SC-CAMLR-VI/BG/23

A RATIONALE FOR CONSERVATION AREAS WITHIN ANTARCTIC WATERS

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Abstract

The application of potential conservation measures listed in Article IX 2 of the Convention requires "the designation of regions and sub-regions based on the distribution of populations of Antarctic marine living resources" (Article IX 2 (b)). In order to select meaningful boundaries for such areas, first priority has been given to surface circulation of southern waters and the distribution of krill. This has been supplemented by (limited) information on the distribution of major consumers including baleen whales, seals and penguins. A possible relationship between general flowline features of the Antarctic ice cap and ragional dynamics of the Southern Ocean ecosystem is also suggested.

From the evidence available, the following six potential conservation areas are proposed:

70°W - 15°W
15°W - 40°E
40°E - 90°E
90°E - 150°E
150°E - 160°W
160°W - 70°W

Examples are given of options available for management approaches within these major conservation areas.

Résumé

La mise en vigueur des mesures de conservation potentielles énumérées à l'Article IX 2 de la Convention nécessite "la désignation de secteurs et de sous-secteurs selon la répartition des populations de ressources marines vivantes de l'Antarctique" (Article IX 2 (b). Afin de sélectionner des limites significatives pour ces régions, la circulation de surface des eaux australes et la répartition du krill ont été considérées en toute priorité. S'y sont ajoutées des informations (limitées) sur la répartition des principaux prédateurs, dont les baleines mysticètes, les phoques et les manchots. L'existence d'une relation éventuelle est également suggérée entre les caractéristiques générales du flux de la calotte glaciaire antarctique et la dynamique régionale de l'écosystème austral.

Se basant sur les indications obtenues, les six régions de conservation potentielles suivantes sont proposées:

70°O - 15°O
15°O - 40°E
40°E - 90°E
90°E - 150°E
150°E - 160°O
160°O - 70°O

Le document présente des exemples d'options disponibles quant aux différentes approches d'aménagement au sein de ces principales régions de conservation.

Resumen

La aplicación de las medidas de conservación potenciales listadas en el Artículo IX 2 de la Convención requiere "la designación de regiones y sub-regiones basada en la distribución de las poblaciones de los recursos vivos marinos antárticos" (Artículo IX 2 (b)). Para seleccionar límites significativos para tales áreas, se ha dado primera prioridad a la circulación superficial de las aguas australes y a la distribución del krill. Esto ha sido suplementado por información (limitada) sobre la distribución de los consumidores más importantes incluyendo a las ballenas baleen, focas y pingüinos. Se sugiere también una posible correlación entre las características generales de las líneas de flujo de la capa de hielo antártica y la dinámica regional del ecosistema del Océano Austral.

En base a la evidencia disponible, se proponen las siguientes seis áreas de conservación potenciales:

70°O - 15°O
15°O - 40°E
40°E - 90°E
90°E - 150°E
150°E - 160°O
160°O - 70°O

Se presentan ejemplos de las opciones disponibles para los enfoques de administración dentro de estas principales áreas de conservación.

Резюме

Применение возможных мер по сохранению, перечисленных в Статье IX.2 Конвенции, требует "определения районов и подрайонов на основе распределения популяций морских живых ресурсов Антарктики" (Статья IX.2 /b/). Для того, чтобы выбрать имеющие смысл границы для таких районов, первостепенное значение

придается поверхностной циркуляции южных вод и распространению криля. Также сюда входит информация (ограниченная) о распространении главных консументов, включая усатых китов, тюленей и пингвинов. Выдвигается предположение о возможной связи между линией налегания ледникового покрова Антарктики и региональной динамикой экосистемы Южного океана.

На основе имеющихся данных предлагается шесть следующих районов применения мер по сохранению:

70°з.д.- 15°з.д.
15°з.д.- 40°в.д.
40°в.д.- 90°в.д.
90°в.д.-150°в.д.
150°в.д.-160°з.д.
160°з.д.- 70°з.д.

Даются примеры возможных вариантов стратегии управления в пределах этих главных районов применения мер по сохранению.

A RATIONALE FOR CONSERVATION AREAS WITHIN ANTARCTIC WATERS

INTRODUCTION

Although the Antarctic Treaty and the various conventions applying around Antarctica contain provisions to zone activities within specified areas (including fully protected reserve areas), such provisions have not yet been applied systematically in these waters.

While the Antarctic Treaty System provides for the setting aside of Specially Protected Areas (SPAs), none of the eighteen SPAs so far designated have marine waters as main components. Marine ecosystems are included in the classification of Antarctic ecosystems proposed by the SCAR Sub-Committee on Conservation (1976).

Under the Convention for the Conservation of Antarctic Seals (Annex 5), three marine areas have been set aside as seal reserves (around the South Orkney Islands; in the south-west of the Ross Sea; and in the vicinity of Cape Hallet). There is also provision under this Convention for sealing alternately within six arbitrarily defined sealing zones.

Under the Whaling Convention, a sanctuary for baleen whales was applied in earlier years within the sector from 70°W to 160°W. More recently there has been a move within the International Whaling Commission to extend the Indian Ocean Whale Reserve southwards into Antarctic waters.

The Convention for the Conservation of Antarctic Marine Living Resources provides for management by open and closed areas (Article IX 2 (g). So far only one area has been closed to fishing (within 12 nautical miles of South Georgia).

One of several strategy approaches discussed in Australia's submission to the CCAMLR Working Group developing a conservation strategy (WG-CSD-87/6), is the operation of open and closed areas. This would require "the designation of regions and sub-regions based on the distribution of populations of Antarctic marine living resources", as specified in Article IX 2(b) of the Convention.

As was recognised in the Australian submission, a critical step in this is the selection of boundaries for conservation areas in a manner which ensures ecological as well as economic viability. In this it is desirable that each area, whether open or closed, contains a unit stock of at least the target species, or preferably, a largely self-contained ecosystem.

Complete segregation of the communities within the conservation areas is not essential or even desirable; only that exchanges between them by migration be low in relation to productivity (growth and survival) within a unit.

To date, apart from an early effort to identify separate stocks of whales (discussed later), management areas in the Southern Ocean have had little ecological basis. The FAO set out three arbitrary statistical regions in the Southern Ocean (areas 48, 58, and 88) as part of the world-wide Statlant system for recording fisheries operations. These three main areas were subsequently sub-divided, particularly in the Southwest Atlantic and Western Indian Ocean sectors, mainly for the purpose of separating demersal fishing operations on discrete banks and shelves.

With the increasing emphasis now on krill harvesting, it is timely to consider whether the areas and sub-areas defined largely for other purposes might be applied effectively to this fishery, under a management convention designed to conserve the ecosystem as a whole rather than the harvested species alone. As stated by Latogursky (1986), "the problem is gaining in importance because of the necessity of setting krill catch quotas for each fishing country in the near future". While a rather arbitrary separation into a number of major regions might suffice as an initial basis for a workable management regime, under the ecosystem approach required by the convention it would be far preferable if areas could be defined on a sound ecological basis.

AN ECOLOGICAL BASIS FOR DELINEATING CONSERVATION AREAS

Water circulation and distribution of krill:

Latogursky (1986) reviews available information upon which it might be possible to differentiate stocks of krill within the Southern Ocean. On the basis of surface water circulation, he suggested at least six cyclonic systems, although the longitudinal limits of each were not specified. Two or three of these systems are of large scale and were suggested as habitats for independent populations of krill.

When the surface water circulation for this region (Lubimova 1982, Fig. 1) is overlaid by the distribution of krill concentrations (Lubimova 1982, Fig. 28), the resultant shows fair agreement between the location of gyres and major concentrations of krill (Figure 1). On this basis, the following separation is suggested:

Sector	1	70°W - 15°W	Weddell gyre
	2	15°W - 55°E	
	3	55°E - 100°E	Prydz gyre
	4	100°E - 150°E	
	5	150°E - 140°W	Ross gyre
	6	140°W - 70°W	

No major surface gyres are evident from 100°E to 150°E, or from 140°W to 70°W, though it is possible that quasi-stationary cyclonic eddies of smaller dimension may occur. The krill distribution within these two sectors appears to be correspondingly patchy.

The identification of concentrations of krill within major gyres has led to an examination of samples for evidence of morphological or biochemical differences that might support an hypothesis of genetic separation of stocks. However, as far as has been determined to date (Latogursky 1986; MacDonald, Williams and Adams 1986) there appears to be a continuous exchange of gene pool throughout the Antarctic populations of *Euphausia superba*. Thus, while there may be unit stocks sufficiently discrete for management purposes, there is adequate exchange to maintain a common genetic entity of *E. superba* as a single composite population. As pointed out by Latogursky, one of the important research tasks is to determine the routes and rates of exchange between one sub-population and another. However, as this may take considerable time to achieve, some interim management framework is required.

Distribution of consumers:

Following the ecosystem approach, we should now examine whether the sectors based on water circulation and the distribution of a key food species, are consistent with the distribution of the major consumers. The various consumers differ greatly in mobility as well as in their environmental needs and responses, so can hardly be expected to show identical patterns of distribution and movements.

Whales: During the height of the pelagic whaling era some fifty years ago, six whaling Areas were delineated (Mackintosh 1942) within the following sectors:

Area II	60°W - 0°
Area III	0° - 70°E
Area IV	70°E - 130°W
Area V	130°E - 170°W
Area VI	170°W - 120°W
Area I	120°W - 60°W

These Areas were based on knowledge available at the time, of the distribution of the larger baleen whales during the summer feeding season, and migration paths to breeding grounds in lower latitudes. Humpback whales were the most clearly segregated into unit stocks. However, while unit stocks of humpback whales within the major Areas were sufficiently discrete to maintain consistently different proportions of body pigment patterns and differing age/size composition as a result of non-uniform fishing pressures (Chittleborough 1965), marked humpback whales occasionally moved from one stock to another. Blue whales, and particularly fin whales, however, were far less clearly segregated into unit stocks (Mackintosh 1942), while sei and minke whales were little segregated at all.

For a re-examination of the distribution of the larger baleen whales during the feeding season, the summer sightings from RRS *Discovery II* from 1933 to 1939 are well representative (Mackintosh 1942), affording an index quite independent of catches by whaling fleets concentrating in selected areas. The distribution of whale sightings shown in Figure 2 indicates feeding concentrations within each of the Sectors from Figure 1, apart from an anomaly within Sector 5. As mentioned by Mackintosh, Discovery II did not cover the main whaling grounds in the Weddell Sea so that the known concentration of large baleen whales in Sector 1 was not well recorded.

Some further indication of the distribution of the larger baleen whales in the Southern Ocean is gained from the maps prepared by Mizroch et al. (1985), based on catches by pelagic whaling fleets. The distribution of blue, fin and humpback whale catches peak well within each of the sectors delineated from Figure 1, though there is little sign of a discrete concentration of these whales within the sector from 100°E to 150°E. Catches of whales within the sector 160°W - 70°W were relatively low, partly because this was a declared Sanctuary Area so that virtually no whaling took place there from 1931/32 to 1954/55 (Horwood 1986). However, when re-opened to whaling, the modest catch rates confirmed earlier suggestions that this sector did not support a large stock of baleen whales. This may reflect a paucity of krill concentrations within that sector.

While some examination has been made of changes in the distribution of larger baleen whales in the Southern Ocean from season to season, and within a season (Mizroch et al 1985), variations in distribution have not been linked directly with variability in the distribution and abundance of krill. Chittleborough (1965) showed that in the Antarctic summer of 1958/59, humpback whales that usually fed between 160°E and 180° spread westward as far as 110°E, and suggested that the wider dispersion of that stock in that season may have been caused by poor development of quasi-stationary cyclones responsible for aggregations of food in the usual feeding grounds.

Seals: The Convention for the Conservation of Antarctic Seals (Annex 4) provides for alternating closures within six sealing zones south of 60°S, having the same meridian boundaries as the Whaling Areas. These Zones are quite arbitrary as so little is known of the distribution and abundance of the pelagic Antarctic seals.

From satellite imagery during the summers of 1970/71 to 1972/73, Gilbert and Erickson (1977) proposed six residual pack ice regions persistent from year to year and presumed to act as foci during the southern summer for seal populations, particularly crabeater seals (Figure 3). Sighting surveys of seals hauled out on pack ice in location A (January-February, 1972) and in location B (January, 1973) enabled densities to be compared with earlier surveys in location F. The observed density of crabeater seals in location A was higher than in location B (1.62 and 1.02/km^2 respectively), but both were well below the previously recorded density in location F (6.56/km^2). No data were available on the densities of seals on pack ice during the summer in locations C, D and E.

Gilbert and Erickson found no correlation between the concentration of chlorophyll in surface waters and the density of crabeater, leopard, Ross or Weddell seals.

On the basis of residual pack ice recorded in the summers of 1970/71 to 1972/73, Gilbert and Erickson proposed zones for seal management divided at 25°W; 22°E; 72°E; 142°; 180°; and 70°W. They suggested that these six zones afford the best available units for shaping management strategies, proposing separate limits for each seal species in each zone.

Satellite imagery supplied by NASA of residual pack ice present during February of 1974 and 1975 confirm the presence of extensive pack ice remaining in locations A, B and F, indicate less extensive and fragmented areas of pack ice in locations C and D, and show little sign of residual pack ice in location E. Hence, while locations A, B and F may afford prospects for discrete populations of these seals (during summer), the case for other separate populations is less substantial. More direct observations are required.

On the other hand, the location of residual pack ice in summer may be less important to pelagic seals than the location, early in spring, of ice floes suitable for pupping and mating, and close to ready supplies of food for the newly weaned pups.

Birds: If the total breeding stock at each rookery of Antarctic seabird was known, together with the foraging range of that species during the breeding season, some inferences might be drawn concerning the distribution of food species at that time. While the locations of most breeding sites of Antarctic seabirds are generally known (e.g. Watson 1975), and counts are being monitored at certain sites, a reliable composite, quantitative picture of the distribution of each species is not readily available.

Figure 4 shows an assessment of the distribution and abundance of breeding stocks of Adelie penguins around Antarctica. This has been derived from Wilson (1983), referring back where necessary to Croxall and Kirkwood (1979) and Horne (1983), and including subsequent additions such as that of Hoshiai et al (1984). It should be noted that as counts were made in different decades they might not all be directly compatible since populations cycle, as evidenced by the steady decline in certain rookeries during the 1970s, followed by a sharp recovery in the early 1980s (Hoshiai et al 1984). Breeding sites favoured by Adelie penguins appear to be linked with localities having little residual pack ice each summer. The density of Adelie penguins recorded in summer on residual pack ice off the Oates and George V coasts (145°E - 170°E) was very low (0.02 per km^2) (Gilbert and Erikson, 1977). Figure 4 shows that the largest breeding stocks of Adelie penguins occur in the eastern margin of the Ross Sea, the coast adjacent to the Prydz Bay gyre, and on the Antarctic Peninsula.

Emperor penguins, breeding on fast ice rather than land, at a different time of the year and having different food preferences to Adelie penguins, might be expected to have different constraints to their distribution. However, Figure 5 indicates the main breeding concentrations to occur also on the eastern margin of the Ross Sea, the coast adjacent to the Prydz Bay gyre, as well as to the south of the Weddell Sea. Aerial surveys (in summer) by Gilbert and Erickson (1977) recorded very low densities on residual pack ice in the Bellingshausen and Amundsen seas (85°W - 135°)W and off the Oates and George V coasts (145°E - 170°E) (0.028 and 0.016 emperor penguins per km^2 respectively).

The rationale for conservation zones based on seabird distribution and abundance may be rather different from one based on the postulated distribution of Antarctic seals. Nevertheless, the areas of greatest concentrations of Adelie and Emperor penguins appear to relate well to the three major gyres of the Antarctic surface water circulation (i.e. the Ross Sea, Prydz Bay region, and Weddell Sea), and the resultant concentrations of food resources.

Relation to land systems:

To date there have been few attempts to relate features of the Antarctic ice cap to regional dynamics of the Southern Ocean and consequent sub-divisions of the marine ecosystem. In an approach to a framework for protected areas within both terrestrial and marine ecosystems, Keage (1986) comments that "an untried land planning concept with potential for polar protected sites is the use of ice catchments and selected ice flowlines, in combination with the adjoining pack ice zone, to delimit conservation units". Keage points out that amongst other effects, the ice cap has a controlling influence on the continental and adjacent surface wind circulation and sea ice movements near-shore.

Figure 6 shows the thirteen major ice catchments and their flowlines on the Antarctic ice cap. Where the ice sheets are extensive and the flowlines convergent, terminating in extensive ice shelves, there are productive marine ecosystems offshore (e.g. Ross Sea, Weddell Sea and Prydz Bay systems). Where there are extensive ice sheet catchments having diverging or parallel ice flow, the adjacent marine systems appear to be rather more diffuse in their productivity. Where the ice sheet catchments are least extensive, adjacent marine systems seem to be least productive, as seen in the Bellingshausen and Amundsen Seas (70°W to 150°W), where baleen whales, crabeater seals and penguins are relatively sparse, as discussed in previous sections.

Another aspect relating to land systems is the growing awareness of the need for Specially Protected Areas declared on land in order to protect breeding sites of birds or seals, to be extended into adjacent water where they feed.

MAJOR CONSERVATION AREAS PROPOSED

From the limited evidence so far available pointing to discrete or semi-discrete systems, as based on surface water circulation and krill distribution (Figure 1), baleen whale distribution (e.g. Figure 2), residual pack ice as a possible indicator of seal distribution (Figure 3), seabird breeding concentrations (Figures 4 and 5), and the major ice catchments of the Antarctic ice cap (Figure 6), the following sectors of Antarctic Surface Water are proposed as having some consistent ecological basis as potential conservation areas:

Sector	1	70°W - 15°W
	2	15°W - 40°E
	3	40°E - 90°E
	4	90°E - 150°E
	5	150°E - 160°W
	6	160°W - 70°W

These potential conservation areas within the CCAMLR region are shown in Figure 7. Future investigations might well verify that Sectors 1, 3 and 5 contain the most productive sub-systems. As further studies are made of both krill and their consumers, it may be found that stocks in certain adjacent sectors are much more closely linked than elsewhere (e.g. sectors 3 and 4), or that finer subdivision might be possible on the basis of local bathymetric effects (e.g. in Sector 6).

While supporting Latogursky's listing of the further studies required to refine the boundaries of such sub-systems, the interactions between them, the transport of krill from one to another, and the assessment of krill stocks in each (as well as their variability), we suggest that the six sectors set out above afford a basis for initiating a conservation strategy for these resources.

There may be a need for later adjustment of boundaries of these conservation areas as their resources, processes and relationships are better understood. Provided, however, that all fishing data are recorded in the form recommended by the Scientific Committee of CCAMLR (see Report of SC-CAMLR-IV, 1985; paragraph 5.9), any re-arrangement of boundaries can be accommodated if needed in the future, since the location of every haul will have been recorded. The need for recording data in this matter was re-iterated during the fifth meeting of the Scientific Committee (see the strong recommendation made in Report of SC-CAMLR-V, 1986, paragraph 5.35).

It is proposed that the conservation areas as presently defined be utilised in selecting open and closed areas as part of the CCAMLR process of shaping and implementing a conservation strategy for Antarctic marine living resources.

MANAGEMENT WITHIN CONSERVATION AREAS

While the tactics of management within the major conservation areas can be developed after the general framework of a conservation strategy has been agreed, some indication of the options available might be outlined here.

The simplest management procedure would be to open three of the major Sectors to krill harvesting (e.g. Sectors 1, 3 and 5 of Figure 7), leaving the intervening Sectors (2, 4 and 6 respectively) closed. That might be preferable to opening each Sector in turn through successive years as proposed under the Sealing Convention.

However, these Sectors are so large and the distribution of certain species within them so circumscribed, that it might be preferable to zone activities within each Sector. Thus within a Sector there might be sub-areas open to specified types of harvesting (perhaps with limited open seasons or catch limits); and sub-areas open to all activities. In such an approach, inshore zones which include nursery areas or the feeding grounds of shore-based breeding colonies, might be given greater protection than offshore (oceanic) zones.

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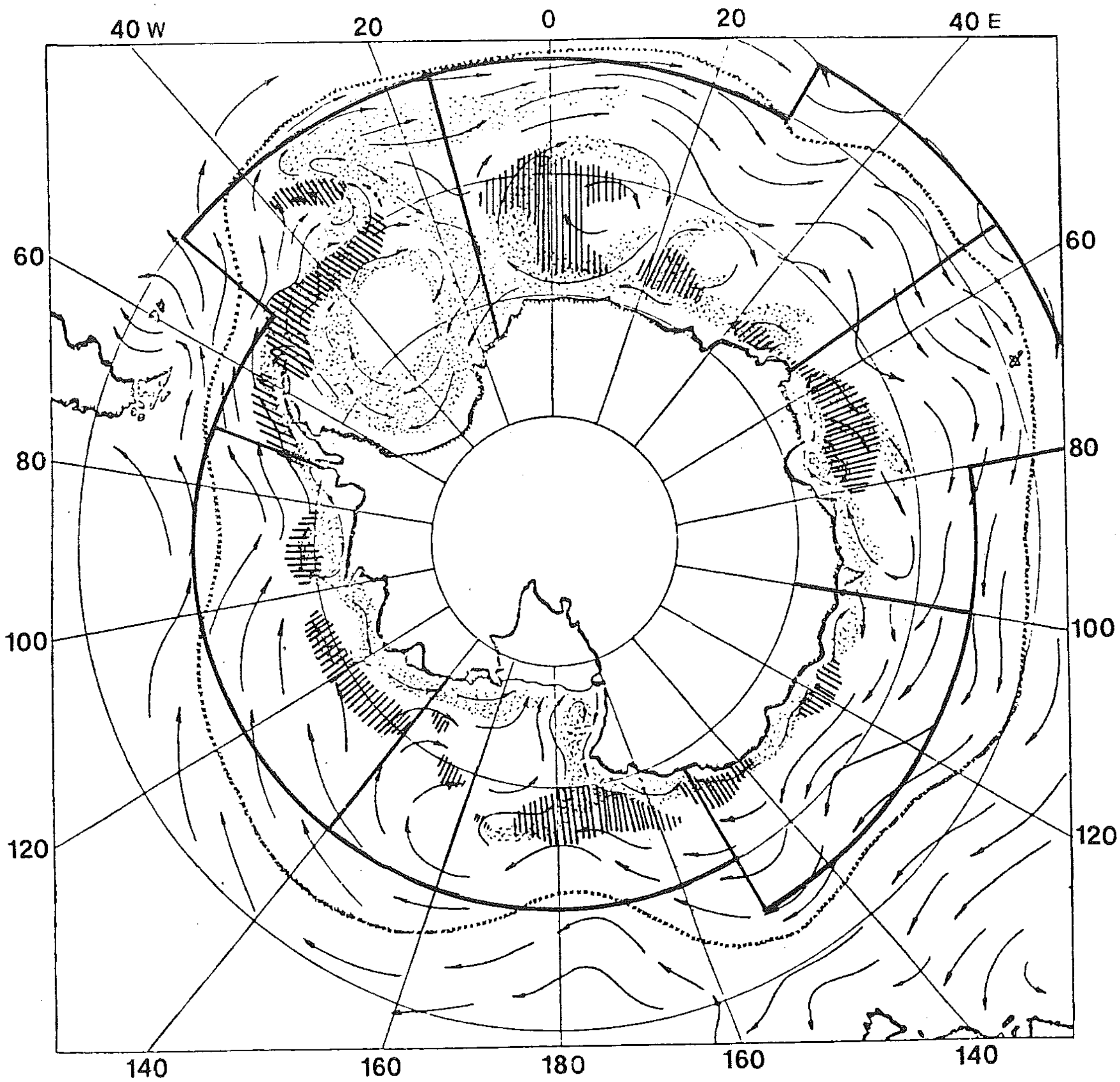

Figure 1 Surface circulation and krill concentrations (hatched areas) within the CCAMLR Convention Area (from Lubimova, 1982).

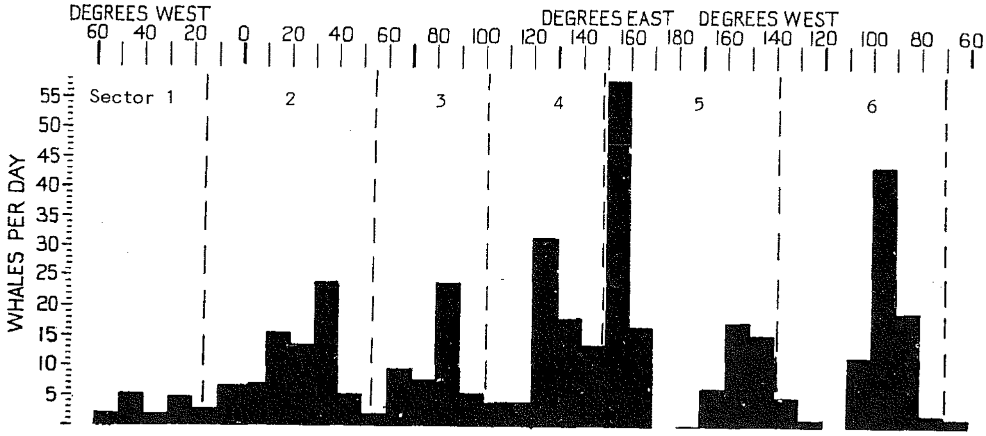

Figure 2 Estimated numbers of whales, presumed to be Blue, Fin or Humpback, seen per day south of 50°S during selected passages of <u>Discovery II</u>, 1933-9. (From Mackintosh, 1942). Proposed krill sectors from Figure 1.

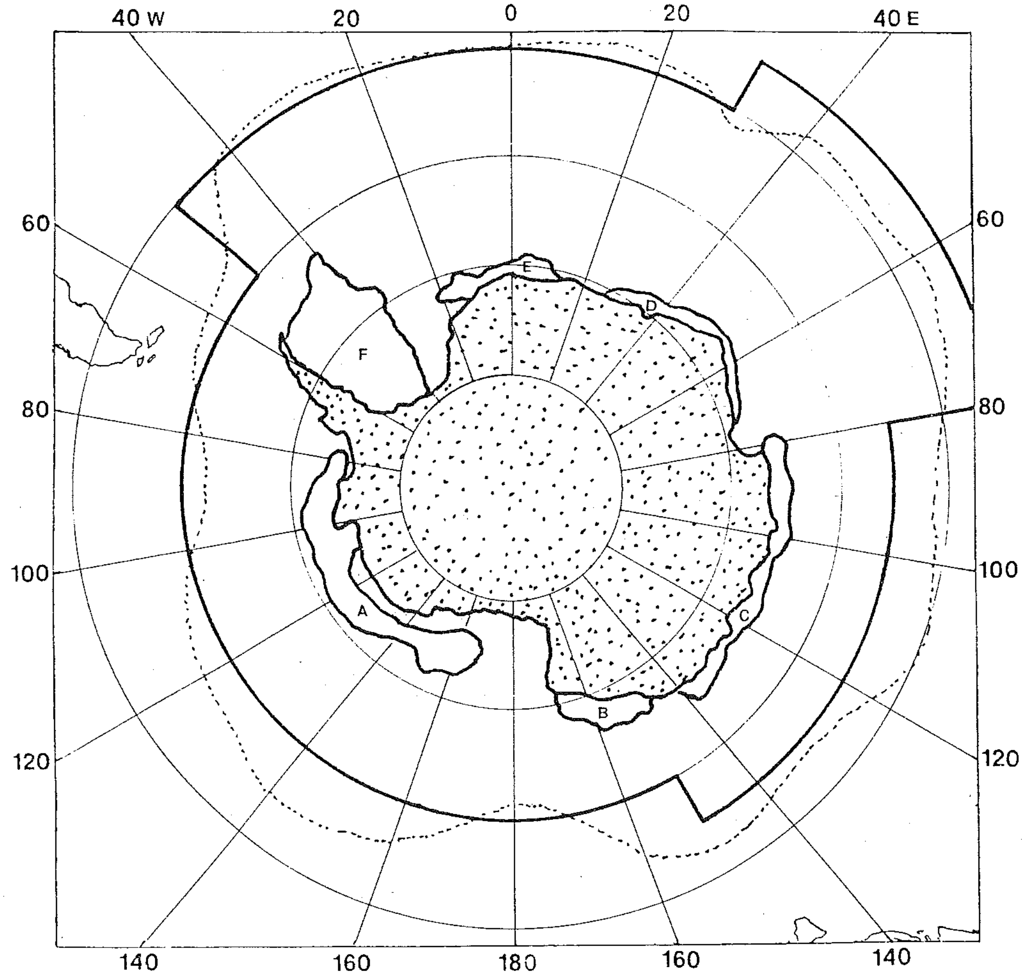

Figure 3 Six residual pack-ice regions presumed to constitute population centers for pelagic Antarctic seals in the austral summer. These regions were as follows : A, Amunsden and Bellingshausen Seas; B, Oates Coast; C, Wilkes Land; D, Queen Maud Land; E, Halley Bay; and F, Weddell Sea. (After Gilbert and Erickson, 1977).

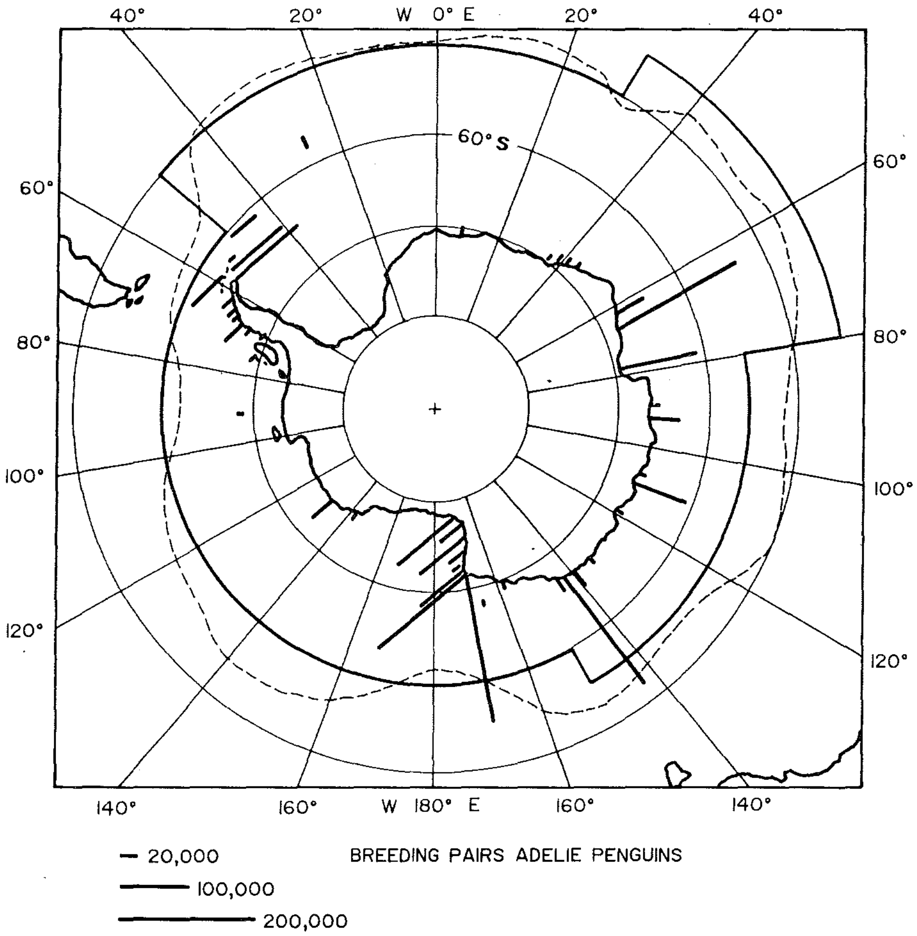

Figure 4 Breeding stocks of Adelie penguin, Pygoscelis adeliae, grouped in 1° latitude x 2° longitude.

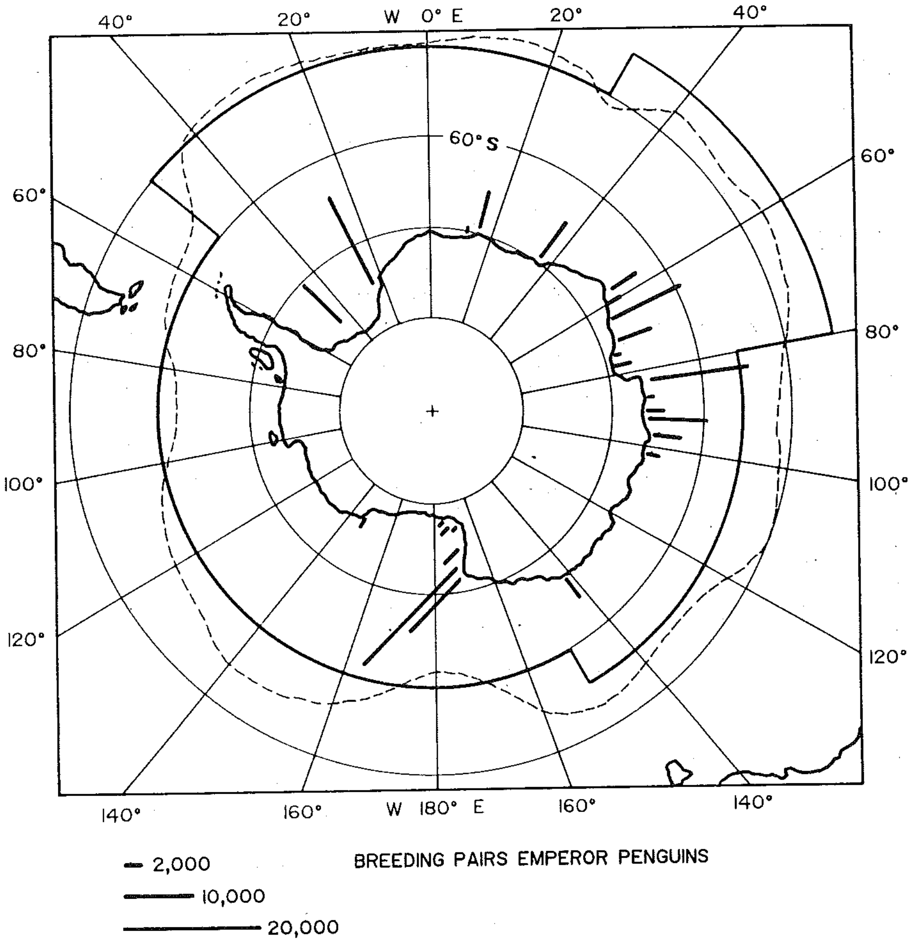

Figure 5 Breeding stocks of Emperor penguin, Aptenodytes forsteri.

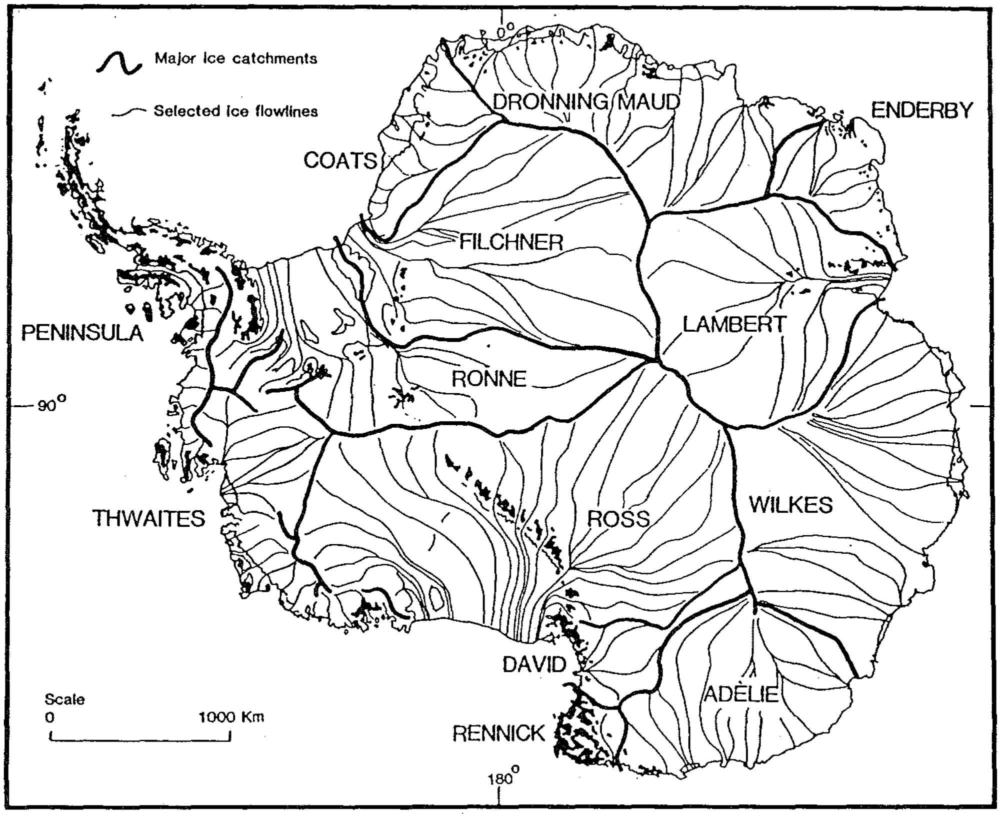

Figure 6 Major ice catchments and flowlines for the Antarctic ice cap, as adapted by Keage (1986) from Drewery (1983).

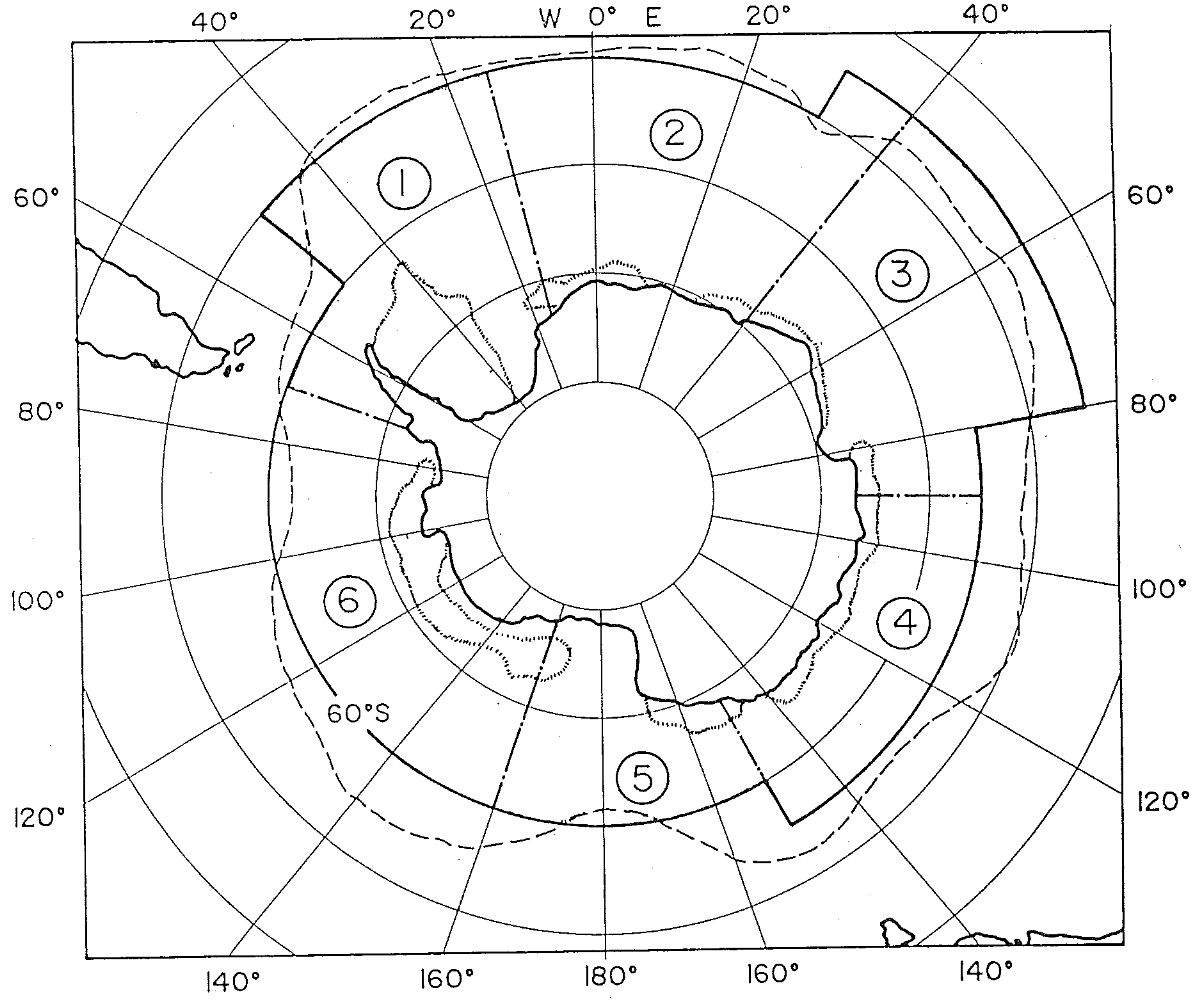

Figure 7 Potential management areas within the CCAMLR region.

Légendes des figures

Figure 1 Circulation de surface et concentrations de krill (zones hachurées) au sein de la zone de la Convention de la CCAMLR (d'après Lubimova, 1982).

Figure 2 Nombres estimatifs de baleines (présumées être des rorquals bleus, des rorquals communs ou des jubartes) aperçues par jour au sud de 50°S au cours de passages sélectionnés de Discovery II, 1933-9. (D'après Mackintosh, 1942). Secteurs de krill proposés d'après la Figure 1.

Figure 3 Six régions de banquise résiduelle présumées constituer des centres de population pour les phoques des couches pélagiques de l'Antarctique au cours de l'été austral. Ces régions sont les suivantes : A, mers d'Amundsen et de Bellingshausen; B, Côtes Oates; C, Terre de Wilkes; D, Terre de la Reine-Maud; E, Baie de Halley; et F, Mer de Weddell. (D'après Gilbert et Erickson, 1977).

Figure 4 Stocks reproducteurs du manchot Adélie, *Pygoscelis adeliae*, groupés par 1° de latitude X 2° de longitude.

Figure 5 Stocks reproducteurs du manchot empereur, *Aptenodytes forsteri*.

Figure 6 Principales accumulations et flux pour la calotte glaciaire antarctique, adapté par Keage (1986) d'après Drewery (1983).

Figure 7 Zones d'aménagement potentielles au sein de la région de la CCAMLR.

Leyendas de las Figuras

Figura 1 Circulación superficial y concentraciones de krill (áreas sombreadas) comprendidas en el Area de la Convención de CCAMLR (según datos de Lubimova, 1982).

Figura 2 Cantidades estimadas de ballenas presumiblemente Azules, Aleta o Jorobadas, vistas por día al sur de 50°S durante travesías seleccionadas del Discovery II, 1933-9. (De Mackintosh, 1942). Los sectores de krill propuestos han sido tomados de la Figura 1.

Figura 3 Seis regiones de hielo a la deriva residual que se presume constituyen centros de población de focas antárticas pelágicas en el verano austral. Estas regiones fueron las siguientes : A, Mares de Amundsen y Bellingshausen; B, Costa Oates; C, Tierra de Wilkes; D, Tierra de la Reina Maud; E, Bahía Halley; y F, Mar de Weddell. (Según Gilbert y Erickson, 1977).

Figura 4 Poblaciones reproductoras del pingüino Adelie, *Pygoscelis adeliae*, agrupadas en 1° latitud x 2° longitud.

Figura 5 Poblaciones reproductoras del pingüino Emperador, Aptenodytes forsteri.

Figura 6 Principales captaciones de hielo y líneas de flujo para el casquete glaciar Antártico, según adaptación de Keage (1986), de la información de Drewery (1983).

Figura 7 Areas de administración potenciales comprendidas en la región de CCAMLR.

Подписи к рисункам

Рисунок 1 Поверхностная циркуляция и скопления криля (заштрихованные участки) в зоне действия Конвенции АНТКОМа (Любимова, 1982 г.).

Рисунок 2 Примерное количество китов, как предполагается, синих, финвалов или горбатых, встречавшихся ежедневно к югу от 50 °ю.ш. во время отдельных рейсов "Дисковери II", 1933-39 гг. (Макинтош, 1942 г.). Предлагаемые на Рисунке 1 крилевые участки.

Рисунок 3 Шесть районов остаточного пакового льда, являющихся, как предполагается, районами концентрации популяций пелагических антарктических тюленей в течение австрального лета. Эти районы следующие: A - моря Амундсена и Беллинсгаузена, B - Берег Отса, C - Земля Уилкса, D - Земля Королевы Мод, E - залив Хэлли, и F - море Уэдделла (по Гилберту и Эриксону, 1977 г.).

Рисунок 4 Размножающиеся запасы пингвинов Адели, Pygoscelis adeliae, сгруппированные по участкам в 1°широты на 2° долготы.

Рисунок 5 Размножающиеся запасы императорских пингвинов, Aptenodytes forsteri.

Рисунок 6 Основные ледовые ловушки и линии налегания ледникового покрова Антарктики, переработка Кигом (1986 г.) данных Дрюэра (1983 г.).

Рисунок 7 Возможные районы управления в зоне действия Конвенции.