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KRILL FISHING IN THE SCOTIA SEA IN RELATION TO BATHYMETRY, INCLUDING THE DETAILED DISTRIBUTION AROUND SOUTH GEORGIA

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Abstract

Analyses of the distribution of krill fishing based on fine-scale (0.5° latitude x 1° longitude) data show that harvesting in the Scotia Sea has been mainly in shelf and shelf-break areas on the northern side of the Scotia Arc. Regional analyses reveal that there are restricted parts of shelf and shelf-break areas where high catches have been obtained. Although these data give a general idea of where the fishery has operated, they do not reveal the localised nature of the fishing operation. Over the last three winter fishing seasons (1993 to 1995) individual trawl statistics have been recorded in the South Georgia area. Analyses of these data show marked interannual variability in the distribution of trawls. The data for 1993 were only available from August but the fishery was restricted in that period to an area on the western edge of the shelf break where negligible fishing occurred in the following two seasons. In 1994 the fishery was almost totally based over a large shallow bank area on the northeast shelf edge. During 1995 the fishery was still predominantly in this area but also operated further west on a range of banks associated with submarine valleys. The results are discussed in relation to the ecology of krill and the fishery's interaction with local predator colonies.

Résumé

Les analyses de la répartition de la pêche de krill fondées sur des données à échelle précise (0.5° de latitude x 1° de longitude) montrent que dans la mer du Scotia, l'exploitation a principalement eu lieu dans les secteurs du plateau et de la bordure du plateau au nord de l'Arc du Scotia. Les analyses par région révèlent que des captures importantes ont été effectuées dans des parties restreintes du plateau et de sa bordure. Bien que ces statistiques donnent une idée générale de l'emplacement des activités de pêche, elles n'en révèlent pas la nature localisée. Ces trois dernières saisons de pêche hivernale (de 1993 à 1995) des statistiques par trait de chalut ont été enregistrées dans le secteur de la Géorgie du Sud. L'analyse de ces données met en évidence une variabilité interannuelle marquée de la répartition des chalutages. Les données de 1993 n'étaient disponibles qu'à partir d'août, mais en cette période, la pêche était restreinte à un secteur à l'ouest de la bordure du plateau ou une pêche insignifiante a eu lieu les deux saisons suivantes. En 1994 la pêcherie était presque totalement concentrée sur un banc étendu et peu profond au nord-est de la bordure du plateau. En 1995 la pêcherie était toujours principalement dans ce secteur, mais des opérations ont également été menées plus à l'ouest sur une série de bancs situés à proximité de vallées sous-marines. Les résultats sont discutés en fonction de l'écologie du krill et de l'interaction de la pêcherie et des colonies de prédateurs locaux.

Резюме

Результаты анализа распределения промысла криля на основании мелкомасштабных (0,5° широты x 1° долготы) данных показывают, что в море Скотия промысел в основном осуществлялся в районах шельфа и его свала к северу от дуги Скотия. Анализы по регионам выявили определенные участки

районов шельфа и границы шельфа, на которых были получены крупные уловы. Несмотря на то, что эти данные дают общее представление о местах ведения промысла, они не отражают локализованный характер промысловых операций. В течение последних трех зимних промысловых сезонов (1993–1995 гг.) были получены статистические данные по тралениям, выполненным в районе Южной Георгии. Результаты анализа этих данных выявили существенную межгодовую изменчивость в распределении мест тралений. Данные 1993 г. имелись только за август, однако в это время промысел был ограничен районом на западном краю свала шельфа, где в последующие два сезона промысел был незначительным. В 1994 г. промысел почти исключительно велся на большой мелкой банке на северо-восточном краю шельфа. В 1995 г. промысел был продолжен как в этом районе, так и дальше к западу на ряде банок, находящихся в районе подводных долин. Приведенные здесь результаты обсуждаются в контексте экологии криля и взаимодействия между промыслом и локальными колониями хищников.

Resumen

El análisis de la distribución de la explotación de kril en base a los datos a escala fina (0.5° de latitud x 1° de longitud) muestra que la explotación de este recurso en el Mar de Escocia se ha centrado en el borde de la plataforma continental y en la plataforma continental misma, en el lado norte del Arco de Escocia. El análisis de los datos por regiones revela que hay algunas zonas del borde continental y de la plataforma en donde se han obtenido capturas abundantes. Si bien estos datos dan una indicación general de las zonas en donde ha operado la pesquería, no muestran exactamente donde se efectuaron las operaciones de pesca. En las tres últimas temporadas de pesca invernales (1993 a 1995) se han registrado datos de los arrastres individuales realizados en la zona de Georgia del Sur. El análisis de estos datos demuestra una variación marcada en la distribución de los arrastres de un año a otro. Para el año 1993 sólo se dispone de datos a partir del mes de agosto pero la pesquería en ese período se limitó a una zona situada en el borde occidental de la plataforma en donde la pesca fue mínima en las dos temporadas siguientes. En 1994 la pesca se concentró casi exclusivamente en un extenso banco somero en el borde noreste de la plataforma. Durante 1995 la pesca se desarrolló en su mayor parte en esta zona aunque también se extendió hacia el oeste en donde existen bancos asociados con valles submarinos. Los resultados se discuten en relación a la ecología del kril y la interacción de la pesquería con las colonias locales de depredadores.

Keywords: bathymetry, interannual variability, krill fishing, South Georgia, trawl positions, CCAMLR

INTRODUCTION

Knowledge of the distribution of krill (*Euphausia superba* Dana) is being enhanced by research surveys aimed at understanding interactions between the environment and krill. Such studies, however, are usually geographically limited and of restricted temporal extent. There are few data available where krill have been studied over more than a few weeks in a year and at other than a local scale. Krill population dynamics operate over ocean basin scales (Miller and Hampton, 1989; Murphy, 1995), so standard research methods do not provide appropriate information. Data of greater spatial and temporal coverage are required to understand what factors control the distribution of krill. Analyses of fisheries data have often been used to reveal aspects of an organism's ecology which cannot be elucidated with traditional ecological methods. This is particularly the case in areas where ship-based sampling programs are difficult or where the distribution of an organism occurs over a spatial scale larger than one that can be easily resolved by one-off discrete sampling surveys. A number of studies have already used krill-fishery data to good effect (e.g. Everson and Goss, 1991; Ichii et al., 1994).

Previously the data available to analyse the krill fishery have been in two forms; subarea or STATLANT data, and fine-scale (0.5° latitude x 1° longitude) data. These data have been used to give a general idea of the large-scale fluctuations in the fishery and the seasonal–regional development of the fishing operation (Everson

and Goss, 1991; Ichii et al., 1994). Subarea data give little indication of the exact location of the fishery. Fine-scale data are more useful, but at a resolution of about 50 km the data provide little information to investigate local environment–krill–predator–fishery interactions.

An understanding of the localised interactions of predators and prey around predator colonies is required (Trathan et al., 1996b) alongside data on the finer-scale distribution of fishing for harvesting to be managed using an ecosystem approach. To this end it would be valuable to obtain better data coverage at finer scales in the areas where the predator colonies and the fisheries occur. This will also allow the value of the broader-scale data already being reported to CCAMLR to be maximised. In this paper we report the geographical analysis, in relation to bathymetry, of the CCAMLR fine-scale data. We also report a further dataset which provides information of the position of individual trawls. This trawl dataset has not been previously available to the CCAMLR scientific community. The analyses utilise a Geographic Information System (GIS) which has been compiled for the area around South Georgia (Trathan et al., 1992). The data give insight into the local interactions between krill and their environment as well as giving us an improved understanding about how the fishery operates.

METHODS AND DATA

A description of the CCAMLR fine-scale data was given by Everson and Goss (1991). These data are reported as catch and effort for rectangles of 0.5° latitude x 1° longitude by 10-day periods. The data are presented in the *CCAMLR Statistical Bulletins* for each quarter of the year and it is those data that have been used in this study. The following new dataset was also available. From August 1994 all vessels licensed to operate in the South Georgia and South Sandwich Islands area reported trawl position and catch and effort data. These data include details of the vessel, gear used and the position and catch of each haul. In this paper we use the positional information to examine where the fishery operated.

The Scotia Sea fine-scale and the South Georgia area–trawl positional data were loaded into an Arc/Info 7.2 (ESRI) GIS. The system includes information on the coastline of South Georgia (McDonald et al., 1987) and a digitised version of the Hydrographic Office South Georgia Approaches Chart (Hydrographic Office, 1992) which gives the most comprehensive view of the bathymetry currently available.

RESULTS

The fine-scale data were used to examine the general distribution of where the fishery has operated over the last decade at both the Scotia Sea and the regional scale. This gives the context for examining the detailed positional data from the South Georgia fishery.

Fine-scale Data

A broad-scale view of the data reveals the extent to which this fishery was conducted around the shelf regions in the southwest Atlantic (Figure 1) and shows that the fishery operates mainly on the shelf and shelf-slope areas on the northern side of the Scotia Arc. Although there has been restricted fishing to the south of Livingston Island on the Peninsula, there has been little penetration of the fishing operation into the Weddell Sea region. The fishery does, however, operate to the east of the South Orkney Islands over a series of deep banks (Bruce, Discovery and Herdman). In the area north and west of the South Shetland Islands and north of the South Orkney Islands the fishery has exploited areas over deeper waters. It was found that these areas are located in association with bathymetric features (i.e. Shackleton Fracture Zone and Pirie Bank respectively), but the ice-edge position will also be a key factor determining fishing distribution in these areas (Everson and Goss, 1991).

These data have not previously been analysed and plotted together with bathymetry information in this way and more detailed maps of the area where large catches have been made further emphasise the shelf and shelf-slope focus of the fishery in these areas. In the Antarctic Peninsula region (Figure 2) the maps highlight the areas noted by Ichii et al. (1994), while around the South Orkney Islands the major area fished was to the north and west, again on the shelf-break areas (Figure 3). An area over a deep (500 m) bank (Pirie Bank; approximately 44–45°W and 59°S) to the north of the South Orkney Islands was also exploited by the fishery. Around South Georgia there are five fine-scale grid cells where high catches have been reported in a number of

quarters (Figure 4). These correspond with the shelf and shelf-slope areas on the north coast of the island.

Trawl Position Data for the South Georgia Area

In utilising the trawl data it must be emphasised that the data relate to a commercial fishery and are not survey data, however they do provide valuable information on where commercial concentrations of krill were found. The total catch from the fishery in Subarea 48.3 has varied over the last decade (*CCAMLR Statistical Bulletins*; Figure 5 below) and was at its lowest level during the winter of 1993 with slightly higher catches reported in 1994. By June 1995 (the last recorded catch) catches were greater than had occurred in all of 1994. During this period there were operational changes in the fishery which must be borne in mind when considering the trawl data which were only available for parts of the last three seasons. The catches recorded in the trawl dataset represent 71% of the catches recorded from August to October 1993 but only 12% of the season total. The complete trawl dataset for 1994 accounts for 85% of the reported catches for Subarea 48.3 and the trawl dataset for June 1995 represents 71% of the total catch reported. It is not clear where in Subarea 48.3 catches were made outside the South Georgia area but it does appear that areas well to the west (~42°W and 54°S) were targeted in some years (*CCAMLR Statistical Bulletins*).

The fishery during late winter 1993 operated on the northern side of the extreme western shelf area at about 39°W and 53.75°S (Figure 6). To the west of this area the depth increases rapidly to greater than 1 000 m. The fishery operated in water depths of about 200 and 500 m over a restricted area of about 30 x 20 km. There were also a few isolated hauls made outside this area. During 1994 the majority of hauls occurred inside a restricted area on the shelf break extending from the northeast of Cumberland Bay to the east of Royal Bay (Figure 7). Examination in relation to the bathymetry indicates that hauls were made over a bank 100 to 200 m in depth centred at 36.5°W and 54.15°S. The bank is on the shelf surrounded by a 150 to 250-metre-deep gully where the offshore edge is steep with the depth increasing from 150 to 1 000 m in a few kilometres. The few isolated hauls made were mainly taken over the 200-m contour. The fishery in 1995 again operated over the same bank but also exploited other areas further west along the northern shelf (Figure 8). The distribution of hauls was not continuous within the area but was associated with gullies and banks in the 150 to 500 m shelf region.

DISCUSSION

The fishery generally targets areas of shelf and shelf-slope on the north and western sides of the Antarctic Peninsula and the Scotia Arc; it is not a fishery that obtains large catches throughout the Scotia and Weddell Sea. The timing of exploitation is related to the ice-edge position (Everson and Goss, 1991). There are also strong oceanographic connections across the shelf areas along the northern side of the Scotia Arc that will transport krill through the area. Geopotential anomaly stream lines (Sievers et al., 1988) indicate that there is a general flow across the shelf from the Antarctic Peninsula region along the northern shelf area of the Scotia Arc. Sievers et al. (1988) note the deflection of the flow northwards in the area of the Shackleton Fracture Zone and such a deflection is also notable around Pirie Bank (see their Figures 15 and 16). The flow is subsequently deflected northwards and east towards South Georgia. The areas fished reflect this general flow pattern, suggesting that the large-scale fishery is operating on a series of connected stocks.

The analyses support the suggestion of Everson and Goss (1991), who utilised more limited datasets, that the fishery targeted the shelf areas and that these areas comprised a small proportion of the Scotia Sea. Furthermore, the trawl position data reveal that even within the area around South Georgia the fishery targets restricted parts of the shelf. The areas exploited are of a scale much smaller than the fine-scale data can resolve. The fishery around South Georgia operates on a series of banks along the northern shelf which are associated with submarine canyons and reflect the fjord structure of the island. It is also likely that the fishery is focused on restricted areas around the South Shetland Islands, Elephant Island and west of the South Orkney Islands, emphasising that similar analyses for these areas would probably be useful.

Research surveys around South Georgia have shown high krill abundance in the northern shelf and shelf-break areas (Murphy et al., 1991), and recently it was found that the bank area where the fishery concentrated in 1994 and 1995 was also an area of high krill abundance during the summer

of 1995/96 (Brierley et al., 1996). The distributions of fishing almost certainly show where some of the major aggregations of krill occurred and how these related to the local bathymetry. As the oceanographic conditions in such areas will be strongly influenced by the bathymetry, the distributions will be related to local oceanographic conditions. Recent detailed oceanographic data for the South Georgia northern shelf area indicate that a shelf break front may be present during summer months (Brandon et al., 1996). Understanding the role of the front in the development and maintenance of mesoscale krill aggregations in this area, particularly between summer and winter, is likely to be important in determining how the ecosystem operates.

The restricted nature of the fishing operation indicates that the fishery targets areas which generate consistent catch rates, so the data do not give a true picture of the krill distribution in the region. The distributions will also have been affected by operational factors dependent on the nationality of the fleet and the prevailing weather conditions. For example, the northern shelf area may be favoured by the fishery because it is in the lee of the island. Only further research surveys will reveal the relation between the fishery and the underlying krill distribution. A regional scientific survey in June or July would be particularly useful.

The indications that the fishery regularly exploits a small number of known areas suggests that little time is spent searching for mesoscale aggregations. The restricted nature of the fishery is further emphasised by the relatively small number of isolated hauls made outside the main fishing areas. The above therefore supports the comments of Fedulov et al. (1996) that the operation of the fishery in this area is likely to make some form of catch-per-unit-effort (CPUE) statistic a useful index of krill abundance. Although there appears to be confusion about this within CCAMLR, the suggestion is consistent with the simulation studies carried out in the late 1980s (Butterworth, 1989; Mangel, 1989).

As well as the distribution being restricted within the shelf-break area, there was also marked interannual variation in the areas fished. The extreme western fishery occurred late in 1993 at the start of the 1993/94 summer season. The predators at Bird Island showed very poor breeding performance that year (SC-CAMLR-XIV, 1995, Tables 3.7 and 3.8), and research surveys indicated that krill abundance was low (Brierley and Watkins, 1996). This was also a year when the sea-ice was located to the south of the mean winter position and warmer sea-surface temperatures characterised the area (BAS, unpublished data). This corresponds with the general pattern noted by Fedulov et al. (1996) of lower krill abundances and lower catch rates in the fishery during warmer years. In 1994 and 1995 the catches were higher and the water temperatures were generally cooler. In these years more eastern areas were targeted by the fishery.

The analyses emphasise that it is necessary to understand what generates and maintains the mesoscale distribution of krill in such areas and to consider what factors determine variability within and between years. This will be particularly important for determining the effect of such targeted fisheries on the population dynamics of predators in local colonies (Trathan et al., 1996b). In the South Georgia area the fishery operates in winter while the main breeding season for most of the krill-dependent predators is in the summer months. This appears to have led to the argument that the temporal separation of the fishery means that there will be little effect on the amount of prey available to the predators. This will, however, depend on a range of direct and indirect effects. The summer krill distribution is in some way related to the previous winter distribution. The turnover time for krill in the area will then be crucial; if it is high then effects of the fishery on the summer prey availability should be low and indirect effects on the predators minimal. The indications from Fedulov et al. (1996) are that the fishery reported major reductions in krill availability in the years when the predators breeding success was low and research surveys in the summer noted a lack of krill. This suggests that the winter and summer levels are related, but whether this is a local effect or a reflection of larger-scale processes remains unclear. A further aspect which may generate more interaction with the fishery than first thought is the potential indirect effects on the predators during the winter months. The predators require quite high prey levels during the winter, indeed higher than for the early part of the breeding season (Boyd and Croxall, 1996). Not much is known about the winter predator foraging distributions, but it seems likely that the large aggregations of krill around South Georgia during winter will also be a focus for marine predators. Indeed this period may be crucial to the breeding success of predators in the following season. Trathan et al.

(1996a) have suggested that the late autumn period may be important in determining the condition of chinstrap penguins at the end of the winter and hence their breeding success in the following season.

The localised nature of the areas fished emphasises that the effort and catch are not evenly distributed through an area, so any competition with predators, if it occurs, is likely to be more intense. A much better understanding is required of the winter foraging strategy of the predators and how the winter prey distribution relates to that in the summer. The fishery during 1994 and 1995 did not operate much within the major foraging areas of the macaroni penguins based at South Georgia as described by their at-sea distribution during the summer months (Trathan et al., 1996b). The fishery is thought, however, to move east along the shelf through the season (Fedulov, pers. comm.; BAS, unpublished data), so it may impact in the main foraging region just at the start of the summer. Indeed during 1993 this area was the major target of the fishery late in the season, suggesting the overlap with the main summer foraging area was greatest in the poor krill year of 1993/94 (Brierley and Watkins, 1996). Thus, years of low krill availability may be the ones in which the predators are most sensitive to fishing effects (cf. Murphy, 1995). In order to manage the ecosystem based on an understanding of how predators and fisheries interact, more detailed information of the type given by the trawl data are required for other areas of the Scotia Sea. Inclusion of information from observers on commercial vessels would improve both ecological knowledge and the advice for ecosystem management.

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REFERENCES

Boyd, I.L. and J.P. Croxall. 1996. Preliminary estimates of krill consumption by Antarctic fur seals and macaroni penguins at South Georgia. Document *WG-EMM-96/66*. CCAMLR, Hobart, Australia: 28 pp.

Brandon, M., E.J. Murphy, P.N. Trathan, D.G. Bone and J. Priddle. 1996. The shelf-break front around South Georgia. Poster presented to the Challenger Society meeting. Bangor, September 1996.

Brierley, A.S. and J.L. Watkins. 1996. Acoustic targets at South Georgia and the South Orkney Islands during a year of krill scarcity. *Mar. Ecol. Prog. Ser.*, 138: 51–61.

Brierley, A.S., J.L. Watkins and A.W.A. Murray. 1996. Krill biomass estimates for two survey boxes to the northeast and northwest of South Georgia in January 1996: the beginning of a five-year monitoring program. Document *WG-EMM-96/18*. CCAMLR, Hobart, Australia: 25 pp.

Butterworth, D.S. 1989. A simulation study of krill fishing by an individual Japanese trawler. In: *Selected Scientific Papers, 1988 (SC-CAMLR-SSP/5)*, Part I. CCAMLR, Hobart, Australia: 1–108.

Everson, I. and C. Goss. 1991. Krill fishing activity in the southwest Atlantic. *Ant. Sci.*, 3: 351–358.

Fedulov, P.P., E.J. Murphy and K.E. Shulgovsky. 1996. Environment-krill relations in the South Georgia marine ecosystem. *CCAMLR Science*, 3: 13–30.

Hydrographic Office. 1992. *The Approaches to South Georgia Admiralty Chart*, 3596.

Ichii, T.M., M. Naganobu and T. Ogishima. 1994. An assessment of the impact of the krill fishery on penguins in the South Shetlands. *CCAMLR Science*, 1: 107–128.

Mangel, M. 1988. Analysis and modelling of the Soviet southern ocean krill fleet. In: *Selected Scientific Papers, 1988 (SC-CAMLR-SSP/5)*, Part I. CCAMLR, Hobart, Australia: 127–236.

McDonald, D.I.M., B.C. Storey and J.W. Thomson. 1987. Geological Map of South Georgia. *BAS GEOMAP Series*, Sheet 1, 1:250000, with supplementary text, British Antarctic Survey, Cambridge.

Miller, D.G.M. and I. Hampton. 1989. Biology and ecology of the Antarctic krill (*Euphausia superba* Dana): a review. *BIOMASS Scientific Series*, 9: 166 pp.

Murphy, E.J. 1995. Spatial structure of the Southern Ocean ecosystem: predator-prey linkages in Southern Ocean food webs. *J. Anim. Ecol.*, 64: 333–347.

Murphy, E., I. Everson and A.W.A. Murray. 1991. Analyses of acoustic line-transect data from the waters around South Georgia: estimation of krill (*Euphausia superba* Dana) biomass. In: *Selected Scientific Papers, 1991 (SC-CAMLR-SSP/8)*. CCAMLR, Hobart, Australia: 225–243.

SC-CAMLR. 1995. Report of the Working Group on Ecosystem Monitoring and Management. In: *Report of the Fourteenth Meeting of the Scientific Committee (SC-CAMLR-XIV)*, Annex 4. CCAMLR, Hobart, Australia: 105–254.

Sievers, H.A. and W.D. Nowlin Jr. 1988. Upper ocean characteristics in Drake Passage and adjoining areas of the Southern Ocean, 39°W–95°W. In: Sahrhage, D. (Ed.). *Antarctic Oceans and Resources Variability*. Springer-Verlag, Berlin Heidelberg: 57–80.

Trathan, P.N., E. J. Murphy, C. Symon and P. Rodhouse. 1992. Ecological and oceanographic relationships in the Southern Ocean. *GIS Europe*, 2 (6): 34–36.

Trathan, P.N., J.P. Croxall and E.J. Murphy. 1996a. Dynamics of Antarctic penguin populations in relation to the inter-annual variability in sea-ice distribution. *Pol. Biol.*, 16: 321–330.

Trathan, P.N., E.J. Murphy, J. Croxall and I. Everson. 1996b. At-sea distribution and potential foraging impact of macaroni penguins during the breeding season. Document *WG-EMM-96/59*. CCAMLR, Hobart, Australia.

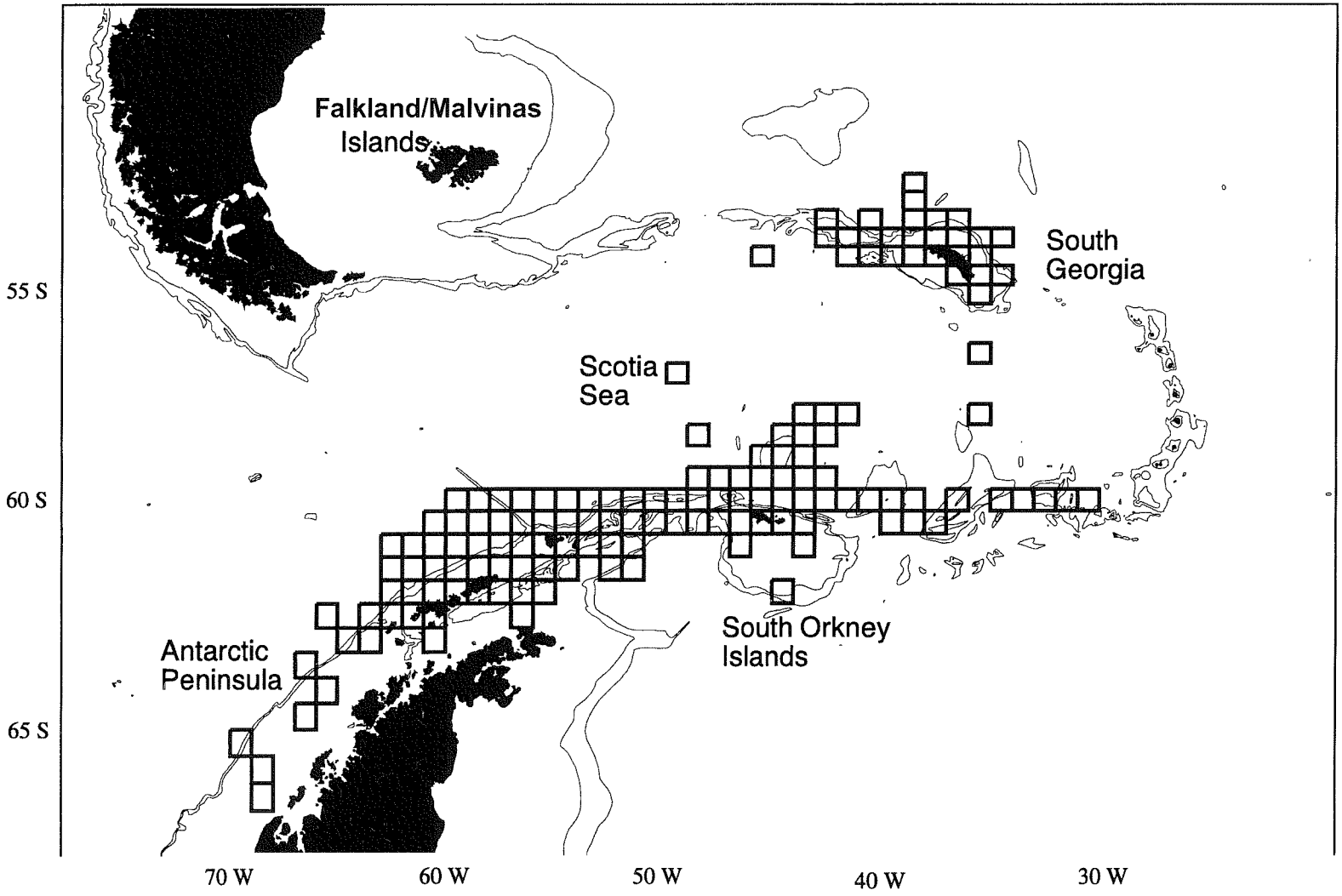


Figure 1: The distribution of the fine-scale grid areas where catches greater than 4 tonnes have been reported in a CCAMLR reporting quarter of the year on at least one occasion between 1986 and 1992. Based on the fine-scale data provided in *CCAMLR Statistical Bulletins*. Contours are shown for the 1 000 and 2 000-metre isobaths.

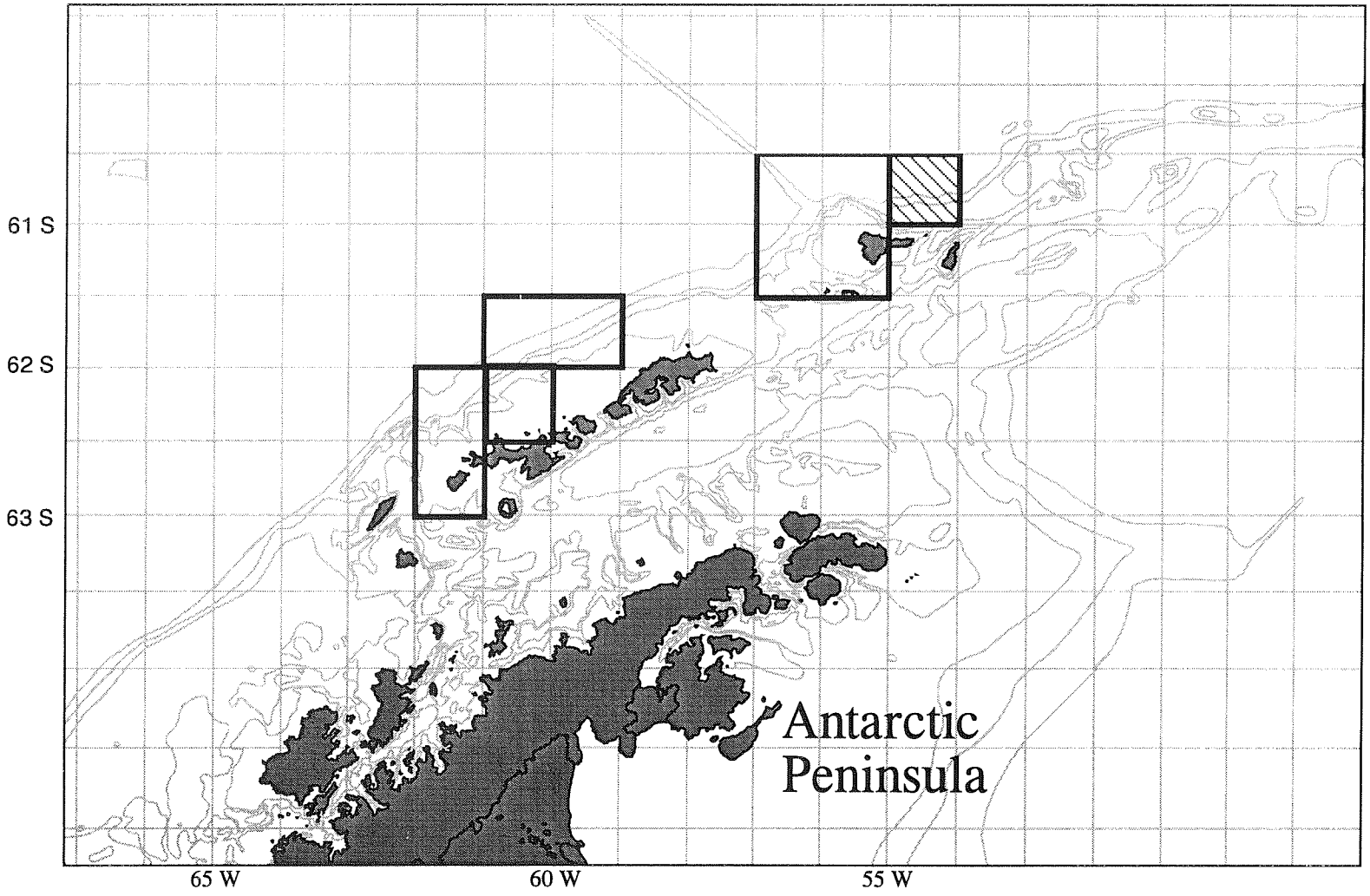


Figure 2: The distribution of the fine-scale grid areas in the Antarctic Peninsula region where catches greater than 3 000 tonnes have been made in a CCAMLR reporting quarter of the year on at least one occasion (shaded areas) or on more than one occasion (open squares). The data cover the period between 1986 and 1992 and are based on the fine-scale data provided in *CCAMLR Statistical Bulletins*. Contours are shown for the 250, 500, 1 000 and 2 000-metre isobaths.

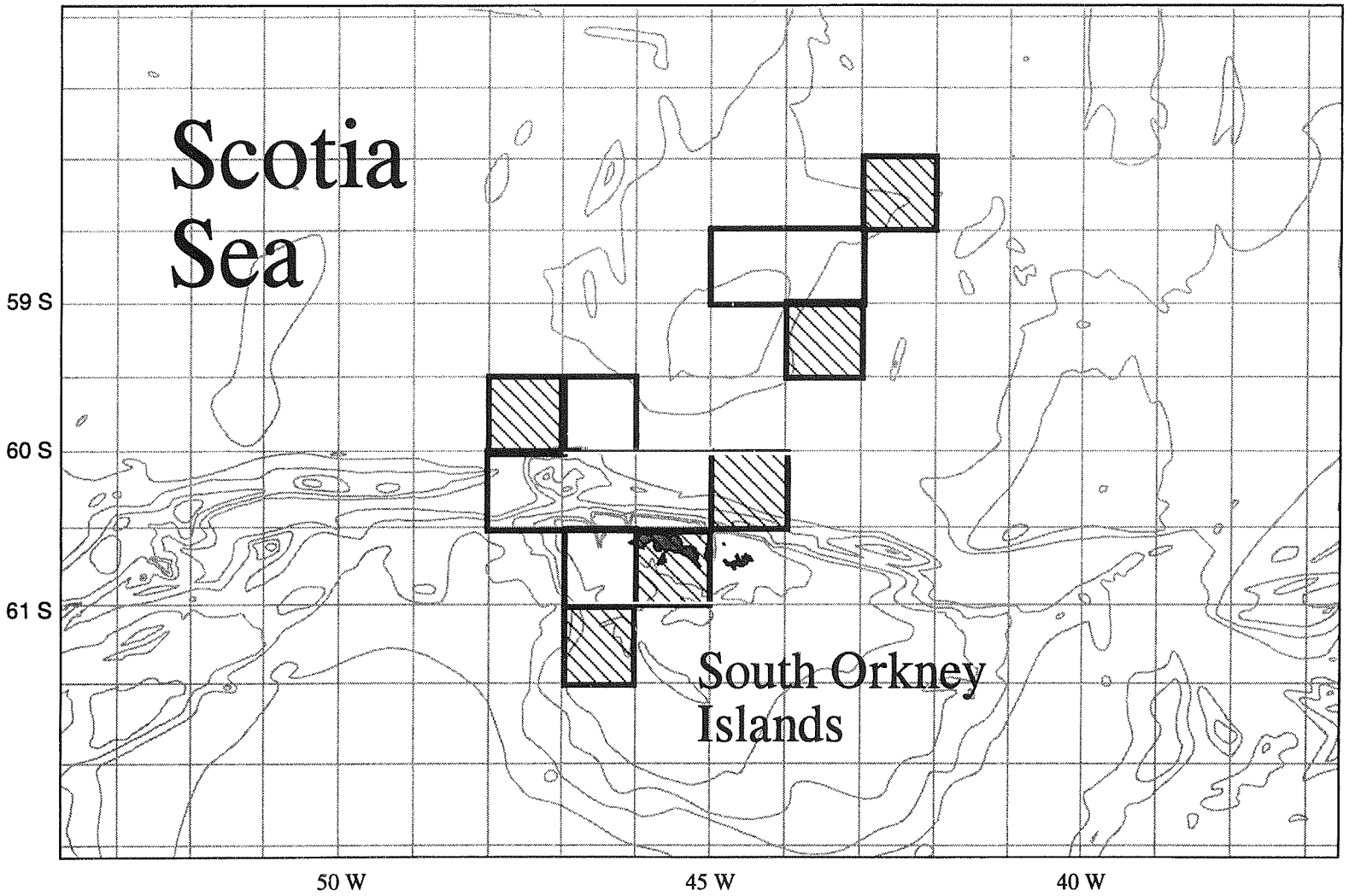


Figure 3: The distribution of the fine-scale grid areas in the South Orkney Islands region where catches greater than 3 000 tonnes have been made. See Figure 2 for details. Contours are shown for the 250, 500, 1 000, 2 000 and 3 000-metre isobaths.

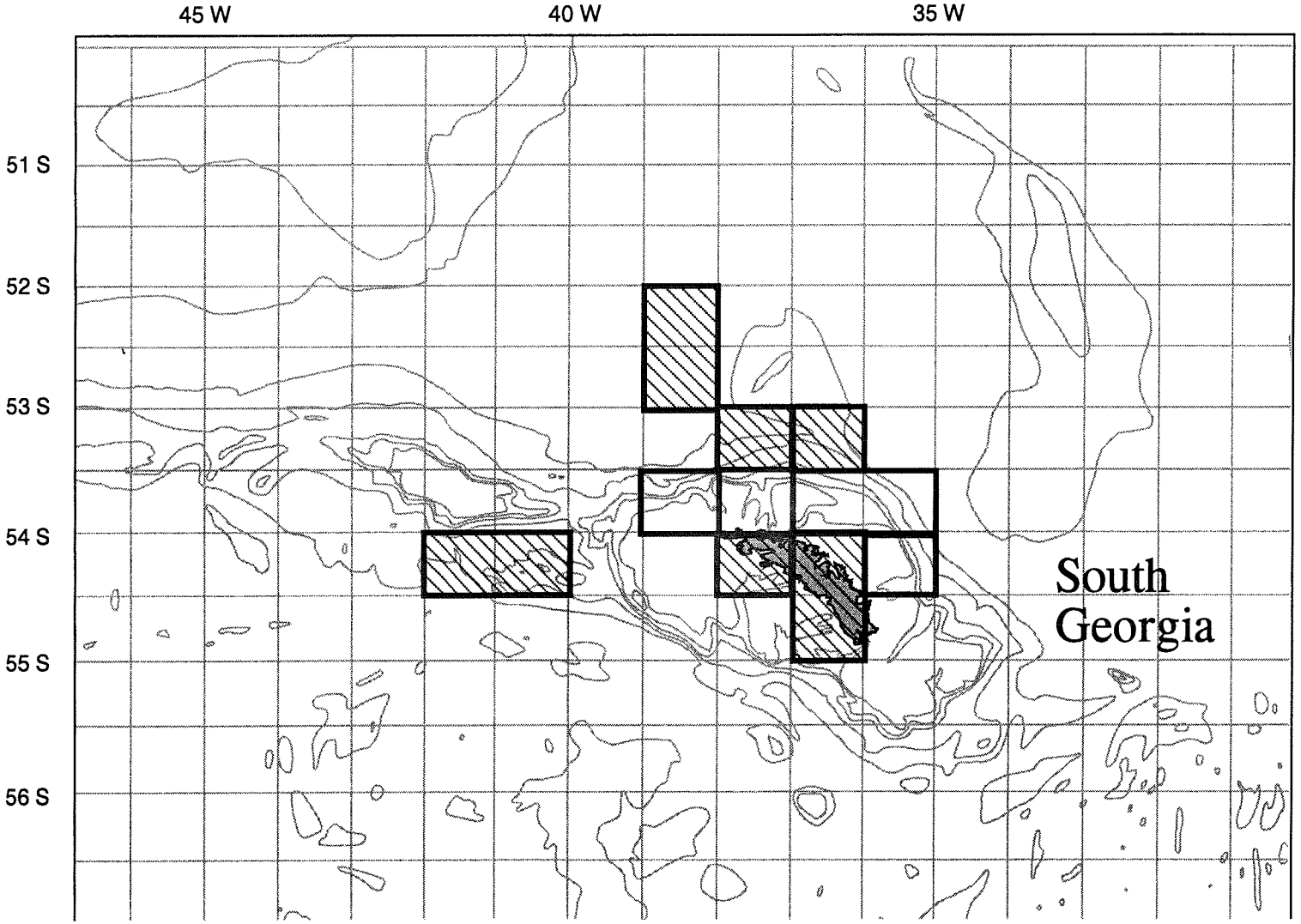


Figure 4: The distribution of the fine-scale grid areas in the South Georgia region where catches greater than 3 000 tonnes have been made. See Figure 3 for details.

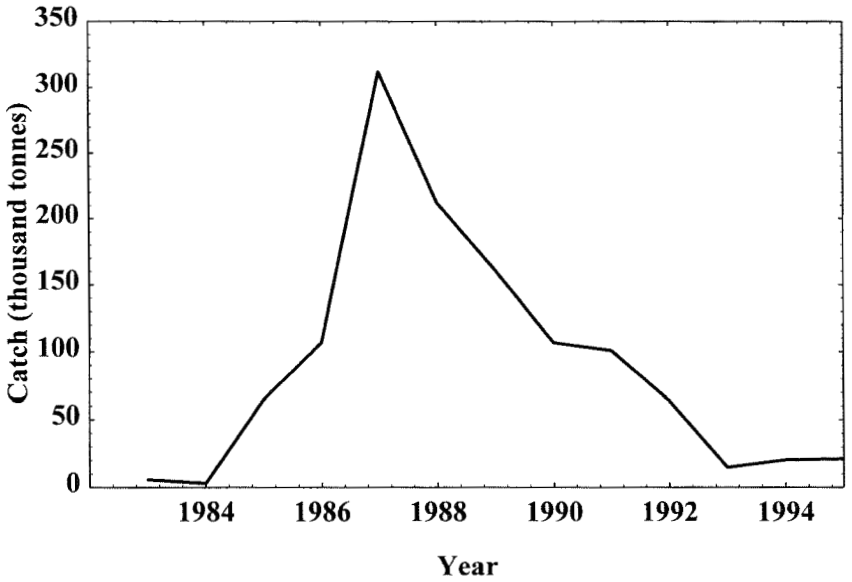


Figure 5: The total catch recorded in Subarea 48.3 during each calendar year from 1983 to 1994.

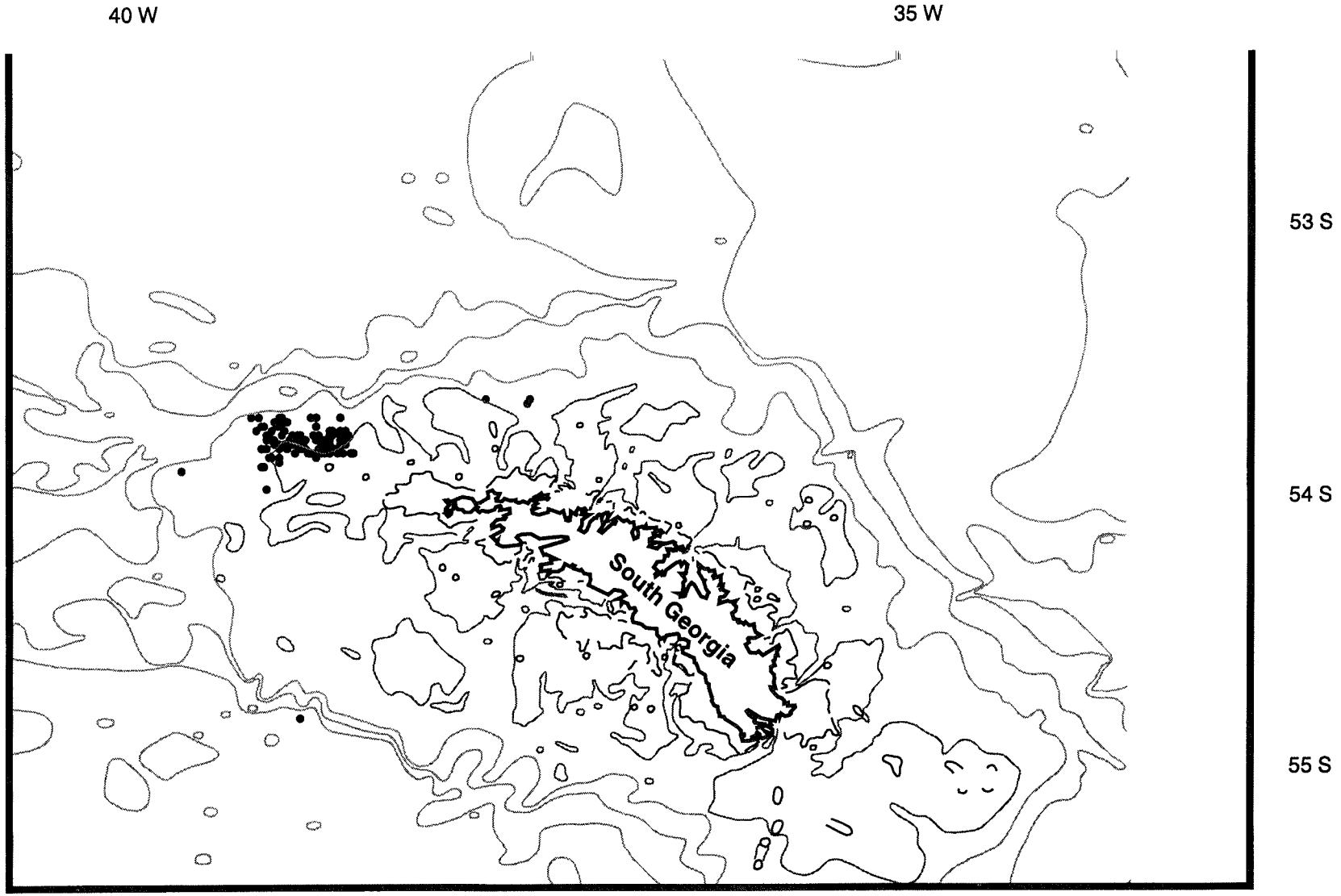
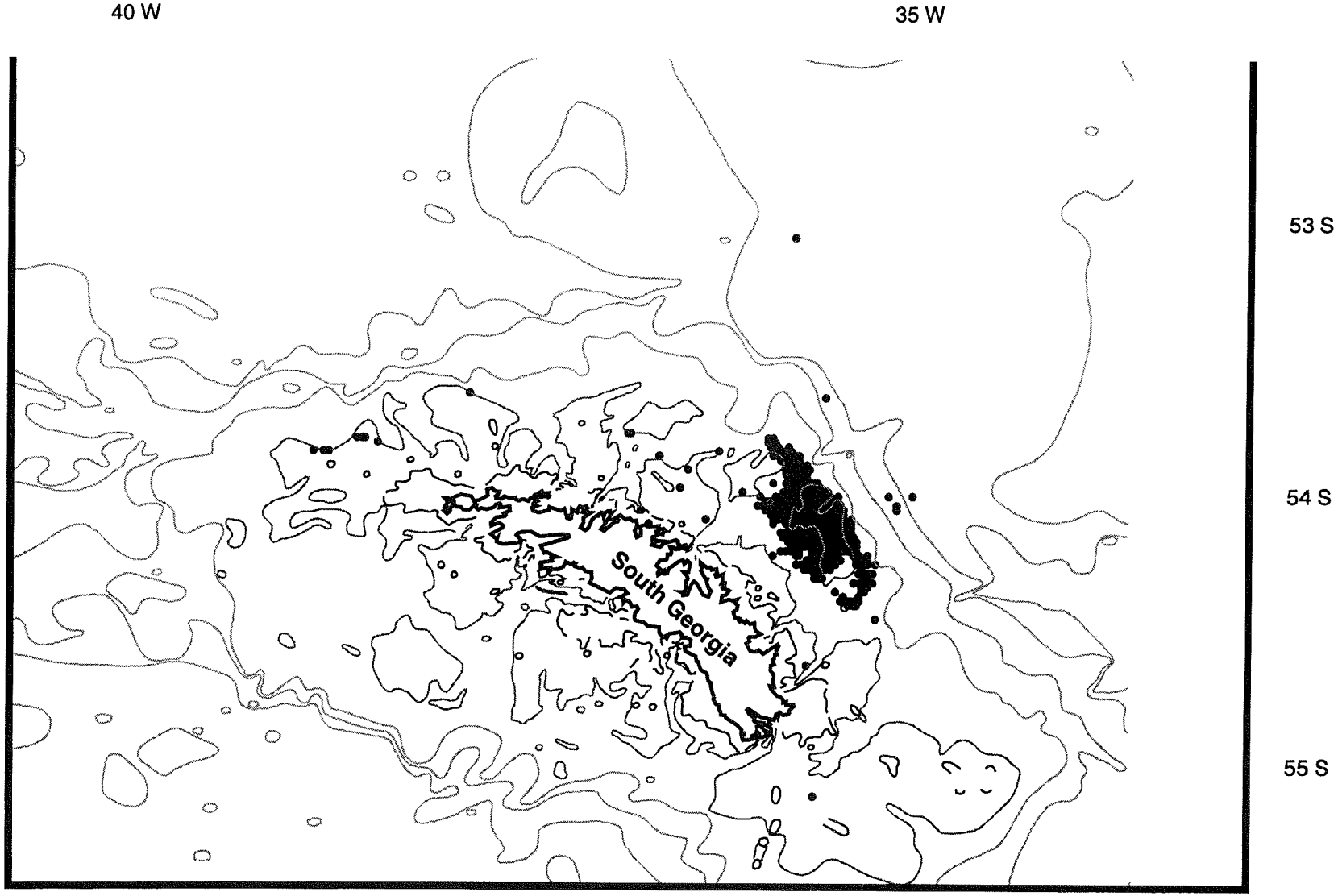


Figure 6: The distribution of individual krill hauls around South Georgia during the 1993 fishing season. The data are shown in relation to the regional bathymetry. Contours are shown for the 100, 200, 1 000, 2 000, and 3 000-metre isobaths.



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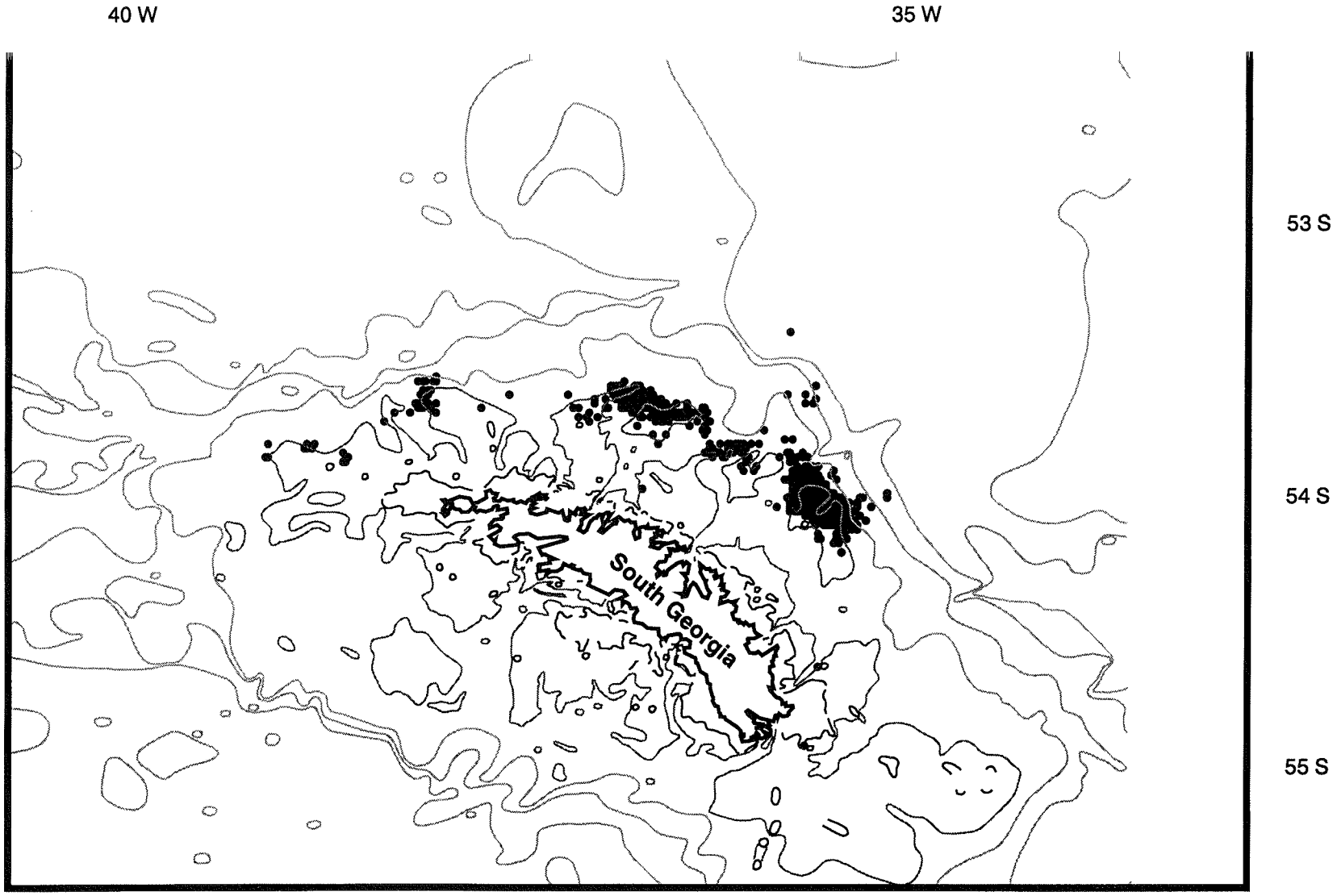

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