ANNEX 7

REPORT OF THE *AD HOC* WORKING GROUP ON ECOSYSTEM MONITORING

REPORT OF THE *AD HOC* WORKING GROUP ON ECOSYSTEM MONITORING SEATTLE, WASHINGTON USA 6–11 May 1985

The Ad Hoc Working Group On Ecosystem Monitoring was established at the 1984 meeting of the Scientific Committee of CCAMLR. As a result of the Group's work during that meeting the Scientific Committee decided that an intersessional meeting of the Working Group be held during 1985 and a draft agenda was prepared (Appendix I).

2. The Scientific Committee accepted an invitation from the National Marine Fisheries Service (NMFS) of the United States to hold the meeting at the National Marine Mammal Laboratory of the NMFS in Seattle.

3. Tie meeting was held from 6 to 11 May 1985.

4. Participants were welcomed by the Director, Northwest and Alaska Fisheries Center, Dr. William Aron, and the Director of the National Marine Mammal Laboratory, Dr. Howard Braham. A list of participants is included as Appendix II.

5. The Convenor, Dr. Knowles Kerry (Australia), opened the meeting and the agenda was adopted. Dr. Kerry explained that while there had been a proposal to revise the draft agenda since the meeting of the Scientific Committee in September 1984, after consultation with members of the Scientific Committee it had been decided to retain the original draft agenda.

ORGANISATION OF THE MEETING

6. Dr. John Bengtson (USA) and Dr. Darry Powell (CCAMLR Secretariat) were appointed rapporteurs for the Working Group.

7. The Group agreed to work through the first four agenda items in Plenary and to form one sub-group to consider and report on items 5, 6 and 7 in relation to krill, fish and squid as prey and another to consider and report on items 5, 6 and 7 in relation to seals, seabirds and whales as predators.

8. The Chairman of the Sub-group on Krill, Fish and Squid was Dr. Inigo Everson (UK) and Drs. Denzil Miller (South Africa) and Eugene Sabourenkov (CCAMLR) acted as rapporteurs. The Chairman of the Sub-group on Seals, Seabirds and Whales was Dr. Robert Hofman (USA) and Drs. John Bengtson (USA) and Darry Powell (CCAMLR) were rapporteurs. The reports of the Sub-groups were presented in SC-CAMLR-IV/7. Several documents were used as a reference for discussions and some papers were tabled at the meeting. A list of documents is in Appendix III.

9. The Chairman invited Dr. D. Siniff, the Co-Convenor of the SCAR Group of Specialists on Seals, and Dr. W.R. Siegfried, the Chairman of the BIOMASS Working Party on Bird Ecology, to present summaries of the responses of their respective groups to the questions posed by the CCAMLR Scientific Committee on the use of Antarctic Seals and birds as indicator species. (See SC-CAMLR-IV/7, Annex VI).

10. The Secretariat was asked to thank the Scar Group of Specialists on Seals and the BIOMASS Working Party on Bird Ecology for their valuable submissions.

OBJECTIVES OF ECOSYSTEM MONITORING

11. The objective of ecosystem monitoring in relation to the Antarctic Marine Living Resources was defined by the group as follows:

- to detect and record significant changes in critical components of the ecosystem, to serve as a basis for the Conservation of Antarctic Marine Living Resources. The monitoring system should he designed to distinguish between changes due to the harvesting of commercial species and changes due to environmental variability, both physical and biological.

12. Bearing in mind the intent of Article II of the Convention for the Conservation of Antarctic Marine Living Resources, it was recognised that it is important to identify and evaluate selected organisms as potential agents for monitoring changes in the structure and functioning of Southern Ocean ecosystems at various spatial scales.

13. The critical consumer species were deemed to be seals, seabirds and whales, and the selection of species (indicator species) for monitoring was restricted to those which may show quantifiably significant changes in the parameters monitored as a result of the decreased availability of prey.

14. Discussions on prey were focussed primarily on the evaluation of how the availability of prey species ray affect certain predators.

15. Thus ecosystem monitoring was considered to consist of two facets:

(a) the monitoring of parameters of indicator species (of seals, seabirds and whales)

(b) the monitoring of harvested species (krill, fish and squid) and other species capable of reflecting change, as an aid to understanding the nature and cause of any observed change.

COMPONENTS OF AN ECOSYSTEM MONITORING PROGRAM

16. The components needed for the development of an ecosystem monitoring program were considered by the Sub-group on Krill, Fish, and Squid and the Sub-group on Seabirds, Pinnipeds, and Cetaceans. The following section briefly reviews the highlights of their discussions.

Species

17. The major criteria used to select predator species thought to be best suited for ecosystem monitoring were:

- specialist predators on the critical prey components identified;
- wide geographic distribution;
- importance in the ecosystem;
- feasibility of study (ease to approach, handle, observe);
- knowledge of general biology;
- availability of baseline data at one or more sites.

18. Of all the Antarctic pinniped, seabird, and cetaceans, the following species were identified as those most likely to be useful as indicators of changes in food availability:

- Crabeater seal
- Antarctic fur seal
- Adelie penguin

- Chinstrap penguin
- Macaroni penguin
- Minke whale

19. Of the Antarctic krill, fish, and squid species that were evaluated for inclusion in ecosystem monitoring programs, the following were considered to be of most immediate and direct relevance with respect to the predators identified:

- *Euphausia superba*
- *Pleuragramma antarctic*
- Early life stages of fish

20. The Minke whale as a potential indicator of the effects of krill harvests was discussed. However within the framework set by the group at this time, it was not given high priority compared with other species identified for monitoring. The Group recommends that the Scientific Committee of CCAMLR consult with the International Whaling Commission to determine whether and how Minke whales or other cetaceans might function as indicators of krill availability as well as the general status of the Antarctic marine ecosystem.

Parameters

21. The parameters within each species group were selected taking into account trophic level, behavior, longevity, sensitivity, and measurability.

22. For food and associated species, the major parameters are the distribution, abundance and availability of the important prey species. The methods available for assessing these are direct sampling using hydroacoustics, a variety of nets or by utilising data from commercial fisheries.

23. Data relating to prey species required for integrated prey/predator monitoring programs would be obtained principally from regular standardised research cruises, but commercial catch and effort data and biological sampling of commercial catches would also be important. Analyses of catch/effort data and age/length structure would be important in contributing to estimations of prey stock abundance. The Group noted that the CCAMLR Workshop on the Use of Catch Per Unit Effort in Krill Stock Assessments and the meeting of the Ad Hoc Working Group on Fish Stock Assessment, both to be held in August 1985, have been asked to consider *inter alia* the question of spatial and temporal scales for the collection

of commercial fisheries data. In this connection the Group agreed that for the purposes of ecosystem monitoring, it would be desirable to have commercial fisheries data collected on as fine a scale as practicable, preferably by the location of each haul.

24. Four broad categories of parameters for predator species were identified for their potential to respond to environmental changes:

- Reproduction
- Growth and condition
- Feeding ecology and behavior
- Abundance and distribution

Within each of these categories, variables were selected for sensitivity to environmental changes in the short or long-term, and on local and regional scales. The feasibility of measuring variables and detecting changes were also considered. On this basis, a list of parameters was drawn up. Some of these are already in use, whereas others having potential require further development (see Tables 3 and 4 in the subsequent sections of the Report).

Spatial and Temporal Scales

25. Temporal and spatial scales were considered of fundamental importance in the collection and interpretation of monitoring data. It is thus imperative that these features be taken into account during the design and planning of ecosystem monitoring programs.

26. In particular, it was considered important to define these scales for variables relating to predators, prey, the environment, and interactions among these variables. Such scales are particularly important in the investigation of cause and effect relationships in monitoring programs. The scales need not be the same for all the components within a particular monitoring program.

27. The temporal scale is crucial both in terms of the longevity of phenomena, the lag time for some changes to occur and be detected, and the time needed to detect trends in these changes. Natural phenomena and responses to these events range in scale from the short-term (days) through the medium-term (months) to the long-term (years).

28. For the purposes of monitoring within the Antarctic marine ecosystem, the most relevant spatial scales are considered to range from local (10's of km) to regional (1000's of km). In addition the micro-scale distribution (metres) of prey species will be important in determining their availability to predators.

29. For integrated studies of both predators and prey, collection of simultaneous data is essential. Depending on the variables and interactions being monitored, simultaneous studies may include elements with short, medium, and long-term variation as well as local and regional scales. Local evaluations of short-tern phenomena as well as regional assessments of medium to long-term phenomena would both constitute simultaneous measurements.

Areas and Sites

30. The Group considered and evaluated the suitability of potential areas and sites for ecosystem monitoring programs. Potential locales were considered on the basis of their utility in monitoring critical prey and predator components of the ecosystem. The following criteria guided the evaluation of various sites:

- The need for a geographical coverage of the Convention area;
- Presence of critical components of the ecosystem;
- Influence of specific predators or predator groups;
- Proximity to concentrations of selected prey;
- Presence of species capable of being monitored;
- Presence or absence of fishing operations in the vicinity;
- Logistics;
- Availability of baseline data;
- The presence of discrete regions or ecotypes in terms of physical /biological attributes.

31. In addition, it was deemed essential to conduct monitoring activities in open ocean, pack ice, and land-based habitats. It was also emphasised that in order to incorporate important elements of various temporal and spatial scales (i.e., local, regional, long and short lag times) into monitoring schemes, it was highly desirable to monitor several species of predators and prey rather than single species.

32. A total of 13 areas and sites were identified as having promise for monitoring programs and their relative merits were summarised. (Table 1 and Figure 1). Each locale can be placed in one of three categories:

TABLE 1: SITES CONSIDERED FOR ECOSYSTEM MONITORING

Area	Presence Species		Baseline		Fishery on prey (since 1975)	Discrete-ness	Logistics	
	Prey	Predators	Prey	Predators			Land	Ships
Prydz Bay* 55–85°E	Krill Pleuragramma	Adelie Crabeater Minke	K + P +	A + CR – M ++	Krill	Yes	Davis Mawson	R.V. F.V.
Capes Hallett-Adare	Krill Pleuragramma	Adelie Crabeater Minke	K (+) P +	A + CR (+) M +	Krill-Boundary	?	Hallett	R.V. S.V.
Bransfield Strait (Palmer, Elephant, S. Shetland Is.)	Krill Pleuragramma	Adelie Chinstrap Furseal Crabeater Minke	K +++ P –	A +++ C ++ F (+) CR +++ M +	Krill Demersal fish	No	Many	R.V. F.V. S.V.
South Georgia Is.		Macaroni Fur seal	K +++	MC +++ F +++	Krill Demersal	No	Bird Is.	R.V. F.V.
Bouvet Is. (South to continent)		Macaroni Chinstrap Fur seal Crabeater Minke	K +	MC (+) C (+) F (+) CR (+) M ?	No	?	SANAE Neumayer	R.V. S.V.
S. Sandwich Is.		Chinstrap (Adelie) Crabeater	No	No	No	No	No	No
S. Orkney Is.	Krill Pleuragramma	Adelie Crabeater Minke	K + P –	C ++ A ++ CR +	Krill Demersal fish	No	Signy Orcadas	R.V. F.V. S.V.
Wilkes Land 100–145°E	Krill Pleuragramma	Adelie Crabeater Minke	K + P –	A + CR – M +	Krill	?	Dumont D'Urville Casey	R.V. F.V. S.V.
Syowa	Krill Pleuragramma	Adelie Crabeater Minke	K + P ?	A + CR + M (+)	Krill	?	Syowa Molodezh-naya	R.V. F.V. S.V.
Southern Ross Sea	Pleuragramma	Adelie Crabeater Minke	P +	A +++ CR (+) M +	No	South of 75°S Yes	Many	Many
Sea Area west of Ant. Penins. (Palmer to Peter I Is.)	Krill Pleuragramma	Adelie Crabeater Minke	K + P (+)	A (+) CR ++ M +	Krill	No	Faraday Rothera San. Martin	R.V. F.V.
Southern* Weddell Sea (South of 70°S)	Krill Pleuragramma	Crabeater Minke	K + P +	CR (+) M +	No	Yes	Neumayer Belgrano Dryzhnaya Halley	R.V. S.V.
Amundsen-* Bellingshausen Seas	Krill Pleuragramma	Crabeater Adelie Minke	K – P –	CR + A + M +	Krill	?	No	F.V.

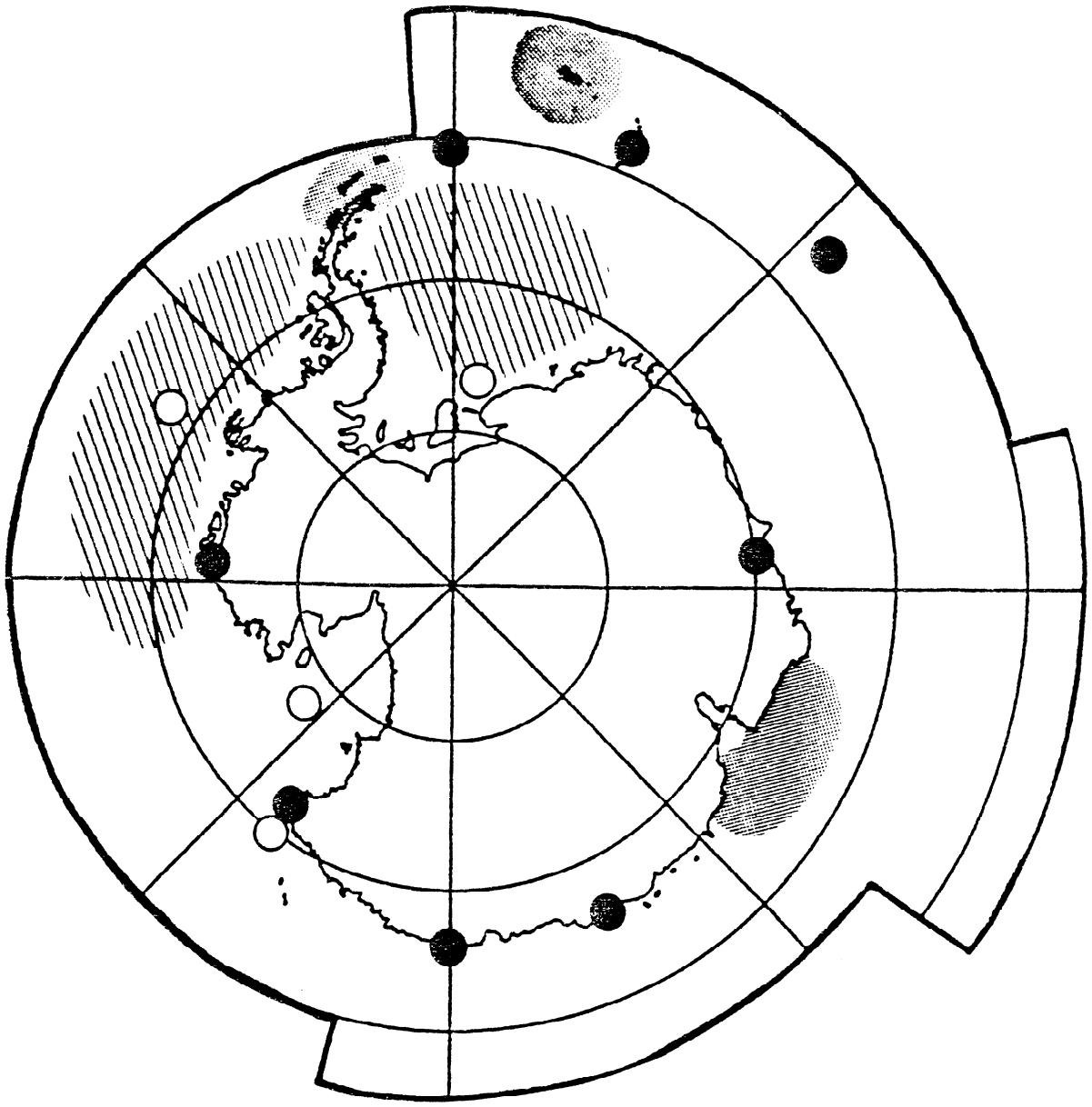
Abbreviations:

A – Adelie penguin
MC – Macaroni penguin
C – Chinstrap penguin
F – Fur seal
CR – Crabeater seal
M – Minke whale
K – Krill
P – Pleuragramma antarcticum
RV – Research Vessels
FV – Fisheries vessels
SV – Support vessels

Rates of baseline existence:
–, (+), +, ++, +++
lowest highest

* Priority Pack-ice Area

Figure 1: Sites and approximate areas suggested for Antarctic ecosystem monitoring programs. Locations were defined by the three categories listed below.



Categories of monitoring sites and areas:

1. Integrated study areas:
2. Network of sites and areas-
   - Land-based sites:
   - Pack ice areas:
3. Sites of special interest for directed research:

(a) Integrated study areas

33. A high priority is placed on the initiation of integrated ecosystem monitoring programs focussed in selected areas. Such programs would combine directed research and monitoring studies of predators and prey in open water, pack ice areas, and onshore. These programs would include simultaneous work on local predator–prey dynamics.

34. The areas recommended as a first priority are:

- Prydz Bay
- Bransfield Strait
- South Georgia

35. An integrated study area recommended as a second priority is the zone comprised of Bouvet Island south to the Antarctic continent.

(b) Network of sites and areas

36. To complement the intensive research and monitoring efforts proposed for the integrated study sites, it is recommended that selected land-based sites and pack ice areas be chosen to form a monitoring network. Activities at network locales would focus principally on predators, but some understanding of local food availability would also be desirable. The sites would provide comparative data for sites inside integrated study areas. The following sites and locales are recommended:

Land-based

- Cape Hallett/Adare
- Bouvet Island
- South Sandwich Islands
- South Orkney Islands
- Wilkes Land (Casey, Dumont D'Urville)
- Syowa Station
- Cape Shepard (Amundsen Sea)

Pack ice:

- Weddell Sea
- Bellingshausen/Amundsen Seas

(c) Sites of special interest for directed research

37. There are several sites that are particularly well-suited to addressing specific research questions relating to ecosystem monitoring. Investigating these questions will provide data important to understanding the dynamics of predator prey interactions observed in the integrated study areas and network sites. The following sites are recommended as desirable locations for the initiation of directed ecological research in support of ecosystem monitoring:

- Cape Hallett/Cape Adare: This site is located adjacent to the Ross Sea, near the boundary between shelf areas and the adjacent pelagic system. Monitoring penguins at this boundary zone could provide insights into prey switching;

- Southern Ross Sea: This high latitude site may provide insight into interactions between *Pleuragramma* and *E. crystallorophias* and local predators such as Adelie penguins, crabeater seals, and possibly minke whales;

- Southern Weddell Sea: This is a particularly important area for crabeater seals, including its interactions with both *E. superba* and *E. crystallorophias*. This would be a useful area to investigate the stock segregation of crabeater seals. Important aspects of predator/prey interactions with *Pleuragramma* could be studied here. (The sea area to the west of the Antarctic Peninsula is of interest for similar reasons, but was accorded lower priority);

- Bellingshausen/Amundsen Seas: The best survey data for crabeater seals are available from this area. It is an important site for dedicated ship surveys for crabeater seal censuses, collections, and studies of stock segregation.

General considerations

38. It was noted there was a need to evaluate the effects of physical and biological factors on the abundance and distribution of both predator and prey species. Table 2 lists major

hydrographic features which should be investigated in relation to temporal and spatial scale effects on the availability of prey to predators in selected monitoring areas. In this respect the need for information on seasonal ice cover and the formation of polynyas was stressed.

TABLE 2: Hydrographic features to be investigated in relation to temporal and spatial-scale-effects on availability of prey to regional predator populations (after Deacon 1936).

Monitoring Area	Macroscale feature (1000's km)	Mesoscale feature (100's km)	Microscale feature (10 km)
Prydz Bay	East Wind and West Wind Drifts	Gyre	ice-edge frontal circulation
Cape Adare/Hallett	East Wind Drift	Ross Sea gyre	ice-edge frontal circulation
Bransfield Strait	–	Weddell-Scotia confluence Flow through high energy system	variable eddies
South Georgia	–	Weddell-Scotia confluence system	variable eddies
Bouvet Island	West Wind Drift	Flow through system	unknown
South Sandwich Islands	–	Weddell-Scotia confluence Flow through system	unknown
South Orkney Islands	Weddell Sea Drift	Weddell Sea Gyre	ice-edge frontal circulation
Wilkes Land	East Wind Drift	Flow through system	ice-edge frontal circulation
Syowa	East Wind Drift	Flow through system	ice-edge frontal circulation
Southern Ross	East Wind Drift	Ross Sea Gyre	ice-edge frontal circulation
Sea Area West of the Antarctic Peninsula	East Wind Drift	Flow through system	ice-edge frontal circulation
Southern Weddell Sea south of 70°	Weddell drift	Weddell gyre	ice-edge partial circulation
Amundsen-Bellingshausen	East Wind Drift	Flow through system	ice-edge partial circulation

39. The group noted in this connection the joint IOC/CCAMLR sponsored 'Scientific Seminar on Antarctic Ocean Variability and its Influence on Marine Living Resources, Particularly Krill' to be held in January-February, 1986 in Paris.

40. The need to define areas offering some form of experimental control was discussed. It was agreed that studies at a variety of locales, each with different characteristics in respect to resources, harvesting, etc., would be the best means of evaluation and that it was impracticable to set up control sites for the recommended monitoring locales at this time.

ESTABLISHMENT OF AN ECOSYSTEM MONITORING PROGRAM

41. In recommending the establishment of an ecosystem monitoring program, the approach adopted was:

- to consider those attributes of predators most suitable for the immediate development of field program and those requiring directed research aimed at this evaluation,

- to consider the kind of information on predator-prey interactions most relevant to establishing correlations between changes in predator parameters and those in prey availability; and for distinguishing between natural variations in prey availability and those induced by harvesting.

42. It was agreed that a variety of specialised research programs on both predators and prey, especially including multi-disciplinary, integrated operations in certain key areas be undertaken. The acquisition of data on the distribution and abundance of predators and prey, by means of both systematic surveys, and, in respect to prey, by means of suitably detailed reporting of harvest catches, should proceed.

43. Species and parameters of species which could form the basis of monitoring programs were identified and set out in Table 3. Theoretically, elements of this program could be implemented but effective implementation on an adequate scale requires development and deployment of automatic recording devices.

44. A second group of parameters (Table 4), again with the focus on predators, was considered to have potential for monitoring purposes, but requires additional research to assess whether this potential can be achieved.

45. Further topics of directed research (Table 5) are required to interpret changes in monitored parameters and to provide increased understanding of important processes operating in the ecosystem.

Table 3: Evaluation of parameters of potential utility for monitoring program starting now.

Species	Parameters	Feasibility at present	Time-series required**	Integration time***
Antarctic fur seal	Foraging/attendance cycles	++*	Short–medium	D
	Pup growth and weaning weight	+++	Short–medium	M
Crabeater seal	Reproductive rates	++	Long	Y
	Age at sexual maturity	+++	Long	Y
	Cohort strength	+	Long	YY
Penguins (Adelie, chinstrap macaroni)	Arrival weight	+*	Medium	MM
	Population size	++	Medium–long	M–Y
	Survival & fecundity	+	Long	M–Y
	Incubation shift duration	+*	Medium–long	D
	Meal size	–	Medium	D
	Breeding success	+++	Medium–long	M
	Foraging trips	+*	Short–medium	D
	Fledging weights	+*	Medium	M
	Adult weight at fledging	+*	Medium	M
	Macaroni weight before moult	+*	Medium	D

* Significantly enhanced by development and/or deployment of automatic recording equipment.
** Short = 3-5 years
Medium = 5-10 years
Long = more than 10 years
*** D = days (real time over which the parameter is measured)
M = months
Y = years

Table 4: Programs of directed research of importance for obtaining data on and evaluation of parameters of potential monitoring significance.

Species	Program	Time-series required**	Integration time***
Antarctic fur seal	Indices of body condition (blood, blubber)	Unknown; prob.medium	MM
	Juvenile tooth size	Medium-long	Y
	Fine structure of teeth	Short-medium	M
Crabeater seal	Collection of material for further analyses of demographic variables	Long	Y
	Instantaneous growth rates	Unknown; prob.medium	M?
	Juvenile tooth size	Medium-long	Y
	Indices of body condition (blood, blubber)	Unknown; prob.medium	MM
	Feeding behaviour, using satellite technology	Unknown	D-M
Penguins	Feeding behaviour and frequency	Unknown	D-M
Minke whales	Surveys of abundance using sightings (as by IDCR)	Long	Y

** - see footnotes to Table 3.
***

Table 5: Programs of directed research on predators providing data Of fundamental importance for initiating or interpreting the results of monitoring studies.

Species	Program	Location/comments
Antarctic fur seal	Survey of potential new sites for monitoring studies	S. Sandwich, S. Orkney, S. Shetland Is., Antarctic Peninsula
	Monitoring population trends by counting of pup production	S. Georgia and other sites selection following above
	Location of summer and winter foraging areas using satellite technology	S. Georgia and other sites when selected
Crabeater	Quantitative studies of diet	All areas, especially selected integrated study areas
	Determination of stock separation using satellite technology and biochemical techniques	All residual pack-ice areas
	Repeat surveys to estimate abundance and assess population trends	Amundsen-Bellingshausen high priority followed by the other two selected areas
	Foraging areas and movements using satellite technology	Develop at selected sites, then expand
Penguins	Development of automatic weighing devices	Develop at selected sites, then all sites if practical
	Foraging areas and movements using satellite technology	as above

46. Parameters to be considered for the assessment of the biological/demographic status of prey species in relation to their availability to predators require information on distribution, abundance, aggregation and causative associations between prey production and their utilisation by predators. In particular, the group draws attention to the importance of evaluating whether regional concentrations of krill constitute separate management stocks.

47. It was further agreed that consideration should be given to the application of fishing pressure in selected areas as perturbation experiments giving insight into the responses of key components of the ecosystem to predetermined pressures on the food resources.

48. Monitoring the status of depleted stocks of whales, which were themselves the subject of a harvest, is another facet of importance to CCAMLR since Article II of the Convention specifies that exploitation of krill or other food species should not impede the restoration of depleted stocks.

49. The Group noted that monitoring of long-term trends in population sizes of each whale stock is an important element in the monitoring of the Antarctic marine ecosystem. It therefore recommended that the Scientific Committee consult with the International Whaling

Commission on the present status of Antarctic whale populations and the means by which trends might be monitored in the future.

50. Satellite sensing is being investigated for a wide range of purposes, some already operational (e.g., sea ice cover), others highly desirable (e.g., foraging movements of seals and penguins in both summer and winter), while some are merely suggestions at this stage (e.g., as a possible means of monitoring the distribution of fishing effort). The group recommends that satellite sensing techniques be developed and applied wherever possible.

51. The establishment of monitoring programs would require the use of a computerised data base system for data storage, retrieval and processing. This in turn will require a suite of processing algorithms to be developed.

RECOMMENDATIONS

The Ad Hoc Working Group on Ecosystem Monitoring recommended that:

1. A long-term ecological monitoring program should be initiated in the priority areas as identified in paragraphs 33–37.

2. Pilot studies on predators and their prey commence as soon as possible to monitor the variables identified in Table 3.

3. Directed ecological research on predators and their prey be initiated as soon as possible to determine potential indicator variables and essential background information for species and parameters as identified in Tables 4 and 5.

4. The CCAMLR Scientific Committee establish a group charged with the design, planning, implementation (including data collection and evaluation), and coordination of an ecosystem monitoring program as recommended above, taking into account the concommittant requirements for monitoring prey and environmental factors.

5. To assist the group described in Recommendation 4, members of CCAMLR conducting research in the Convention area be requested to submit to the Secretariat inventories of relevant past and present programs and relevant data concerning the species and parameters at the priority monitoring sites and areas listed in this report.

6. The Scientific Committee of CCAMLR consult with the international Whaling Commission on the current status of Antarctic whale populations and the means by which trends might be monitored in the future.

7. That a high priority be given to further evaluation whether regional concentrations of krill constitute separate stocks for management purposes.

CLOSING OF THE MEETING

1. The report was adopted and the meeting was closed at 1700 hours on Saturday, 11 May.

2. The Convenor thanked the Rapporteurs of all Groups and the Chairmen of the Sub-groups for their work. He particularly thanked Dr. J. Bengtson for the organisation of the meeting and the Director of the National Marine Mammal Laboratory and his staff for hosting the meeting.

APPENDIX I

AGENDA

1. Introduction by Convenor, and proposed procedures for conducting the meeting.

2. Approval of Agenda.

3. Review the objectives of ecosystem monitoring.

4. Review the responses to the CCAMLR Scientific Committee of the SCAR Group of Specialists on Seals and the BIOMASS Working Party on Bird Ecology.

5. Review the life history characteristics and parameters of dependent and related species likely to be useful to ecosystem monitoring studies.

6. Identify dependent and related species which have greatest potential to function as indicators of the possible effects of krill harvesting.

7. Consider the types of studies necessary to establish baseline data and to evaluate natural variation in biological and environmental variables.

8. Describe sampling and data collection procedures required to detect effects of fisheries activities on components of the ecosystem.

9. Consider experiments to be undertaken in collaboration with fisheries activities.

10. Evaluate potential sites and areas for ecosystem monitoring programs.

11. Formulate and recommend specific actions for planning and implementing multinational ecosystem monitoring programs.

12. Other items.

13. Adoption of report.

APPENDIX II

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APPENDIX III

BACKGROUND DOCUMENTS

The following list contains documents which provided background information for the meeting.

(a) Documents submitted to SC-CAMLR

Report of SC-CAMLR-II. Questions to the BIOMASS Working Party on Bird Ecology and the SCAR Group of Specialists on Seals with respect to the potential role of birds and seals as indicators of change in the Antarctic marine ecosystem.

SC-CAMLR-III/7. Ecosystem management: Proposal for undertaking a coordinated fishing and research experiment at selected sites around Antarctica.

SC-CAMLR-III/BG/4. Ecosystem monitoring and management: Summary of papers presented at the third meeting of the Scientific Committee.

SC-CAMLR-III/BG/5. Monitoring indicators of possible changes in the Antarctic marine ecosystem.

SC-CAMLR -III /BG/7. Marine mammal fishery interactions: Modelling and the Southern Ocean.

SC-CAMLR-III/BG/9. Summary of the responses of the BIOMASS Working Party on Bird Ecology and SCAR Group of Specialists on Seals on the questions of SC-CAMLR on indicator species.

(b) BIOMASS SCAR Reports

BIOMASS Report Series Numbers 8, 16, 18 and 21 provide background for Reports Numbers 34 and 35 and are included here for the sake of completeness.

BIOMASS REPT SER No. 8. Antarctic bird biology. Pretoria 1979.

BIOMASS REPT SER No. 16. Data, statistics and resource evaluation. Cambridge 1980.

BIOMASS REPT SER No. 18. Antarctic bird biology - II. Queenstown 1980.

BIOMASS REPT SER No. 21. Meeting of the BIOMASS Working Party on Bird Ecology. Hamburg 1981.

BIOMASS REPT SER. No. 34. Meeting of the Biomass Working Party on Bird Ecology. Wilderness 1983.
The relevant information is contained in SC-CAMLR-III/BG/9.

BIOMASS REPT SER. No. 35. Meeting of the SCAR Group of Specialists on Seals. Pretoria 1983.
The relevant information is contained in SC-CAMLR-III/BG/9.

SCAR - Conservation Areas in the Antarctic (March 1985).
Edited by W.N. Bonner and R.I. Lewis Smith, c/o Scott Polar Research Institute, Lensfield Road, Cambridge, UK.

Background documents presented at the meeting

Antarctic research activities of the Federal Research Board of Fisheries in Hamburg (FRG).

Bengtson, J.L. (1984) Review of Antarctic marine fauna. Final report prepared for the U.S. Marine Mammal Commission. (USA).

Current research by Ecology Division, DSIR, New Zealand, on the biology of Adelie penguins in the Ross Sea, Antarctica. (New Zealand)

Miller, D.G. (1985). A conceptual framework for the institution of a monitoring regime in the Antarctic marine ecosystem. (South Africa).

Hubold, G. German marine biological investigations in the Southern Weddell Sea. (FRG).

Hoshiai T., Sweda T., Tanimura A. (1984). Adelie penguin census in the 1981–82 and 1982–83 breeding seasons near Syowa Station, Antarctica. In 'Memoirs of National Institute of Polar Research, Special Issue N32, Proceedings of the Sixth Symposium on Polar Biology.' (Japan).

Slosarczyk W. (1983). Juvenile *Trematomus bernacchii* and *Pagothenia brachysoma* (Pisces, Nototheaiidae) within krill concentrations off Balleny Island (Antarctic). Polish Polar Research, V. 4, N1–4.

Slosarczyk W. (1983). Preliminary estimation of abundance of juvenile *Nototheniidae* and *Channiththyidae* within krill swarms east of South Georgia. Acta Ichthyologica et Piscatoria. V-XIII, Fasc. 1.

Slosarczyk W., Rembriszewski J.M. (1982). The occurrence of *Nototheniidei* (Pisces) within krill concentrations in the region of the Bransfield Strait and the southern Drake Passage. Polish Polar Research. V. 3, N3–4.

Summary of responses to Convenor's letter of 21 December 1984 on the objectives and arrangement of the meting (prepared by Secretariat).