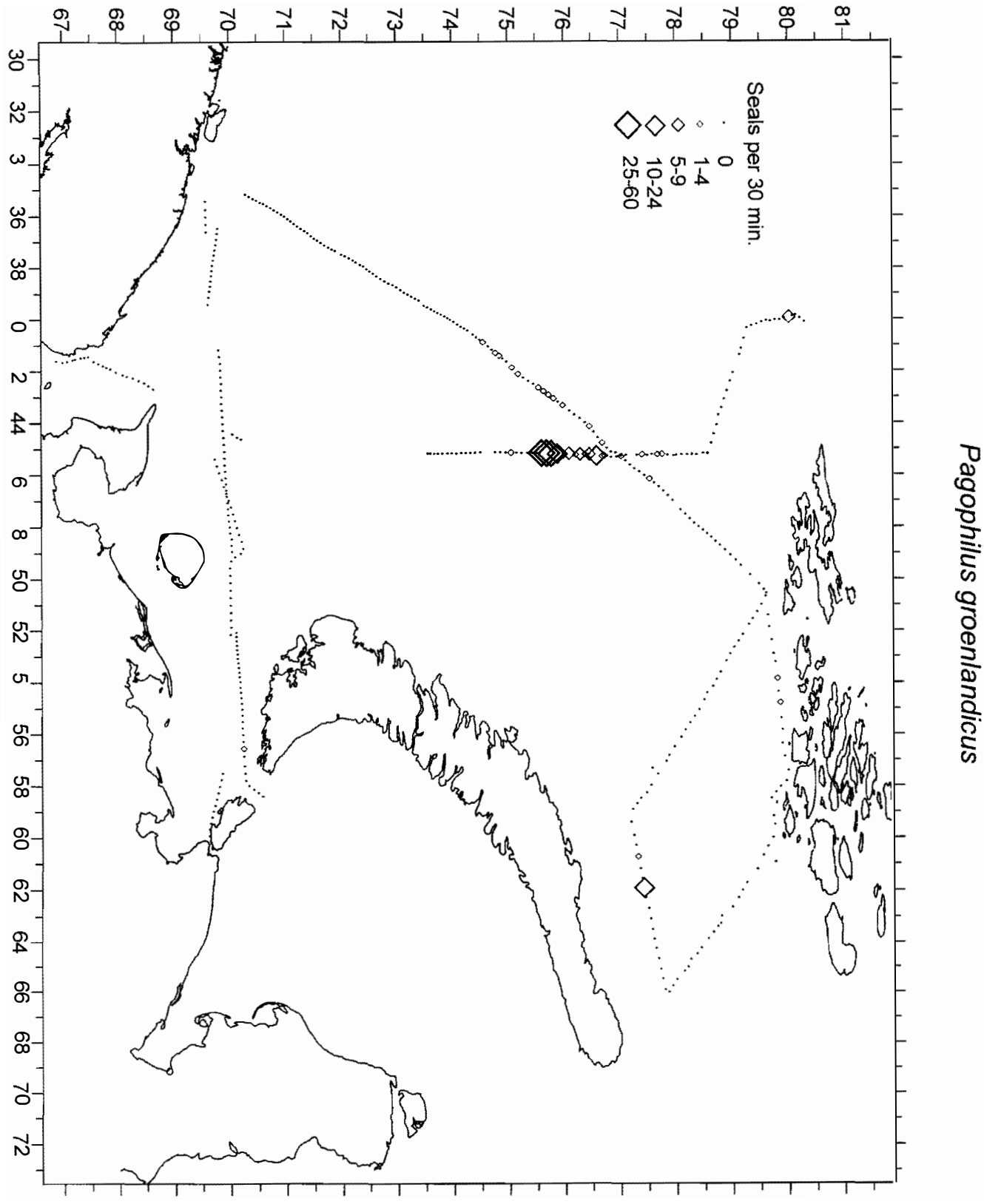


Fig. 28. Distribution of harp seals (*Pagophilus groenlandicus*) (ind. per 30 min.) in the Barents Sea during August 3-16 and September 8-10, 1995.

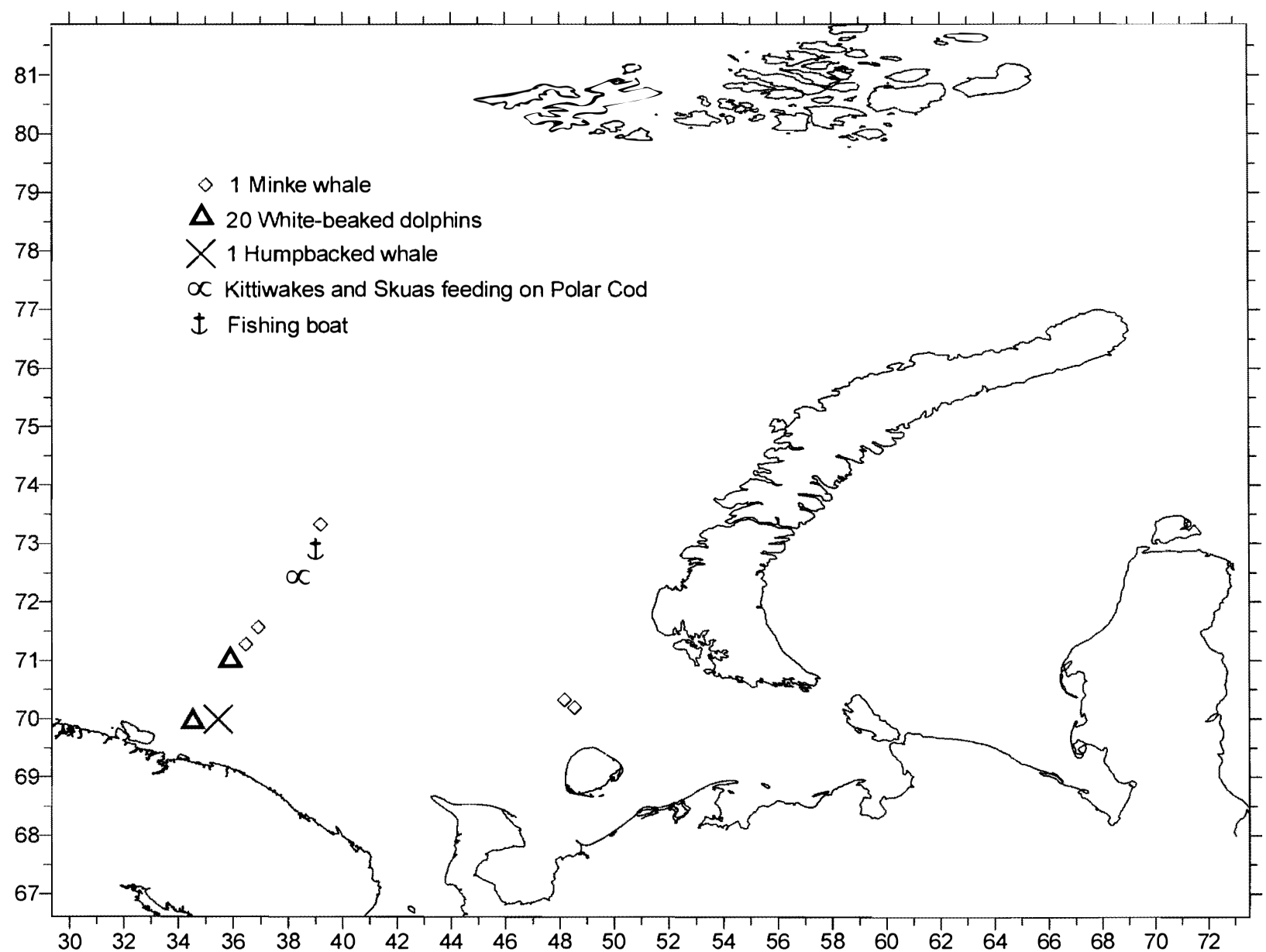
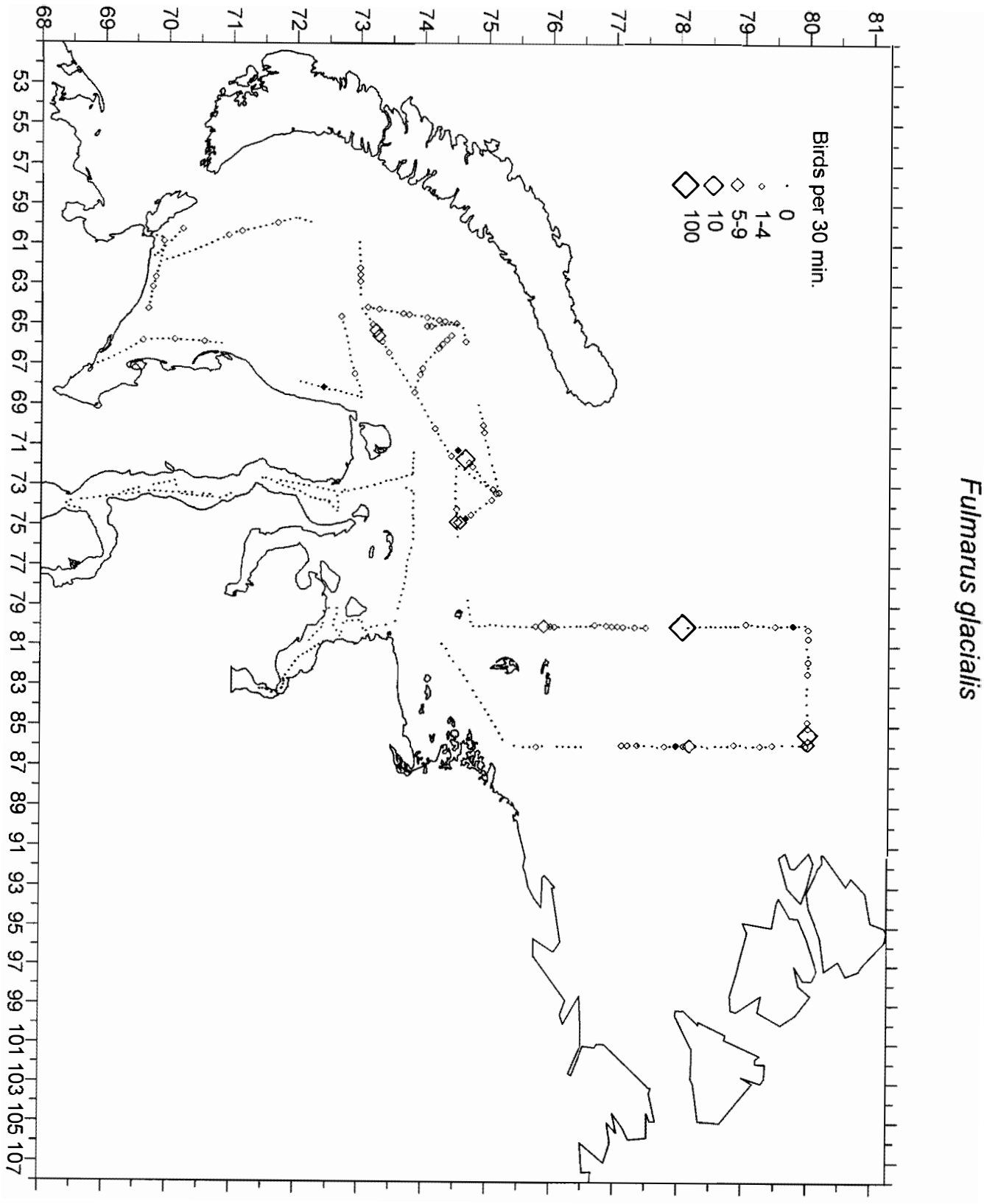
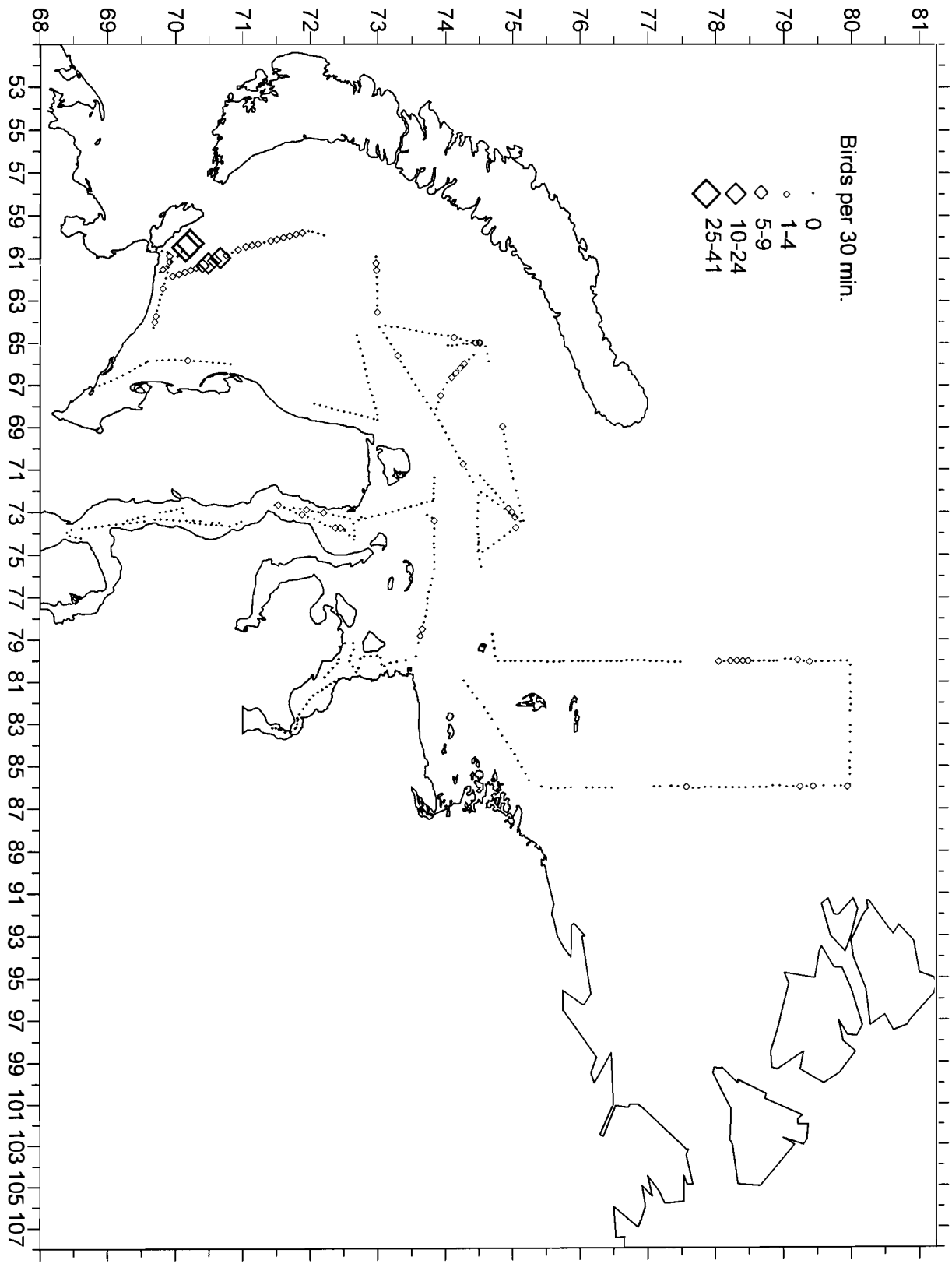


Fig. 29. Sightings of selected marine mammals and foraging flocks of marine birds in the southeastern Barents Sea during August 3-16, 1995.



Fulmarus glacialis

Fig. 30. Distribution of northern fulmars (*Fulmarus glacialis*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.



Stercorarius pomarinus

Fig. 31. Distribution of pomarine skuas (*Stercorarius pomarinus*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

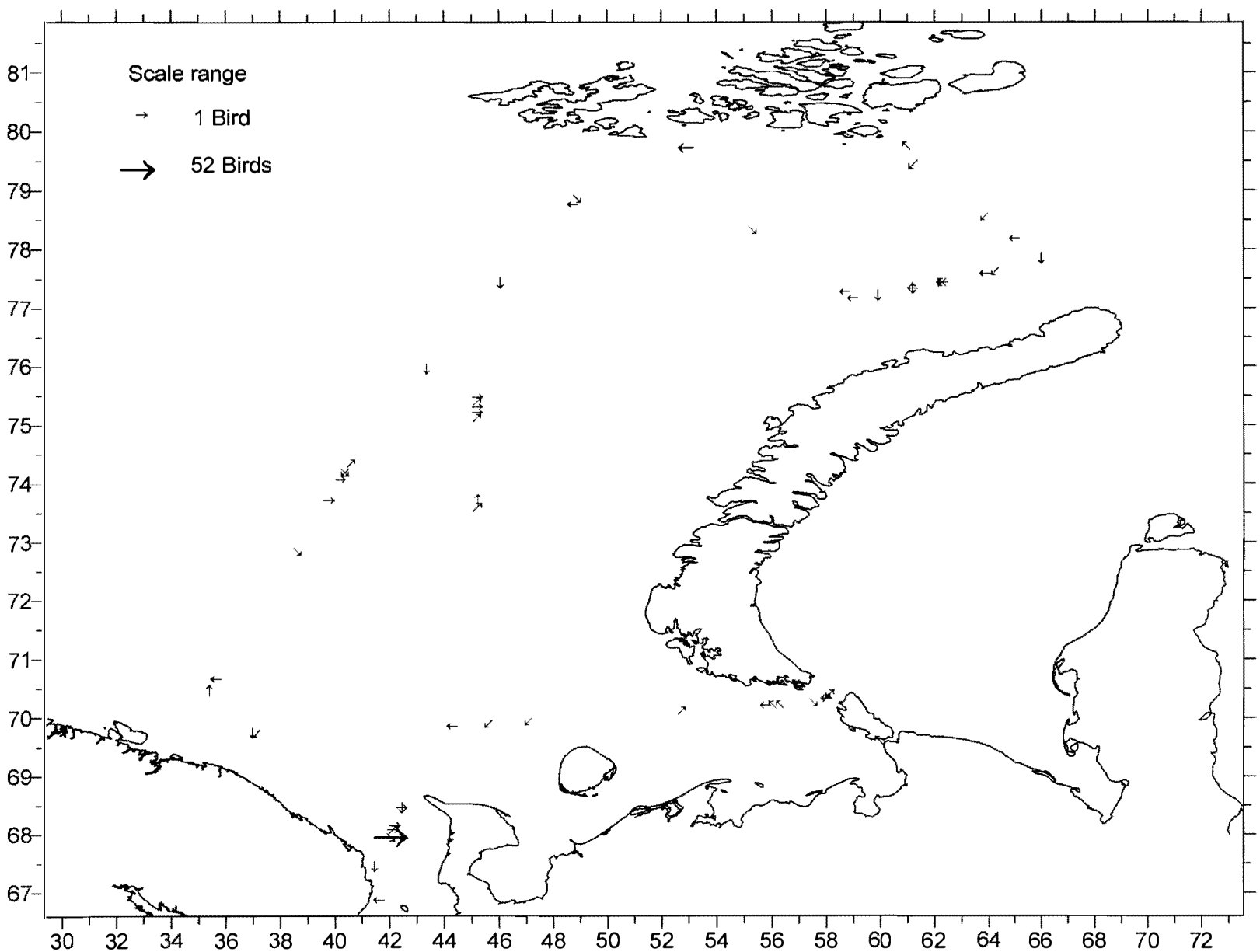


Fig. 32. Flight directions of pomarine skuas (*Stercorarius pomarinus*) (ind. per 30 min.) Barents Sea during August 3-16 and September 8-10, 1995.

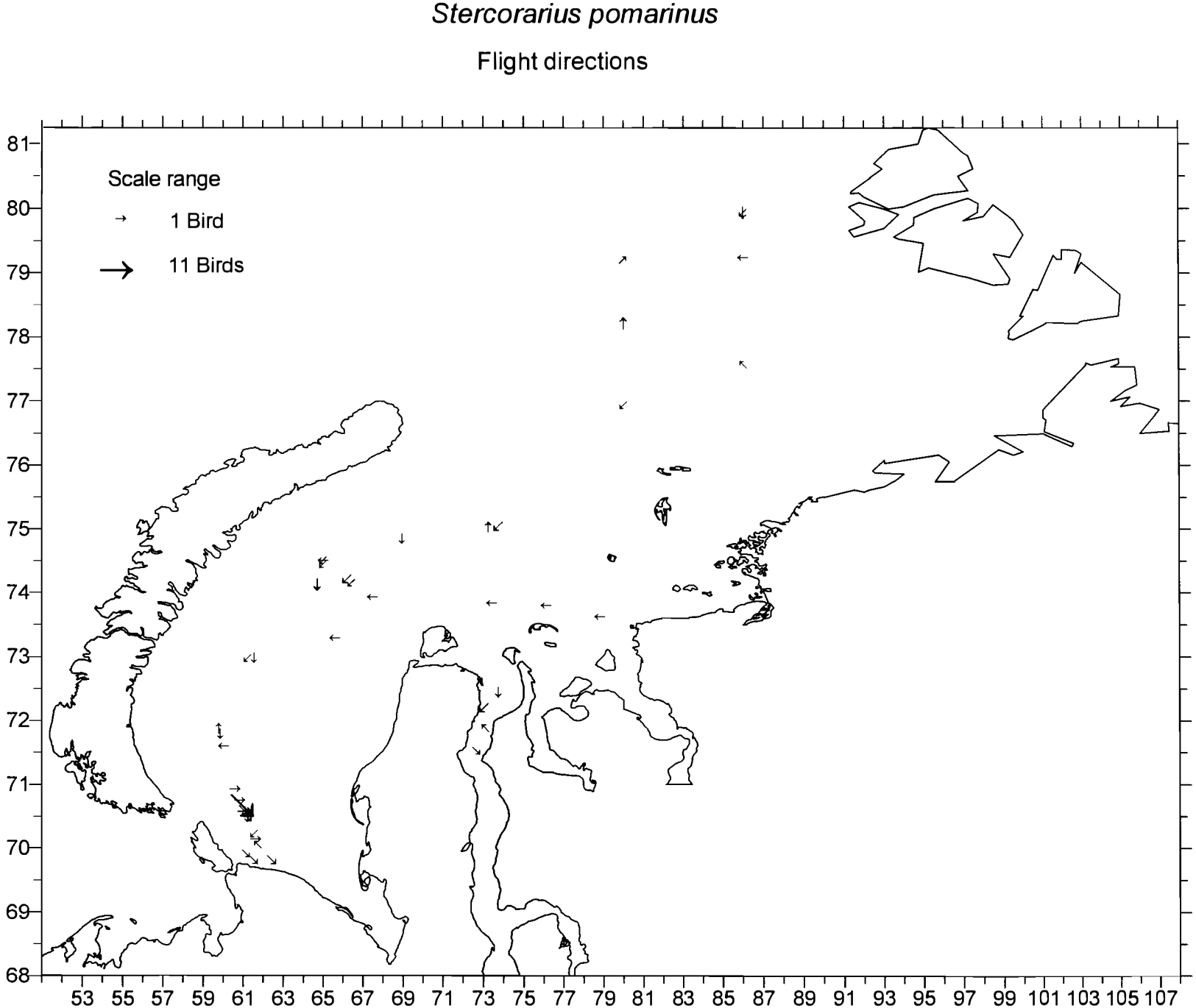


Fig. 33. Flight directions of pomarine skuas (*Stercorarius pomarinus*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

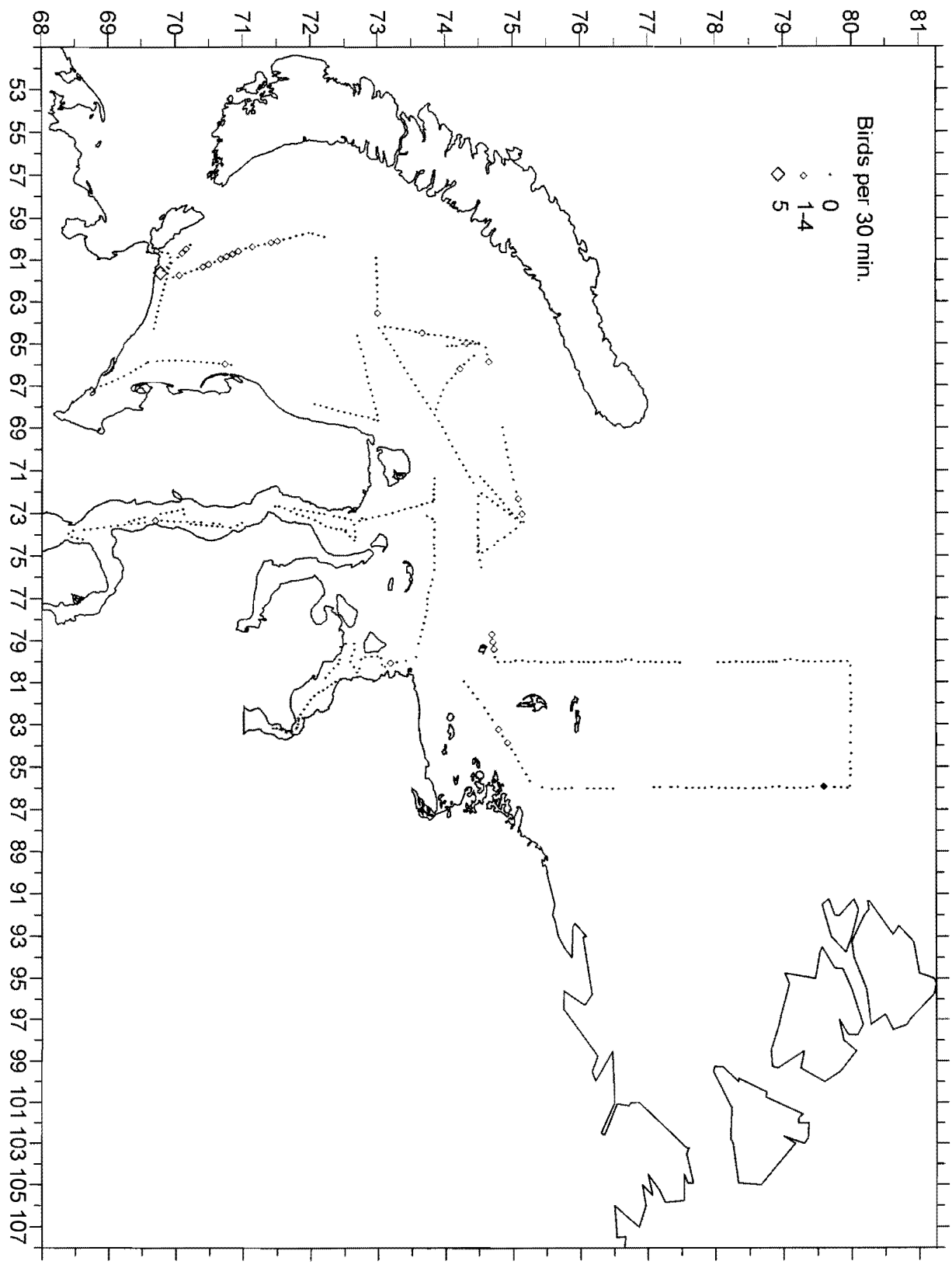


Fig. 34. Distribution of long-tailed skuas (*Stercorarius longicaudus*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

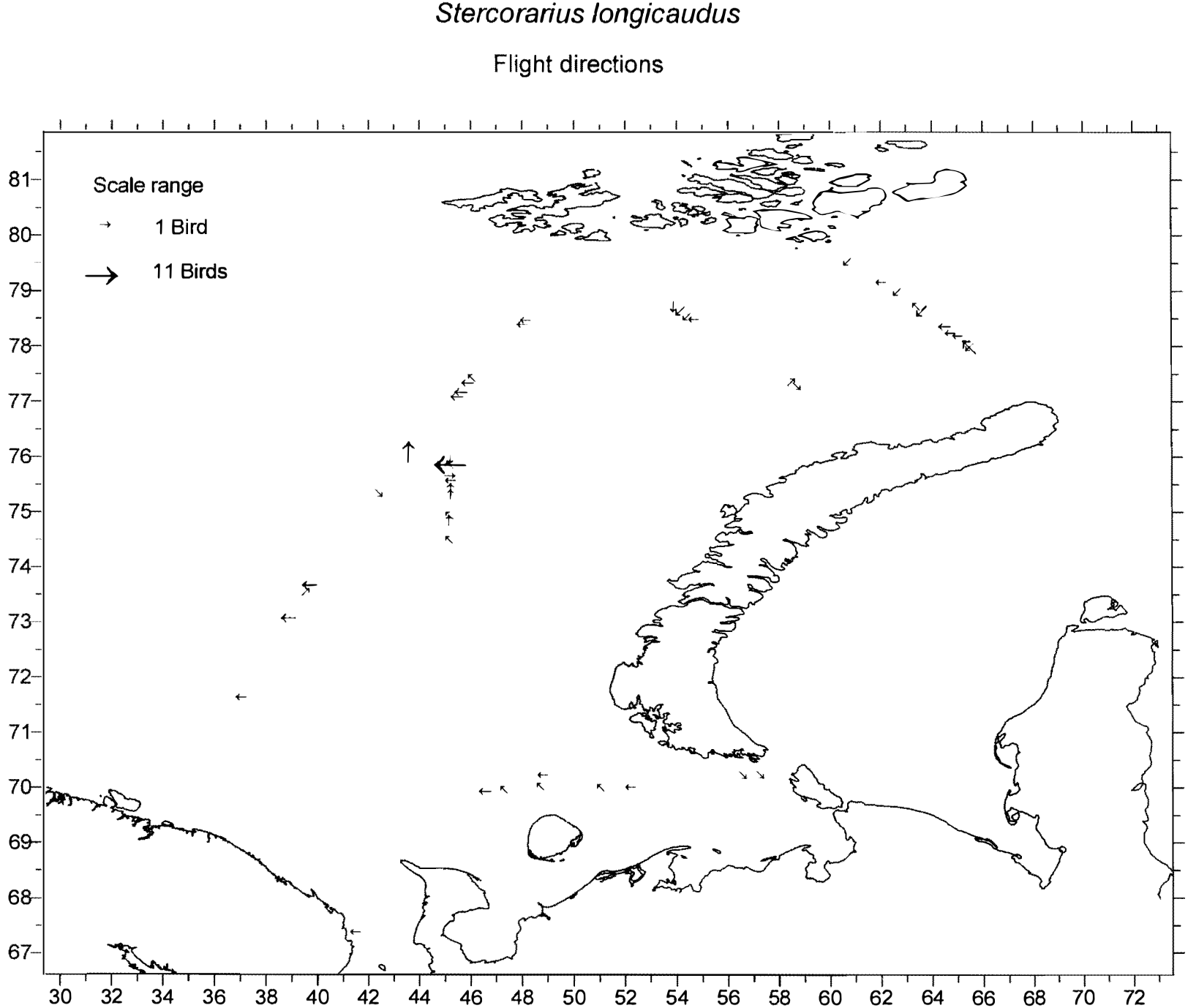


Fig. 35. Flight directions of long-tailed skuas (*Stercorarius longicaudus*) (ind. per 30 min.) Barents Sea during August 3-16 and September 8-10, 1995.

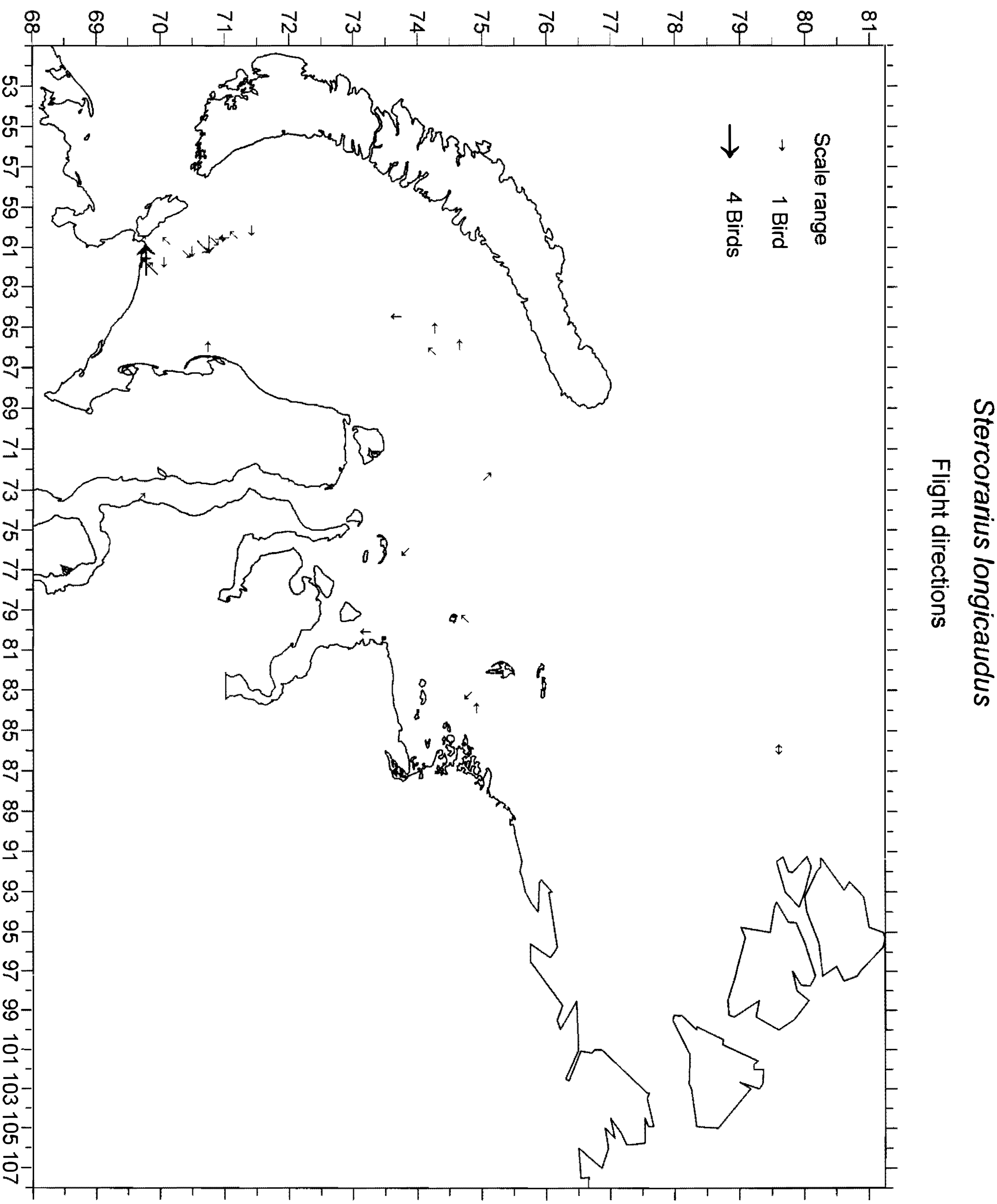
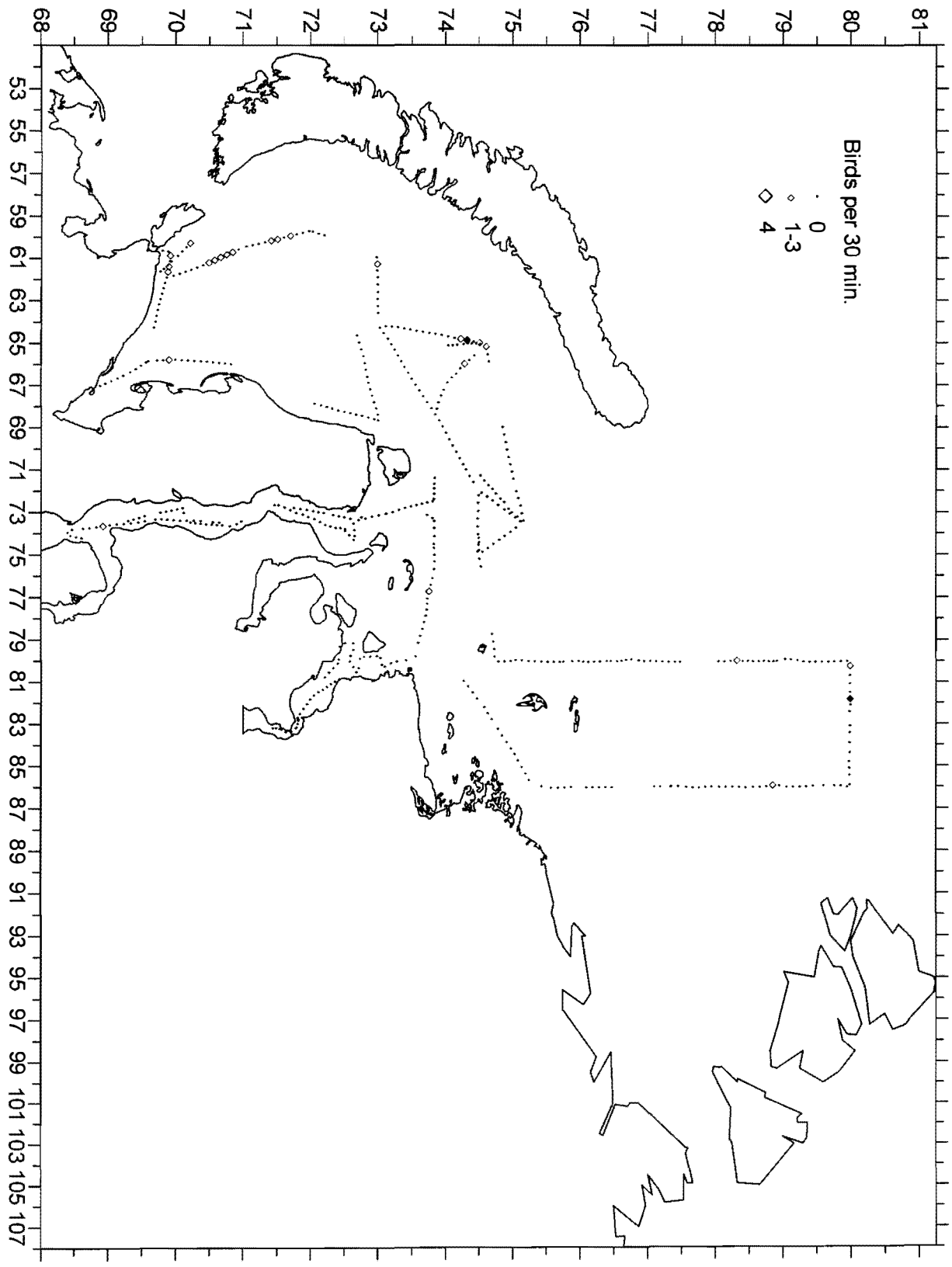


Fig. 36. Flight directions of long-tailed skuas (*Stercorarius longicaudus*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.



Stercorarius parasiticus

Fig. 37. Distribution of arctic skuas (*Stercorarius parasiticus)* (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

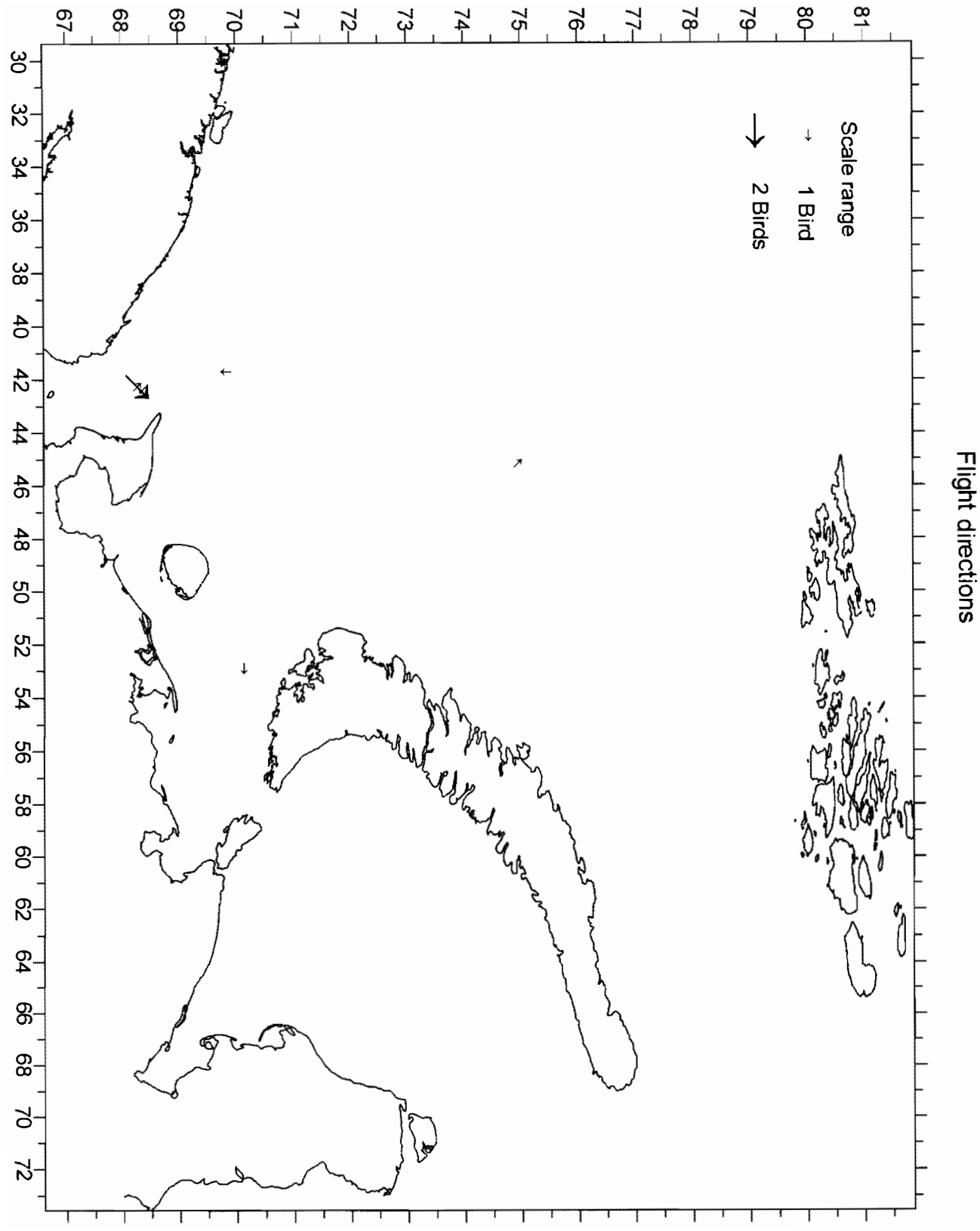


Fig. 38. Flight directions of arctic skuas (*Stercorarius parasiticus)* (ind. per 30 min.) Barents Sea during August 3-16 and September 8-10, 1995.

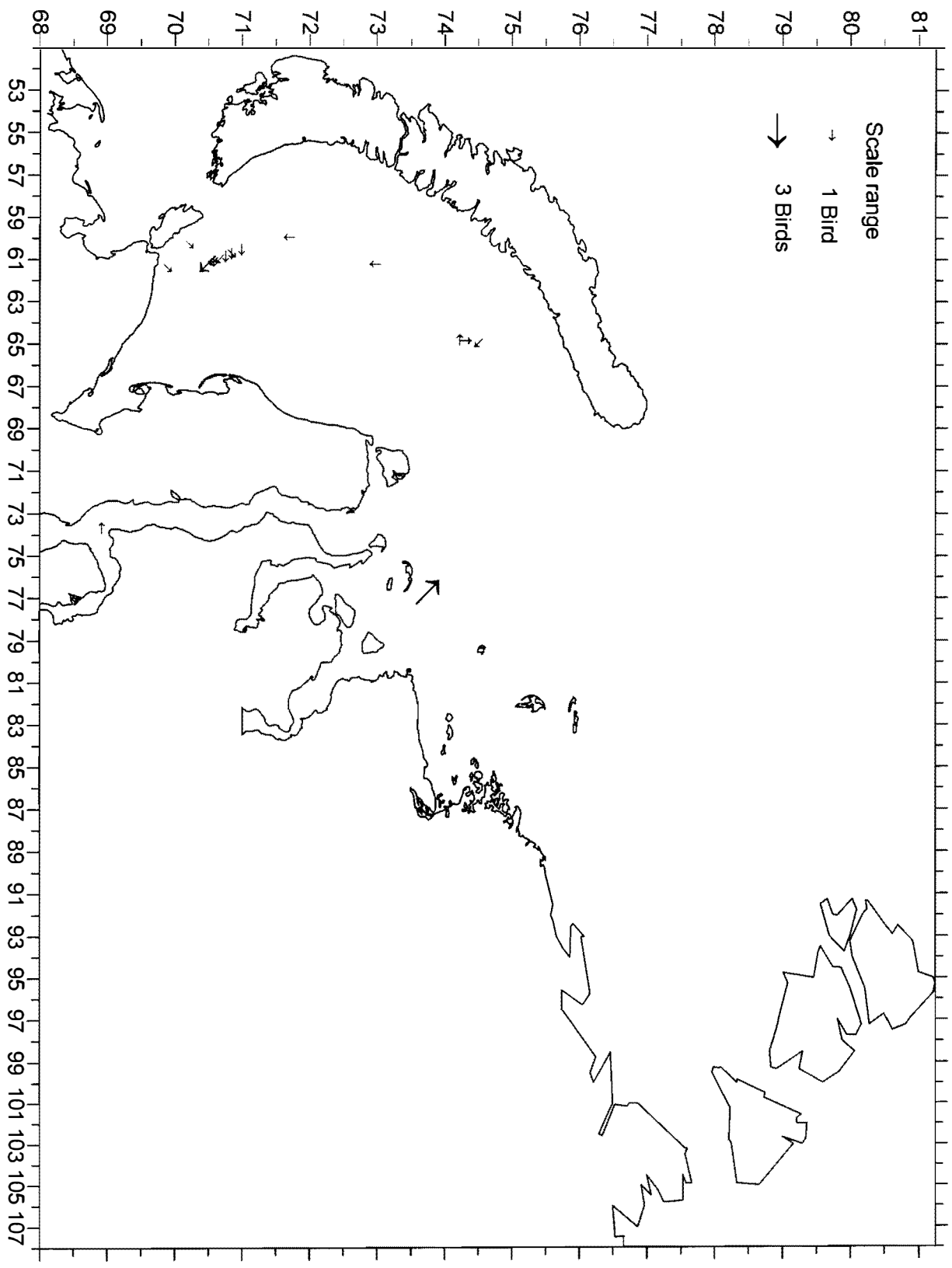


Fig. 39. Flight directions of arctic skuas (*Stercorarius parasiticus)* in the Kara Sea during August 17-September 8, 1995.

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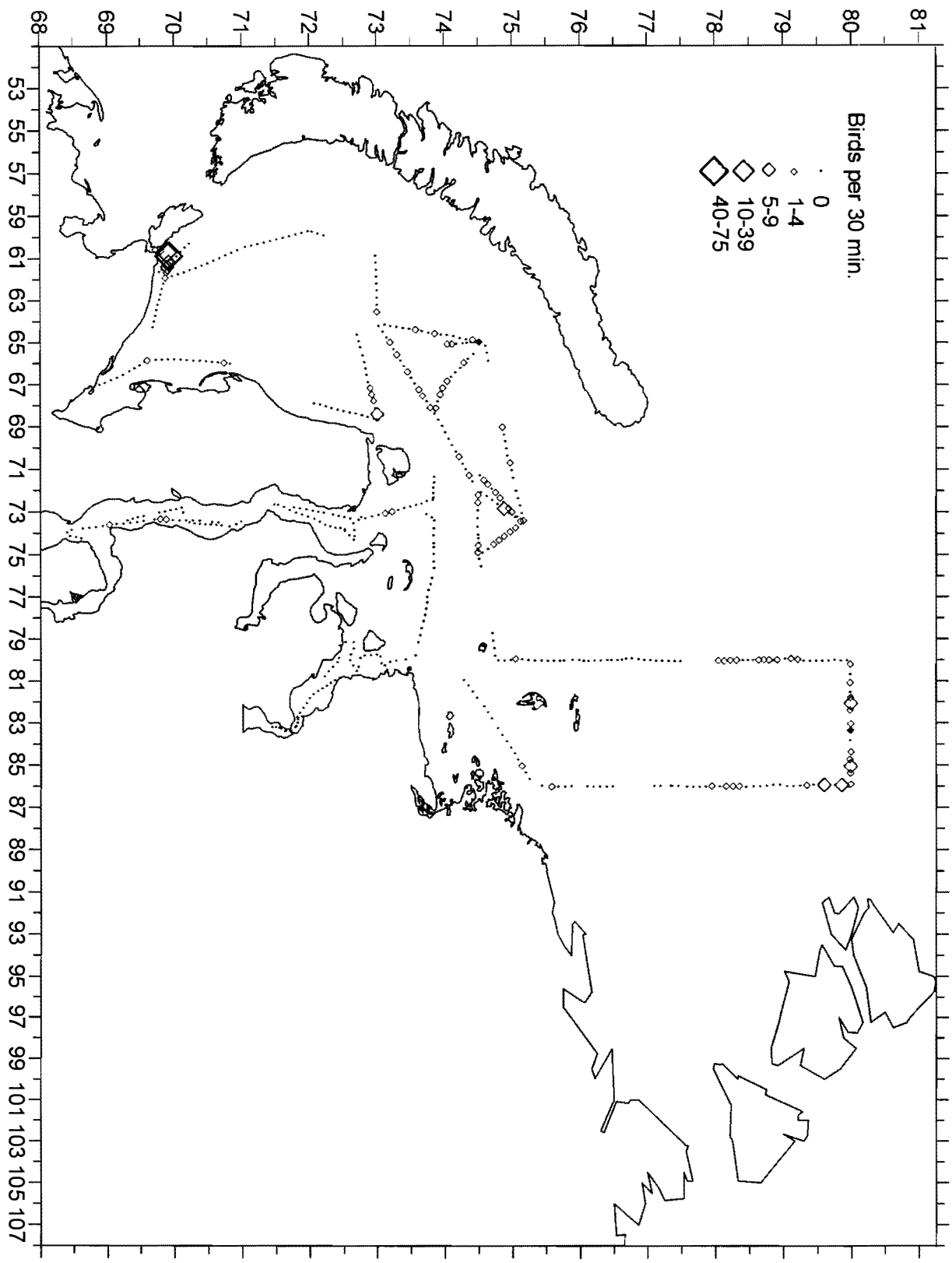
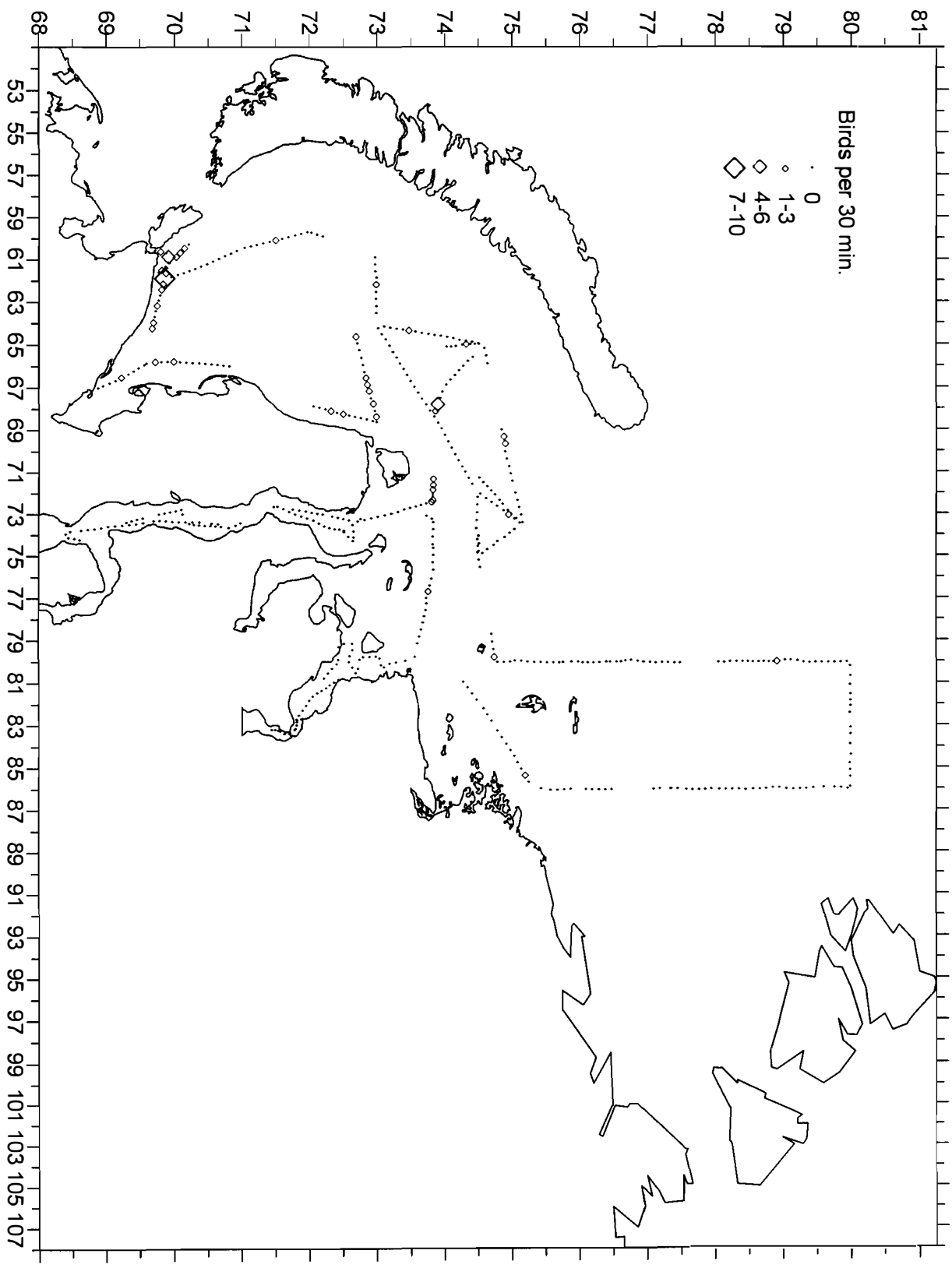


Fig. 40. Distribution of black-legged kittiwakes (*Rissa tridactyla*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.



Larus hyperboreus

Fig. 41. Distribution of glaucous gulls (*Larus hyperboreous*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

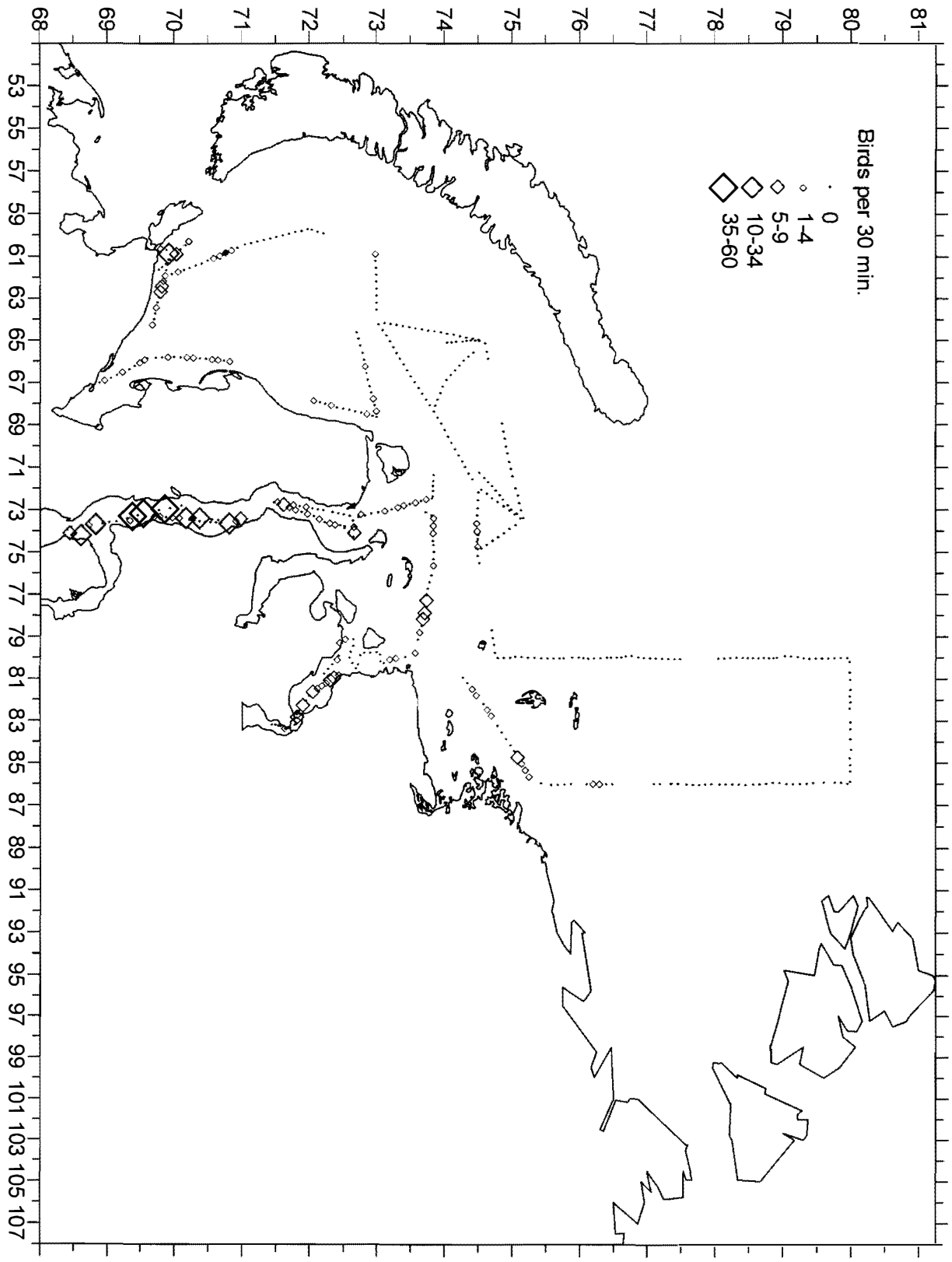


Fig. 42. Distribution of herring gulls (*Larus argentatus*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

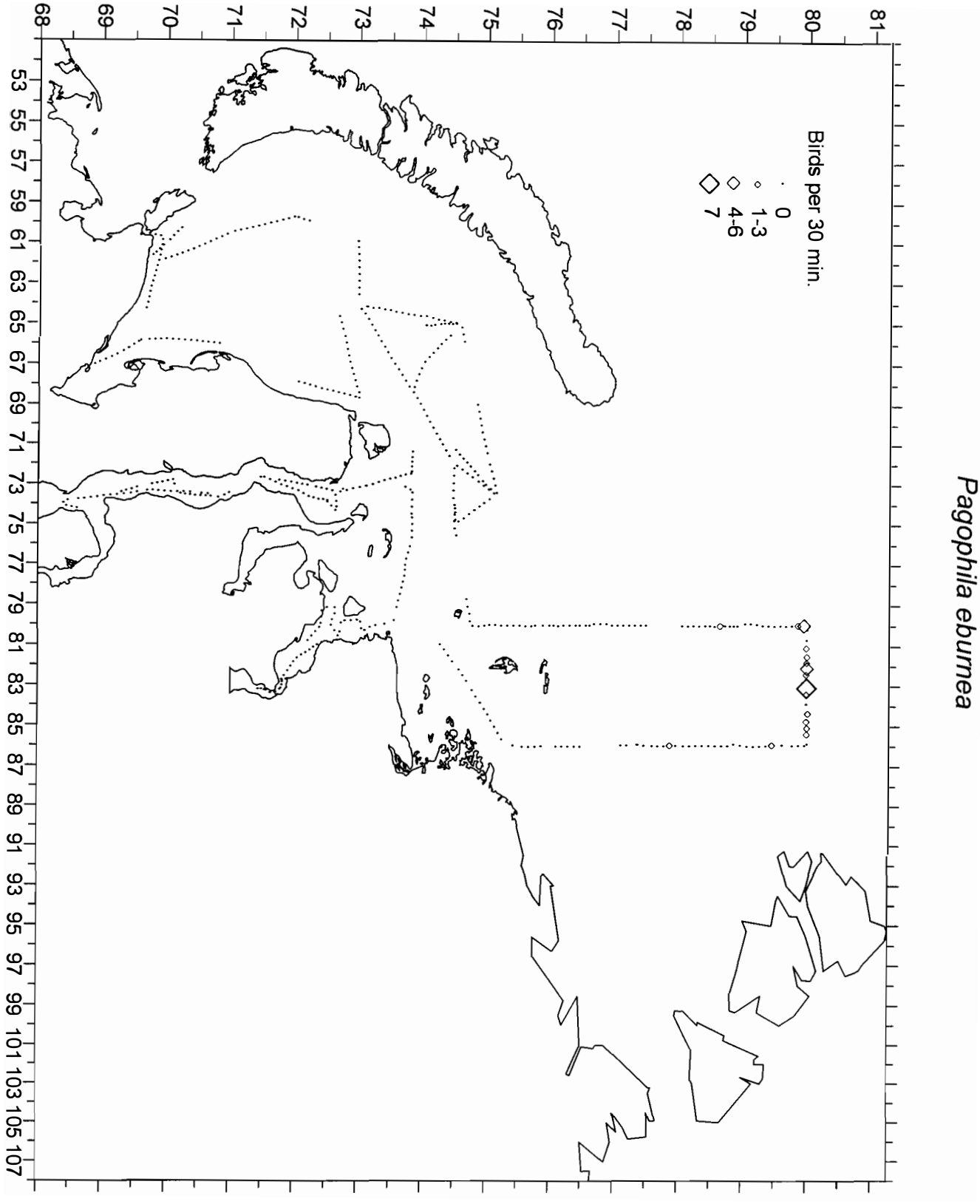
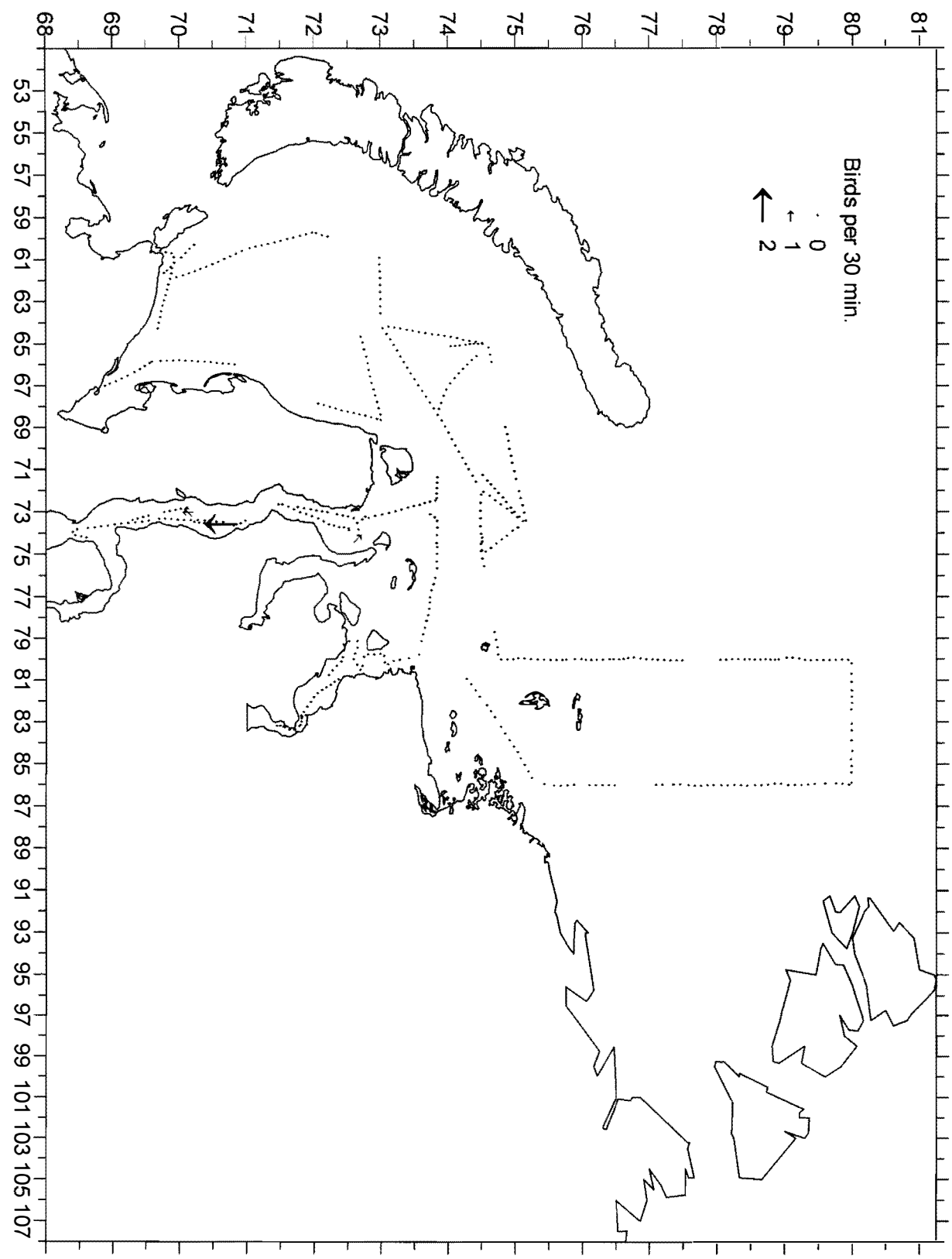
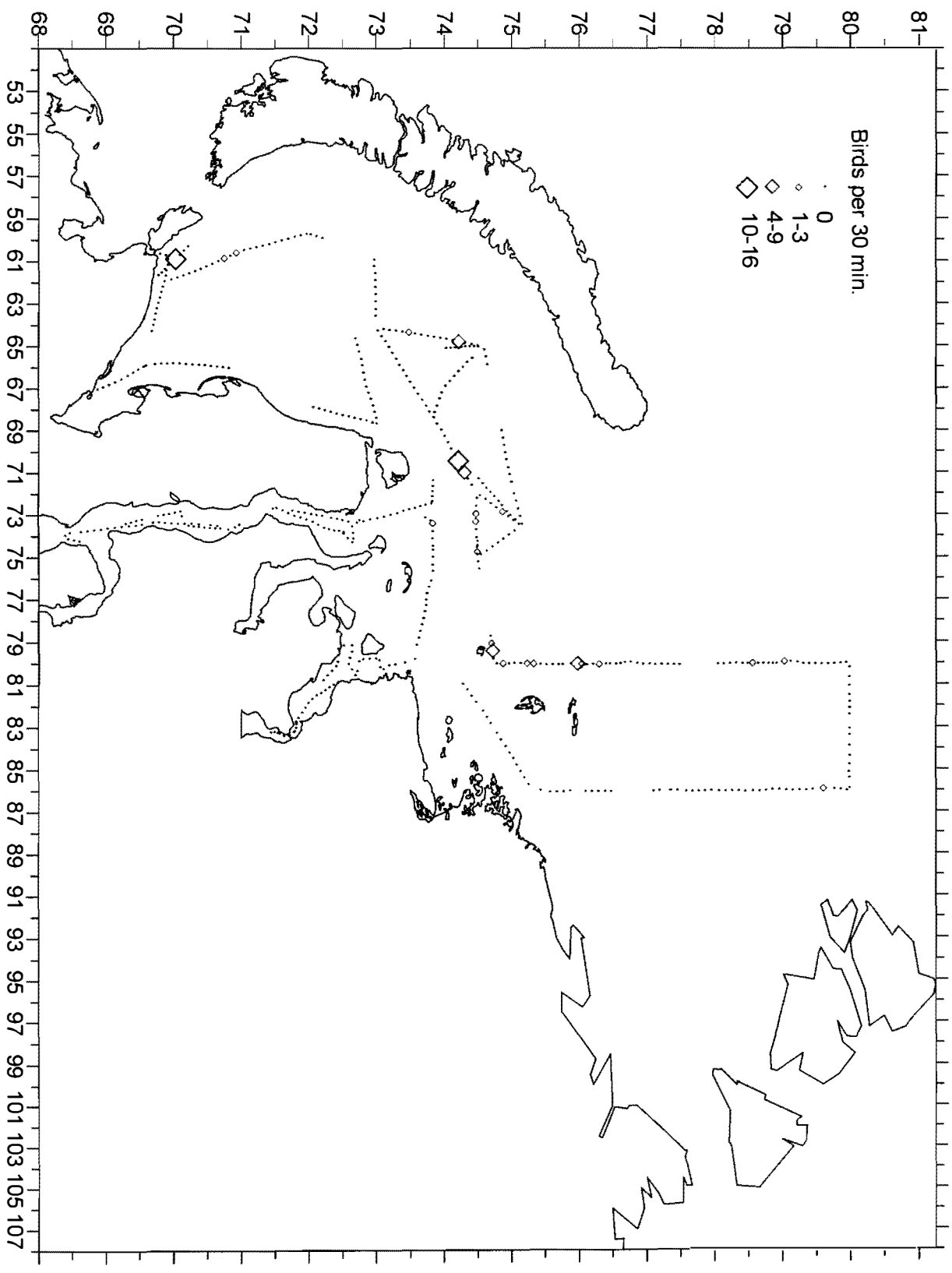


Fig. 43. Distribution of ivory gulls (*Pagophila eburnea*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.



Larus sabini

Fig. 44. Distribution of Sabine's gulls (*Larus sabini*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.



Sterna paradisaea

Fig. 45. Distribution of arctic terns (*Sterna paradisaea)* (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

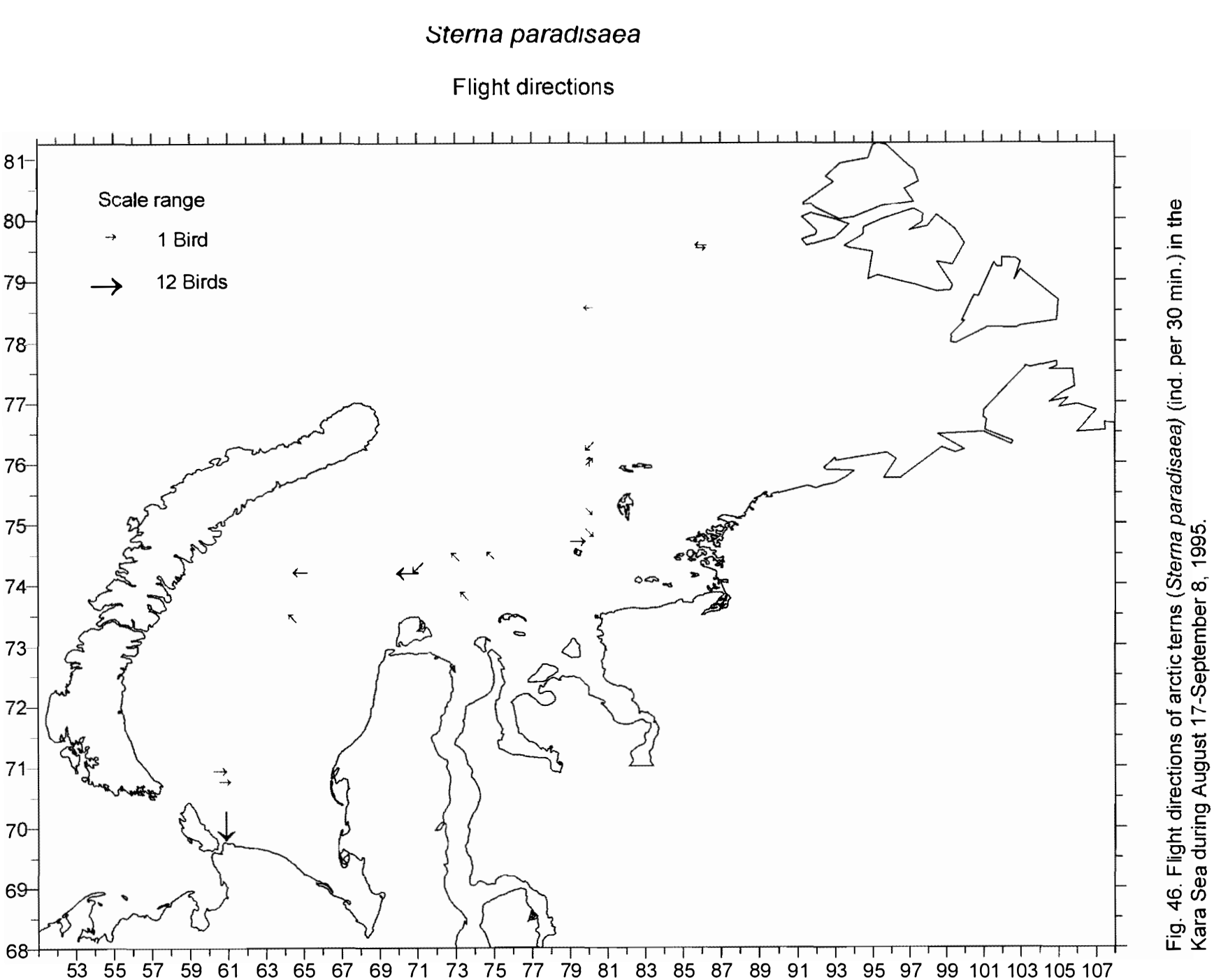


Fig. 46. Flight directions of arctic terns (*Sterna paradisaea)* (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

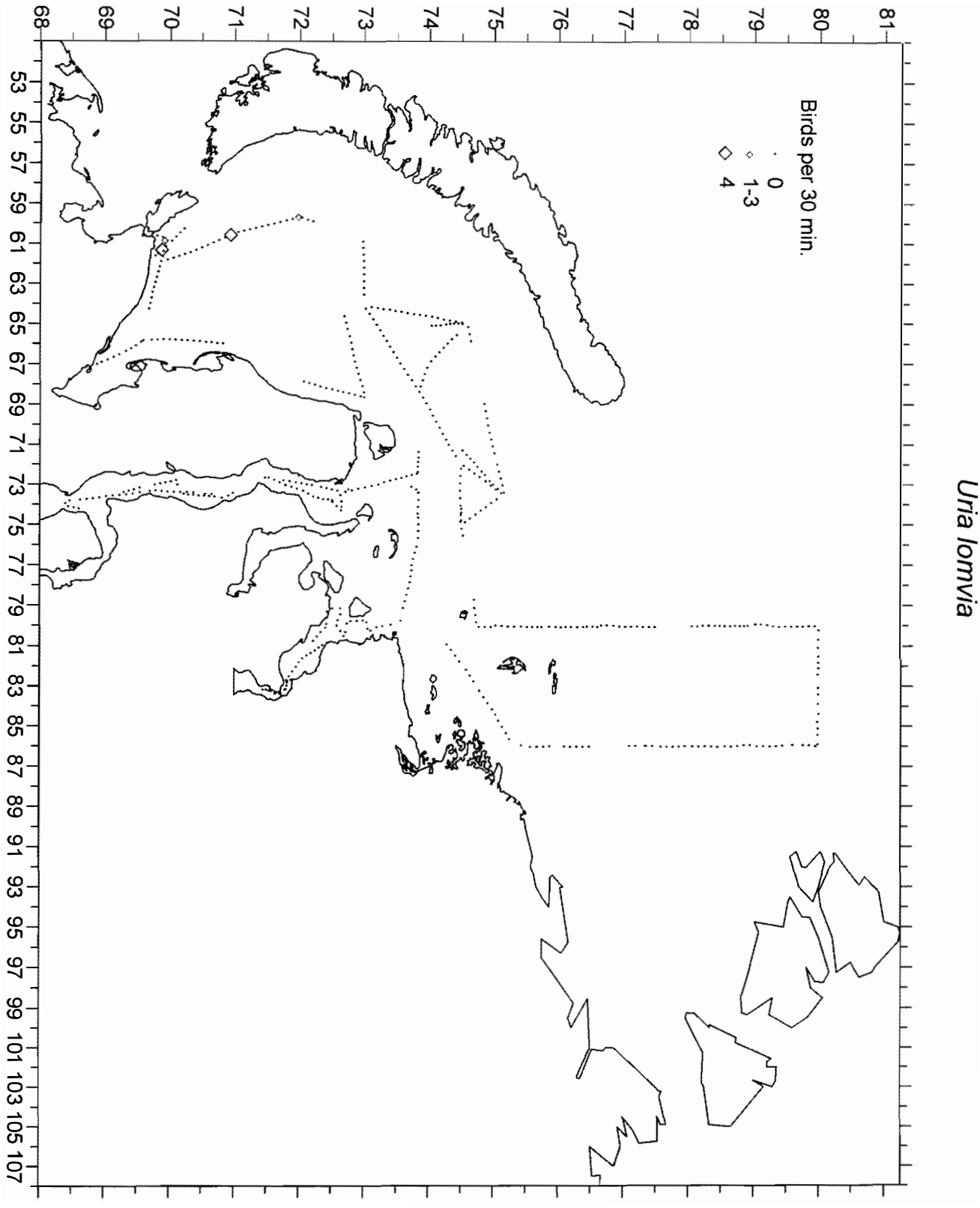


Fig. 47. Distribution of Brünnich's guillemots (*Uria lomvia)* (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

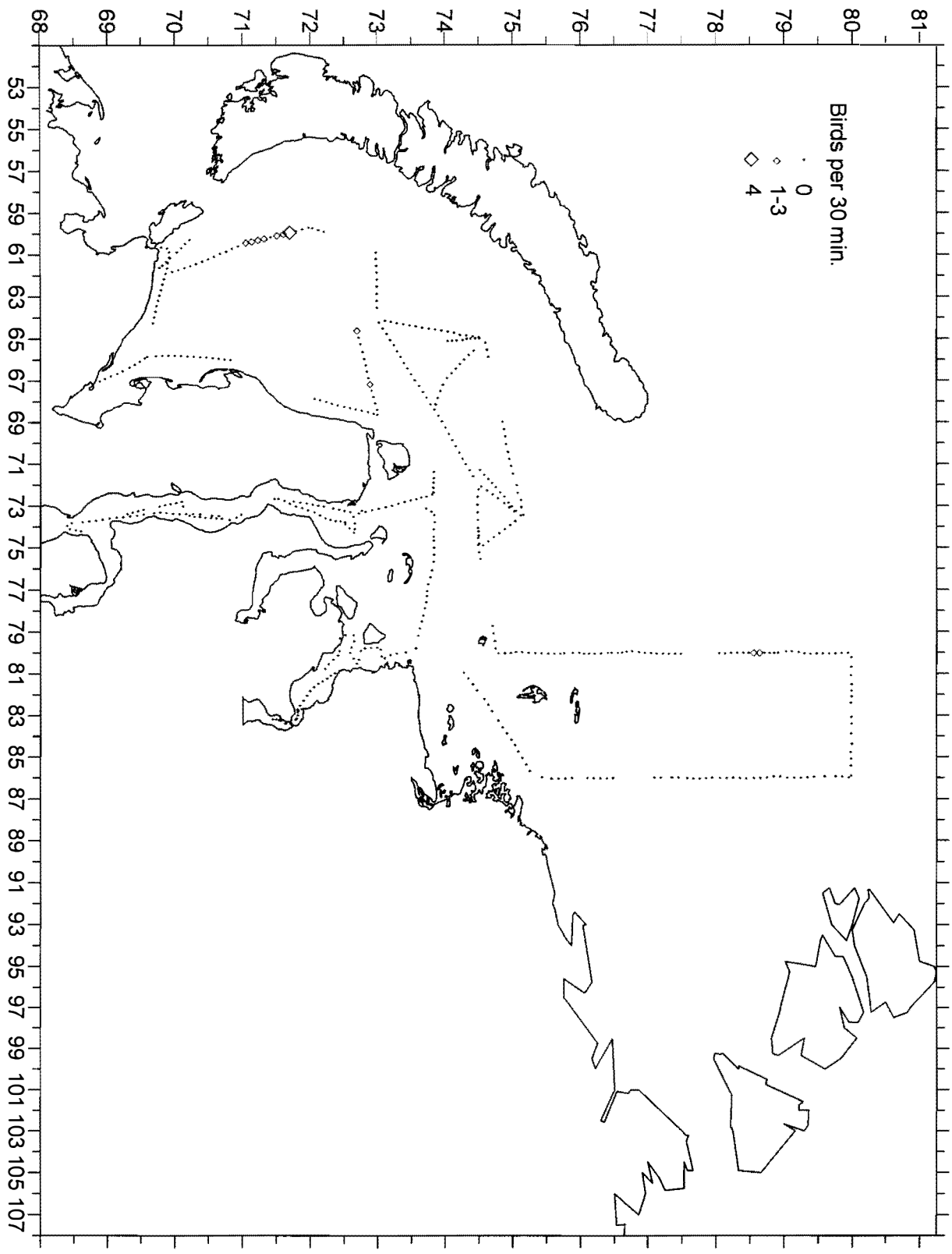
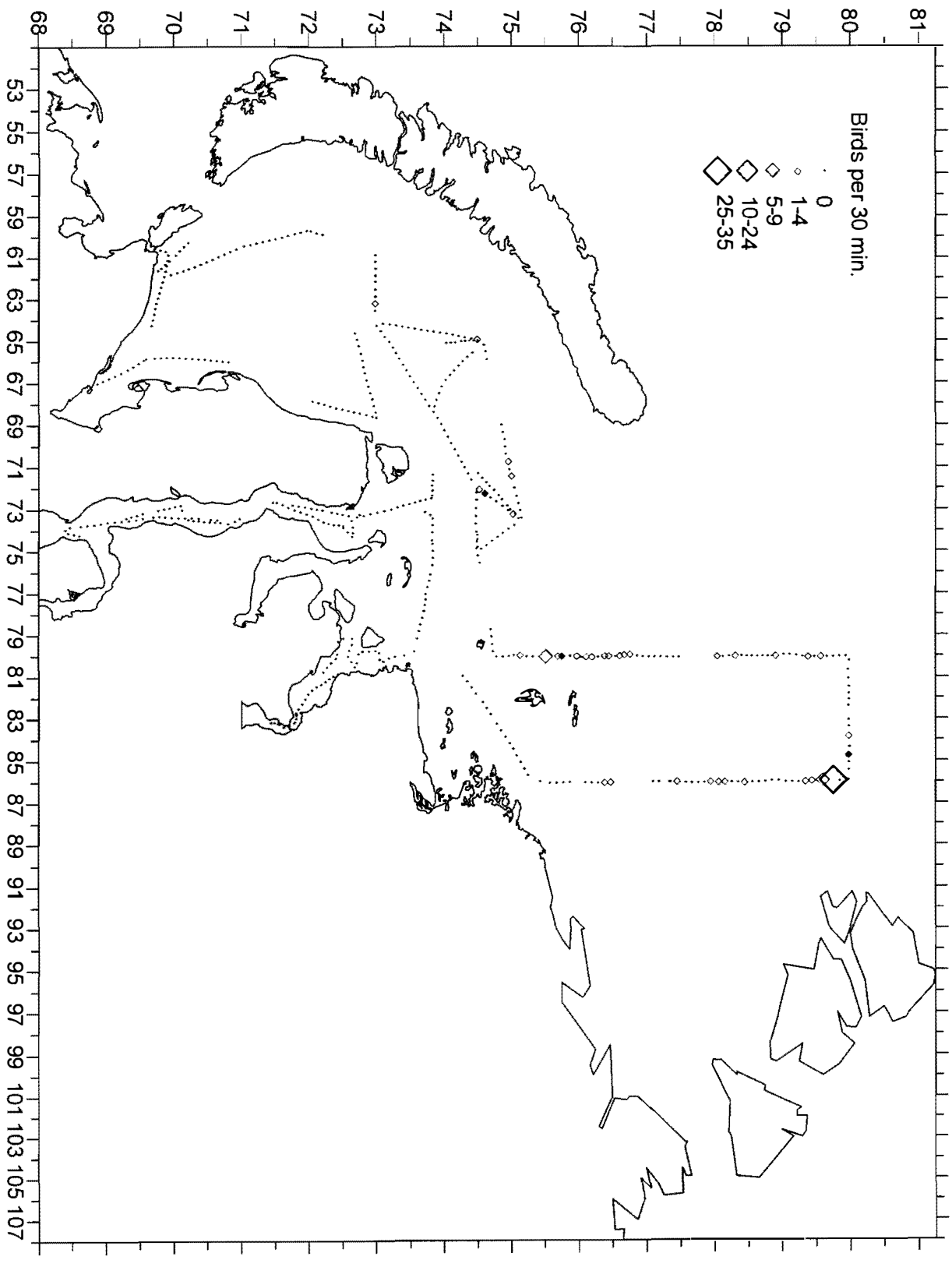


Fig. 48. Distribution of little auks (*Alle alle)* (ind. per 30 min.) in the Kara Sea during August 17-September 8 1995.



Cepphus grylle

Fig. 49. Distribution of black guillemots (*Cepphus grylle*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

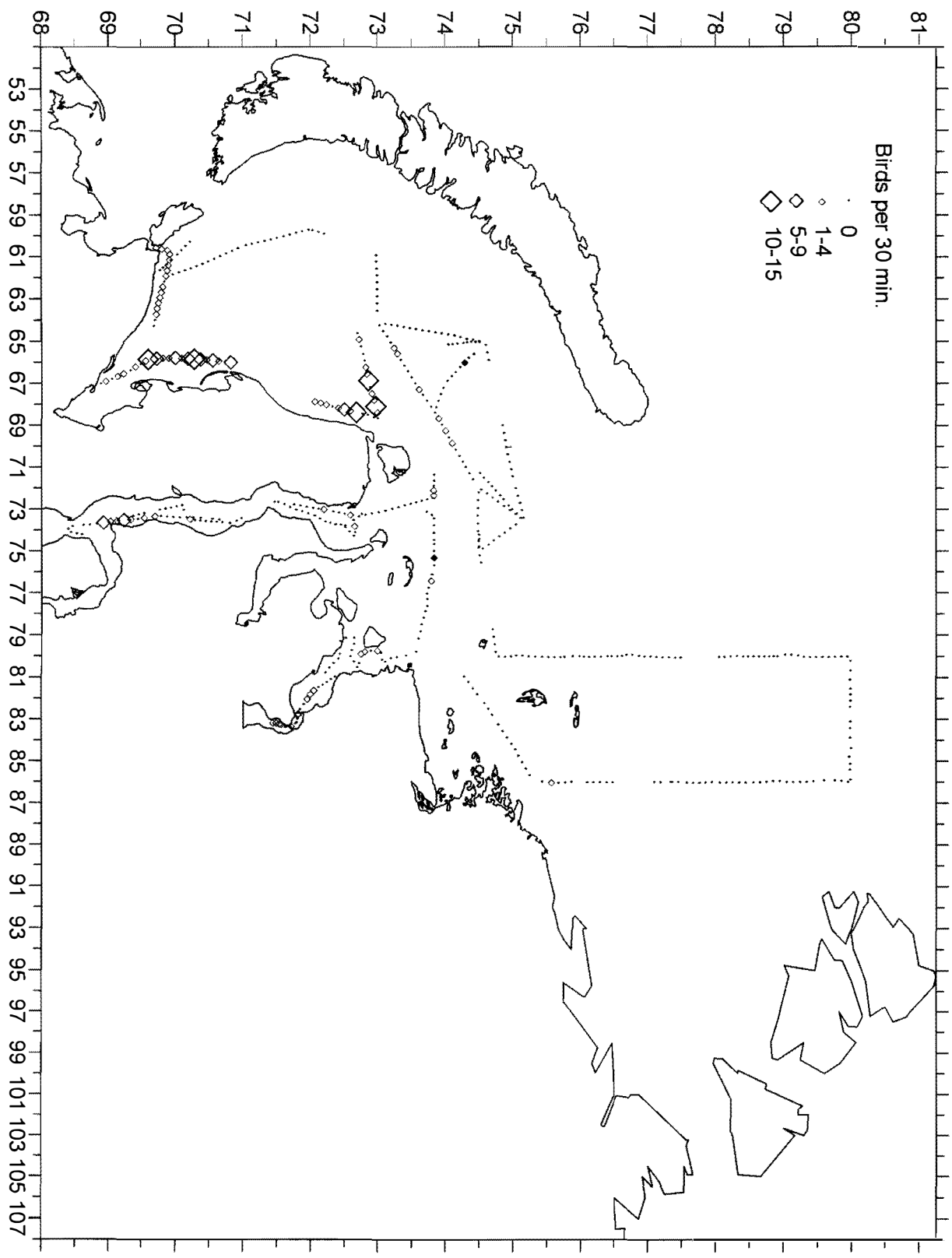


Fig. 50. Distribution of divers (*Gavia* sp.) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

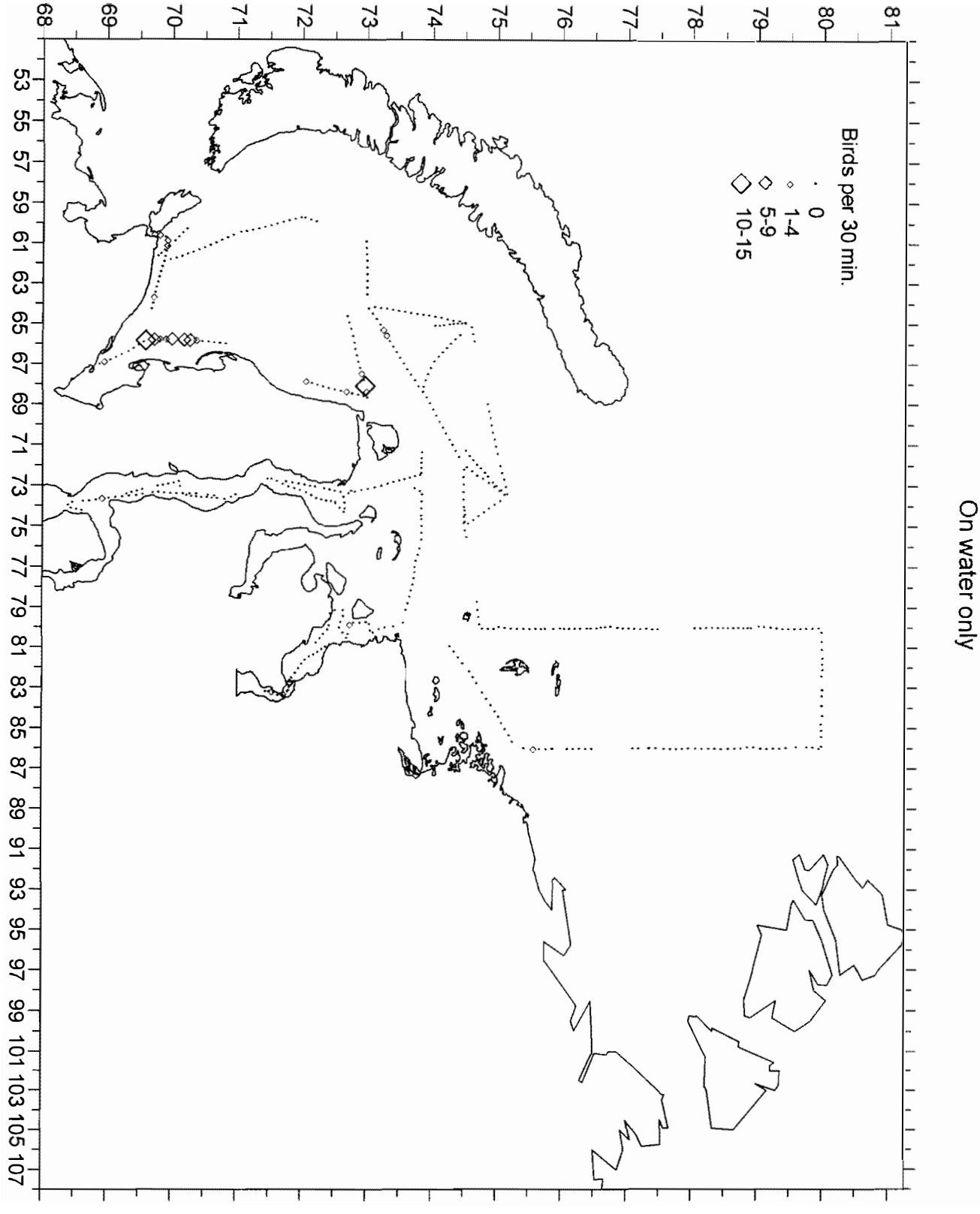


Fig. 51. Distribution of divers (*Gavia* sp.) on water only (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

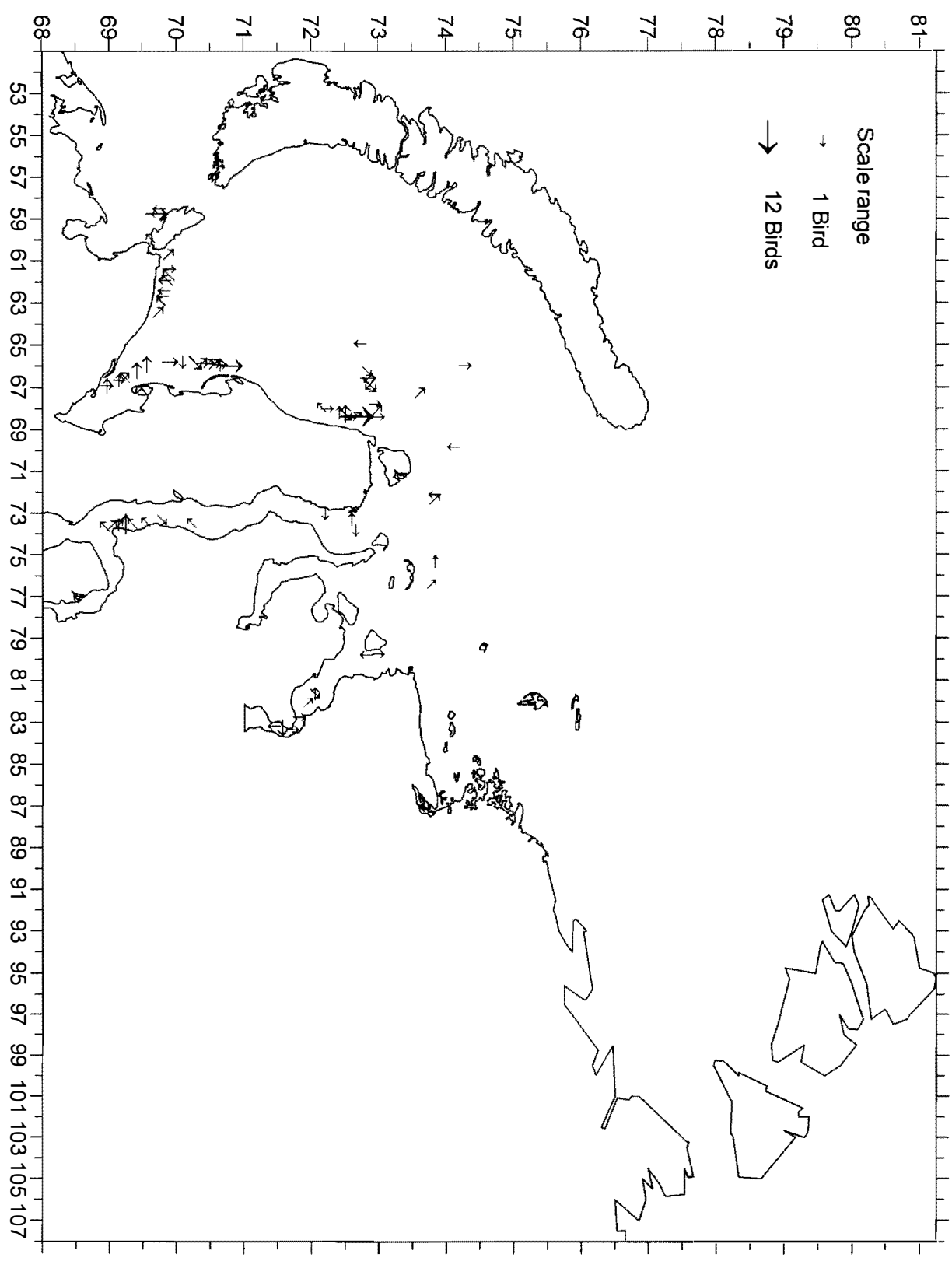


Fig. 52. Flight directions of divers (*Gavia* sp.) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

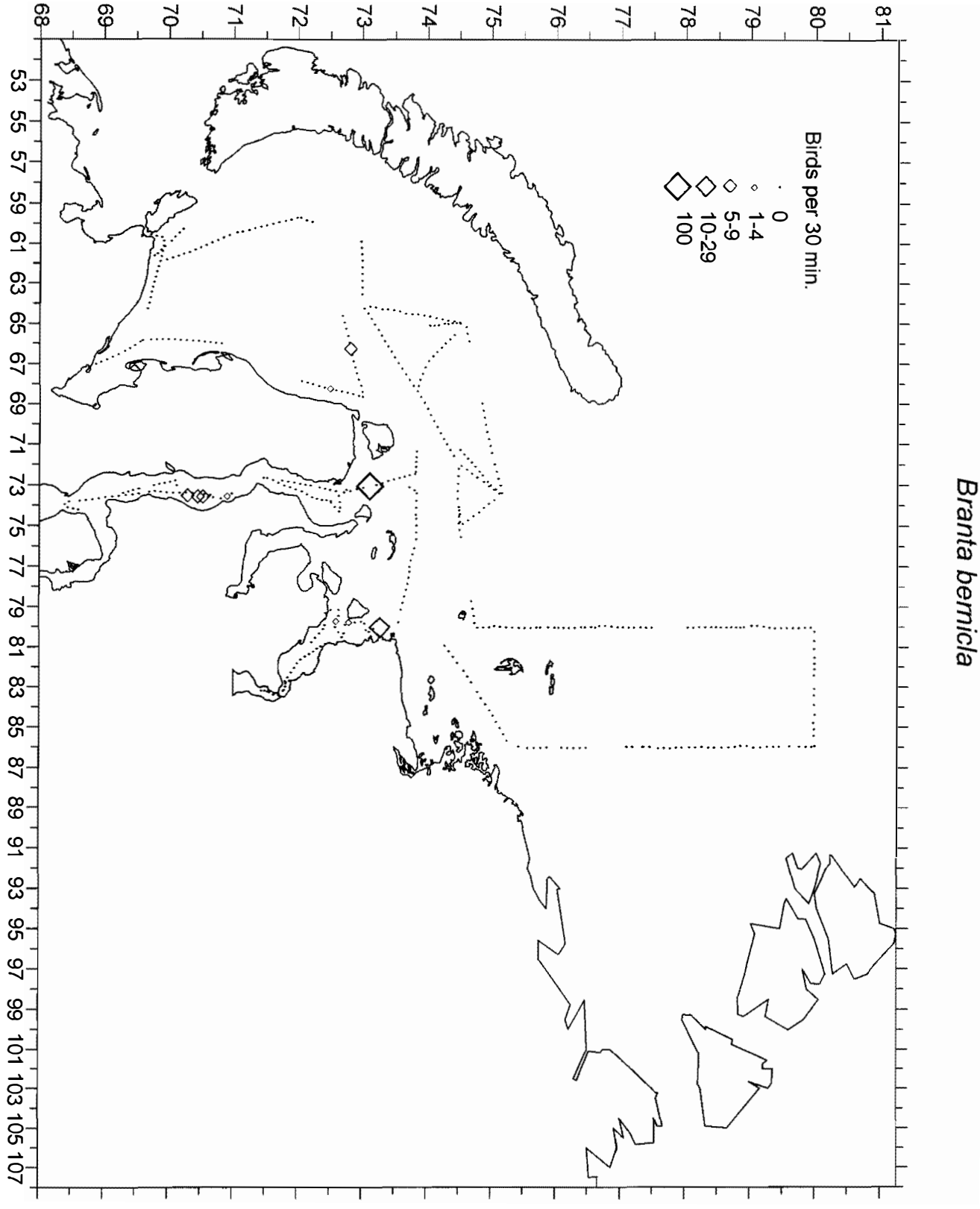


Fig. 53. Distribution of barnacle geese (*Branta leucopsis*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

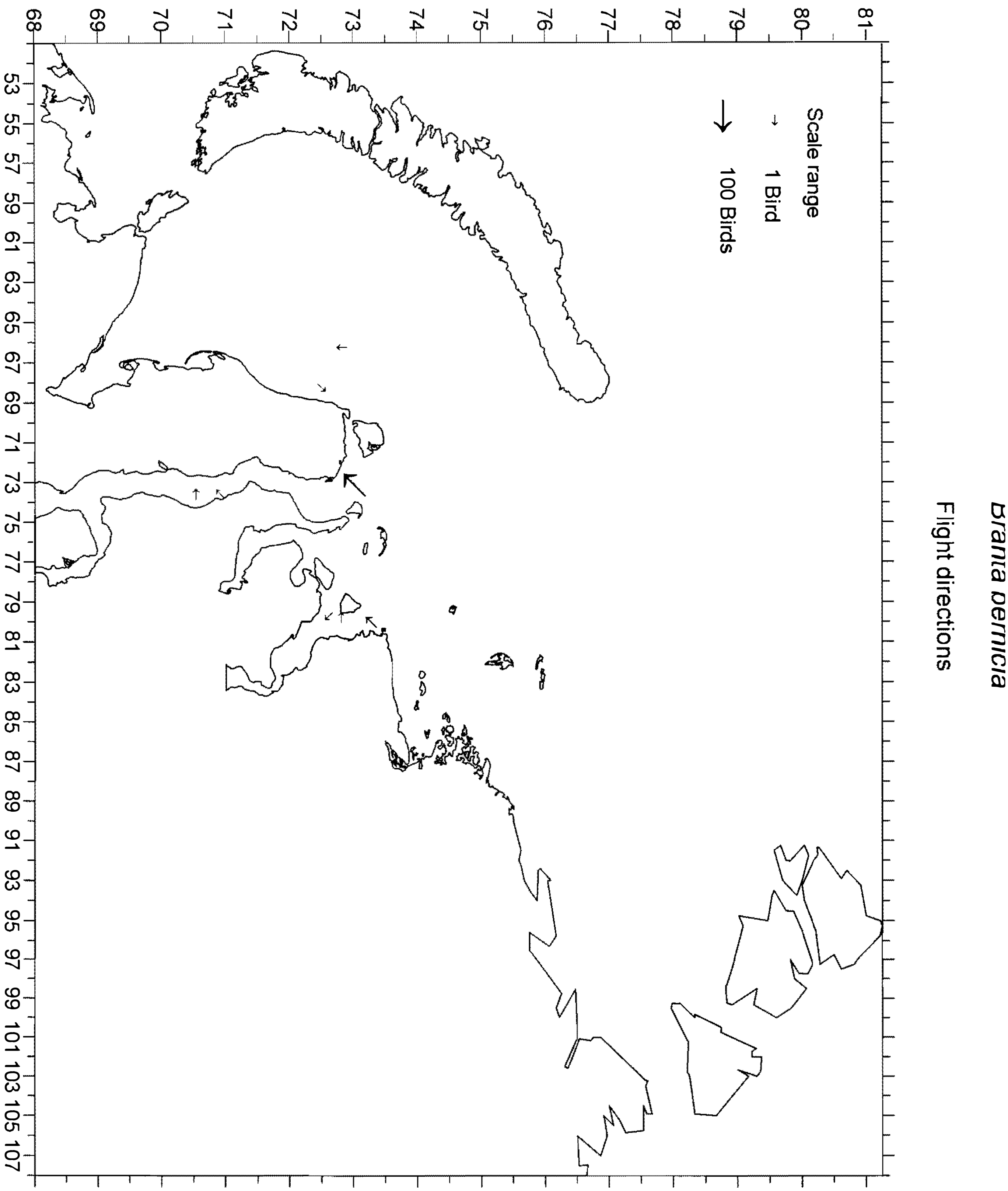


Fig. 54. Flight directions of barnacle geese (*Branta leucopsis*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

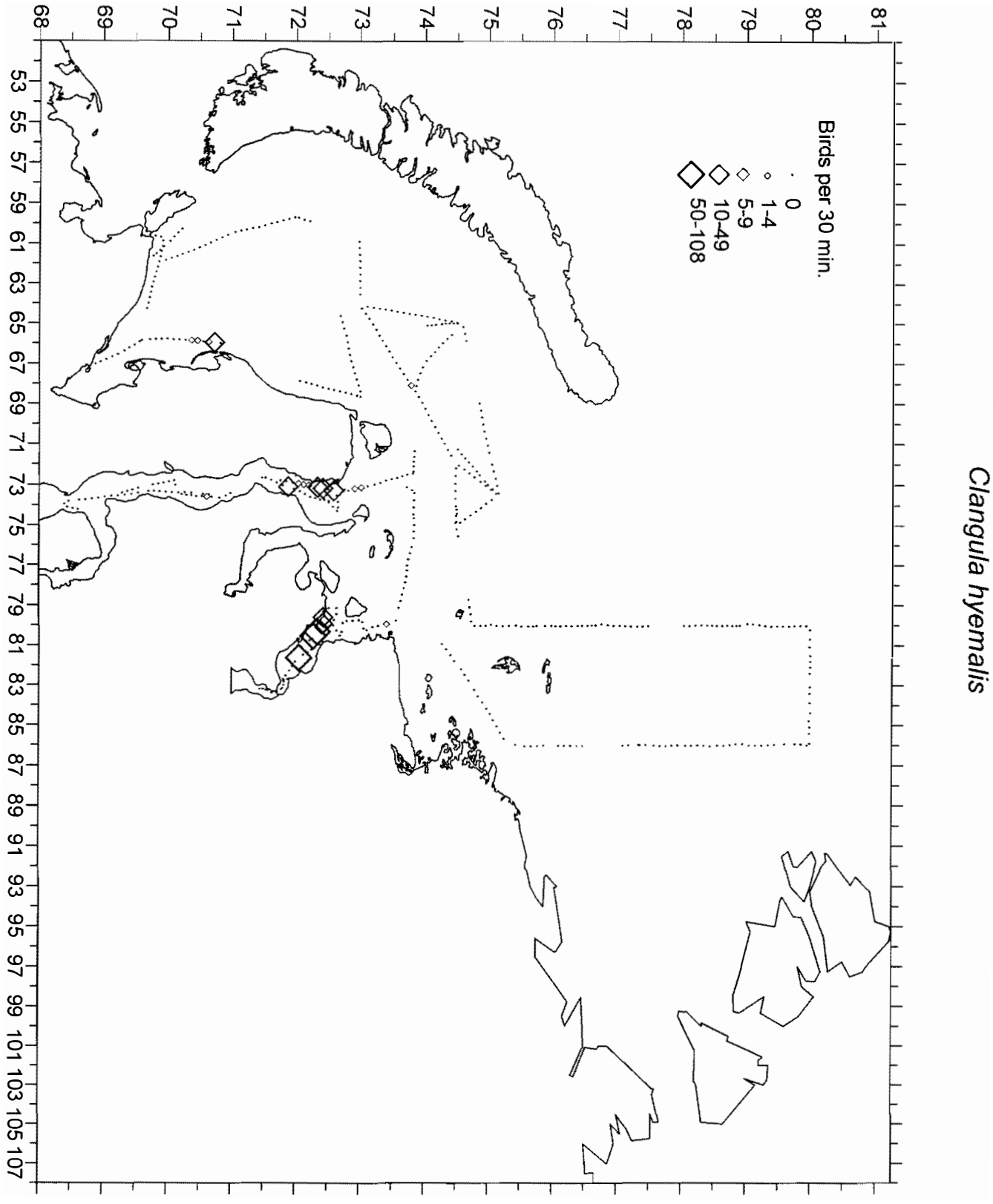


Fig. 55. Distribution of long-tailed ducks (*Clangula hyemalis*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

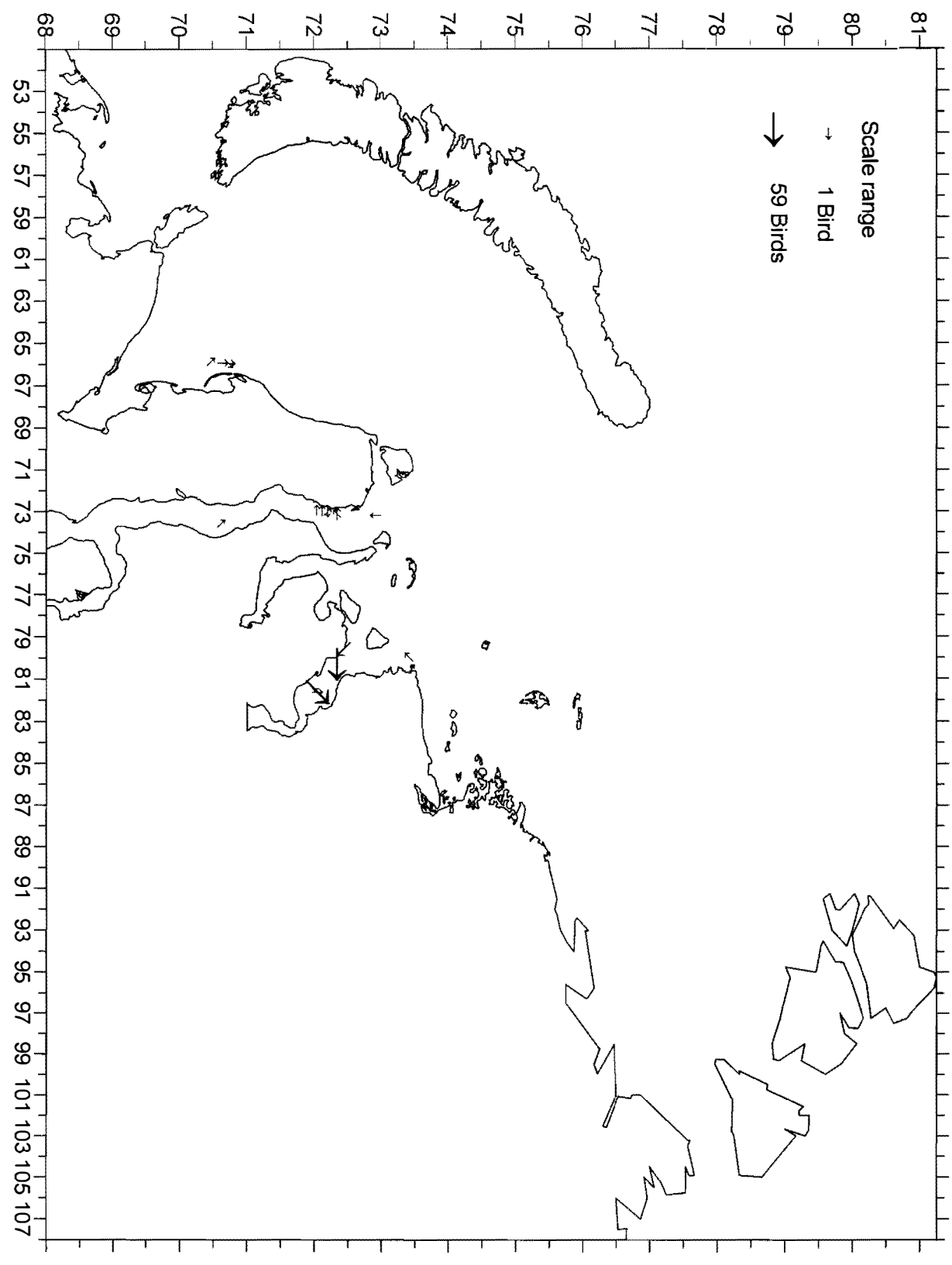


Fig. 56. Flight directions of long-tailed ducks (*Clangula hyemalis*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

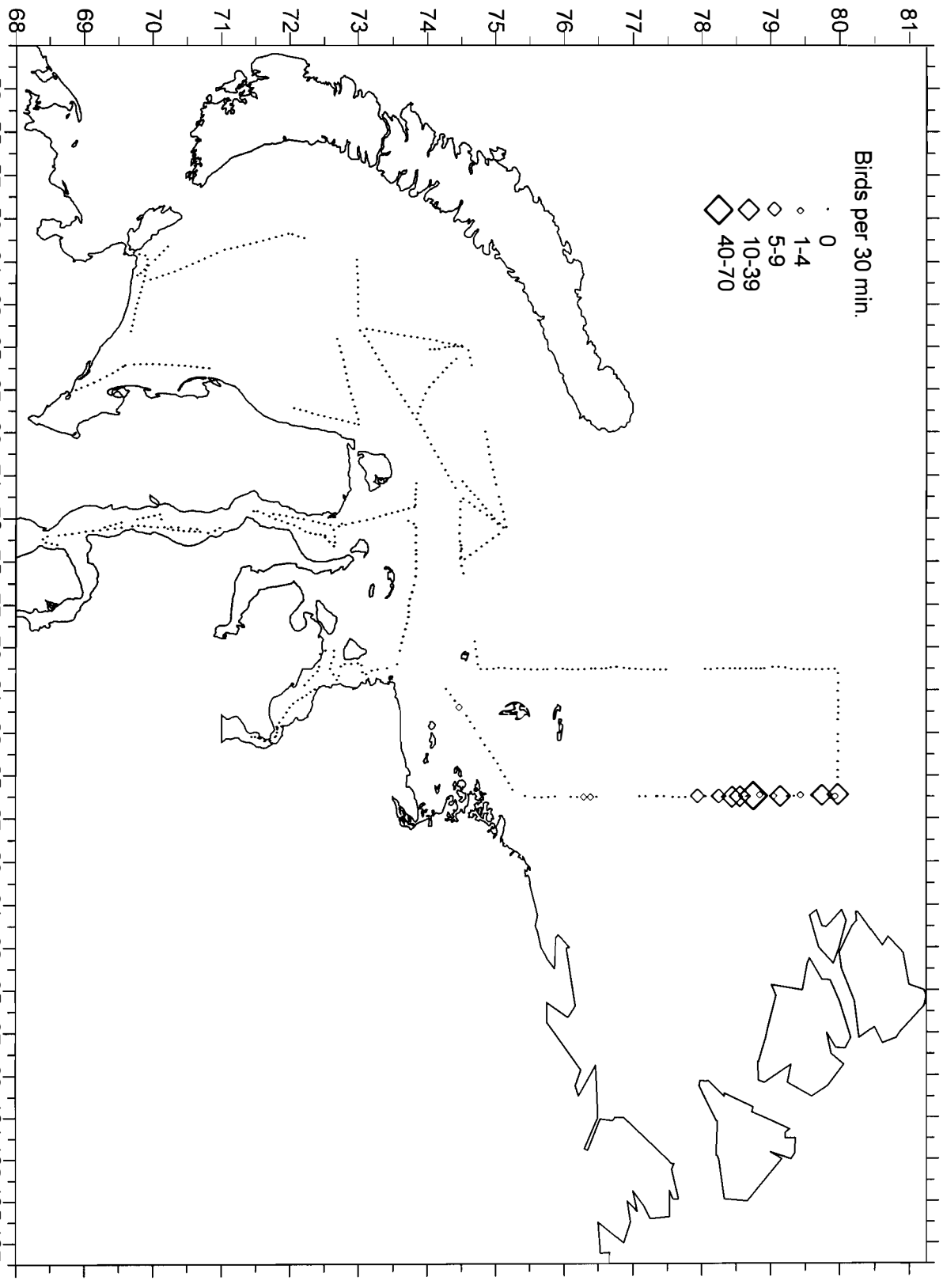


Fig. 57. Distribution of grey phalaropes (*Phalaropus fulicarius*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

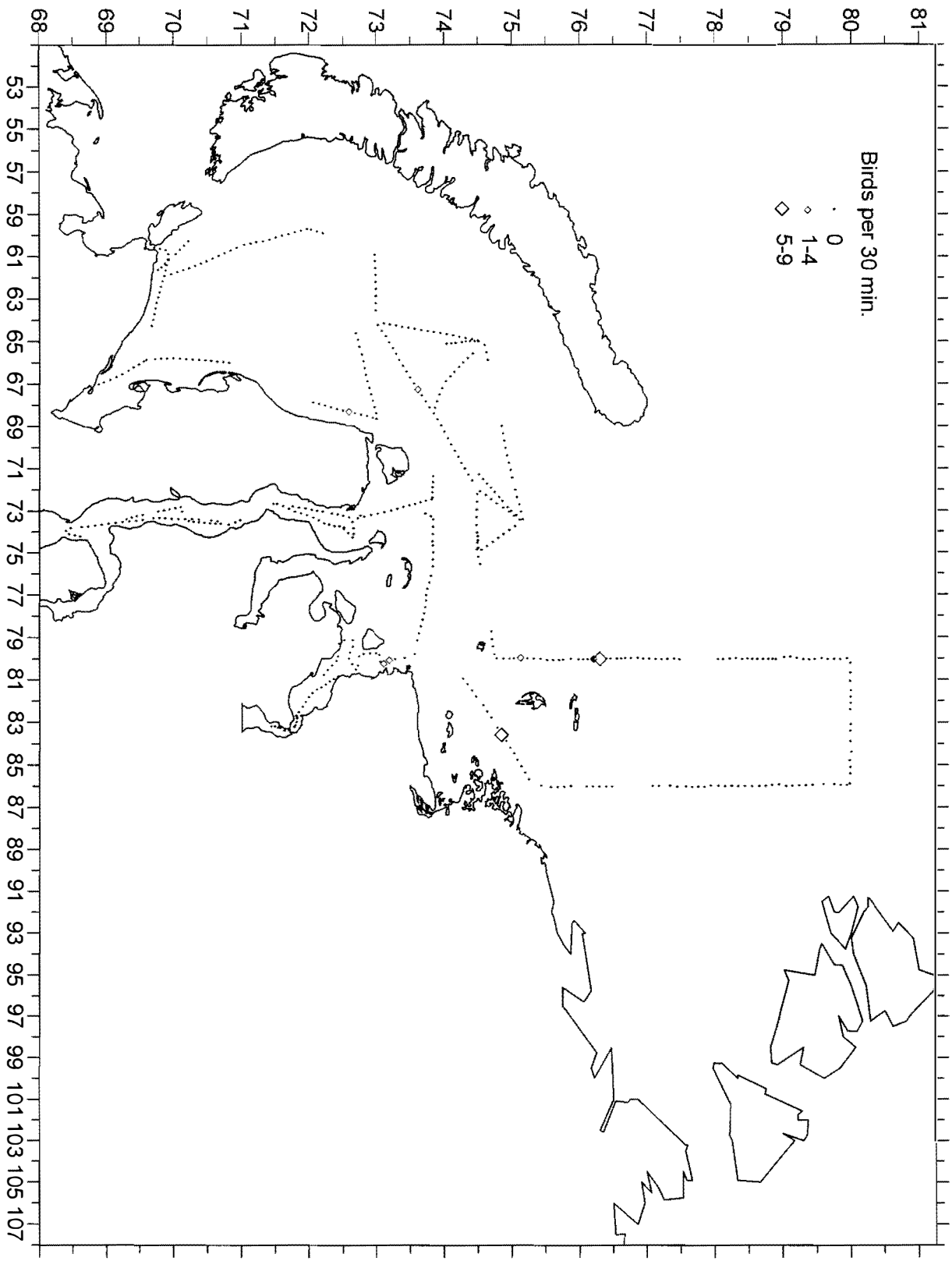
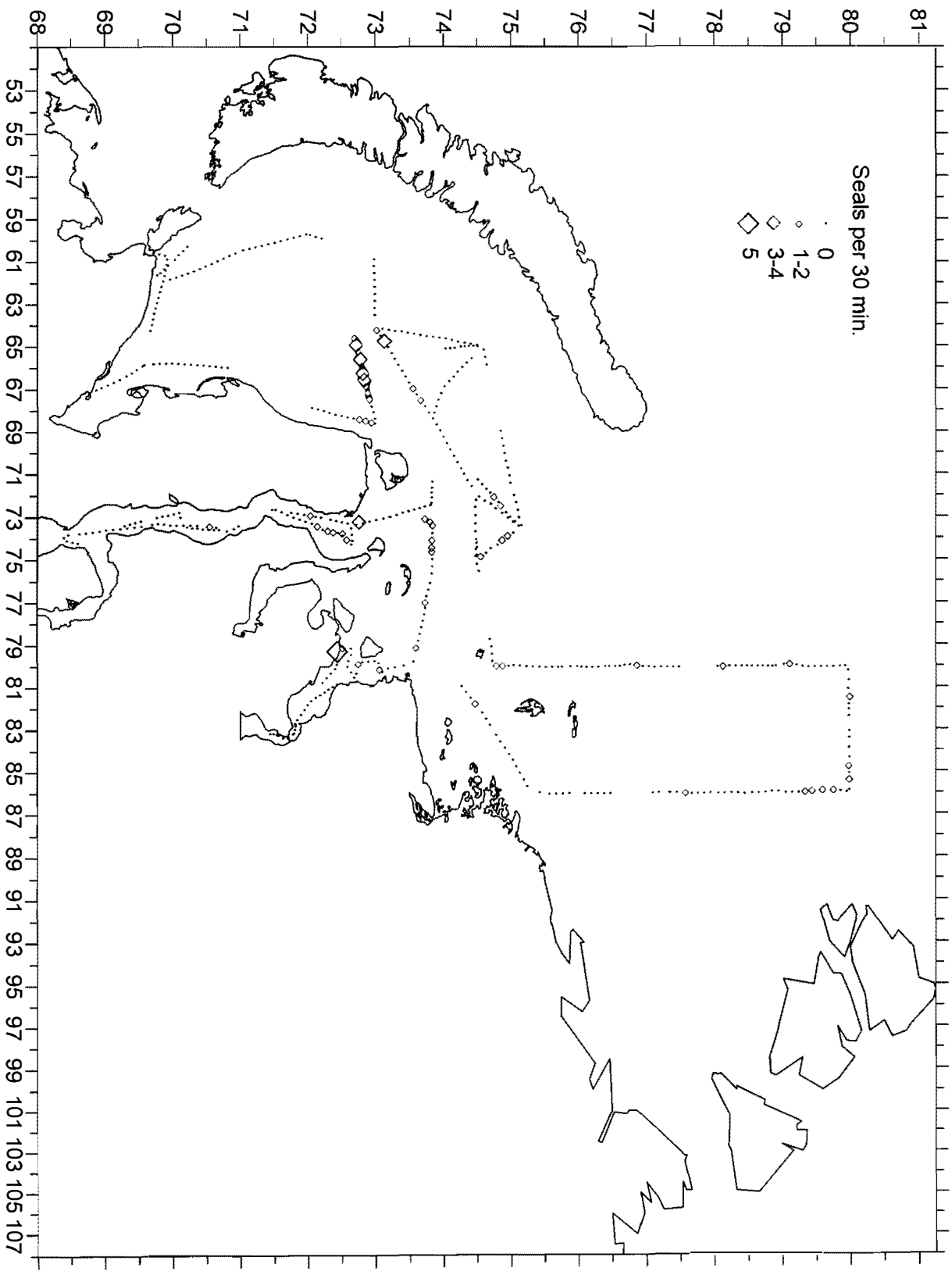


Fig. 58. Distribution of red-necked phalaropes (*Phalaropus lobatus*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.



Pusa hispida

Fig. 59. Distribution of ringed seals (*Pusa hispida*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

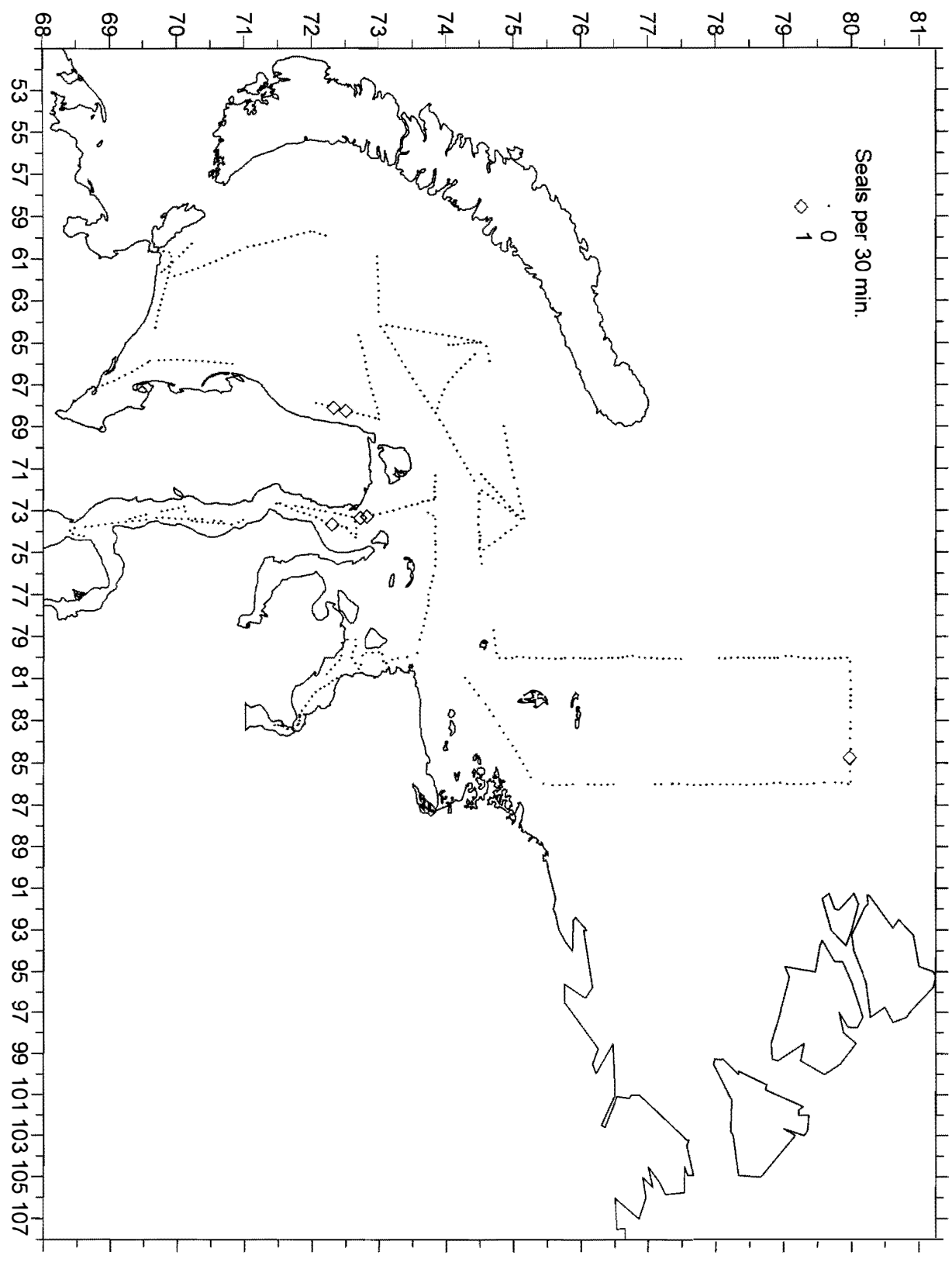


Fig. 60. Distribution of bearded seals (*Erignathus barbatus*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.

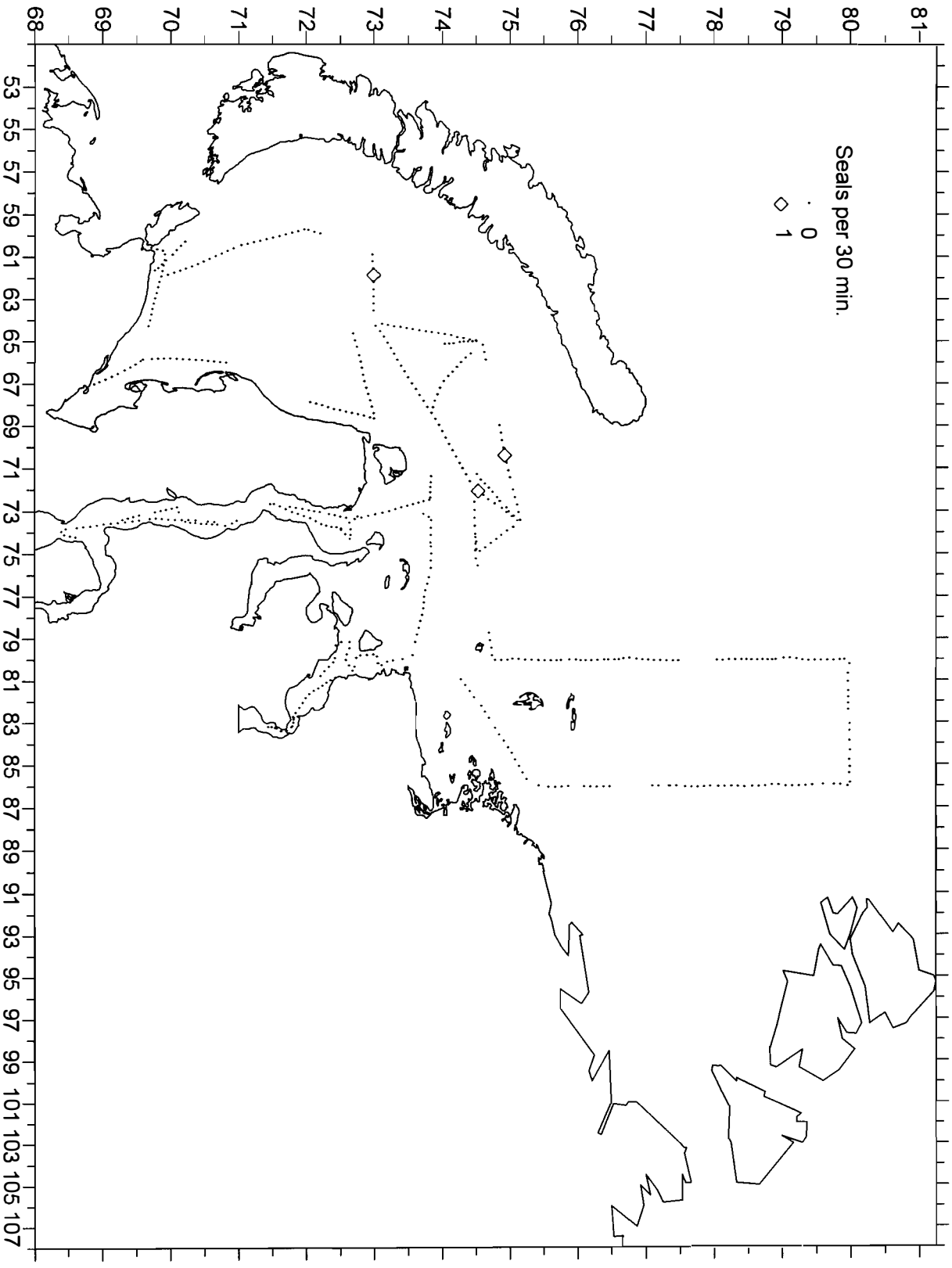


Fig. 61. Distribution of harp seals (*Pagophilus groenlandicus*) (ind. per 30 min.) in the Kara Sea during August 17-September 8, 1995.