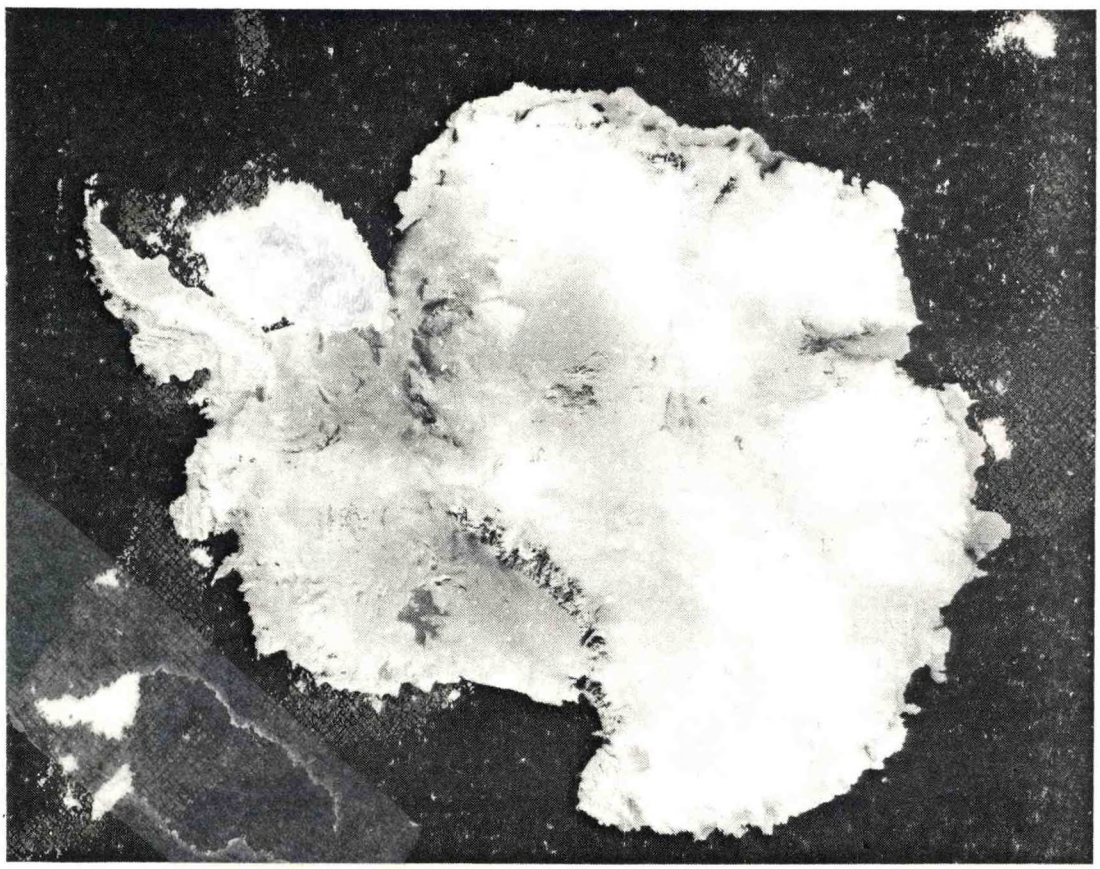
A REPORT TO THE CONGRESS

Directed Research Antarctic Marine Living Resources (AMLR) Program Update Plan

March 1990



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

A mosaic of 23 AVHRR images prepared by NOAA, NESDIS and National Remote Sensing Center, Farnsworth, United Kingdom.

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Prepared by the National Marine Fisheries Service
National Oceanic and Atmospheric Administration
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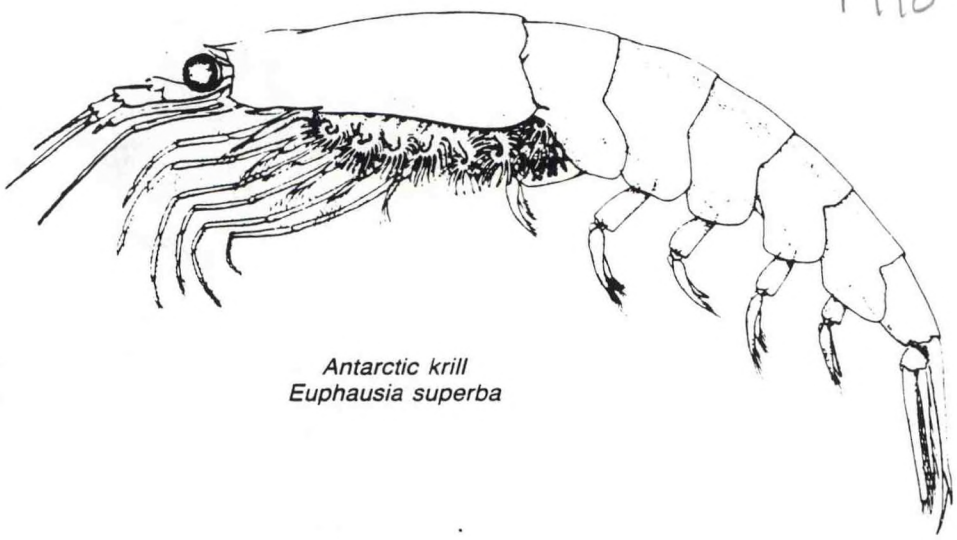

Antarctic krill
Euphausia superba

U.S. DEPARTMENT OF COMMERCE
Robert A. Mosbacher, Secretary

National Oceanic and Atmospheric Administration
John A. Knauss, Under Secretary

National Marine Fisheries Service
William W. Fox, Assistant Administrator for Fisheries

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

U.S. ANTARCTIC MARINE LIVING RESOURCES PROGRAM

The U.S. Antarctic Marine Living Resources (AMLR) Program is a national program providing information needed for U.S. policy relating to the conservation and management of marine living resources in the ocean areas surrounding Antarctica. The program is in support of the U.S. participation in the Commission and Scientific Committee of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), which established a system for managing the living resources of the Antarctic ecosystem through international cooperation.

The U.S. AMLR Program is a directed research program designed to complement the U.S. Antarctic Program (USAP) of basic research managed by the National Science Foundation (NSF), with the goal of maximizing the productivity of the overall U.S. science effort in Antarctica through close coordination in planning and cooperative work between the two programs, where appropriate.

The Antarctic Marine Living Resources Convention Act, P.L. 98-623, Title III, was signed into law in 1984, implementing the Convention for the United States. Congress found that directed and basic research programs concerning the marine living resources of Antarctica are essential to achieving the U.S. goal of effective implementation of the Convention. Section 312 (B) of the Act states that:

> " The Secretary of Commerce, in consultation with the Director of the NSF, the Secretary of State and the heads of other appropriate Federal agencies, shall design and conduct a program of directed scientific research coordinated with the United States Antarctic Program. " The U.S. AMLR Program of directed research is defined by this Program Plan.

The long history of mostly unregulated harvesting activities in Antarctic waters has already contributed to the over exploitation of Antarctic fish and marine mammal stocks. In the 50 years between 1930 and 1980 the populations of blue, fin, sei, and humpback whales are estimated to have been reduced to 10% of their former abundance levels. Similarly uncontrolled fishing has reduced the stocks of marbled rockcod (*Notothenia rossii)* to less than 10% of their former biomass. The recovery of depleted whale stocks is dependent in part on the continued availability of krill in the rich Southern Ocean feeding grounds. Since the 1970's several countries have commenced krill fishing and a repeat of excessive fishing effort in local areas could have an adverse impact on local populations of krill dependent predators. The AMLR program is providing information on the actual and potential impacts of these fisheries on the recovery of depleted populations in relation to the overall structure and function of the principal components of the Antarctic ecosystem.

The National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA) has implemented the AMLR Program, in cooperation with other government agencies and the private sector. The AMLR Program undertakes research that will provide data for the effective conservation of the marine living resources of the Antarctic ecosystem, the primary goal of the Convention. The AMLR program is intended as a U.S. contribution to joint international research efforts which are planned and conducted by the Parties to the Convention, in support of its objectives.

The principal objective of the United States directed AMLR research program is to provide the information needed to detect, monitor, and predict the effects of harvesting and associated activities on target, dependent, and related species and populations of the Antarctic marine living resources and the ecosystem(s) of which they are a part. Studies in support of AMLR objectives include:

(1) assessments of catch, effort, and related biological data to determine and monitor the effects of fishing on both target species and species taken as by-catch during commercial fishing operations;

(2) baseline surveys and periodic sampling to detect and monitor natural variation and possible harvest-caused changes in key components of the Antarctic marine ecosystem, including plankton, krill, fish, seals, whales, squid, and seabirds;

(3) biological surveys to validate the reliability of catch, effort and related biological data provided by countries engaged in commercial operations in the Convention Area and to assess the effectiveness of conservation Measures enacted or contemplated in the Convention.

(4)planning and implementation of coordinated multinational research programs and experiments to test and develop standard survey techniques, improve knowledge of the structure and dynamics of the Antarctic marine ecosystem, and test hypotheses concerning the direct and indirect effects of different harvest levels and strategies.

Since the inception of the AMLR field activities in 1986, the program of directed research has enabled the U. S. Delegation to the Commission and to the Scientific Committee to participate actively in the formation of Convention Conservation Measures. Notable in these accomplishments was the presentation of U. S. data which led to a series of Conservation Measures which established mesh sizes in the finfish area of South Georgia and the closed seasons for marbled rockcod (*Notothenia rossii*) and five other commercially targeted species. The Eighth Meeting of the Commission, November 1989, saw the adoption of a U. S. proposal for a system of Observation and Inspection which includes authority for Convention certified inspectors to board and inspect harvesting vessels in Convention waters. A U. S. certified inspection team will participate in this activity in the Austral summer of 1990.

The projected cost for operating a balanced U.S. program of directed research for FY 1991 and outyears is $2.0 million annually and the use of a dedicated research vessel capable of operating in Antarctic waters for a period of 120 days each year. An additional 60 days of ship time may be required for the round-trip transit time from the northern hemisphere to the Antarctic sampling areas.

1. INTRODUCTION

The Antarctic Marine Living Resources (AMLR) Program is a national program providing information needed for the development and support of U.S. policy regarding the conservation and management of the marine living resources in the ocean areas surrounding Antarctica. The program supports U.S. participation in both the Commission and Scientific Committee (SC) of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), and is directed towards achieving the conservation objectives of the Convention. The program emphasizes directed research undertaken for the express purpose of managing Antarctic marine living resources from an ecosystem perspective. It is designed to complement the U.S. Antarctic Program (USAP) of basic research managed by the National Science Foundation (NSF), and to maximize the productivity of overall U.S. science efforts in Antarctica through close coordination in planning and cooperative work between the two programs, where appropriate.

This Program Plan assumes that the NSF will continue to support basic studies in marine biology and physical and chemical oceanography in the Antarctic region.

The U.S. AMLR Program has been developed in the context of long-term U.S. interests in Antarctica concerning exploration and discovery, resource use, scientific research and cooperation, demilitarization, denuclearization, and environmental protection. As the first, and primary, expression of these interests, the United States was instrumental in the negotiation of the Antarctic Treaty, the instrument and system under which the nations active in Antarctica make decisions regarding all of their common interests and activities there.

Substantial interest in Antarctic marine resources has developed since the Antarctic Treaty entered into force in 1961. Fishing for krill (the dominant species) and finfish began in Antarctic waters in the 1960's, as did research on the potential for oil and gas on the continental shelf of Antarctica. Such resource activities, which were not dealt with in the Antarctic Treaty itself, raised complex questions relating to sovereignty claims in Antarctica asserted by certain countries, but not recognized by others. Therefore, Consultative Parties to the Antarctic Treaty decided, during the 1970's, that the best system for dealing with these complicated resource questions would be new international agreements specifically tailored to address the resource issues, and would be consistent with the basic agreements under the Antarctic Treaty. Negotiations relating to conservation and management of marine living resources including fishing were successful, culminating in the entry into force of the Convention in 1982. Negotiations for a regime on Antarctic minerals have been concluded. The Convention on the Regulation of Antarctic Mineral Resource Activities now awaits ratification, acceptance, approval or accession by 16 Antarctic Treaty Consultative Parties.

1.1 Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)

The Convention (see Appendix 1) was negotiated during the three-year period 1977 to 1980, when it was signed at a Diplomatic Conference in Canberra, Australia. The United States took an active and leading role in the negotiation of the Convention, spurred on by concern to prevent over exploitation in Antarctic waters, especially for Antarctic krill (*Euphausia superba*), and any consequent disruption of the food chain, with implications for impeding the recovery of the whale and seal populations. Equally strong was the U.S. interest in supporting the aims of the Antarctic Treaty by resolving this major question of resource use in a manner consistent with the Treaty.

The Convention Area includes the marine area south of the Antarctic Convergence, the boundary between the cold Antarctic waters and warmer sub-Antarctic waters which defines the Antarctic marine ecosystem. The convention applies to "the populations of finfish, mollusks, crustaceans, and all other species of living organisms, including birds, found south of the Antarctic Convergence."

The conservation standard of the Convention (Article II) requires that Antarctic marine living resources be managed from an ecosystem perspective. This is a unique goal for international conservation agreements, offering challenges and opportunities for the countries involved in the Convention and for the U.S. AMLR Program. According to the Convention, any harvesting and associated activities must be conducted so as to:

- prevent any harvested populations from falling below the level that ensures the greatest net annual increment;
- maintain the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources;
- restore depleted populations; and
- prevent or minimize the risk of changes in the marine ecosystem that are not potentially reversible over two to three decades.

Members of the Convention are: Argentina, Australia, Belgium, Brazil, Chile, Federal Republic of Germany, France, German Democratic Republic, India, Japan, New Zealand, Norway, Poland, Republic of Korea, South Africa, Spain, Union of Soviet Socialist Republic, United Kingdom, United States and the European Economic Community. Canada, Finland, Greece, Italy, Peru, Sweden and Uruguay are acceding states and send observers to the Commission's meetings. The functions of the Commission are to:

- facilitate study of Antarctic marine living resources and the ecosystem of which they are a part;
- compile data on the status of, and changes in the distribution, abundance and productivity of harvested and dependent or related species and populations of Antarctic marine living resources;
- ensure the acquisition of catch and effort statistics; and
- formulate, adopt, and revise conservation measures on the basis of the best scientific information available.

The Commission has met eight times starting in 1982. The first seven meetings completed organizational business; produced conservation measures for depleted stocks of finfish, including regulations defining mesh sizes and prohibiting all directed fisheries for the demersal species *Notothenia rossii* (marbled rockcod) in the waters of South Georgia, the South Orkneys, and the Antarctic Peninsula; designed a program of data gathering; and, agreed that existing conservation measures should remain in force from year to year. During the eighth meeting, the Commission adopted conservation measures that set a Total Allowable Catch (TAC) for directed fisheries on two additional fish species; prohibited directed fishing and set TAC limits on by-catch for four fish species; and, established closed seasons around South

Georgia. The Commission could not agree on the Krill Working Group's recommendation that krill catches "...should not greatly exceed the current level until assessment methods are developed further and until more is known about predator requirements and local krill availability." Finally, a system of observation and inspection to verify compliance with conservation measures was implemented. Excerpts from the report of the eighth meeting of the Commission are given in Appendix 2.

The SC of the Convention has also held eight meetings and has implemented a program to meet its obligations under Article XV of the Convention. They are to:

- establish criteria and methods for determining needed conservation measures;
- assess regularly the direct and indirect effects of harvesting on the status and trends of Antarctic marine living resources; and
- formulate proposals for the conduct of national and international research programs related to Antarctic marine living resources.

To facilitate this work, Article XX of the Convention requires the members of the Commission to provide:

- statistical, biological and other data as the Commission and SC may require to carry out their functions;
- information about their harvesting activities, including fishing areas and vessels, so as to enable reliable catch and effort statistics to be compiled; and
- information on steps taken to implement conservation measures adopted by the Commission.

Conservation of a marine ecosystem as large as the Antarctic system requires substantial international cooperation. Members of the Commission and SC are required to cooperate with the Consultative Parties to the Antarctic Treaty, the Food and Agricultural Organization (FAO) the International Council of Scientific Unions (ICSU) of the United Nations, and specialized agencies with Antarctic interests. They are specifically required to develop working relationships with ICSU's Scientific Committee on Antarctic Research (SCAR), and the Scientific Committee on Oceanic Research (SCOR). Additional consultation is required with the International Whaling Commission (IWC), the Convention for the Conservation of Antarctic Seals (CCAS), and other intergovernmental and nongovernmental organizations that can contribute to the objectives of the Convention. The SC has developed close working relationships with several of these international organizations.

At its eighth meeting, in November 1989, the SC attempted to review the status of Antarctic fish stocks and provide management advice to the Commission concerning the various fish stocks. However, the status of all stocks was either unknown due to lack of data, uncertain due to wide differences in the results of different analyses, or the stocks were depleted and in need of protection. In the case of depleted stocks, which had suffered recruitment failure, it was not clear that by-catches would be sufficiently small to ensure recovery. Therefore, based on the findings of the Working Group on Fish Stock Assessment, the SC recommended that all conservation measures prohibiting fishing on *Notothenia rossii* (marbled cod) be retained. In addition, all delegations, except the USSR, recommended that

the Commission should consider a closing of the fishery around South Georgia for a short time of at least one year, pending a new assessment.

The Working Group on Krill recognized that to minimize the potential for over exploitation of krill, consideration should be given by the Commission to the initiation of a general policy whereby precautionary TACs may be set in certain restricted areas. Finally, the SC noted that the work completed by the Convention Ecosystem Monitoring Program (CEMP) Working Group to define the accuracy and precision of estimates of basic population parameters provided the essential first steps to answering these questions. The Group revised existing data collection methods for standard data elements. Excerpts from the Report of the Eighth Meeting of the SC are given in Appendix 3.

1.2 U.S Implementation of the Convention

The Antarctic Marine Living Resources Convention Act of 1984 (P.L. 98-623) was signed into law on November 8, 1984, implementing the Convention for the United States (see Appendix 4). Congress found that a directed research program, as well as a basic research program concerning the marine living resources of Antarctica, is essential to achieve U.S. objectives under the Convention. The Secretary of Commerce, in consultation with the heads of appropriate Federal agencies, is required to design and conduct the U.S. program of directed scientific research.

The U.S. plan for the directed research program must be prepared and updated annually. The plan shall:

- describe priority research needs for the implementation of the Convention;
- identify which of those needs are to be fulfilled by the United States; and
- specify the design of the directed research and the funds, personnel, and facilities required for the research, including, in particular, the need for and the cost of enhanced ship capacity.

In preparing the plan, the Secretary of Commerce shall take into account, the possibilities of securing productive results, the reduction of duplication of research, the methods for monitoring and evaluating a project, and other factors considered appropriate.

The initial Program Development Plan, submitted to Congress in February 1986, covered fiscal years 1986, 1987, and 1988. This Program Plan covers the fiscal years 1990, 1991, 1992 and 1993.

1.3 Antarctic Marine Living Resources (AMLR) Program Plan

The criteria of section 1.2 above form the guidelines for developing the AMLR Program Plan of directed research. This is a Federal plan prepared by the National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA), Department of Commerce, in consultation with appropriate Federal agencies, as well as appropriate private sector U.S. scientists, environmental groups, fishing companies, and others.

The program plan includes directed research elements encompassing the collection and analysis of data to provide information on the location, abundance, composition, and condition of the principal populations within the Antarctic marine ecosystem. It describes the U.S.

contribution to joint international research efforts in support of the convention objectives that have been defined by the CEMP Working Group and undertaken by member countries of the Convention.

The keystone species in the Antarctic marine ecosystem is Antarctic krill (*Euphausia superba*). It is not yet clear how much biomass of krill is produced on a sustained annual basis, or even how krill is distributed throughout the 36 million square kilometers of the Antarctic marine ecosystem. Within this large marine ecosystem, 3 species of seals, 5 species of whales, 20 species of fish, several species of squid, 3 species of penguins, and some flying sea birds are all dependent on krill as a prime food source. At present, it is not known how much krill can be harvested from any area without reducing and depleting either krill stocks or species dependent upon krill. Estimates of sustainable yield range from 10-20 million metric tons to more than 200 million metric tons, which is several times greater than the present annual world fish catch of about 70 million metric tons. In recent years, vessels from Chile, the German Democratic Republic, Japan, the Republic of Korea, Poland and the Soviet Union have engaged in krill fishing. The Soviet Union and Japan have the largest fishing operations respectively taking about 75 and 20 percent of the annual reported catch. Combined reported catches between 1981 and 1988 have ranged from 130,875 to 445,673 tons. The reported catch for 1989 was 395,470 tons.

The major emphasis of the U.S. AMLR research program will be to investigate the ecological relationships in the Antarctic pelagic marine ecosystem, specifically between krill, key environmental factors, and krill predators. The research plan will address the Convention's goal to determine the impact of increased krill harvests on dependent predators. This will be approached by describing how the spatial distribution of krill varies from year to year, what factors determine the spatial distribution of krill, how the spatial distribution of krill affects the feeding behavior of krill predators, how predator feeding behavior affects reproductive success, and ultimately, how the harvest of krill will affect predator populations.

The AMLR research program will also assess fish stocks for the Fish Stock Assessment Working Group of the SC. These assessments will address important issues, such as affects of closing specified areas to fishing that are currently being considered by the SC and the Commission.

During 1989, an extensive strategic planning exercise was completed to determine the optimal plan for AMLR research during the next 10 years. Concurrent with this planning exercise, the 1988-89 field season was completed. A summary of the preliminary results of this field research is given by Hewitt (1989)[1].

2. AMLR PROGRAM ELEMENTS

In order to make rational and effective conservation and management decisions, the Convention must have information on the status of stocks and a knowledge of trophic interactions in the Antarctic ecosystem. The Commission and the SC of the Convention, through the cooperative scientific efforts of member countries, are charged with providing this information. To do so, the Scientific Committee must assess the direct and indirect effects of harvesting on the status and trends of Antarctic marine living resources on a regular basis.

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[1]Hewitt, R. P. 1989. Cruise Report AMLR 8901. Objectives, accomplishments and tentative conclusions. Antarctic Ecosystem Research Group - Southwest Fisheries Center. 41 pp.

Current assessments of the status of Antarctic stocks and knowledge of trophic interactions are limited.

The SC coordinates a program of commercial fisheries data collection and analysis, as well as directed ecological research, to obtain the necessary information. Ongoing basic research will also make contributions to the SC effort. The SC Working Groups on Krill and Fish Stock Assessments continue to address the data and analysis needs for target species. The CEMP Working Group has standardized data collection and methodologies for non-target species to provide data to meet the objectives of ecosystem conservation. The U.S. AMLR Program supports research objectives of all three Working Groups.

An underlying objective of the U.S. AMLR Program is to integrate research investigations of various key components of the Antarctic marine ecosystem. Only through this approach will it be possible to maintain the ecosystem perspective embodied in the Convention. The United States is addressing the following topics by integrating the results of various AMLR Program elements:

- estimate the potential direct and indirect effects of commercial harvests on target stocks and on dependent predator and competitor species;
- investigate the functional relationships between krill and consumers (marine mammals, fish, and birds) in subregions of Antarctic waters;
- investigate the extent to which regional krill concentrations vary, and the impact this variability has on the growth, behavior, reproduction, and recruitment of key predators;
- investigate options for the recovery of whales and other depleted populations, based on a conservation regime that allows for both rational utilization of krill resources and the accelerated recovery of exploited stocks:
- design sampling regimes to meet the needs of monitoring highly aggregated species and their fisheries; and
- examine the conceptual and practical implications of Article II as a basis for formulating alternative management strategies.

The U.S. AMLR Program supports the Commission's and SC's need for information, both through analysis of commercial fisheries data and through directed ecological research on selected key species groups in the Antarctic marine ecosystem. For resources presently being harvested such as krill and finfish, the AMLR Program focuses on evaluation and validation of fisheries catch, effort and related biological data. These analyses include assessments of the biological characteristics of commercial catches (e.g., reproductive status, size and age classes, species composition, and by-catch aspects). Directed research on prey species is conducted in integrated study areas to detect and interpret trends in various predator parameters being evaluated.

The objectives of the CEMP are to detect and record significant changes in critical components of the ecosystem and to provide the Commission with the information it requires to make management and conservation decisions concerning Antarctic marine living resources. The monitoring system is designed to distinguish between changes in key components due to harvesting of commercial species and changes due to environmental variability, both physical

and biological.

Because the Antarctic marine ecosystem encompasses such an enormous geographical area, it is unrealistic to attempt studying all areas at once. Hence, the CEMP Working Group identified priority study areas where it has encouraged nations to undertake research. It suggested Australia, Japan, the Soviet Union, and several other countries focus their efforts in the Prydz Bay area, and the United States, Poland, the Federal Republic of Germany, the United Kingdom, and possibly several other countries focus their efforts in the Southwest Atlantic. The U.S. AMLR Program plan focuses its field research activities in the area designated in the CEMP as the Antarctic Peninsula Integrated Study Area (APISA) which comprises the southwest Atlantic Ocean, Scotia Arc, and Antarctic Peninsula (Figure 1). The APISA is important to commercial fisheries, and is a major breeding ground for several protected species.The AMLR research program operating in this area offers the advantage of complementing other U.S. marine research efforts conducted in this region and funded by the NSF. Special attention is directed to the vicinity of South Shetland Islands and the Palmer Archipelago. In addition to the APISA, the AMLR Program conducts field work, as needed, in other areas to provide comparative data. For example, this may include research such as the sampling of crabeater seals in Bellingshausen or Weddell Seas and collaborative studies on platforms of opportunity.

The 1989/90 field program will focus observation effort on a 100 by 100 mile area around Elephant Island. Objectives are to describe 1) the physical structure of the mixed layer, 2) the distribution of primary productivity, 3) the distribution of krill, and 4) the foraging patterns of krill predators within the study area (see Appendix 4). An important element in the design of the field programs is the need to examine both intra- and inter-annual natural variability to assess the potential impact of human activities. At least a 10-year time series of measurements is crucial to understanding the nature of this variability.

Satellite imagery will be examined for broad patterns in environmental conditions within the integrated study area. Data from this source offer synoptic perspectives from a variety of spatial scales and are complementary to austral summer sampling at land-based and pelagic study areas. Movements of crabeater seals, the major pelagic predator on krill, will be monitored by satellite telemetry.

Spatial descriptions of components of the pelagic marine ecosystem will be incorporated into ecosystem models. The models will be used to determine the relative importance of hydrography, predation and competition to variations and trends in krill abundance. The models will also be used to determine the sensitivity and potential effectiveness of management recommendations.

The AMLR program conducts research on critical components of the Antarctic marine ecosystem. Each of these species groups is discussed below, specifying the priority directed research needs required for the implementation of the Convention, and which of those priority needs is to be addressed by the United States in the context of an international, multi-disciplinary research effort guided by the Convention.

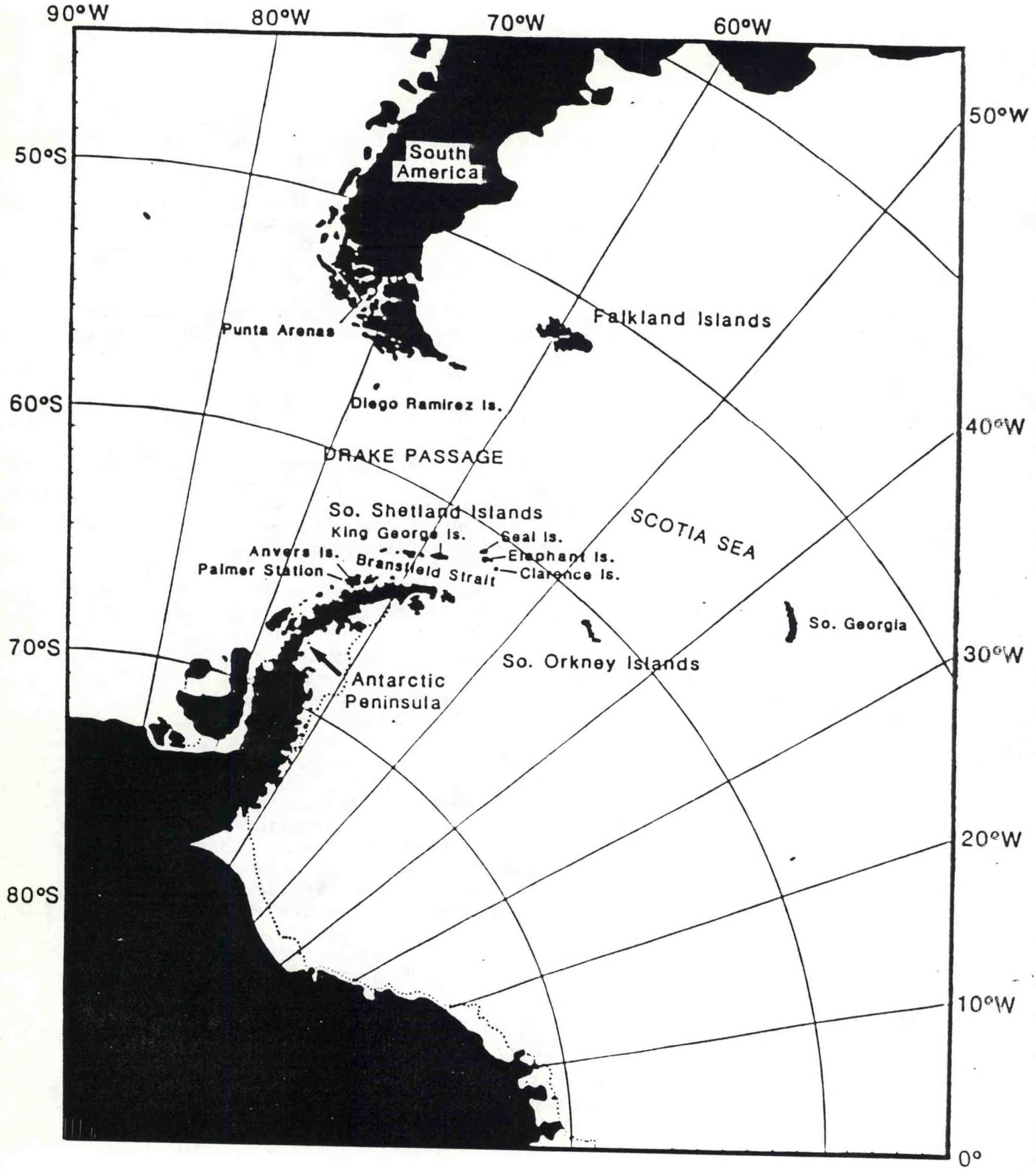

Figure 1. Map of the Antarctic Peninsula Study Area (**AIPSA**).

2.1 Krill

One of the principal tenets of the Convention is that the harvest of living resources shall be managed with the goal of preserving species diversity and stability of the entire marine ecosystem. Antarctic krill (*Euphausia superba*) is the dominant prey in the pelagic marine ecosystem. As much as 300 million mt of krill may be consumed annually by seals, birds, whales and squid. Krill is also the target of a developing fishery (currently 400,000 mt annually). In order to manage this fishery, within the mandate of Convention, the effects of increased krill harvest on dependent predators must be thoroughly understood.

Present estimates of the biomass of Antarctic krill are based largely on data provided by the fishing countries and the fishery-independent surveys of the SCAR/SCOR program entitled Biological Investigations of Marine Antarctic Systems and Stocks (BIOMASS) conducted in the early 1980's. Soviet estimates of annual production of krill, calculated by applying growth functions to biomass data obtained from net hauls and acoustic surveys, range from 360 to 700 million metric tons (mmt).

Estimates of krill abundance produced from 1982 data collected by the BIOMASS studies which used multi-ship international acoustic surveys varied between 200 and 600 million metric tons. The wide range in the estimates of krill biomass and predator consumption levels make it difficult to establish the levels of krill that could be harvested without having adverse effects on either krill stocks or dependent and related species.

The distribution of krill is circumpolar, but discontinuous, suggesting that several discrete populations may exist. The observed low krill abundance in the Scotia Sea during the 1983-84 and 1984-85 summer seasons has been attributed to a southward shift of the Polar Front. This hypothesis is supported by the presence of krill concentrations in the South Orkney and South Sandwich Islands areas, indicating that there may not have been a significant change in total krill abundance. Significant interannual changes in krill distribution have also been observed in Prydz Bay in the Indian Ocean sector of the Southern Ocean.

2.1.1. Convention Priority Research Needs (Krill)

Central to the Convention's objective of conserving the Antarctic marine ecosystem is a requirement for knowledge of basic population parameters of krill (growth, recruitment, mortality) as well as of ecological relationships, including predator-prey relationships to other species found in Antarctic waters. The SC requires information on abundance and distribution of krill, in both dispersed and aggregated distributions, over appropriate temporal and spatial scales for the purpose of stock assessment and understanding of interspecific predator-prey relationships with other important species of the Antarctic marine environment.

In an effort to obtain a better understanding of the Antarctic marine ecosystem, the CEMP Working Group recommended consideration of smaller subsystems on the assumption that different limiting factors may be important to the relationship between krill and consumer populations (marine mammals, fish and birds) in the various subsystems. The APISA targeted by the U.S. AMLR Program was one of these areas.

Analyses of the commercial catch data contribute to measuring fishing and natural mortality rates, and evaluating annual changes in abundance caused by fishing or environmental changes. Such analyses are used to construct yield curves and population models

to make stock abundance forecasts, and to produce status-of-stock reports for input to management decisions. The Convention Working Group on Krill recommended that data collected over the past decade on krill stocks by fishing nations (principally Japan, the USSR, the GDR, and Poland) should be deposited with the Secretariat for analysis. Krill assessments will examine how analyses of the commercial catch data can be used to extrapolate fishing data to larger subareas, to measure fishing and natural mortality rates, and to detect changes in abundance caused by fishing or environmental changes. To complement the fishery catch statistics, additional biological, physical, and chemical data of interest to the SC must be archived systematically and analyzed to refine our understanding of how these factors affect estimates of population levels.

2.1.2. U.S. AMLR Directed Research Program (Krill)

The AMLR Program Plan proposes that U.S. efforts be directed toward improving the knowledge of the demography and dynamics of krill populations. The U. S. is participating in the joint, international research programs coordinated by the Convention. The purpose is to evaluate the potential effect of fishing mortality on krill abundance in the Convention area.

The AMLR program is designed to determine the impact of increased krill harvests on dependent predators. The AMLR field research strategy approaches the problem by investigating how the spatial distribution of krill varies from year to year, what factors determine the spatial distribution of krill, how the spatial distribution of krill affects the feeding behavior of krill predators, how predator feeding behavior affects reproductive success and ultimately, how the harvest of krill will affect predator populations. This strategy emphasizes the determination of critical ecological relationships in the Antarctic pelagic marine ecosystem, specifically between key environmental factors, prey, and predators. It is based on the working hypotheses that physical features in the pelagic ocean (such as water mass fronts, sea ice and upper layer mixing) constrain primary production and the spatial distribution of krill; that the spatial distribution of krill affects the recruitment of land-based predator populations during the reproductive season; and that pelagic predators interact with prey populations in a very different manner than land-based ones. The strategy is to link land-based studies of predator feeding ecology and reproductive success with observations of krill distribution and key environmental factors. This linkage will be accomplished by comparing two-dimensional plots of the physical structure apparent in the upper layers of the ocean, the spatial distribution of primary production, the spatial distribution of krill, the foraging patterns of land-based predators, and the movement and feeding patterns of pelagic predators.

The U.S. will conduct research to refine absolute estimates of krill abundance. Existing estimates of krill abundance determined by using hydroacoustic measurements are very variable. The Convention Working Group on Krill noted that acoustic data may be used to estimate absolute density of krill provided that a representative mean backscattering cross section or scaling factor is used to convert relative estimates to absolute estimates. The mean backscattering cross section and scaling factor may each vary with the size, distribution, behavior (e.g. orientation) and physiological condition (e.g. nutritional, reproductive state) of krill detected and insonified. These quantities will also generally vary with the frequency of sound. Controlled measurements on *Euphausia superba* need to be conducted to ensure accurate absolute density estimates. After appropriate methodologies have been developed to determine precise estimates of absolute abundance, the AMLR Program will either continue the existing time series for absolute abundance of krill or initiate a modified program.

The U.S. will also support research to refine data from sampling nets. The Convention Working Group on Krill recognized that net hauls are essential for the verification of acoustic data on krill (i.e., for target identification and to obtain representative length frequency distributions). They also recognized that it is unlikely a single net will sample all size classes of krill representatively. There is little information on inter-net comparisons for Antarctic krill therefore the U.S. will participate in investigations of net characteristics and limitations.

The U.S. AMLR Program will provide support in the analysis of commercial catch data on krill. Stock assessment scientists from the United States will participate in the analyses of historic (e.g., echocharts from fisheries survey vessels) and current data bases. Fine scale (data summed over areas of 0.5° latitude by 1° longitude and 10-day periods) catch and effort data

have been submitted to the Convention. Results from the CPUE (Catch per Unit Effort) Simulation Study will be used to investigate this data.

The principal objectives of the U.S. AMLR research program for krill are to:

- participate in discussions and planning activities relating to krill in the SC
- determine the relationships between krill and its predators (marine mammals, fish, and birds) in subregions of Antarctic waters;
- measure the natural variability in abundance and distribution of regional krill concentrations;
- determine the nature and characteristics of krill swarms, the factors affecting the formation, size, and behavior of krill swarms, and the possible effects of fishing operations on the number, size, and behavior of krill swarms;
- participate in the international effort to investigate factors affecting estimates of absolute abundance of krill;
- after improvements are made to measure mean backscattering cross section and scaling factors, complete an experimental design to initiate a monitoring program to measure absolute abundance of krill in the APISA;
- complete comparisons of net characteristics to determine the most appropriate sampling methods to collect representative samples of krill; and
- analyze historical and current data from commercial krill harvests.

A summary of the AMLR Program of directed research on krill during FY 1989 is given by Hewitt (1989)[1]. Field research to be conducted during FY 1990 is presented in Appendix 4.

2.2 Zooplankton (other than *Euphausia superba*)

The zooplankton fauna present south of the Antarctic Convergence is comprised of diverse taxonomic groups that provide the crucial link between primary producers and carnivores. Despite the great attention focused on Antarctic krill, *E. superba*, that single species represents but one of the many important zooplankton taxa present in Antarctic waters. Although the relative importance of various macrozooplankton groups varies with locality and season, the taxa with the largest total biomass are probably copepods, euphausids (other than *E. superba*) salps, and the early life stages of fish (i. e., eggs and larvae, known as ichthyoplankton). Copepods are the dominant herbivore in many areas of the Antarctic, and salps can be found in widespread, dense concentrations.

2.2.1. Commission Priority Research Needs (Zooplankton)

Four categories of information on zooplankton are needed by the SC: species composition, relative abundance, distribution, and life history of the major species. Documenting and monitoring the species composition and relative abundance of zooplankton in different areas of the Antarctic will help determine numerical and functional relationships between various groups, and may well provide one of the earliest and most sensitive indicators of possible changes in biological communities caused by krill harvesting. Such information is necessary to assess the potential impacts of fisheries activities on other components of the ecosystem. For example, the SC should document any significant changes and trends in the composition of by-catch species.

The SC requires information to consider the following questions: To what extent do changes in local krill abundance affect krill competitors such as copepods and salps? How stable is the relative species composition of various regional zooplankton complexes? What is the intra- and interannual variability in the relative abundance of different zooplankton species, and how do these competitors interact?

Information on the life history of the major zooplankton species is required to better understand their role in the marine ecosystem. In particular, there is a need for data on the factors affecting the reproduction, growth, food habits, and survival of major taxa. In addition to zooplankton species' role as herbivores, the SC also requires information on the importance of these species as prey .

2.2.2. U.S. AMLR Directed Research Program (Zooplankton)

The AMLR Program has an interest in three areas identified as SC data needs: species composition, distribution, and relative abundance of zooplankton. Data on these topics will be obtained from commercial catch information and in conjunction with research projects designed primarily around krill. Information on the distribution and abundance of zooplankton will also be obtained in coordination with the integrated Studies of predators and their prey as proposed by the CEMP Working Group.

To support the data requirements relating to zooplankton other than Antarctic krill, the U.S. AMLR Program will:

- monitor the by-catch composition from net hauls made during krill research activities;

- analyze by-catch data from commercial fisheries;

- participate in discussions within the SC that address zooplankton issues; and

- monitor the frequency of occurrence and the relative importance of various species of zooplankton in the diets of seals, birds, fish, and other consumers of both krill and other zooplankton.

A summary of the AMLR Program of directed research on zooplankton during FY 1989 is given by Hewitt (1989)[1]. Field research to be conducted during FY 1990 is presented in Appendix 4.

2.3. Fish

The biomass of fish in the Antarctic ecosystem is not extensive, in comparison to other ecosystems. The dominant Antarctic fish are members of the Nototheniidae, which represent 75% of all species. They are demersal fish inhabiting the continental shelf and the shelf areas surrounding island groups. In addition, epipelagic schooling species such as *Pleuragramma antarcticum* (Antarctic silverfish) are abundant in pack ice areas. *P. antarcticum* is known to be an important forage species for many vertebrate predators. The reported catches of demersal fish exceeded the estimated sustained yield levels in three years of the eight-year period, 1971 to 1978. In 1971, catches of *Notothenia rossii*, marbled rockcod exceeded one-half million metric tons, e.g., 400,000 mt in the South Georgia area and 200,000 mt in the Kerguelen Islands area. By 1983, the estimate of biomass for *N. rossii* was less than 10% of the initial biomass of the period preceding the fishery. In 1988/89, the total catch of all species of finfish was 104,405 mt.

During the eighth Commission meeting, November 1989, the SC determined that in spite of the take reducing regulations previously enacted, the status of all fish stocks was either unknown due to the lack of data, uncertain due to wide differences in the results of different analyses or depleted and in need of protection. Therefore, all delegations, except the USSR delegation, felt that a closure of the fishery around South Georgia for a short period of at least one year, pending a new assessment, should be considered by the Commission. Because the Soviet delegation would not agree, the Commission could not reach consensus concerning the closure. Instead, the Commission adopted conservation measures setting directed catch and by-catch limits on several species. Mesh size limits and seasonal area closures were also set.

2.3.1. Convention Priority Research Needs (Fish)

Recognizing the overexploited state of several Antarctic demersal fish stocks, the lack of extensive information on the status of the pelagic fish stocks, and the need to monitor the effects of conservation and management measures adopted by the Commission, the most important SC research needs are: to understand the life history and measure the recovery of the stocks under regulation; clarify the status of the pelagic fish component in the ecosystem; and examine the interrelationships among fish, their predators (including fishing predation) and prey.

Assessing the condition of Antarctic fish stocks requires analyses of data collected from commercial catches as well as direct (fishery independent) surveys of the stocks. Analyses of the commercial catch data make possible the measurement of fishing and natural mortality rates, and of annual changes in abundance caused by fishing or environmental changes. Where gaps in commercial catch data are identified, direct and indirect surveys of the stocks are required.

Based on current and historical information, a number of regional concentrations of fish have been identified on the shelf areas in the vicinity of islands. Of major importance to the Commission is the recovery of overexploited fish stocks. To provide information on reproductive success and recruitment levels for indications of recovery, the stocks need to be monitored. This may be accomplished through analysis of commercial catch/effort data and scientific surveys to obtain growth, fecundity, and recruitment information on both demersal and pelagic stocks.

2.3.2. U.S. AMLR Directed Research Program (Fish)

The AMLR Program provides support in the analysis of commercial catch data on fish. Scientists from the United States participate in the analyses of historical and current data and contribute expertise to the SC's Fish Stock Assessment Working Group. Assessments are based on a chain of investigations which begin with the identification of a resource, its distribution, and number of component stocks, followed by measurement of mortality and other parameters. The synthesis of such data provide the basis for abundance estimates and management recommendations.

When appropriate, the AMLR Program will contribute its operational and scientific expertise to joint international surveys of juvenile and adult fish, and ichthyoplankton. The United States will provide expertise in experimental design, survey operations, and data analyses. At present the AMLR Program does not propose to conduct dedicated research vessel surveys of fish stocks because the vessel presently available to the AMLR Program is not equipped to handle large commercial-size nets. The United Kingdom, however, is presently conducting such surveys around South Georgia, which is the area of major concern. If the fishing effort shifts to the Antarctic Peninsula Integrated Study Area (APISA), then the U.S. may have to seek funding to charter a suitable vessel to complete surveys in this area.

To address Commission priority research needs regarding the assessment of Antarctic fish stocks, the U.S. AMLR Program will:

- participate in discussions and planning activities relating to fish stocks in the SC;

- analyze historical and current data from commercial fish harvests;

- participate in internationally coordinated ichthyoplankton surveys to assess changes in species composition and dominance within the fish community; and

- evaluate methods for studying fish growth parameters (e.g. ageing Antarctic fish).

A summary of the AMLR Program of directed research on fish during FY 1989 is given by Hewitt (1989)[1]. Field research to be conducted during FY 1990 is presented in Appendix 4.

2.4 Seabirds

The role of the approximately 45 species of seabirds present within the Antarctic marine ecosystem is one of considerable importance. Although much remains to be learned of the abundance, distribution, and life history of this group, crude estimates of biomass and potential prey consumption indicate the magnitude of these predators' impact in structuring the marine community. Antarctic seabirds may consume as much as 115 mmt of krill annually, as well as considerable amounts of fish and squid.

Penguins are one of the most specialized of the many seabirds which dominate the avifauna biomass. Penguins represent a key component in the Antarctic marine ecosystem, and are therefore one of the important groups that the SC addresses. All remaining species of seabirds are recognized as a significant component of the marine ecosystem, possibly competing with other apex predators for prey on a seasonal basis.

2.4.1 Commission Priority Research Needs (Seabirds)

The SC requires information about various aspects of seabird ecology to ensure that commercial fisheries do not adversely affect this nontarget group. Furthermore, seabirds are an important group to the Convention because they are one of two species groups for which there are the most data indicating a direct link between fisheries resources and predator populations. The SC data needs include three areas: abundance and distribution throughout the year, life history, and indicator parameters. These areas are briefly discussed below, followed by a description of proposed seabird research within the AMLR Program.

The SC requires information on the abundance, distribution and variation in reproduction, relative to prey availability of Antarctic seabirds to assess this group's ecological role and interactions with commercial fisheries. Although the general distribution of seabirds is relatively well known (most are circumpolar), changes in the seasonal distribution of many important species are poorly documented. There are virtually no data on seabird distribution during winter months. Understanding seasonal changes in distribution is essential for evaluating temporal and spatial aspects of trophic interactions among birds, their prey, and their predators. Regarding estimates of seabird abundance, many areas of Antarctic have received only cursory seabird census efforts. The Commission is interested in documenting, as far as possible, the extent to which krill-eating penguin populations may have increased in response to decreased populations of baleen whales.

In association with the development of an ecosystem monitoring program, the CEMP Working Group has identified several aspects of seabird life history suitable to a program of directed ecological research. During its 1989 meeting, the CEMP Working Group revised and defined standard data parameters and methodologies which members have agreed to use. Life history parameters such as reproductive timing and success, growth, and diet vary with latitude, local environmental conditions, and seasonality of prey. Data are needed on inter-season and inter-site variability associated with these life history parameters.

The CEMP Working Group has identified certain seabirds as being key species in ecosystem monitoring programs. In the Antarctic, penguins are particularly well suited as upper trophic level indicator species. They are abundant, widespread, site-faithful, long-lived, and relatively tolerant of disturbance by scientists. Furthermore, the dominant penguin species are specialized krill predators.

2.4.2. U.S. AMLR Directed Research Program (Seabirds)

The AMLR Program addresses SC needs for data on seabirds in the areas identified above. The emphasis is to support the coordinated, multinational CEMP program developed by the Commission.

An effective scheme using seabirds to monitor the availability of prey such as krill must take into account the abundance of both the winter and summer krill populations. The AMLR seabird research will investigate the relationships between various seabird life history parameters, prey availability, and environmental conditions. This work will also evaluate the inter-seasonal variability of parameters. Various life history parameters (e.g., reproductive condition, feeding behavior, etc.) can be monitored to indicate both winter and summer prey availability.

The AMLR Program will collect and synthesize pertinent seabird data that will lead to improved estimates of abundance, prey consumption, changes in life history parameters, and potential impact on the ecosystem of predator/prey interactions.

The AMLR Program monitors penguins at Seal Island, Elephant Island and at Palmer Station. In addition, the Program works in close coordination with several other nations' seabird research. From both a logistic and scientific perspective, it is desirable to carry out penguin and pinniped research at nearby locations, when both species are present. Hence, land-based penguin monitoring activities will be coordinated with fur seal study sites where possible. Although dedicated sightings cruises are not projected, their potential utility will also be considered. If implemented, seabird sightings studies would be integrated into marine biology cruises and would utilize trained observers.

The CEMP Working Group has emphasized the need for the development of remote-sensing and automated recording equipment suitable for penguin research in ecosystem monitoring programs. Hence, the AMLR Program will give priority to the development and modification of technology for automated monitoring of selected penguin ecological factors (e.g.,individual weights, nest attendance, feeding trip duration, foraging, and diving behavior).

To support seabird research program, the AMLR Program will:

- participate in developing automatic penguin monitoring and remote-sensing capabilities;
- collect baseline data for penguins at several land-based field sites;
- assess feeding and reproductive ecology of penguins and certain flighted birds (petrels) at selected colonies, as well as the relationship of these parameters to variability in other ecosystem components and processes;
- consider the implementation of carefully designed sighting surveys and collection of flying seabirds;
- consider the functional relationships between seabirds and other components of the ecosystem; and
- develop and use satellite remote sensing methods to determine the winter distribution and movements of selected penguin and seabird species.

A summary of the AMLR Program of directed research on seabirds during FY 1989 is given by Hewitt (1989)[1]. Field research to be conducted during FY 1990 is presented in Appendix 4.

2.5 Pinnipeds

Of the six species of pinnipeds that are found south of the Antarctic Convergence, four are associated with ice: these include crabeater, *(Lobodon carcinophagus)* leopard, *(Hydruga leptonyx)* Ross, *(Ommatophoca rossii)* and Weddell *(Leptonychotes weddellii)* seals. The first three species inhabit the pack ice zone, whereas Weddell seals breed mostly in fast ice habitats. Antarctic fur seals *(Arctocephalus gazella)* and southern elephant seals *(Miruonga leonina)* are found in pelagic areas in lower latitudes, where they breed principally on sub-Antarctic islands. Of these six species, crabeater seals are the most important ecologically because of their great abundance and specialization as krill predators. Throughout the Antarctic, crabeater seals alone are estimated to consume more than three times the total amount of Antarctic krill presently eaten by all species of whales combined. Hence, the pinnipeds, and crabeater seals in particular, are a key component of the Antarctic marine ecosystem.

2.5.1. Commission Priority Research Needs (Pinnipeds)

To evaluate management and conservation options, the SC requires information about pinnipeds in four areas: feeding and reproductive ecology, abundance and distribution, life history, and spatial and temporal trophic interactions. Details of pinniped reproduction, feeding ecology, population dynamics, and individual growth rates are necessary to fully assess this group's ecological role in the marine ecosystem. In particular, the functional relationships between pinnipeds and other species need to be further defined. These SC data needs are discussed in detail below, followed by a description of the directed pinniped research to be undertaken by the U.S. AMLR Program.

Most Antarctic pinnipeds depend, directly or indirectly, on the availability of krill. Directed research on the trophic relationships between pinnipeds and their prey is essential to the development of indicator ecological indices. Fluctuations in food availability may be reflected in responses by primary or secondary predators of krill. For many species, variables such as reproduction, behavior, and growth are flexible factors that change in response to food resources. For example, feeding patterns of crabeater seals are likely to be sensitive to krill abundance and distribution. Duration and frequency of feeding bouts could serve as indices of krill availability, and could be monitored by satellite telemetry or by other instrumentation. Pinniped reproductive factors are potentially valuable indicators for ecosystem monitoring programs. Comparison of such ecological indices may demonstrate changes in the status of a variety of features, ranging from prey availability to the abundance of the predators themselves.

A knowledge of pinniped distribution and abundance is fundamental to developing an understanding of trophic relationships among components of the ecosystem. Crabeater, leopard, Ross, Weddell, fur, and elephant seals are all apex predators which could be affected indirectly by commercial fisheries for krill, finfish, and squid. Accurate estimates of population trends in crabeater seals, the largest group of Antarctic mammalian predators, are necessary for assessing numerical relationships of their impact on prey populations. One research priority to achieve Convention objectives is to determine whether crabeater seal populations are increasing, stable, or decreasing in various sectors of Antarctica. Because of their circumpolar distribution, high abundance, and nearly exclusive diet of Antarctic krill, crabeater seals may

be particularly good indicators of the possible impacts of krill harvesting on krill predators.

Information is also required on the relative recovery status of depleted populations of Antarctic fur seals and southern elephant seals in different zones of seal and fish harvesting. Antarctic fur seals were almost harvested to extinction by United States and British sealers in the 1800's, and have made a remarkable comeback in some areas. The degree to which former rookeries of fur seals have been or are being recolonized is of immediate interest to the Commission. Recent evidence has indicated that populations of southern elephant seals are declining in some sectors of the Antarctic, possibly due to depletion of finfish food resources by commercial fisheries. The SC needs to evaluate the extent and causes of this apparent decline, by considering the historical relationship, if any, between trends in commercial finfish harvests and elephant seal abundance. In addition, it is not known what affect the over-harvesting and subsequent 90% decrease in the stocks of krill-eating whales has had on the abundance of crabeater, fur and leopard seals.

The diet, energetics, feeding behavior, and movements of pinnipeds are integral components of ecological interactions among these predators, their prey, and commercial fisheries. Major information needs relating to the spatial and temporal aspects of pinniped trophic interactions include information on the species composition, quantities, size classes, and reproductive stages of pinniped prey. Additional information is needed on the feeding behavior of crabeater seals, a specialist krill predator, in relation to krill densities, depths, and swarm configurations. The foraging range, seasonal migration, and age and sex segregation patterns of all species of Antarctic pinnipeds require further study. The extent to which various discrete populations of pinnipeds occur in different regions has also been identified as a priority research need by the SC.

2.5.2. U.S. AMLR Directed Research Program (Pinnipeds)

The AMLR Program has a long-term interest in each of the four pinniped research areas identified as Commission data needs: abundance and distribution, life history, spatial and temporal trophic interactions, and indicator parameters. U.S. AMLR Program research on pinnipeds is designed to support the coordinated, multinational, CEMP research. The major emphasis will be to investigate their use as indicator species for changes in krill abundance. Of the six species of Antarctic pinnipeds, the AMLR Program focuses on crabeater, leopard, Weddell and Antarctic fur seals.

Population and individual parameters can assist in monitoring the ecological status of populations or communities, if selected variables respond in predictable ways to environmental changes. Populations respond to density-dependent factors such as prey abundance and suitable habitat availability, or in response to changes in physical conditions such as ice characteristics. To adequately interpret changes in selected indices, directed ecological research is required to answer specific questions pertaining to distribution, diet, reproduction, and stock separation. Research on such indicators provides information on both prey and pinnipeds.

The AMLR Program collects and synthesizes available data for crabeater, leopard, Weddell and fur seals to review estimates of their stock abundance, distribution, prey consumption, and potential predator/prey interactions.

To support the objectives of the CEMP, the U.S. AMLR Program will:

- participate in discussions and planning activities relating to pinnipeds in the SC;

- investigate the functional relationships among Antarctic pinnipeds, their prey, and their environment;

- monitor the feeding ecology, reproduction, growth rates, and abundance of Antarctic fur seals at selected land-based sites;

- analyze past Antarctic fur seal feeding behavior through the interpretation of fine tooth structure;

- study the feeding and attendance behavior of Antarctic fur seals;

- investigate the feeding ecology, reproduction, and demographic changes of crabeater and leopard seals in the pack ice zone;

- investigate indices of physiological condition in crabeater and Antarctic fur seals, and monitor the intra- and inter-annual changes in these parameters;

- refine estimates of population size for pack ice seals;

- review the population trends of pinnipeds, especially in regard to the recovery of depleted and potentially declining stocks; and

- evaluate the daily and seasonal movements and stock separation of crabeater and leopard seals in the pack ice zone.

Each of these projects directly supports priority Commission data needs, and will be closely coordinated with other nations' research efforts within the SC.

A summary of the AMLR Program of directed research on pinnipeds during FY 1989 is given by Hewitt (1989)[1]. Field research to be conducted during FY 1990 is presented in Appendix 4.

2.6 Cetaceans

Seven species of baleen whales and eight species of toothed whales occur seasonally south of the Antarctic Convergence. Prior to commercial exploitation during this century, the waters around Antarctica supported large numbers of baleen whales. During a few short decades, the populations of these once abundant animals were decimated, endangering the existence of several species, and very likely changing the structure of the Antarctic marine ecosystem in the process. For example, from 1931-32 to 1979-80, whaling in the waters around Antarctica took 1,090,685 blue, fin, sei, and humpback whales, reducing these populations to less than 10% of their former abundance. Assessments of the interaction of these species with the ecosystem and commercial fisheries, leading to recovery of these populations, are necessary to meet Convention objectives.

2.6.1. Commission Research Needs (Cetaceans)

The principal interests in Cetaceans are to document the recovery of whale stocks and understand their interactions with other key components of the marine ecosystem. In general, the Commission requires information in three areas: abundance and distribution, life history, and spatial and temporal trophic interactions. These data needs are discussed below, followed

by a description of the directed cetacean research proposed for the U.S. AMLR program.

The SC requires information on the current status of whale stocks and how they may be affected by future fisheries for their prey. Commercial exploitation of the great whales of the Southern Hemisphere had a major impact throughout the Antarctic marine ecosystem. There is evidence that possible whale competitors such as seals and birds have increased in recent decades. The degree to which the recovery of whale populations are being affected by increased abundance of their prey and increased competitors remains unknown. Increased populations of krill consumers such as crabeater seals and some penguin populations, may retard the rate of recovery of whales by reducing the availability of krill.

Article II of the Convention specifies that exploitation of krill or other food species should not impede the recovery of depleted populations. Data indicating a recovery of depleted whale populations will be difficult to obtain, and may include both changes in sighting frequency and changes in spatial distribution. In the absence of future data from whaling, sighting surveys and radio/satellite tracking will become the major scientific tools for data collection. Additionally, reanalysis of existing data, especially from the Bureau of International Whaling Statistics (BIWS), the International Decade of Cetacean Research program (IDCR)/IWC data base, and from Japanese whaling fleets, may prove valuable in identifying changes in the latitude of whaling operations as the preference for different target species changed, as well as the relative abundance and possible separation of populations of the various whale species.

Estimates of the productivity of whales, and hence their ability to recover, involve assumptions about changes in rates of reproduction, recruitment, and adult survival. A moratorium against further commercial whaling was implemented in 1986. Hence, it will be difficult to directly monitor these rates. Alternative information from field observations on these animals will be required (e.g., aerial photogrammetric techniques to determine relative calving rates).

While in the Antarctic, whales feed on a variety of organisms, with many whales dependent on krill. Although the general prey preferences of most whales are known, data on change in diet associated with variable prey availability and changes in the spatial distribution of whales would be desirable. This data is no longer available from commercial whaling operations. The SC may have to consider attempting to obtain future data from alternate means to verify models of cetacean interactions with krill and other prey.

2.6.2. U.S. AMLR Directed Research Program (Cetaceans)

Cetacean research priorities in the AMLR Program will reflect the U.S. interest in the conservation and recovery of the Southern Hemisphere whale populations and the data needs of the Commission. These priorities include research concerning abundance and distribution, life history, and spatial and temporal trophic interactions. The AMLR Program will focus its research efforts on cetacean distribution, and in conjunction with the IWC, assess abundance and the question of stock separation. As feasible, additional work will be undertaken on feeding ecology through the analysis of stomach contents data from commercial catch records to be presented at the Convention/IWC Workshop on the Feeding Ecology of Southern Hemisphere Baleen Whales. The workshop, scheduled for 1989, has been tentatively rescheduled for 1991 or 1992.

The potential utility of multi-disciplinary surveys has been considered as a means to assess the species composition, distribution, and abundance of bird and mammal populations.

The spatial and temporal distribution of these sightings data would be of value when coupled to information concerning environmental conditions and the abundance of fish and krill populations. At the present level of funding, dedicated surveys will not be conducted.

However, an important source of data has been the dedicated sighting cruises conducted under the auspices of the IDCR/IWC. Because of the great expense and technical difficulty of conducting such cruises, it is uncertain whether they will continue in the future. Moreover, it is unlikely that any one nation could afford to undertake such cruises independently. Although the U.S. AMLR Program plan does not propose to initiate dedicated sighting cruises, U.S. scientists will assist in the design and analysis of information from internationally sponsored cruises. The potential need for dedicated cetacean sighting cruises will be considered during future years.

The development and deployment of radio tags for tracking whales by satellite would greatly facilitate determining movement patterns of whales within and between seasons. Such information can be used by the SC to interpret sightings data and to identify areas where interactions between whales and commercial fisheries of their prey may be most likely. Furthermore, satellite technology can potentially provide data on whale feeding rates, dive profiles, and other parameters. Information on whales' use of space and the manner in which those patterns change will be useful in interpreting census data. Development of remote sensing techniques has been recommended as a priority research need by the CEMP Working Group and is an area where the United States can make a strong contribution.

Biopsy darts will be used to obtain tissue samples of humpback and right whales encountered during normal survey operations. These samples will be evaluated to establish the feasibility of using biopsy techniques to characterize the population structure of baleen whales.

To investigate the abundance and distribution of Antarctic whale populations, the U.S. AMLR Program will:

- encourage and facilitate discussions and planning activities within the Commission that relate to cetaceans;
- evaluate the possible use of sightings data for collecting information on cetacean population recovery, abundance, and distribution;
- assist in the design and implementation of multi-disciplinary, international sighting surveys and the analysis of dedicated cetacean sightings data to improve estimates of whale abundance;
- evaluate the feasibility of using biopsy darts to obtain tissue samples of humpback and right whales for population structure studies;
- investigate the feasibility of developing an experimental protocol for deployment of satellite linked telemetry; and
- encourage utilization of visual, photogrammetric, and satellite-linked technology to monitor the distribution, movements, and behavior of whales.

A summary of the AMLR Program of directed research on cetaceans during FY 1989 is given by Hewitt (1989)[1]. Field research to be conducted during FY 1990 is presented in Appendix 4.

2.7 Cephalopods

Antarctic cephalopods play a potentially critical role in the marine ecosystem. Pelagic squid are thought to be major predators of Antarctic krill and are known to be frequent prey of many vertebrate predators. An Antarctic squid fishery is not expected to be developed in the near future; however, the potential for this fishery should be evaluated.

Approximately 72 cephalopod species, predominantly squid, are known or thought to occur south of the Antarctic Convergence. The distribution and relative abundance of these species are poorly known because of sampling difficulties. Because squid are fast-swimming, active predators, they are difficult to catch in nets and other sampling gear. Therefore, much of the information presently available has come from the stomach contents of seabirds, seals, and whales. If interest in squid ecology and their potential as a fisheries resource intensifies, this group may become increasingly important to the Commission and the SC.

2.7.1. Commission priority Research Needs (Cephalopods)

Given the potential commercial and ecological importance of cephalopods, the SC may require information on their species abundance, distribution, and ecological role. Further research must be conducted to determine the species composition and relative abundance of squid in various sectors and habitats (e.g., open water, pack ice, shelf areas). Obtaining information on the seasonal and interannual changes in distribution and abundance will allow evaluation of potential interactions among squid, its prey, and predators.

The ecological role of cephalopods needs to be investigated to determine this group's relative importance as a predator and as prey. For example, to what extent does squid predation impact krill populations or the early life stages of fish? What species and what quantities of squid are consumed by sperm whales, elephant seals, Weddell seals, Ross seals, Antarctic fur seals, and albatrosses? The SC will require information on these topics as it considers trophic interactions among species groups and the potential impacts of commercial fisheries.

2.7.2 U.S. AMLR Directed Research Program (Cephalopods)

The AMLR Program has an interest in determining the abundance, distribution, and ecological role of Antarctic squid. Although no major field research is proposed, U.S. scientists will participate in activities concerning squid within the SC. Consideration will also be given to future squid research that should be initiated by the AMLR Program. In particular, potential methods to sample squid will be evaluated for possible inclusion in future field programs.

As part of the AMLR Program research on pinnipeds, opportunistic collections of Ross seals, elephant seals, leopard seals, and Antarctic fur seals may produce squid beaks and other body parts. Since squid beaks can be identified by species, this material from stomach contents will be analyzed to provide information on the species composition, distribution, and relative importance of squid as prey to various predators. Samples of cephalopod larvae and juveniles obtained as by-catch of krill research trawls will also be analyzed.

In order to begin addressing selected Commission data needs regarding Antarctic cephalopods, the U.S. AMLR Program will:

- develop and maintain status reports on changes in the distribution and abundance of squid within the Antarctic ecosystem, based on available catch statistics and scientific literature;

- participate in squid assessments within the SC;

- consider developing and testing improved sampling techniques for squid, including night-time trawls; and

- undertake opportunistic collection and analysis of squid beaks and body parts obtained from predator samples.

A summary of the AMLR Program of directed research on cephalopods during FY 1989 is given by Hewitt (1989)[1].

2.8 Environmental conditions

The waters around the Antarctic continent contain major oceanic current systems, large scale frontal regions that separate waters of characteristically different properties, and an ice cover that undergoes a large annual advance and retreat. Each of these aspects of the environment exerts an important influence on the distribution and productivity of organisms at all levels of the ecosystem. Currents determine the location of planktonic organisms, density stratification affects light and nutrient availability for phytoplankton production, and temperature influences growth rates. The research needs identified in each of the biological components of this plan will require, to varying degrees, knowledge of the environmental conditions and an understanding of the influence that environmental variability exerts on species identified for specific studies, their prey and their predators.

During the seasonal retreat of Antarctic sea ice, the ice edge passes over 15 million square kilometers of the Southern Ocean, including most regions where major krill concentrations occur. Physical and biological processes acting at the ice edge offer the potential for enhanced primary productivity. This occurs with the release of nutrients and phytoplankton from the ice and the establishment of favorable light conditions due to stability of the upper water column induced by the melt water. Such a pulse of production occurring over the entire area of the seasonal sea ice could supply a major portion of the food source for the krill-dominated ecosystem. Variations in this production may account for variability in the abundance of krill populations.

2.8.1. Commission Priority Research Needs (Environmental Conditions)

The identification of environmental influences on the distribution and abundance of populations is important to the Commission. To assess and monitor the effects of fishing pressure on krill stocks and other components of the Antarctic ecosystem, changes in their distribution and abundance due to the influence of natural environmental variability must be known.

The search for linkages between environmental conditions and population abundance begins with simultaneous knowledge of the spatial and temporal distribution of environmental and biological parameters. Ssimilarity of patterns that are observed in data collected in successive years leads to hypotheses that can be tested in dedicated studies of the specific processes controlling environmental-biological relationships. Detailed, high quality, synoptic

environmental and biological data are not generally available and are needed for some areas before appropriate dedicated studies of environmental processes can be undertaken. Hence, the SC has encouraged biological sampling programs which have an environmental component to monitor local environmental conditions and, where practicable, large scale conditions. Such data will help define the environmental context in which future research on physical oceanography will be based. The physical variables of primary importance to the SC are water properties, location of frontal boundaries, local circulation patterns, and the extent and movement of the seasonal ice cover.

2.8.2. U.S. AMLR Directed Research Program (Environmental Conditions)

The APISA, the subarea of the Antarctic ecosystem to be investigated by the United States, is a very dynamic and complicated area from an oceanographic perspective. Considerable physical oceanographic research, including broad scale circulation and frontal patterns, has been conducted in this region. The highly dynamic nature of the region results in temporal and spatial variability in local environmental conditions that can have important impacts for interannual changes in the ecosystem. The AMLR Program will document these broad scale environmental conditions in order to provide a background against which biological observations can be interpreted. Information on both biological and environmental variables is needed as well to provide the necessary means to distinguish between changes induced by harvesting of particular species (especially krill) and changes resulting from natural environmental variability. The AMLR Program will also initiate or cooperate in studies investigating specific aspects linking the physical environment to the distribution and abundance of target organisms. Of particular importance are the influence of seasonal ice cover and mesoscale water circulation patterns. Important biologically are phytoplankton productivity and dynamics, the benthos, and the relationship of these factors to higher trophic levels in the food web.

The SC recognized the need for more cooperation among member nations in the collection of environmental data. The AMLR Program agreed to investigate the feasibility of development of a standardized grid of oceanographic stations throughout the Convention statistical areas. The grid system will include locations of stations and a suite of data collection methods that would be applied by any vessel at a station.

Measurements of the water temperature, location of frontal boundaries and distribution of the ice cover are available from a variety of sources, particularly via satellite remote sensing. To meet its environmental monitoring needs, the AMLR Program will consult with other U.S. government agencies (e.g., NWS, NESDIS, Navy, NASA) to obtain the appropriate available data and to evaluate the feasibility of utilizing satellite technology to achieve AMLR Program goals.

Whether krill are food limited is unknown. The orders-of-magnitude difference observed both temporally and geographically in phytoplankton biomass and productivity impact directly on krill and other herbivores. Geographical variability in food resources (phytoplankton) contributes to the spatial variability observed in krill biomass and is responsible, at least in part, for krill swarm characteristics. Seasonal and interannual differences in phytoplankton standing stocks and production rates are likely reflected in differences in krill abundance over similar time scales. The cell size distribution of phytoplankton is also an important factor in considering the food resources available to krill. This is because the capture efficiency of filter-feeding zooplankton (including krill) is a function of the size of the prey, with larger cells being caught more readily than smaller cells.

Phytoplankton cell size distribution, like biomass and productivity, is extremely variable in Antarctic waters.

The AMLR studies on phytoplankton will focus on monitoring interannual and seasonal variability in phytoplankton biomass and productivity as they relate to krill distribution and the physical environment. A critical aspect in the study of phytoplankton/krill distributional relationships will be coordination of the phytoplankton component with hydroacoustic krill assessment surveys.

Antarctic benthic species, or bottom dwelling organisms, tend to have broad distributions and very high densities influenced by the overlying current patterns and productivity. There are interactions between benthic species and those living in the water column (e.g., demersal fish and Weddell seals eat benthic invertebrates, and conversely, benthic invertebrates consume krill). Effects of perturbation in the benthos are less ephemeral than in the overlying water column. Benthic species are relatively stationary compared to species in the water column, may have life spans of several hundred years, and can be monitored. In particular, the feasibility of using benthic species as indicators of environmental perturbation should be evaluated. Environmental monitoring techniques using benthic species will be developed.

To investigate the influence of environmental conditions on the distribution and abundance of krill and other key components of the Antarctic marine ecosystem, the U.S. AMLR Program will:

- monitor broad scale distribution of frontal boundaries, water properties, and sea ice cover in association with AMLR biological research activities;
- undertake process-related interdisciplinary studies in the marginal ice zone to investigate the relationships between physical and biological aspects;
- model the physical and biological variability inherent in the Southern Ocean, especially in the APISA, in relation to krill distribution and abundance;
- investigate development of environmental grids in AMLR study areas for collection of standardized suite of data elements;
- monitor phytoplankton standing stocks, primary productivity, cell size, and meso- and micro-scale distribution patterns in relation to environmental conditions and other Antarctic food web components (e.g., krill/zooplankton consumers); and
- identify benthic species and techniques important in determining and monitoring effects of various environmental perturbations on the Antarctic marine ecosystem.

A summary of the AMLR Program of directed research on environmental conditions during FY 1989 is given by Hewitt (1989)[1]. Field research to be conducted during FY 1990 is presented in Appendix 4.

3. FUNDING AND IMPLEMENTATION

Resource needs for implementation of the AMLR Program are summarized in this section. Stock assessments, studies of trophic interactions, and environmental monitoring are projected by the United States under the following assumptions:

- the United States will maintain a role in pursuance of the objectives of the Convention, within the Commission, and as a full participant in joint multinational scientific programs recommended by the SC;
- the United States will continue to encourage conservation of the Antarctic marine ecosystem as outlined in the Convention; and
- the United States will continue to approach the objective of conservation of the Antarctic ecosystem to allow for the rational utilization of resources that have not been overexploited (within levels which will ensure that any potential detrimental effects are reversible over a period of time not exceeding two or three decades).

Under these assumptions, assessment information and monitoring programs at least sufficient to make and verify the reliability of estimates of individual stock yields and the probable consequences of these yields on the structure and dynamics of the Antarctic marine ecosystem are projected.

3.1 Management Goals of the Convention

A. General Goal

The general goal of management by the Convention is the conservation of Antarctic marine living resources, including rational use of the resources consistent with the conservation principles established by Article II of the Convention.

B. Policy Assumptions

Effective conservation of Antarctic marine living resources assumes the availability of information on the abundance, distribution, and condition of the key populations (e.g., krill, fish, birds, mammals), their spatial and temporal variability, and changes in these factors caused by fishing and environmental conditions.

The AMLR program assumes the projection of continuous support by NSF of its program of basic research.

C. Assessment Needs

Management responsibilities, imposed by jurisdiction over living resources within the Convention area, will involve long-term and short-term assessments. The long-term approach to ecosystem conservation and management necessitates changing from concentration on a few species to initiating studies of all the key populations, and conducting seasonal, synoptic resource surveys over defined management areas. This approach is required to monitor the effects of fishing pressures and environmental changes on the ecosystem, initially to assess the status of the resources; secondly, to provide adequate advice concerning the effects of different

management regimes from a conservation standpoint; and ultimately to understand production processes and interrelations of the total biomass components. A long-term assessment objective is the accurate and precise prediction of events. Short-term (annual) management decisions concerned with preventing damage to a resource require assessment information sufficient to establish preemptive (preliminary) quotas on specific stocks or for other management action (e.g., closed areas or seasons).

D. Warnings and Forecasts

Resource assessment information gathered through the AMLR Program provides forecasts and warnings of changes in abundance, distribution, and condition of key stocks located in the Convention area. This information is used to prevent further overexploitation, allowing overexploited stocks to recover to agreed levels and permitting exploitation of other stocks without jeopardizing the structure of the ecosystem.

E. Realization of Management Goals and Assessment Requirements

Ecosystem conservation and management in each Antarctic region is the principal goal toward which assessment efforts are directed. However, realization of this goal will be more critical and/or feasible for certain ocean regions. Specific management objectives for defined Antarctic ocean regions and stocks in these regions are to be considered by the SC.

3.2. Present Status of U. S. AMLR Directed Research Program

Initial progress in directed research has been accomplished through domestic and international cooperation. For example, in 1982 operations designed to improve acoustic estimates of krill abundance were conducted from the (UNOLS) *RV Melville* in cooperation with NSF, Scripps Institute of Oceanography (SIO) and the University of Washington. The principal objective of NMFS participation was to refine acoustic biomass estimates of krill abundance. This was done by combining acoustic survey methods with different net sampling strategies designed to capture krill in different stages of development. NMFS scientists participated in the discovery of one of the largest superswarms of krill ever reported. The total biomass within the region of Bransfield Strait and Elephant Island was estimated at 2.8 mmt. During subsequent surveys in 1983 and 1984, scientists from NMFS, the Federal Republic of Germany, and the United Kingdom reported significantly lower biomass of krill in the region of the Antarctic Peninsula. The reasons for the apparent change from the 1982 abundance estimates are not understood.

Earlier studies of krill abundance, using acoustic and net sampling systems, and ice edge oceanography were conducted by NMFS scientists on the vessel *RV Melville* and the Coast Guard icebreaker *Westwind* in 1983. This was accomplished in cooperation with the NSF-AMERIEZ program and scientists from SIO and Lamont-Doherty Geological Observatory. In 1984, arrangements were made with the Federal Republic of Germany to place scientists from NMFS, Texas A&M, and University of Washington on the *RV Polarstern [FRG]* as part of the NMFS directed research program during the 1984 Austral summer. The primary objective of the cruise was to assess the biomass of krill in the Atlantic, Bransfield Strait, and Elephant Island regions.

In 1985, NMFS scientists collaborated with the Marine Mammal Commission to analyze historical whaling data from the Southern Hemisphere. This study's objective was to determine whether commercial catch records of blue, fin, sei, humpback, and minke whales provide any indication of possible traditional feeding grounds for krill-eating baleen whales in the Southern Ocean. An atlas was produced indicating the spatial and temporal distribution of baleen whale catches south of 40° S. latitude.

During the 1986-87 Antarctic summer season, a survey of Antarctic marine living resources was conducted in the vicinity of the Antarctic Peninsula and the fishing grounds around South Georgia. This survey aboard the Polish vessel *Professor Siedlecki* was designed to provide absolute and relative estimates of abundance independent of commercial fishery data, to provide information on life history parameters of fish stocks, and to provide the basis for examining interrelationships among fish and other ecosystem components. Hydroacoustic surveys of krill were made in the Bransfield Strait, King George and Elephant Island areas. Krill were distributed broadly over the area in low densities. A field party also collected bird and pinniped life history data at Seal Island.

The field season during 1987-88 used the same vessel and had similar objectives as the 1986-87 effort. Fish and krill surveys in the APISA were again conducted and the field station on Seal Island was occupied. During 1988-89, the NOAA ship *Surveyor* was used to survey fish stocks around South Georgia and conduct krill hydroacoustic surveys in the Elephant Island and Bransfield Strait areas (See Hewitt 1989[1]). Research plans for the 1989-90 field season are provided in Appendix 4.

3.3. Funding FY 1990

For FY 1990, the AMLR Program requested $2,000,000 and 180 sea days aboard a NOAA research vessel. Congress appropriated $1,300,000 and NOAA provided 122 sea days aboard the NOAA ship *Surveyor*. This enabled the United States to initiate a field program in support of the U.S. objectives for the Convention. The research effort concentrated on investigating critical ecological relationships among krill, predators (penguins and pinnipeds) and environmental factors (Appendix 4).

The funds were allocated ($ in thousands) as follows:

Stock assessments	
Fish	$100.1
Krill	443.9
Pinnipeds	198.0
Birds	221.0
Cetaceans	10.5
Subtotal	973.5
Environmental Conditions	
Oceanography	58.5
Primary Productivity	64.5
Subtotal	123.0
Management and Operational Support	213.7
Ship Charter[2]	0.0
Total	$1,300.0

[2]NOAA Ship *Surveyor* was utilized for 60 days in the study area, and 62 days in transit to and from the study area.

3.4. Funding FY 1991, FY 1992, and FY 1993

The projected annual cost for operating a balanced U.S. program of directed research for FY 1991 and outyears, is $2.0 million. The Program assumes allocation of 180 days (includes 60 days transit time) aboard a NOAA research vessel. If a NOAA vessel is unavailable, the estimated additional cost of a 180 day ship charter is $2.520 million. Adjusted figures are indicated for FY 1992 and FY 1993. Table 3.1 outlines the proposed budget allocations including the cost of major program elements.

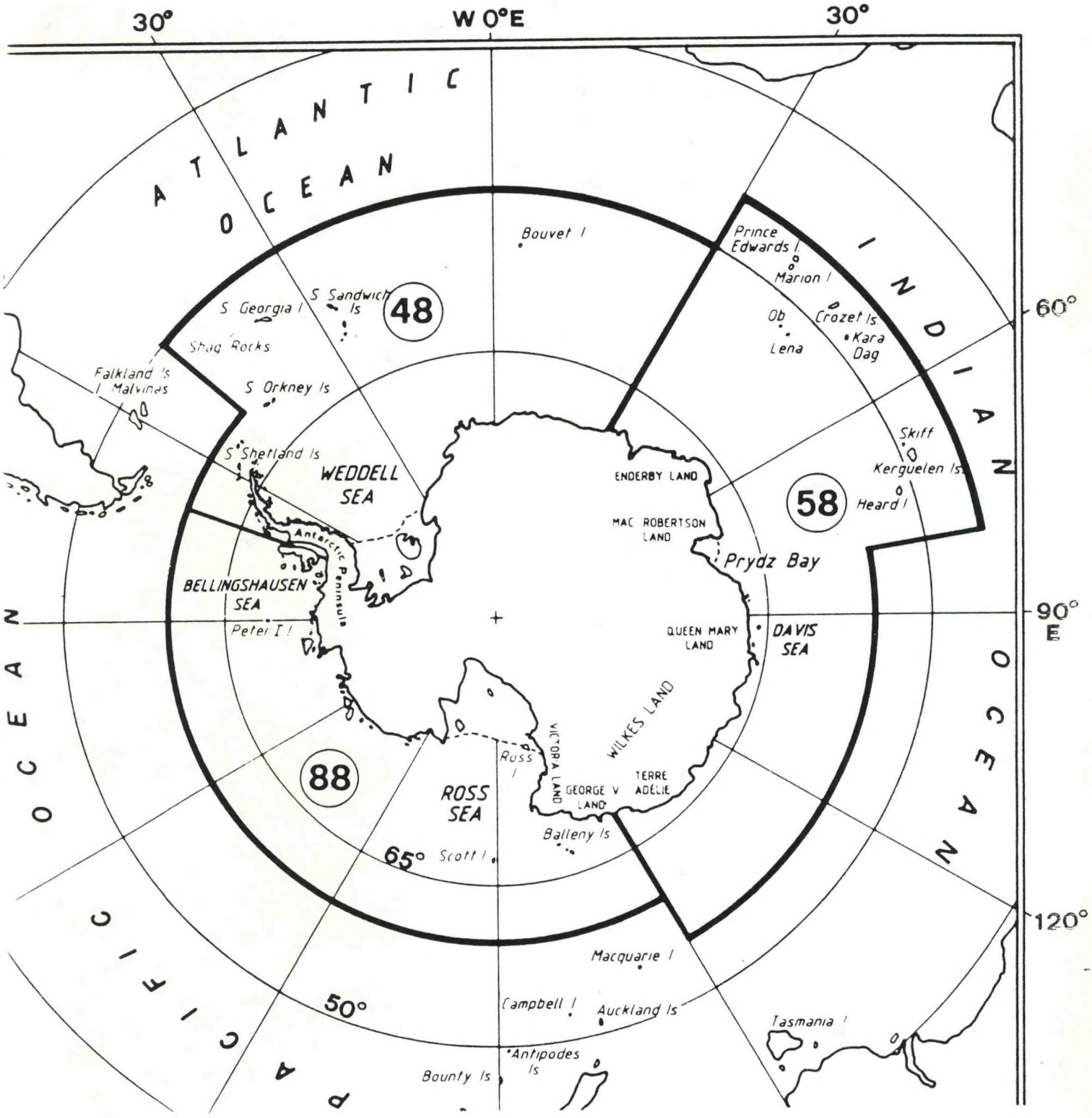

Figure 2. Southern Ocean and CCAMLR Convention Waters.

Table 3.1 Proposed AMLR Program Budget Allocation for FY 1991, FY 1992, and 1993. ($ in thousands)

Guidelines	FY 1991	FY 1992	FY 1993
Stock Assessment	$1,470	$1,544	$1,621
Regularly assess the direct and indirect effects of harvesting on the status and trends of Antarctic fish, krill, seals, birds, and whales.			
Environmental Conditions	280	294	309
Monitor physical oceanographic conditions for effects on the distribution, abundance, growth, and survival of krill and its predators and prey			
Management	250	263	276
Manage the AMLR Program utilizing the NMFS Program and Management System			
Ship Charter[1]	0	0	0
Use of a suitable ice-strengthened vessel for a field program and transit time of 180 days per year.			
Totals	$2,000	$2,100	$2,205

[1]U.S.AMLR Program assumes allocation of 180 days (includes 60 days transit time) aboard NOAA research vessel. If NOAA vessel is unavailable, the estimated cost of 180 days ship charter is an additional $2,520 K.

3.5 AMLR Program Vessel and Logistic Plans

The objectives of the AMLR Program necessarily requires Antarctic field work. Much of the directed research data being requested by the SC involves the collection of synoptic (within season) data from diverse projects, e.g., land-based, open water, and pack ice studies on prey, predators, and environmental conditions. The AMLR Program requires support of a dedicated vessel throughout the austral summer and possibly other seasons as appropriate. The vessels supporting the NSF program are currently being used at capacity. Additional ship support is required for the success of the AMLR Program.

The AMLR Program anticipates use of NOAA vessels, which are able to provide a suitable research platform, in: (1) open water situations, and (2) pack ice areas. Thus, a ship with an ice-strengthened hull is essential. The ship's design should provide for oceanographic winches and trawl gear. The vessel should meet the approximate specifications of the *RV Polar Duke* (the vessel employed by the NSF) given in Table 3.2.

The approximate amount of ship time projected by the AMLR Program in FY 1991, FY 1992, and FY 1993 is given in Table 3.3. Many of the field projects to be undertaken cannot be done simultaneously, and therefore individual studies would benefit from dedicated ship time. For example, the SC is coordinating fish stock assessment surveys on an agreed-upon standard protocol requiring dedicated vessel operations in predesignated sectors allocated to participating countries. The United States may be required to conduct such surveys in the Elephant Island, Bransfield Strait, and Scotia Sea regions. In addition, the United Kingdom is currently surveying the South Georgia area but may require assistance in performing replicate surveys to increase the precision of the estimates.

Other needs for dedicated vessel time include the unique requirements of pack-ice operations. Studies of predators in pack ice areas do not often follow regular cruise tracks, and therefore are difficult to integrate with projects designed around systematic assessments over large areas. Studies of land-breeding pinnipeds and seabirds require dedicated shiptime for surveys of various areas and for transportation between field sites ashore.

Table 3.2 Approximate minimum specifications for ice strengthened vessel for the AMLR Program.

Specifications

Beam:	43 feet	Length:	219 feet
Endurance:	90 days	Draft:	19 feet
Range:	25,000 nautical miles	Gross tonnage:	615 tons
Crew:	14	Displacement:	1,600 tons
Icebreaker classification: IAA		Science personnel: 26	
Engines:	Two diesels, each 2250 bhp	Bow and stern thrusters	
Propeller:	Controllable pitch, 240 rpm, in shrouded Kort nozzle		

Stern trawl capability
Covered deck area for processing samples

Major Science Equipment

Deep sea trawl winch (1/2-inch wire rope x 30,000 ft) and stern ramp with A-frame for nets and towed arrays
Hydrographic winch (1/4-inch wire x 12,000 ft)
Hydrographic winch (.322-inch conducting cable x 10,000 ft) Starboard side A-frame and platform
Crane: 22 tons (at 8 meters reach) or 12 tons (at 15 meters)
Crane: 1.5 tons (for boat launching)
Laboratories (four, totaling 900 sq. ft.)
110-volt and 220-volt 60-hertz electrical supply
Scuba gear van
Holding tanks (2x3x4 ft)
Zodiacs (two) with outboard motors
Precision depth recorder
Helicopter deck and maintenance capability

Communication and Navigation

Satellite communication: Racal SES-A1 (Comsat General MCS-9000) Satellite navigation receiver: Magnavox MX3102
Radios: single sideband, vhf, portable uhf, aero vhf Telephone: automatic, all cabins and mess rooms, with hailing Radar:
Decca RM 916 A/C-3cm
Decca TMS 1230C-10 cm true motion
Doppler log: Simrad NL

*The specifications listed are those of the *RV Polar Duke* currently employed by the NSF. The AMLR directed research program outlined here would not need a vessel as specifically outfitted as the *RV Polar Duke*.

Table 3.3 Estimated amount of dedicated ship time required for Antarctic field work by various components of the U.S. AMLR Program in FY 1991, FY 1992, and FY 1993. Transit times assume that the ship would originate in the continental United States. The dedicated period would be from mid-October through mid-April.

Operation	Number of days
Transit time: passage from USA to Antarctica.	30
Coastal survey: census of Antarctic fur seal and penguin colonies and support for offshore research near land-based sites in the ecosystem monitoring network.	10
Pack ice operations: 1) collecting data on food habits, reproduction, physiological condition, and age from crabeater and leopard seals for ecosystem monitoring, and 2) satellite and radio tracking of crabeater seals for feeding behavior, distribution, and stock separation data.	30
Pelagic and demersal operations: 1) assessments of variability in fish abundance, krill abundance in relation to fishery activities and predators and prey, 2) sampling of ichthyoplankton and zooplankton to assess variability in community structure, and 3) monitoring of changes in physical and chemical hydrographic features in relation to krill abundance.	70
Special operations: tasks for physical and chemical oceanography that cannot be done simultaneously with krill studies.	10
Transit time: passage from Antarctica to USA.	30
Total days estimated to be required:	180

4. PROGRAM MANAGEMENT

The U.S. AMLR Program is located in the National Marine Fishery Service's Southwest Fisheries Center (SWC) and is responsible to the Science and Research Director, Southwest Region (SWR). AMLR Program activities are managed by the Antarctic Ecosystem Research Group (AERG) located at the SWC's La Jolla, CA Laboratory. The Chief of the AERG manages the program following the sequence of events for program implementation and review as given in Appendix 5.

4.1. Antarctic Ecosystem Research Group Responsibilities

The AERG Chief's primary responsibility is to assist the Science and Research Director SWR in ensuring that the operational system functions effectively. The Program Plan, the Current Year Operating Plans (CYOP), and field activity reports constitute the basic documents by which the AERG monitors program status.

The Chief of the AERG also serves as the AMLR Chief Scientist. The Chief Scientist's responsibilities are to oversee design, implementation, and evaluation of the AMLR scientific program. He/she represents the United States at pertinent scientific meetings concerned with Antarctic ecosystem studies (e.g. Convention, ICES, SCAR, IWC, ACMRR) and serves as the Representative of the United States to the SC of the Commission.

The AERG scientific staff has the specific research functions summarized below:

- implement techniques and procedures necessary to insure maximum productivity and efficiency in field and laboratory studies;
- conduct field research to provide the data necessary to achieve research objectives;
- process and analyze data required for testing hypotheses; and
- evaluate program performance in relation to Convention objectives.

4.2. Antarctic Program Officer Responsibilities

The NMFS Senior Scientist for Fisheries in Washington, D.C. serves as the Antarctic Program Officer (APO). The APO provides liaison for Antarctic-related elements within the NMFS. These include international affairs, observation and inspection of fisheries vessels, legislative affairs and the AMLR Program, etc. He/she provides advice and assistance for the development and administration of AMLR Program policy and plans. The APO serves on the AMLR Advisory Board to formulate Program direction and policy. He/she and staff provide assistance at the Fisheries Headquarters level for issues involving the Office of International Affairs, the Office of Enforcement, State Department, and other federal agencies as required.

4.3. Data Management

All data collected as part of the AMLR Program are entered into the AMLR data archive and retrieval system located at the SWC. The AMLR data archive will be established with formats consistent with those developed by the CCAMLR Secretariat's Data Manager.

To provide information from this archive in a timely manner as needed by the Commission and the SC, the AMLR Chief Scientist will coordinate with the Data Manager and the Secretariat of the Commission. The AMLR data will be reformatted when necessary to be compatible with the Secretariat's data system requirements.

Appendix 1

CONVENTION ON THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

The Contracting Parties,

RECOGNIZING the importance of safeguarding the environment and protecting the integrity of the ecosystem of the seas surrounding Antarctica;

NOTING the concentration of marine living resources found in Antarctic waters and the increased interest in the possibilities offered by the utilization of these resources as a source of protein;

CONSCIOUS of the urgency of ensuring the conservation of Antarctic marine living resources;

CONSIDERING that it is essential to increase knowledge of the Antarctic marine ecosystem and its components so as to be able to base decisions on harvesting on sound scientific information;

BELIEVING that the conservation of Antarctic marine living resources calls for international co-operation with due regard for the provisions of the Antarctic Treaty and with the active involvement of all States engaged in research or harvesting activities in Antarctic waters;

RECOGNIZING the prime responsibilities of the Antarctic Treaty Consultative Parties for the protection and preservation of the Antarctic environment and, in particular, their responsibilities under Article IX, paragraph 1 (f) of the Antarctic Treaty in respect of the preservation and conservation of living resources in Antarctica;

RECALLING the action already taken by the Antarctic Treaty Consultative Parties including in particular the Agreed Measures or the Conservation of Fauna and Flora as well as the provisions of the Convention for the Conservation of Antarctic Seals;

BEARING in mind the concern regarding the conservation of Antarctic marine living resources expressed by the Consultative Parties at the Ninth Consultative Meeting of the Antarctic Treaty and the importance of the provisions of Recommendation IX-2 which led to the establishment of the present Convention;

BELIEVING that it is in the interest of all mankind to preserve the waters surrounding the Antarctic continent for peaceful purposes only and to prevent their becoming the scene or object of international discord;

RECOGNIZING, in the light of the foregoing, that it is desirable to establish suitable machinery for recommending, promoting, deciding upon and coordinating the measures and scientific studies needed to ensure the conservation of Antarctic marine

living organisms;

HAVE AGREED as follows:

ARTICLE I

1. This Convention applies to the Antarctic marine living resources of the area south of 600 South latitude and to the Antarctic marine living resources of the area between that latitude and the Antarctic Convergence which form part of the Antarctic Marine ecosystem.

2. Antarctic marine living resources means the populations of fin fish, mollusks, crustaceans. and all other species of living organisms, including birds,found south of the Antarctic Convergence

3. The Antarctic marine ecosystem means the complex of relationships of Antarctic marine living resources with each other and with their physical environment.

4. The Antarctic Convergence shall be deemed to be a line joining the following points along parallels of latitude and meridians of longitude:

   50^0S, 0^0, 50^0S, 30^0E, 45^0S, 30^0E, 80^0E
   55^0S, 80^0E, 55^0S, 150^0E, 60^0S, 150^0E, 60^0S, 50^0W
   50^0S, 50^0W, 50^0S, 0^0.

ARTICLE II

1. The objective of this Convention is the conservation of Antarctic marine living resources.

2. For the purposes of this Convention, the term "conservation" includes rational use.

3. Any harvesting and associated activities in the area to which this Convention applies shall be conducted in accordance with the provisions of this Convention and with the following principles of conservation:

   (a) prevention of decrease in the size of any harvested population to levels below those which ensure its stable recruitment. For this purpose its size should not be allowed to fall below a level close to that which ensures the greatest net annual increment;

   (b) maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources and the restoration of depleted populations to the levels defined in sub-paragraph (a) above;

   and

(c) prevention of changes or minimization of the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades, taking into account the state of available knowledge of the direct and indirect impact of harvesting, the effect of the introduction of alien species, the effects of associated activities on the marine ecosystem and of the effects of environmental changes, with the aim of making possible the sustained conservation of Antarctic marine living resources.

ARTICLE III

The Contracting Parties, whether or not they are Parties to the Antarctic Treaty, agree that they will not engage in any activities in the Antarctic Treaty area contrary to the principles and purposes of that Treaty and that, in their relations with each other, they are bound by the obligations contained in Articles I and V of the Antarctic Treaty.

ARTICLE IV

1. With respect to the Antarctic Treaty area, all Contracting Parties, whether or not they are Parties to the Antarctic Treaty, are bound by Articles IV and VI of the Antarctic Treaty in their relations with each other.

2. Nothing in this Convention and no acts or activities taking place while the present Convention is in force shall:

   (a) constitute a basis for asserting, supporting or denying a claim to territorial sovereignty in the Antarctic Treaty area or create any rights of sovereignty in the Antarctic Treaty area;

   (b) be interpreted as a renunciation or diminution by any Contracting Party of, or as prejudicing, any right or claim or basis of claim to exercise coastal state jurisdiction under international law within the area to which this Convention applies;

   (c) be interpreted as prejudicing the position of any Contracting Party as regards its recognition or nonrecognition of any such right, claim or basis of claim;

   (d) affect the provision of Article IV, paragraph 2, of the Antarctic Treaty that no new claim, or enlargement of an existing claim, to territorial sovereignty in Antarctica shall be asserted while the Antarctic Treaty is in force.

ARTICLE V

1. The Contracting Parties which are not Parties to the Antarctic Treaty acknowledge the special obligations and responsibilities of the Antarctic Treaty Consultative Parties for the protection and preservation of the environment of the Antarctic Treaty area.

2. The Contracting Parties which are not Parties to the Antarctic Treaty agree that, in their activities in the Antarctic Treaty area, they will observe as and when appropriate the Agreed measures for the Conservation of Antarctic Fauna and Flora and such other measures as have been recommended by the Antarctic Treaty Consultative Parties in fulfillment of their responsibility for the protection of the Antarctic environment from all forms of harmful human interference.

3. For the purposes of this Convention, "Antarctic Treaty Consultative Parties" means the Contracting Parties to the Antarctic Treaty whose Representatives participate in meetings under Article IX of the Antarctic Treaty.

ARTICLE VI

Nothing in this Convention shall derogate from the rights and obligations of Contracting Parties under the International Convention for the Regulation of Whaling and the Convention for the Conservation of Antarctic Seals.

ARTICLE VII

1. The Contracting Parties hereby establish and agree to maintain the Commission for the Conservation of Antarctic Marine Living Resources (hereinafter referred to as 'the Commission").

2. Membership in the Commission shall be as follows:

   (a) each Contracting Party which participated in the meeting at which this Convention was adopted shall be a Member of the Commission;

   (b) each State Party which has acceded to this Convention pursuant to Article XXIX shall be entitled to be a Member of the Commission during such time as that acceding Party is engaged in research or harvesting activities in relation to the marine living resources to which this Convention applies;

   (c) each regional economic integration organization which has acceded to this Convention pursuant to Article XXIX shall be entitled to be a Member of the Commission during such time as its States members are so entitled;

(d) a Contracting Party seeking to participate in the work of the Commission pursuant to sub-paragraphs (b) and (c) above shall notify the Depositary of the basis upon which it seeks to become a Member of the Commission and of its willingness to accept conservation measures in force. The Depositary shall communicate to each Member of the Commission such notification and accompanying information. Within two months of receipt of such communication from the Depositary, any Member of the Commission may request that a special meeting of the Commission be held to consider the matter. Upon receipt of such request, the Depositary shall call such a meeting. If there is no request for a meeting, the Contracting Party submitting the notification shall be deemed to have satisfied the requirements for Commission membership.

3. Each Member of the Commission shall be represented by one representative who may be accompanied by alternate representatives and advisers.

ARTICLE VIII

The Commission shall have legal personality and shall enjoy in the territory of each of the States Parties such legal capacity as may be necessary to perform its function and achieve the purposes of this Convention. The privileges and immunities to be enjoyed by the Commission and its staff in the territory of a State Party shall be determined by agreement between the Commission and the State Party concerned.

ARTICLE IX

1. The function of the Commission shall be to give effect to the objective and principles set out in Article II of this Convention. To this end, it shall:

   (a) facilitate research into and comprehensive studies of Antarctic marine living resources and of the Antarctic marine ecosystem;

   (b) compile data on the status of and changes in population of Antarctic marine living resources and on factors affecting the distribution, abundance and productivity of harvested species and dependent or related species or populations;

   (c) ensure the acquisition of catch and effort statistics on harvested populations;

   (d) analyse, disseminate and publish the information referred to in sub-paragraphs (b) and (c) above and the reports of the Scientific Committee;

   (e) identify conservation needs and analyse the effectiveness of conservation measures;

   (f) formulate, adopt and revise conservation measures on the basis of the best scientific evidence available, subject to the provisions of paragraph 5 of this Article;

   (g) implement the system of observation and inspection established under Article XXIV of this Convention;

   (h) carry out such other activities as are necessary to fulfil the objective of this Convention.

2. The conservation measures referred to in paragraph 1 (f) above include the following:

   (a) the designation of the quantity of any species which may be harvested in the area to which this Convention applies;

3. Conservation measures adopted by the Commission in accordance with this Convention shall be implemented by members of the Commission in the following manner:

   (a) the Commission shall notify conservation measures to all Members of the Commission;

   (b) conservation measures shall become binding upon all Members of the Commission 180 days after such notification, except as provided in sub-paragraphs (c) and (d) below;

(c) if a Member of the Commission, within ninety days following the notification specified in sub-paragraph (a), notifies the Commission that it is unable to accept the conservation measure, in whole or in part, the measure shall not, to the extent stated, be binding upon that Member of the Commission;

(d) in the event that any Member of the Commission invokes the procedure set forth in sub-paragraph (c) above, the Commission shall meet at the request of any Member of the Commission to review the conservation measure. At the time of such meeting and within thirty days following the meeting, any Member of the Commission shall have the right to declare that it is no longer able to accept the conservation measure, in which case the Member shall no longer be bound by such measure.

ARTICLE X

1. The Commission shall draw the attention of any State which is not a Party to this Convention to any activity undertaken by its nationals or vessels which, in the opinion of the Commission, affects the implementation of the objective of this Convention.

2. The Commission shall draw the attention of all Contracting Parties to any activity which, in the opinion of the Commission, affects the implementation by a Contracting Party of the objective of this Convention or the compliance by that Contracting Party with its obligations under this Convention.

(b) the designation of regions and sub-regions based on the distribution of populations of Antarctic marine living resources;

(c) the designation of the quantity which may be harvested from the populations of regions and sub-regions;

(d) the designation of protected species;

(e) the designation of the size, age and, as appropriate, sex of species which may be harvested;

(f) the designation of open and closed seasons for harvesting;

(g) the designation of the opening and closing of areas, regions or sub-regions for purposes of scientific study or conservation, including special areas for protection and scientific study;

(h) regulation of the effort employed and methods of harvesting, including fishing gear, with a view, inter alia, to avoiding undue concentration of harvesting in any region or sub-region;

(i) the taking of such other conservation measures as the Commission considers necessary for the fulfillment of the objective of this Convention, including measures concerning the effects of harvesting and associated activities on components of the marine ecosystem other than the harvested populations.

3. The Commission shall publish and maintain a record of all conservation measures in force.

4. In exercising its functions under paragraph 1 above, the Commission shall take full account of the recommendations and advice of the Scientific Committee.

5. The Commission shall take full account of any relevant measures or regulations established or recommended by the Consultative Meetings pursuant to Article IX of the Antarctic Treaty or by existing fisheries commissions responsible for species which may enter the area to which this Convention applies, in order that there shall be no inconsistency between the rights and obligations of a Contracting Party under such regulations or measures and conservation measures which may be adopted by the Commission.

ARTICLE XI

The Commission shall seek to co-operate with Contracting Parties which may exercise jurisdiction in marine areas adjacent to the area to which this Convention applies in respect of the conservation of any stock or stocks of associated species which occur both within those areas and the area to which this Convention applies, with a view to harmonizing the conservation measures adopted in respect of such stocks.

ARTICLE XII

1. Decisions of the Commission on matters of substance shall be taken by consensus. The question of whether a matter is one of substance shall be treated as a matter of substance.

2. Decisions on matters other than those referred to in paragraph 1 above shall be taken by a simple majority
of the Members of the Commission present and voting.

3. In Commission consideration of any item requiring a decision, it shall be made clear whether a regional economic integration organization will participate in the taking of the decision and, if so, whether any of its member States will also participate. The number of Contracting Parties so participating shall not exceed the number of member States of the regional economic integration organization which are Members of the Commission.

4. In the taking of decisions pursuant to this Article, a regional economic integration organization shall have only one vote.

ARTICLE XIII

1. The headquarters of the Commission shall be established at Hobart, Tasmania, Australia.

2. The Commission shall hold a regular annual meeting. Other meetings shall also be held at the request of one-third of its members and as otherwise provided in this Convention. The first meeting of the Commission shall be held within three months of the entry into force of this Convention, provided that among the Contracting Parties there are at least two States conducting harvesting activities within the area to which this Convention applies. The first meeting shall, in any event, be held within one year of the entry into force of this Convention. The Depositary shall consult with the signatory States regarding the first Commission meeting, taking into account that a broad representation of such States is necessary for the effective operation of the Commission.

3. The Depositary shall convene the first meeting of the Commission at the headquarters of the Commission. Thereafter, meetings of the Commission shall be held at its headquarters, unless it decides otherwise.

4. The Commission shall elect from among its members a Chairman and Vice-chairman, each of whom shall serve for a term of two years and shall be eligible for re-election for one additional term. The first Chairman shall, however, be elected for an initial term of three years. The Chairman and Vice-Chairman shall not be representatives of the same Contracting Party.

5. The Commission shall adopt and amend as necessary the rules of procedure for the conduct of its meetings, except with respect to the matters dealt with in Article XII of this Convention.

6. The Commission may establish such subsidiary bodies as are necessary for the performance of its functions.

ARTICLE XIV

1. The Contracting Parties hereby establish the Scientific Committee for the Conservation of Antarctic Marine Living Resources (hereinafter referred to as "the Scientific Committee") which shall be a consultative body to the Commission. The Scientific Committee shall normally meet at the headquarters of the Commission unless the Scientific Committee decides otherwise.

2. Each Member of the Commission shall be a member of the Scientific Committee and shall appoint a representative with suitable scientific qualifications who may be accompanied by other experts and advisers.

3. The Scientific Committee may seek the advice of other scientists and experts as may be required on an ad hoc basis.

ARTICLE XV

1. The Scientific Committee shall provide a forum for consultation and co-operation concerning the collection, study and exchange of information with respect to the marine living resources to which this Convention applies. It shall encourage and promote co-operation in the field of scientific research in order to extend acknowledge of the marine living resources of the Antarctic marine ecosystem.

2. The Scientific Committee shall conduct such activities as the Commission may direct in pursuance of the objective of this Convention and shall:

   (a) establish criteria and methods to be used for determinations concerning the conservation measures referred to in Article IX of this Convention;

   (b) regularly assess the status and trends of the populations of Antarctic marine living resources;

   (c) analyse data concerning the direct and indirect effects of harvesting on the populations of Antarctic marine living resources;

   (d) assess the effects of proposed changes in the methods or levels of harvesting and proposed conservation measures;

   (e) transmit assessments, analyses, reports and recommendations to the Commission as requested or on its own initiative regarding measures and research to implement the objective of this Convention;

   (f) formulate proposals for the conduct of international and national programs of research into Antarctic marine living resources.

3. In carrying out its functions, the Scientific Committee shall have regard to the work of other relevant technical and scientific organizations and to the scientific activities conducted within the framework of the Antarctic Treaty.

ARTICLE XVI

1. The first meeting of the Scientific Committee shall be held within three months of the first meeting of the Commission. The Scientific Committee shall meet thereafter as often as may be necessary to fulfil its functions.

2. The Scientific Committee shall adopt and amend as necessary its rules of procedure. The rules and any amendments thereto shall be approved by the Commission. The rules shall include procedures for the presentation of minority reports.

3. The Scientific Committee may establish, with the approval of the Commission, such subsidiary bodies as are necessary for the performance of its functions.

ARTICLE XVII

1. The Commission shall appoint an Executive Secretary to serve the Commission and Scientific Committee according to such procedures and on such terms and conditions as the Commission may determine. His term of office shall be for four years and he shall be eligible for reappointment.

2. The Commission shall authorize such staff establishment for the Secretariat as may be necessary and the Executive Secretary shall appoint, direct and supervise such staff according to such rules, and procedures and on such terms and conditions as the Commission may determine.

3. The Executive Secretary and Secretariat shall perform the functions entrusted to them by the Commission.

ARTICLE XVIII

The official languages of the Commission and of the Scientific Committee shall be English, French, Russian and Spanish.

ARTICLE XIX

1. At each annual meeting, the Commission shall adopt by consensus its budget and the budget of the Scientific Committee.

2. A draft budget for the Commission and the Scientific Committee and any subsidiary bodies shall be prepared by the Executive Secretary and submitted to the Members of the Commission at least sixty days before the annual meeting of the Commission.

3. Each Member of the Commission shall contribute to the budget. Until the expiration of five years after the entry into force of this Convention, the contribution of each Member of the Commission shall be equal. Thereafter the contribution shall be determined in accordance with two criteria: the amount harvested and an equal sharing among all Members of the Commission. The Commission shall determine by consensus the proportion in which these two criteria shall apply.

4. The financial activities of the Commission and Scientific Committee shall be conducted in accordance with financial regulations adopted by the Commission and shall be subject to an annual audit by external auditors selected by the Commission.

5. Each Member of the Commission shall meet its own expenses arising from attendance at meetings of the Commission and of the Scientific Committee.

6. A Member of the Commission that fails to pay its contributions for two consecutive years shall not, during the period of its default, have the right to participate in the taking of decisions in the Commission.

ARTICLE XX

1. The Members of the Commission shall, to the greatest extent possible, provide annually to the Commission and to the Scientific Committee such statistical, biological and other data and information as the Commission and Scientific Committee may require in the exercise of their functions.

2. The Members of the Commission shall provide, in the manner and at such intervals as may be prescribed, information about their harvesting activities, including fishing areas and vessels, so as to enable reliable catch and effort statistics to be compiled.

3. The Members of the Commission shall provide to the Commission at such intervals as may be prescribed information on steps taken to implement the conservation measures adopted by the Commission.

4. The Members of the Commission agree that in any of their harvesting activities, advantage shall be taken of opportunities to collect data needed to assess the impact of harvesting.

ARTICLE XXI

1. Each Contracting Party shall take appropriate measures within its competence to ensure compliance with the provisions of this Convention and with conservation measures adopted by the Commission to which the Party is bound in accordance with Article IX of this Convention.

2. Each Contracting Party shall transmit to the Commission information on measures taken pursuant to paragraph 1 above, including the imposition of sanctions for any violation.

ARTICLE XXII

1. Each Contracting Party undertakes to exert appropriate efforts, consistent with the Charter of the United Nations, to the end that no one engages in any activity contrary to the objective of this Convention.

2. Each Contracting Party shall notify the Commission of any such activity which comes to its attention.

ARTICLE XXIII

1. The Commission and the Scientific Committee shall co-operate with the Antarctic Treaty Consultative Parties on matters falling within the competence of the latter.

2. The Commission and the Scientific Committee shall co-operate, as appropriate, with the Food and Agriculture Organization of the United Nations and with other Specialized Agencies.

3. The Commission and the Scientific Committee shall seek to develop co-operative working relationships, as appropriate, with inter-governmental and non-governmental organizations which could contribute to their work, including the

Scientific Committee on Antarctic research, the Scientific Committee on Oceanic Research and the International Whaling Commission.

4. The Commission may enter into agreements with the organizations referred to in this Article and with other organizations as may be appropriate. The Commission and the Scientific Committee may invite such organizations to send observers to their meetings and to meetings of their subsidiary bodies.

ARTICLE XXIV

1. In order to promote the objective and ensure observance of the provisions of this Convention, the Contracting Parties agree that a system of observation and inspection shall be established.

2. The system of observation and inspection shall be elaborated by the Commission on the basis of the following principles:

   (a) Contracting Parties shall co-operate with each other to ensure the effective implementation of the system of observation and inspection, taking account of the existing international practice. This system shall include, inter alia, procedures for boarding and inspection by observers and inspectors designated by the Members of the Commission and procedures for flag state prosecution and sanctions on the basis of evidence resulting from such boarding and inspections. A report of sucK prosecutions and sanctions imposed shall be included in the information referred to in Article XXI of this Convention;

   (b) in order to verify compliance with measures adopted under this Convention, observation and inspection shall be carried out on board vessels engaged in scientific research or harvesting of marine living resources in the area to which this Convention applies, through observers and inspectors designated by the Members of the Commission and operating under terms and conditions to be established by the Commission;

   (c) designated observers and inspectors shall remain subject to the jurisdiction of the Contracting Party of which they are nationals. They shall report to the Member of the Commission by which they have been designated which in turn shall report to the Commission.

3. Pending the establishment of the system of observation and inspection, the Members of the Commission shall seek to establish interim arrangements to designate observers and inspectors and such designated observers and inspectors shall be entitled to carry out inspections in accordance with the principles set out in paragraph 2 above.

ARTICLE XXV

1. If any dispute arises between two or more of the Contracting Parties concerning the interpretation or application of this Convention, those Contracting Parties shall consult among themselves with a view to having the dispute resolved by negotiation, inquiry, mediation, conciliation, arbitration, judicial settlement or other peaceful means of their own choice.

2. Any dispute of this character not so resolved shall, with the consent in each case of all Parties to the dispute, be referred for settlement to the International Court of Justice or to arbitration; but failure to reach agreement on reference to the International Court or to arbitration shall not absolve Parties to the dispute from the responsibility of continuing to seek to resolve it by any of the various peaceful means referred to in paragraph 1 above.

3. In cases where the dispute is referred to arbitration, the arbitral tribunal shall be constituted as provided in the Annex to this Convention.

ARTICLE XXVI

1. This Convention shall be open for signature at Canberra from 1 August to 31 December 1980 by the States participating in the Conference on the Conservation of Antarctic Marine Living Resources held at Canberra from 7 to 20 May 1980.

2. The States which so sign will be the original signatory States of the Convention.

ARTICLE XXVII

1. This Convention is subject to ratification, acceptance or approval by signatory States.

2. Instruments of ratification, acceptance or approval shall be deposited with the Government of Australia, hereby designated as the Depositary.

ARTICLE XXVIII

1. This Convention shall enter into force on the thirtieth day following the date of deposit of the eighth instrument of ratification, acceptance or approval by States referred to in paragraph 1 of Article XXVI of this Convention.

2. With respect to each State or regional economic integration organization which subsequent to the date of entry into force of this Convention deposits an instrument of ratification, acceptance, approval or accession, the Convention shall enter into force on the thirtieth day following such deposit.

ARTICLE XXIX

1. This Convention shall be open for accession by any State interested in research or harvesting activities in relation to the marine living resources to which this Convention applies.

2. This Convention shall be open for accession by regional economic integration organizations constituted by sovereign States which include among their members one or more States Members of the Commission and to which the States members of the organization have transferred, in whole or in part, competences with regard to the matters covered by this Convention. The accession of such regional economic integration organizations shall be the subject of consultations among Members of the Commission.

ARTICLE XXX

1. This Convention may be amended at any time.

2. If one-third of the Members of the Commission request a meeting to discuss a proposed amendment, the Depositary shall call such a meeting.

3. An amendment shall enter into force when the Depositary has received instruments of ratification, acceptance or approval thereof from all the Members of the Commission.

4. Such amendment shall thereafter enter into force as to any other Contracting Party when notice of ratification,acceptance or approval by it has been received by the Depositary. Any such Contracting Party from which no such notice has been received within a period of one year from the date of entry into force of the amendment in accordance with paragraph 3 above shall be deemed to have withdrawn from this Convention.

ARTICLE XXXI

1. Any Contracting Party may withdraw from this Convention on 30 June of any year, by giving written notice not later than 1 January of the same year to the Depositary, which, upon receipt of such a notice, shall communicate it forthwith to the other Contracting Parties.

2. Any other Contracting Party may, within sixty days of the receipt of a copy of such a notice from the Depositary, give written notice of withdrawal to the Depositary in which case the Convention shall cease to be in force on 30 June of the same year with respect to the Contracting Party giving such notice.

3. Withdrawal from this Convention by any Member of the Commission shall not affect its financial obligations under this Convention.

ARTICLE XXXII

The Depositary shall notify all Contracting Parties of the following:

(a) signatures of this Convention and the deposit of instruments of ratification, acceptance, approval or accession;

(b) the date of entry into force of this Convention and of any amendment thereto.

ARTICLE XXXIII

1. This Convention, of which the English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Government of Australia which shall transmit duly certified copies thereof to all signatory and acceding Parties.

2. This Convention shall be registered by the Depositary pursuant to Article 102 of the Charter of the United Nations.

Drawn up at Canberra this twentieth day of May 1980.

IN WITNESS WHEREOF the undersigned, being duly; authorized, have signed this Convention.

ANNEX FOR AN ARBITRAL TRIBUNAL

The arbitral tribunal referred to in paragraph 3 of Article XXV shall be composed of three arbitrators who shall be appointed as follows:

The Party commencing proceedings shall communicate the name of an arbitrator to the other Party which, in turn, within a period of forty days shall communicate the name of the second arbitrator. The Parties shall, within a period of sixty days following the appointment of the second arbitrator, appoint the third arbitrator, who shall not be a national of either Party and shall not be of the same nationality as either of the first two arbitrators. The third arbitrator shall preside over the tribunal.

If the second arbitrator has not been appointed within the prescribed period, or if the Parties have not reached agreement within the prescribed period on the appointment of the third arbitrator, that arbitrator shall be appointed, at the request of either Party, by the Secretary-General of the Permanent Court of Arbitration, from among persons of international standing not having the nationality of a State which is a Party to this Convention.

The arbitral tribunal shall decide where its headquarters will be located and shall adopt its own rules of procedure.

The award of the arbitral tribunal shall be made by a majority of its members, who may not abstain from voting.

Any Contracting Party which is not a Party to the dispute may intervene in the proceedings with the consent of the arbitral tribunal. The award of the arbitral tribunal shall be final and binding on all Parties to the dispute and on any Party which intervenes in the proceedings and shall be complied with without delay. The arbitral tribunal shall interpret the award at the request of one of the Parties to the dispute or of any intervening Party.

Unless the arbitral tribunal determines otherwise because of the particular circumstances of the case, the expenses of the tribunal, including the remuneration of its members, shall be borne by the Parties to the dispute in equal shares.

APPENDIX 2

CONSIDERATION OF CONSERVATION MEASURES

Review of Existing Measures

76. The Commission agreed that Conservation Measures 2/III, 3/IV, 4/V, 5/V, 6/V and 7/V should remain in force as they stand. Conservation Measures 11/VII and 12/VII expired on 20 November 1989 and at the end of the 1988/89 season, respectively. As there was no consensus on the retention of Conservation Measure 1/III, it is no longer in force. Certain of these Conservation Measures were discussed further in the light of advice from the Scientific Committee.

77. The general fisheries management strategy of the Commission (CCAMLR-VI, paragraphs 59 to 65, 80 to 83; CCAMLR-VII, paragraphs 87, 88 and 90), has attempted to restore depleted populations and to limit fishing mortality to low levels of F, preferably $F_{0.1}$,

by means of some combination of TACs and protection for small fish. The protection for small fish would be achieved by some combination of:

(a) establishing a minimum mesh size that will allow small fish to escape capture;

(b) prohibiting fishing in certain areas where small fish are most likely to be caught; and

(c) prohibiting fishing during certain periods of time when small fish are most likely to be caught.

78. The situation of a species which while being protected to permit restoration, forms a by-catch in a directed fishery for another species, has been an additional and particular, source of concern.

79. The Commission had requested specific advice from the Scientific Committee on the topics set out in CCAMLR-VI, paragraph 84; CCAMLR-VII, paragraphs 113 to 116 and 118.

80. The Commission noted that the Scientific Committee had, through its WG-FSA, provided detailed advice in respect of:

(a) mesh size to effect specific potential levels of protection for juvenile fish;

(b) closed seasons;

(c) explicit comments in respect of Commission questions directed at the *C. gunnari*, *N. gibberifrons* and *N. rossii* fisheries;

(d) TACs based especially on the $F_{0.1}$ level of fishing mortality, but including advice in situations where this approach was judged inappropriate;

(e) general management advice on a wide variety of stocks and areas.

81. In respect of mesh selection, the Scientific Committee recommended (SC-CAMLR-VIII, paragraph 3.18) that the Commission consider introducing the following minimum mesh sizes for the commercial fisheries in Statistical Area 48:

(a) Subarea 48.3

(i) Fishery targeted at *C. gunnari*
80 mm, to protect immature fish, or
90 mm, to protect first spawners, or
100 mm, to give an age at first capture of 4 years;

(ii) Fishery targeted at *Patagonotothen brevicauda guntheri*
50 mm, to protect immature fish;

(iii) Mixed fishery (not targeted at *C. gunnari* or *P.b. guntheri*)
120 mm extended to include *N. gibberifrons*, *Chaenocephalus aceratus* and *P. georgianus* (in addition to *N. rossii* and *Dissostichus eleginoides*, which have had such a mesh regulation since 1984 - Conservation Measure 2/III), to ensure better protection of immature fish;

(b) Subareas 48.1 and 48.2
110 mm, to ensure protection of first spawners of *C. gunnari* and immature *N. gibberifrons*.

In addition, the Scientific Committee recommended inclusion of a provision prohibiting use of chafers and specifying that codends should be of diamond-shaped mesh with twine no thicker than 4.5 mm.

82. The Commission noted that it should have reached the point when the mesh size regulation, adopted in 1984, might be reviewed after five years of operation, on the basis of completed selectivity experiments. The Soviet Union indicated that it was unable to agree to new mesh size requirements additional to those which already existed in Conservation Measure 2/III. Therefore, no consensus could be reached on the implementation of the Scientific Committee's recommendations. The other Members of the Commission regretted this decision. It was further noted that lack of consensus and failure to act on the advice of the Scientific Committee does not encourage Members to undertake further costly experiments on mesh selectivity. However, there are still a number of questions to be solved including especially the construction of codends and their rigging etc. and escapement and survival rates of fish.

83. It was agreed that Conservation Measure 2/III should remain in force.

84. In respect of closed seasons to protect young fish and spawning grounds/aggregations, the Scientific Committee endorsed (SC-CAMLR-VIII, paragraph 3.66) the recommendation of the WG-FSA (SC-CAMLR-VIII, Annex 6, paragraph 198) that a closed season should operate from 1 March to the end of the Commission meeting.

85. The Commission noted this advice and that the original questions (CCAMLR-VII, paragraph 116) had been addressed to the *C. gunnari* fishery. It noted the desire of several Members of the Commission that the 1989/90 fishery should not start until 15 January 1990. Accordingly, the Commission agreed, without prejudice to future decisions about closed seasons, to close the *C. gunnari* fishery in Subarea 48.3 from 20 November 1989 to 15 January 1990 and from 1 April to 4 November 1990.

86. In respect of the Commission's questions concerning *N. gibberifrons* and *N. rossii* (CCAMLR-VII, paragraph 114 (ii)), the Commission noted that the Scientific Committee had advised that:

(a) The calculation of F_{max} is dependent on a particular equilibrium assumption of constant recruitment and hence is violated when recruitment declines. The priority for these stocks should be to facilitate recovery to a level where recruitment improves.

(b) Although juvenile *N. rossii* may be experiencing increased predation from Antarctic fur seals, *A. gazella*, low recruitment associated with low spawning stock size is the most likely cause of the currently low recruitment.

(c) Use of semipelagic or midwater trawls would reduce by-catch of *N. gibberifrons* and *N. rossii*. However, the use of midwater trawls might also result in increased targeting of the youngest age classes of *C. gunnari*.

(d) Persistent catch levels as high as four times TAC calculated from F_{max} will drive *N. gibberifrons* stocks to extinction.

87. In respect of the Commission's request (CCAMLR-VII, paragraph 114 (i)) for advice on the likely trajectories of *C. gunnari* catch, total biomass and spawning biomass and the effects of different patterns of fishing mortality, a summary of the conclusions of (and discussions about) the analyses addressing these questions is presented in paragraphs 67 to 71 of the WG-FSA Report (SC-CAMLR-VIII, Annex 6). The general conclusion (SC-CAMLR-VIII, Annex 6, paragraph 72) is that the two studies, although based on different

approaches, provide essentially similar advice with regard to the South Georgia *C. gunnari* fishery: that is, a pause of one to two years to let the spawning stock recover and thereafter a conservative fishing mortality rate not higher than $F_{0.1}$.

88. The Commission's discussion of the management advice provided by the Scientific Committee focussed on Statistical Area 48 generally and Subarea 48.3 in particular.

89. The Commission noted the difficulties the Scientific Committee had in providing agreed management advice recommending specific TACs and/or other measures to limit fishing mortality and protect juvenile fish. It recognized that this was because of:

(a) difficulties in reconciling the results of different approaches (e.g. UK/Polish surveys and USSR VPA analysis of *C. gunnari* in Subarea 48.3);

(b) lack of data to investigate the causes of historical fluctuations and apparent trends in catches (e.g. *C. gunnari* and *N. gibberifrons* in Subareas 48.1 and 48.2 and to a lesser extent *C. gunnari* in Subarea 48.3); and

(c) lack of current data on existing directed fisheries (e.g. *Electrona carlsbergi* and *D. eleginoides* in Subarea 48.3).

90. Concerning the state of fisheries in Statistical Area 48 as described in the WG-FSA and the Scientific Committee Reports, the view of most Members was that all available evidence indicated that restoration of significantly depleted stocks would best be achieved by a complete closure of all three subareas, and especially Subarea 48.3, to finfishing.

91. The Soviet Union expressed the opinion that an approach which examined individual stocks is adequate to ensure the conservation of fish resources.

92. Members reviewed the advice of the Scientific Committee on a stock by stock basis.

Champsocephalus gunnari in Subarea 48.3

93. The Commission examined the two assessments of the *C. gunnari* stock considered by the Scientific Committee and noted the large discrepancy between them. The Commission further noted that if the higher biomass estimate is in error, then a TAC set on this basis

will lead to a substantial depletion of the stock. However, if the lower biomass estimate is in error, then a TAC set on this basis will simply result in more, larger fish being available to the fishery the following year.

94. The Commission agreed a TAC for *C. gunnari* in Subarea 48.3 of 8 000 tonnes, being a TAC based on the lower biomass of $F_{0.1}$ plus an addition to allow for the area not covered in the survey which provided that biomass estimate.

Notothenia gibberifrons in Subarea 48.3

95. Taking account of the Scientific Committee's recommendation, the Commission agreed there would be no directed fishery for *N. gibberifrons* in Subarea 48.3 and by-catch would be restricted to not more than 300 tonnes.

96. It noted with concern, however, that in 1988/89 the by-catch of *N. gibberifrons* associated with a catch of *C. gunnari* of 21 359 tonnes in Subarea 48.3 was 838 tonnes. Such a catch was nearly twice the level at $F_{0.1}$.

Chaenocephalus aceratus and *Pseudochaenichthys georgianus* in Subarea 48.3

97. The Commission noted the endorsement by the Scientific Committee (SC-CAMLR-VIII, paragraph 3.37) of the advice of the WG-FSA (SC-CAMLR-VIII, Annex 6, paragraph 109) that no directed catches be taken and the by-catch reduced to a minimum to allow recoveries of these stocks.

Notothenia squamifrons in Subarea 48.3

98. The Commission noted with concern the Scientific Committee's comments about the absence of information from which to calculate a TAC or estimate a potential yield. It agreed that there should be no directed fishery for this species in the 1989/90 season.

99. In accordance with paragraphs 93 to 95 above, Conservation Measures 13/VIII, 14/VIII and 15/VIII were adopted.

Electrona carlsbergi in Subarea 48.3

100. The Commission noted with concern the 25-fold increase in catches between 1987 and 1989 and the absence of data made available on which to base stock assessment and management advice.

Patagonotothen brevicauda guntheri in Subarea 48.3

101. The Commission noted with concern the Scientific Committee's comments concerning the lack of adequate data for accurately assessing current stock size and the consequent difficulty in making specific management recommendations.

102. The Commission recollected that last year, in the absence of specific recommendations, it had decided to limit the catch of *P.b. guntheri* to a level between the catches of the previous two years. This year, in view of the fact that adequate management data was still unavailable, it was decided to set the catch limit at a slightly lower level; a TAC of 12 000 tonnes was agreed.

103. Conservation Measure 16/VIII was adopted.

Dissostichus eleginoides in Subarea 48.3

104. The Commission echoed the Scientific Committee's concern at the rapid rise in catch levels concurrent with the commencement of a longline fishery and the very limited data available for any estimation of stock size.

105. The Commission noted the advice of the Scientific Committee that a biomass figure of 40 000 tonnes, some five times the stock estimate obtained by the FRG survey in 1984/85 using a bottom trawl, provided a useful basis for setting a TAC. Applying a standard method to this figure gives a TAC of 1 200 tonnes.

106. Most Members of the Commission were of the view that this advice represents the best scientific evidence available, and hence should be useful to set a TAC. The USSR stated that the longline fishery takes senescent fish. Consequently, they did not agree that setting

any TAC for the longline fishery was justified. They stated that they would not increase the number of vessels taking part in the fishery by more than one or two above the six vessels used in the 1988/89 season.

107. The Commission reiterated its concern at the commencement of an unregulated fishery of a type known elsewhere in the World to cause substantial incidental mortality of seabirds (see paragraph 24 above).

108. As a result of this discussion, the Commission adopted Resolution 5/VIII.

109. The Commission agreed that past catch and effort data shall be submitted as a matter of urgency, using the format agreed by the Scientific Committee. Future catch and effort data shall be collected and submitted. The USSR also undertook to provide full biological data from the longline catches including age compositions, length compositions, age/length keys, age-maturity stage data and age-fecundity data.

Champsocephalus gunnari and *Notothenia gibberifrons* in Subareas 48.1 and 48.2

110. The Commission noted with concern that due to lack of data the Scientific Committee had been unable to recommend TACs for either species in either area.

111. In considering the data presented in the WG-FSA Report (SC-CAMLR-VIII, Annex 6, paragraph 128), for Subarea 48.2, many Members expressed the view that declines in catches of *C. gunnari* from 139 000 and 21 000 tonnes in the first two years of the fishery to an annual average of less than 3 000 tonnes over the last decade reflected a substantial decline in stock and merited protective management action.

112. The Soviet Union expressed the view that because of this species' sporadic occurrence in the area, no catch limit was required.

113. A similar divergence of views prevailed in respect of Subarea 48.1.

114. It was agreed, however, that stocks of *N. gibberifrons* in Subareas 48.1 and 48.2 were at a level where protective measures were necessary. The Commission agreed to adopt a resolution urging all parties to refrain from directed fishing on *N. gibberifrons* in Subareas 48.1 and 48.2 and to ensure that by-catch of *N. gibberifrons* in directed fishing for other species be avoided.

115. Resolution 6/VIII was adopted.

General Considerations

116. A central consideration in setting the TACs for Subarea 48.3, particularly in view of the low catch figures involved, was a concern to limit as far as possible by-catches of already depleted species. To this end the Commission agreed to adopt a Catch Reporting System for catches and by-catches in Subarea 48.3 based on five-day reporting periods.

117. Conservation Measure 17/VIII was adopted.

118. Throughout this review, great difficulty was experienced in reconciling two opposing views. The first, held by most Members, was that in the absence of more detailed historical and current biological data, which should have been available from the fishery, thus allowing the WG-FSA to make stock assessments and provide management advice, it was prudent to set conservative TACs and provide as much protection as possible for juvenile fish.

119. The other view, held by the Soviet Union, was that in the absence of more detailed historical and current biological data from fishing vessels, management procedures should not be enacted.

120. The Commission noted that this contradiction, which formed a fundamental obstruction to its management responsibilities, seemed likely to persist either until all available historical and current data were provided or it was accepted that, in the absence of data which can only be provided by fishing nations, precautionary measures become essential.

121. The Commission welcomed the offer of the USSR to organize an international collaborative survey in the 1989/90 season in Subarea 48.3. In this regard, attention was drawn to plans for a UK/Polish survey in the same region in January 1990. Details of these two surveys would be discussed by principal scientists and the Convener of the WG-FSA and the proposed survey plans sent to the Secretariat in advance of the commencement of the surveys.

122. In connection with the avoidance of by-catch, the Commission recalled the advice of the Scientific Committee that the use of semipelagic or midwater trawls for *C. gunnari* would reduce the by-catch of *N. rossii* and *N. gibberifrons* (SC-CAMLR-VIII, Annex 6,

paragraph 193). It also noted the additional statements concerning whether or not this change in gear and fishing practice might target young age classes of *C. gunnari* (SC-CAMLR-VIII, Annex 6, paragraph 193 and SC-CAMLR-VIII, paragraph 3.67). The Commission agreed to prohibit the use of bottom trawls in Subarea 48.3.

123. Some Members expressed the view that developing fisheries should be subject to some form of regulation and that to meet the objectives of CCAMLR, fishery development should not proceed faster than development of the data base necessary to assess the effects of harvesting on target, dependent, and associated species. The Commission therefore requested that the Scientific Committee provide advice on:

(a) the types of information needed to characterize and estimate the potential yield of unexploited and under-exploited fishery resources;

(b) the types of information needed to determine an initial threshold level above which catches should not be allowed to increase without programs in place to assess the effects of the catches, including by-catch, on target, dependent and associated species;

(c) how the needed baseline information can best be obtained;

(d) how the developing fishery might best be regulated in order to identify and efficiently achieve, but not exceed the maximum catch levels consistent with Article II of the Convention.

(e) how the identified information needs might best be met; and

(f) how long it might take to acquire the required knowledge.

CONSERVATION MEASURE 13/VIII
Limitation of the Total Catch of *Champsocephalus gunnari*
in Statistical Subarea 48.3 in the 1989/90 Season

124. The Commission, in accordance with Conservation Measure 7/V, hereby adopts the following Conservation Measure in accordance with Article IX of the Convention:

1. The total catch of *Champsocephalus gunnari* in the 1989/90 season shall not exceed 8 000 tonnes in Statistical Subarea 48.3.

2. The by-catch of any of the following species: *Notothenia rossii*, *Notothenia gibberifrons*, *Chaenocephalus aceratus* and *Pseudochaenichthys georgianus* in Statistical Subarea 48.3 shall not exceed 300 tonnes.

3. The fishery in Statistical Subarea 48.3 shall close if the by-catch of any of the species named in paragraph 2 above reaches 300 tonnes or if the total catch of *Champsocephalus gunnari* reaches 8 000 tonnes, whichever comes first.

4. If, in the course of the directed fishery for *Champsocephalus gunnari*, the by-catch of any one haul of any of the species named in paragraph 2 above exceeds 5%, the fishing vessel shall move to another fishing ground within the subarea.

5. The use of bottom trawls in the directed fishery for *Champsocephalus gunnari* in Statistical Subarea 48.3 is prohibited.

6. For the purpose of implementing paragraphs 1, 2 and 3 of this Conservation Measure, the Catch Reporting System set out in Conservation Measure 17/VIII shall apply in the 1989/90 season.

CONSERVATION MEASURE 14/VIII
Prohibition of Directed Fishery on *Notothenia gibberifrons*, *Chaenocephalus aceratus*, *Pseudochaenichthys georgianus* and *Notothenia squamifrons* in Statistical Subarea 48.3 in the 1989/90 Season

125. The Commission, in accordance with Conservation Measure 7/V, hereby adopts the following Conservation Measure in accordance with Article IX of the Convention:

Directed fishing on *Notothenia gibberifrons*, *Chaenocephalus aceratus*, *Pseudochaenichthys georgianus* and *Notothenia squamifrons* in Statistical Subarea 48.3 is prohibited in the 1989/90 season.

CONSERVATION MEASURE 15/VIII
Closed Seasons in the 1989/90 Season
in Statistical Subarea 48.3

126. The Commission, in accordance with Conservation Measure 7/V, hereby adopts the following Conservation Measure in accordance with Article IX of the Convention:

Directed fishing on *Champsocephalus gunnari* between 20 November 1989 and 15 January 1990 and between 1 April and 4 November 1990 is prohibited. During those periods *Champsocephalus gunnari*, *Notothenia rossii*, *Notothenia gibberifrons*, *Chaenocephalus aceratus*, *Pseudochaenichthys georgianus* and *Notothenia squamifrons* shall not be taken in Statistical Subarea 48.3 except for scientific research purposes.

CONSERVATION MEASURE 16/VIII
Catch Limit on *Patagonotothen brevicauda guntheri*
in Statistical Subarea 48.3 for the 1989/90 Season

127. The Commission, in accordance with Conservation Measure 7/V, hereby adopts the following Conservation Measure in accordance with Article IX of the Convention:

The catch of *Patagonotothen brevicauda guntheri* in Statistical Subarea 48.3 in the 1989/90 season shall be limited to 12 000 tonnes. For the purpose of implementing this Conservation Measure the Catch Reporting System set out in Conservation Measure 17/VIII shall apply in the 1989/90 season.

CONSERVATION MEASURE 17/VIII
Catch Reporting System in Statistical Subarea 48.3
in the 1989/90 Season

128. The Commission, in accordance with Conservation Measure 7/V, hereby adopts the following Conservation Measure in accordance with Article IX of the Convention:

1. For the purposes of this Catch Reporting System the calendar month shall be divided into six reporting periods, viz: day 1 to day 5, day 6 to day 10, day 11 to

day 15, day 16 to day 20, day 21 to day 25 and day 26 to the last day of the month. These reporting periods are hereinafter referred to as periods A, B, C, D, E and F.

2. At the end of each reporting period, each Contracting Party shall obtain from each of its vessels its total catch for that period and shall, by cable or telex, transmit the aggregated catch for its vessels so as to reach the Executive Secretary not later than the end of the next reporting period.

3. Such reports shall specify the month and reporting period (A, B, C, D, E or F) to which each report refers.

4. Immediately after the deadline has passed for receipt of the reports for each period, the Executive Secretary shall notify all Contracting Parties of the total catch taken during the reporting period, the total aggregate catch for the season to that date, together with an estimate of the date upon which the total allowable catch is likely to be reached for that season. Each estimate shall be based on a projection forward of the average daily catch rate (calculated as the total catch by all contracting parties divided by the number of days in the period) for the most recent period based on the reports received for the period in question, to the point at which the total allowable catch will have been taken.

5. When the Executive Secretary has received reports which show that 90% of the total allowable catch has been taken, the Executive Secretary shall make a final estimate of the date upon which the total allowable catch will be reached. The fishery shall close at the end of the last day of the reporting period within which that date falls.

RESOLUTION 5/VIII

Protection of Seabirds from Incidental Mortality Arising from Longline Fishing

129. The Commission took note of the recent introduction of longline fishing in the CCAMLR Convention Area. It expressed its concern that fishing with this technique could cause substantial incidental mortality of seabirds.

130. In this connection the Commission:

(a) takes note of the intention of the Soviet Union not to increase, by more than one or two vessels, the number of its vessels engaged in longline fishing on *Dissostichus eleginoides* in Subarea 48.3 in the 1989/90 season;

(b) recalls that techniques have been developed and are being used on a trial basis in other longline fisheries, such as in the tuna longline fishery in the South West Pacific, to minimize incidental mortality of seabirds; and

(c) urges all parties to the Convention conducting longline fishing in the CCAMLR Convention Area to investigate and introduce as soon as possible methods to minimize incidental mortality to seabirds arising from the use of longline fishing techniques.

RESOLUTION 6/VIII

Protection of *Notothenia gibberifrons* in the Peninsula Area
(Statistical Subarea 48.1) and Around South Orkneys
(Statistical Subarea 48.2)

131. The Commission recognized that it was important that fishing mortality in *Notothenia gibberifrons* should, as a precautionary measure, be minimized. To this end the Commission requests all parties to the Convention to keep the catch of *Notothenia gibberifrons* in the Peninsula Area (Statistical Subarea 48.1), and around South Orkneys (Statistical Subarea 48.2), in the season 1989/90 to the lowest possible level.

132. To this end the Commission requests all parties to the Convention in the 1989/90 season:

(a) to refrain from directed fishing for *Notothenia gibberifrons* ; and

(b) to ensure that by-catch of *Notothenia gibberifrons* in directed fishing for other species be avoided.

133. At the conclusion of the Commission's consideration of this agenda item, the Convener of the WG-FSA, Dr K.-H. Kock, FRG, was given the opportunity to make a statement. A copy of his statement is included in this report as Annex F.

APPENDIX 3

REPORT OF THE EIGHTH MEETING OF THE SCIENTIFIC COMMITTEE

OPENING OF THE MEETING

1.1* The Scientific Committee for the Conservation of Antarctic Marine Living Resources met under the Chairmanship of Dr Inigo Everson (UK) from 6 to 10 November, 1989 at the Wrest Point Hotel, Hobart, Australia.

1.2 Representatives from the following Members attended the meeting: Argentina, Australia, Belgium, Brazil, Chile, European Economic Community, France, German Democratic Republic, Federal Republic of Germany, India, Japan, Republic of Korea, New Zealand, Norway, Poland, South Africa, Spain, Union of Soviet Socialist Republics, United Kingdom and United States of America.

1.3 At the invitation of the Scientific Committee, representatives from the Intergovernmental Oceanographic Commission (IOC) and the Scientific Committee on Antarctic Research (SCAR) attended the meeting as observers. Observers from the acceding states of Italy, Peru, Sweden and Uruguay participated by invitation.

1.4 Observers were welcomed and encouraged to participate, as appropriate, in discussion of agenda items 2 through 9.

1.5 A list of participants is at Annex 1. A list of documents considered during the session is at Annex 2.

1.6 Responsibility for the preparation of the Scientific Committee's Report was assigned to the following rapporteurs: Mr D. Miller (South Africa), krill resources and squid resources; Dr J. Beddington, (UK) fish resources; Dr J. Croxall (UK), ecosystem monitoring and management; Dr J. Bengtson (USA) marine mammal and bird populations; and Mr P. Heyward (Australia) all other items.

* The first part of the number relates to the appropriate item of the agenda (see Annex 3).

ADOPTION OF THE AGENDA

1.7 The Chairman noted that as a result of discussion with the Convener of the Commission's Working Group for the Development of Approaches to Conservation of Antarctic Marine Living Resources (WG-DAC), Australia, an additional item "Development of Approaches to Conservation of Antarctic Marine Living Resources" was proposed after the preparation and distribution of the Preliminary Agenda. Explanatory notes had been distributed to Members as required.

1.8 The Provisional Agenda for the meeting had been circulated to Members in accordance with the Rules of Procedure. No amendments to the Provisional Agenda were proposed and the Agenda was adopted (Annex 3).

REPORT OF THE CHAIRMAN

1.9 The Chairman noted that Members had continued their work during the intersessional period with several meetings taking place. He thanked the conveners, rapporteurs, participants, host countries and the Secretariat for contributing to the success of these meetings.

1.10 A Workshop on the Krill CPUE Simulation Study (WS-KCPUE) was held at the Southwest Fisheries Centre, La Jolla, USA from 7 to 13 June 1989 (Convener, Dr J. Beddington, UK) and a meeting of the Working Group on Krill (WG-Krill) at the same venue from 14 to 20 June 1989 (Convener, Mr D. Miller, South Africa). The Report of the Workshop was distributed as SC-CAMLR-VIII/3. The Report of the Working Group meeting was distributed as SC-CAMLR-VIII/4 and a report on the meeting by the Convener as SC-CAMLR-VIII/5.

1.11 The Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP) met in Mar del Plata, Argentina from 23 to 30 August 1989 (Convener, Dr K. Kerry, Australia). The Report of the meeting was distributed as SC-CAMLR-VIII/6.

1.12 The Working Group on Fish Stock Assessment met in Hobart, Australia from 25 October to 2 November 1989 (Convener, Dr K.-H. Kock, FRG). The Report of the meeting was distributed as SC-CAMLR-VIII/7.

2.2 The total krill catch by Statistical Area and year since 1973 is illustrated in the Figure 2.1.

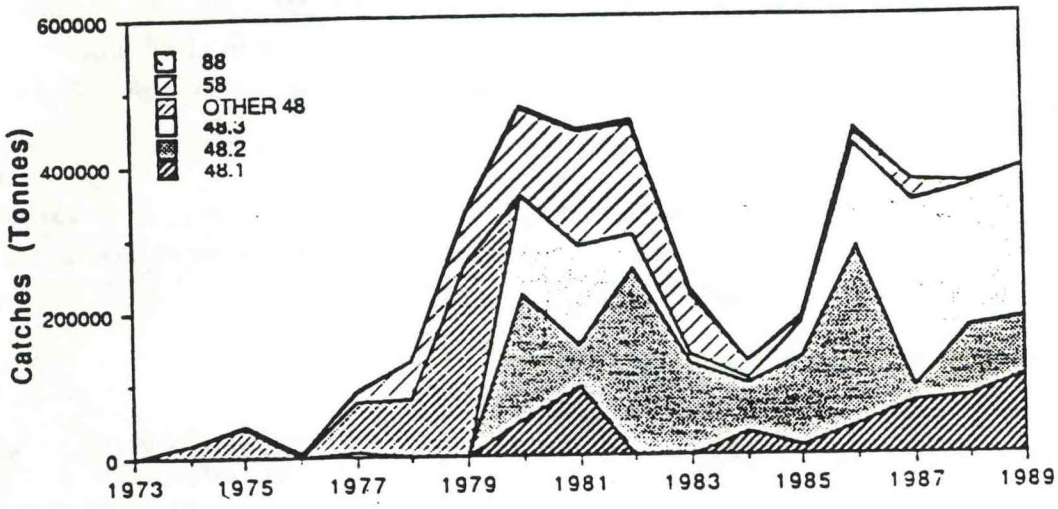

Figure 2.1: Total krill catches from 1973 to 1989. ("Other 48" refers to catches from Statistical Area 48 not allocated to Subareas 48.1, 48.2 or 48.3.)

2.3 An analysis of the 1988/89 landings by area indicated an increase in total catches from Statistical Area 48 compared with the previous year. In this regard, Soviet catches in Subareas 48.1 and 48.3 increased by approximately 20 000 and 15 000 tonnes respectively, while in Subarea 48.2 they decreased by about 13 000 tonnes (see paragraph 2.6).

2.4 In contrast to the above, there was a marked decrease of catches (from 6 490 to 217 tonnes) taken in Subarea 58.4.

2.5 With the exception of Soviet catches, which increased by some 16 600 tonnes, i.e. 6%, krill catches by most nations were similar to 1987/88 levels, although both Japanese and Polish catches increased by 5 816 tonnes, i.e. 8% and 2 656 tonnes, i.e. 50% respectively.

2.6 The total Soviet krill catch (301 498 tonnes) by area during 1988/89 was as follows:

Subarea 48.1	20 875	(0 tonnes in 1987/88)
Subarea 48.2	76 494	(89 888 tonnes in 1987/88)
Subarea 48.3	203 912	(188 391 tonnes in 1987/88)
Statistical Area 88	0	(0 tonnes in 1987/88)
Subarea 58.4	217	(6 490 tonnes in 1987/88)

2.7 Dr T. Lubimova (USSR) indicated that the increase in Soviet catches in Subarea 48.3 was as a result of the sustained presence of fishable krill concentrations in summer and autumn over the South Georgia continental slope. This was a result of the dynamics of the water circulation during the 1988/89 split-year.

2.8 Dr Lubimova indicated that for processing reasons, a priority target in krill fishing operations is krill that had not been feeding recently. Aggregations of such krill are particularly characteristic of Subarea 48.3 in the summer and autumn.

2.9 As indicated during last year's Scientific Committee meeting (SC-CAMLR-VII, paragraph 2.7), Dr Lubimova further emphasized that the continued reduction of Soviet catches in Subarea 58.4 could be attributed to unfavourable ice conditions.

2.10 In this context, Dr Y. Shimadzu (Japan) reported that the confinement of the Japanese fishery to Subareas 48.1, 48.2 and 58.4 (particularly Subarea 48.1) since 1984 was essentially the result of logistical constraints resulting from the re-direction of fishing operations from geographical areas immediately adjacent to the Convention Area.

2.11 Papers distributed at the meeting dealt with: commercial krill fishing in the Convention Area (SC-CAMLR-VIII/BG/11), the determination of krill acoustic target strength (SC-CAMLR-VIII/BG/30), the long-term distribution of krill fishing in Statistical Area 58 (SC-CAMLR-VIII-BG/21), the analysis of fine-scale data reported to the Commission (SC-CAMLR-VIII/BG/43 and 44) and Japanese krill fisheries research (SC-CAMLR-VIII/BG/28, 29, 30, 31 and 52). Dr Lubimova drew attention to various Soviet papers dealing with aspects of Soviet fishing operations and krill biology in general. Topics considered in these papers were concerned with catchability by krill trawls (SC-CAMLR-VIII-BG/9), the assessment of krill biomass in fishing grounds (SC-CAMLR-VIII/BG/4, 5, 7 and 10) and the analysis of the operating conditions of fishing vessels with respect to krill distribution, biology and behaviour (SC-CAMLR-VIII/BG/23).

Various other Soviet papers dealt with the biology of krill in general (SC-CAMLR-VIII/BG/22 and 24) and population dynamics with relation to development of the fishery (SC-CAMLR-VIII/BG/21). It was agreed that detailed consideration of such papers should be referred to the next meeting of the WG-Krill (see paragraph 2.29 below).

2.12 Most krill fishing nations indicated that recent trends (i.e. slight increases or decreases in catches from year to year) would continue. In this regard, Dr Shimadzu indicated that the limited market potential of krill tail meat in Japan is likely to keep Japanese krill catches at more or less current levels. Dr Lubimova reported that recent technological advances in the Soviet Union had been made with respect to the processing of krill for human consumption and that there was some likelihood that the total krill catch from Soviet fishing would increase as operations were broadened into Statistical Areas 58 and 88 in the near future.

REPORT OF THE WORKSHOP ON THE KRILL CPUE SIMULATION STUDY (WS-KCPUE)

2.13 Dr J. Beddington (UK), Convener of the CPUE Simulation Study, briefly outlined the results of the Workshop on the Krill CPUE Simulation Study (Annex 4) held at the Southwest Fisheries Centre, La Jolla, USA between 7 and 13 June 1989.

2.14 The Workshop provided the opportunity for participants to work closely with the CCAMLR appointed consultants (Dr M. Mangel, University of California, Davis and Prof. D.S. Butterworth, University of Capetown) on the details of their simulations/analyses of Soviet krill survey and Japanese krill fishing operations.

2.15 Recognizing limitations associated with the absence of Soviet participation in the Workshop, a substantial amount of work had been done and various conclusions reached (Annex 4, paragraphs 17 to 28). In brief, it was concluded that although the Soviet and Japanese fisheries operate in different ways, various types of catch and effort data could be utilized to obtain a Composite Index of Krill Abundance. As such, this Composite Index could be constructed from information on krill concentrations derived from USSR survey vessels and krill abundance within concentrations from Japanese fishing vessels. However, the Workshop concluded that the application of this Composite Index of Abundance is currently limited due to the small area of operation of the Japanese fishery.

2.16 The Workshop strongly emphasized that care needs to be exercised in the evaluation of the Composite Index as many of the component variables do not change in proportion to krill

abundance and in addition there are considerable uncertainties with respect to how many of these variables can be best estimated. The Workshop felt, therefore, that in order to improve the applicability of the Composite Index, the collection of relevant data should, as far as possible, follow standard procedures. Furthermore, a number of suggestions were made in this regard. The Workshop agreed that certain within-krill concentration parameters (e.g. swarm size, number of swarms per unit area of concentration and inter-swarm distance) are essential for the monitoring of krill abundance and the necessary data would be best collected acoustically.

2.17 The Workshop therefore recommended the following:

(a) survey vessels operating in support of a fishing fleet should collect data in accordance with a recommended bridge log format (Annex 4, Appendix 5) and that data so obtained should be analyzed to provide estimates of the size and type of krill concentrations along the lines suggested in WS-KCPUE-89/5;

(b) all catching vessels should collect haul-by-haul data in the same way as is currently done by the Japanese fishery;

(c) haul-by-haul data should be analyzed to provide appropriate indices of krill abundance based on catch-per-unit searching time within krill concentrations by ten-day reporting period;

(d) the above analytical procedures should be conducted on a trial basis and reviewed after three years; and

(e) acoustic data should be used to better determine swarm size, number of swarms per unit area of concentration and inter-swarm distance within concentrations.

2.18 Dr Lubimova expressed the view that the potential utility of the Soviet research vessel data which were used to construct the model of commercial fishing operations was limited because these vessels are not operating in support of the fishery activities. In addition, a number of Soviet documents tabled at the present meeting (specifically SC-CAMLR-VIII/BG/8, 10, 21 and 23) indicated the possibility that several alternative variables could be utilized to improve current understanding and simulations of fishing operations in relation to krill abundance and distribution. Information gathered by scientists aboard Soviet fishing vessels has indicated that such information will be more objectively defined and useful than data from research vessels operating in a pre-determined

way and independently of fishing vessels. Dr Lubimova also indicated that data routinely collected aboard Soviet fishing vessels were difficult to validate as it had been gathered in an unscientific manner and, as a result, its application is limited.

2.19 A further important conclusion of the Workshop was that the general properties of the Composite Index were such that small changes in krill abundance were unlikely to be detected, but any statistically significant change in the Composite Index would imply that a major change in krill abundance had occurred. Although it was possible to deduce the general properties of the Composite Index, the Workshop recognized that a detailed understanding of the quantitative behaviour of the Composite Index is required. Accordingly, the Workshop recommended that the sensitivity of the Composite Index to variation in parameter values should be further investigated. In this connection, certain delegations felt that it was rather premature to commence evaluation of the sensitivity of the Composite Index to changes in abundance in a mechanistic way and in the absence of a better understanding of certain critical biological properties of the krill population(s) being considered (e.g. seasonal emigration or immigration from or into specific geographical areas).

2.20 With respect to the views expressed in paragraphs 2.17 and 2.18 above, it was agreed that there would be considerable merit to be gained by considering the recommendations of the Workshop in combination with those from the First Meeting of the WG-Krill (see paragraphs 2.24 to 2.36 below).

2.21 The Scientific Committee thanked Dr Beddington for organizing the study and for its conduct over the past few years and for convening the concluding Workshop and Study as a whole.

REPORT OF THE WORKING GROUP ON KRILL (WG-KRILL)

2.22 The terms of reference of the WG-Krill (SC-CAMLR-VII, paragraph 2.26) and the objectives for its first meeting (SC-CAMLR-VII, paragraph 2.29) were agreed at last year's meeting of the Scientific Committee.

2.23 The Working Group met directly after (14 to 20 June 1989) the WS-KCPUE and at the same venue. The Convener, Mr D. Miller (South Africa) briefly outlined the topics addressed and conclusions resulting from the meeting (Annex 5 and SC-CAMLR-VIII/5).

2.24 In brief, the Working Group

- reviewed available data on, and techniques to determine, krill abundance and distribution;
- defined various scales of krill distribution and developed broad definitions of the types of krill concentration most frequently fished;
- acknowledged the potential utility and limitations of the Composite Index of Krill Abundance developed by the WS-KCPUE to monitor changes in krill abundance;
- reviewed available information on current and historic patterns in commercial krill catch levels as well as the distribution of fisheries activities;
- highlighted the importance of Statistical Area 48 as a whole to the krill fishery;
- made various recommendations concerning the analysis and collection of krill fisheries data, particularly length frequency distribution data from commercial catches; and
- repeatedly emphasized the importance of studying predator-krill interactions in the context of estimating the possible impact of fishing on krill-dependent predators.

2.25 The Working Group also recognized that the Krill CPUE Simulation Study had done much to focus attention on the more pertinent aspects of data necessary for monitoring effects of fishing on krill distribution and abundance. As such, the major factors introducing variance into the estimation of krill distribution and abundance were considered by the Working Group to depend on the size of the area being considered. Similarly, the applicability of available estimation techniques is also a function of the scale(s) over which the process being investigated operates.

2.26 The Scientific Committee discussed the Reports of the WG-Krill and the WS-KCPUE meetings which Soviet scientists were unable to attend for reasons beyond their control. The discussions focussed on the practicality of collecting specific data and on the constraints associated with their validation and potential utility. As a general principle, it was agreed

that haul-by-haul data from survey, research and commercial fishing vessels would provide information essential to improving current understanding of krill distribution/abundance in relation to krill fishing operations.

2.27 Dr Lubimova stated that there is a practical difficulty in collecting haul-by-haul data on board USSR commercial vessels which can currently be solved only when scientific observers are on board. Such scientific observers will provide reliable information in addition to simple haul-by-haul data which would be relevant to further investigations of the Working Group.

2.28 It was felt that in view of the large number of documents tabled at the present meeting, specific details of the type of analyses to be carried out on such data should be deferred to the next meeting of the Working Group. However, the Scientific Committee did agree that certain data collection and evaluation procedures could be initiated immediately and these are set out in paragraph 2.33 to 2.41.

2.29 Considerable discussion was also held on the development of an approved procedure to deal with the problem of uncertainty with respect to assessing the possible impact of fishing on both local and global krill stocks. In this connection, note was taken of one of the Working Group's recommendations that commercial catches should not greatly exceed current levels, particularly with respect to the potential impact of such catches on local predator populations within Statistical Area 48. A number of Members expressed their reservation with this recommendation as they considered the development of restrictive catch limits to be premature at this stage, especially in the absence of acceptable estimates of krill production and in the absence of necessary data concerning the functional relationships between krill and dependent predators.

2.30 The Scientific Committee, however, noted the views expressed in SC-CAMLR-VIII/BG/11 and 19 with respect to the possible extent of the impact of fishing on local krill resources and the formulation of a suitable protocol to deal with assessing such impact taking into account operational definitions of Article II of the Convention. The Scientific Committee recognized that this particular problem holds specific significance for the Commission's Working Group on the Development of Approaches to Conservation (WG-DAC) (this is discussed in general terms in paragraphs 7.6 to 7.17).

2.31 Taking into consideration Dr Lubimova's indication of possible increases in Soviet fishing activities (see paragraph 2.11 above), the Scientific Committee agreed that there was a considerable lack of relevant data concerning the functional relationships between

1.13 The Chairman noted that the Commission had received STATLANT reports from three Members (France, UK and USSR) on harvesting of finfish, with a total of 104 397 tonnes being caught, and reports from three Members (Japan, Republic of Korea and USSR) on harvesting of krill with 382 205 tonnes being caught. Chile and Poland subsequently reported catches of krill (5 394 tonnes and 7 871 tonnes respectively) bringing the total krill catch to 395 470 tonnes. A report from one Member (UK) had also been received on harvesting of squid, with a total of 8 tonnes being caught.

1.14 The Chairman reported on documents available for consideration by the Scientific Committee. Twelve Members' Activities Reports were submitted, nine had been received by the Secretariat by the deadline set, 11 Working Papers were submitted, nine had been received by the Secretariat by the deadline set, and 57 Background Papers were submitted, 23 had been received by the Secretariat by the deadline set.

KRILL RESOURCES

FISHERY STATUS AND TRENDS

2.1 The total krill catch for the 1988/89 season was some 6.7% larger than in 1987/88. At 395 470 tonnes this is the second largest annual catch for the past seven seasons (Table 2.1).

Table 2.1: National krill landings (in tonnes) since 1982/83

	Split-Year*						
Member	1983	1984	1985	1986	1987	1988	1989
Chile	3 752	1 649	2 598	3 264	4 063	5 938	5 394**
GDR	0	0	50	0	0	0	0
Japan	42 282	49 531	38 274	61 074	78 360	73 112	78 928
Republic of Korea	1 959	5 314	0	0	1 527	1 525	1 779
Poland	360	0	0	2 065	1 726	5 215	7 871**
Spain	0	0	0	0	379	0	0
USSR	180 290	74 381	150 538	379 270	290 401	284 873	301 498
Total	228 643	130 875	191 460	445 673	376 456	370 663	395 470

* The Antarctic split-year begins on 1 July and ends on 30 June. The column "split-year" refers to the calendar year in which the split-year ends (e.g. 1988 refers to the 1987/88 split-year).

** From catch data tabled during the meeting.

krill abundance/distribution and dependent predators as well as more direct effects of fishing operations (e.g. the possible by-catch of already depleted fish species in krill trawls).

2.32 Dr Lubimova indicated that recent estimates of krill yield in the entire Antarctic were relatively high (ca. 50 million tonnes) (Hempel, 1988). Other Members raised considerable doubts as to the applicability of this estimate.

2.33 Given the views expressed in paragraph 2.30 and 2.31, certain Members were of the opinion that to minimize the potential for over-exploitation, consideration should be given by the Commission to the initiation of a general policy whereby precautionary Total Allowable Catches (TACs), may be set in certain restricted areas. This particular matter is discussed again in paragraph 2.48.

2.34 Finally, the Scientific Committee agreed that many of the items detailed above (paragraphs 2.22 to 2.30) and in the Working Group's Report (Annex 5) require the analysis and review of data. In view of the urgency of the Working Group's task (SC-CAMLR-VII, paragraph 2.28) as a whole, the timely submission of subsequent results will be necessary if the Working Group is to demonstrate any progress. For this reason the Scientific Committee recommended that a meeting of the WG-Krill be held during the next intersessional period.

2.35 The major objective of this meeting will be to further develop procedures to assess krill abundance and distribution in selected subareas of the Antarctic. A secondary objective would be to consider how such information could be utilized with a view to assessing the possible effects of changes in krill abundance and distribution with respect to both fishing operations and the possible impact on krill dependent predators (see also paragraphs 5.15 and 7.13 to 7.17). In order to achieve these objectives the Working Group will be required to review and consider:

(a) information on krill abundance and distribution (including available and relevant fisheries information/data);

(b) liaison with the CCAMLR Ecosystem Monitoring Program with respect to assessing any impact of changes in krill abundance and distribution on dependent and related species; and

(c) possible procedures to evaluate the impact on krill stocks and krill fisheries of current and future patterns of harvesting, including changes brought about through management action in order that the Scientific Committee may formulate appropriate scientific advice on krill to the Commission.

2.36 The Scientific Committee agreed that a meeting of the Working Group will be held in the Soviet Union at a time to be determined by the Chairman in consultation with Members.

DATA REQUIREMENTS

2.37 Review of the analyses of both past and currently available acoustic data should be undertaken in order to verify the definitions of concentration and aggregation types (Annex 5, Table 4) proposed by the WS-KCPUE and endorsed by the WG-Krill. Results of such analyses could be useful in the investigation of the possible underlying causes of the formation and maintenance of concentrations. As far as possible, these results should be presented at the Working Group's next meeting.

2.38 Available echo-charts should be examined to gather data on krill concentration parameters and aggregations types (i.e. swarm size, number of swarms per unit area of concentration and inter-swarm distance within-concentration). This should be undertaken as soon as possible, either on a national or cooperative basis, and submissions on how such data could be accessed and analyzed should be reported to the Working Group's next meeting.

2.39 Haul-by-haul data from commercial fishery vessels should be collected. It would appear (at least for the Soviet and Polish fisheries) that the utility of these data in subsequent analyses could be most readily achieved through the placement of scientific observers aboard fisheries vessels. The development of suitable reporting formats for such data is encouraged and recommendations along these lines should be submitted to the Working Group's next meeting.

2.40 The majority of Scientific Committee Members perceived some utility in the acquisition of bridge log data from krill survey and fishing vessels. The Scientific Committee recommended that Members provide information on the type and extent of data currently being collected on fishing vessels when scientific observers are present and also on research vessels in accordance with the standard formats currently used on these

vessels. This should be submitted to the next meeting of the WG-Krill along with details on extent of, and procedures followed in the annotation of echo-charts aboard both survey and fisheries vessels.

2.41 Available fine-scale catch and effort data should be further analyzed in order to investigate the spatial distribution of fishing activities during ten-day periods and within each season. Similarly, the necessary analyses should be undertaken (either nationally or cooperatively) as soon as possible in order to investigate possible patterns in distribution of commercial fishing operations within a season and between years. Results of such analyses should be reported to the Scientific Committee.

2.42 The reporting of fine-scale catch data should continue for Subareas 48.1, 48.2 and 48.3. The Scientific Committee noted that there is a contradiction between paragraphs 2.19 of SC-CAMLR-VII and paragraph 59 of CCAMLR-VII in this regard. For this reason, the Scientific Committee once more recommended that fine-scale catch data should be reported from Subareas 48.1, 48.2 and 48.3. Wherever possible, fine-scale catch data from other Statistical Areas should be collected.

2.43 Studies to develop standardized sampling procedures for krill catches should be undertaken. In particular, these should take account of the number and frequency at which samples of krill length distributions in commercial catches should be collected. Due account should also be taken of developing procedures to assess within-catch variances in the sampling of length distributions as well as between-catches and vessels.

2.44 As an interim measure, length samples of at least 50 krill from one haul per day per vessel should be taken by all commercial vessels. It was agreed that, where possible, more than one sample should be taken from each haul in order to provide estimates of variance. The standard length measurement to be used should be from the front of the eye to the tip of the telson. Members are urged to report any difficulties experienced with the above sampling procedure as well as on the procedures they are currently using or intending to carry out with respect to sampling krill catch length distributions (e.g. using observers aboard single commercial vessels to record length frequencies from all catches in one area). As far as possible, Members are also urged to collect krill length frequency data from commercial and scientific catches in the same area.

ADVICE TO THE COMMISSION

2.45 The WG-Krill should hold an intersessional meeting during 1989/90 in order to develop its tasks further and in order to sustain the momentum achieved at its first meeting.

2.46 Haul-by-haul catch and effort data including the relevant operational details should be collected and prepared pending discussion at the WG-Krill on specific analyses to be performed.

2.47 The Scientific Committee recommended that fine-scale catch data should be reported for Subareas 48.1, 48.2 and 48.3. Collection of such data in other areas where commercial fishing is undertaken, should be encouraged.

2.48 There is a substantial krill fishery in Subarea 48.3. The area is favoured by commercial operators as it contains concentrations of krill which have not been feeding. The current knowledge of the effect of krill fishing on krill predators and the impact on depleted fish stocks of by-catches, during the krill fishery, is poor.

Some Members of the Scientific Committee felt that it was now appropriate for the Commission to consider the implications of imposing a precautionary limit on the krill catch in this area.

Other Members expressed doubts about this view. Krill productivity was very important for prey-predator interactions and there were no data on this. In addition, no functional relationship between krill and its dependent predators had been established.

FISH RESOURCES

FISH STOCK ASSESSMENT - REPORT OF THE WORKING GROUP

3.1 The Convener of the Working Group on Fish Stock Assessment (WG-FSA), Dr K.-H. Kock (FRG), presented a report of the meeting which had been held in Hobart at the offices of the Secretariat from 25 October to 2 November 1989.

3.2 The Report of the WG-FSA is attached at Annex 6.

3.3 In reviewing the Report, the Scientific Committee thanked the Convener and participants for all their hard work. There were a large number of background papers presented to the WG-FSA and in addition, a number of background papers presented to the Scientific Committee covered matters involved in fish stock assessment. A list of documents is given in Annex 6, Appendix 3.

3.4 The Scientific Committee endorsed the Report of the WG-FSA and in receiving the Report, used its findings as a basis for discussion of the agenda items to be covered under fish resources.

3.5 To avoid unnecessary duplication, where certain sections of the WG-FSA Report were accepted with only minor or no comment, this Report refers to the relevant paragraphs in the Working Group Report. This should be read in conjunction with this Report.

SCIENTIFIC RESEARCH EXEMPTION PROVISION

3.6 During the meeting of the Working Group the Secretariat had been in correspondence with the USSR. Three research vessels (*Slavgorod, Borispol* and *Passat 2*) had started a fishery survey in the South Georgia region (Statistical Area 48.3). It was announced during the meeting that these vessels had been withdrawn.

3.7 Dr Lubimova reported that the vessels had fished for less than one week and that catches were small and mainly of the species *Champsocephalus gunnari*. The results will be presented to CCAMLR at its next meeting.

3.8 The Scientific Committee noted the concerns of the WG-FSA, (Annex 6, paragraphs 3 and 4) and recommended that:

(a) plans for such research cruises should be circulated in advance;

(b) catches should be reported on a haul-by-haul basis to the Secretariat; and

(c) research vessel catches should be considered as part of TAC.

3.9 Dr Beddington referred to the plans presented to the WG-FSA for a further joint UK/Polish research cruise to Subarea 48.3 in January 1990. The vessel that would be used

was a commercial trawler *Hillcove* as the RV *Profesor Siedlecki* was unavailable. The survey design was randomized and catches were therefore expected to be small (Annex 6, paragraph 3).

CATCH AND EFFORT STATISTICS

Statistical Area 48 (Atlantic Ocean Sector), (Annex 6, paragraphs 5 to 12)

3.10 The concerns of the the WG-FSA about reporting catch and effort statistics from the operations of a longline fishery by the USSR for *Dissostichus eleginoides* in Subarea 48.3 were noted by the Scientific Committee.

3.11 The Secretariat at the request of the WG-FSA had prepared in SC-CAMLR-VIII/BG/54, a reporting format for presenting catch and effort statistics for longline fisheries.

3.12 The Scientific Committee recommended that all past and current catch and effort statistics for this fishery should be presented to CCAMLR in the format set out in this document.

3.13 Concern was expressed about the operation of this longline fishery as similar fisheries elsewhere in the world had posed conservation problems which were difficult to detect from catch and effort statistics alone. In addition, there had been significant instances of incidental mortality, particularly of albatrosses and large petrels, in other longline fisheries.

3.14 Dr Lubimova explained that the fishery operated at an average depth of 800 metres and would on occasion, go as far as 1 200 metres. The fishery targeted primarily on older age groups which appeared sporadically close to the continental slope. There was no indication of any problem of incidental mortality, but noted that SC-CAMLR-VIII/BG/54 involved a procedure for reporting any such incidents.

Statistical Area 58 (Indian Ocean Sector), (Annex 6, paragraphs 13 to 14)
Statistical Area 88 (Pacific Ocean Sector), (Annex 6, paragraph 15)

3.15 The above paragraphs were endorsed without comment.

AGE DETERMINATION, (Annex 6, paragraphs 17 to 20)

3.16 Lic E. Barrera-Oro (Argentina) emphasized the importance of correct age data and noted how errors in these data would be propagated through other analyses. A workshop was considered as the best way of dealing with such problems and it was agreed that the Scientific Committee should consider holding such a workshop in two to three years time.

OTHER BIOLOGICAL INFORMATION, (Annex 6, paragraphs 21 to 27)

3.17 Some doubts were expressed by Dr Lubimova about the major difference in the length at first spawning of *C. gunnari* between South Orkney and South Georgia reported in SC-CAMLR-VIII/BG/16. These were noted, but could not be resolved.

MESH SELECTION, (Annex 6, paragraphs 28 to 39)

3.18 Dr W. Slosarczyk (Poland) drew attention to some inconsistencies in different parts of the WG-FSA Report where mesh selection was discussed. The Scientific Committee noted this and endorsed the summary conclusions as follows:

Assuming that the actual size of the twine mesh in commercially used codends is on the average 10% greater than the nominal mesh (SC-CAMLR-VII/BG/11), the introduction of the following mesh sizes in the commercial fishery in Statistical Area 48 should be considered:

(a) Subarea 48.3

(i) Fishery targeted at *C. gunnari*
80 mm, to protect immature fish, or
90 mm, to protect first spawners, or
100 mm, to give an age at first capture of 4 years;

(ii) Fishery targeted at *Patagonotothen brevicauda guntheri*
50 mm, to protect immature fish;

(iii) Mixed fishery (not targeted at *C. gunnari* or *P.b. guntheri*)
120 mm extended to include *Notothenia gibberifrons, Chaenocephalus aceratus* and *P. georgianus* (in addition to *Notothenia rossii* and

D. eleginoides, which have had such a mesh regulation since 1984 - Conservation Measure 2/III), to ensure better protection of immature fish;

(b) Subareas 48.1 and 48.2
110 mm, to ensure protection of first spawners of *C. gunnari* and immature *N. gibberifrons*.

In addition to the above, the provision should be included that chafers will not be used and codends will be diamond shaped mesh made of twine, no thicker than 4.5 mm.

"Although the Working Group agreed that further work was necessary it was felt that the analyses presented were now at a stage when selection factors could be used as a guide in introducing new mesh sizes."

3.19 Concern was expressed by Dr Lubimova that there could be substantial mortality of small fish passing through nets which could lessen the benefits to be gained from mesh regulations. Given the morphological peculiarities of the species concerned, before taking decision on new mesh size, studies should be carried out on the survival rate of fish escaped from the trawl.

3.20 Dr O. Østvedt (Norway) noted that this concern had been raised in meetings of ICES, but the decision had been that mesh regulations were still of substantial benefit and should be retained.

ASSESSMENTS PREPARED BY MEMBER COUNTRIES, (Annex 6, paragraphs 42 to 76)

3.21 A large number of assessments had been prepared for the WG-FSA and discussed at length by them. Given the technical nature of the work and comments, the Scientific Committee felt that it could only note and endorse these discussions.

STATISTICAL AREA 48

Subarea 48.3 (South Georgia)

Catches, (Annex 6, paragraphs 77 to 79)

3.22 Table 1, paragraph 77 of the WG-FSA Report (Annex 6) indicated catches of *Myctophidae spp.* increasing from 1 102 tonnes in 1987 to 29 673 tonnes in 1989. Concern was expressed that this was a very large increase in catch levels which had occurred without any stock assessment.

3.23 Dr Lubimova explained that this was an experimental fishery directed at a single species, *Electrona carlsbergi* which had an extended range beyond the Polar Front. Preliminary biomass estimates of the stock were high and the by-catch was limited to squid. This by-catch was at an extremely low level and only single squids were caught. Results of the analyses would be presented to CCAMLR next year.

3.24 Concern was expressed about the definition of an experimental fishery by several delegations and the view was expressed that the large increases in catch should have been preceded by some assessment that could be reviewed by the Scientific Committee.

3.25 The Scientific Committee recommended that in order to avoid confusion concerning the species involved, the Secretariat should ensure that the target species involved was identified in future reporting of catch statistics to the Commission.

Assessments of Individual Stocks

Notothenia rossii in Subarea 48.3, (Annex 6, paragraphs 80 to 84)

3.26 The Scientific Committee endorsed the WG-FSA Report and noted that there were no data presented on the size-at-age composition of the catch of this species. In view of the high degree of depletion of this species such data were essential. The Scientific Committee recommended that length compositions and age compositions from recent catches should be provided to the Working Group.

Management Advice

3.27 The Scientific Committee recommended that in view of the current low level of the stock *N. rossii*, all Conservation Measures should be kept in force.

Champsocephalus gunnari in Subarea 48.3
(Annex 6, paragraphs 85 to 99)

3.28 Dr Beddington pointed out that the comments on the reliability of the biomass estimates for the UK/Polish survey contained in Annex 6, Appendix 6 (paragraph 91) had been submitted by the USSR Delegation after the close of the meeting. The Scientific Committee recommended that this authorship should be reflected in a revision of paragraph 91 of Annex 6, Appendix 6.

Management Advice

3.29 There is a large difference between the assessment of the stock of *C. gunnari* as presented in two separate analyses. WG-FSA-89/27 has a high level of uncertainty as the survey estimate on which it is based could be a substantial over-estimate or under-estimate of the stock, while the WG-FSA could not agree on a way of assessing the reliability of the results presented in WG-FSA-89/22 Rev. 1.

3.30 The large differences between the two analyses for the final year pose serious problems in presenting management advice to the Commission. The TACs at different target F levels that have been derived from the two assessments are given in Table 3.1. They differ substantially.

Table 3.1: TAC levels (tonnes) for *C. gunnari*, Subarea 48.3, calculated from assessments presented in WG-FSA-89/27 and WG-FSA-89/22 Rev. 1 (M = 0.35).

	Assessment presented in WG-FSA-89/27	Assessment presented in WG-FSA-89/22 Rev. 1
$F_{0.1} = 0.313$	6 545	22 235
$F_{max} = 0.645$	11 961	40 273

3.31 In essence, if the trawl survey and the analysis based on it is correct, a TAC based on the CPUE tuned VPA will lead to a substantial depletion of the stock. If the analysis based on the CPUE tuned VPA is correct and a TAC is set on the basis of the trawl survey results, the stock will increase substantially.

3.32 A number of delegations expressed the view that given both the uncertainties and the wide differences between the estimates, any compromise position, e.g. the setting of a TAC

based on the average value of the two assessments, would present problems similar to those posed in paragrapah 3.31. The reason is that if the status of the stock based on the trawl survey is close to the correct one, a TAC based on an averaging of the assessments will lead to a substantial depletion of the stock. If the status of the stock based on WG-FSA-89/22 Rev. 1 is close to the correct one, the stock will increase substantially.

3.33 Dr Lubimova expressed the view that the advice given in paragraphs 3.30 and 3.31 was sufficient advice to the Commission.

Notothenia gibberifrons in Subarea 48.3,
(Annex 6, paragraphs 101 to 103)

3.34 The analysis performed in the WG-FSA had identified a strong relationship between stock and recruitment which implied that any further reduction in the stock would lead to yet lower recruitment.

3.35 Lic Barrera-Oro reiterated concern expressed in previous meetings by Argentine delegates, about the take of *N. gibberifrons* as by-catch in the directed fishery for *C. gunnari*. Even with the lowest of the TACs presented at the WG-FSA for *C. gunnari* (6 545 tonnes) the by-catch of *N. gibberifrons* will reach a level higher than the limit set by the Working Group (300 tonnes). The proportion of *N. gibberifrons* taken as by-catch in the *C. gunnari* fishery fluctuated between 4 and 10% in previous years. This view was shared by a number of other delegations.

Management Advice

3.36 The WG-FSA had reported that because of the current stock size and the evidence for a stock recruitment relationship, it is inappropriate to recommend catches at the level of $F_{0.1}$. Catches should be kept to a minimum to increase the stock size as much as possible. The Working Group recommended that there should be no directed fishery for *N. gibberifrons* and by-catch should be restricted to not more than 300 tonnes.

This was endorsed by the Scientific Committee with the reservation made by some delegations (see paragraph 3.33) that 300 tonnes may be too large.

Pseudochaenichthys georgianus in Subarea 48.3
Chaenocephalus aceratus in Subarea 48.3
(Annex 6, paragraphs 104 to 106 and 107 to 108 respectively)

3.37 The Scientific Committee endorsed the WG-FSA's review of these stocks without comment.

Management Advice

3.38 In view of the 'by-catch' problem associated with the catch of these species, its likely detrimental effects on other species with a low stock size (e.g. *N. gibberifrons*) and an apparent stock-recruitment relationship in the case of *C. aceratus*, the Scientific Committee recommended that no directed catches of these species be taken and by-catches be reduced to a minimum to allow the recovery of these stocks.

Notothenia squamifrons in Subarea 48.3
(Annex 6, paragraphs 110-113)

3.39 Concern was expressed that this species is relatively long lived, has a low potential yield and that no estimates of mortality or recruitment were available.

Management Advice

3.40 The WG-FSA had been unable to recommend a TAC because the status of the stock was unknown. The Scientific Committee noted this.

3.41 Some delegations expressed the view that in the absence of information on which to calculate a TAC or even estimate potential yield, two options should be presented. One option was for the Commission to recommend a cessation of any directed fishery. If this option was taken, the stock would be expected to increase. The second option was to permit a directed fishery at some level. In this situation, it would not be possible to predict the effect on the stock.

Dissostichus eleginoides in Subarea 48.3
(Annex 6, paragraphs 115 to 119)

3.42 Concern was expressed that catch levels have increased by a factor of four in the last two years and that the WG-FSA had been unable to assess the status of the stock. It was noted that the longline fishery was exploiting older age classes, and the productivity of this species is probably low, although the fecundity is high.

Management Advice

3.43 The WG-FSA had suggested a method for assessing the possible sustainable yield. Even in the absence of information on the stock size it is possible to calculate the yield for different levels of the unexploited stock size (using, for example, the Gulland formula, yield equals half the product of mortality and unexploited biomass). Natural mortality is estimated to be 0.06 (Kock, Duhamel and Hureau, 1985).

Biomass	Sustainable Yield
8 000 tonnes	240 tonnes
40 000 tonnes	1 200 tonnes

As the figure of 40 000 tonnes is some five times the stock estimate obtained by the FRG survey in 1984/85, this could be considered as a reasonable upper limit until further data become available. The Scientific Committee endorsed this as a useful basis for setting a TAC. However, the wide discrepancy between the TAC set on the basis of the survey estimate and that based on the assumption that biomass was five times the survey estimate presented in the Report, was felt to be so wide as to serve only as broad guidelines for a TAC.

Patagonotothen brevicauda guntheri Subarea 48.3
(Annex 6, paragraphs 121 to 127)

3.44 The Scientific Committee endorsed the WG-FSA's analyses without comment.

Management Advice

3.45 The Scientific Committee endorsed the view of the WG-FSA that "uncertainty in the value of natural mortality and the lack of any time series showing trends in biomass levels

prevent accurate assessment of the current stock size. In the absence of reliable estimates of natural mortality to evaluate the alternative analyses and in the absence of information on current stock size, catch levels should not be based on VPA results, using $F_{0.1}$ calculations and assumptions about recruitment. The current status of this stock is unknown".

General Management Advice

3.46 Following its review of the status of the fish stocks in Subarea 48.3, the Scientific Committee discussed the general situation. The Commission has been setting conservation measures for individual stocks over the last few years.

3.47 The view of the USSR Delegation was that this stock by stock approach was adequate to ensure conservation of the fish resources.

3.48 All other delegations present felt that an alternative option involving a closure of the fishery for a short period of at least one year, pending a new assessment, should be presented to the Commission for consideration. The status of all stocks in the area was either unknown due to the lack of data, uncertain due to wide differences in the results of different analyses or depleted and in need of protection. In the case of depleted stocks which had suffered recruitment failure, it was not clear that by-catches would be sufficiently small to ensure recovery. Accordingly, the efficiency of a stock by stock approach was currently low.

3.49 The Convener of WG-FSA was asked to draft a note outlining data and analyses and surveys which would be required to improve the knowledge of the stocks.

3.50 The benefits that might be expected from a short closure would be an increase in heavily depleted stocks and a build up of other stocks to higher levels of productivity.

Subarea 48.2 (South Orkney Islands), (Annex 6, paragraphs 128 to 135)

3.51 The Scientific Committee noted with concern that insufficient data were available for the WG-FSA to complete any assessments. Two stocks are currently exploited, *C. gunnari* and *N. gibberifrons*.

Management Advice

3.52 The management advice of the WG-FSA was that, "due to the lack of data the Working Group was unable to recommend a TAC for either species. In case, however, the recruitment failure in *C. gunnari* is real, the stock should be protected until evidence to the contrary is available". This was noted.

In the discussion on this advice, two views were presented. The one that in absence of assessments, some precautionary TAC should be considered. The other, that due to the sporadic nature of the occurrence of *C. gunnari* and *N. gibberifrons* in the area, no catch limit was required.

Subarea 48.1 (Antarctic Peninsula), (Annex 6, paragraphs 135 to 140)

3.53 The Scientific Committee made similar comments on the WG-FSA Report as in paragraph 3.51 for the South Orkney area.

Management Advice

3.54 Due to the lack of data the Working Group had been unable to recommend a TAC for either species. In the discussion on this advice, two views were presented. The one that in absence of assessments, some precautionary TAC should be considered. The other, that due to the sporadic nature of the occurrence of *C. gunnari* and *N. gibberifrons* in the area, no catch limit was required.

STATISTICAL AREA 58, (Annex 6, paragraphs 141 to 143)

Subarea 58.4, (Annex 6, paragraphs 144 to 146)

Division 58.4.4 (Ob and Lena Banks), (Annex 6, paragraphs 147 to 150)

3.55 The Scientific Committee endorsed the Report of the WG-FSA without comment on the above matters.

3.56 Dr Lubimova reported that attempts would be made to present historical data for the Ob and Lena Banks separately.

Subarea 58.5

Division 58.5.1 (Kerguelen Island), (Annex 6, paragraphs 151 to 180)

Champsocephalus gunnari in Division 58.5.1

3.57 The Scientific Committee noted that analysis by the WG-FSA had identified certain problems in the stratification of the joint USSR/France survey in 1988. These problems and their solutions are dealt with in paragraph 158 of the Working Group's Report.

Management Advice

3.58 The WG-FSA had reported, "because the stock in the last decade has consisted of only one cohort every three years it should be managed with caution until further information can be collected which could determine whether high post-spawning or similar natural mortality might explain the exhaustion of the cohorts. It would be prudent to assume, on the basis of the CPUE data, that the current cohort in the fishery is of comparable strength to the preceding strong cohorts of 1979 and 1982. Thus, the biomass of the 1985 cohort during the1989 season could have been of the order of 23 to 45 thousand tonnes, and thus substantially affected by the catch of 23 thousand tonnes. A low level of fishing mortality should help to resolve the question whether high natural mortality is the cause of cohort exhaustion. If substantial survival proves possible in fish of the current age, it will have the desirable effect of increasing the number of year classes in the fishery and could lead to cohorts recruiting to the fishery more frequently than the current three year interval. Accordingly, the catch level in 1990 could be no higher than occurred on the preceding cohorts at age four, that is, in the range of 0 to 6 000 tonnes".

The Scientific Committee noted that the final sentence was ambiguous. It was agreed that what was meant was that catches similar in size to recent catches from recent cohorts aged four, should not be exceeded in the next season.

Dissostichus eleginoides in Division 58.5.1
(Annex 6, paragraphs 160 to 166)

3.59 The Scientific Committee endorsed the WG-FSA Report without comment.

Management Advice

3.60 *D. eleginoides* is a long-lived species with probable low productivity albeit high fecundity (see paragraph 3.42). An assessment of the stock is urgently required to estimate the level of catch to stabilize the stock. Adding the cumulative catch to the survey estimate gives a rough estimate for the unexploited biomass of 38 000 tonnes. Applying the Gulland rule to this estimate gives a TAC of 1 100 tonnes.

Notothenia rossii in Division 58.5.1, (Annex 6, paragraphs 167 to 170)

3.61 The Scientific Committee endorsed the WG-FSA Report without comment.

Management Advice

3.62 Conservation Measures (no directed fishery) will be continued into the beginning of the 1990's for the adult stock. Trends in the abundance of juvenile part of the stock need to continue to be monitored. Biomass surveys will be required to establish that the stock has made a substantial recovery prior to any resumption of exploitation.

Notothenia squamifrons in Division 58.5.1
(Annex 6, paragraphs 171 to 180)

3.63 The Scientific Committee endorsed the WG-FSA Report without comment.

Management Advice

3.64 A lack of information on recruitment patterns makes it difficult to provide objective predictions of future trends in the stock. However, given observed exploitation trends and the present status of the stock, protection of the *N. squamifrons* stock in Division 58.5.1

will be facilitated by closure of the directed fishery for this species. Similarly, recovery of this already depleted stock will be facilitated. Since only about 15% of the current total stock biomass is comprised of adults and that fishing on other species in this area will continue, the setting of acceptable by-catch levels appears necessary. As the current quota levels authorized by France in that area have not been attained, it is recommended that future by-catch levels should be substantially lower than current level.

Division 58.5.2 (Heard Island), (Annex 6, paragraphs 181 to 182)

3.65 The WG-FSA Report was endorsed subject to a note that there had been no commercial fishery at any time in this area.

GENERAL ADVICE TO THE COMMISSION, (Annex 6, paragraphs 183 to 206)

3.66 The WG-FSA had provided answers to the Commission's questions outlined in CCAMLR-VII, paragraphs 114 to 116.

3.67 The Scientific Committee endorsed the advice given to the Commission with two exceptions:

- with reference to paragraph 193, Mr E. Balguerias (EEC) indicated that protection of *C. gunnari* at age 1 and 2 was assured using a semipelagic trawl. This was based on results of a comparison of catches made by Spanish and US/Polish surveys in 1986/87; and

- with reference to paragraph 204, Dr Lubimova pointed out that measures to minimize and assess the level of larval or young fish caught during krill fishing were in place for the last four years.

Data Requirements	Annex 6, paragraphs 207 to 212
Data Analysis	Annex 6, paragraphs 213 to 215
New Trends in Assessment Work	Annex 6, paragraphs 216 to 217
Organization of Next Meeting	Annex 6, paragraphs 218 to 220

3.68 These matters were endorsed by the Scientific Committee without comment.

OTHER BUSINESS

3.69 It was agreed by the Scientific Committee that provision should be made in the budget for a visit by the Data Manager to consult with the Chairman of the Scientific Committee and the Convener of WG-FSA.

SQUID RESOURCES

REVIEW OF ACTIVITIES RELATED TO SQUID RESOURCES

4.1 Dr Beddington reported to the Scientific Committee that during February 1989, exploratory fishing was carried out by two Japanese registered commercial squid jigging vessels (with UK scientists on board). They fished within Statistical Area 48.

4.2 Catches of commercial quantities were obtained within Subarea 48.3, some 185 nautical miles west of Shag Rocks. A total of 8.23 tonnes of the Ommastrephid squid, *Martialia hyadesi* was caught (SC-CAMLR-VIII/BG/25). Fine-scale catch and effort data were reported to the Secretariat by the UK.

4.3 Dr Beddington also indicated that he had received information on the operation of a Taiwanese squid jigging vessel which had made catches within the Convention Area during the past year.

4.4 In discussing the above developments, the Scientific Committee agreed that there was not much likelihood that squid fishing in the Convention Area would expand in the near future. There were a number of reasons for this, but in brief, these could be mainly attributed to the limited and relatively uncompetitive market potential of *M. hyadesi*. Dr Lubimova felt that the resource was not available in sufficient quantities or with adequate predictability to be of future importance as a commercial resource. Dr Shimadzu said that it was unlikely the Japanese vessels would fish for squid in the near future.

4.5 Despite the reservations expressed in paragraph 4.4, however, the Scientific Committee was of the opinion that given the ecological importance of squid in general (particularly to certain predators found in Statistical Area 48), there would be considerable merit ensuring that fine-scale catch and effort data on future squid fishing operations (as provided by the UK) are reported to the Commission.

ADVICE TO THE COMMISSION

4.6 The Scientific Committee drew the Commission's attention to catches of squid taken during 1988/89 in the Convention Area by a non-member nation. It was suggested that the institution of some mechanism to obtain data of this kind from non-member nations should be investigated.

4.7 The Scientific Committee recommended that fine-scale catch and effort data from squid fishing operations in the Convention Area should be submitted to the Commission. It was also suggested that the Secretariat should, in consultation with Members most experienced in the analysis of data and the mechanics of squid jigging operations, develop a reporting system for presenting squid jigging catch and effort statistics.

ECOSYSTEM MONITORING AND MANAGEMENT

5.1 Dr K. Kerry (Australia), Convener, presented his report (SC-CAMLR-VIII/11) and the Report of the Third Meeting of the Working Group for the CCAMLR Ecosystem Monitoring Program (CEMP), held at Mar del Plata, Argentina, 23 to 30 August 1989 (Annex 7). Tables 3, 7 and 8 in this Annex provide a detailed summary of Members' CEMP activities and related research.

5.2 The Scientific Committee noted that the Working Group had made excellent progress in responding to the extensive program of work developed at last year's meeting of the Scientific Committee (SC-CAMLR-VII, paragraphs 5.28 to 5.44). The Scientific Committee reviewed the WG-CEMP Report, noting the current state of progress and the implications and requirements for future work.

APPROVED PREDATOR MONITORING PARAMETERS

Sites and Species

5.3 WG-CEMP had reviewed and revised sites and species in the light of comments from Members and specialist groups. The new list of these is at Annex 7, paragraph 7 to 19, Tables 1 and 2. Subsequently, it had been established (after actions specified in Annex 7, paragraph 16) that monitoring black-browed albatrosses at Kerguelen was inappropriate.

5.4 The Scientific Committee approved these changes and confirmed that the revised listings of species and sites are desirable and appropriate for CEMP monitoring activities in Integrated Study Regions and complementary network areas.

5.5 The Scientific Committee noted and supported the strong recommendation of the WG-CEMP (Annex 7, paragraphs 20 and 21) for registration and protection of the land-based sites at which CCAMLR's long-term predator monitoring work is being carried out (see paragraph 5.43).

Methods

5.6 The contents of the CCAMLR Booklet "Standard Methods for Monitoring Parameters of Predator Species" were reviewed in detail (Annex 7, paragraphs 23 to 56) in the light of:

(a) Members' experiences of using them in the field; and

(b) sensitivity analyses conducted in accordance with the advice given in SC-CAMLR-VII, paragraphs 5.26 (a) and (b) and further elaborated by the Secretariat (WG-CEMP-89/13).

5.7 The Scientific Committee approved the recommendation of the WG-CEMP that investigators attempt sampling at their sites, designed to detect at least a 10% change in the measured parameter at a 90% confidence level.

5.8 WG-CEMP established a subgroup to prepare a revision of the Standard Methods booklet taking into account the information mentioned under paragraph 5.6 and other comments from Members. Additional information on sexing penguins by numerical methods was prepared by Dr D. Vergani (Argentina) and submitted for consideration at the next meeting of WG-CEMP.

Data Collection

5.9 The subgroup had completed revision of this section of all existing standard methods sheets and had developed these for the black-browed albatross as requested in Annex 7, paragraph 30. This material will now be circulated to all Commission Members and

relevant SCAR specialist groups by 1 December for final comments before being adopted at the WG-CEMP's next meeting as the new standard field methods.

Data Processing and Analysis

5.10 The revision of the methods of data collection, and discussions arising from the conduct of sensitivity analyses, necessitated preparation of instructions for processing and analyzing data. The Secretariat, in consultation with appropriate specialists, was asked to prepare the sections on data processing and analysis for the revised Standard Methods booklet. These methods will be circulated to all Members in preparation for discussion at the intersessional meeting of the Working Group. To facilitate these discussions it was proposed that the CCAMLR Data Manager should attend this meeting.

Data Reporting

5.11 (a) Changes to the method of data collection, processing and analysis require modifications (some quite extensive) to the existing versions of the draft data reporting forms (SC-CAMLR-VII/BG/8). The Secretariat, in consultation with the Convener of WG-CEMP, is asked to revise these as soon as possible and circulate them to all Commission Members for review and comment (Annex 7, paragraph 114), so that reporting formats (including submission of data in computer compatible media) can be discussed and revised as needed and approved at the next meeting of WG-CEMP;

(b) Procedures for checking and logical validation of data need developing and the CCAMLR Data Manager should investigate these procedures as outlined in Annex 7, paragraphs 113 and 115 and prepare a proposal for consideration at the next meeting of WG-CEMP; and

(c) As soon as the data submission and access procedures are agreed (paragraphs 13.1 and 13.7) and the reporting forms are approved, the summarized data should be submitted, annually by 30 September, by all Members who have indicated that they are monitoring approved parameters using standard methods at approved sites. Retrospective submission of data should also be requested.

Parameter Evaluation

5.12 Further work is needed to permit a critical evaluation of the limitations of presently approved parameters (Annex 7, paragraph 55). Members were urged to prepare for this before the next meeting of WG-CEMP.

DIRECTED RESEARCH ON PREDATORS

5.13 The Scientific Committee noted the considerable amount of research:

(a) investigating additional parameters which may have potential for monitoring (Annex 7, paragraph 64 to 66, Table 7); and

(b) collecting data providing essential background information for interpreting changes in monitored predator parameters (Annex 7, paragraphs 68 and 69, Table 8).

ENVIRONMENTAL DATA FOR PREDATOR MONITORING

5.14 The main environmental features that have a direct influence on predators and which need to be recorded at land-based monitoring sites were reviewed (Annex 7, paragraphs 61 and 62, Table 6). The Secretariat, in consultation with the Convener of WG-CEMP, is requested to prepare and circulate before the next meeting of WG-CEMP, draft standard instructions for recording these parameters.

5.15 Environmental features that influence predators indirectly through their effects on distribution and abundance of prey were considered in relation to the requirements of prey monitoring (see paragraph 5.20).

PREY MONITORING

5.16 In reviewing prey monitoring the WG-CEMP had in mind the comments of the Scientific Committee last year (SC-CAMLR-VII, paragraph 5.40) regarding the high priority accorded this item and had available the Reports from the WG-Krill and the WS-KCPUE meetings and an analysis of the fine-scale catch data of krill (WG-CEMP-89/9).

Survey Design

5.17 WG-CEMP noted the inability of WG-Krill to start providing specifications for prey monitoring surveys as they relate to interpreting predator parameters being monitored. It remedied this by providing a detailed summary of the appropriate characteristics of predators both in general terms and for each of the Integrated Study Regions (Annex 7, paragraphs 58 to 60, Tables 4 and 5). It also noted the desirability of data on a slightly larger spatial scale and in advance of the critical time period (Annex 7, paragraph 87).

Survey Methods

5.18 WG-CEMP noted that although WG-Krill had identified acoustic and net sampling as the best methods currently available for estimating krill distribution and abundance, it had not yet been able to provide any standard method protocols.

5.19 Dr R. Holt (USA) took over as WG-CEMP coordinator of studies of net sampling efficiency and will liaise with the Convener of WG-Krill regarding studies of this topic.

Environmental Data for Prey Monitoring

5.20 WG-CEMP understood that the comprehensive list of environmental data requirements (SC-CAMLR-VI, Annex 4, Table 6) was being reviewed by WG-Krill.

General

5.21 In considering the whole topic of prey monitoring, the Scientific Committee noted that this issue was complex and felt that recent progress had been disappointing. It recommended, as a matter of high priority, that the WG-Krill, in consultation with WG-CEMP as necessary:

(a) develop appropriate designs for prey monitoring surveys for the Integrated Study Regions and their vicinities;

(b) prepare standard methods for the technical aspects of such prey surveys;

(c) review the relevant environmental data required in the context (i.e. in terms of the spatial and temporal scales involved) of CEMP's requirements for prey monitoring. The offer from the Delegation of the USA to investigate the availability of relevant satellite data and to report to the next meeting of the Scientific Committee on its relevance to CEMP and methods of accessing, processing and analyzing it, was gratefully accepted; and

(d) develop operational plans for collaborative and cooperative integrated surveys, with particular emphasis on the Integrated Study Regions.

5.22 In undertaking these tasks, the Scientific Committee drew the attention of WG-Krill to the following documents made available at the present meeting: SC-CAMLR-VIII/BG/4, 5, 8, 9, 10, 28, 29, 30, 31 32 and 49.

5.23 The Scientific Committee emphasized the importance of integrating research undertaken on predators, prey and environmental features. In particular, it was recognized that cooperative research among nations linking investigations of krill, its predators and the environment would be valuable. Fostering close contact between the WG-Krill and WG-CEMP represents one of the effective means of achieving this goal.

Implications of Fine-Scale Analysis of Krill Data

5.24 WG-CEMP noted that analysis of the fine-scale data for Subareas 48.1, 48.2 and 48.3 is important in assessing the status of krill in the Integrated Study Regions and adjacent areas. This analysis has also provided the first unequivocal indication that a substantial proportion of recent krill harvesting had regularly occurred within the foraging ranges of breeding predators being monitored by CCAMLR, particularly so within the Antarctic Peninsula and South Georgia Integrated Study Regions (Annex 7, paragraphs 83, 84 and 90).

5.25 Recognizing the importance to the CEMP of fine-scale krill catch data, the Scientific Committee reiterated its recommendation that the requirements for reporting fine-scale data of krill catches should be altered to include the entire Subareas 48.1, 48.2 and 48.3 (see paragraphs 2.42 and 2.47).

5.26 In preparation for the studies foreshadowed above in paragraph 5.21, WG-CEMP:

(a) recommended continued collection of data on a haul-by-haul basis; and

(b) asked Members to synthesize data on predator population size, diet and energy budgets in order to provide estimates of krill requirements of predators in Integrated Study Regions, at least during their breeding seasons (Annex 7, paragraphs 91 and 92).

5.27 The Scientific Committee endorsed these recommendations. However, it noted that estimating energy requirements (and thereby krill consumption) of predators needs careful evaluation of the appropriate parameter values to be used in many parts of the necessary models. Previous attempts to produce similar, but more general, models (e.g. for South Georgia in SC-CAMLR-VIII/BG/12 and 15) provide a useful starting point. The extensive recent data on activity-specific energy budgets (e.g. SC-CAMLR-VIII/BG/13 and 14) and foraging patterns and ranges of seals and penguins (WG-CEMP-89/22) will, however, need critical evaluation to provide for standardization (e.g. between Integrated Study Regions and between species within regions).

5.28 The Scientific Committee requested that the Convener of WG-CEMP discuss with Members and other appropriate specialists and specialist groups how best to proceed towards this important goal. Specific proposals should be made to the next meeting of WG-CEMP.

GENERAL

Relevance of CEMP to CCAMLR Management Strategies

5.29 WG-CEMP had responded briefly to requests from:

(a) the Scientific Committee on how information from CEMP might be used in the management of fisheries in the Convention Area (SC-CAMLR-VII, paragraph 5.44); and

(b) WG-DAC via the Scientific Committee on the ability of the CEMP to detect changes in ecological relationships and to recognize the effects of simple dependencies between species, including distinguishing between natural fluctuations and those induced by fisheries (CAMLR-VII, paragraph 141).

5.30 WG-CEMP noted that:

(a) its work in defining the accuracy and precision of the predator parameter estimates provided essential first steps to answering these questions;

(b) it is actively considering various key questions about relationships between predator indices and prey abundance/availability. However, all of these, and especially the last part of the question from WG-DAC, are complex issues which require considerable further study;

(c) some Members had already produced papers addressing these strategic issues. Further discussion would take place at the next meeting of WG-CEMP; and

(d) predator indices as derived from the CEMP are not expected to provide a useful index of total prey stock abundance, but would provide a useful index of the level of prey availability to predators (Annex 7, paragraph 103).

5.31 The Scientific Committee agreed to discuss these responses under agenda item 7.

Analysis of Interdependencies Between Monitoring Predators and Prey

5.32 Last year the Scientific Committee recommended that WG-CEMP investigate various aspects of this issue (SC-CAMLR-VII, paragraphs 5.22 and 5.23). Members had not responded to the request for explicit suggestions and information (SC-CAMLR-VII, paragraph 5.43). The WG-CEMP believed that this was because of difficulties in doing so until there was a clearer understanding of the type of data to be collected in monitoring operations.

5.33 The Scientific Committee endorsed the WG-CEMP request that Members should respond to the original questions so that these issues can be considered at the next meeting of WG-CEMP.

CCAMLR/IWC Workshop on the Feeding Ecology of Southern Baleen Whales

5.34 This Workshop is intended to permit a functional evaluation of the minke whale as a potential indicator of changes likely to result from harvesting of krill.

5.35 The Workshop was due to be held in San Diego, USA in September 1989. The Report (SC-CAMLR-VIII/8) of the CCAMLR Co-Conveners (Dr J. Bengtson, USA and Mr D. Miller, South Africa) shows that IWC asked to postpone the meeting until 1991, on advice from its Convener (Dr J. Harwood, UK), because of prior and higher-priority commitments of potential IWC Workshop contributors to the IWC Comprehensive Assessment (scheduled to be completed in 1990).

5.36 The Scientific Committee reaffirmed its commitment to this Workshop and asked the Co-Conveners to request Dr Harwood to let CCAMLR know when the analyses requested from IWC contributors are sufficiently advanced to let the Workshop be re-scheduled.

Awareness of the CEMP

5.37 WG-CEMP commended the Secretariat for producing a review of the origins, aims and development of the CEMP. It had been suggested that this might usefully be distributed outside CCAMLR to promote awareness of the CEMP in other countries (Annex 7, paragraphs 124 and 125).

5.38 The Scientific Committee agreed that the review of the CEMP (SC-CAMLR-VIII/BG/51) was useful and that the Secretariat should update it before each meeting of WG-CEMP. It was felt inappropriate to distribute to an external audience, a document primarily intended for internal use. Instead, the Secretariat was asked to prepare, for wide dissemination, a brief article on the CEMP Program and to circulate a draft of this for comments before the next meeting of WG-CEMP.

Next Meeting

5.39 WG-CEMP had emphasized the need to maintain strong links with WG-Krill, especially to ensure that the needs of the CEMP program for prey monitoring were being met.

5.40 It was noted that there were a number of substantive issues requiring discussion and action as soon as possible in order to move ahead with the work of the WG-CEMP. There was widespread approval in Scientific Committee for a meeting of WG-CEMP in 1990 and unanimous support that it should meet in conjunction with WG-Krill, ideally at the same location.

5.41 The Scientific Committee gratefully accepted the invitation extended by the Delegation of the Soviet Union to host a 1990 intersessional meeting of WG-CEMP scheduled to be held adjacent to the meeting of WG-Krill.

5.42 The Delegation of the United Kingdom felt that if a joint meeting was not possible, a separate meeting of WG-CEMP at a different time and place (which would then principally involve predator-related matters), could not be justified on the basis of the agreed priority tasks in hand (SC-CAMLR-VIII/11, paragraph 35). In these circumstances they would prefer to see the next WG-CEMP meeting postponed until 1991 (and held then in conjunction with WG-Krill). In the meantime the single really urgent matter (revision of the Standard Methods booklet), would be dealt with by correspondence in the Scientific Committee intersessional period.

Convener

5.43 Dr Kerry had informed WG-CEMP that he wished to retire as Convener. The Scientific Committee thanked him for his role in guiding CEMP through its first six years, during which great progress had been made. Dr J. Bengtson (USA) was proposed and unanimously supported as the new Convener.

ADVICE TO THE COMMISSION

5.44 The Scientific Committee advised the Commission of the urgent need to accord some form of protection to CEMP land-based sites. It drew the Commission's attention to the reasons set out in Annex 7, paragraphs 20 and 21.

5.45 The Scientific Committee drew the attention of the Commission to the recommendation (paragraph 5.11 (a)) that, once data submission protocols are agreed, Members monitoring approved parameters of selected species at nominated sites using approved standard methods should submit these data to the Secretariat annually by 30 September. Where retrospective data, conforming to the same criteria, exist, these should also be submitted as soon as possible.

5.46 The Scientific Committee recommended that WG-CEMP should meet in 1990 in association with the meeting of WG-Krill.

MARINE MAMMAL AND BIRD POPULATIONS

6.1 At the Seventh Meeting of the Scientific Committee, a summary of information on the status and trends of marine mammal and bird populations was reviewed (SC-CAMLR-VII/9). This summary had been prepared with the assistance of the SCAR Sub-Committee on Bird Biology, the SCAR Group of Specialists on Seals, and the Scientific Committee of the International Whaling Commission.

6.2 During the intersessional period, the Executive Secretary asked the Conveners of the SCAR Group of Specialists on Seals and the SCAR Sub-Committee on Bird Biology if they would be prepared to continue to assemble and update data pertaining to the status and trends in Antarctic seal and bird populations. The Chairman of the Bird Biology Sub-Committee responded that a review of bird populations will be initiated at its next meeting (to be held in 1990), concluded at its 1992 meeting, and the results made available prior to the 1992 Meeting of the CCAMLR Scientific Committee. The Secretary of the Seals Group indicated that a review of seal populations would be undertaken on a schedule similar to the one outlined above.

6.3 Dr Kerry drew the attention of the Scientific Committee to the Report of the CCAMLR Observer to the latest meeting of the International Whaling Commission's Scientific Committee (SC-CAMLR-VIII/10). This document lists recent estimates of whale populations based on data from IDCR/IWC sightings cruises.

6.4 The Scientific Committee agreed that a comprehensive review of Antarctic seal and bird populations should be undertaken every five years, which is consistent with the timetable indicated by the SCAR groups.

6.5 It was noted that scheduling a comprehensive review of marine mammal and bird populations every five years does not preclude raising issues pertaining to the status of these populations at any time when discussion of such topics seem warranted.

6.6 E. Marschoff, noting the decline in southern elephant seal (*Mirounga leonina*) populations in some sectors of the Antarctic, suggested that the SCAR Group of Specialists on Seals and the SCAR Sub-Committee on Bird Biology should be asked to provide advice to the Scientific Committee when significant population declines are identified. The Scientific Committee agreed to seek such advice, specifically requesting guidance concerning:

(a) the likely or possible causes of particular marine mammal and bird population declines; and

(b) steps that might be taken to halt these declines.

6.7 Dr Croxall noted that new information pertaining to the declining populations of wandering albatross (*Diomedea exulans*) has recently become available (CCAMLR-VIII/BG/6). There is now considerable evidence that this population decline is due principally to incidental mortality by injury or entrapment from active gear in longline fisheries on tuna outside the Convention Area.

6.8 The Chairman had been asked by the Commission to correspond with the Conveners of the SCAR Group of Specialists on Seals and the SCAR Sub-Committee on Bird Biology concerning incidental mortality, ingestion of plastics, and entanglement in marine debris. The Sub-Committee on Bird Biology noted that the incidence of plastic ingestion by seabirds within the Convention Area is geographically widespread and includes a high proportion of species as well as a high proportion of individuals within certain populations. The Sub-Committee also made specific suggestions for appropriate research and monitoring. The reply from the Seals Group suggested standardizing a sampling scheme at breeding colonies to monitor the incidence of entanglement of pinnipeds in marine debris. The Seals Group also indicated the need for CCAMLR to acquire more detailed information on seal entanglement at sea in order to assess the magnitude of this problem.

6.9 The Scientific Committee noted that although issues pertaining to the assessment and avoidance of incidental mortality are currently being addressed in the Commission, it would be desirable and appropriate for the Scientific Committee to consider these topics and provide advice to the Commission on recommended actions. The Scientific Committee agreed that in the future, it would consider these issues either as part of discussions on marine mammal and bird populations or under a separate agenda item.

DEVELOPMENT OF APPROACHES TO CONSERVATION OF ANTARTIC MARINE LIVING RESOURCES

7.1 During the last meeting of the Commission, advice was sought from the Scientific Committee (CCAMLR-VII, paragraphs 140 to141) on:

"operational definitions for depletion and target levels for recovery of depleted species", and

"the ability of the CCAMLR Ecosystem Monitoring Program to detect changes in ecological relationships and to recognise the effects of simple dependencies between species including distinguishing between natural fluctuations and those induced by fisheries".

7.2 Following correspondence between the Chairman of the Scientific Committee and the Commission's Working Group for the Development of Approaches to Conservation of Antarctic Marine Living Resources (WG-DAC) during the intersessional period, these matters were referred to the specialist working groups of the Scientific Committee; the Working Group on Krill (WG-Krill), Working Group on Fish Stock Assessment (WG-FSA), Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP), and to the Workshop on the Krill CPUE Simulation Study (WS-KCPUE) for comments which might be taken into account by the Scientific Committee in providing advice to the Commission.

7.3 All working groups had considered the Commission's questions, but none had been able to devote sufficient time to consider them in depth. The responses were recorded in the groups' reports, and relevant excerpts were compiled by the Secretariat for the consideration of the Scientific Committee (SC-CAMLR/BG/56).

7.4 The Krill CPUE Simulation Study Workshop noted that the ability to detect changes in krill abundance from CPUE data is limited (see paragraphs 2.16 and 2.19). It further noted that the implications of this for a conservation strategy were a matter for the WG-Krill in the first instance.

7.5 The WG-Krill agreed that at this stage it had no contribution to make to the preparation of the advice to the Scientific Committee on the Commissions's questions, but that at some stage it may be able to assist WG-CEMP in the provision of its advice on krill parameters.

7.6 In this context, the Scientific Committee also considered SC-CAMLR-VIII/BG/17. On introducing the paper, Mr Miller indicated that in his view, the approach outlined, although focussing on krill (see also paragraph 2.30), had some applicability in the broader context of development of an operational management procedure for marine living resources in the Convention Area. The approach is one already being used by other international fishery

organizations (IWC, ICSEAF and ICES) and its development is based on four active principles. These are that there should be:

(a) a basis for assessment of the status of a resource in the region under consideration (an "estimator");

(b) an algorithm for specifying appropriate levels of regulatory activities (a "catch control law") which is a function of the assessment;

(c) a basis for assessing the performance of the management procedure (related to the two components above); and

(d) an operational definition of Article II of the Convention to provide criteria against which performance can be assessed.

The management procedure being suggested thus consists of a combination of a "control law" and an "estimator" ((a) and (b) above).

7.7 The overall approach espoused in the paper was not claimed to be the only one available and both the Soviet and Japanese Delegations expressed some reservations about some of the assumptions underlying its formulation with respect to the krill fishery.

7.8 Dr Shimadzu was of the opinion that an alternative or more direct approach should be given priority over the development of simulation models. Such an approach would estimate krill biomass in areas being fished, the advection of krill in and out of fishing areas, rates of exploitation of krill and the amount of krill taken by predators within fishing areas. The last point in particular would be important for the evaluation of the potential impact of krill fishing activities on local predators.

7.9 Mr Miller made the point (as is made in SC-CAMLR-VIII/BG/17) that it is inadequate to offer reservations alone. What must also be provided is alternative, and presumably better, assumptions, or indications of the extent to which the original assumptions may be in error. It is precisely such information which is relevant to testing any management procedure that may be suggested; not just the one detailed in the paper.

7.10 The Scientific Committee welcomed this initiative, and Dr Lubimova in particular emphasized the seriousness of the matters being addressed, and the need for in-depth

consideration of them. The Scientific Committee therefore agreed that approaches to management of the krill fishery such as that discussed in SC-CAMLR-VIII/BG/17 should be referred to the WG-Krill for detailed consideration.

7.11 The WG-FSA noted that a useful working definition of the stock level where recruitment may be impaired would be the lowest spawning stock biomass estimated for the stock. Hence if the current spawning stock was the lowest observed, the aim of management should be to ensure that future stock levels do not drop below this level. It was noted in SC-CAMLR-VIII/BG/47 that, taking into account the average spawning stock size over a number of years, the corresponding coefficients of variation and the number of years when the spawning stock size was low, a certain level was introduced as a measure of spawning stock stability. The WG-FSA further noted that there were a number of significant uncertainties associated with the assessment of all stocks considered.

7.12 The WG-CEMP noted the progress made in the definition of the accuracy and precision of estimates of predator parameters being monitored. They were investigating the possibility of distinguishing between changes in food availability that result from commercial harvesting and changes due to natural fluctuations in the biological and physical environment. Because of the complexity of this topic and the possible need for modelling studies, they noted that advice could not be provided at present and that further work and discussion will be needed.

7.13 Dr Croxall introduced SC-CAMLR-VIII/9, which reviewed the feasibility of using indices of predator status and performance (i.e. the predator parameters being monitored by the CEMP) as part of CCAMLR fishery management strategies.

7.14 The paper suggested that it was relatively straightforward and highly desirable to devise a system for annually assessing the overall pattern of changes in indices at the levels of parameter, species, site and area. Management recommendations would arise from considering the patterns of change in predator indices in the light of available relevant biological and physical environmental data. Such recommendations would only be likely where there is evidence of significant broad-scale general effect, or of acute effects at more local levels. This would apply, however, even when there was no evidence that harvesting is, or has been, a contributing factor. The logic for this is that if predator populations may be in trouble, any level of harvesting if conducted at critical times and places may have significant adverse effects. Examples of possible management action, involving restrictions on krill catch size, timing and location were compared from the perspectives of ease of implementation, consequences for the fishery and the probability of aiding predators.

7.15 Dr Lubimova expressed reservations about paragraph 7.14 and noted that they contained a number of speculative ideas based on an approach to the problem solely from the perspective of predators. In spite of the fact that the document was distributed to the Members in all the agreed languages of the Commission, these ideas have not been discussed in any real detail at this meeting.

7.16 There was general agreement that such approaches as outlined in SC-CAMLR-VIII/9 and the comments contained in paragraph 7.15 merited further investigation and development and WG-CEMP was encouraged to discuss this whole topic at its next meeting.

7.17 From these considerations, two broad areas of the work of the Scientific Committee were identified as contributing to the development of approaches to conservation:

(a) actual work at assessment level in key areas involving coordination and integration of studies which would enable definition of appropriate management options. An example would be investigation of the krill flux in the South Shetlands/Peninsula area combined with determination of the impact of predators on stocks, leading to drawing up a budget of predator prey interactions; and

(b) the wider task of evaluating the effectiveness of approaches to management adopted by the Commission in the light of the objectives of the Convention. It was suggested that the fundamental problem is how to deal with the uncertainty of the assessments that can be made.

7.18 The Scientific Committee agreed that it was important for more time and effort to be devoted to both of these areas of work. It was therefore agreed that, in addition to the consideration of the matters referred to in paragraphs 7.14 and 7.15 above, the specialist working groups should reconsider the Commission's questions and the wider issue of development of appropriate approaches to conservation in the light of the Scientific Committee's consideration of the issue. It was recognized that there had been relevant work done by Members, particularly in the context of the Commission's WG-DAC, which would assist in this consideration.

7.19 It was recognized that the data requirements for different conservation approaches may be vastly different and the cost of pursuing inappropriate approaches could be high. It was therefore agreed that the Commission should be asked for more specific guidance on the strategic issues it would like the Scientific Committee to consider and provide advice on.

COOPERATION WITH OTHER ORGANIZATIONS

8.1 The CCAMLR Scientific Committee was represented at the following meetings during the intersessional period:

77th Statutory Meeting of ICES, Dr O. Østvedt (SC-CAMLR-VIII/BG/55)

1989 Annual Meeting of the IWC Scientific Committee, Dr W de la Mare (SC-CAMLR-VIII/10)

Meeting of the BIOMASS Executive, Prof. J.-C. Hureau

EPOS-related meetings, Prof. J.-C. Hureau

8.2 The observers to ICES and IWC Scientific Committee presented their reports to the Scientific Committee. As Prof. Hureau was not present, Dr Kock reported on EPOS related meetings, and Dr Croxall reported on the meeting of the BIOMASS Executive. Dr Croxall also reported that the SCAR Workshop in Norway on "Ecology of the Antarctic Sea Ice Zone", which Prof. Hureau was to have attended as SC-CAMLR observer, had been postponed until 17 to 24 May 1990.

8.3 In presenting his report on the ICES meeting, Dr Østvedt noted that the Secretariat held abstracts of papers presented at the ICES meeting, and mentioned that the work of a number of ICES working groups was relevant to the work of the Scientific Committee, particularly in relation to collection of environmental monitoring data and stock assessment techniques. The work of working groups dealing with the application of hydroacoustic methods to zooplankton and mesh selectivity was also mentioned.

8.4 In presenting his report on the IWC Scientific Committee meeting, Dr de la Mare discussed the progress being made in the evaluation of assessment methodology and alternative management procedures. He also reported on the latest population estimates of the large whales of the Southern Ocean, noting that even allowing that there are high coefficients of variation for the estimates, the numbers are low, but the estimates in some cases require adjustment for incomplete survey coverage and that further revisions could be expected.

8.5 The Scientific Committee was informed that SCAR had published "The Biology and Ecology of Antarctic Krill - A Review", (D. Miller and I. Hampton), BIOMASS Scientific

Series No. 9, 1989, with financial support from CCAMLR. The Chairman noted that copies of the publication had been sent to the Secretariat.

8.6 Dr Croxall noted that the BIOMASS Executive had decided that the colloquium for final evaluation of the BIOMASS program is now to be held from 18 to 21 September 1991 back to back with the SCAR Antarctic Science Conference in Federal Republic of Germany. Before the colloquium, a suite of workshops finalising evaluation of SIBEX data will be held. Once details of these are available, they will be provided to the Secretariat. The Executive also discussed the future of the BIOMASS Data Centre. The centre will remain at the British Antarctic Survey, Cambridge until 1994. If funding for its maintenance is not available after that date, the Executive recommended that it be transferred to the CCAMLR.

8.7 Dr Kock noted that there will be a meeting in early December in Texel, Netherlands to discuss the results of the first two EPOS cruise legs, and a Workshop on fish research conducted as part of EPOS tentatively scheduled for 1990 .

8.8 The Observer from SCAR (Dr Kerry) noted that SCAR XXI will be held in Sao Paulo, Brazil from 15 to 27 July 1990, and that the Sub-Committee on Bird Biology and the Group of Specialists on Seals are both to meet then.

8.9 The Observer from IOC (Dr P. Rothlisberg) submitted a paper (SC-CAMLR-VIII/BG/57) on IOC activities in the Southern Ocean. The paper had earlier been submitted to the Fifteenth Antarctic Treaty Consultative Meeting. He also mentioned IOC activities of relevance to CCAMLR which were not detailed in the paper, including the OSLR (Ocean Science in Relation to Living Resources) Program.

8.10 The proposal from the United Nations Environment Program (UNEP) that CCAMLR sign a Memorandum of Understanding on the Global Plan of Action for Conservation, Management and Utilisation of Marine Mammals was discussed. The proposal, to be discussed in the Commission, is detailed in CCAMLR-VIII/8, and the objectives of the Global Plan are summarized in CCAMLR-VIII/BG/13.

8.11 The Scientific Committee agreed that the appropriate response to the proposal would be for the Executive Secretary to convey to UNEP that the provisions of CCAMLR, the Convention for the Conservation of Antarctic Seals (CCAS) and other elements of the Antarctic Treaty System adequately address the relevant parts of the Global Plan as it applies to the Antarctic and that CCAMLR would be happy to provide UNEP with reports of its work which might be of relevance.

8.12 After consideration of the reports of observers, it was agreed that the Scientific Committee would be represented at future meetings as indicated below:

78th Statutory Meeting of ICES, 1 to 12 October, Copenhagen, Denmark,

- Dr O. Østvedt

1990 Annual Meeting of the IWC Scientific Committee, 10 to 23 June 1990, Noordwilkerhout, Netherlands

- Dr W. de la Mare

SCAR Workshop on "Ecology of the Antarctic Sea Ice Zone", 17 to 24 May 1990, Norway

- Prof. J.-C. Hureau, or if he is unable to assume this role, Dr J. Croxall

XXIth Meeting of SCAR, Sao Paulo, Brazil

- Dr J. Croxall

REVIEW AND PLANNING OF THE PROGRAM OF WORK OF THE SCIENTIFIC COMMITTEE

ACTIVITIES IN THE INTERSESSIONAL PERIOD

9.1 In previous years the Chairman of the Scientific Committee, in consultation with the Conveners of the Working Groups, had drafted plans of intersessional activities with the aim of assisting the Secretariat in organizing its work. Last year it was decided that such a plan would also be of assistance to all Members in preparation for the annual meetings of the Scientific Committee and its subsidiary bodies (SC-CAMLR VII, paragraphs 8.1 to 8.2) Accordingly a schedule of activities was prepared and distributed shortly after the meeting.

9.2 The Scientific Committee agreed that the plan had been useful and the practice should be repeated.

COORDINATION OF FIELD ACTIVITIES FOR THE 1989/90 AND 1990/91 FIELD SEASONS

9.3 The Scientific Committee last year requested the Secretariat to maintain, annually update and distribute a summary of national research plans (SC-CAMLR-VII, paragraph 8.8). The summary is to be used by Members and the Scientific Committee for the coordination of

national research programs in support of CCAMLR. The specific aspects of coordination of field research will be handled by the Scientific Committee's specialist working groups.

9.4 Following the Scientific Committee's decision, the Secretariat requested national CCAMLR representatives for information on planned research in the 1989/90, 1990/91 and 1991/92 seasons. A summary of research plans of Members for these seasons was later compiled by the Secretariat and distributed as SC-CAMLR-VIII/BG/3.

9.5 It was emphasized that these are not statements that activities are definitely to take place, but indications of activities that it is hoped will take place, and which may present opportunities for collaboration.

9.6 It was pointed out that the request for this information was sent out shortly after that for Reports of Members' Activities and that the two involved similar, but not identical information which complicated the task of its compilation for some Members. It was also pointed out that SC-CAMLR-VIII/BG/3 had only become available very late in the meeting and still did not include information on some Members' plans, limiting its usefulness in facilitating coordination of research.

9.7 It was agreed that the Secretariat should be asked to look at the range of information requested of Members and presented to the Commission and Scientific Committee, not with a view to a change in the information required, but to review the means and timing of requests for the information, the format in which it is presented, and the time it is presented to the Scientific Committee.

9.8 Last year Dr I. Barrett (USA) informed the Scientific Committee of a special methodology used in the Southwest Fisheries Centre (La Jolla) for elaboration of a strategic framework on long-term research plans (SC-CAMLR VII, paragraph 8.11).

9.9 Dr Barrett reported to the Scientific Committee that he had submitted additional documentation on the method to the Secretariat, as he had undertaken, and had introduced it to participants in the meeting of the WG-Krill, held at the Centre during 1989. This is reported in SC-CAMLR-VIII/4, paragraphs 97 and 98. He also referred to a paper on strategic planning for the US Antarctic Marine Living Resources Program (SC-CAMLR-VIII/BG/50) which briefly describes an application of the process. Participants included some Members of the CCAMLR Scientific Committee.

BUDGET FOR 1990 AND FORECAST BUDGET FOR 1991

10.1 The Scientific Committee developed a proposal for the 1990 Budget and the Forecast Budget for 1991 in accordance with the recommendations made for activities during the forthcoming intersessional period. The proposed Budgets for 1990 and 1991 as approved by the Commission are given in Annex 8.

ELECTION OF VICE-CHAIRMEN OF THE SCIENTIFIC COMMITTEE

11.1 E. Marschoff (Argentina) nominated Dr T. Lubimova (USSR) and Dr Y. Shimadzu (Japan) nominated Dr G. Duhamel (France) as Vice-Chairmen of the Scientific Committee. In making the nominations, E. Marschoff and Dr Shimadzu referred to the considerable experience of Dr Lubimova and Dr Duhamel in Antarctic marine research, their active participation in, and valuable contributions to the work of the Scientific Committee, and their existing record of collaboration.

11.2 Dr Lubimova and Dr Duhamel were unanimously elected as Vice-Chairmen of the Scientific Committee for the period from the end of the Eighth Meeting until the end of the Scientific Committee meeting in 1991, in accordance with Rules 3 and 8 of the Rules of Procedure.

11.3 The Chairman congratulated the new Vice-Chairmen on their election. He also paid tribute to their predecessors, E. Marschoff and Dr Shimadzu, and thanked them for their continued support and valuable contributions to the work of the Scientific Committee during the past two years.

NEXT MEETING

12.1 In accordance with discussions held during the 1988 Meeting, hotel bookings have been made in Hobart for the Ninth Meeting of the Scientific Committee and Commission for the period 21 October to 2 November 1990.

12.2 It was noted that the WG-FSA meeting has been planned in association with the Ninth Meeting of the Scientific Committee, and is tentatively scheduled for the period from 9 to 18 October 1990.

12.3 The timing and venue of future meetings will be discussed by the Commission.

OTHER BUSINESS

ACCESS TO AND USE OF CCAMLR DATA

13.1 The Scientific Committee discussed the purposes and circumstances under which data submitted to the CCAMLR Data Centre could be used. The status and appropriate use of documents tabled at meetings of the Commission, the Scientific Committee, or any of their subsidiary bodies were also discussed. In particular, the results of previous discussions within the WG-FSA (SC-CAMLR-VII, paragraph 3.3) and the WG-CEMP (SC-CAMLR-VIII/6, paragraphs 116 to 118) were considered.

13.2 The Scientific Committee stated its understanding (paragraphs 13.3 to 13.7) regarding the appropriate uses of CCAMLR data and papers. The Scientific Committee recommended that the Commission should confirm whether or not the Scientific Committee's understanding is correct.

13.3 All data submitted to the CCAMLR Data Centre should be freely available to Members for analysis and preparation of papers for use within the CCAMLR Commission, Scientific Committee, and their subsidiary bodies.

13.4 The originators/owners of the data should retain control over any use of their unpublished data outside of CCAMLR.

13.5 When Members request access to data for the purpose of undertaking analyses or preparing papers to be considered by future meetings of CCAMLR bodies, the Secretariat should supply the data and inform the originators/owners of the data. When data are requested for other purposes, the Secretariat will, in response to a detailed request, supply the data only after permission has been given by the originators/owners of the data.

13.6 Data contained in papers prepared for meetings of the Commission, Scientific Committee, and their subsidiary bodies should not be cited or used in the preparation of papers to be published outside of CCAMLR without the permission of the originators/owners of the data. Furthermore, because inclusion of papers in the "Selected Scientific Papers" series or any other of the Commission's or Scientific Committee's publications constitutes formal publication, written permission to publish papers prepared for meetings of the Commission, Scientific Committee and Working Groups should be obtained from the originators/owners of the data and authors of papers.

13.7 The following statement should be placed on the cover page of all unpublished working papers and background documents tabled:

> This paper is presented for consideration by CCAMLR and may contain unpublished data, analyses, and/or conclusions subject to change. Data contained in this paper should not be cited or used for purposes other than the work of the CCAMLR Commission, Scientific Committee, or their subsidiary bodies without the permission of the originators/owners of the data.

ENVIRONMENTAL DATA COLLECTION

13.8 Dr Barrett noting Dr Lubimova's comments on the need for more cooperation, made a proposal to contribute to the collection of environmental data. This involved the development of a standardized grid of oceanographic stations throughout the CCAMLR Convention Statistical Areas and a suite of data collection methods which would initially be applied, as far as possible, by any vessel at a station. Dr Barrett offered to prepare a tentative station pattern and suite of methods for consideration by the Working Groups of the Scientific Committee.

13.9 The proposal received general support, although it was recognized that the establishment of such a program would be beyond the scope of existing working groups. It was also recognized that this program may overlap with some existing international programs such as the Joint Global Ocean Flux Study (JGOFS) and the International Geosphere Biosphere Program (IGBP)and others referred to in SC-CAMLR-VIII/BG/57.

13.10 It was agreed that the Scientific Committee would welcome an indication from Dr Barrett as to the development of the program, including the criteria for station selection, and information on the scope of other initiatives, to prevent overlap and duplication.

SCIENTIFIC COMMITTEE PAPERS

13.11 Dr Shimadzu raised three points in relation to papers submitted to the Scientific Committee's meeting:

(a) some papers had been dealt with by working groups and need not be submitted to the Scientific Committee; . .

(b) some papers may not have been given the degree of consideration that might have been warranted; and

(c) many papers arrived after the deadlines for submission, precluding early distribution.

13.12 In relation to (a) it was agreed that a paper should not be re-submitted after consideration by a working group unless it had been revised in the light of that consideration, in which case this should be indicated by the author of the paper in the revised draft. It was also agreed that Members should target their papers correctly; to a working group, as a background paper to discussion or as a working paper.

13.13 As a general response to these problems, it was proposed that the Chairman review all background papers received by the deadline with a view to determining whether they were germane to the item proposed and had been correctly targeted. The results of this review, including considerations of which papers it was not appropriate to consider, should be discussed with Scientific Committee representatives at the meeting just prior to the commencement of the annual meeting. Those papers received after the deadline would not be submitted to the Scientific Committee or its Working Groups unless they were the result of requests from the Commission or Scientific Committee.

APPLICATION BY ASOC FOR OBSERVER STATUS

13.14 Late in the meeting the Chairman received a letter from Ms L. Goldsworthy (ASOC Observer to the Commission) which requested access to the Scientific Committee as an observer. It was recalled that the Commission had decided that the ASOC observer should only have access to the plenary sessions of the Commission (CCAMLR-VIII, paragraphs 153 to 156). Some Members supported ASOC's involvement in the Scientific Committee's work, but it was agreed that the decision on the issue should be made in the Commission.

RULES OF PROCEDURE

13.15 A proposal had been made for a change in Rule 8 of the Rules of Procedure to ensure that a Chairman of the Scientific Committee is not also a representative of or adviser to a Member. This paralleled a proposal made to the Commission. It was pointed out that changes to the Scientific Committee's Rules of Procedure must be endorsed by the Commission.

ADOPTION OF THE REPORT

14.1 The Report of the Eighth Meeting of the Scientific Committee was reviewed and adopted.

CLOSE OF THE MEETING

15.1 The Chairman thanked Members and other participants, in particular the Conveners of Working Groups and Rapporteurs, for their cooperation and support. He thanked the interpreters for their forebearance. He especially singled out the Secretariat, conveying his gratitude for their efforts in meeting the deadlines for the preparation of documents, their translation and all other aspects of support for the meeting. He commended the Executive Secretary for having drawn together such a competent and efficient team.

Appendix 4
Antarctic Ecosystem Research Group
Southwest Fisheries Center
P.O. Box 271
La Jolla CA 92038

CRUISE PLAN
(November 9, 1989)

Pacific Marine Center Cruise Number SU-89-02
Project Instructions

Description: Replicate observations of 1) the physical structure of the upper water column, 2) phytoplankton abundance and primary productivity, 3) krill abundance, distribution and physical condition, and 4) krill predator foraging behavior and reproductive success will be made around Elephant Island, Antarctica. Additional operations include the collection of detailed bathymetric data, tissue samples from mysticete whales, sediment cores, and pelagic bird observations. Post-cruise analyses of these observations will help form the basis for advice given to the United States delegation to the Convention on the Conservation of Antarctic Marine Living Resources.

Vessel: NOAA Ship *Surveyor*

Operating Area: Elephant Island, Antarctica

Itinerary: Depart Seattle 27 November 1989
Return Seattle 15 April 1989
127 days at sea; 14 days in port

			Sea Days	Port Days
Transit Seattle to San Diego	27 Nov	- 2 Dec 1989	6	
Overnight in San Diego	2 Dec			0
Transit San Diego to Valparaiso	3 Dec	- 21 Dec	19	
Port call in Valparaiso	22 Dec	- 23 Dec		2
Transit Valparaiso to Punta Arenas	24 Dec	- 29 Dec	6	
Port call in Punta Arenas	30 Dec	- 31 Dec		2
Leg I	1 Jan	- 30 Jan 1990	30	
Port call in Punta Arenas	31 Jan	- 3 Feb		4
Leg II	4 Feb	- 5 Mar	30	
Port call in Punta Arenas	6 Mar	- 7 Mar		2
Transit Punta Arenas to Callao, Peru	8 Mar	- 17 Mar	10	
Port call in Callao	18 Mar	- 20 Mar		3
Transit Valparaiso to San Diego	21 Mar	- 10 Apr	21*	
Port call in San Diego	11 Apr			1
1Transit San Diego to Seattle	12 Apr	- 16 Apr	5	
			127*	14

* Includes 6 days-at-sea charged to the NOAA/NOS Office of Coastal Resource Management.

Objectives and Operational Plan (Southbound Transit):

1. Collect Seabeam data along a GEOSAT trackline and over the eastern portion of the Sala y Gomez Ridge. The trackline, from a point outside San Diego to the beginning of the Sala y Gomez survey, coincides with the GEOSAT trackline. The Sala y Gomez ridge will be intersected at its western end at approximately 27.00° South, 97.45° West on a southeasterly course. After crossing the ridge, the ship will turn approximately 65° from north to transect the ridge. At approximately 24.30° South, 87.30° West the ship will set course for Valparaiso, crossing the ridge again.

   Preprocessed Seabeam data, navigational data, tracklines and preliminary maps will be provided to Dr. David Sandwell for final processing at Scripps Institution of Oceanography.

Objectives and Operational Plan (Leg I):

1. Re-provision Seal Island shore camp and retrograde trash. Approximately 300 cubic feet of material will be landed on a beach on the southwestern side of Seal Island (north of Elephant Island); alternate landing sites exist on the northwestern and northeastern sides of the island. The supplies will be boxed, sealed, palletized and loaded aboard the *Surveyor* in Seattle. The project will provide two Zodiac Mark V's and four outboard motors for this purpose. (NOTE: The Seal Island field team will be transported to Seal Island by Society Expeditions aboard the ship *Society Explorer* on either the 10th or 15th of December. If both of these attempts are unsuccessful, the field team will transfer to the ship *World Discoverer* on December 20 in the Falklands and try again to access Seal Island on the 28th of December.)

   The ship will provide 4 divers, a crane operator, and 4-6 deckhands to assist this operation. The Command will also be asked to hold radio guard for Seal Island on specified VHF and SSB frequencies; radio guard will be held by Palmer Station before the ship arrives in the operating area and between cruise legs.

2. Conduct hydroacoustic survey for krill around Elephant Island. Two 7-day surveys will be conducted; one at the beginning of each cruise leg, and one at the end of each cruise leg. The acoustic transducer will be deployed on a V-fin depressor and towed at 6-8 knots. Signal processing equipment will be located on the bridge deck. Operations will be conducted 24 hours per day with breaks for directed sampling (Objective 5). Surveys will also be interrupted for CTD/rosette casts (Objectives 3 and 4).

   The ship will provide a winchman and a deckhand to help deploy and recover the hydroacoustic fish.

3. Conduct CTD/rosette casts. A series of CTD/rosette casts will be conducted to 500 m, or 90% of the water depth if shallower than 500 m. A Sea-Bird SBE-9 CTD instrument will be supplied by the project and used in conjunction with a ship supplied rosette and 10-liter bottles. The ship's Sea-Bird unit will be used as backup. Operations will be conducted 24 hours per day; the station grid will be occupied twice during each cruise leg. Data acquisition equipment will be located on the bridge deck. Salinity calibration equipment will be located in the forward oceanographic lab. A portable weather system will be installed on the flying bridge with cable leading to bridge deck. Continuous sea surface temperature and salinity measurements will be required from the ship's thermosalinograph.

   The ship will provide a winchman, one deckhand to help deploy and recover the CTD/rosette, and another deck hand to tend the hydroacoustic fish.

4. Sample phytoplankton and conduct primary productivity measurements. Water samples will be obtained via rosette at ten standard depths (2, 5, 10, 15, 20, 30, 40, 50, 100, and 200 m), and drained immediately into polycarbonate bottles for analyses. Analyses will include chlorophyll-a measurement, particulate organic carbon and nitrogen measurement, primary production measurement using standard C^{14} techniques, ATP content, size fractionation, and floristics. Continuous vertical profiles of particulate matter and ambient light will also be made with instruments mounted on the rosette. Operations will be conducted 24 hours per day; the station grid will be occupied twice during each cruise leg. Laboratory equipment will be located in the 8-foot laboratory van.

   An incubator (4'x 6') will be located on the helo pad; the ship will supply it with running salt water.

5. Sample krill using MOCNESS, MIK and bongo nets. Objectives will be to 1) obtain representative samples of krill length, weight, maturity stage, moult stage, sex ratio, reproductive condition, and gut fullness; and 2) describe the vertical distribution of krill. Sampling will be opportunistic, interrupting the hydroacoustic survey whenever high densities of krill are encountered. Approximately 20-hours per survey will be initially devoted to direct sampling. Direct sampling effort will be adjusted such that the survey (hydroacoustic transects, CTD/rosette casts, and net sampling) is completed within 7 full days (168 hours).

   The ship will provide a winchman to operate the J-frame and winch, and a deckhand to help deploy and recover nets.

6. Conduct fur seal and penguin tracking studies. Radio-direction finding equipment will be used to follow fur seals and penguins as they make foraging trips to sea from their breeding colonies ashore at Seal Island. Radio transmitters will be attached to animals ashore, and the following monitoring gear will be used aboard *Surveyor*: 1) four 4-element Yagi antennae will be mounted near the top of the forward mast, with 4 coaxial cables running to the bridge, 2) a radio receiver and automatic direction finder will be monitored on the bridge, and 3) a DC power source (gel cell) will power the direction-finding system. The direction of the fur seal or penguin from the ship will be determined with this equipment, and the officer on watch will be advised what course the ship should follow to maintain contact with the animal being tracked.

   Tracking will proceed as follows: 1) the *Surveyor* will stand off Seal Island (approximately 1-2 nm) waiting for a seal or penguin to depart on a feeding trip; 2) the ship will follow this individual out to its foraging area, which may be 15-50 nm offshore; 3) the ship will stay with the fur seal or penguin until it is clear that the individual has settled into a specific foraging area; and 4) the ship will return to Seal Island to pick up another individual to follow. The field team will stand 4-hour watches around the clock throughout the tracking period. A detailed record of the ship's position and track line is essential for these operations.

   When practical, hydroacoustic data will be collected during tracking operations. Net sampling will also be conducted at the termination of a track.

Two members of the Seal Island party will be picked up prior to this operation and returned to Seal Island at its completion. The antennae base and coaxial cables will be installed prior to the ship's departure from Seattle. To prevent damage during transit, the antennae elements will be mounted in the field.

7. Collect Seabeam data. Detailed bathymetric data will be collected on an opportunistic basis. Areas of particular interest include the Shackleton Fracture Zone (extending from a point west of the mouth of Beagle Channel to Elephant Island), the region around Elephant Island, Bransfield Strait, and an area to the northeast of Clarence Island. Preprocessed Seabeam data, navigational data, tracklines and preliminary maps will be provided to Dr. Lawrence Lawver at the end of the second leg for final processing at the University of Texas at Austin.

8. Collect biopsy samples from mysticete whales. Standard sighting and photographic surveys will be conducted for humpback and right whales. If concentrations of three or more whales are sighted and if sea conditions are favorable (wind less than 20 kt and wind chop less than 3-feet) a small boat will be launched to photograph individuals and obtain samples of skin tissue using a crossbow and biopsy darts. The small boat (either a project-supplied Zodiac Mark V or the *Surveyor*'s RHIB) will work within visual range of the ship. This is a second-order priority item to be conducted on a time-available basis; it may be possible to allow the small boat to work while the ship continues to conduct higher priority operations.

   The ship will provide a boat driver for this operation.

Objectives and Operational Plan (Leg II):

1. Conduct hydroacoustic survey around Elephant Island; same as Leg I.

2. Conduct CTD casts on Elephant Island survey grid; same as Leg I.

3. Sample phytoplankton and conduct primary productivity measurements on Elephant Island survey grid; same as Leg I.

4. Sample krill using MOCNESS, MIK, and bongo nets; same as Leg I.

5. Conduct ice seal studies. Various bays and channels in the vicinity of the Antarctic Sound or Erebus and Terror Gulf will be visited to find groups of crabeater seals in suitable habitat (loose ice floes in protected embayments). The objectives of the study will be to deploy satellite-linked transmitters on selected seals and to collect specimen material. At each site, a Mark II Zodiac (supplied by the project) will be deployed to gain access to crabeater seals on ice floes. The ship will stand off and be prepared to recover the field party on short notice in the event of deteriorating weather. The field party may be deployed from the ship during any daylight hours, and will return to the ship at the end of each work period. The field team will be prepared to split into two work teams, both of which would be deployed simultaneously in two Mark II Zodiacs. Specimen material will be brought back to the ship for processing.

   The ship will provide 1-2 personnel for this operation.

6. Collect Seabeam data; same as Leg I.

7. Collect biopsy samples from mysticete whales; same as Leg I. The best opportunities for this work may be when the *Surveyor* is supporting the ice seal studies in Antarctic Sound or Erebus and Terror Gulf (Objective 5, Leg II).

   The ship will provide a boat driver for this operation.

8. Recover Seal Island shore party. The Seal Island party and their trash shall be recovered at the end of Leg II. Our intention is to keep the party on the island as long as possible; however, if a favorable weather window occurs anytime during the last four days spent in the vicinity of Elephant Island, the party and their gear shall be recovered.

Objectives and Operational Plan (Northbound Transit):

1. Obtain sediment cores (pending funding). Three sediment cores will be obtained on the Peruvian continental shelf in water depths ranging from 150-400 m. Coring time per site is estimated at 2-4 hours (several attempts may be required to obtain a satisfactory sample). The coring device will be shipped to Valparaiso for loading aboard the *Surveyor* during her March 14-16, 1990 inport. The cores (.2 m square and 3 m long) will be stored in their liners aboard ship and unloaded in San Diego.

   The ship will provide a winch operator and two deckhands to help deploy and recover the coring device.

2. Conduct bird observations. A bird observer will maintain a daylight watch on either the flying bridge or the navigational bridge. The observer will require periodic position information and sea surface temperature and salinity. Of particular interest is a transect 20 miles off the coast of Peru between 15° South and 5° South. The exact northern and southern extent of this transect will be determined by the *Surveyor*'s position relative to daylight hours. The vessel's northbound progress will not be delayed so as to extend the observational window. It may be possible, however, to adjust the position and/or timing of the sediment coring operations (Objective 1, Northbound Transit) so as to maximize the daylight time available for bird observations. The final decision for adjustments to the work schedule shall rest with the Commanding Officer after consultation with the bird observers and the sediment coring group.

Ancillary Projects (to be conducted by the ship's force):

1. Collect and transmit SEAS data in accordance with PMC OPORDER 1.1.1.

2. Collect navigational data from Loran C comparisons in accordance with PMC OPORDER 1.2.4.

3. Conduct bathymetric tracklines, when appropriate, in accordance with PMC OPORDER 1.2.5.

4. Collect marine mammal observations in accordance with Project Instructions RP-12-89, Marine Mammal Reporting Program, 1989.

5. Collect sea turtle observations in accordance with Project Instructions SP-PMC-2-89, Sea Turtle Observation Program, 1989.

Scientific Personnel:

Southbound transit:
Seabeam transects:
David Sandwell, Scripps Institution of Oceanography, male
Mary Ann Lynch, Scripps Institution of Oceanography, female

Leg I:
Cruise Leader:
Roger Hewitt, Southwest Fisheries Center, male
Hydroacoustic survey:
Michael Macaulay, University of Washington, male
Adrian Madirolas, Argentine national, male
CTD/rosette casts:
Anthony Amos, University of Texas, Austin, male
Margaret Lavender, University of Texas, female
Phytoplankton/primary production:
Osmund Holm-Hansen, Scripps Institution of Oceanography, male
Walter Helbling, Scripps Institution of Oceanography, male
Krill sampling:
Valerie Loeb, Moss Landing Marine Laboratories, female
Stephen Berkowitz, Texas A&M University, male
Fur seal and penguin tracking:
John Bengtson, National Marine Mammal Lab, male
Peter Boveng, National Marine Mammal Lab, male
Seabeam surveys:
Sally Zellers, University of Texas at Austin, female
Whale tissue sampling:
Phillip Hamilton, New England Aquarium, male
Kim Robertson, College of the Atlantic, female

Leg II:
Cruise Leader:
Rennie Holt, Southwest Fisheries Center, male
Izadore Barrett, Southwest Fisheries Center, male
Hydroacoustic survey:
Kendra Daly, University of Washington, female
Pat Morrison, University of Washington, female
Sam McClatchie, Cornell University, male
CTD/rosette casts:
Margaret Lavender, University of Texas, female
Phytoplankton/Primary Production
Technician, to be named
Walter Helbling, SIO, male

Krill Sampling:
Valerie Loeb, Moss Landing Marine Laboratories, female
John Wormuth, Texas A&M University, male
Chul Park, South Korean national, male
Ice seal studies:
John Bengtson, National Marine Mammal Lab, male
Peter Boveng, National Marine Mammal Lab, male
Seabeam surveys:
Lawrence Lawver, University of Texas at Austin, male
Kieth Klepeis, University of Texas at Austin, male
Whale tissue sampling:
Phillip Hamilton, New England Aquarium, male
Kim Robertson, College of the Atlantic, female
Seal Island Party (Seal Island to Punta Arenas transit only)
Don Croll, National Marine Mammal Lab, male
Steve Osmek, National Marine Mammal Lab, male
Mike Goebel, National Marine Mammal Lab, male

Northbound transit:
Sediment coring (pending funding):
Thomas DeVries, University of South Carolina, male
Technician, University of South Carolina, to be named
Technician, University of South Carolina, to be named
Bird observations:
Craig Strong, Point Reyes Bird Observatory, male
Debra Jacques, Point Reyes Bird Observatory, female

Appendix 5
Management Sequence for Program Implementation and Review

This appendix describes the sequence of events which will be utilized to manage the implementation and operation of the AMLR Program.

Program Plan

The Program Plan is the overall plan for accomplishing the AMLR Program. It is the responsibility of the AERG Chief to update the plan as the program progresses in order to provide current management planning information for program participants and to obtain concurrence of the Assistant Administrator of NOAA for Fisheries. The plan will be implemented by means of detailed planning documents.

AMLR Program Reports

A. Annual Program Report to Congress

The Chief of the AERG will prepare an annual plan for Congress on the U.S. directed research program in support of the Convention, which is the AMLR Program Plan. This current Plan addresses the FY 1990 research plans and provides projections for the FY 1991, FY 1992, and FY 1993. The plan:

- describes priority research needs for the implementation of the Convention;
- identifies which of those needs are to be fulfilled by the United States; and
- specifies the design of the directed research and the funds, personnel, and facilities required for the research, including research vessel requirements.

B. Financial Management Report

The Chief of the AERG will prepare an annual report which will provide management with necessary data for a complete financial appraisal of the AMLR Program. It will reflect program status in such areas as funds allotted, obligations, estimates versus actual cost, and forecasted commitments by individual projects and for the program as a whole. Manpower and financial management report information from contractors, Universities, and nonprofit institutions shall also be included, where applicable. A report format will be prepared by the AERG to define the scope, schedule, and extent of detailed information required of those elements providing inputs to this report.

C. AMLR Program Review

During 1989, the AERG undertook an extensive strategic planning exercise to determine the optimal plan for AMLR research during the next 10 years. The AERG utilized the principles of interactive management (Delbecq et al 1975)[1], supported by consensus building techniques for facilitating meetings, to produce the elements of the plan. A Southwest Fisheries Center (SWC) Task Force (Table 1) reviewed Convention goals and a history of the AMLR Program in a background document presented to participants of a Strategic Planning Workshop held at the SWC. Workshop participants (Table 1) included the conveners of the SC working groups on krill and fish, the Chairman of the SC, and recognized scientists representing several national programs, NOAA, and academia. The workshop and planning sessions were facilitated by a professional facilitator and the SWC planning officer.

The workshop identified 43 objectives that would contribute to the achievement of Convention goals during the next 10 years. The workshop then identified 76 research options (29 additional options were subsequently identified by the Task Force). These alternatives were reviewed by an Advisory Panel (Table 1) comprised of representatives of the Marine Mammal Commission, Environmental Defense Fund, National Science Foundation, U.S. Department of State, and NMFS Headquarters.

Based upon advice from the Planning Workshop and Advisory Panel, we completed a research plan designed to:

1) Support the work of the Scientific Committee, especially by active participation in the Fish Stock Assessment, CEMP, and Krill Working Groups;

2) Conduct a cohesive, integrated research effort that will allow NOAA to respond to priority information needs of Commission as well as to undertake a program of scientific excellence that will broadly contribute to marine living resource management and conservation in general;

3) Recognize that NOAA has a special opportunity to enhance U.S. research activities in Antarctic marine ecology by emphasizing long-term (i.e., 10 year) studies of natural and anthropogenic interactions in the ecosystem;

4) Select research topics where the U.S. has particular strengths or expertise to contribute;

5) Avoid duplication of research efforts that are being addressed adequately by other national programs; and

6) Focus AMLR research activities on specific, well-defined objectives in

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[1]Dalbecq, A. L., A. H. Van de Ven and D. H. Gustafson. 1975. *Group Techniques For Program Planning -- A Guide To Nominal Group And Delphi Processes.* Scott, Foresman & Co. 174 pp.

selected geographical areas.

This plan was submitted to the 1989 SC for review. This plan served as the basis for the U.S. AMLR Program presented in this document.

The AERG, in consultation with the SWC Task Force, will prepare an annual review of the AMLR research program which will be presented to the Advisory Board for review and advice.

Table 1: Participants In AMLR Strategic Planning Process

WORKSHOP PANEL	
John Bengtson	Alaska Fisheries Center
Inigo Everson	Convention Scientific Comm. (UK)
John Gulland	United Kingdom
Ray Hilborn	University of Washington
Pierre Kleiber	Southwest Fisheries Center
Karl Koch	Convention Fish Working Group (FRG)
Denzil Miller	Convention Krill Working Group (RSA)
Donald Siniff	University of Minnesota
Tim Smith	Northeast Fisheries Center
ADVISORY PANEL	
Robert J. Hofman	Marine Mammal Commission
Bruce Manheim	Environmental Defense Fund
Polly Penhale	National Science Foundation
Tucker Scully	U.S. State Department
Michael Tillman	National Marine Fisheries Service
SWC TASK FORCE	
Izadore Barrett	
Douglas DeMaster	
Roger Hewitt	
Rennie Holt	
Jeffery Polovina	
Paul Smith	
FACILITATORS	
Alexander Christakis	Christakis & Associates
David Mackett	Southwest Fisheries Center

D. Coordination with NSF

The APO, AMLR Chief Scientist, and NMFS management will consult with officials of the Division of Polar Programs, National Science Foundation to coordinate research activities and logistic support related to marine living resources, and to ensure that there is no duplication of effort.

E. Consultation with the U.S. Antarctic Science and Conservation Communities

The AMLR Chief Scientist will consult annually with members of the U.S. Antarctic science and conservation communities concerning research needs and the best means for implementing research necessary to support the Convention.

GLOSSARY OF INSTITUTIONAL ACRONYMS

CCAMLR	CONVENTION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES. Entered into force in 1982.
CCAMLR-SC	CCAMLR-SCIENTIFIC COMMITTEE Established by Article XIV of the Convention
COMMISSION	CCAMLR Decision making body of the Convention established in Article VII
CEMP	CCAMLR ECOSYSTEM MONITORING PROGRAM Established by the SCIENTIFIC COMMITTEE
AMLR	U. S. ANTARCTIC MARINE LIVING RESOURCES Program to implement U. S. participation in the programs of the CCAMLR-SC. Administered by NOAA/NMFS. The AMLR directed Research Program is managed by the Antarctic Marine Ecosystem Group (AERG) at the Southwest Fisheries Center (SWC) in La Jolla California.
NOAA	NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U. S. Department of Commerce
NMFS	NATIONAL MARINE FISHERIES SERVICE, One of five component agencies comprising NOAA. NWS- National Weather Service, NOS- National Ocean Service, NESDIS- National Environmental Satellite Information Service, OAR- Oceanic and Atmospheric Research. These and other agencies can or do participate in the AMLR Program.
NSF	NATIONAL SCIENCE FOUNDATION. The Foundation provides funding for basic scientific research for the U. S. in Antarctica. The Foundation operates under the authority of the Antarctic Conservation Act of 1978 (16 USC 2401-2412). The Division of Polar Programs (DPP) (within NSF Geosciences Directorate), manages the United States Antarctic Program (USAP) under the authority of Executive Order No. 6646. USAP activities include the maintenance of three Antarctic stations; South Pole, McMurdo and Palmer. A NSF representative serves on the U.S. Delegation to CCAMLR.

FAO — FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS The Commission has adopted the FAO Fisheries Catches Statistical Areas as its basis for data and management measures. The FAO Fisheries Department has published two volumes of species identification sheets for the fauna and flora of the Convention Area. The volumes have been produced in each of the four languages of the Convention.

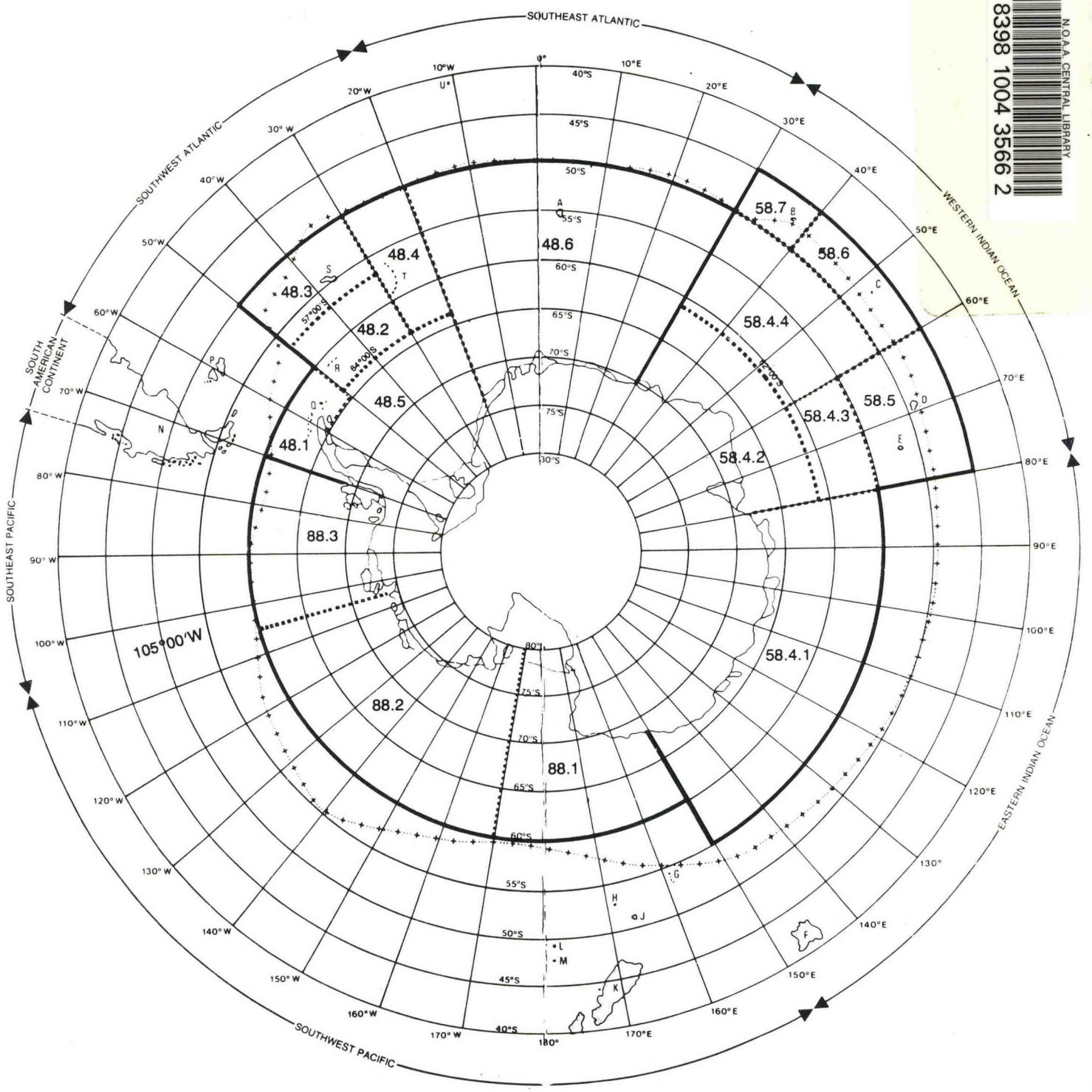
ICSU — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS. A UNESCO agency administering programs of many inter-governmental science bodies including SCAR and SCOR.

SCAR — SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH. Advises the Antarctic Treaty Consultative Parties on implementing the scientific goals of the Antarctic Treaty. Advises the Parties to the Convention for the Conservation of Antarctic Seals and Sealing (CCAS).Consults and collaborates with the CCAMLR-SC. SCAR managed the BIOMASS program which preceded the programs of CCAMLR-SC.

SCOR — SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH. Advises the same and other Treaty organizations as SCAR on oceanographic research programs and policies.

BIOMASS — BIOLOGICAL INVESTIGATIONS ON MARINE ANTARCTIC SYSTEMS AND STOCKS. A major program of SCAR with particular emphasis on estimating the stocks of krill in Antarctic waters.

IWC — INTERNATIONAL WHALING COMMISSION. Regulates whaling in international waters including Antarctica. Conducts the International Decade of Cetacean Research program (IDCR) which includes the Antarctic Minke Whale Assessment project. This latter program gathers information on the numbers and distribution of all species of cetaceans in Antarctic waters. The information generated by this program is of particular interest to CCAMLR.



LEGEND

- STATISTICAL AREA
- STATISTICAL SUBAREA
- ANTARCTIC CONVERGENCE
- CONTINENT, ISLAND

LEGEND

- A Bouvet Island
- B Prince Edward and Marion Islands
- C Crozet Islands
- D Kerguelen Islands
- E McDonald and Heard Islands
- F Tasmania
- G Macquarie Islands
- H Campbell Island
- J Auckland Islands
- K South Island
- L Antipodes Islands
- M Bounty Islands
- N South America
- P Falkland Islands (Malvinas)
- Q South Shetland Islands
- R South Orkney Islands
- S South Georgia
- T South Sandwich Islands
- U Gough Island