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DISTRIBUTION OF THE SOVIET KRILL FISHING FLEET IN THE SOUTH ORKNEYS AREA (SUBAREA 48.2) DURING 1989/1990

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Abstract

The results of an analysis of haul-by-haul catch statistics from the Soviet krill fishing fleet during the 1989/90 season (sample of 3 614 hauls for the period from 1 November 1989 to 12 June 1990) are presented. During the season, fishing vessels worked one fishing ground off the northwestern tip of Coronation Island. CPUE showed variability with a minimum in November (3.2 tonnes/hour) and maximums in February and March (9.6 tonnes/hour and 11.0 tonnes/hour respectively), followed by a decrease to 6.9 and 7.1 tonnes/hour by May and June. The location of the fishing ground was observed to be stable, and it is considered that the location was determined by certain hydrodynamic characteristics of the area, for example a complex current around the islands together with topographically-induced effects. Except in November 1989, temporally and spatially sustained fishable krill aggregations did not form outside the main fishing area. During the November period the commercial fleet fished over oceanic areas, and targeted krill aggregations found in the major current flowing towards the north-east of the region. The fleet was observed drifting with the current together with krill aggregations. A maximum CPUE (3.8 tonnes/hour) was recorded at the beginning of the period, with a subsequent gradual decrease towards the minimum level acceptable to the fleet (2.5 tonnes/hour). Over the last five days of November, the aggregation disintegrated, having existed for about 25 days, and commercial vessels returned to Coronation Island. Krill drift velocity, estimated on the basis of the fishing ground shift, amounted to 7.4 km/day or 8.7 cm/sec. This is comparable to, though less than, the drift velocity off Elephant Island (11 to 13 cm/sec), evaluated earlier using the same method (Sushin and Myskov, 1992).

Résumé

L'auteur présente ici les résultats d'une analyse des statistiques de capture par trait de la flottille de pêche de krill de la saison 1989/1990 (soit un échantillon de 3 614 traits du 1[er] novembre 1989 au 12 juin 1990). Les navires pêchaient alors sur un lieu de pêche situé à la pointe nord-ouest de l'île du Couronnement. La CPUE présente une certaine variabilité avec un minimum en novembre de 3,2 tonnes/heure et des niveaux maximum en février (9,6 tonnes/heure) et en mars (11,0 tonnes/heure), suivis par une baisse, soit 6,9 tonnes/heure en mai et 7,1 tonnes/heure en juin. La position du lieu de pêche semble stable et vraisemblablement déterminée par certaines caractéristiques hydrodynamiques de la région comme un courant complexe autour des îles, ainsi que des effets dus à la topographie. Il ne s'est pas formé de concentrations durables et exploitables de krill en dehors du principal secteur de pêche, si ce n'est en novembre. Or, en ce mois, la flottille commerciale pêchait sur des secteurs océaniques et visait les concentrations de krill rencontrées dans le courant principal dirigé vers le nord-est de la région. La flottille a donc dérivé dans le courant, avec les concentrations de krill. C'est au début de cette période que la CPUE maximale a été enregistrée (3,8 tonnes/heure), suivie d'une baisse progressive jusqu'au niveau minimum acceptable pour la flottille (2,5 tonnes/heure). Au cours des cinq derniers jours de novembre, la concentration s'est désintégrée, après une existence de 25 jours environ et les navires commerciaux sont retournés à l'île du Couronnement. La vitesse de la dérive du krill, estimée à partir du déplacement de la pêche, atteignait 7,4 km/jour ou 8,7 cm/sec. Ces chiffres sont comparables, ou peu s'en faut, à la vitesse de la dérive au large de l'île Éléphant (11 à 13 cm/sec), évaluée précédemment par la même méthode (Sushin et Myskov, 1992).

Резюме

В данной работе представлены результаты анализа данных за каждое отдельное траление при промысле криля советскими траулерами в течение сезона

1989/90 г. (выборка состоит из 3614 тралений за период с 1 ноября 1989 г. по 12 июня 1990 г.). В этом сезоне суда работали на промысловом участке у северо-западной оконечности о-ва Коронейшен. Минимальная величина CPUE (3,2 т/час) наблюдалась в ноябре, а максимальные величины (9,6 т/час и 11,0 т/час) - в феврале и марте соответственно. Вслед за этим отмечалось снижение до 6,9 и 7,1 т/час в мае и июне. Местонахождение промыслового участка было стабильным, и считается, что оно определялось гидронамическими особенностями данного района, напр. наличием комплексного течения вокруг островов, и топогенными факторами. За исключением ноября 1989 г. за пределами основного промыслового участка не образовывалось устойчивых во времени и пространстве коммерческих концентраций криля. В ноябре 1989 г. промысловые суда работали в океанических районах на агрегациях криля, встречавшихся в главном течении, направленном на северо-восток региона. Агрегация криля дрейфовала с течением, вместе с тем изменялось и местонахождение промыслового флота. Максимальная величина CPUE была зарегистрирована в начале периода (3,8 т/час), а затем наблюдалось постепенное снижение до минимального допустимого для флота уровня (2,5 т/час). В течение последних пяти дней ноября агрегация, сохранявшаяся на протяжении около 25 суток, распалась, и суда вернулись к о-ву Коронейшен. Скорость дрейфа криля, рассчитанная на основе сдвига промыслового участка, составила 7,4 км/день или 8,7 см/сек. Это сравнимо с (но меньше, чем) скоростью дрейфа в районе о-ва Элефант (11 - 13 см/сек.), рассчитанной раньше с помощью этого же метода (Сушин и Мысков, 1992).

Resumen

En este trabajo se presentan los resultados de un análisis de las estadísticas de pesca de cada lance efectuado por la flota de pesca de kril soviética durante la temporada 1989/90 (muestra compuesta de 3 614 lances durante el período del 1° de noviembre de 1989 al 12 de junio de 1990). Durante la temporada, los barcos faenaron en un caladero de pesca frente a la punta noroeste de la isla Coronación. El CPUE mostró variabilidad con un mínimo en noviembre (3,2 toneladas/hora) y máximos en febrero (9,6 toneladas/hora) y marzo (11,0 toneladas/hora), seguido de un descenso en mayo y junio (6,9 y 7,1 toneladas/hora, respectivamente). Se observó que el caladero era estable y su localización estaba determinada por las características hidrodinámicas de la zona, por ejemplo, una corriente compleja alrededor de las islas conjuntamente con efectos producidos por la topografía del lugar. Con excepción del mes de noviembre de 1989, no se formaron concentraciones estables aptas para la explotación, tanto en el tiempo como en el espacio, fuera de la zona de pesca principal. Durante noviembre la flota comercial faenó en alta mar concentrándose en las agrupaciones de kril que se desplazaban con la corriente principal en dirección noreste. Se observó que la flota se desplazó a la deriva junto con las concentraciones de kril. Se registró un CPUE máximo (3,8 toneladas/hora) en los inicios de la temporada, seguido de un descenso gradual hasta llegar a un nivel mínimo aceptable para la flota (2,5 toneladas/hora). En los últimos cinco días de noviembre, luego de 25 de días de duración, la concentración se desintegró y los barcos comerciales se devolvieron a isla Coronación. La velocidad de arrastre del kril, estimada según el traslado de la zona de pesca, alcanzó 7,4 km/día (8,7 cm/seg). Esto es comparable a, si bien menor que, la velocidad de arrastre frente a isla Elefante (11 a 13 cm/seg), calculada anteriormente mediante el mismo método (Sushin y Myskov, 1992).

Keywords: krill, fishing, USSR, South Orkneys, aggregations, drift, distribution, CCAMLR

INTRODUCTION

The South Orkneys area was the main fishing ground of the Soviet Union krill fishing fleet operating in the Antarctic sector of Atlantic Ocean. The total catch obtained by the Soviet fleet between 1984 and 1993 amounted to 1 037 thousand tonnes, of which only 35 thousand tonnes came from the Antarctic Peninsula region (Subarea 48.1). Further, the Soviet catch in the South Orkneys area was more than twice the total catch from Subarea 48.1 (459 thousand tonnes), the main fishing ground of other krill fishing fleets (CCAMLR, 1994).

Unfortunately, apart from various reports by observers aboard some vessels during some periods, no publications exist that document the precise location of the Soviet fishery or document details of the operation. In particular, until now no publications have been available that document the distribution of catch per unit effort (CPUE) based on haul-by-haul catch statistics from Soviet commercial vessels. Such data are very important for understanding particular processes that occur in the Southern Ocean ecological system, and coupled with other information may help solve a wide range of problems relevant to monitoring and management of the ecosystem.

In this paper, data are presented on the distribution of the Soviet commercial fleet in Subarea 48.2 during the 1989/90 season, together with information on CPUE determined from the resulting haul-by-haul data. An attempt is also made to use the movement of the fleet to determine changes in krill distribution and rates of current flow.

The quantitative assessment of krill movement is one of the most important tasks proposed by the CCAMLR Scientific Committee (SC-CAMLR, 1994), since the interpretation of acoustic survey data and the subsequent calculation of krill biomass estimates can be difficult unless flux is taken into account.

Previous attempts have been made to estimate krill transport velocity in Subarea 48.1 using commercial fleet operation data similar to that available in this analysis (e.g. Sushin and Myskov, 1992). In this paper we extend the same approach to the South Orkneys area.

MATERIAL AND METHODS

Commercial statistics for the period 1 November 1989 to 12 June 1990 were obtained from Soviet vessels operating in the South Orkneys area, including haul-by-haul data (i.e. the date, coordinates at trawling start, time of trawling start, trawling duration, vessel speed during trawling, catch per trawling) for individual catches taken in the krill fishery. In total, data from 3 614 trawl operations were analysed for the period. From this number of hauls, 1 532 (42.4%) were made by BMRT* vessels with an engine of 2 000–2 400 hp, 1 518 (42%) by BMRT vessels with an engine of 3 000–3 100 hp and 564 (15.6%) by BMRT vessels with an engine of 5 000–5 200 hp. The least number of vessels operated in November 1989 and June 1990 (statistical data were submitted from five and six vessels respectively) and the most in February and March 1990 (statistical data were submitted from 17 and 15 vessels respectively). During other months statistical data were reported from 10 to 13 vessels. Fishing gear comprised midwater 74/416 trawl and its modifications.

These hauls comprised a substantial proportion of all hauls made in the fishery. They include 95 710 tonnes (43%) of the total catch of 220 517 tonnes made by Soviet vessels and reported in CCAMLR statistics (CCAMLR, 1994). Thus, the individual catches reported here represent an important sample of those taken by the fishery.

Irrespective of type, all Soviet fishing vessels worked in groups, each of which fished more or less significant krill aggregations. Within these groups the vessels continuously exchanged information on trawling results and krill distribution, behaviour and quality. There was a regular (twice per a day) exchange of information between the groups of vessels, including those operating in different subareas. These group tactics made it possible to monitor significantly larger areas, helped with tracking a krill aggregation when it drifted, and facilitated searching if the aggregation disintegrated.

Most fishing vessels worked according to the schedule given below. Prior to trawling the fishing vessel, taking into account the results of its and other vessels' hauls, carried out local hydroacoustic exploration (most often near or along the tracks of other vessels) aimed at finding and determining the location and depth of krill swarms. After completing an exploratory tack where the most dense and extended swarms were found, the vessel turned around and retraced the tack. The trawl was set so that it was completely opened by the time the vessel reached the krill aggregation. Trawling velocity was about 3 to 4 knots in most cases. The trawl was lifted when sufficient krill had been caught in terms of the vessel's processing capacity and the kind of product required. Short-term target tows were rare since there were no reliable sonars on the Soviet vessels. Most tows lasted from one to

* BMRT – large fishing trawler freezer

several hours depending on krill aggregation density. The trawl passed through several krill swarms and filtered a large volume of water in the intervals between swarms.

The maps of vessel distribution are based on the coordinates of the trawling start position. CPUE was estimated in tonnes per hour of trawling by calculating the total catch from all vessels operating in the period and dividing by the total trawling duration for the same period.

RESULTS AND DISCUSSION

During the 1989/90 season the area adjacent to the north and northwest of Coronation Island was the main fishing ground of the Soviet commercial krill fishing fleet (Figure 1a). Such a situation is characteristic of other seasons, and at a coarse scale can be seen in CCAMLR statistics (e.g. SC-CAMLR, 1994; Murphy et al., 1997). The relative stability of the fishing ground is thought to be determined by local hydrographic characteristics of the area that result in krill retention and accumulation in the anticyclonic flow around the South Orkneys (Makarov, 1996). The location of this flow and its proximity to the Weddell–Scotia Confluence is described in Makarov (1996 – Figures 2 and 3).

Monthly analysis of the fishing fleet distribution shows that the fishing ground was of major importance during all months of the 1989/90 season with only a small degree of variation, i.e. a slight shift of the fishing ground southwards to the western edge of Coronation Island in April and May (Figures 1b, 1c, 2 and 3).

It is also interesting that the fleet continued to work in the area despite the seasonal decrease in catches (from 11.0 tonnes/hour of trawling in March to 7.6 tonnes/hour and 6.9 tonnes/hour in April and May respectively) (Figure 4a). This is possibly related to the relative absence of more attractive (from the point of view of spatial or temporal stability) fishable patches of krill in the vicinity.

If such patches were available locally, certainly some would be found and exploited by the fleet, since some vessels periodically make exploratory trawl hauls relatively far from the main group of vessels; this is evident in Figures 1, 2 and 3.

Only one variation from this fleet distribution pattern was observed. This occurred in November 1989, when the fishery moved to oceanic waters. During this period the fishery extended in a relatively narrow band from the northern tip of Coronation Island northeastwards to about 59°S (Figure 1b) and coincides with the location of the Weddell–Scotia Confluence zone within the South Orkney area (e.g. Maslennikov and Solyankin, 1988). More detailed consideration by five-day intervals showed that the fishing ground gradually shifted northeastwards during November (Figure 5). The most northeasterly position was attained towards the latter part of November, after which all vessels returned to their former location near the northern tip of Coronation Island.

At the beginning of November catches were approximately 1.6 tonnes/hour of trawling, but as the northeasterly movement progressed, catches increased to 3.8 tonnes/hour of trawling (in the second and third five-day periods), and then gradually decreased to 2.5 tonnes/hour in the next five-day period (Figure 4b). These lower catches were probably uneconomic and therefore the vessels returned to their traditional fishing grounds off Coronation Island, where catches amounted to 3.7 tonnes/hour during the last five days of November (Figure 4b). More detailed information on fishing fleet operation is presented in Table 1.

Table 1: Characteristics of krill fishing operations by five-day periods in November 1989.

Date	Number of Vessels	Number of Tows	Average Time of Tow Duration (hours)	CPUE (tonnes/hour)
1–5 November	2	15	5.3	1.6
6–10 November	2	19	5.1	3.8
11–15 November	2	25	5.5	3.8
16–20 November	3	28	5.9	2.9
21–25 November	2	16	6.1	2.5
26–30 November	3	34	6.0	3.7

Based on the evidence presented here, it would appear that there is less spatial and temporal stability of commercial krill aggregations in open oceanic waters compared to those found in coastal or shelf-break areas. In shelf and coastal areas hydrodynamic processes may promote the formation of krill aggregations that are easier to locate and which are relatively long lived. Makarov (1996) noted a higher probability of stable krill aggregations in areas where mesoscale hydrographic features were also found, while Murphy et al. (1997) and Trathan et al. (1998) highlighted similar relationships between the location of fishing grounds north of South Georgia and the local mesoscale hydrography.

The movement of the fishing ground to the northeast coincides with the direction of general water transport and krill flux within Subarea 48.2 (e.g. Makarov, 1996; Kasatkina et al., 1997). If we assume that fishing vessels moved northeastwards because they followed a krill aggregation that was economic to fish, it is possible to estimate the approximate krill transport velocity in the area. Taking into account the slight curvature in the trajectory of the fishing ground movement, the distance between the centre of location in the first five-day period and that at the northeastern-most location amounted to about 102 miles. Therefore, the average velocity of the krill flux amounted to about 4 miles (7.4 km) per day or 8.7 cm/sec during the 25-day period. This value is lower than the estimate obtained from a similar analysis carried out for the Elephant Island area (11 to 13 cm/sec) (Sushin and Myskov, 1992). It is also considerably lower than the average velocity of the eastward ocean current observed in the South Shetland Islands (14.6 cm/sec), and estimated by Japanese scientists on the basis of the movement of drifting buoys (Ichii and Naganobu, 1996). At the same time, our estimate of krill flux velocity actually corresponds to the current velocity in the western Weddell gyre (8 cm/sec) and does not exceed the velocity range (5–10 cm/sec) typical of boundary currents over the continental slope and at the western boundaries of the Antarctic subpolar gyres (Gordon, 1988). The lower speed of krill flux in the area studied, as compared to the oceanic drift northwards of South Shetland Island, may be explained by intense meanders and eddy activity characteristic of the Weddell–Scotia Confluence (Gordon, 1988), which may slow down the velocity of krill transport in general.

CONCLUSIONS

The Soviet fleet fished krill in the 1989/90 season mainly near the South Orkneys, presumably off the northwestern tip of Coronation Island. This may be explained by the relative spatial and temporal stability of krill aggregations near the islands (compared to the surrounding waters) due to the water circulation pattern (e.g. a current around the islands) and a topographically induced effect.

In November, vessels fished mainly for a less stable oceanic krill concentration within the Weddell Scotia Confluence Zone, which was drifting northeast in the direction of the general current movement. The krill drift speed, calculated according to the rate of shift of fishing grounds, was 8.7 m/sec which is slightly slower than the speed calculated earlier for the Elephant island area using the same method (Sushin and Myskov, 1992). These differences are apparently not one-off occurrences, but are caused by the water dynamics and structure in comparable areas.

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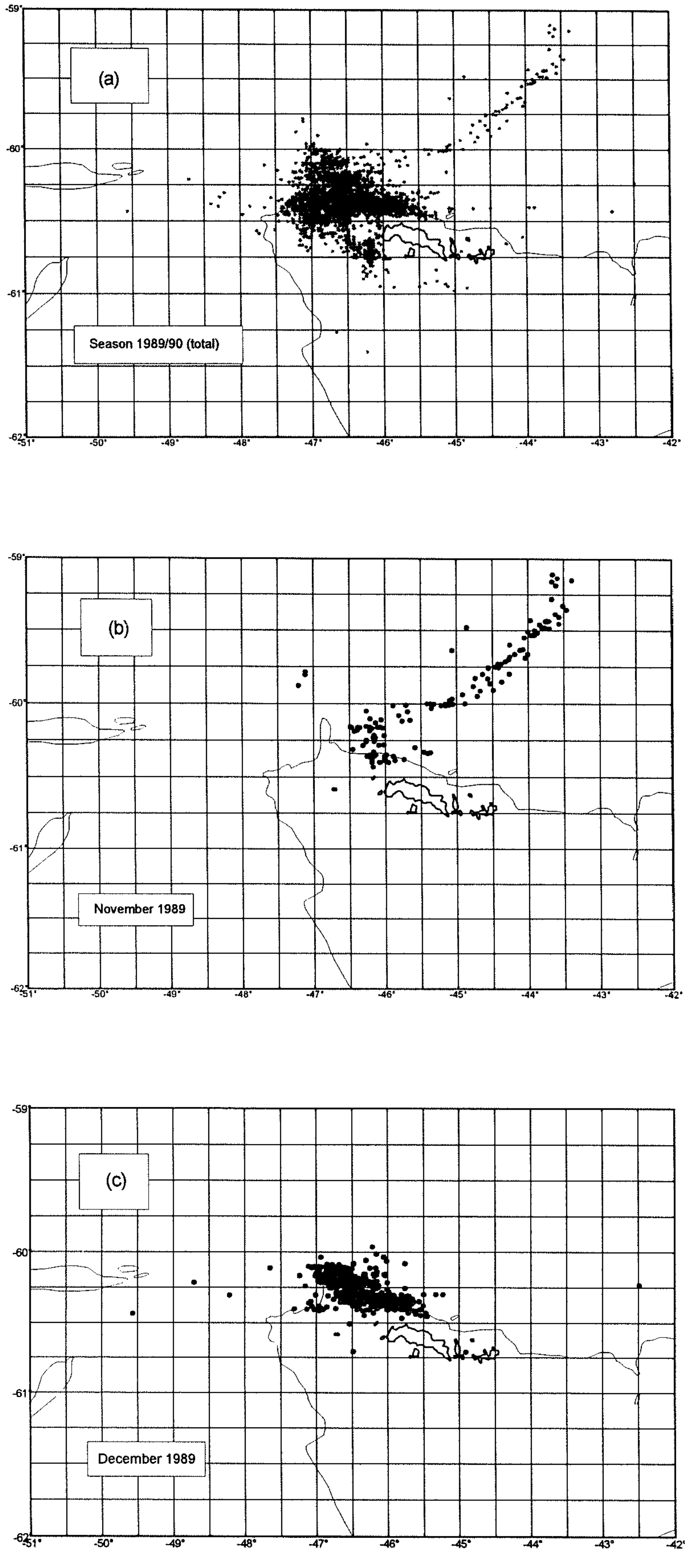

Figure 1: Location of the Soviet commercial krill fishing fleet: (a) complete fishing season in 1989/90; (b) November 1989; and (c) December 1989. The solid line represents the 1 000 m isobath.

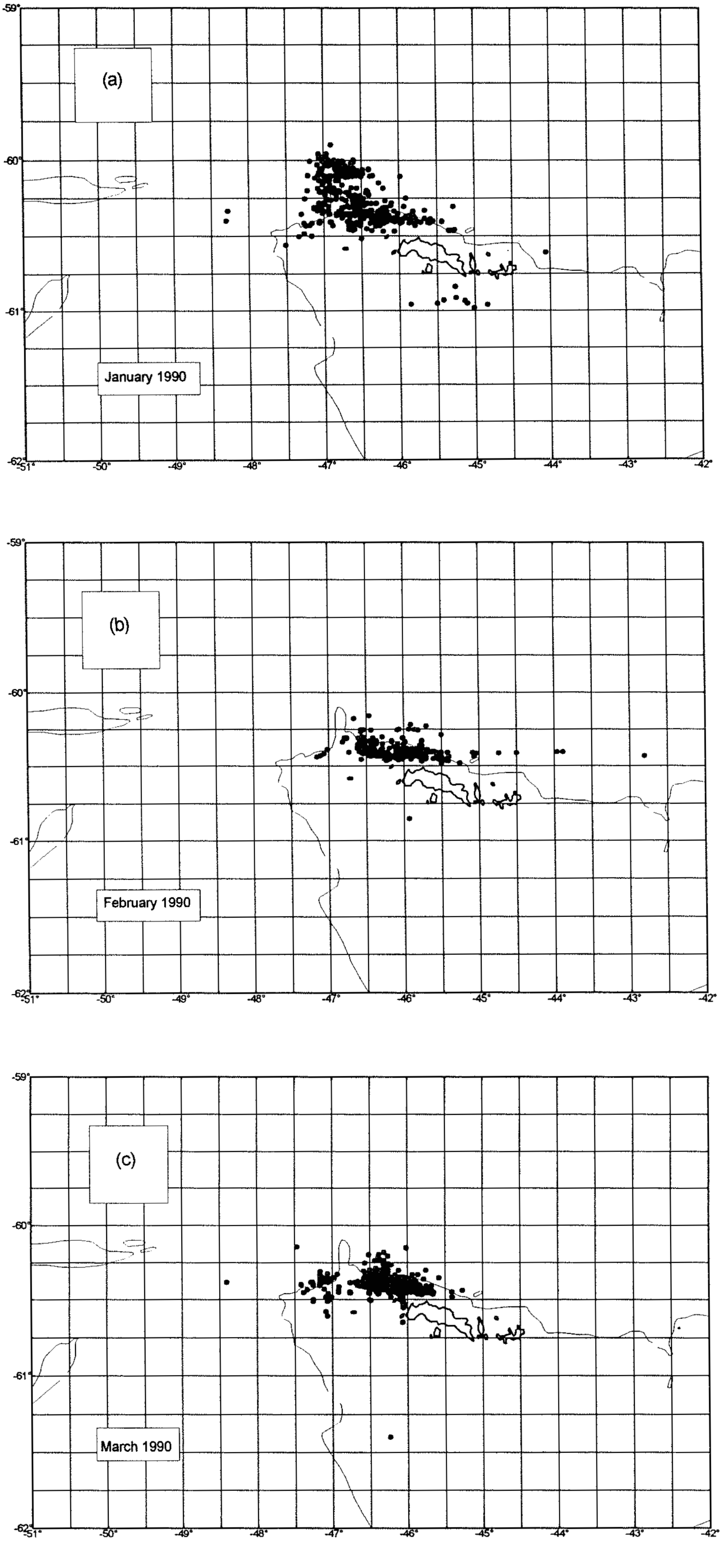

Figure 2: Location of the Soviet fishing fleet: (a) January 1990; (b) February 1990; and (c) March 1990. The solid line represents the 1 000 m isobath.

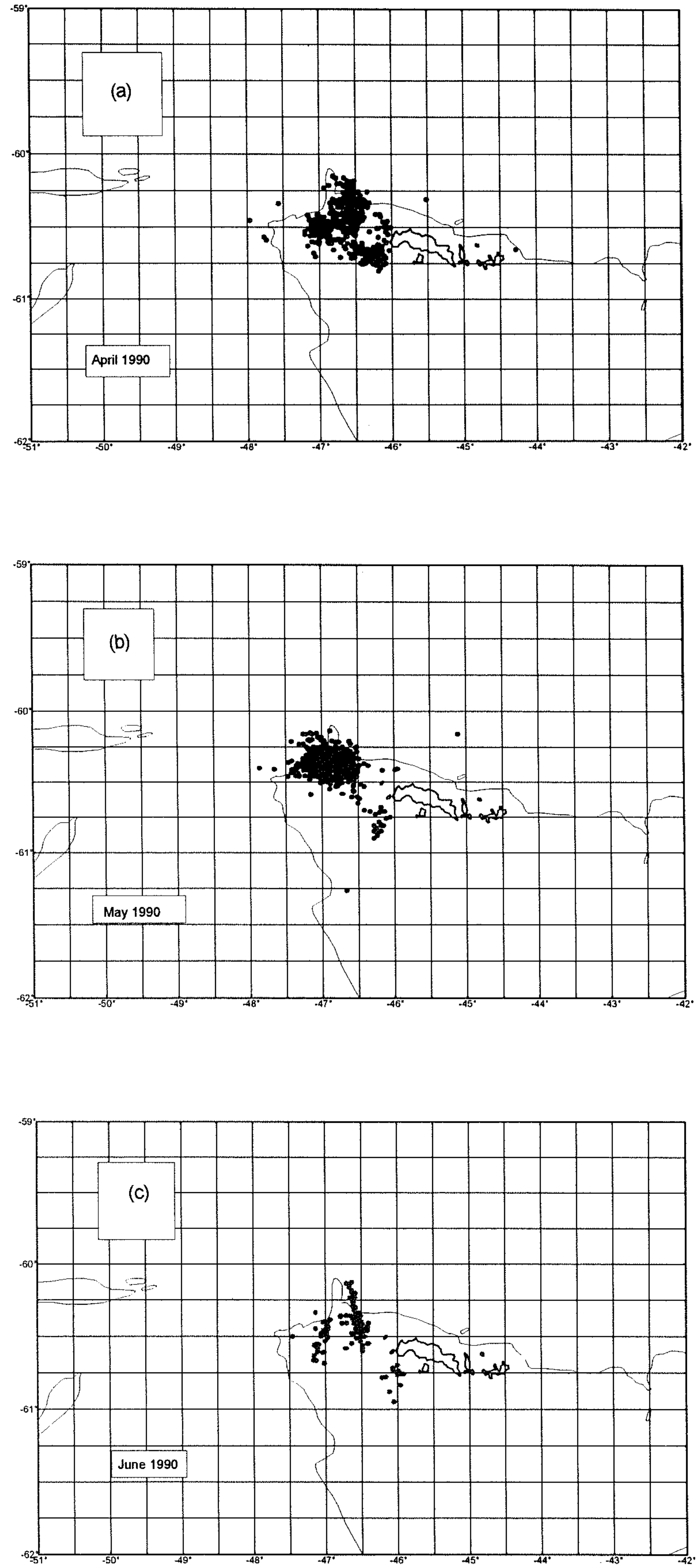

Figure 3: Location of the Soviet fishing fleet: (a) April 1990; (b) May 1990; and (c) June 1990. The solid line represents the 1 000 m isobath.

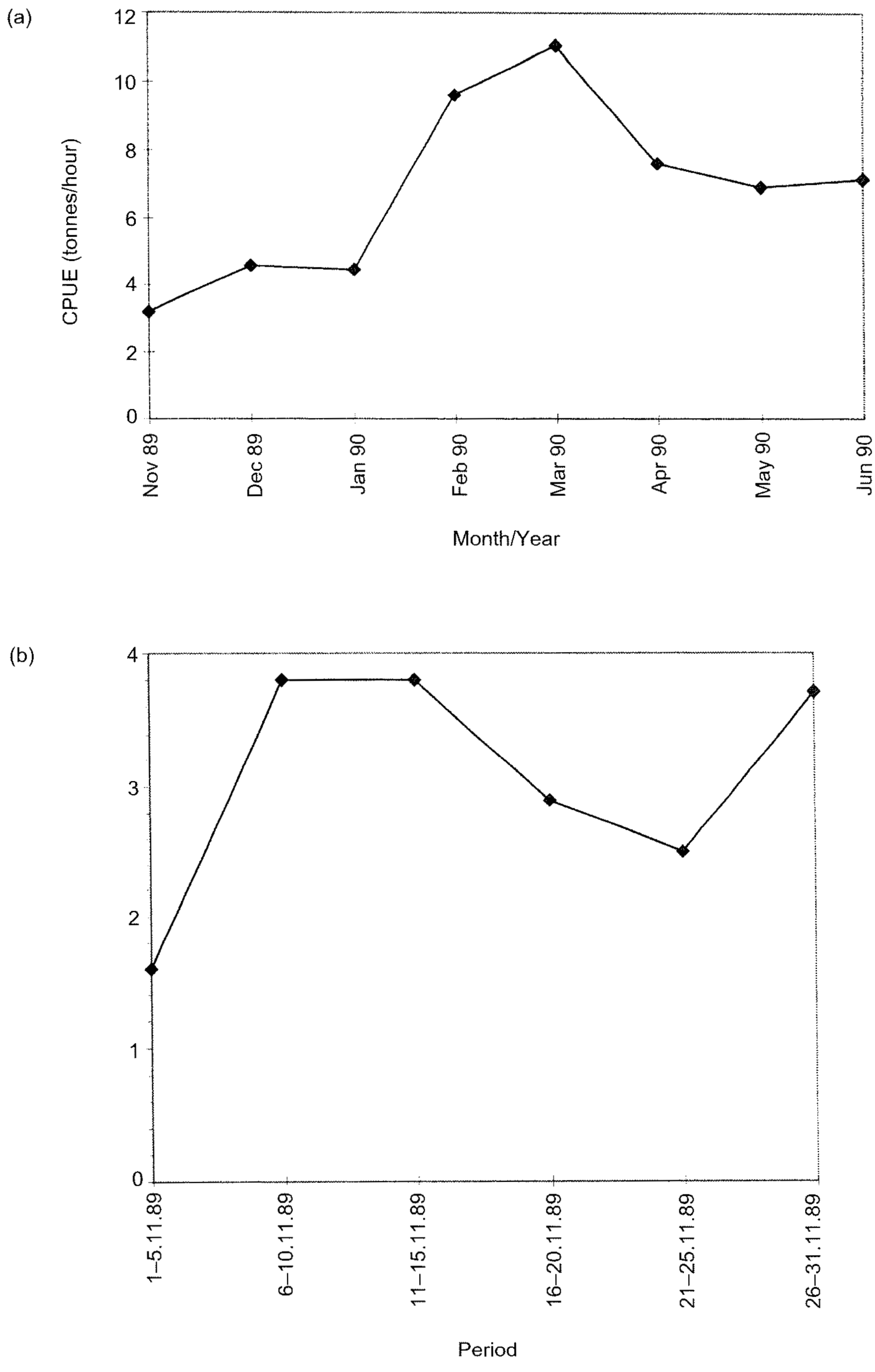

Figure 4: Catch per unit effort (CPUE) (tonnes/trawling hour) for the Soviet fishing fleet: (a) November 1989 to June 1990; and (b) November 1989 (five-day periods).

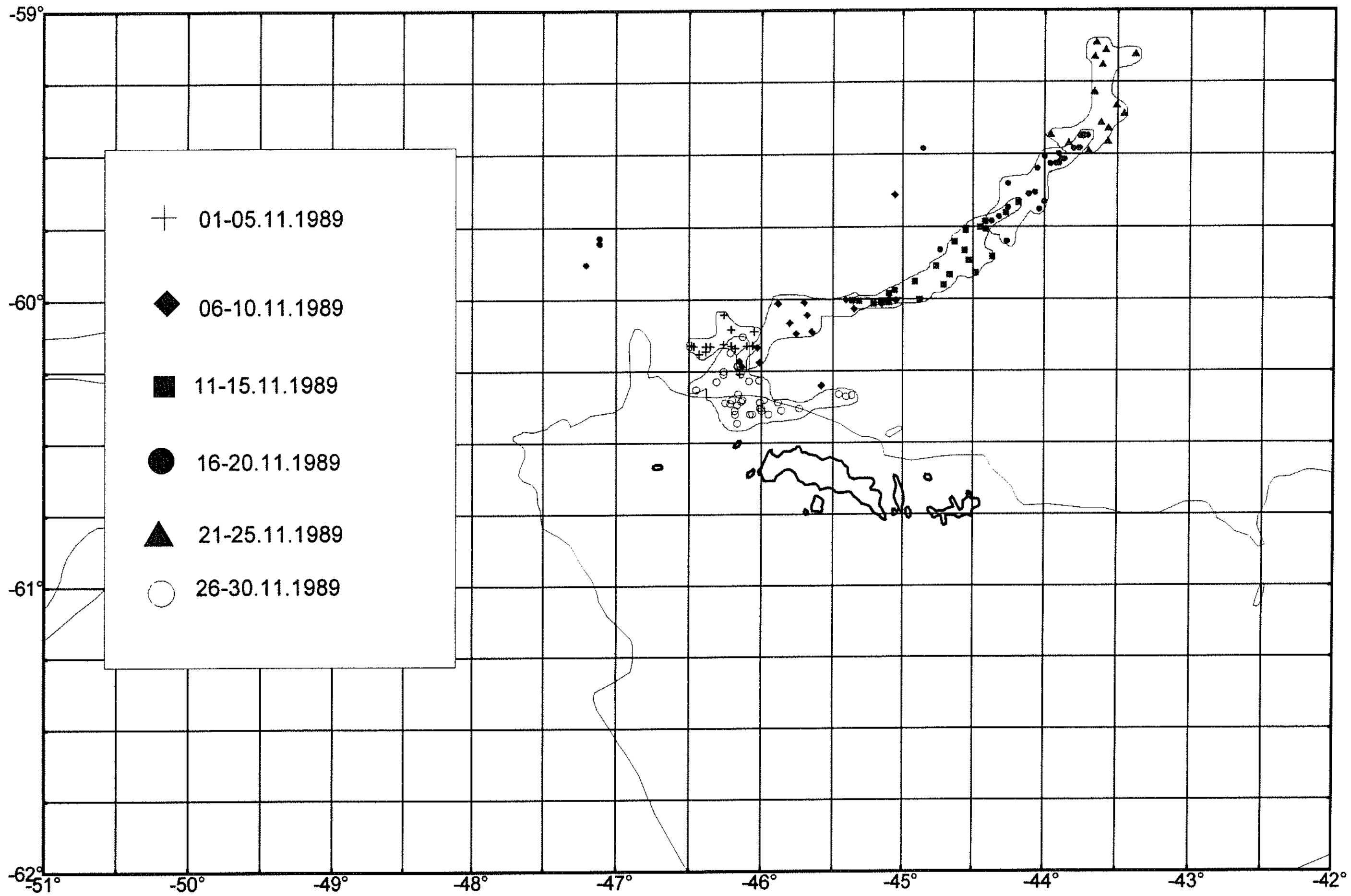

Figure 5: Movement of the Soviet fishing fleet, November 1989 (five-day periods). The solid line represents the 1 000 m isobath.

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