LOCATION AND INTENSITY OF THE SOVIET KRILL FISHERY IN THE ELEPHANT ISLAND AREA (SOUTH SHETLAND ISLANDS), 1988/89

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Abstract

This paper analyses fine-scale data from the Soviet krill fishery off Elephant Island (Subarea 48.1) between 59°-62°S and 53°-57°W during the period from 21 November 1988 to 25 March 1989. Although the total catch of the USSR in this season reached a maximum, for the last nine seasons the total fishing intensity by the USSR around Elephant Island has been low. In 1988/89 only one standard fishing vessel operated in the area over 40% of the time. The highest catch-per-unit-effort was observed in January 1989 (7.7 tonnes per hour of trawling on average), and the lowest in November 1988 (3.5 tonnes per hour of trawling on average). Fishing strategy in the Elephant Island area conforms to the following simple pattern: (i) vessels enter the island near-shore zone (north of Elephant Island) and start searching for krill concentrations; (ii) krill concentrations are fished and followed as they drift from the island with the current; and (iii) vessels return to position (i) when aggregations are dispersed or lost due to storms and other factors. The velocity of the northeast drift of krill concentrations, calculated on the basis of vessel relocation, was from 9.7 to 11.1 km/day (11 to 13 cm/sec). An analysis of the location of fishing grounds by five-day periods showed that the areas in which the fleet operated overlap a minor part of the foraging zones of krill predators. Based on this, and taking into account the low fishing intensity, it was concluded that the current krill fishery does not significantly affect krill-eating seals and birds.

Résumé

Analyse des données à une échelle très précise sur la pêche soviétique de krill effectuée au large de l'île Eléphant (sous-zone 48.1) entre 59-62°S et 53-57°W durant la période comprise entre le 21 novembre 1988 et le 25 mars 1989. Bien que la capture totale de l'URSS pendant cette saison ci-dessus ait atteint un maximum, l'intensité de pêche totale de l'URSS autour de l'île Eléphant a été faible ces neuf dernières saisons. En 1988/89, un seul navire standard de pêche menait des opérations de pêche dans le secteur pendant 40% de la période. La capture par unité d'effort la plus élevée était observée en janvier (en moyenne, 7,7 tonnes par heure de chalutage), et la plus faible en novembre (en moyenne, 3,5 tonnes par heure de chalutage). La stratégie de pêche dans le secteur de l'île Eléphant suit le simple schéma suivant: (i) les navires entrent dans la zone de l'île proche du littoral (au nord de l'île Eléphant) et commencent à rechercher les concentrations pêchables de krill; (ii) ils exploitent ces concentrations en les suivant alors qu'elles s'éloignent de l'île à la dérive du fil de l'eau; (iii) les navires retournent à la première zone de recherche lorsqu'ils ont perdu la trace des concentrations par suite d'orages et d'autres facteurs, ou lorsque les

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concentrations se sont dispersées. La vitesse de la dérive des concentrations de krill vers le nord-est, calculée à partir des déplacements des navires, variait de 9,7 à 11,1 km/jour (de 11 à 13 cm/sec). Une analyse de la répartition des lieux de pêche par période de cinq jours a révélé que les secteurs d'opération de la flotte empiétait sur une partie peu importante des secteurs d'alimentation des prédateurs de krill. A partir de ces résultats, et compte tenu de la faible intensité de la pêche, il a été déduit que la pêcherie actuelle de krill n'affecte pas de manière significative les phoques et les oiseaux qui s'alimentent de krill.

Резюме

В настоящей работе анализируются мелкомасштабные данные по советскому промыслу криля около о-ва Элефант (Подрайон 48.1) между 59°- 62°ш. и 53°-57°р.д. за период с 21ноября 1988 г. по 25 марта 1989 г. Несмотря на то, что общий вылов СССР за вышеупомянутый сезон достиг максимума, за последние девять сезонов общая промысловая интенсивность СССР в районе о-ва Элефант была низкой. В 1988/89 г. лишь одно стандартное промысловое судно работало в этом районе в течение 40% данного периода. Наивысшая величина СЗГУ наблюдалась в январе (7,7 тонны за час траления в среднем), а наименьшая - в ноябре (3,5 тонны за час траления в среднем). Промысловая тактика сводится к следующей простой схеме: (i) суда входят в прибрежную зону (к северу от о-ва Элефант) и начинают разыскивать концентрации криля; (ii) эти концентрации облавливаются по пути их дрейфа от острова; и (iii) суда возвращаются в район первоначального поиска когда концентрации теряются в результате штормов и прочих факторов. Скорость северовосточного дрейфа концентраций криля, вычисленная по перемещению судов, составила 9,7 - 11,1 км/день (11 - 13 см/секунду). Анализ местоположения промысловых участков по пятидневным периодам указал на частичное совпадение незначительной части нагульных ареалов питающихся крилем животных и районов ведения промысла. В связи с этим и приняв во внимание низкую интенсивность промысла, мы пришли к заключению, что промысел криля в настоящее время не оказывает значительного влияния на питающихся крилем тюленей и птиц.

Resumen

Este documento analiza los datos de microescala obtenidos durante el período del 21 de noviembre de 1988 al 25 de marzo de 1989 de la pesquería de kril soviética, realizada a la altura de la isla Elefante (Subárea 48.1) entre 59° a 62°S y 53° a 57°W. Aunque la captura total de la URSS alcanzó un máximo durante esta temporada, la intensidad de pesca total de este país alrededor de la isla Elefante en las últimas nueve temporadas ha sido baja. En 1988/89 sólo un buque pesquero estándar faenó en esta zona durante el 40% de este período. En enero se registró la captura por unidad de esfuerzo más alta (un promedio de 7.7 toneladas por hora de arrastre), y en noviembre la más baja (un promedio de 3.5 toneladas por hora de arrastre). Las tácticas pesqueras

en la zona de la isla Elefante se ciñen al siguiente régimen: (i) los buques entran a la zona costera de la isla (al norte de la isla Elefante) e inician la búsqueda de concentaciones de kril; (ii) comienzan la pesca de estas concentraciones, y se desplazan juntamente con éstas, alejándose de la isla ayudados por la corriente; y (iii) regresan a la posición (i) cuando las concentraciones se dispersan o se pierden debido a las tormentas u otros factores. La velocidad del desplazamiento noreste de las concentraciones, calculada según la nueva posición del buque, fluctuó entre 9.7 a 11.1 km/día (11 a 13 cm/seg). El análisis de la asignación de los caladeros de pesca por períodos de cinco días demostró que las zonas en que faena la flota coincide solo en una pequeña parte de las zonas de alimentación de los animales krilógrafos. Basado en esto, y tomando en cuenta la baja intensidad de pesca, se concluyó que la pesquería actual de kril no afecta significativamente a las aves y focas que se alimentan de éste.

1. INTRODUCTION

One of the tasks of the Working Group on Krill (WG-Krill) is to analyse the operation of the krill fishery, including catch size and fishing area locations. The results of such analyses are important in developing measures for managing the krill fishery within the framework of the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR). The information obtained may be useful for stock identification, studying krill drift in fishing areas, and assessing the potential effect of the krill fishery on other ecosystem components (Marín *et al.*, 1991). Such information also provides a better understanding of strategies employed in the krill fishery by various nations. This document presents the preliminary results of an analysis of Soviet fishing fleet's activities around Elephant Island (Subarea 48.1) in the 1988/89 season. An attempt was made to interpret available data in relation to fishing regimes, krill flux from Elephant Island to the South Orkney Islands, and the potential effect of the fishery on krill-dependent predators in the Elephant Island area.

2. MATERIAL AND METHODS

The source information was obtained from commercial vessels (Komarevtsev, 1989) and vessels' log books (where available).

The following data were extracted from this information and stored as a computer database:

- date, time and haul duration;
- coordinates at start of haul;
- vessel course and towing speed;
- haul depth; and
- catch per haul.

At present the database consists of information on 1 200 hauls. This constitutes some 70 to 90% of the total number of hauls made by the Soviet fleet in the area during the 1988/89 fishing season (Komarevtsev, pers. comm.).

Fishing activity was analysed using methods developed in AtlantNIRO (Kadylnikov, 1985). The BMRT vessel of the *Grumant* class with a 78/420 m trawl was taken to be the standard fishing unit. It yielded the highest total catch of all vessels engaged in the fishery.

Calculations and mapping of fishing areas were made with an EC-1046 computer, using the STARTOP and STARTK programs developed by AtlantNIRO.

The starting co-ordinates of each haul were shown on the maps attached (Figures 1 to 8).

3. RESULTS

Summary results of the Soviet krill fishery in the Elephant Island area (Subarea 48.1) in 1988/89 are given in Table 1.

The information in Table 7 demonstrates that the krill fishery was variable in terms of the number of vessels operating and their fishing efficiency. Over 40% of the time the average number of vessels fishing was one to two (standard fishing units) with a maximum of seven vessels during one five-day period.

Catch-per-day fished and catch-per-hour of fishing by a standard vessel by month were highest in January 1989. The number of fishing hours-per-day was about 12 hours, while in other months it was close to 15 hours. In February/March catch-per-day fished decreased from 85-90 tonnes to 50 tonnes. This may have been due to vessels moving to other areas where the fleet's catching efficiency increased considerably.

The locations of fishing grounds from November 1988 to March 1989 are shown in Figures 1 to 5.

In November 1988, the fishery was concentrated within one small area northeast of Elephant Island between 60°-60°30'S and 54°-55°W.

In December 1988, krill was targetted in a larger area within the broad zone from Elephant Island to 59°S.

In January 1989, vessels worked in three main areas. The first and most remote area to the northeast of Elephant Island between 59°45'-60°15'S and 53°-54°15'W, the second one to the north of Seal Island between 60°-60°30'S and 55°-56°00'W and the third one located to the west of Elephant Island in the area between 61°-61°30'S and 56°-57°W.

In February and March 1989 the fishery was carried out mainly in one area to the north of Seal Island, almost in the same area as in January 1989. Compared with February, in March the fishing area extended further east to 54°30'W.

Figures 6a to 6f show the locations of fishing grounds by five-day period in December 1988 and January and February 1989 (i.e., in months critical for the breeding populations of penguins and seals).

During the first five days of December 1988 (Figure 6a) the area 60° to 61°S was the main fishing ground, moreover most hauls were carried out in the small "patch" northeast of Elephant Island between 60°-60°15' and 54°10'-54°45'W.

After the second five-day period, the fleet gradually moved northeast (Figures 6b and 6c). In the fourth five-day period vessels operated at a considerable distance from Elephant Island in the northeast corner of the area (Figure 6d) and then moved south. In the last five-day period of December most vessels worked in two groups, and in the area far from Elephant Island, 59°30'-60°30'S and 53°-54°W (Figure 6f).

Early in January 1989 some vessels moved closer to Elephant Island and operated in two fishing grounds (Figures 7a to 7f). The first one, fished throughout the month, was located to the north of Seal Island between 60°30'-61°S and 55°-56°W. The second one was to the west

of Elephant Island between 61°-61°30'S and 56°-57°W, where vessels fished only during the second five-day period. The remote area northeast of Elephant Island (53°-54°30'S and 59°30'-60°30'W) was the main fishing ground in the first half of January 1989.

In the next five-day period vessels started to leave the study area one by one and in the last ten days of January 1989 fishing in the area had ceased (Figure 7f).

Early in February 1989, krill fishing in the study area resumed and was carried out at low fishing effort within the coastal zone between 60°45'-61°S and 55°10'-55°45'W. Fishing then ceased until early in the fifth five-day period (Figures 8a to 8c). When the fishery resumed in the fifth five-day period, this area became the major fishing ground until the end of February 1989 (Figures 8d and 8e).

4. DISCUSSION

The data presented reveal significant instability in the location of fishing grounds within the study area over the period concerned, particularly in December 1988 and January 1989. Some regularities were noted, however, such as the existence of two general directions of vessel movement relocation during the season: to the northeast of Elephant Island and from the east and northeast towards the island.

The first one was most apparent in December 1988 (Figures 6a to 6d) and was probably related to the direction of the krill flux. The direction of krill flux follows the current direction in the area.

Relocation of vessels in the opposite direction towards Elephant Island was most evident in the first five days of January and February 1989 (Figures 7a and 8a). It is unlikely that movement in this direction is related to krill migrations because krill, in this case, should move upstream. It is more probable that the relocation of fishing vessels had resulted from searching for previously known locations of krill concentrations.

Fishing strategy in the Elephant Island areas conforms to the following pattern:

(i) vessels enter the Elephant Island area and start searching for krill concentrations;

(ii) fishing is targetted on these concentrations and vessels follow these concentrations as they drift from the island; and

(iii) if the targetted concentrations are lost due to storm or other circumstances, vessels return to the area where krill concentrations were initially found.

This strategy has been commonly used by Soviet vessels operating in Statistical Area 48. As a rule, early in the season (November) one or two vessels enter the Elephant Island area and start searching for krill concentrations.

Assuming that the relocation of fishing vessels to the northeast of Elephant Island follows the drift of krill concentrations, it is possible to calculate the velocity of the latter. Krill aggregations drifted northeast for about 105 to 120 n miles (194 to 222 km) from 1 to 20 December 1988 (Figures 6a to 6d). Thus, the average krill drift velocity would be from 9.7 to 11.1 km/day or 11 to 13 cm/sec. The value obtained is within the range determined by WG-Krill in 1991 (SC-CAMLR, 1991 - Annex 5, Table 1).

Although the Soviet catch from Subarea 48.1 during the season discussed was the highest one for the last nine seasons and amounted to 20.9 thousand tonnes (CCAMLR, 1991 - Table 7.2; SC-CAMLR, 1991), fishery intensity was low. Data in Table 1 show that during the

period critical for the survival of krill-dependent predators from December to March (SC-CAMLR, 1990 - Annex 4, Table 3), fishing effort never exceeded 1.0 vessel/day, i.e. only one vessel had permanently worked in the area from 16 January to 20 February.

Comparison of the distribution of fishing grounds with the location of krill predator foraging zones (during the periods when fishing effort exceeds 1.0 vessel/day*) showed that they do overlap, although not always entirely. Thus, in the second half of December, the Soviet krill fishery moved out of the 50 km foraging zone. The vessels worked only in the northeastern part of the 100 km zone (Figure 6). During the first half of January the majority of vessels also operated in the northeastern part of the 100 km zone, while in the 50 km zone they were dispersed and only sometimes (the second five-day period of January) covered up to one-third of the area (Figure 7b). The highest density of vessels within the 50 km zone was observed from the end of February (Figures 8d and 8e). However, the fishing effort applied in the 50 km zone off Elephant Island was within the range of 13.7 to 25.1 vessel/days per five-day period at the end of February to March 1989. Such a level of fishing effort would hardly have any impact on predator populations.

According to the latest calculation the amount of krill caught in the nearshore zone of Subarea 48.1 at the current rate is comparable with the total amount of krill consumed by predators inhabiting the area. However, at present there is no evidence of the fishery having a negative impact on the populations of krill-eating birds and seals as krill biomass is sufficiently high in the area (Agnew, 1991).

The survey of fishing ground locations and fishing intensity supports the assumption that krill predators always have a sufficient amount of krill for feeding outside commercial fishing grounds.

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* Foraging zones of krill predators are marked by circles in the figures; the centres of the two most densely populated predator colonies in the area (Seal Island and Point Lindsey at Elephant Island) were used to mark foraging zones (Agnew, 1991). The large circle (radius of 100 km) outlines the outer boundary of the seal foraging zone and the small one (radius of 50 km) outlines the outer boundary of the bird foraging zone (SC-CAMLR, 1990 - Annex 4, Table 3).

Table 1: Summary of Soviet commercial krill fishery in the Elephant Island area in 1988/89 (standard vessel - BMRT *Grumant*).

Period	Total Catch (tonnes)	Number of Days Fished	Catch-per-Day Fished (tonnes)	Catch-per-Hour Trawling (tonnes/hour)
1988:				
21 to 25 November	333	6.6	50.4	3.60
26 to 30 November	1 636	29.4	55.6	3.50
Total for November	1969	36.2	54.4	3.50
1 to 5 December	1 548	18.9	81.9	4.67
6 to 12 December	764	7.5	101.9	5.30
11 to 15 December	608	5.3	83.3	4.85
16 to 20 December	1 537	20.0	76.9	5.40
21 to 25 December	1 091	12.2	89.4	5.55
26 to 31 December	1 874	16.6	112.9	9.01
Total for December	7 422	90.1	82.4	5.70
1989:				
1 to 5 January	2 900	38.5	75.3	4.74
6 to 10 January	1 707	20.9	81.7	6.41
11 to 15 January	664	7.4	89.7	7.45
16 to 20 January	368	1.5	245.3	22.30
21 to 25 January	158	1.0	158.0	15.50
26 to 31 January	209	1.0	209.0	15.40
Total for January	6006	66.4	90.5	7.74
1 to 5 February	310	3.5	88.6	5.10
6 to 10 February	598	3.9	153.3	6.54
11 to 15 February	-	-	-	-
16 to 20 February	84	1.0	84.0	15.24
21 to 25 February	1 935	22.9	84.5	5.56
26 to 28 February	1 244	15.1	82.4	5.28
Total for February	4 171	48.2	86.5	5.63
1 to 5 March	1 658	25.1	66.1	3.91
6 to 10 March	2 346	24.6	95.4	6.14
11 to 15 March	1 726	19.0	90.8	5.28
16 to 20 March	965	13.7	70.4	5.40
21 to 25 March	706	14.0	50.4	3.95
Total for March	7 401	95.1	77.8	5.07

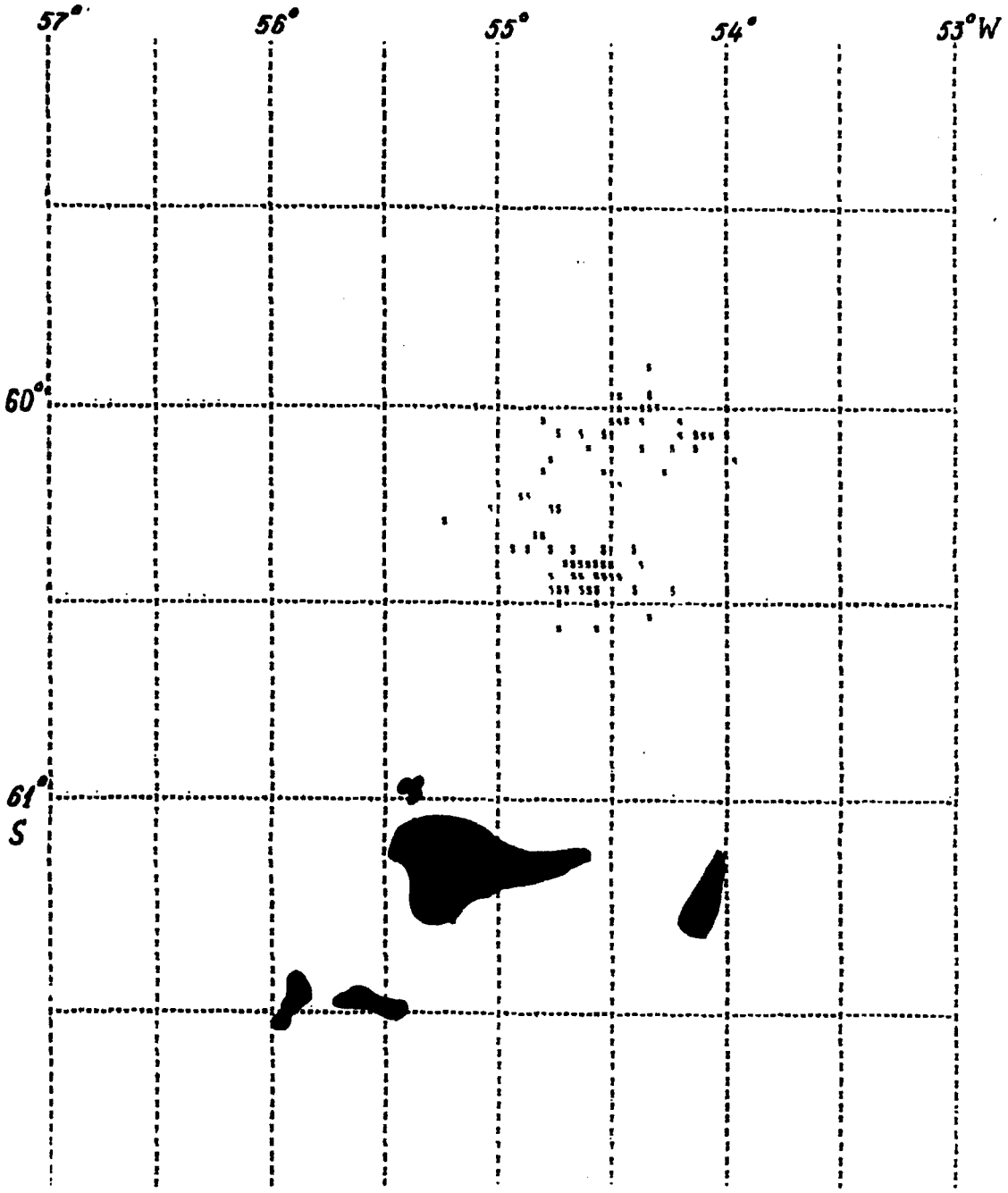


Figure 1: Krill fishery location from 21 to 30 November 1988 (here and elsewhere the haul locations are shown by the starting coordinates).

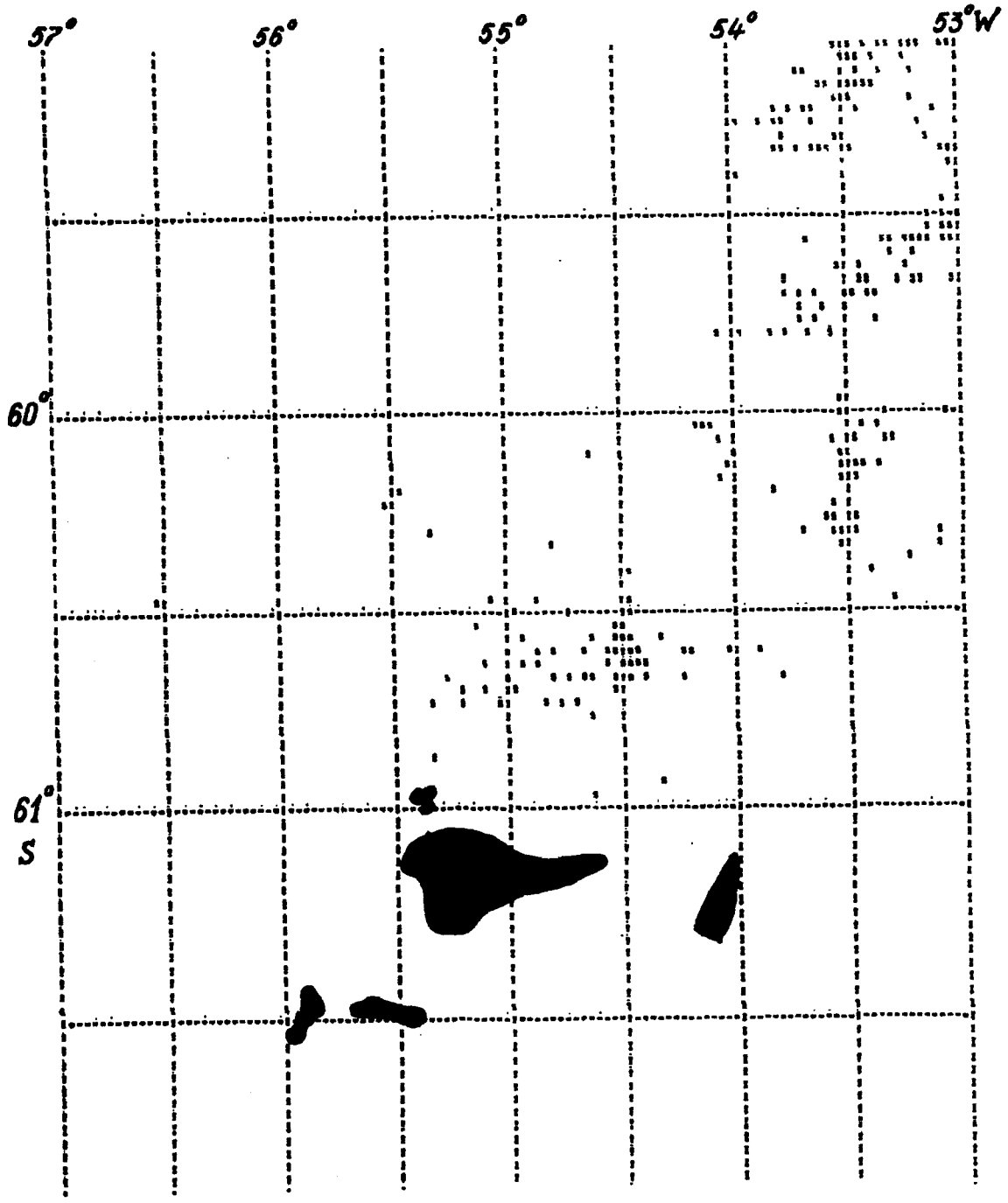


Figure 2: Krill fishery location from 1 to 31 December 1988.

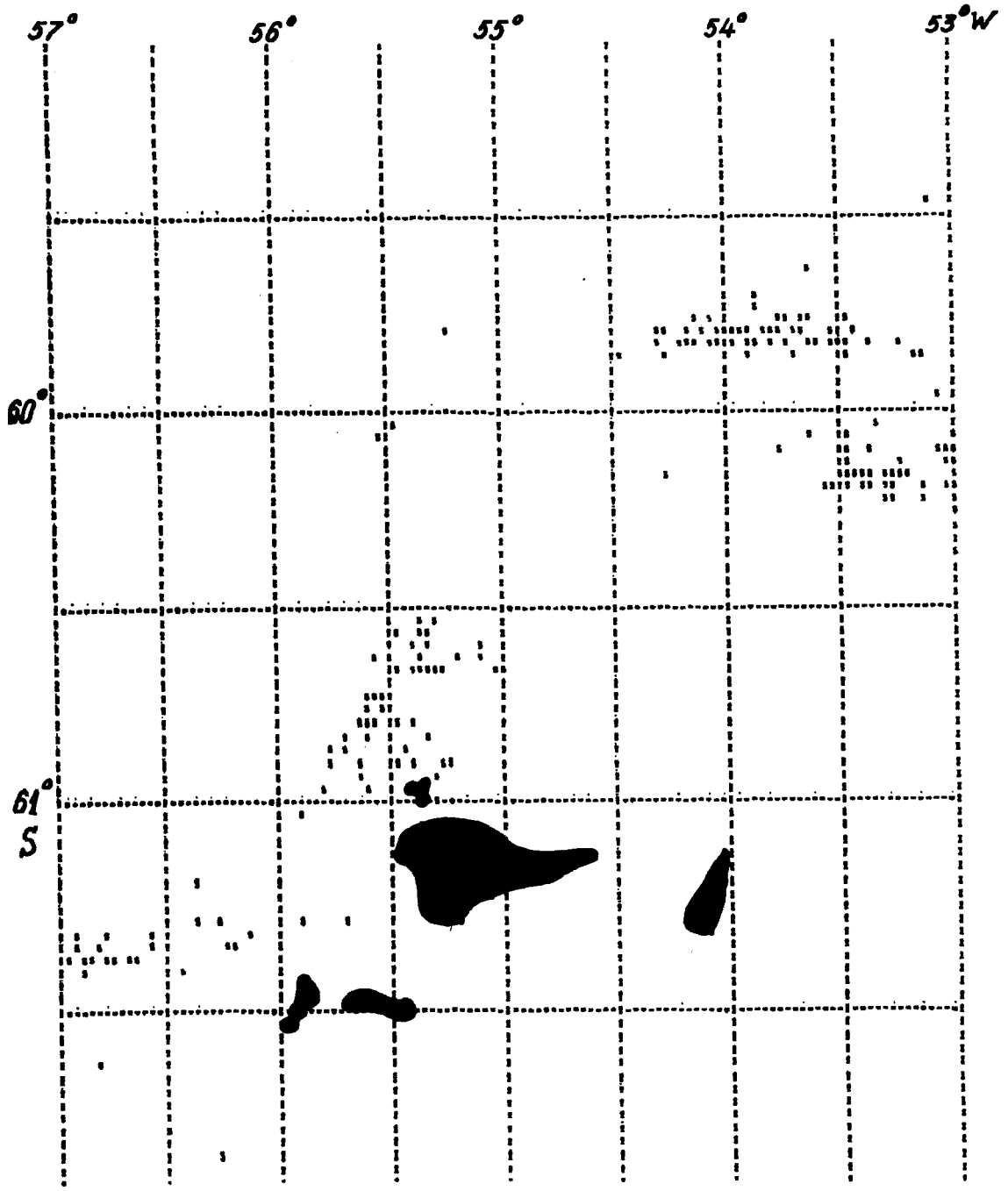


Figure 3: Krill fishery location from 1 to 31 January 1989.

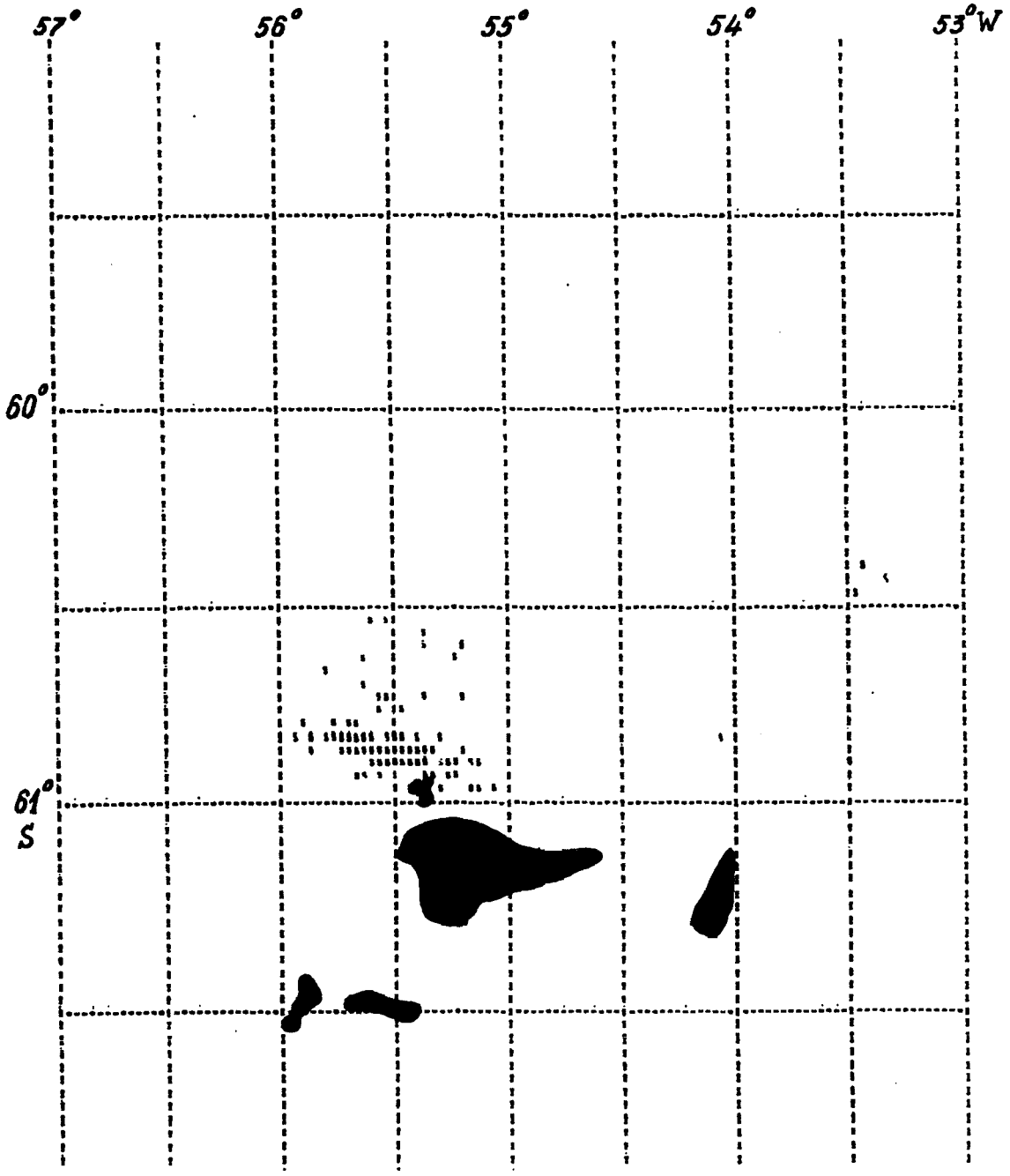


Figure 4: Krill fishery location from 1 to 28 February 1989.

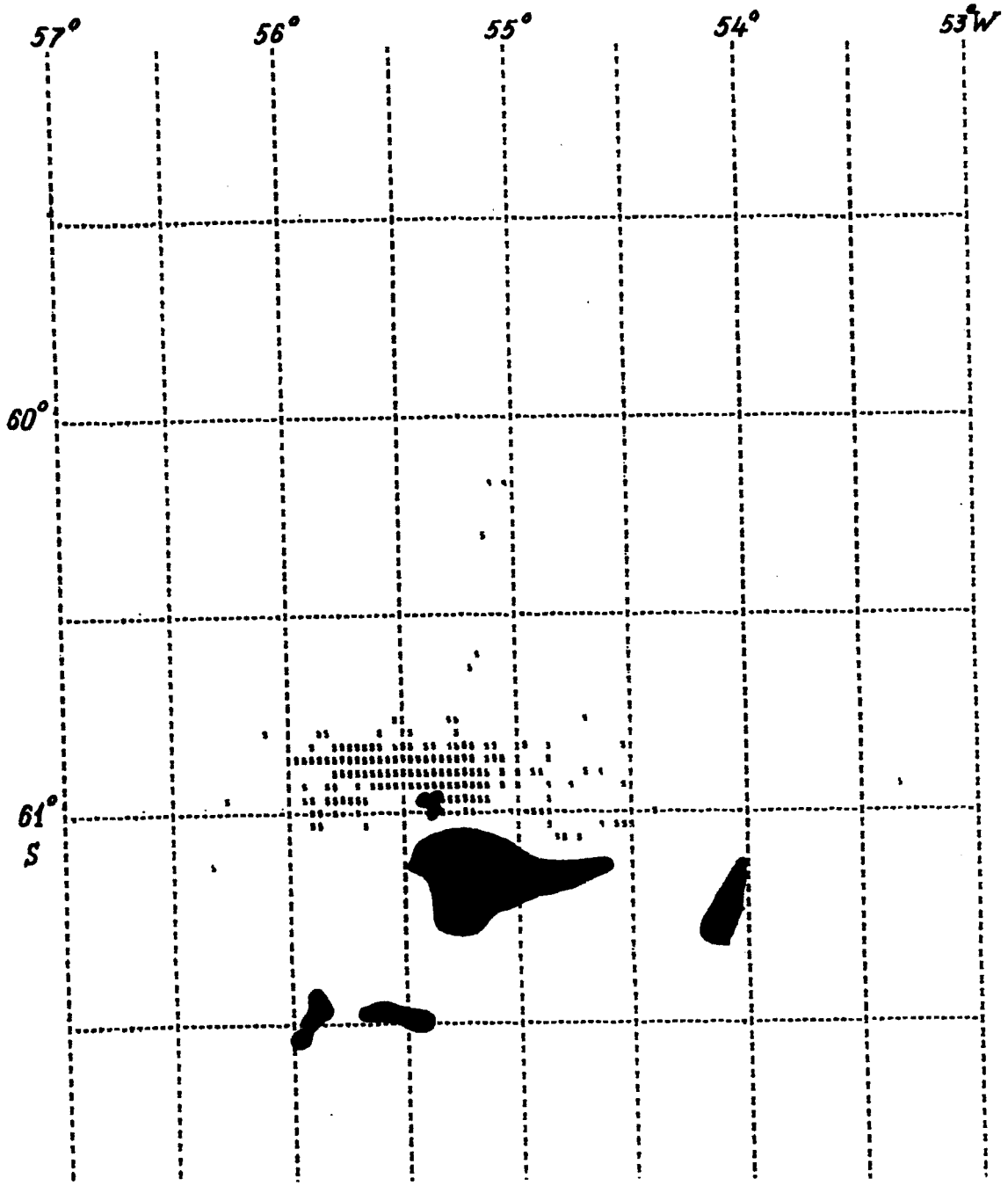


Figure 5: Krill fishery location from 1 to 25 March 1989.

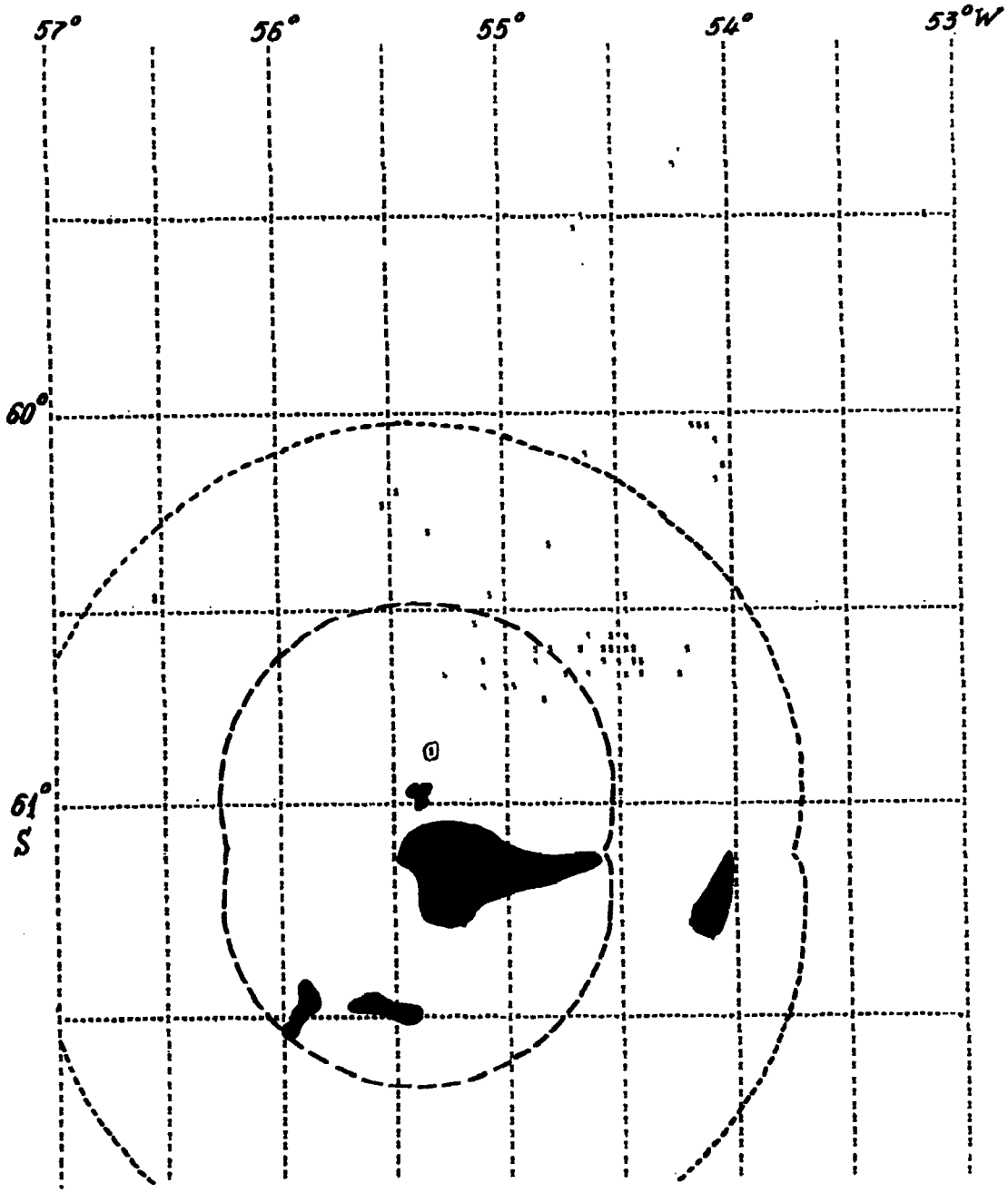


Figure 6a: Krill fishery location by five-day periods from 1 to 5 December 1988.

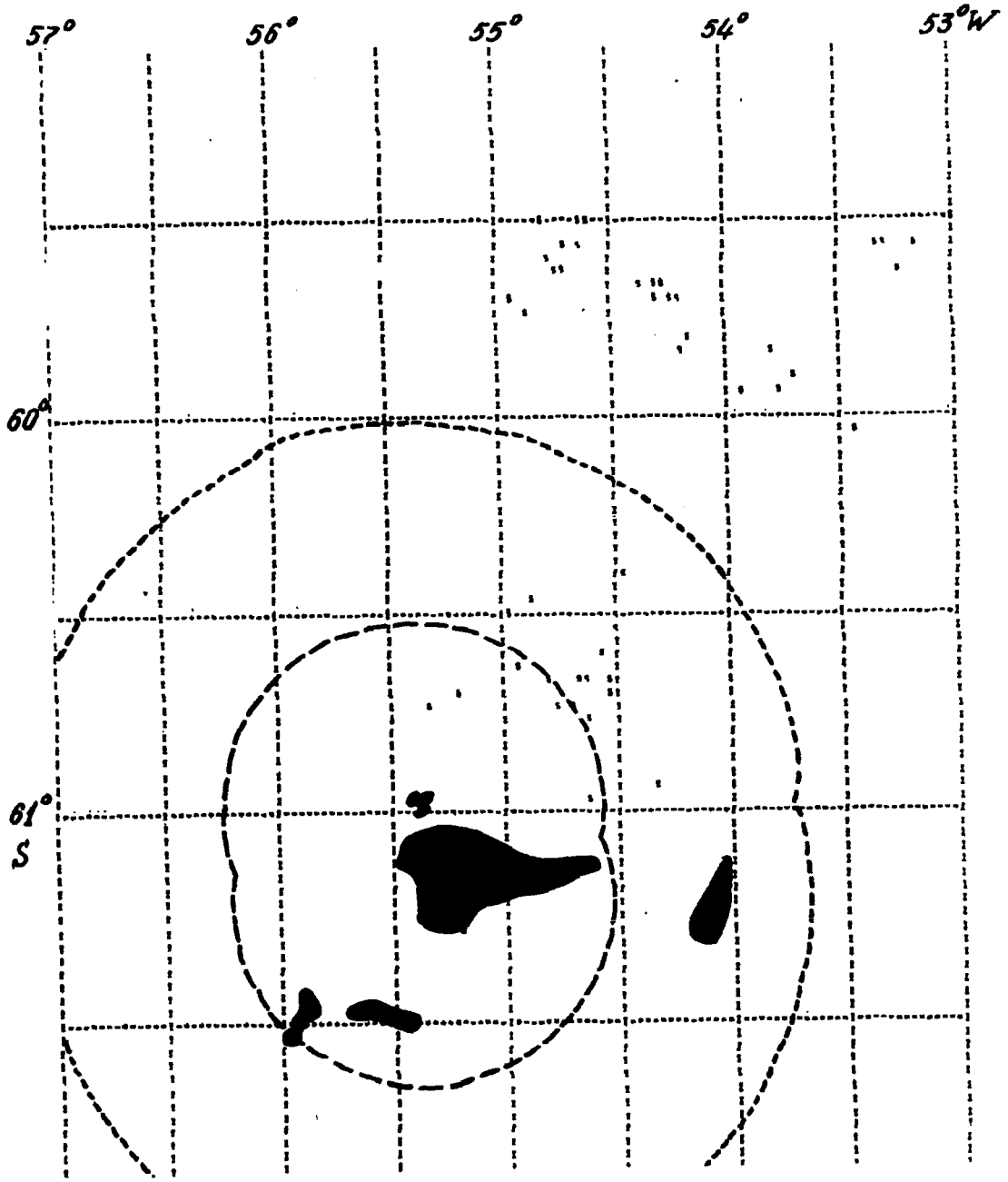


Figure 6b: Krill fishery location by five-day period from 6 to 10 December 1988.

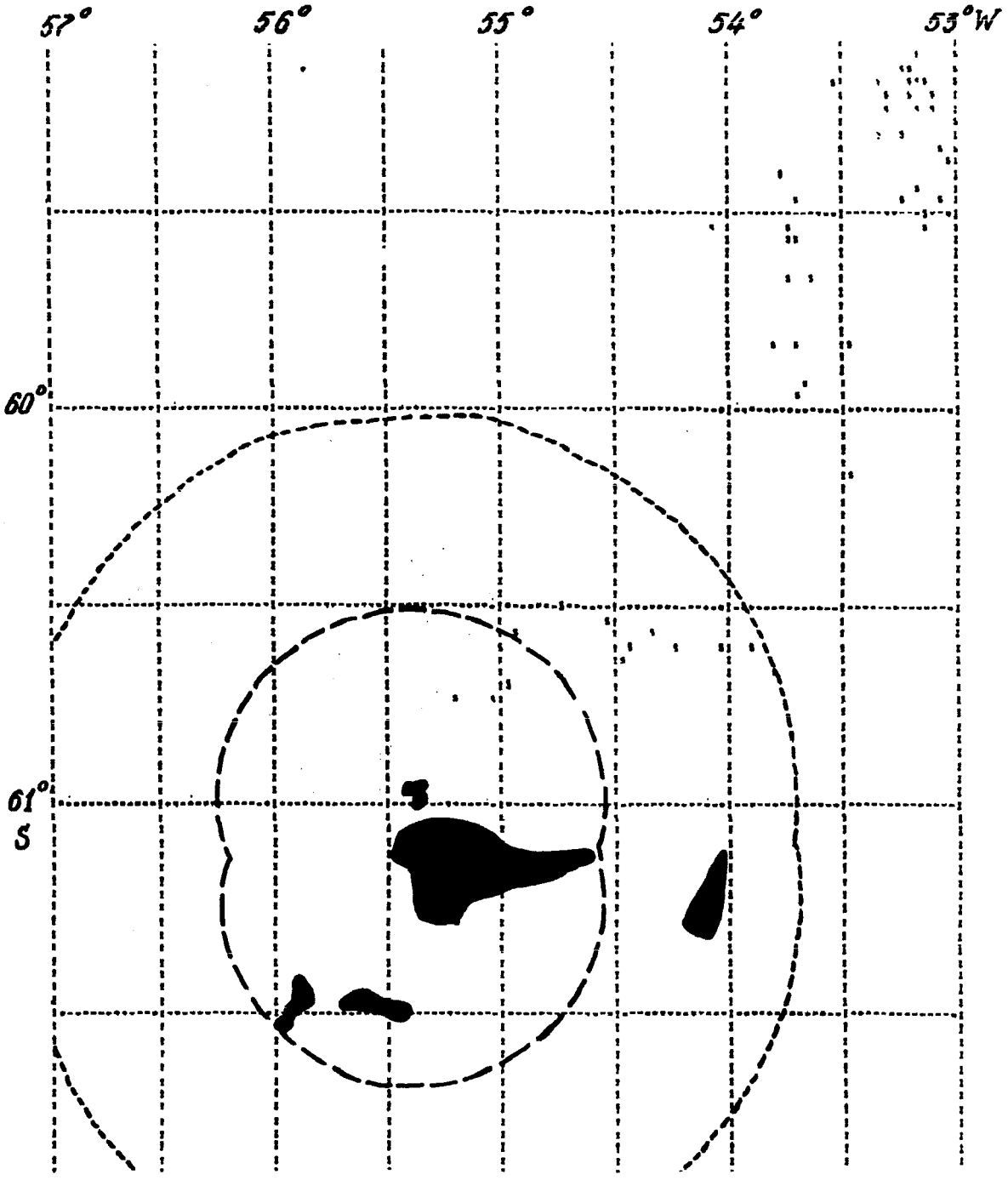


Figure 6c: Krill fishery location by five-day period from 11 to 15 December 1988.

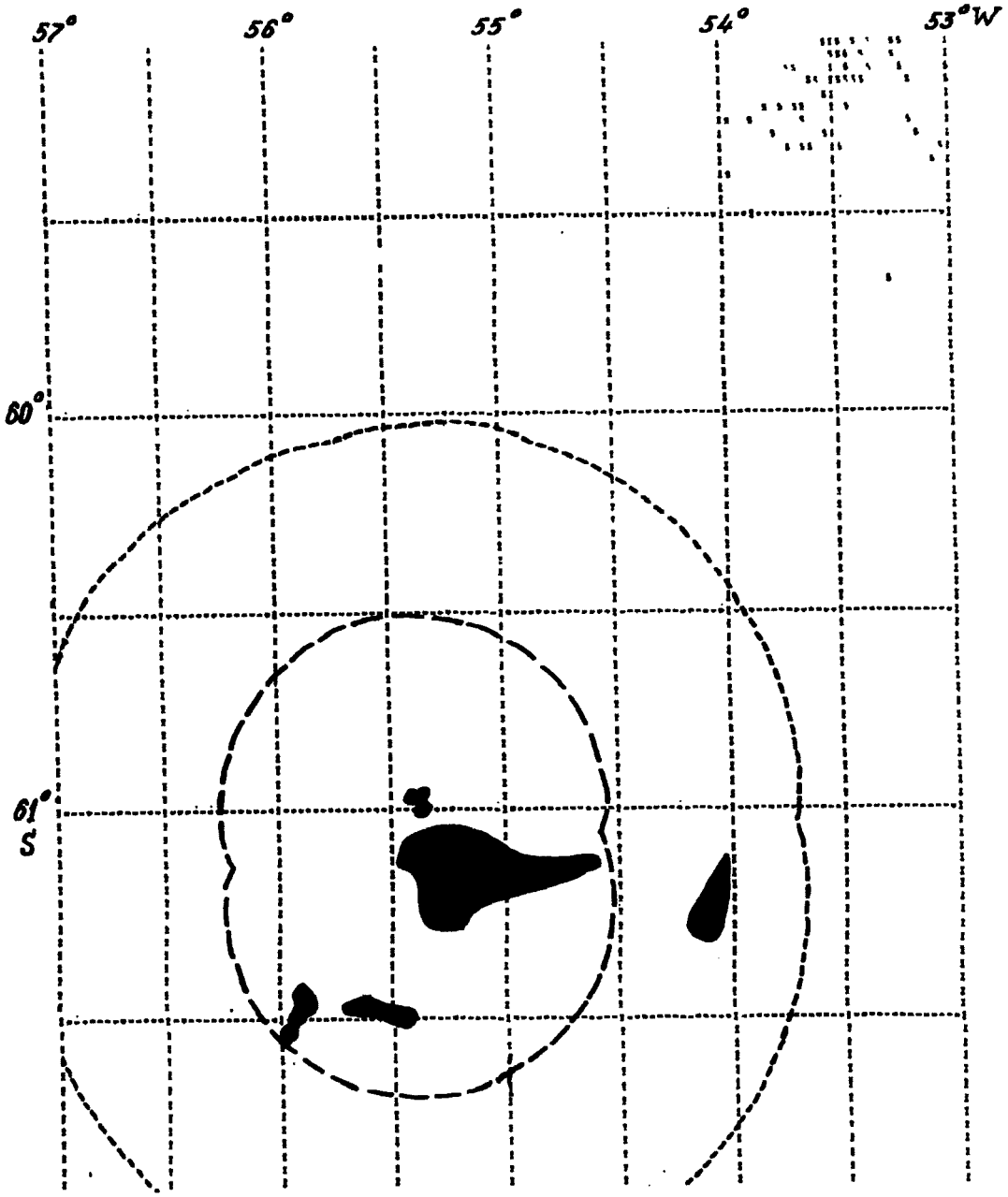


Figure 6d: Krill fishery location by five-day period from 16 to 20 December 1988.

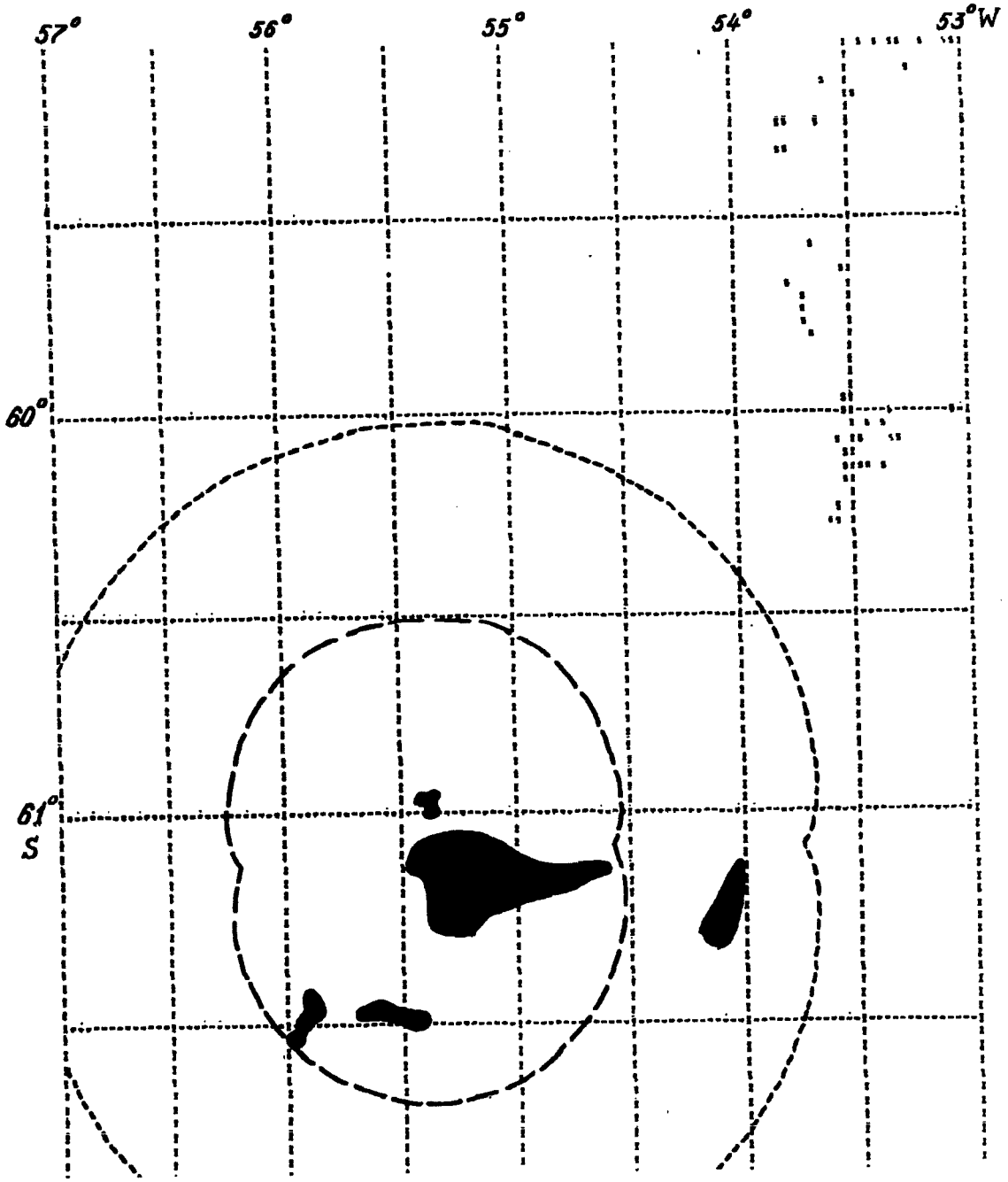


Figure 6e: Krill fishery location by five-day period from 21 to 25 December 1988.

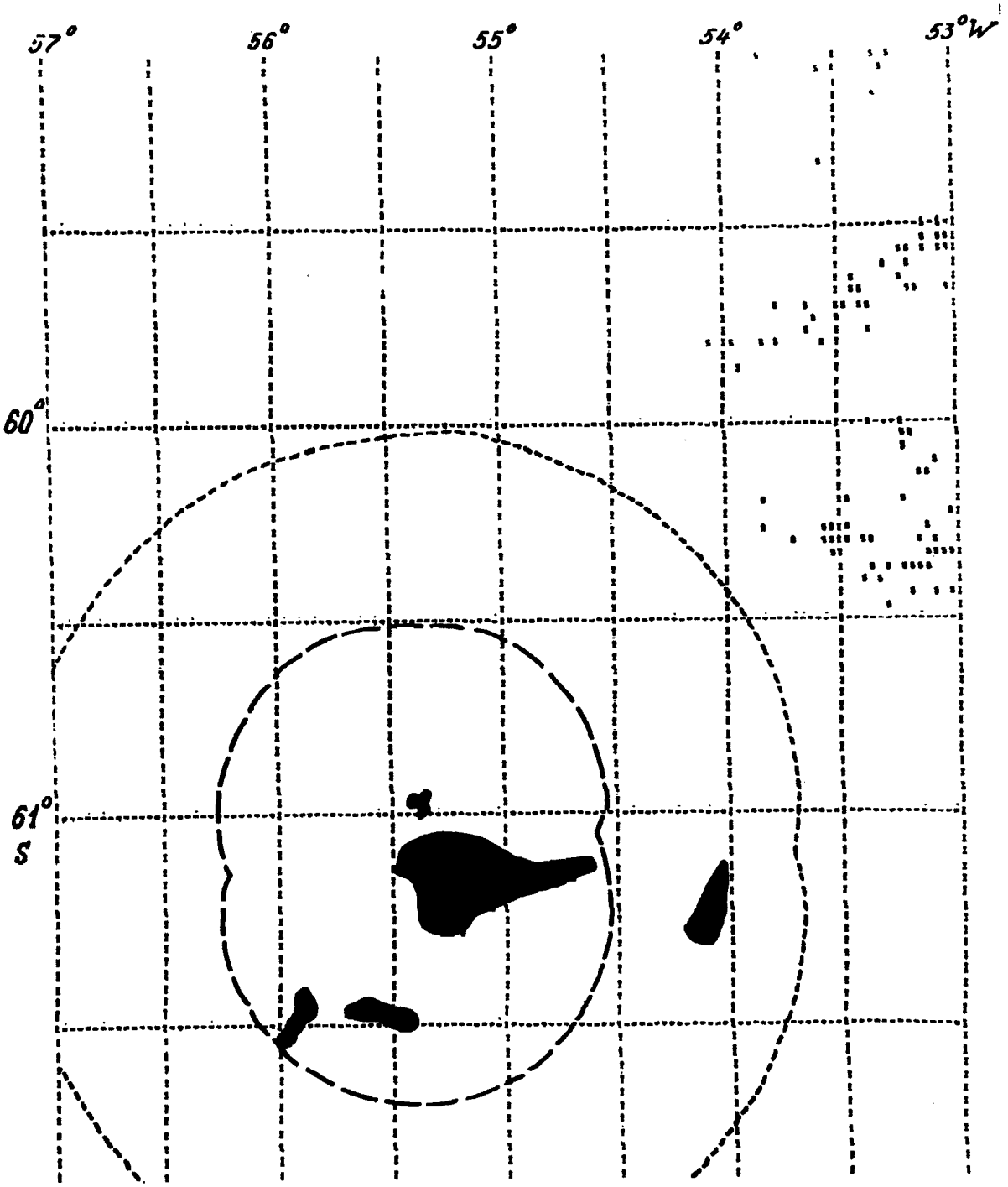


Figure 6f: Krill fishery location by five-day period from 26 to 31 December 1988.

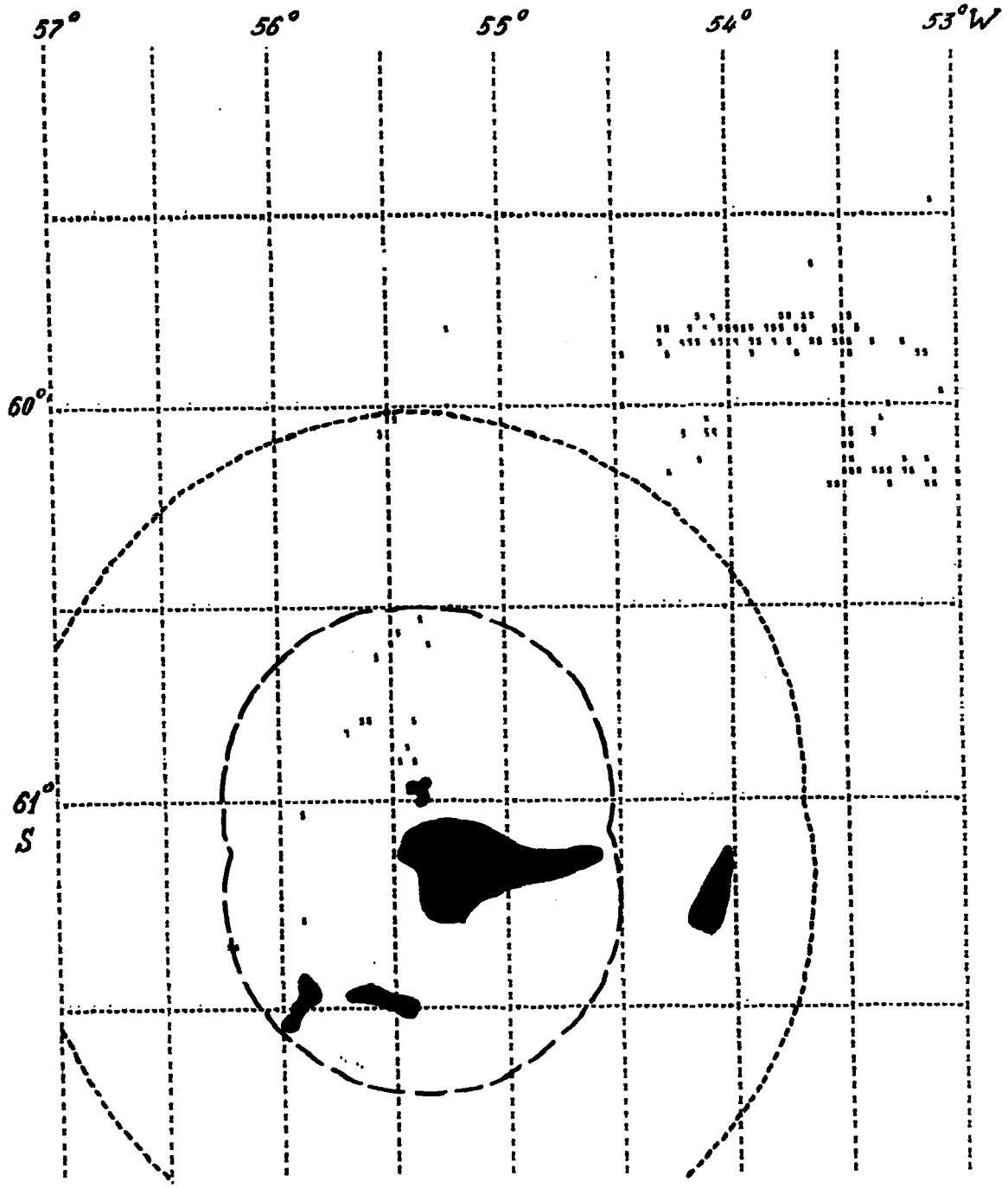


Figure 7a: Krill fishery location by five-day period from 1 to 5 January 1989.

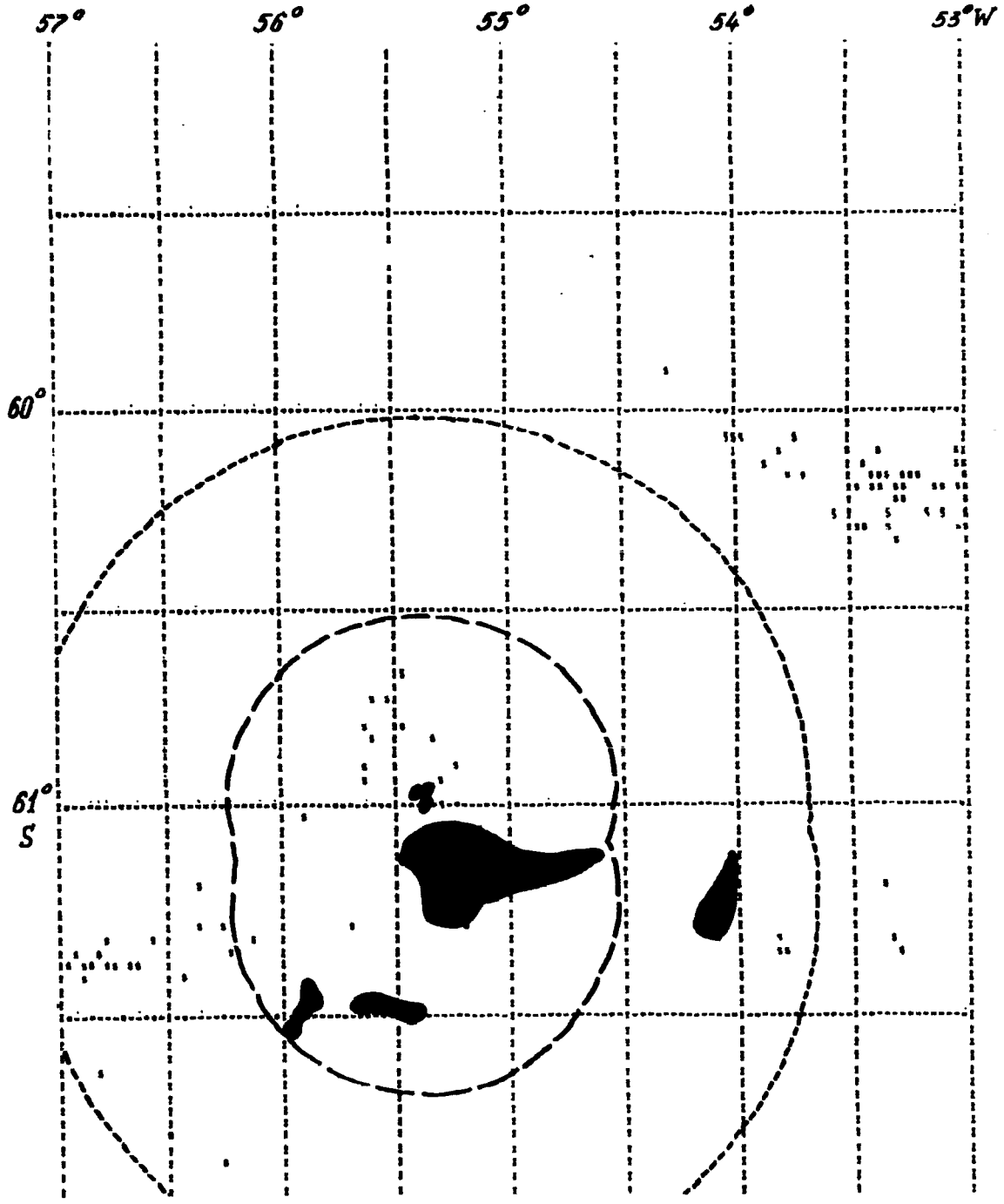


Figure 7b: Krill fishery location by five-day period from 6 to 10 January 1989.

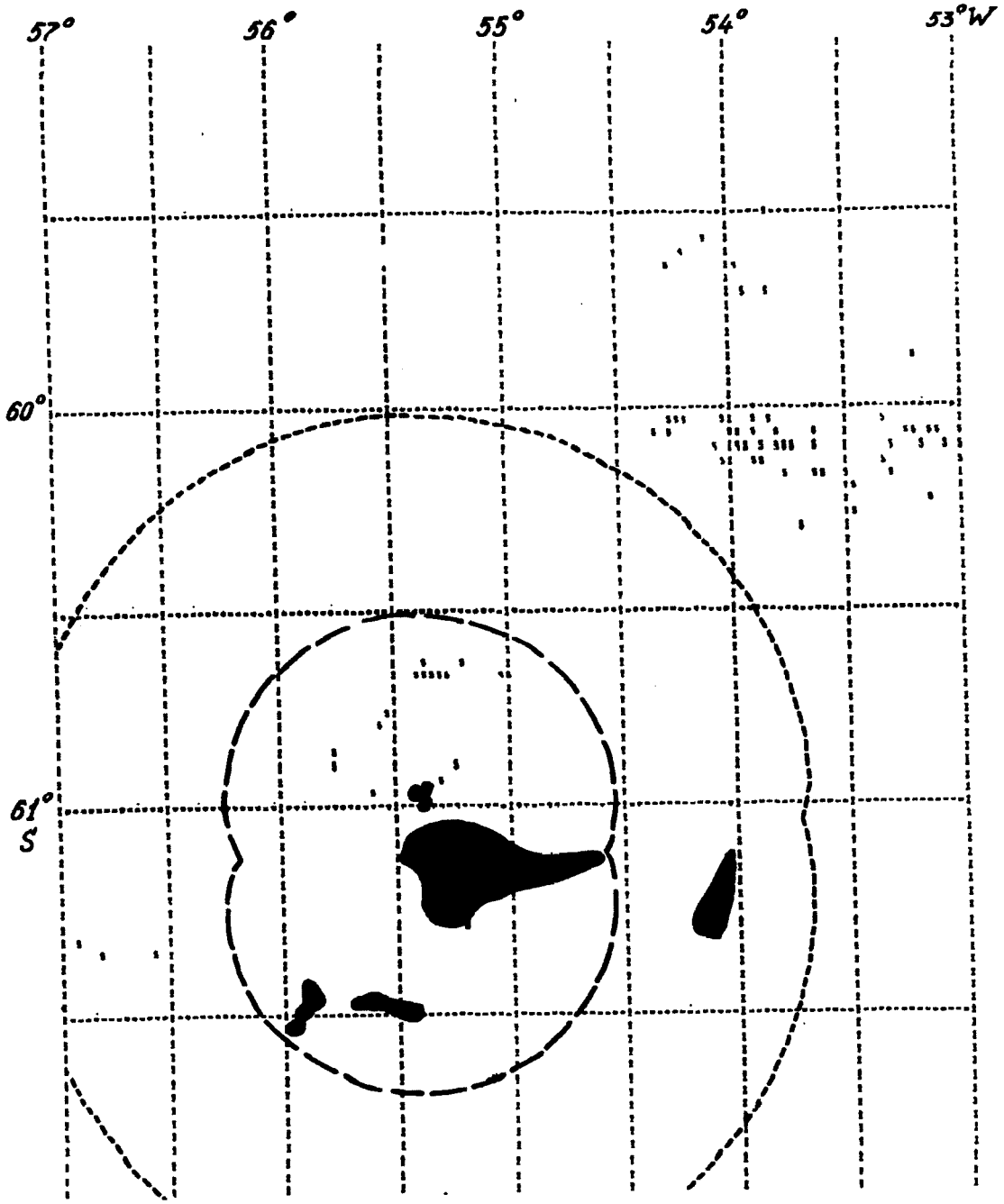


Figure 7c: Krill fishery location by five-day period from 11 to 15 January 1989.

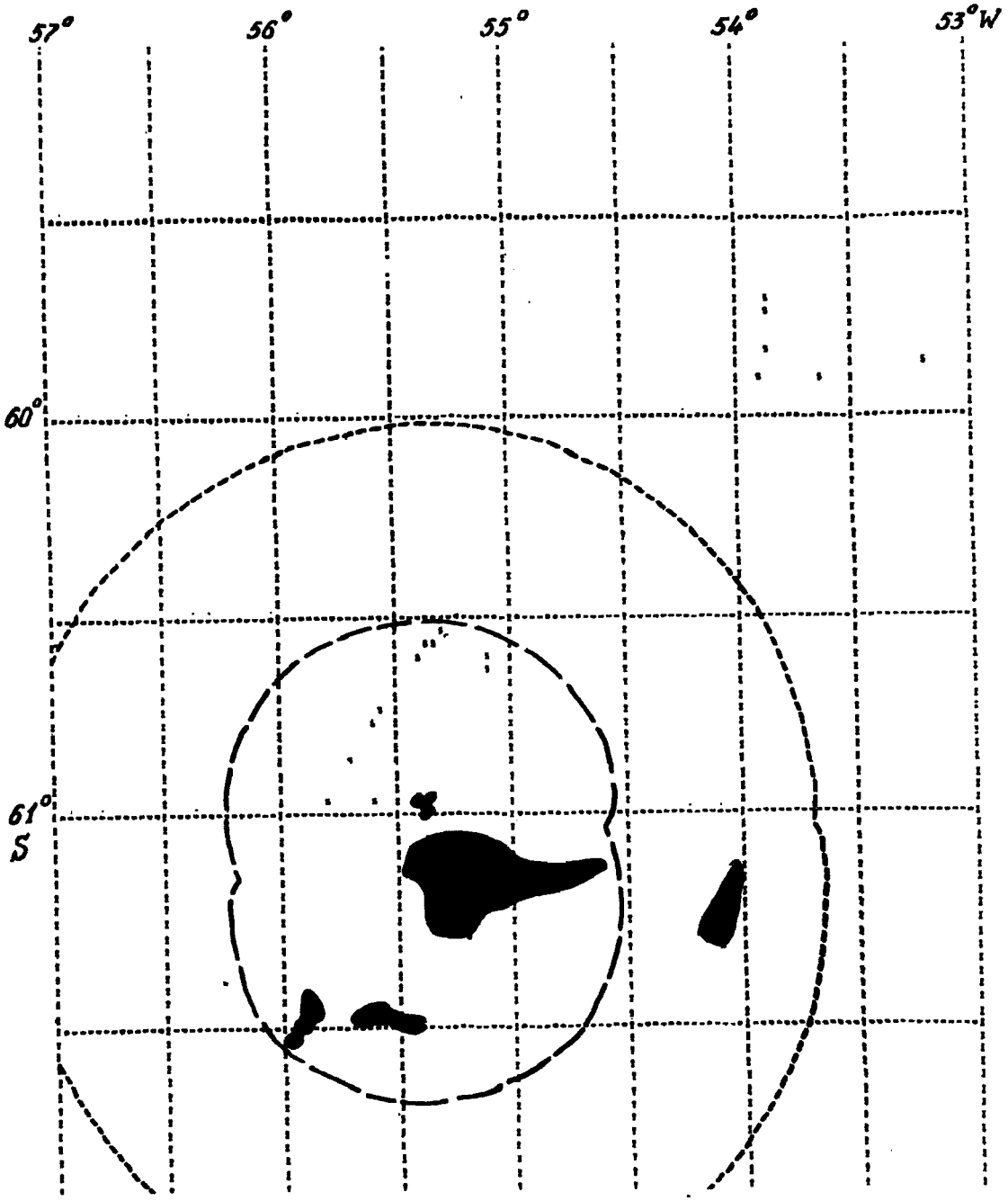


Figure 7d: Krill fishery location by five-day period from 16 to 20 January 1989.

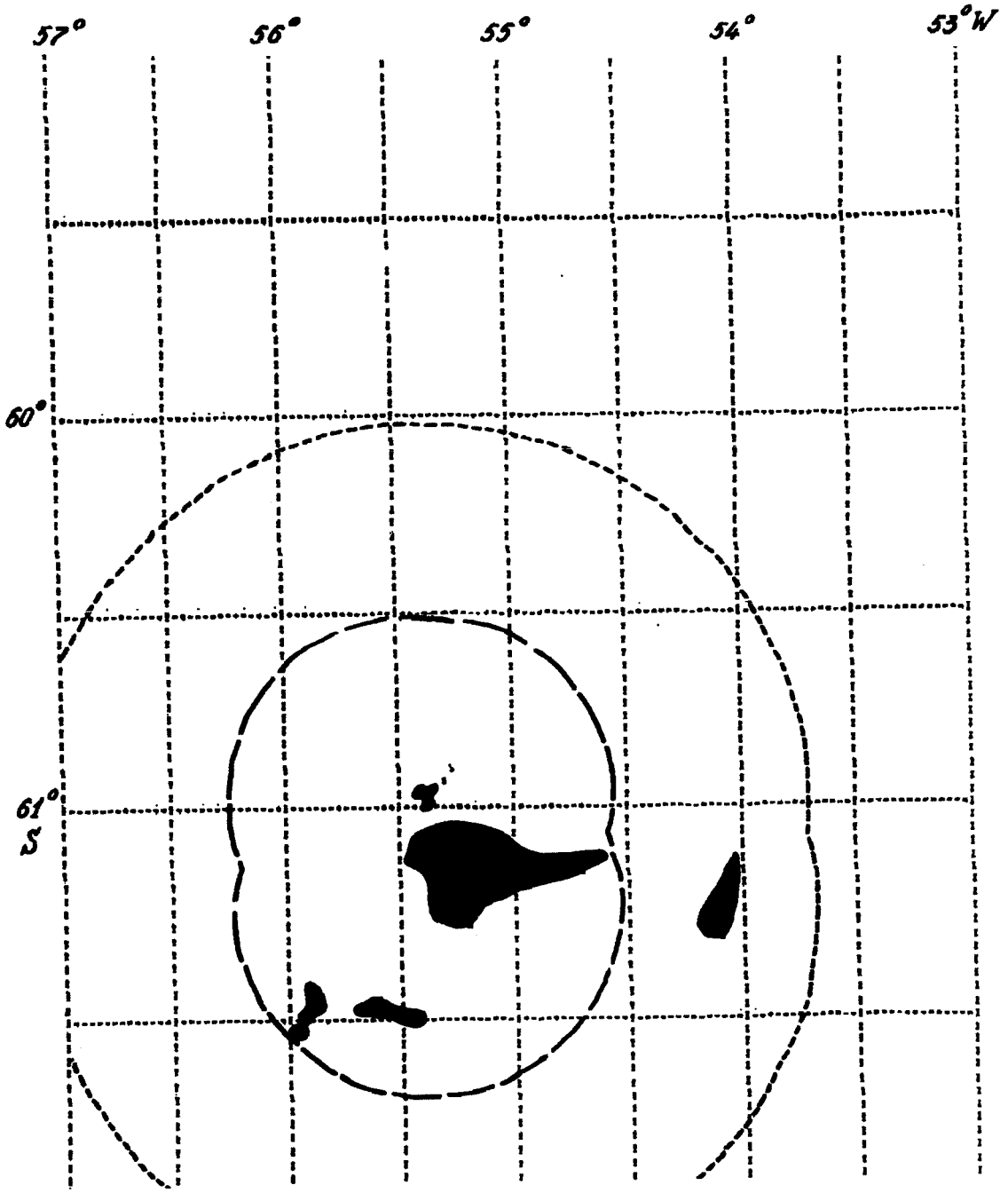


Figure 7e: Krill fishery location by five-day period from 21 to 25 January 1989.

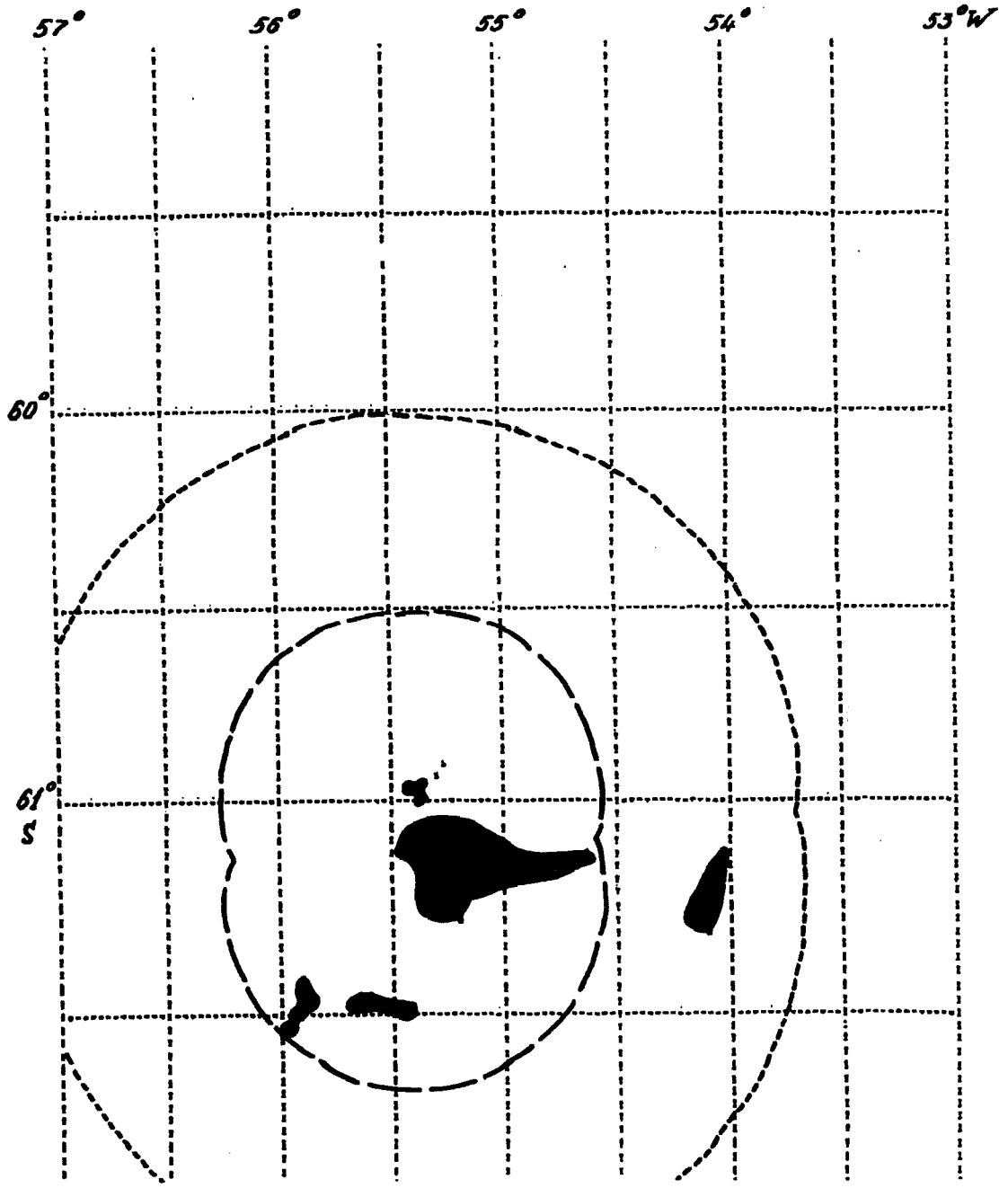


Figure 7f: Krill fishery location by five-day period from 26 to 31 January 1989.

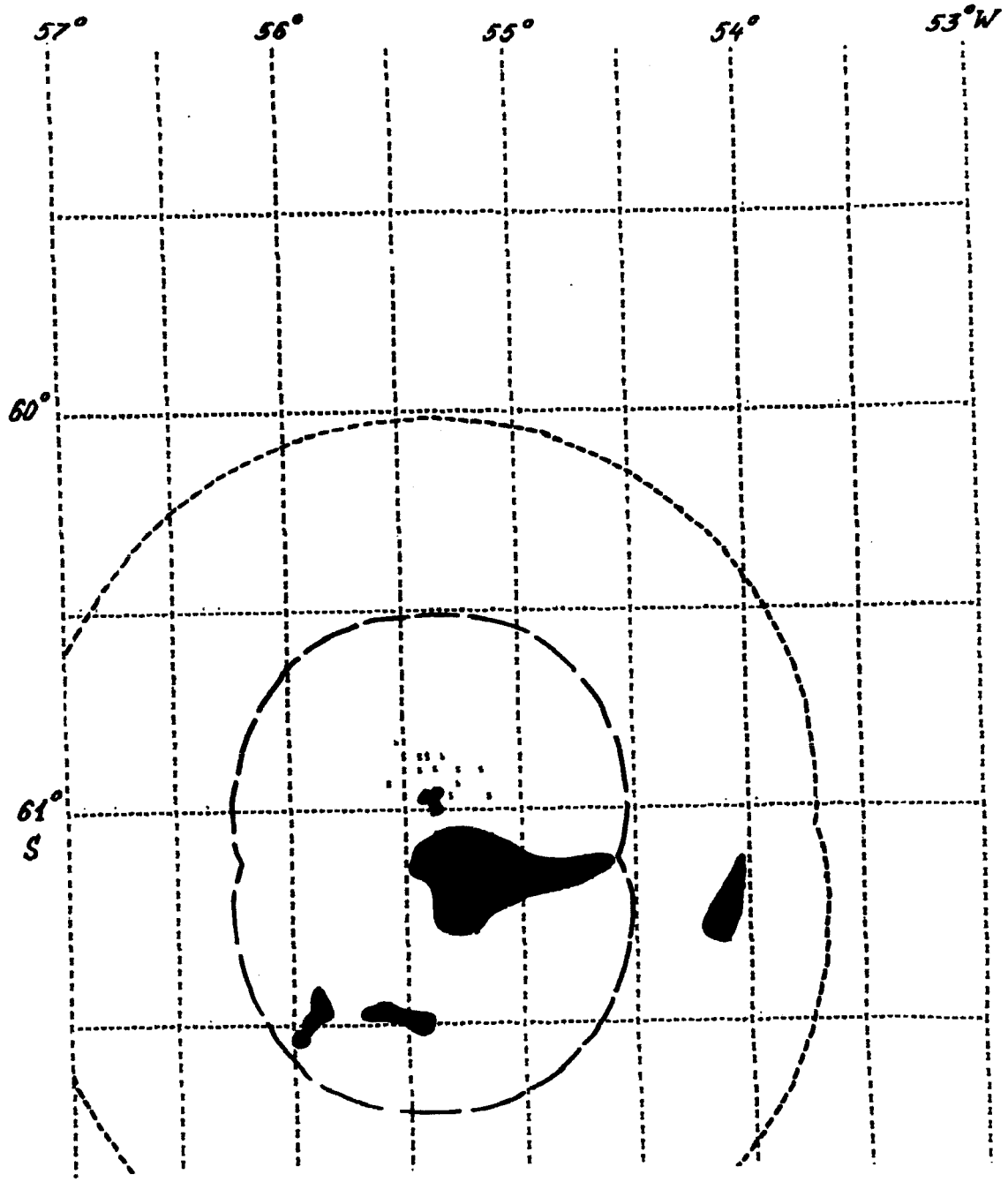


Figure 8a: Krill fishery location by five-day period from 1 to 5 February 1989.

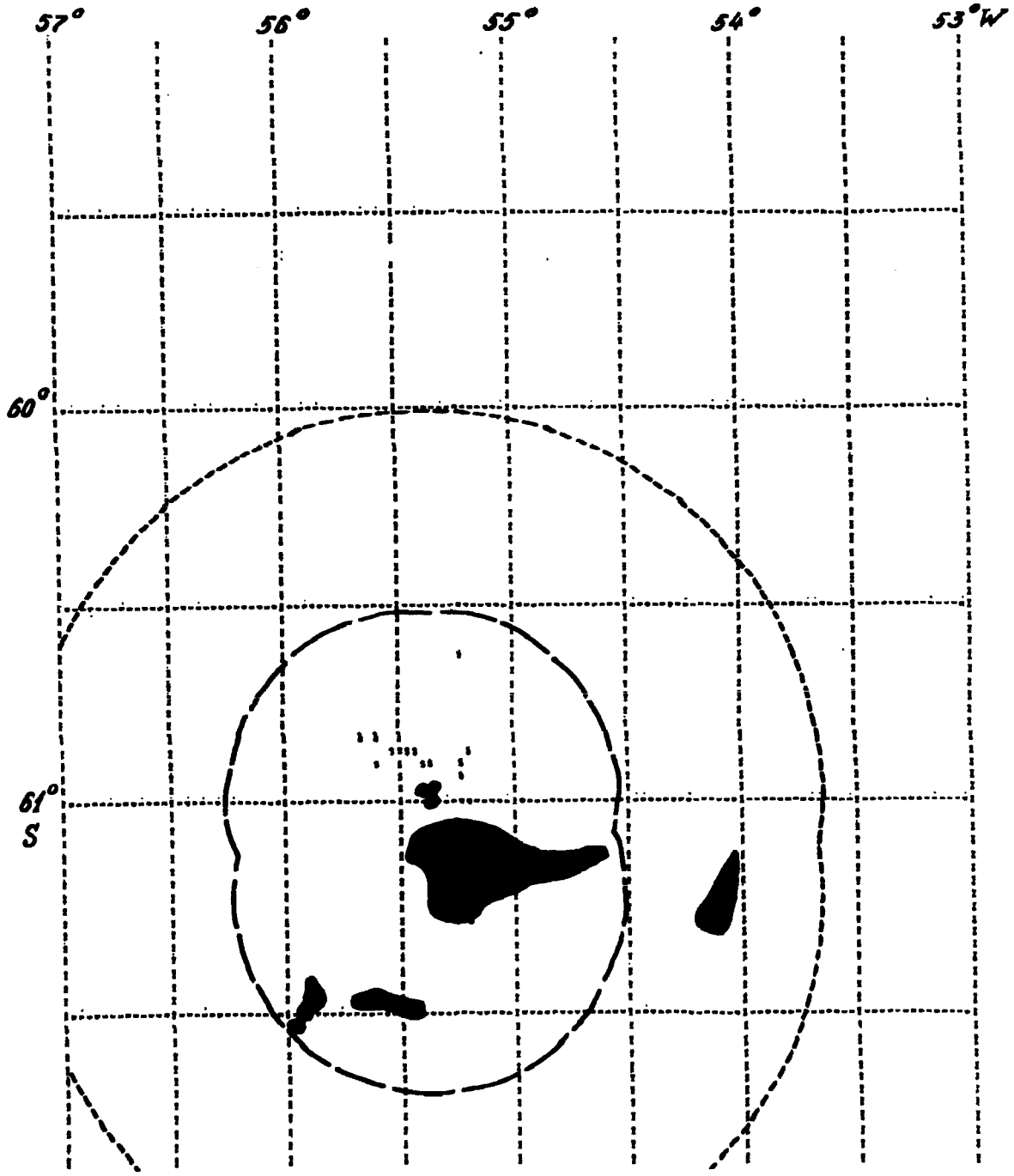


Figure 8b: Krill fishery location by five-day period from 6 to 10 February 1989.

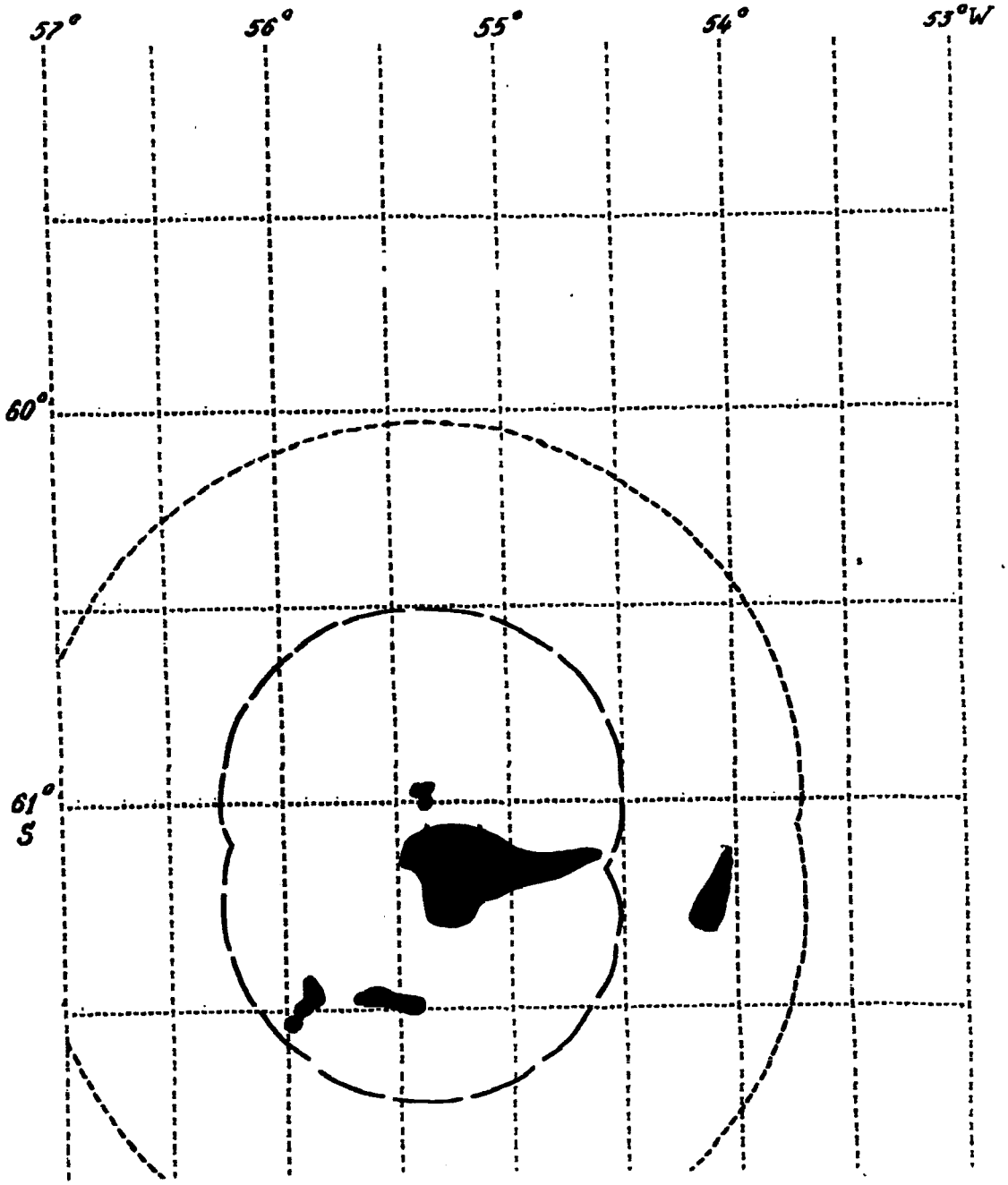


Figure 8c: Krill fishery location by five-day period from 16 to 20 February 1989.

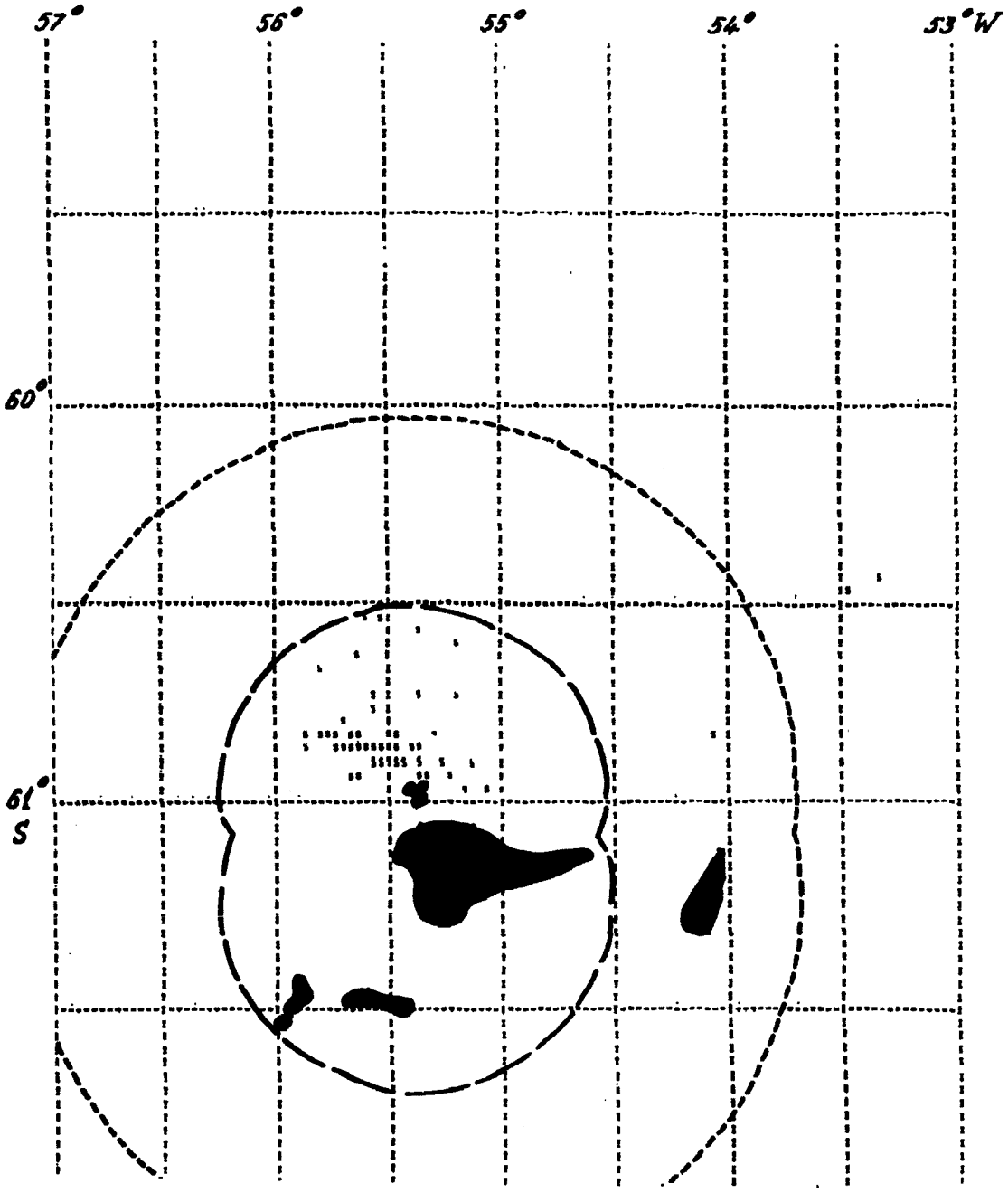
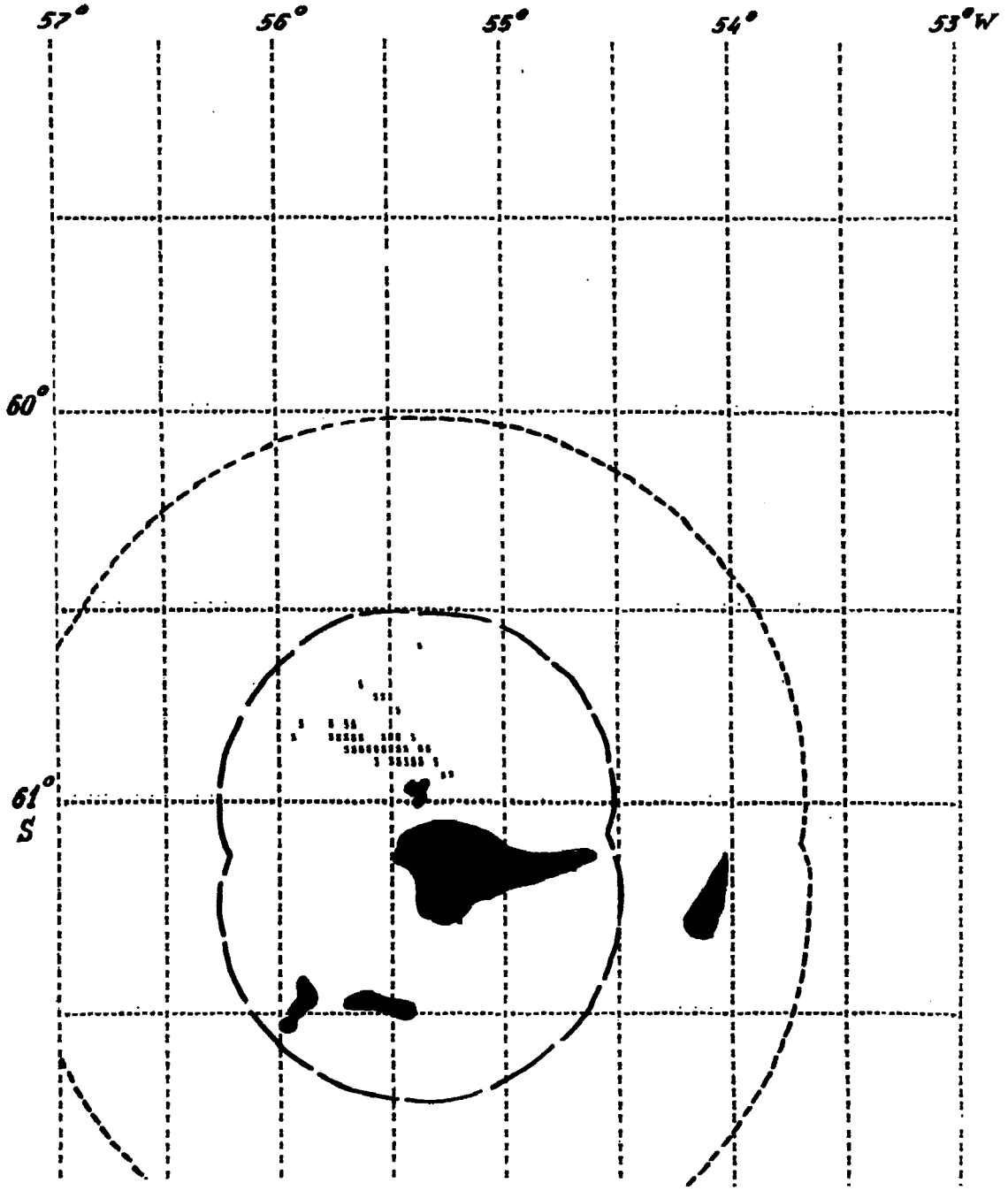


Figure 8d: Krill fishery location by five-day period from 21 to 25 February 1989.



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(a) 1er-5 janvier 1989 (c) 11-15 janvier 1989 (e) 21-25 janvier 1989
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