ANTARCTIC TREATY
XVIIth CONSULTATIVE MEETING

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FIRST MEETING OF EXPERTS ON ENVIRONMENTAL MONITORING IN ANTARCTICA

BUENOS AIRES, JUNE, 1-4, 1992

(Submitted by Argentina)

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Note: The meeting of Experts was held in agreement with the XVI Antarctic Treaty Consultative Meeting (Bonn, 1991), and was sponsored and supported by the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), the Dirección Nacional del Antártico and the Argentine Navy.

1.- The first Meeting of Experts on Environmental Monitoring in Antarctica was held in Buenos Aires from 1-4 June, 1992 pursuant to Recommendations IV-24 and XV-V, and in accordance with paragraphs 62-66 of the Final Report of the XVI Antarctic Treaty Consultative Meeting (Bonn, 1991).

2.- Representatives of the following Antarctic Treaty Parties participated. **Consultative Parties**: Argentina, Australia, Brasil, Chile, China, Germany, India, Italy, Japan, Netherlands, New Zealand, Norway, Russia, South Africa, Spain, Sweden, the United Kingdom, the United States and Uruguay; **Non Consultative Parties**: Greece.

3.- The following organisations were invited as observers: Comission for the Conservation of Antarctic Marine Living Resources (CCAMLR); Scientific Committee on Antarctic Research (SCAR); Council of Managers of National Antarctic Programmes (COMNAP); Antarctic and Southern Ocean Coalision (ASOC); International Civil Aviation Organisation (ICAO); International Hydrographic Organisation (IHO); Intergovernmental Oceanographic Comission (IOC); International Union for the Conservation of Nature and Natural Resources (IUCN); United National Environment Programme (UNEP); World Meteorological Organisation (WMO); World Tourism Organisation (WTO). Representatives from the first four also attended the Meeting. A list of participants is included as Annex 1.

4.- In the opening session Antarctic and Southern Ocean Coalition presented a request to participate with two representatives. This was accepted by the Meeting.

5.- Dr. Carlos Rinaldi (Argentina) was elected Chairman and after thanking the delegations for having elected him Chairman, proposed Lic. Irene Schloss (Argentina) and Lic. Gustavo A. Ferreyra (Argentina) be appointed as Secretaries of the meeting.

6.- After welcoming participants, the Chairman opened the meeting.

7.- Two draft agendas were presented and combined to produce the following:

(1) Opening of the Meeting;

(2) Election of Officers;

(3) Adoption of the Agenda;

(4) History and development of environmental monitoring under the Antarctic Treaty System. The need for monitoring under the Environment Protocol;

(5) The objectives of environmental monitoring;

(6) Potential adverse impacts on the Antarctic environment;

(7) Antarctic resources of special concern;

(8) Monitoring methodologies;
   a) Selection of monitoring variables,
   b) Establishment of protocols and assessment of technologies,
   c) Quality assurance of data (standardisation, accuracy and reproducibility);

(9) Management of data:
   a) existing data sets,
   b) analysis, evaluation and curation,
   c) data exchange and international co-operation;

(10) The use of monitoring in operational management;

(11) Resource implications;

(12) The role of institutions (e.g., Antarctic Treaty Consultative Meeting (ATCM); Comission for the Conservation of Antarctic Marine Living Resources (CCAMLR); Committee on Environmental Protection (CEP); Council of Managers of National Antarctic Programmes (COMNAP); Scientific Committee on Antarctic Research (SCAR).

(13) Report writing and Recommendations.

It was agreed that the Agenda items should be discussed in the context of the Termos of Reference for the meeting adopted at the XVI ATCM Bonn, 1991 (below)

8.- TERMS OF REFERENCE

Antarctic Treaty Consultative Meeting XVI agreed that the Meeting of Experts should be provided with the following terms of reference:

To Consider Monitoring for the following Purposes

To obtain a regular and verifiable record of activities and environmental data necessary to:

- assess and quantify impacts of activities, including impacts predicted in the course of environmental impact assessments;
- provide early warning of negative impacts;
- identify preventative or remedial measures needed to reduce or eliminate adverse impacts;
- plan similar activities in the future.

Topics to be Considered by a Meeting of Experts

- Identification of the nature and possible significance of adverse impacts on the values jof Antarctica, as set forth in Article 3 of the Protocol on Environmental Protection to the Antarctic Treaty, which might require monitoring, (Agenda Items 6 and 7);

- Identification of activities, environmental and other data required to detect and monitor possible impacts and to distinguish these impacts from natural variability, (Agenda Item 8 (a);

- Identification of methodologies and technologies available for monitoring (especially inexpensive and automated systems), (Agenda Item 8 (b) and (c);

- Identification of steps needed to create national and co-operative data systems which would provide for collection, quality control, archiving, evaluation, exchange and retrieval of environmental data, (Agenda Item 9 (b) and (c);

- Identification of existing relevant data sets, including baseline data repositories, as well as programmes which generate these data, (Agenda Item 9 (a).

9.- Following a general discussion on agenda items and terms of reference for the group, a number of subgroups were appointed to deal with agenda items 4, 5, 6, 7, 8, 9, 10, 11. Documents and papers that circulated at this meeting are listed in Annex 2.

Agenda item 4

THE HISTORY AND DEVELOPMENT OF ENVIRONMENTAL MONITORING WITHIN THE ANTARCTIC TREATY

10.- Scientific and environmental monitoring has been undertaken in Antarctica for many years. However, discussion of monitoring by the Antarctic Treaty Consultative Parties is relatively recent.

11.- The issue of environmental monitoring had arisen often during the six year negotiations on the Convention on the Regulation of Antarctic Mineral Resource Activities (CRAMRA) and the ability to monitor key environmental parameters was incorporated in CRAMRA's Article 4 as a key principle governing potential activities.

12.- Coordinated monitoring was considered useful as a tool for management in the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), where it developed into an international programme aimed at monitoring the status of selected biological variables "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 (SC-CAMLR-IV, Annex 7). Since its inception, the CCAMLR Ecosystem Monitoring Programme (CEMP)has developed a wealth of methodological and practical information.

13.- Treaty Parties first focussed on environmental monitoring in a more general sense at ATCM XII (Canberra, 1983) where they adopted Recommendation XII-3. This called on Governments to assess and take steps to minimise the possible harmful environmental effects of planned scientific and related logistic activities. SCAR was invited to provide advice on (i) the categories of research and logistic activities that might be expected to have a significant impact on the Antarctic environment, and (ii) procedures that might be used to assess the potential environmental impacts

of planned research and logistic activities.

14.- In response to the invitation in Recommendation XII-3 to provide advice, SCAR prepared the report -"Mans Impact on the Antarctic Environment: A procedure for evaluating impacts from Scientific and Logistic Activities". This report was tabled at ATCM XIII (Brussels, 1985).

15.- Subsequently, SCAR has taken account of Recommendation XIII-5 by studying the needs for collecting, evaluating and managing data for environmental assessment, monitoring and scientific research.

16.- At ATCM XIV (Rio de Janeiro, 1987) the Parties, taking account of advice from SCAR, adopted Recommendation XIV-2.This contained two explicit references to monitoring in relation to Comprehensive Environmental Evaluation (CEE). These were that CEEs should include:

> -identification of measures, including monitoring programmes,that could be taken to minimise or mitigate impacts and detect possible unforeseen effects;
>
> -key indicators of the environmental effects of the activities should be monitored.....'

17.- The Report of ATCM XIV affirmed the desirability of considering steps useful for improving the comparability and accesibility of Antarctic scientific data, including identification of data useful for planning management and evaluation of activities and the development of a data directory.

18.- Environmental monitoring was developed further at the ATCM XV (Paris, 1989) where monitoring within the wider framework of comprehensive environmental evaluation was recognised in a number of key papers. Notable amongst these were the set of draft Principles on Comprehensive Protective Measures put forward by the Chairman of Working Group I. These reiterated the earlier principle enshrined in CRAMRA that informed judgements on proposed activities must take full account of whether there exists the capacity to monitor key environmental parameters, and stated that continuous and effective monitoring should take place to verify predicted effects and detect unforeseen effects.

19.- Other papers tabled at the 1989 meeting laid stress on monitoring to a greater or lesser extent. An Australian-French proposal called for the general principles of a monitoring system to be framed. New Zealand drew attention to the monitoring requirements of Recommendation XIV-2 and suggested that Treaty Parties "should agree to apply effective and open monitoring and reporting procedures to all major activities in Antarctica....", whilst the US identified monitoring (the collection of time series of scientific and environmental data) as one of the standards and procedures needed for comprehensive protection. The net result of these deliberations was the adoption of Recommendation XV-5, based on an initial draft by the US.

20.- Recommendation XV-5 addressed two distinctly different types of environmental monitoring, first, monitoring in the Antarctic in order to detect changes in the global environment, and

second, monitoring in order to detect the local environmental impacts of activities taking place within Antarctica. These two aspects of monitoring were dealt with in the operative paragraphs 1 and 2 of Recommendation XV-5 respectively. The initial call for a Group of Experts Meeting under the terms of Recommendation IV-24 was aimed at addressing both types of monitoring. This requested advice on:

"(a). the types of cooperative, long-term monitoring programmes that would be useful for detecting, quantifying, monitoring, and determining the likely causes of observed changes in air quality, snow and water quality, and other key features of Antarctic environments and living resources;

(b) the methods that should be used to collect, report, store, exchange, and analyse data; and

(c) where and how frequently various environmental parameters should be measured."

21.- ATCM XV also adopted Recommendation XV-16. This called upon Governments, in cooperation with SCAR, to develop an Antarctic Scientific Data Directory and to take steps to improve the accessibility and comparability of Antarctic scientific data. SCAR has taken steps to identify Antarctic data holdings, and to circulate to SCAR national committees a survey for national distribution.

22.- The survey results demonstrate that data are usually organised in a manner reflecting the structure of national Antarctic programmes. For instance, in countries with decentralised programmes, data are usually distributed amongst a number of institutions making the collection of information a difficult and complex task.

23.- Recommendation XV-5 also called on Governments to continue and,as appropriate, expand programmes for monitoring global environmental changes, as well as local monitoring programmes related to human activities in Antarctica. Governments were also urged to maintain accurate records of materials introduced into, and removed from, Antarctica and to establish co-operative working relationships with international organisations involved or interested in environmental monitoring.

24.- Unfortunately, the Group of Experts Meeting envisaged by Recommendation XV-5 had not been convened by the time of the ATCM XVI in Bonn, October 1991.Three further important steps had however been taken.

25.- First, at their meeting in June,1991 in Bologna, Italy, the Council of Managers of National Antarctic Programmes prepared a set of draft Practical Guidelines on the Antarctic Environmental Assessment Process. These guidelines identified the need for monitoring activities to allow for appropriate decision making, and stressed that such monitoring should be scientifically justifiable.

26.- Second, SCAR in a separate paper on environmental monitoring in the Antarctic set out useful guidelines on monitoring,stressing that monitoring would be most effective when organised on a standardised, multi-national basis and stating clearly that the scientific design of any monitoring

programme would depend on the objectives of monitoring i.e. the particular questions requiring answers. SCAR stressed the need for a clear indication of the importance of parameter selection for monitoring.

27.- Third, the greatest boost to the debate on monitoring has come from the Protocol on Environmental Protection to the Antarctic Treaty adopted at Madrid in October, 1991. This lays certain obligations on State Parties - including obligations to monitor in Antarctica.

28.- The Protocol on Environmental Protection calls, under Article 3.2(d) and 3.2(e), for regular and effective monitoring. This would allow assessment of the impacts of ongoing activities, including the verification of predicted impacts as well as facilitate early detection of the possible unforeseen effects of activities carried on both within and outside the Antarctic Treaty area on the Antarctic environment and dependent and associated ecosystems. The same issue is addressed in Recommendation XV-5. This specifies monitoring programmes relevant to activities such as:

a) waste disposal;
b) contamination by oil or other hazardous or toxic substances;
c) construction and operation of stations, field camps, and related ship, aircraft, and other logistic support facilities;
d) conduct of science programmes;
e) recreational activities; and
f) those affecting the purposes of designated Protected Areas.

29.- The Protocol identifies monitoring (Article 10 (1)(k)) as an activity for which the Committee for Environmental Protection should have an advisory role whilst further more detailed provisions for monitoring are set out in Annex I (Articles 3 and 5) on Environmental Impact Assessment.

30.- Against this background the Treaty Parties at the ATCM XVI, Bonn refocussed on the need to implement Recommendation XV-5 and in particular on the need to convene a Meeting of Experts under the terms of Recommendation IV-24. The Treaty Parties recognised however the disadvantage of attempting to address both types of environmental monitoring simultaneously. It was also recognised that the Meeting of Experts on Data Management called for in Reccomendation XV-16 could be initially addressed in this more limited context. Accordingly they considered that the subject of monitoring to be addressed by the Group of Experts Meeting should confine itself to local activity monitoring rather than wider monitoring for global change. They requested the meeting to consider monitoring under the terms of reference set out in Item 3.

31.- Recommendation XV-5 also invites SCAR and COMNAP to provide advice on monitoring to assist the Group of Experts. The response from SCAR and COMNAP was to prepare a report entitled "Environmental Monitoring in Antarctica: a Discussion Document".

Agenda Item 5

OBJECTIVES OF ENVIRONMENTAL MONITORING

Environmental Monitoring

32.- The objectives of environmental monitoring are to detect and measure changes in the environment by collecting time series of data for defined purposes and observing trends in the selected variables. Since the purposes of collecting data can be defined by both basic and applied research questions, the general objectives are:

a) To further basic understanding of the structure, range of variability in, and interactions within and among natural systems;

b) To obtain baseline information on the environment in order to be able to detect and measure future environmental changes and to differentiate between natural and anthropogenic changes;

c) To verify predictions concerning the effects of human activities on variables such as atmospheric processes, ice dynamics, biogeochemical cycling, and ecosystem structure and processes and record unforeseen effects of human activities on selected variables;

d) To evaluate the effectiveness of existing conservation measures and regulatory mechanisms in relation to operation and management procedures;

e) To assess the consequences of natural and anthropogenic environmental change for conservation, regulatory mechanisms and procedures for operations and management measures to help in identifying improvements or remedial actions.

Antarctic Environmental Impact Monitoring

33.- The Protocol on Environmental Protection to the Antarctic Treaty calls, under Articles 3.2(d) and 3.2(e), for regular and effective monitoring to allow assessments of the adverse impacts of human activities. It is therefore necessary to focus especially on those objectives concerned with anthropogenic effects at a local level. Thus there will be a continuing need in Antarctica for environmental monitoring which will:

a) collect baseline data against which the impact of activities can be detected and measured;

b) assess and quantify these impacts, including impacts predicted in the course of environmental impact assessments and possible cummulative impacts;

c) provide early warning of adverse impacts;

d) assist in identifying and assessing the effectiveness of measures to reduce or eliminate adverse impacts;

e) provide the basis for reducing or eliminating the possible adverse impacts of future activities;

Agenda Items 6-7

POTENTIAL ADVERSE IMPACTS ON THE ANTARCTIC ENVIRONMENT AND ANTARCTIC RESOURCES OF SPECIAL CONCERN

34.- Article 3 of the Protocol on Environmental Protection specifies protection of the Antarctic environment and its dependent and associated ecosystems, including its wilderness and aesthetic values and its value as an area for the conduct of scientific research. Within this context, there are features and areas of value and special interest which are recognised as being important to protect. Table 1 lists several examples of such features and areas. These are listed in several categories, including discrete components of the ecosystem as well as ecological processes. In addition, selected types of geographical areas are included because of their conservation, scientific, or aesthetic importance.

35.- All components of the Antarctic environment are susceptible to impacts from human activities. They include physical features (sea ice, sea floor, lakes and ponds, air, glacial ice, and snow), living organisms (flora and fauna), and processes (physical, chemical, and biological). Impacts arising from human activities potentially affecting all or any of these features, organisms, and processes might require monitoring.

36.- It was noted that CCAMLR and International Whaling Commission (IWC) have responsibilities for assessing the potential impacts of commercial marine harvesting on target and non-target species and the ecosystems of which they are apart. It is important that environmental monitoring under the Protocol be closely coordinated, where appropriate, with activities within CCAMLR (e.g., the CCAMLR Ecosystem Monitoring Programme) and IWC, to complement the ecosystem-related research and monitoring activities undertaken by these groups.

37.- The meeting also took note of the need to assess the levels of marine pollution within the Treaty area, which was raised by the Parties at ATCM XVI in Bonn (Para 72 [ii] and [iii] of Final Report) and recommends that these matters be considered initially by SCAR with due regard to the current activities by CCAMLR in this field.

38.- The value of the features listed in Table 1 can be diminished or eliminated by environmental impacts, which can be of many different kinds, of varying intensities, and often will be site specific (see Table 2).

39.- The most obvious impacts affecting the terrestrial environment, which includes, in addition to soil and rocks, inland waters, ice fields, and glaciers, are often the result of activities occurring within the Antarctic. These are likely to be most apparent in the neighbourhood of stations and field camps. Antarctic areas of exposed rock or inland waters are of limited extent, thus the spatial scale of impact is generally small. However, features of restricted extent may be more vulnerable to perturbation if they have limited capacity to absorb changes.

40.- In the marine environment, a distinction needs to be made between coastal waters, particularly those enclosed in small bays, and the open ocean. In coastal waters, the scale of impacts may be local, as on land, but the extent and continuity of the open ocean ensures that most impacts are widely distributed and are less likely to be detectable. In the open ocean around the Antarctic, the majority of existing impacts are those associated with harvesting and shipping operations. Commercial harvesting and its associated activities, and the impacts arising from these are the concern of CCAMLR and the IWC, though they are included in Table 2 for completeness.

41.- Impacts on the atmosphere of the Antarctic are most likely to arise from activities far outside the region. Conspicuous among these are the increase of greenhouse gases and the depletion of stratospheric ozone. However, combustion of fuels and other substances in the Antarctic can introduce compounds, such as oxides of carbon, sulphur, and nitrogen, which may have long residence times in the atmosphere. Others, such as heavy metals, fly ash and organic compounds are temporary atmospheric pollutants, though once deposited they may cause long-term terrestrial pollution.

42.- The list of possible impacts in Table 2 is not exhaustive. Likewise, not all the impacts have been identified on all the features or areas possibly at risk. Further research, possibly in association with environmental impact assessment procedures carried out under Annex 1 of the Protocol, will undoubtedly disclose other examples.

43.- The meeting noted that the possibility and significance of impacts would depend on their location, timing, and scale as well as on the nature of the activities. The meeting also noted that, at present, the nature and scale of most activities in Antarctica are such that they are unlikely to have significant adverse environmental impacts as defined in Article 3 and the various Annexes to the Protocol, except at the local level.

44.- A particular activity could impact any or all of the terrestrial, marine, or atmospheric systems. The selection of particular activities can illustrate both the extent of impacts which must be considered in designing a monitoring regime and highlight those which are currently of considerable concern. In the light of experience of familiar and existing activities, the view of the meeting was that the activities most likely to have impacts of possible concern in terms of Article 3 of the Protocol are:

a) Station and airstrip construction and logistic operations;

b) Waste water and sewage disposal;

c) Incineration of waste;

d) Power and heat generation;

e) Human activities involving or affecting native flora and fauna;

f) Scientific research activities; and

g) Accidents resulting in fuel spills or other types of environmental contamination.

45.- The first steps in environmental impact monitoring are defining the programme objectives, identifying the variables of concern, determining the natural variations therein, and establishing baselines against which the nature, magnitude, and significance of future changes can be evaluated. Because substantial financial, logistic, and personnel resources will be required to establish such programmes, it is important that care be taken in selecting the variables of concern.

46.- To assist in this regard, it was noted that much valuable information could be obtained by assessing the nature, scale, and intensity of environmental impacts caused by existing scientific stations, aircraft runways, field camps, and related operations. Such information would provide a useful basis for predicting the likely effects of future activities. Therefore, the meeting recommended that research programmes be established at a representative subset of facilities of different types and sizes in different environments (e.g., coastal and inland, on rock or earth, and on inland ice or ice shelves) to record their present impacts on the surrounding environment.

47.- The object of these evaluations would be to determine the nature and intensity of impacts at increasing distances from the center of activities of different types and scales in different environments. Knowing the "footprints" of such varied facilities and activities could be used to help predict the possible impacts of future activities. This, in turn, would facilitate environmental impact assessment and the identification and design of necessary monitoring programmes.

48.- The meeting noted that a wide range of Antarctic activities could give rise to impacts on the environment. Examples of such possible impacts are listed in Table 3.

Table 1. Examples of Antarctic features and areas.

Features	Areas
Terrestrial	Bird and seal breeding sites and access routes
Particularly vulnerable species and communities (e.g., grass, moss, and lichen communities and associated invertebrates)	Ice-free coasts and mountains
	Continental shelf
Snow algae	Dry valleys
Meteorites, ventifacts, fossils, mineral occurrences, and other geological features	Lakes, ponds, and subsurface waters

Table 1. (cont.)

Features	Areas
Mountains and other areas with particular wilderness and aesthetic value	Glaciers and ice shelves
Pollution-free land and ice	Existing scientific stations and field camps
Marine	Protected areas
Marine living resources Phytoplankton Coastal benthos Antarctic krill and other zooplankton Finfish Squid Penguins and flying birds Marine mammals	Sites visited by tourists
Pollution-free water and ice	
Atmospheric	
Pollution-free air	
Ecosystem integrity and processes	
Functional integrity	
Interactions	
Nutrient cycles	
Productivity	

Table 2. Examples of possible environmental impacts in the Antarctic.

Terrestrial (includes inland waters, ice fields, and glaciers)

- Habitat destruction/modification
- Destruction/removal/modification of biota, fossils, ventifacts, etc.
- Modification of vital rates of biota (disturbance to production and/or growth)
- Modification of distribution of biota
- Introduction of alien biota
- Pollution by:
  - biocides and noxious substances
  - nutrients (eutrophication)
  - radionuclides
  - inert materials
  - electromagnetic radiation
  - noise
  - heat
- Modification of thermal balance of environment
- Aesthetic intrusion

Marine

Shoreline/enclosed waters/benthos

- Habitat destruction/modification
- Destruction/removal/modification of biota
- Modification of vital rates of biota
- Pollution by:
  - biocides and noxious substances nutrients
  - radionuclides noise
  - inert materials (dumping) heat

Open ocean

- Destruction of biota
- Deep seismic explosions
- Noise
- Catastrophic pollution
- Commercial marine harvesting (the responsibility of CCAMLR and IWC)

Table 2. (cont.)

Atmospheric	
Pollution by:	
sulphur oxides	nitrogen oxides
radionuclides	carbon monoxide
hydrocarbons	carbon dioxide
microbiota	dusts
electromagnetic radiation	

Table 3. Examples of activities causing possible impacts on the Antarctic environment.

Construction

Stations
- Airstrips
- Harbours
- Roads

Routine logistic operations

Stations:
- fuel storage and transfer
- power generation
- heating
- water desalination
- waste disposal

Transport:
- helicopters
- fixed wing aircraft
- trucks and other vehicles
- ships

Field camps

Scientific activities

Collection of biological samples

Table 3. (cont.)

Experimental harvesting/perturbation
Drilling
Seismic surveys (terrestrial and marine)
Collection of geological samples
Use of chemicals and isotopes
Commercial activities
Harvesting of marine living resources
Tourism
Accidents
Ship/aircraft/vehicles
Fuel leaks
Fires
Introduction of alien species

Agenda Item 8

MONITORING METHODOLOGIES

49.- Environmental impact monitoring programmes need to be designed and conducted to answer specific questions (i.e., to test specific hypotheses). There exists a wide range of physical, chemical, and biological data and models from studies outside the Antarctic, and these should be considered where appropriate in framing the hypotheses.

50.- Monitoring is the planned measurement of selected variables in defined areas and the evaluation of the results in a predetermined fashion to answer a specific question or to test a specific hypothesis. It therefore is essential to give much attention to the framing of hypotheses and to the selection of variables to be assessed. Monitoring is not the measurement of many variables at many

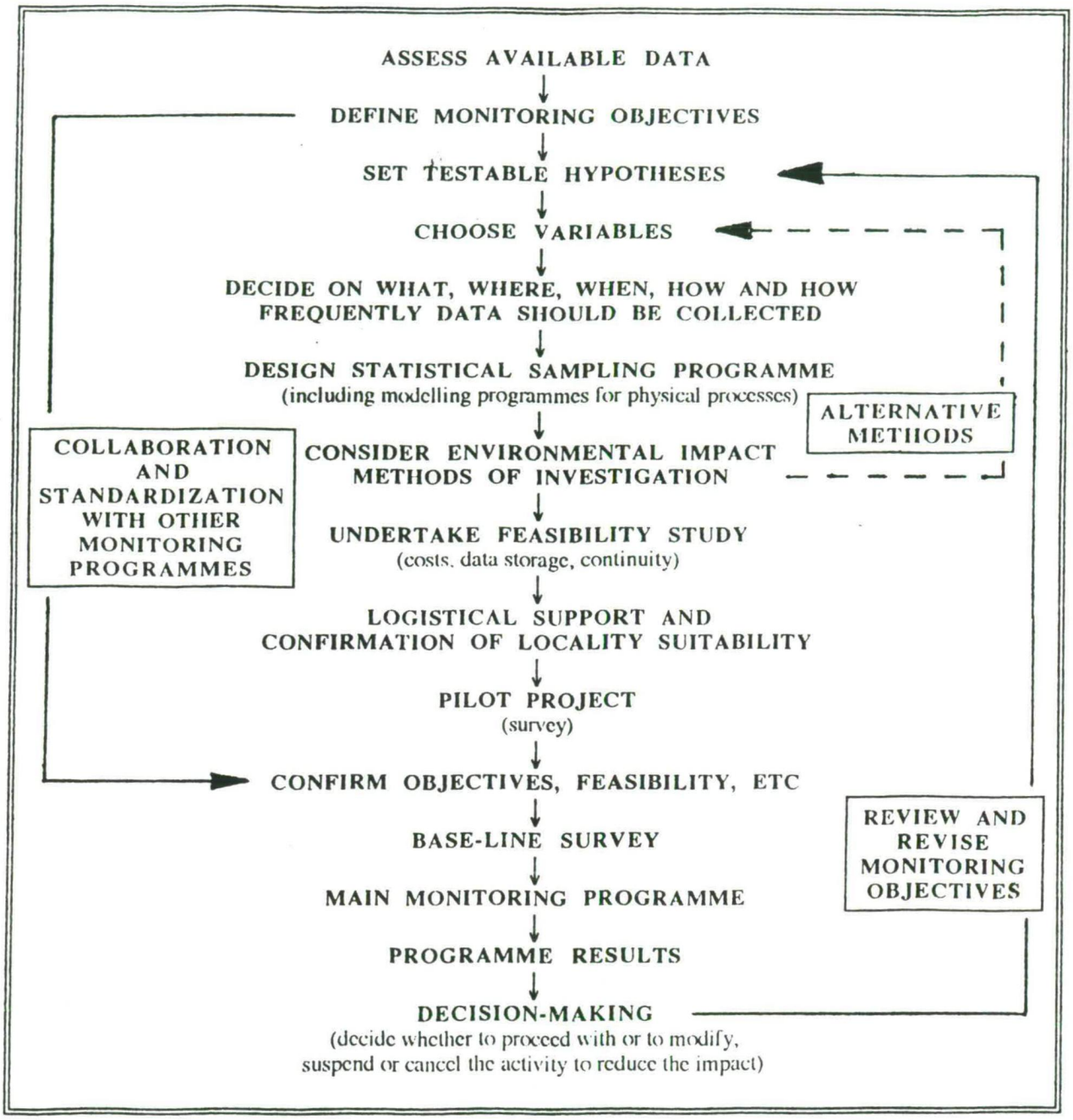

Figure 1. Flow diagram for designing environmental monitoring programmes (adapted from Table 4 in SCAR and COMNAP (1992) *Environmental monitoring in Antarctica: a discussion document*).

sites in the hope that subsequent analyses will reveal a cause-effect relationship.

51.- Selecting the appropriate variables and deciding what, where, when, how, and how frequently data should be collected to answer the questions of concern in the most rapid and cost-effective way possible may be a difficult task. Factors that need to be considered in the process of making these determinations include available technology, experience of monitoring personnel, and specific environmental and climatic conditions at the time of sampling.

52.- The specific questions that drive monitoring; the various features, areas and impacts of concern; and the availability of resources (in terms of funds and personnel) will dictate on a case-by-case basis the technologies and methodologies needed. The meeting did not attempt to identify or describe specific aspects of potentially useful methodologies, but recommends that this be the subject of a future meeting of technical experts.

53.- Figure 1, derived from Table 4 in the discussion paper provided by SCAR and COMNAP, illustrates the process that generally should be used to design effective monitoring programmes and to incorporate the programme results into decisions necessary to give effect to the Protocol.

54.- The sampling programme must be designed with due regard to statistical methods and must recognise the extreme seasonality of the Antarctic environment. It must aim to distinguish between natural environmental change and change induced by the activity under investigation. The design of the sampling programme must ensure that the number of samples collected does not exceed the available analytical capacity. When possible, the programme should aim for economy of effort by using observational, collection, and analytical techniques which can measure more than one useful parameter. Where possible, sampling techniques should be standardised to permit comparison of information collected by different programmes.

55.- In general, measurement techniques should be as simple and as cost-effective as possible so that they may be widely applied. Where there is already an agreed international protocol for monitoring a particular variable, this should be used. Wherever possible, non-destructive techniques should be used, especially for biological sampling. If destructive techniques are unavoidable, the over-riding consideration should be the intrinsic value of the sample being measured, i.e., its rarity, the effect of its removal from the ecosystem, etc. When sampling of biota is undertaken, efforts should be made to select an appropriate subsample for inclusion in existing specimen banks. This would allow retrospective investigation using new techniques or focussing on new problems. Continuous sampling is only necessary when a fine resolution time series is essential for interpretation.

56.- For physical and chemical measurements, it is essential that measurements are referenced to standards accepted by all the laboratories undertaking a particular type of measurement, and that these laboratories undertake regular intercalibration studies. In many countries undertaking the most technically demanding analyses, it is expected that the laboratories will be registered under quality assurance schemes. Accuracy and repeatability should be covered by quality assurance requirements, recognising that resolution (detection limits) are critically dependent on technique and instrumentation. It is suggested that both blank and measurement values should be routinely reported and that caution should be exercised when judging the significance of results. In cases

where the measurements are near the detection limits of the procedure, acceptable data would normally be considered as those more than ten times the value of the blank or the detection limit.

57.- For some types of monitoring, indicator species may prove valuable. When searching for suitable species it is suggested that the marine ecosystem, with its high species diversity, may offer greater opportunities than the terrestrial ecosystem. The CCAMLR Ecosystem Monitoring Programme (CEMP) may be helpful in this regard.

58.- Not all biological monitoring may be best done at the whole organism level. For example, the use of cellular and organ systems from Antarctic species may provide very useful experimental approaches to toxicity assessments.

59.- It was agreed that the following guidelines are likely to facilitate future discussions on this subject:

a) monitoring on a local scale is most relevant to national operators' environmental decision-making;

b) monitoring in Antarctica, must often be short term; innovative monitoring strategies are needed to address this constraint;

c) given the difficulties with collecting samples in extreme weather conditions, it might be appropriate in some cases to model the dispersion of pollutants rather than sampling for their presence. This requires, of course, data and models which are applicable to the Antarctic and validation of the models;

d) screening for inorganic contaminants through the use of spectrography and other techniques is relatively simple and cost-effective, whereas organic contaminant analysis is typically more complex, time-consuming, and expensive;

e) the assessment of exposure to a contaminant needs further development, especially with such techniques as biomarkers; and

f) basic biological and other studies being conducted by national programmes, and directed studies being carried out by other organisations such as CCAMLR and the IWC, provide important sources of information for environmental monitoring.

Agenda Item 9

MANAGEMENT OF DATA: DATA ACCESSIBILITY AND COMPARABILITY

60.- In the context of environmental impact assessment, the primary purpose of an Antarctic data system is to maintain a reliable record for use in determining the causes and possible significance of changes in Antarctic ecosystems. Data that may be useful for assessment and monitoring are being collected by many basic scientific research studies in Antarctica. Additional data will be

collected in the course of directed environmental impact monitoring. The utility of the data will depend upon their reliability, accessibility, and comparability. The meeting agreed that, as a matter of priority, a cooperative system for collecting, verifying, archiving, and exchanging relevant data should be developed.

61.- Establishing a data system for monitoring to assess the effects of Antarctic activities will facilitate the creation of a broader data system for all scientific data collected in Antarctica. While such a broadening is not the subject of the Meeting of Experts, the goal of establishing such a system has been endorsed by Antarctic Treaty Recommendations and should, therefore, be kept in mind in considering the design of the activities-related system.

Basic Requirements of an Effective Data Management System

62.- A coordinated Antarctic environmental data management system should at the least permit users to:

- know what data are available;

- know the form and extent of the various data sets; and

- easily access and communicate data.

To these ends, countries engaging in monitoring activities should consider how to:

- obtain international agreement on a data collection and analysis protocol with laboratories that are interested in the specific variables;

- organise and coordinate inter-laboratory calibration schemes and provide international standards as required;

- curate and archive data obtained under such a protocol;

- make these data available to the scientific community and to the Committee on Environmental Protection (CEP);

- provide to each other and to the CEP an initial summary of the data and an initial evaluation of their environmental consequences.

Current Activities

63.- At present, there are few international Antarctic environmental databases per se, although many organisations and individuals within the SCAR membership hold relevant data. In addition, environmental databases are known to be in various stages of development in Argentina, Chile, Italy, New Zealand, the United Kingdom and the United States, and possibly in other countries.

SCAR is currently analysing the responses to a questionnaire on data holdings within SCAR.

64.- A report is being prepared for presentation to XXII SCAR in Bariloche, Argentina, during June 1992. The report is expected to list subject areas, and administrative details of the principal databases of the SCAR countries currently undertaking environmental monitoring.

65.- SCAR experience with the BIOMASS (Biological Investigations of Marine Antarctic Systems and Stocks) database showed that one of the major problems was that of data validation to ensure comparability of data. Existing environmental data are unlikely to be comparable between data sets. The value of these data will need to be assessed before embarking upon their evaluation or the collection of new data. It will be necessary to establish a new baseline from which to work. Most existing data will probably need to be discarded although recalculation of some data may be possible. SCAR's experience will prove valuable if one country is willing to accept responsibility for handling data sets provided by several contributors.

Steps Toward Creation of a Cooperative Data Management System

66.- The first step in the creation of an Antarctic data management system is identification by Parties with active Antarctic programmes of their existing data sets, and their ongoing and planned research and monitoring programmes. These national descriptions should be exchanged by an agreed date among ATCP's to form the basis for the development of the Antarctic data system.

67.- An Antarctic data network between Parties is preferable to establishing a single centralised repository for all Antarctic environmental data. A network approach has many advantages. First, it is likely to be less costly to establish. Second, assuming good communication links, data descriptions and common formatting, access through a network is potentially easier than through a single data center. Moreover, a network approach allows Parties to build on existing data archives.

68.- Even a network approach will require some coordinating mechanism, since agreement must be reached on common formatting and methods of access. It is essential that all data be similarly processed so that individual datasets are comparable with others. This will demand, in the long term, internationally agreed standards and protocols both for the treatment of data and for communication among databases. Data will need to meet quality assurance standards and to be validated before inclusion in a database. Meeting these requirements will facilitate national and international tracking of data and exchange of information through computer networks. In addition, a coordinated approach will allow identification of appropriate technologies and economic resources.

69.- A logical first step toward a coordinated network approach is the creation of an Antarctic data directory. Such a directory must be as transparent as possible so as to provide easy access for potential data users.

Antarctic Data Directory

70.- Since data documentation is a fundamental principle of data management, early agreement on

the documentation required for a directory is needed. The following format is suggested:

a. title of data set;

b. purpose of collecting the data;

c. parameters measured;

d. date of start of the actvities;

e. duration of observations, including date(s) on which data were collected;

f. names of organisation(s) and individuals(s) responsible for collecting the data;

g. identification of the instrument(s) and techniques used to collect the data;

h. keywords for data access;

i. instrument calibration;

j. data collection or monitoring procedures, with details of spatial and temporal sampling schemes, including references to published descriptions of any "standard" procedures used;

k. make, model, operating system and medium format of the originating computer. Also listing of a programme that will read the original data medium, and a listing of the first few data records;

l. description of any data processing necessary to calibrate or scale values;

m. data quality assurance procedures performed either during or after collection;

n. analysis and/or research notes that provide information about strengths or weaknesses of the data set so as to establish the accuracy, reliability and precision of observation;

o. a description of the data set or product, including:

-algorithms (formulae) used to process the data collected by the instrument;

-storage medium (tape, diskettes, optical disk, CD-ROM, etc) and physical format (i.e., record length, block length, operating system of originating computer, etc.) on that medium;

-distribution medium (hard copy, tape, diskette, optical disk, CD-

ROM, etc.) and physical format of that medium;

-geograhical coverage;

p. address, contact person, Telex, FAX and/or telephone number of the organisation from which the data may be obtained;

q. any conditions attached to data use (e.g. costs, response time, etc.)

71.- In addition to appearing in a consolidated Antarctic data directory, the documentation package described above should be "attached" to the data sets and data products to ensure they remain with the data for all future use. The packages should be maintained in a machine-readable form for ease of updating and distribution on any media format. Documentation packages should be subject to peer review procedures to ensure completeness and accuracy. The regular updating of the directory is important.

Other Considerations

72.- Consideration should be given by each Party to establishing a national scientific advisory board with representation from a range of disciplines addressed by a particular data node or center. This board could provide guidance on scientific questions, as well as assist in the design of data products and access mechanisms that are well-founded in scientific needs and that respond to operations monitoring and research issues.

73.- SCAR and COMNAP are currently considering steps needed to create a data directory. The Treaty Parties should consider calling upon these organisations to provide the guidance referred to in the previous paragraph on an international level. In addition, to providing guidance on the scientific underpinning of monitoring programmes and data management, SCAR should be asked to identify the basic research programmes and data collected therein that could contribute to a comprehensive environmental research and data system, bringing together monitoring data collected in the course of ongoing studies in Antarctica.

74.- Existing mechanisms for the regular exchange of Antarctic information could be used to enable the transfer of useful and practical data on environmental impact monitoring. This would form a valuable sharing of experience, leading to more efficient and effective monitoring and better decision-making for minimising environmental impacts.

75.- Monitoring programme planning should go from the overall definition of the purpose and scope to detailed activities such as sampling, collection of data, analysis and storage of samples. Such plans may change over time in response to the monitoring results .

76.- Publication of data should be encouraged and data should be freely exchanged. The CEP could, as is the case with CCAMLR, institute a publication series.

77.- Maintenance of accurate records of Antarctic activities is a monitoring requirement called for

in Recommendation XV-5, and is already being implemented. These existing data are of importance to monitoring materials brought into Antarctica and the environmental impacts of waste production. Examples include records of the types and quantities of:

- Fuels and materials transported and used;

- Wastes removed from Antarctica;

- Wastes disposed of in Antarctica.

78.- In the longer term (beyond five years), it may be possible to establish on-line access to data catalogs, inventories and the data themselves. To accomplish this, data centers would have to incorporate Antarctic Data System needs into capital planning.

79.- Because of ongoing technological development, consideration should be given to establishing agreed methods for migration of data sets across technologies. As an Antarctic environmental data system is developed, a key issue to be resolved is how the interests of individual scientists who have collected data are safeguarded.

Development of a Common or Coordinated Geographic Information System

80.- The development of Geographic Information Systems (GIS) will allow the integration of mutiple datasets for different variables within a specified area. These datasets may then be viewed singly or in combination to reveal related effects. Sequential datasets may be similarly viewed to show temporal trends and allow predictions of future impacts to be made.

81.- As a first step, a survey should be done to identify the kinds of systems (computer software as well as hardware) currently being used by national programme operators and others to organise, store, display and analyse Antarctic environmental data. Also consideration should be given to adopting a common set of base maps or a common grid system for plotting environmental data.

Agenda Item 10

THE ROLE OF MONITORING IN OPERATIONAL MANAGEMENT

82.- The need of Antarctic operators to know about past, existing and potential future environmental impacts caused by their activities is the intent of environmental impact monitoring. By posing focussed questions about how activities cause or may cause environmental impacts, operators embark upon achieving environmental protection goals. Results of environmental impact monitoring focussed on these questions provide the feedback operators need to improve their activities through prevention or mitigation of environmental impacts. Part of this feedback depends upon the maintenance of accurate records of activities (e.g., inventories) as discussed in this document under Management of Data (Item 9).

83.- Substantial environmental impact monitoring has already been undertaken outside of the

Antarctic and can provide useful guidance for Antarctic operators. It must be recognised, however, that environmental impact monitoring is a recent undertaking for national Antarctic programmes; many programmes do not share the experience of monitoring done in Antarctica for basic scientific research purposes. This undertaking by Antarctic operators poses substantial challenges in terms of:

a) financial investment necessary to achieve the goals of Antarctic environmental protection;

b) awareness of the opportunities provided by focussed environmental impact monitoring;

c) developing and retaining personnel experienced in efficient, yet reliable, environmental impact monitoring; and

d) capitalising both on the results of basic scientific research and existing knowledge of environmental monitoring, and on the valuable resources, experience and guidance of academic communities and industry.

84.- Seven activities have already been listed (paragraph 44) as those most likely to cause impacts of concern. Each of these is examined briefly here to illustrate the range of monitoring programmes that need to be considered to give effect to the monitoring provisions of the Protocol.

Station and airstrip construction and logistic operations

85.- Construction and operation of research stations, airstrips, and other support facilities in Antarctica can have a variety of environmental impacts. Waste water and sewage disposal, incineration of combustible waste, and power and heat generation are the activities most likely to have impacts of concern. These are discussed below.

86.- Construction and operation of support facilities also can disturb or otherwise affect flora, fauna, research and atmospheric, terrestrial, and marine environments in the areas where these activities occur. Prior to initiating construction, surveys should be carried out to identify flora, fauna, geographic features, research or environmental conditions that could be affected by facility construction and operation. If could be affected, studies should be undertaken, before authorising and beginning construction, to determine the pre-construction reference state of the potentially affected populations, Protected Areas etc., keeping in mind that Annexes II and V of the Protocol prohibit activities that would adversely affect native flora and fauna and areas that have been afforded special protection under the Antarctic Treaty. If stations are built in areas where they could affect native flora and fauna, unique geographic features or sites that have been afforded special protection under the Antarctic Treaty, a monitoring programmes should be designed and conducted to provide warning if possible of any unforeseen effects before they reach levels inconsistent with the Protocol. Such programmes will necessarily vary from site to site.

Waste water and sewage disposal

87.- Sewage and waste water generated at inland stations are unlikely to have significant adverse

environmental impacts if they are disposed of in deep pits not located on ice-flow lines in accordance with Annex III to the Protocol. To identify and avoid possible problems that may be caused by disposal of sewage and waste water at inland stations, surveys should be done as part of the planning process to determine where disposal pits should be located to avoid present and possible future health hazards and impacts on scientific research. If there is uncertainty as to where, and how rapidly, materials deposited in ice pits may be dispersed, monitoring programmes should be designed and carried out to resolve the uncertainties.

88.- At current levels, sewage and waste water discharges from ships are unlikely to have significant adverse environmental impacts if the discharge is carried out in conformance with the relevant provisions of the Protocol (e.g., if food wastes are macerated and discharge is done when ships are moving at four knots or more at distances no less than 12 nautical miles from land or ice shelves in the Treaty Area).

89.- Discharge into the marine environment of sewage and domestic liquid wastes from coastal stations is likely to have greater environmental impacts than discharge from ships. Sewage and waste water discharge into the sea appears in most instances unlikely to produce significant nutrient enhancement. The most common and measurable impacts are likely to be water pollution and changes in flora and fauna (e.g., species composition) downstream from the sewage discharges.

90.- To provide the basis for assessing and monitoring impacts from sewage and waste water disposal, systematic studies should be done prior to initiation of operations to determine such things as:

a) currents that will carry sewage and waste water from the planned discharge point;

b) the species composition, distribution, and abundance of flora and fauna present in areas that could be affected by the discharges; and

c) heavy metals or other potentially toxic substances that may be naturally present in sediments and organisms in areas that could be contaminated by the discharges.

91.- Transects and/or sampling sites should be established and monitored periodically (e.g. at 3-5 year intervals) to detect any changes caused by the subsequent discharge of sewage and waste water. At existing sites, where baseline information was not gathered prior to beginning operations, one or more reference (control) areas should be selected, and monitored periodically to detect, measure and determine the cause(s) of subsequent change in the variables of concern.

92.- Annex III of the Protocol prohibits disposal in the Antarctic Treaty Area of "wastes containing harmful levels of heavy metals or acutely toxic or harmful persistent compounds". Testing of dischargess should be done if there is reason to believe that potentially harmful contaminants are being introduced into the marine environment. If such contaminants are found during testing or there is evidence of potential contaminant-caused changes in benthic biota in the vicinity of discharges, it may be necessary to establish compliance monitoring programmes. Also, if any of the contaminants are likely to be biomagnified, potentially affected fish, bird and/or marine

mammal populations in the area should be monitored to determine the levels and effects of contaminants present at the top of the food web.

Incineration of waste

93.- Annex III of the Protocol requires that all open burning of waste be phased out as soon as practicable, but no later than the end of the 1998/1999 austral summer. Thereafter, combustible wastes are to be removed from the Antarctic Treaty Area or burned in incinerators "which to the maximum extent practicable reduce harmful emissions". The solid residue of such incineration is to be removed from the Antarctic Treaty Area.

94.- Pending implementation of the prohibition on open burning, Annex III requires that, when necessary to dispose of waste by open burning, allowance should be made for wind direction and speed and the type of waste to be burned "to limit particulate deposition and to avoid such deposition over areas of special biological, scientific, historic, aesthetic or wilderness significance including, in particular, areas accorded protection under the Antarctic Treaty". Monitoring programmes should be designed and carried out until such time as open burning is phased out, to determine what and how much particulate material is produced and where it is deposited, and to verify that no deposition is occurring in areas afforded special protection under the Treaty.

95.- The Protocol's Annex III will prohibit incineration of plastics and other materials that could produce harmful emissions. It also will require that the solid residue left after incineration be removed from the Treaty Area. Therefore, the possible environmental impacts of waste incineration in the Antarctic will depend primarily on the quality, maintenance and proper operation of the technology used. Monitoring of emissions should be done during start-up and periodically thereafter to verify that potentially harmful substances (e.g. dioxins and furans) are not being discharged.

Power and heat generation

96.- Most stations, field camps and vehicles in Antarctica rely on combustion of fossil fuels to generate heat and power. These produce heat and emissions (e.g. carbon dioxide, nitrogen oxides, sulphur dioxide and lead) that may be harmful to flora and fauna if they reach sufficiently high levels. Such emissions may also pollute atmospheric, terrestrial, glacial and marine environments in ways which could compromise the value of Antarctica as a scientific laboratory. Also, petroleum and other fuels can evaporate and introduce harmful contaminants into the air if they are not stored and transferred properly.

97.- At present, heat and other products of fossil fuel combustion and storage in Antarctica are unlikely to have significant adverse effects on air quality, native flora and fauna, or other variables much beyond the immediate vicinity of scientific and logistic support facilities.

98.- SCAR and/or the Consultative Parties should be asked to recommend emission standards which will ensure that the scientific values of Antarctica are not compromised by the combustion of fossil fuels. In the meantime, each Antarctic Treaty Party that has not already done so should:

a) conduct a complete and careful inventory of the types and quantities of fuels currently maintained in Antarctica for heat and power generation and for operation of ships, aircraft, and land vehicles;

b) maintain an accurate record of the types and quantities of fuels transported to, and used at, its various facilities in Antarctica; and

c) do everything feasible to prevent evaporation and to reduce the quantities of fossil fuels used in Antarctica. In addition, power generators, desalination plants, space heaters, automotive engines, etc. should be maintained within the manufacturers specifications to minimise emissions.

99.- Where appropriate, surveys should be conducted to determine the baseline levels of potentially harmful combustion products present in mosses and lichens, and in snow, ice and soils in the vicinity of established research and logistic support facilities. If significant levels of contaminants are found, programme(s) should be designed and established to determine the sources, deposition patterns and accumulation rates of the contaminants.

100.- As with incinerators, tests should be done to determine and, as appropriate, periodically monitor the types and quantities of potentially harmful emissions produced by power generators, desalination equipment, etc.

Human activities involving or affecting native flora and fauna

101.- Tourists, support staff, researchers and others traveling through vegetated areas can damage and destroy plant communities. Similarly, persons present in and near bird and seal colonies or haulout areas can interfere with breeding, chick and pup rearing and other vital functions. Such disturbance may make animals more vulnerable to predation, decrease productivity and cause animals to abandon or avoid traditional breeding areas. Research involving collection of plants, and handling, tagging and collection of birds and seals may be particularly harmful if it is not planned and carried out carefully.

102.- Annex II of the Protocol prohibits taking or harmful interference (disturbance) of native fauna and flora, except in accordance with a permit authorising taking for a specified purpose. The Protocol's Annex V prohibits entry into Antarctic Protected Areas (former SSSIs and SPAs), except in accordance with a permit authorising activities consistent with the agreed management plan for the area. Unless specified otherwise in the agreed management plan, tourists are prohibited from entering Antarctic Protected Areas.

103.- If taking and disturbing native flora and fauna, and entry into Antarctic Protected Areas, are regulated as required by the Protocol, tourism, scientific research and related support activities are not likely to have significant adverse effects. Some form of monitoring may be required to ensure compliance with the Protocol. In addition, at least a sub-set of the seal and bird colonies visited regularly by tourists, researchers and others should be monitored to verify that they are not being affected adversely by either permitted or non-permitted activities. The SCAR Group of Specialists on Seals and the SCAR Working Group on Biology should be asked for advice on the types of long-term monitoring programmes necessary to verify that tourism, scientific research and other

activities do not have unforeseen effects on Antarctic birds, seals and plants.

Scientific research activities

104.- Under the Protocol, all activities, including scientific research, must be evaluated for environmental impact. The meeting recognised that scientific research, especially in the fields of physical and earth sciences, might cause environmental impacts. It drew attention to possible localised contamination by drilling fluids, atmospheric contamination by release of trace gases, or the generation of radiofrequencies etc. Environmental monitoring, appropriate to such activities, would need to be developed if significant adverse effects are predicted.

Accidents resulting in fuel spills or other types of environmental contamination

105.- Fuel spills resulting from ship accidents, pipeline breaks etc. may pose the greatest current threat of environmental impact in Antarctica. Annex IV of the Protocol requires that contingency plans be developed to respond effectively to marine pollution emergencies. Article 15 of the Protocol calls upon Parties to cooperate in the formulation and implementation of contingency plans to facilitate prompt and effective reponse to accidents that could have adverse environmental impacts. The meeting noted the current efforts of COMNAP in developing and implementing contingency plans as a matter of priority. If accidents occur in areas where they could have long-term effects on native flora and fauna, on Protected Areas, or on terrestrial, glacial, or marine environments, long-term studies should be designed and carried out to document the impacts.

Agenda Item 11

RESOURCES IMPLICATIONS

106.- The Consultative Parties, as well as the scientific community in Antarctica, face the difficult challenge of designing and implementing the environmental monitoring programmes that will be obligations under the Protocol to the Treaty when it enters into force. These obligations will be clarified through the environmental impact assessments procedures set forth in the Protocol.

107.- Any environmental monitoring should be scientifically defensible, practicable and cost effective. Monitoring should be focussed only on what is essential and necessary under the Protocol. Unrestricted monitoring will consume substantial resources, have the potential to diminish the ability of Parties to undertake cutting-edge research in a region dedicated to peace and science, and could be used as a substitute for basic research, thus reducing the overall value of Antarctic science to address questions of global relevance in the service of humankind.

108.- It is important that the full organisational and resource implications of any applied monitoring programmes should be recognised. Monitoring is expensive and requires long term commitment. Therefore it is in the interest of all Parties to maximise the value of data collected, and to see that resources are used efficiently. There is a common concern that the resources required to meet the environmental monitoring challenge may not be available.

109.- The Antartic Treaty has proved an outstanding model of international cooperation. Such cooperation will help in carrying out cost effective and productive monitoring. The Meeting agreed that monitoring programmes should aim to reinforce each other.

110.- The following could be adopted in order to optimise the use of limited resources:

a. A significant amount of environmental monitoring is already undertaken by several operators in Antarctica.
Data and results from different research groups could be compared and standard protocols adopted;

b. Standardization of hardware, calibration of instruments, and data processing must not be overlooked;

c. An approach which enables the evolution of Antarctic environmental programmes at the national level should be adopted;

d. To avoid significant gaps and unneccesary duplication and overlapping, the programmes on environmental monitoring should be internationally consistent and compatible;

e. The programmes, while being scientifically based, should be simple, effective and easy to implement;

f. In order to develop expertise in Antarctic environmental monitoring, long term education and training programmes involving academic communities and industry must be undertaken;

g. Environmental monitoring programme personnel must use effective communications to ensure the required consistency, standardisation and compatibility. There should be an appropriate network for cooperative management of the automated data processing.

Agenda Item 13.

RECOMMENDATIONS.

The Meeting of Experts agreed upon the following recommendations for consideration by the Consultative Parties:

1. Select a representative sample of existing facilities and their activities to assess the nature and scale of their environmental impact in consultation with SCAR and COMNAP.
Agenda Item 6 (Adverse Impacts).

2. Develop an international data management system based on a co-ordinated data network spread amongst Parties for the Antarctic to collect, validate, archive and exchange environmental monirtoirng data. To this end, Parties with active Antarctic programmes, should identify their

existing sets, current and planned research and monitoring programmes.
Agenda Item 9 (Data Management).

3. Make such information available to other ATCPs, SCAR and COMNAP by an agreed date to facilitate the establishment of a data system and lead to the production of an Antarctic Data Directory.
Agenda Item 9 (Data Management).

4. Establish national scientific advisory boards to provide guidance to scientific questions and assist in the design of data products and means of data access.
Agenda Item 9 (Data Management).

5. Invite SCAR to investigate and advise on appropriate standards which will ensure that the scientific values of Antarctica are not compromised by the combustion of fossil fuels, or the products of incinerators.
Agenda Item 10 (Operational Management).

6. Invite SCAR to provide advice on the types of long-term monitoring programmes necessary to verify that tourism, scientific research and other activities do not have an adverse impact on Antractic flora and fauna.
Agenda Item 10 (Operational Management).

7. Invite SCAR to consider and advise on the need to assess and monitor the levels of marine pollution and the establishment of base-line surveillance programmes for the seas of the Antarctic Treaty area.
Agenda Item 10 (Operational Management).

8. Ensure environmental monitoring under the Protocol be closely coordinated, where appropriate, with activities within CCAMLR (e.g., the CCAMLR Ecosystem Monitoring Programme) and IWC to complement the ecosystem-related research and monitoring activities undertaken by these groups.
Agenda Items 6-7 (Antarctic Resources of Special Concern).

9. Convene a mmeting of a group of technical experts on environmental monitoring to examine in greater detail the issues of:
- design of monitoring programmes;
- scientific protocols for monitoring;
- standardisation and quality assurance;
- applicable technology;
- data management.

Buenos Aires, 4 June 1992

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ANNEX II

LIST OF DOCUMENTS:

- ENVIRONMENTAL MONITORING IN ANTARCTICA (SCAR-COMNAP)
  May 1992.

- THE ANTARCTIC ENVIRONMENTAL ASSESSMENTS PROCESS (Practical Guidelines) Bologna, Italy June 20 - 1991. Revised Washington DC, March 4 - 1992.

- IDENTIFICATION OF ENVIRONMENTAL IMPACT MONITORING PROGRAMS NECESSARY TO EFFECTIVELY IMPLEMENT THE PROVISIONS OF THE PROTOCOL ON ENVIRONMENTAL PROTECTION TO THE ANTARCTIC TREATY (Rep. USA)
  June 4 - 1992.

- THE NEED FOR ENVIRONMENTAL MONITORING IN ANTARCTICA: BASELINES, ENVIRONMENTAL IMPACT ASSESSMENTS ACCIDENTS AND FOOTPRINTS.
  DWH Walton and J.Shears (Bs.As.) 1992

- HISTORY AND DEVELOPMENT OF ENVIRONMENTAL MONITORING UNDER THE ANTARCTIC TREATY SYSTEM. THE NEED MONITORING UNDER THE ENVIRONMENTAL PROTOCOL.

-NOTE: The original documentation corresponding to the final report, items 4-5-6-7-8-9-10-11 were disscused during the Meeting and whith their modifications were included into the final report.