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# Antarctic Pack Ice Seals:

## INDICATORS OF ENVIRONMENTAL CHANGE AND CONTRIBUTORS TO CARBON FLUX

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An international research program coordinated by the SCAR Group of Specialists on Seals

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### INTRODUCTION

The SCAR Group of Specialists on Seals is developing an international research program focusing on the ecological importance of pack ice seals in the Antarctic marine ecosystem. The broad elements of the Antarctic Pack Ice Seals (APIS) Program were initially outlined in 1992 at the Group's meeting in Bariloche, Argentina. These elements were refined and described in a program prospectus, which was produced at a 1993 workshop in St. Paul, USA, supported by SCAR, CCAMLR, and the U.S. National Science Foundation. At its May, 1994, meeting in Padova, Italy, the Group developed this implementation plan, which addresses from a logistical perspective, undertaking the APIS Program during the period 1995/96 to 1999/2000; the major logistic effort is envisaged for 1998/99.

### **Scientific Justification**

The Antarctic pack ice seals are thought to comprise up to 80% of the world's total biomass of seals. As top level predators in the Southern Ocean ecosystem, they are remarkable because of their potential importance in the carbon cycle and for monitoring shifts in ecosystem structure and function in response to human activities and global climate changes (e.g., ozone thinning and climate warming). Further, the development of sensing instruments attached to seals, combined with satellite data retrieval, provide a means to acquire data in ice-covered seas on ocean physical and chemical parameters that have been previously unavailable, or at best, extremely costly to obtain. The APIS Program will take advantage of this new

technology and address new questions which could provide important information on many globally important issues, as well as providing baseline data for many questions about potential impacts asked within the Antarctic Treaty System.

### **Liaison with International Science Programs**

The APIS Program would welcome liaison and coordination with other scientific bodies. These include o t h e r S C A R Groups of Specialists, working groups, and o t h e r s c i e n t i f i c initiatives such as SO-GLOBEC (Southern Ocean Global Ecosystem Dynamics) and CEMP (CCAMLR Ecosystem Monitoring Program). Coordination is important to ensure comparability of research plans that have mutually related objectives, data collection procedures, exchanges of data, and where appropriate, logistic coordination. A Steering Committee for the APIS Program has been formed from members of the SCAR Group of Specialists on Seals to promote international coordination of science objectives and logistics. To ensure close liaison with planning at the national program level, COMNAP (Council of Managers of National Antarctic Programs) will be invited to nominate a member of the Steering Committee.



### **Antarctic Treaty System**

APIS can play a major role in the implementation of the various components of the Antarctic Treaty System: the Antarctic Treaty, the

Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), and the Convention for the Conservation of Antarctic Seals (CCAS). These international agreements are charged with attempting to ensure that Antarctica's ecosystems are protected from adverse impacts from human activities. Once it comes into force, the Antarctic Treaty's Protocol on Environmental Protection will add an important new dimension to this goal by protecting the Antarctic environment, its dependent and associated ecosystems, its wilderness and aesthetic values, and its value as an area to conduct scientific research. The APIS Program will provide valuable scientific information needed by these groups. Indeed, both CCAMLR and an informal meeting of CCAS have already endorsed the APIS Program.

### **RESEARCH FOCUS**

The studies involved in this program fall into three categories according to logistical support and the extent of international collaboration needed. Scales of operations vary from broad and circumpolar, to more intensive and regional, to very highly focused and sub-regional. That structure reflects the need, identified within the APIS prospectus, for integration of broadly-based surveys of distribution and abundance with process-oriented studies of the detailed biology of Antarctic pack ice seals.

Each of these operational scales will require a different approach. These are summarized in Table 1. A major point to note from Table 1 is that a part of the APIS program can be implemented without requiring coordinated multinational operations and can be achieved without the need for long-term planning of ship and aircraft schedules. Also, some of the objectives can be addressed within the

umbrella of both the specialized logistical support requested for specific parts of the APIS Program and the logistic support provided to other biological or oceanographic studies of the Southern Ocean.

However, one of the program's major objectives, a coordinated survey of abundance and distribution of the pack ice seals, requires a major commitment of ship and aircraft time. When combined with the regional and sub-regional process-oriented studies, results from circumpolar surveys are central to the use of pack ice seals as indicators of environmental change and to developing a better understanding of their role in Southern Ocean carbon flux. To meet this objective, multi-national and multi-platform support will be sought during one year of the program, which will be coordinated over the whole of the circumpolar region.

Circumpolar studies will require the international coordination of simultaneous deployments of ships, ships with helicopters, long-range helicopters, and fixed-wing aircraft because of the enormous areas to be surveyed. It is important that this be a multinational operation carried out during the designated core year in the study period (1998/99). Otherwise, variation in conditions between years would make the results less reliable. Studies will take place in all of the geographical regions identified in the APIS prospectus. Survey methods will be standardized among regions and survey designs will be carefully planned prior to the core years. The general design will include:

- 1) Movement of survey vessels along predetermined transects, most probably associated with physical features of the bathymetry (such as the shelf break) or of the pack ice (such as the frontal ice zone).

- 2) Helicopter-based surveys of pack-ice seals along transects, perpendicular to the track of the survey vessel, which will cross the physical feature being tracked by the vessel and/or cover the whole of the pack ice region from the outer edge of the pack to the continental/fast ice margin.

- 3) In some areas, such as locations where pack ice is particularly extensive, fixed-wing aerial surveys, mainly using aerial photographic techniques, will be carried out to provide full coverage. These areas would include those where simultaneous ship-board helicopter censuses were being carried out, in order to compare among methods.

Regional studies are most appropriately carried out through collaboration between national programs which have traditionally operated within specific regions and which would benefit from coordinating their activities within and across years. For example, studies of diet would benefit from a degree of spatial and temporal coordination on a regional basis to ensure minimum duplication of effort and maximum coverage of the annual cycle and the geographical range of the animals. Regional studies will involve ship and aircraft support, but may also include operations from land stations requiring small boat support. Some aspects of the regional studies should be completed in advance of the coordinated circumpolar studies. Of particular importance will be those which identify patterns of distribution and abundance of seals in relation to ice extent and characteristics and bathymetric features because these could lead to advances in survey design and increased efficiency and precision of the circumpolar survey.

Table 1. Logistical aspects of the APIS Program's implementation.

Scale of operation		Types of logistical support required	Degree of coordination required	Areas of research addressed from the APIS Program prospectus (numbers refer to those within the prospectus)
Spatial/temporal	Research programs			
Circumpolar/multiregional  (January-February 1999)	Multinational	<ol style="list-style-type: none"> <li>Multiple ship (minimum of one per region) plus ship-based helicopter support.</li> <li>Fixed-wing aircraft (with or without photographic capability) and long-range helicopters.</li> </ol>	<p>All studies will take place within this one year of the program:</p> <ol style="list-style-type: none"> <li>Concurrent operations within all regions using identical methods.</li> <li>Coordinated use of fixed-wing aircraft with ship-based operations in some areas</li> </ol>	<ol style="list-style-type: none"> <li>Distribution, abundance, and species composition. (The APIS prospectus emphasized the fundamental importance of this aspect of research in addressing the main objectives of the program).</li> </ol>
Regional  (mostly summer, 1995/96 to 1999/2000)	Bi- or tri-national	<ol style="list-style-type: none"> <li>Single ship (with or without helicopter support depending upon specific objectives).</li> <li>Fixed-wing aircraft (with or without aerial photographic capability).</li> <li>Land-based (with or without small boat support).</li> </ol>	<p>Little or no cross-platform collaboration required. There may be a requirement for some intra-regional collaboration within specific Antarctic seasons.</p>	<ol style="list-style-type: none"> <li>Habitat use and seasonal movements.</li> <li>Seals as platforms for oceanographic research.</li> </ol>
Sub-regional  (all seasons, 1995/96 to 1999/2000)	Individual national programs	<p>Dependent upon requirements of specific projects, but the objective would be to integrate these projects within the logistics available for circumpolar and regional studies or within the logistical constraints that normally operate within national Antarctic research programs on an opportunistic basis.</p>	<p>No requirement for geographical or temporal coordination.</p>	<ol style="list-style-type: none"> <li>Genetic identity of populations.</li> <li>Population dynamics.</li> <li>Diving, feeding behavior, and activity patterns.</li> <li>Diet.</li> <li>Energetics and physiology.</li> <li>Toxicology and disease.</li> </ol>

Sub-regional studies are those to be carried out independently by national programs. These comprise mainly those studies of basic aspects of the biology of pack ice seals for which the specific temporal coordination and geographical location of studies is less critical. Of course, there are exceptions to this situation. For example, the determination of the genetic identity of populations will require the collection of samples from all regions and even from sub-regions. Such collections can be obtained opportunistically within the context of other studies and there is unlikely to be a requirement to establish a field project which addresses solely this question as its central objective. The specialized nature of some of these studies will, however, require specialized logistical and technical support which may include laboratory facilities (e.g. for the measurement of metabolic rates), the capability of capturing seals, and helicopter or small-boat support in the vicinity of land stations or from ships.

## **IMPLEMENTATION/LOGISTICS**

### **Timing**

The program will be focused over the five-year period 1995/1996 to 1999/2000. Within this period, the season 1998/99 (year 4) has been targeted for the multinational, circumpolar surveys of pack ice seals. These surveys will need to be carried out during the months of January and February, the season of minimum sea ice extent, when the surveys can be performed most efficiently. The timing requirements for the various regional and sub-regional studies will depend on the topic being studied, and the amount of past work already completed. Some of these can be done on an opportunistic basis when neither the year nor the month when data are collected is of particular importance. Others will require sequencing on an

annual basis; priority months for these might not be particularly critical for some, while being of paramount importance in other cases (Table 1).

### **Ship and Aircraft Requirements**

In order to perform a coordinated circumpolar census of pack ice seals, helicopters operating from icebreakers or ice-reinforced ships, supplemented by several land-based aircraft, will be required in each of the six residual pack ice areas (see map). It is expected that most nations with such ice-capable vessels will be able to participate in these surveys (i.e., Argentina, Australia, Finland, France, Germany, Japan, Norway, Russia, South Africa, Sweden, United Kingdom, and United States). Land-based aircraft suitable for performing aerial censuses include twin otter aircraft operated by Chile and Argentina in the Antarctic Peninsula area and fixed-wing aircraft operating from German stations. Other nations operate aircraft that would be useful for these surveys as well.

The planned aerial censuses of seals in the Antarctic circumpolar pack ice will be performed according to standardized census methodology which has been developed by Antarctic seal researchers in recent years, supplemented by aerial photographic technology.

### **Areas of Operation**

This research initiative will require circumpolar coverage during the 1998/99 field season when the entire pack ice region will be surveyed. Several factors were considered in selecting the study areas for regional and sub-regional studies: 1) coordination and integration with other Antarctic research programs, 2) sites where long-term data bases already exist (facilitating comparisons of past and future data),

and 3) logistic convenience in relation to research bases and vessel operations areas. The APIS Program will focus on the following areas for regional and sub-regional projects:

- 1) the Bellingshausen Sea;
- 2) the Antarctic Peninsula and South Shetland Islands area;
- 3) the Weddell Sea;
- 4) the Prydz Bay area; and
- 5) the Ross Sea.

In each of these areas, some research activities will be focused on the zones associated with the edge of the continental shelf and the marginal sea ice. The APIS Steering Committee will evaluate the desirability of targeting specific portions of the broad areas noted above and, as appropriate, will encourage research to be undertaken there.

### **Centers of Analytical Expertise**

The studies to be conducted under the aegis of the APIS Program will provide much collected material from field activities. The analysis of these materials will involve specialized techniques, and there is merit in various specialized laboratories acting as centers for analyzing such collections. Opportunities for collaboration include:

- 1) Genetic identity of populations: application of genetic and molecular biology techniques to relevant samples of seal material from different locations, in particular mitochondrial DNA, serum proteins, and isosomes;
- 2) Diet: stable isotope studies of seal tissue in relation to potential prey; serological analysis of fecal or stomach samples; analysis of adipose tissue or milk in relation to known lipid components of potential prey; and analysis of stomach samples (or component group in stomach samples);

- 3) Age: age determination of tooth collections by the application of established techniques; and
- 4) Toxicology: measuring the levels of pollutants, e.g., organochlorines and heavy metals accumulated in seal tissues, to provide insights to global pollution levels and to evaluate the toxic risk for seal populations.

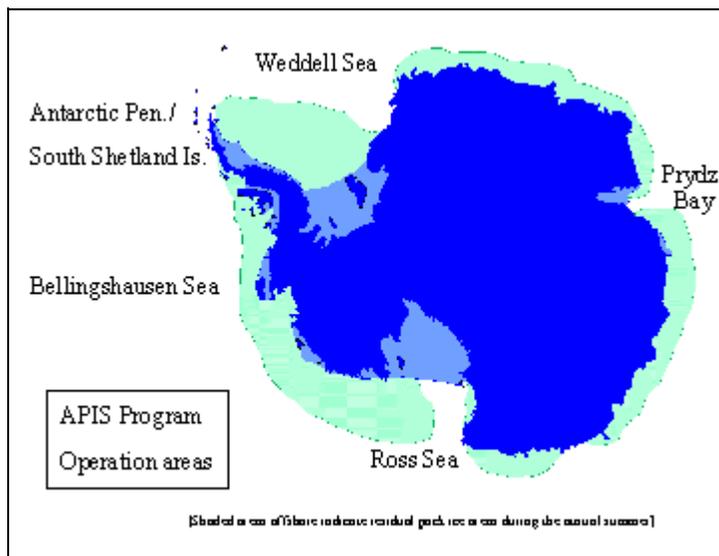
The Group of Specialists on Seals invites responses to the APIS Steering Committee from specialized laboratories which are interested in seeking to take up such opportunities to participate in the analytical components of the APIS Program.

### **Funding**

To be successful, the APIS Program will require a greater level of funding than Antarctic seal research has received in the past. The large-scale surveys planned will involve an increased level of logistic commitment. In addition, to promote and coordinate the APIS Program, the Group of Specialists on Seals plans to seek financial support:

- 1) to bring participants to international meetings and workshops to develop individual field research activities within the ambit of the program, to decide details of implementing it and, later, for analyses;
- 2) for a central office to coordinate activities and facilitate communications, including data handling and management; and
- 3) for special needs such as procuring instrumentation.

The Group of Specialists on Seals intends to seek additional funding



from outside SCAR for these activities. Contributions will be sought from funding bodies such as foundations and environmental organizations, and from commercial companies. It is intended that individual scientists will approach their own national programs for support of their individual research projects, which contribute to the wider program framework and objectives.

### **OUTCOMES AND PRODUCTS**

Many scientific disciplines and issues of environmental concern will benefit from the APIS Program. A few examples are mentioned below; others will develop as the program moves ahead.

Abundance and Distribution: The uncertainty about the number of crabeater seals in the Antarctic pack ice region has been a matter of concern for some years. It has been hypothesized that changes in the ecosystem have caused changes in crabeater seal abundance. These ecosystem changes may be due to the decline of the great whales, and have been used as an example of possible cause and effect within marine ecosystems. Population estimates

have varied widely because of variable census techniques and platforms. For example, the timing of censuses and changing ice conditions all contribute to variations in counts. The research outlined in year four of this plan will clarify the question of abundance by applying standardized methods. Changes in the abundance of crabeater seals may indicate changes in the ecosystem. This work will provide an important baseline for future comparisons.

Stock Identification & Management: CCAMLR Article II requires that harvesting of living marine resources will not adversely impact target or non-target species. Data from this program will greatly aid the work of CCAMLR and CCAS by confirming the abundance and distribution of seals and in defining management zones for stocks.

Food Requirements and Energetics: Changes in ecosystems because of human impacts and natural environmental changes, either globally or locally, could easily change the ability of species to fulfill their food and energy needs. Since these top level predators are being used to monitor ecosystem change (under CCAMLR), the APIS Program will provide essential data against which future changes in diet and

energetics can be assessed.

Seals and the Ecosystem: In addition to changes in the abundance, diet and energetic patterns of seals as an indication of ecosystem change, changes in life history parameters (survival, reproduction rates and patterns) will reflect ecosystem-wide shifts.

Baseline Information Needed by the Antarctic Treaty System: APIS can play a large role in the implementation of the various elements of the Antarctic Treaty System. These conventions require collection of baseline data and the

implementation of monitoring programs, and nations are obligated to assess the impacts of their activities on the Antarctic environment before proceeding. Research results from APIS will be useful in determining if planned activities should go forward, and contribute to the determination of the level of anticipated impact.

### CONCLUSION

This document has drawn attention to the importance of research on the Antarctic pack ice seals, as contributing to the work of CCAS,

CCAMLR, and the Environmental Protocol to the Antarctic Treaty, to monitoring ecosystem changes in the Southern Ocean, to understanding aspects of global change, global pollution levels, and illuminating various aspects of Antarctic seal biology. Some national programs have already initiated such research. Other groups are strongly urged to support similar investigations. The efforts of the Group of Specialists on Seals in initiating, promoting, planning, and coordinating the APIS Program are expected to maximize the returns from such research.

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In 1993, the SCAR Group of Specialists on Seals developed a research prospectus defining a coordinated, multinational research initiative focused on the Antarctic Pack Ice Seals (APIS). At a meeting held in Padova, Italy, from 25-28 May 1994, the Group continued the development of the APIS Program by producing this draft implementation plan and establishing a Steering Committee. The participants of the May, 1994, meeting included:

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The following persons comprise the APIS Program Steering Committee:  
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