ANNEX 7

REPORT OF THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM

(Santa Cruz de Tenerife, Spain, 5 to 13 August 1991)

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INTRODUCTION

1.1 The Sixth Meeting of the Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP) was held at the Instituto Español de Oceanografía, Santa Cruz de Tenerife, Spain from 5 to 13 August 1991. The meeting was chaired by the Convener, Dr J.L. Bengtson (USA).

1.2 The Convener, on behalf of the Working Group, expressed thanks to the Government of Spain for inviting the Working Group to hold its meeting in Santa Cruz de Tenerife and appreciation to the hosts at the Instituto Español de Oceanografía for arranging such a pleasant and efficient meeting venue.

1.3 The Convener opened the meeting and welcomed participants. Scientists from 10 Member countries attended the meeting and a special word of welcome was extended to Dr S. Focardi (Italy) since he was the first scientist from Italy to attend a WG-CEMP meeting.

1.4 It was noted with regret that several Members, namely Argentina, Brazil and Chile, actively engaged in monitoring approved CEMP parameters had not sent scientists to the meeting. It was also noted that scientists from France, Germany, New Zealand and South Africa, all of whom have programs of research highly relevant to CEMP, including studies of monitored parameters, were not present.

ADOPTION OF THE AGENDA

2.1 The Provisional Agenda was introduced and discussed. A revised Agenda was adopted with the addition of three items: 7.5 ‘CCAMLR Scheme of International Scientific Observation’, 7.6 ’New and Developing Fisheries’ and 9. ‘Summary of Recommendations and Advice to the Scientific Committee’.

2.2 The Agenda is attached as Appendix A, a List of Participants is given in Appendix B and documents submitted for consideration at the meeting are listed in Appendix C.

2.3 Rapporteurs were Drs D. Agnew (Secretariat), P. Boveng (USA), I. Everson (UK), K. Kerry (Australia) and J. Croxall (UK).

REVIEW OF MEMBERS' ACTIVITIES

3.1 The Convener called attention to the substantial amount of monitoring and directed research being conducted by Members in support of CEMP. Summaries of these activities are given in Tables 1, 2 and 3.

3.2 Information in Table 2 (directed research on the assessment of potential predator parameters) has been accumulating for several years. The Working Group felt that the format and content of Table 2 no longer provided a convenient summary of work undertaken or a useful guide to the likely availability of data on or advice concerning these additional parameters.

3.3 The Secretariat was asked to prepare a new version of Table 2 which would summarize the data on each parameter collected and analyzed by each Member in each year and allow the inclusion of references to publications describing results of the analyses. The Secretariat would circulate intersessionally a draft version of this new Table 2 soliciting comments and especially references to the sources of the published information and circulate the updated table in advance of the Working Group meetings.

3.4 Scientists present at the meeting provided brief reports on recent and prospective activities as part of CEMP. Written reports also were received from German and New Zealand scientists. These reports are attached at Appendix D.

MONITORING PROCEDURES

Predator Monitoring

Sites and Species

4.1 The Working Group considered a draft management plan for the protection of the CEMP site at the Seal Islands, South Shetland Islands (WG-CEMP-91/7). This plan was submitted under the Commission's formal guidelines (Conservation Measure 18/IX). The Working Group reviewed those aspects which related specifically to monitoring and agreed that with the inclusion of minor revisions the proposal adequately provided the information specified by the Commission. The Working Group noted however that there were aspects with legal implications, such as permits, disposal of waste and the restriction of activities, which would be more appropriately addressed by the Scientific Committee and the Commission.

4.2 The Working Group recommended that the revised proposal be reviewed by the Scientific Committee at its 1991 meeting.

Proposals for New Procedures

4.3 At its 1990 meeting the Working Group accepted a proposal to include the gentoo penguin (*Pygoscelis papua*) in the list of species designated for monitoring. Dr Croxall had been requested to provide descriptions of changes to the Standard Methods that would be necessary for monitoring gentoos. The proposed changes were presented to the Working Group as WG-CEMP-91/6.

4.4 The Working Group accepted the changes proposed in WG-CEMP-91/6. It was agreed that additional comments on these methods, especially details relating to gentoo studies at South Georgia and the Antarctic Peninsula, should be collated by Dr Croxall and passed to the Secretariat. In the interim WG-CEMP suggests modifying Method A9 to include a subsample of nests from several colonies to quantify the well documented, asynchronous breeding chronology of gentoo penguins.

4.5 It was noted that the Standard Methods document was expensive to publish and that it might be most efficient to issue occasional addenda between less frequent editions of the full

document. The Secretariat agreed to complete an analysis of the costs of alternative formats for addenda and to report to the Working Group.

4.6 It was recommended that the comments and any relevant interim advice on existing monitoring sites, species, parameters and procedures should be circulated by the Secretariat (together with appropriate supporting documents), separately from the Scientific Committee report, to all Members and specifically to the investigators undertaking the CEMP studies.

Standard Methods for Penguins

4.7 The Working Group reviewed the methods for monitoring predator parameters set out in Standard Methods for Monitoring Studies (CEMP, 1991). No changes were made to the Methods A3, A6 and A7. Comments on and changes to other parameters are set out below.

Standard Method A1:
Adult Weight on Arrival at Breeding Colony

4.8 This method requires that the sex of birds be determined at the time of weighing and that a discriminant analysis of morphometric parameters (e.g. bill length and depth) be used to determine sex. Studies reported in WG-CEMP-91/5 show, however, that determination of the sex of Adélie penguins at the time of arrival remains a problem because discriminant analysis of morphometric parameters could not be used realistically to determine sex in Adélie penguins if a better than 90% success rate is required (at Béchervaise Island, 89% of birds could be correctly sexed by comparing the discriminant score: $D = 0.582$ (bill length) + 1.12 (bill depth) + 0.219 (flipper width), with a mean discriminant score (MDS) of 55.39). The paper recommended that a correct MDS be determined separately for each site by a single operator.

4.9 The probability of correctly identifying the sex of birds can be increased by avoiding those with a discriminant score close to the mean. However, to be >90% certain of sex using this method, 80% of the total measured sample would have to be discarded. The Working Group agreed that such discarding would introduce an unacceptable bias into the results of monitoring.

4.10 The Working Group agreed that the only practical method to positively identify the sex of Adélie and chinstrap penguins at first arrival was by cloacal examination. It was noted, however, that considerable practice is required to achieve a level of competence in this technique.

4.11 Members were encouraged to investigate whether Method A1 would retain sufficient power to detect changes if the sexes were pooled for this parameter.

4.12 Alternative methods for sexing Adélie penguins are provided in paragraphs 4.22 to 4.24.

Standard Method A2: Duration of First Incubation Shift

4.13 Preliminary evidence from several sources suggests that for Adélie penguins, the duration of the first incubation shift may not be strongly related to prey availability (e.g. results of Dr L. Davis's (New Zealand) research). Dr W. Trivelpiece (USA) indicated that for Adélie penguins annual variations in this parameter may be related to variations in distance to the pack-ice edge.

Standard Method A4:
Age-Specific Annual Survival and Recruitment

4.14 Dr Croxall presented evidence of substantial variation in mate and nest-site fidelity of gentoo and macaroni penguins at South Georgia (WG-CEMP-91/20). Low return rates were caused by extensive non-breeding as well as mortality. Those results imply that several years of resighting effort may be required before concluding that a banded bird has died.

Standard Method A5: Duration of Foraging Trips

4.15 The Working Group considered a study by US investigators of the effects of radio-telemetry transmitters on foraging behaviour and reproductive success of chinstrap penguins (WG-CEMP-91/33). No significant effects of the transmitters on parameters such as foraging trip and visit durations were found, in contrast to a previous study (WG-CEMP-90/21) that used larger transmitters. There were, however, significant

differences in reproductive success that may have been caused by transmitters and/or handling during attachment.

4.16 The question of whether one or both adults per nest should be instrumented was discussed. Because of the possibility that attaching instruments to both members of a pair may increase the probability of nest failure (WG-CEMP-91/33), and the likelihood that the foraging patterns of paired birds during the guard stages are not independent, the Working Group advised that pending further studies of this issue, only one member of each pair should be instrumented with a radio transmitter for this parameter.

4.17 It was noted that there may be chronic effects on birds carrying instruments for long periods. Members were encouraged to continue efforts to detect and minimize deleterious effects of procedures used for CEMP research. Those efforts could include investigation of new technologies such as the implanted passive inductance transmitters now being tested by Australian investigators.

Standard Method A8: Chick Diet

4.18 The Working Group noted that data submitted to CEMP for this method should be based on a consistent sample size at least as large as that suggested in the Standard Methods.

Standard Method A9: Breeding Chronology

4.19 It was noted that WG-CEMP-91/29 presents analytical techniques for sampling distribution over time and that such techniques might reduce the work involved in characterizing the breeding chronology and choosing critical dates for calculation of indices. Members were encouraged to consider during the intersession period whether the procedures described in WG-CEMP-91/29 might be applicable to CEMP studies.

Standard Methods B1 to B3: Flying Birds

4.20 Dr Croxall hoped that a paper on black-browed albatross demography would be available at the next meeting of the Working Group. The analytical methods for this species are very similar to those presented previously for wandering albatross.

Standard Methods for Seals

4.21 A study by UK scientists of Antarctic fur seal foraging/attendance cycles in relation to pup growth (WG-CEMP-91/24) found that despite significant differences between years in the duration of both foraging trips and periods ashore, neither proportion of time spent at sea nor pup growth rates showed significant differences between years (and the latter did not relate significantly to foraging trip duration). In neither year did maternal age or size influence foraging cycles or pup growth. These results indicate the potential importance of assessing aspects of foraging performance in addition to quantifying trip duration.

Determining the Sex of Penguins

4.22 The Working Group agreed that the only way to positively identify the sex of Adélie penguins was from behaviour during copulation or by cloacal examination during the first half of the breeding cycle (i.e. until hatching). At later times cloacal sexing becomes increasingly difficult. The methods for cloacal sexing are referenced in WG-CEMP-91/5.

4.23 Dr Trivelpiece pointed out that weighing each member of the pair after the laying of the first egg can also be used to determine sex as the male is always heavier. Additionally, within pairs, males have larger culmens than females; however, neither weight nor bill measurements can be used to distinguish sex of birds in the colony as a whole.

4.24 Dr Kerry noted in WG-CEMP-91/31 that at Béchervaise Island a period could be identified when in excess of 97% of birds at nest sites are males and another period when a similar percentage of females are present. Thus observation at these times will identify the male or female bird. Since the breeding cycle of Adélie penguins is highly synchronous it is probable that the dates at which the incubating birds will be one sex or the other will be consistent from year to year for a specific site. This, however, needs to be tested.

Future Proposals for Potential Sites, Species and Parameters

4.25 The Working Group agreed that any future proposals for inclusion of new species, parameters or sites in CEMP should be submitted in writing to the Secretariat by 30 June each year. Such proposals should contain reasons and supporting evidence for their inclusion.

4.26 The results of UK investigations of aspects of foraging performance (during trips to sea in the breeding season) of gentoo penguins and fur seals were presented (WG-CEMP-91/18, 19 and 23). Both WG-CEMP-91/18 and 23, in addition to data on dive depth and duration, review several variables connected with foraging and diving. Estimates of proportion of trip spent diving, and dive rate are given for different categories of dive and within and without objectively defined bouts of intense diving activity. In addition, for fur seals, transit time (including time submerged) can be estimated allowing potential foraging time to be calculated. Many of these variables may have significance as potential indices of foraging performance in the context of CEMP studies. This work will be especially relevant to the proposed workshop evaluating such parameters.

Processing/Analysis Methods

4.27 At its 1990 meeting the Working Group agreed that in order to facilitate its annual evaluation of status and trends of predator parameters, indices of monitored parameters would have to be calculated from the data available at the CCAMLR Data Centre. Analyses based on these indices would then be considered for the formulation of advice to the Scientific Committee.

4.28 The Secretariat had prepared WG-CEMP-91/8 which suggested a rationale and methodology for the calculation of indices. There was broad support for this approach in the Working Group.

4.29 A subgroup composed of Drs Agnew (Convener), Bengtson, Boveng, Croxall, Kerry, Naganobu, Penhale and Trivelpiece was formed to review the methods of calculating these indices and the presentation of the results to the Working Group. The subgroup reviewed document WG-CEMP-91/8 with particular reference to technical comments from Dr P. Rothery (UK) given in WG-CEMP-91/36.

4.30 To reduce the number of individual indices presented to the Working Group, it was recommended that data be combined to calculate summaries by site. If any further divisions of the data are required, these should proceed following consideration of special features of the data especially as noted by the originators of the data.

4.31 Several problems were noted concerning the indices suggested for Parameter A6 ‘breeding success’. Although it was recognized that any single summarising index will lose information if it ignores separated data on the numbers of pairs rearing 0, 1 and 2 chicks, the

ad hoc approach suggested by WG-CEMP-91/8 or WG-CEMP-91/36 should be followed until further investigation of analytical techniques is performed.

4.32 The subgroup noted that in WG-CEMP-91/8 Method 1(a) combines samples with the same underlying distribution. Dr Agnew explained that the weighting in Method 1(b) is necessary to accompany the weighting of means in CEMP Methods A1 and A7. It was agreed that these methods were adequate for the time being.

4.33 The arcsin transformation of the proportions of crustaceans in the chick diet parameter (A8) is a commonly used transformation for these sorts of data. Comparisons should be made using the transformed indices, and the back-transformed numbers should be used only as a reference.

4.34 Based on the recommendations of the subgroup, the Working Group agreed that:

(i) indices should be calculated by the Secretariat using the methods described by WG-CEMP-91/8;

(ii) a document describing the methods of calculation of indices, with worked examples of calculations, should be prepared by the Secretariat for review at the next meeting of WG-CEMP. The source code (e.g. in FORTRAN) used by the Secretariat to compile indices should also be distributed for testing and corroboration by the CCAMLR community;

(iii) a summary of the calculated indices and trends in indices should be presented by the Secretariat to the Working Group each year, starting at the next meeting of the Working Group, utilising all data held at the CCAMLR Data Centre (following the annual reporting deadline of 30 June). These data should be presented in two forms:

(a) a concise summary of all data including a description of what data have been submitted by Members and calculation of the specified indices; and

(b) a summary of changes and trends in parameters between years, and between colonies, sites and species as appropriate.

(iv) Members are encouraged to perform analyses of their own data, and those held by CCAMLR, with a view to refining the methods of calculating indices so that

they better fit the criteria described on page 3 of WG-CEMP-91/8 and the requirements of the Working Group.

Reporting Formats and Requirements

4.35 The importance of reporting CEMP predator data on the latest version of reporting forms was emphasized. Representatives of the Scientific Committee were requested to ensure that scientists from their countries use the correct data submission form.

4.36 The CEMP data submissions received from Members have generally been easy to understand. The most common problems were with the 'split-year' entry on all forms (the second year in a split-year should be used as the designator) and with the five-day period definitions (the standard periods described in Appendix 2 of the Standard Methods should be used).

4.37 The Data Manager noted that for Method A5 (Duration of Foraging Trip), the information requested in Category C of the present data sheet is not ideally suited to the calculation of indices (WG-CEMP-91/8) which use only data from Category B. Members were encouraged to propose improved analytical procedures concerning indices for Method A5.

4.38 It was agreed that the Secretariat has the authority to make minor changes to data submission formats as appropriate.

4.39 The purpose of the Standard Methods is to obtain data and incorporate them into indices that can be easily compared between sites, but it was recognized that on occasion it may not be possible to follow the methods exactly. There was some discussion concerning whether Members should submit data that had been collected in a way that did not follow precisely the Standard Methods. It was noted that initially it is up to investigators to judge whether their data have been collected by methods that do not deviate substantially from the Standard Methods.

4.40 For example, sample sizes specified in the Standard Methods should be viewed as guidelines (usually minimum); if they are not achieved, it may reduce the power of the data to detect change, but the data can still be compared with other years or sites. In contrast, there is less flexibility in most other technical aspects of the methods. Using different techniques

or collecting different types of data other than those specified will reduce the comparability of results with other CEMP data.

4.41 The degree to which the Standard Methods are followed by individual investigators will become increasingly important now that indices are being calculated and compared among sites and years. Given that the data will be scrutinized closely to detect potential methodological inconsistencies, investigators should be prepared to provide an acceptable explanation of any deviations that were necessary from the procedures described in the Standard Methods. Data considered by the Working Group to have been collected using procedures inconsistent with the Standard Methods will be excluded from the calculations of indices.

Field Research Procedures

4.42 Dr Kerry indicated that efforts by Australia to develop and refine automated monitoring of Adélie penguins which include the use of implanted transmitters (WG-CEMP-90/24) are continuing to yield promising results. These studies will facilitate estimating rates of loss for standard flipper bands.

4.43 Dr Trivelpiece informed the Working Group of his investigations of the impact of research activities on penguins. A report on his results should be available in about one year.

4.44 It was noted that several participants have begun to document field research procedures on video, in response to last year's discussion of a need to standardize and compare procedural details that are difficult to portray in the Standard Methods (SC-CAMLR-IX, Annex 6, paragraph 85). A video prepared by Dr Kerry was made available for viewing during the meeting. It was agreed that this topic will remain open and participants should continue collecting documentation for a possible future workshop.

4.45 At its 1990 meeting, WG-CEMP noted that a Standard Method for activity budgets of birds and seals at-sea might be proposed in the future. It was agreed that it might be useful to hold a workshop to standardize sampling protocols, set-up of instruments used in these studies and subsequent data analysis (e.g. time-depth recorders (TDRs) and satellite transmitters) (SC-CAMLR-IX, Annex 6, paragraphs 88 and 89).

4.46 In response to a request from the Working Group, Dr Bengtson had written during the intersessional period to scientists active in this field to solicit their views on the utility of

holding such a workshop. Scientists and manufacturers indicated broad support for holding such a workshop, and a summary of their responses was provided in WG-CEMP-91/27.

4.47 The Working Group agreed that the primary focus of such a workshop should be on new methods and technology rather than a symposium-style presentation of scientific results. Because of the importance of participation by scientists outside the working group (including scientists working in the Northern Hemisphere), it was agreed that there should be a general workshop (approximately three days) followed by a session focussing on the specific needs of CEMP (approximately two days).

4.48 The Working Group agreed that the general workshop would have the following terms of reference:

(i) to review the current state of the art regarding the design and deployment techniques;

(ii) to review the available information on the potential instrument effects on animals;

(iii) to review the existing data collection, processing, and analytical methods and the compatibility of these within and between various devices and species;

(iv) to identify appropriate procedures for analysing the data sets of at-sea behaviour produced by TDRs and satellite-linked instruments; and

(v) to assess whether indices of at-sea activity, suitably standardized for use in routine monitoring operations (e.g. as part of CEMP), can be derived from the data currently being collected on behaviour of seals and seabirds.

4.49 It was agreed that the general workshop should seek to produce a report of workshop discussions, including summaries of various technical reviews of data collection, definitions of dive record components, analytical approaches, and hardware.

4.50 The Working Group agreed that the two-day session focussing on the specific needs of CEMP should have the following terms of reference:

(i) to advise on the most suitable indices for monitoring the at-sea behaviour of pinnipeds and penguins; and

(ii) to propose draft standard methods for collecting, processing, analysing and submitting summaries of such data to CCAMLR.

4.51 The Working Group feels that holding a workshop on methods to monitor the at-sea behaviour of penguins and pinnipeds is worthwhile and should be scheduled for the earliest feasible opportunity. However, it noted that scheduling the workshop in the near future is complicated because:

(i) the calendar for the remainder of 1991 and most of 1992 (aside from the field season) is filled with meetings already scheduled;

(ii) although an at-sea behaviour workshop is important, the Working Group agreed that the proposed workshop to estimate the prey requirements of predators should be given higher priority; and

(iii) given the scheduling realities described above, it would be difficult to hold an at-sea behaviour workshop before late 1993 or early 1994.

4.52 To prepare for a workshop in the future, the Convener was asked to undertake the following tasks with the assistance of other participants:

(i) to advise appropriate scientists of the responses received to the initial circular (i.e. WG-CEMP-91/27) and the decisions taken by WG-CEMP at this meeting;

(ii) to prepare an agenda within the terms of reference above;

(iii) to identify necessary preparatory tasks to accomplish the goals of the workshop;

(iv) to investigate sources of support to supplement CCAMLR funding that may be available for the conduct of the workshop and for the participation of selected key experts;

(v) to investigate potential venues and optimal scheduling for the proposed workshop;

(vi) to coordinate logistics for the workshop as the meeting date draws nearer; and

(vii) to report to WG-CEMP and to appropriate scientists regarding progress in preparing the workshop.

Prey Monitoring

Review of WG-Krill and Subgroup on Survey Design Reports

4.53 Dr Everson introduced the Report of the Working Group on Krill (WG-Krill) (Annex 5); that report also contained, as Appendix D, the Report of the Subgroup on Survey Design (SGSD). He outlined the main conclusion in both reports and then highlighted the topics of particular relevance to CEMP.

4.54 The total krill catch for the 1990/91 season was expected to be similar to that in previous years. However, WG-Krill, when considering the locations of fishing activities, had noted that a significant proportion of the krill catch in Subarea 48.1 had been taken from waters in the vicinity of penguin and fur seal colonies.

4.55 WG-Krill and SGSD had considered monitoring krill in support of CEMP predator studies and had provided outline survey designs at different scales, (Survey Designs 1 to 4 in Attachment 4 of Appendix D, Annex 5).

4.56 A specific design aimed at determining the availability of krill within the foraging range of penguins in the Antarctic Peninsula Integrated Study Region of CEMP to take into account predator parameter A5 (Foraging Trip Duration) was discussed. The design provides for a totally different layout of transects to that adopted as an interim approach last year (SC-CAMLR-IX, Annex 4, paragraph 100). However, other features such as time of day for sampling, and net tows to supplement acoustic data remain the same.

4.57 The design involved a series of regularly spaced parallel transects running offshore and perpendicular to the predominant currents. It was noted that the design assumed a reasonably straight coastline; different transect layouts would be required for other localities.

4.58 There was some discussion on the relative merits of a regular, as opposed to a random, spacing of transects. WG-CEMP agreed with conclusions provided by WG-Krill that regularly spaced transects offer advantages in analysing the data to obtain information on krill distribution. It was agreed that, on balance, this advantage outweighed the alternative advantage of statistical rigour of biomass estimates derived from randomly spaced transects.

4.59 In many cases, areas particularly close inshore are not well charted. It was recognized that this would pose problems for survey vessels and would almost certainly result in underestimates of the total krill available. It was noted that these inshore areas are not generally used for foraging by chinstrap and Adélie penguins, the species under consideration for the proposed design.

4.60 WG-CEMP agreed that, although aimed at predator parameter A5, the design outlined in Survey Design 1 could be used, with slight modification, for investigating krill distribution directly related to parameters A6, A7, A8, C1 and C2 because they integrate information over approximately the same spatial and temporal scales. Sufficient information was provided in the report to enable further surveys to be designed to cater for different situations. These modifications could be undertaken by those groups planning the field work.

4.61 WG-CEMP discussed the general principles outlined in Survey Design 3 to be used in designing surveys on a larger meso-scale. It was felt that for the present time, sufficient information had been provided from which designs for such surveys could be developed in association with CEMP prey monitoring.

4.62 Meso-scale surveys are also required around those restricted areas identified as having direct relevance to parameters A5 to A8, C1 and C2. WG-CEMP felt that surveys of this scale should be undertaken to provide information on the distribution, abundance and flux of krill. It was noted that this information was essentially on the same spatial and temporal scales as that required by WG-Krill to assess krill biomass.

4.63 The primary aim of meso-scale studies, for the time being, should be biomass estimation. It was recognized that in the future, attention will need to be paid to the distribution of krill within these meso-scale areas and that WG-CEMP would try to determine those aspects of greatest significance to support predator monitoring.

4.64 At the macro-scale, much would depend on the ability to understand the distribution of krill with respect to major environmental features such as sea-ice, oceanographic and atmospheric circulation. This topic was of particular interest to WG-CEMP in helping it interpret results from monitoring studies on predator parameters A1 to A4. On the macro-scale it was noted that there was much commonality between the spatial and temporal scales of interest to WG-CEMP and WG-Krill.

4.65 Because interpretation of predator indices will be facilitated by information on aggregation parameters as well as biomass, all the methods of acoustic data presentation

outlined in SC-CAMLR-IX, Annex 4, paragraph 102 and Annex 5 of this report, paragraph 4.14 are of potential interest. However, it was accepted that a summary form of ping-by-ping data would be desirable.

4.66 WG-CEMP felt that the outline Survey Designs 2, 3 and 4 were all of value for designing surveys for prey monitoring in support of CEMP.

4.67 Several anomalies were noted in the summary of temporal and spatial scales for monitoring CEMP predator parameters (WG-CEMP-91/4). The Working Group provided corrections to this information; the revised tables are given in Appendix E.

4.68 WG-CEMP thanked WG-Krill and its Subgroup on Survey Design for the information provided in their reports. Responses to the questions posed by WG-Krill in paragraph 5.9 of its report are included in paragraphs 4.56 to 4.66 of this report.

Other Species

4.69 At its 1990 meeting, the Scientific Committee reiterated the requirement for the submission of fine-scale data for catches of *Pleuragramma antarcticum* in Subarea 58.4 (and especially in the Prydz Bay Integrated Study Region) (SC-CAMLR-IX, paragraph 5.20).

4.70 Dr K. Shust (USSR) informed the Working Group that Soviet scientists are presently completing papers concerning *P. antarcticum* catch rates, distribution, and demography from fine-scale surveys conducted from 1978 to 1989 in the Indian Ocean sector. It is anticipated that these reports will be made available to the 1991 meeting of the Working Group on Fish Stock Assessment (WG-FSA). It was noted that the fine-scale catch data requested by the Scientific Committee (SC-CAMLR-IX, paragraph 3.101) have been submitted to the Secretariat.

4.71 Dr Trivelpiece reported on studies near Palmer Station which indicated that the status of the south polar skua (*Catharacta maccormicki*) was closely linked to the availability of *P. antarcticum*, one of its principal prey items. There are plans to conduct annually a series of larval tows to assess the status of the *P. antarcticum* population as part of the Long-Term Ecological Research (LTER) program at Palmer Station. Since this work is of direct interest to CEMP, Dr Trivelpiece agreed to arrange for information on the LTER to be made available to WG-CEMP.

Environmental Monitoring

4.72 The Working Group reviewed the Standard Methods F1 (sea-ice as viewed from the colony), F3 (local weather) and F4 (snow cover in the colony) for monitoring environmental parameters which have a direct effect on predators. They were considered adequate. No additional requirements were proposed. It was noted that Members are required to archive their own data and that there is no requirement to submit data to the Secretariat at present.

4.73 It was noted that weather conditions prevailing at a monitoring site may in some instances be quite different from those at a nearby meteorological station. Members were encouraged to determine the degree of similarity of data collected locally and at nearby stations.

4.74 Detailed discussions were held over the provision of data required under Method F2 'Sea-Ice Within the Integrated Study Region'. Method F2 aims to determine the amount and characteristics of sea-ice within the Integrated Study Regions, and suggests for data collection:

(i) information on the regional distribution of sea-ice can only feasibly be obtained using remote sensing techniques. Sea-ice imagery is available from a number of satellites that pass over the Integrated Study Regions;

(ii) sea-ice data should be collected at least for the period beginning two to three weeks prior to the arrival of adult birds or seals, and should continue until counts indicate that most breeding adults have arrived. In addition, it may be desirable to consider sea-ice data obtained via satellite throughout the year; and

(iii) as feasible, it would be desirable to obtain data on sea-ice cover, extent, and type.

4.75 Dr Shust informed the Working Group that his institute was preparing detailed maps which show changes occurring in the macro-scale distribution of ice for the past five years over the whole of the Antarctic.

4.76 Dr R. Holt (USA) reported progress (see SC-CAMLR-IX, Annex 6, paragraph 112) on the analysis of satellite data from the Antarctic Peninsula Integrated Study Region. Of the approximately 500 images available over the past two years, some 300 had been examined

for temperature, chlorophyll, cloud-cover and sea-ice conditions. Data will be presented at the next Working Group meeting.

4.77 At its meeting in 1990, WG-CEMP asked the Secretariat to investigate procedures for acquiring and archiving summary data on sea-ice distribution (Method F2) available from organisations which process and supply satellite imagery (SC-CAMLR-IX, Annex 6, paragraph 118).

4.78 The Secretariat in response prepared a paper (WG-CEMP-91/9) on the information and analytical techniques available for these data that would be of use in the routine monitoring of sea-ice distribution for CEMP. Dr Agnew presented the paper setting out details of satellite imagery available and presented options for acquisition of and presentation to the Working Group.

4.79 The Working Group agreed that the data requirements set out in Method F2 were still appropriate and that there were two scales over which the monitoring of sea-ice should be considered:

(i) CCAMLR subarea monitoring, which has particular relevance to parameters A1 to A4;

- spatial scale: over 100 km, including the whole area or subarea;
- spatial resolution: 1 to 50 km;
- temporal scale: several months or the whole year;
- temporal resolution: half-monthly to quarterly;

(ii) local monitoring, i.e. within the foraging range of land-breeding animals and relevant to parameters A5 to A8, C1 and C2;

- spatial scale: 25 to 150 km;
- spatial resolution: 50 m to 1 km;
- temporal scale: several months (e.g. November to March);
- temporal resolution: 5 to 30 days.

4.80 The most readily accessible satellite data that could be used to investigate ice distribution over the first scale (i), are the US Navy/NOAA Joint Ice Centre (JIC) weekly charts of circum-Antarctic ice extent, concentration, and type of ice in different parts of the Southern Ocean.

4.81 The Working Group noted that many sources of satellite imagery with a resolution of the second scale (ii) or better were available and include the NOAA Polar Orbiter, Landsat Multispectral Scanner (MSS), Landsat Thematic Mapper (TM), SPOT Multispectral Imager, Synthetic Aperture Radar (SAR) mounted on the European Research Satellite-1 (ERS1), Soyuzkarta Panchromatic Imager and the Soyuzkarta Multispectral Imager. The three satellites that have the highest temporal and spatial resolution are the NOAA Polar Orbiter, SPOT and ERS1. Whilst many of these satellites offer extremely high resolution (20 to 30 m) this is at the expense of temporal resolution because of the narrow swath widths that must be adopted by the satellite. High temporal resolution is especially important in the Antarctic where cloud-cover may obscure a given area for much of the time.

4.82 Furthermore, high resolution data (e.g. from MSS, SPOT or ERS1) are expensive and the purchasing agreements of the distribution companies mean that CCAMLR would have to purchase images directly from the company. The cost of images from MSS, TM, SPOT and ERS1 is US$200 or more per photographic image. Data from the NOAA Polar Orbiter, in particular from AVHRR (Advanced Very High Resolution Radiometry) are cheaper and available from organisations with a receiving or processing agreement with NOAA at a cost of around US$90 per image.

4.83 The Working Group therefore agreed that the most suitable and cost effective data would be those obtained from AVHRR. This type of imaging which has a spatial resolution of 1.1 km and repeat time of approximately 0.25 days, is the most commonly processed by several organisations, and is the most readily available.

4.84 For higher spatial resolution close to monitoring sites it was suggested that the use of aerial surveys, possibly conducted by aircraft performing regular fly-overs *en route* to re-supply Antarctic bases, would provide very high resolution photographs.

4.85 Several receiving stations for AVHRR data operate in the Antarctic Peninsula area, the principal being at Palmer Station on Anvers Island. This receiving station covers an area from approximately 30˚W to 80˚W. A receiving station will be installed soon at Casey Station which will access data from a 'window' covering some of the Prydz Bay area.

4.86 The Working Group therefore recommends:

(i) JIC weekly ice charts be used for monitoring of sea-ice conditions at large spatial scales (over 100 km, relevant to predator parameters A1 to A4 and larger considerations of prey distribution);

(ii) AVHRR data on sea-ice distribution, in fully processed image form be used for monitoring sea-ice conditions on smaller scales (25 to 150 km, with a frequency of five to ten days, relevant to predator parameters A5 and to prey monitoring surveys); and that

(iii) when available and needed, aerial photography rather than satellite imagery be used for monitoring of sea-ice conditions on much smaller scales (less than 50 m).

4.87 The Working Group discussed the classification of sea-ice data, and agreed that both first and second order interpretations as set out in the following table would be required.

	Type (i) Submissions JIC Antarctic Ice Extent Maps	Type (ii) Submissions AVHRR (or other) Imagery
Raw data storage	Hard copy of maps	Hard copy of images. Bit mapped images (pixels).
First order interpretation	Digitized sea-ice extent by subarea -outlines and extent of different ice types. Presentation to Working Groups as maps.	Digitized sea-ice extent boundaries and extent of different ice types. Presentation to Working Groups as maps.
Second order interpretation	Data on ice distribution parameters by subarea. Presentation to Working Groups as indices.	Data on ice distribution parameters by CEMP site. Presentation to Working Groups as indices.

4.88 Regarding the types of indices to be calculated, Dr Trivelpiece suggested that data collected should contain as a minimum the following elements: (i) maximum extent of ice cover; (ii) duration of ice cover; (iii) rate of retreat and advance past a given monitoring site; and (iv) distance from the site to the ice edge. Dr Croxall suggested that in the case of island sites this should include distance to the nearest ice edge when the island had open water all round.

4.89 The Working Group agreed that these parameters and those set out on page 8 of WG-CEMP-91/9 should be evaluated further, as appropriate, as part of a pilot study.

4.90 It was agreed that the only practical method of data acquisition would be for the Secretariat to obtain it by direct agreement with distributing organisations. This would remove the burden from Member organisations, eliminate the problem of copyright and ensure a regular supply of data. This approach has the added advantage that CCAMLR will own copies of the raw data which will enable many different analyses to be performed should these be required in the future.

4.91 It is understood that the acquisition of AVHRR images could be met by direct purchase of these images by the Secretariat from a number of organisations, including CSIRO, Australian Bureau of Meteorology, Scott Polar Research Institute or NOAA itself.

4.92 The Working Group agreed that it would be highly desirable to have the Secretariat obtain the necessary hardware and then on a trial basis obtain AVHRR images and process them for future examination by the Working Group. It is therefore recommended that a pilot study be conducted for two CEMP sites during a two-month period for which images would be obtained and processed every five days. The Working Group asked the Secretariat to prepare a detailed estimate of the expected costs for consideration by the Scientific Committee.

4.93 Pending evaluation of the pilot study, consideration should be given to expanding the number of sites and the period covered so that sea-ice data would be available for all relevant CEMP sites during the appropriate time of the year. Future costs associated with data acquisition would relate to the purchase of images only.

ECOSYSTEM ASSESSMENT

5.1 The Convener noted that WG-CEMP and the issues that it addresses have moved into a new phase. Over the past several years excellent progress has been made in identifying CEMP priorities, developing methodological protocols, and specifying data submission formats. Now that the Secretariat is receiving and archiving Members' CEMP data, the emphasis of the Working Group is shifting away from solely program development toward data evaluation and the formulation of advice to the Scientific Committee.

Predator Data

5.2 The Working Group emphasized that although methods for calculating indices had been established, insufficient data had been submitted to the CCAMLR Data Centre prior to the meeting to allow meaningful comparisons of calculated indices between years to be undertaken at the present meeting. However, it is anticipated that sufficient data will be available at the next meeting of WG-CEMP to allow consideration of predator indices and formulation of advice to the Scientific Committee.

5.3 To enable relevant data to be incorporated into annual summaries of CEMP predator data for calculating indices and for presenting results for the Working Group's consideration, Members were strongly encouraged to submit their data prior to the annual deadline of 30 June.

5.4 If they have not already done so, Members were encouraged to submit data that were previously reported as 'being prepared' (see Table 1 in SC-CAMLR-IX, Annex 6) and to submit other data collected in previous seasons as soon as possible. A list of CEMP monitoring data submitted prior to 30 June 1991 was presented in Appendix 2 of WG-CEMP-91/8. Data collected during the forthcoming 1991/92 field season are to be submitted to the Secretariat by 30 June 1992.

Prey and Environmental Data

5.5 Although standard sampling protocols for prey monitoring have not been adopted, and CEMP environmental monitoring methods do not provide detailed protocols, relevant data are available from directed research and surveys conducted under interim guidelines (SC-CAMLR-IX, Annex 4, paragraphs 90 to 100). Tabled documents presenting data pertaining to prey and environmental features included WG-CEMP-91/11, 17, 26, WG-Krill-91/7, 9, 11, 14, 15, 22, 23, 27, 30, 34, 37 and 39. These papers provided useful examples of the types of data that will be available for the Working Group's future assessments.

5.6 It was agreed that in order to perform its annual assessments and to formulate advice based on integrated perspectives of predator, prey, and environmental data, the following prey and environmental information should be assembled prior to each future meeting of WG-CEMP:

(i) summaries of fine-scale krill catch data (e.g. WG-Krill-91/9) and an analysis of the distribution of catches relative to predator colonies (e.g. WG-CEMP-91/25). The Secretariat is requested to provide these summaries;

(ii) the most recent estimates of krill biomass (or relative biomass) in each of the Integrated Study Regions (and other subareas or meso-scale survey areas as estimates become available). WG-Krill is requested to provide these estimates;

(iii) results of specific fine-scale surveys near CEMP sites (e.g. Annex 5, Appendix 4, Attachment 4, Survey Design 1) or surveys to determine aspects of distribution, movements, or behaviour, as they become available (e.g. WG-Krill-91/7 and 14). Members are requested to undertake these surveys and report the results; and

(iv) summaries of sea-ice conditions derived from satellite imagery (see paragraphs 4.79 to 4.87 and 4.93) and other key environmental data as these become available. The Secretariat is requested to provide these summaries.

Interactions Among Predators, Prey, and Environmental Features

5.7 The Working Group considered various methods to collectively evaluate predator, prey, and environmental data and to develop mechanisms to facilitate such an evaluation. At the present meeting, discussion focussed on identifying relevant data sets and methods for effective presentation of the data. It is anticipated that at WG-CEMP's next meeting, the Working Group will initiate comparisons of predator, prey, and environmental data and later advise the Scientific Committee on the outcome of these discussions.

5.8 The Working Group agreed that two papers that had been tabled (WG-CEMP-91/13 and 28) provided helpful examples of analyses of the relationships among predators, their prey, and the environment. Both studies identified features of predator populations that appear to fluctuate in response to cyclic environmental phenomena. Although such results suggest that identifying and evaluating the specific impacts of fisheries will be complicated, this approach may be helpful for determining periods when predator populations are particularly vulnerable.

5.9 Dr Trivelpiece noted that WG-CEMP-91/28 suggests that penguin population parameters indicate that the year in which FIBEX krill data were collected (1980/81) may have been a year of particularly high prey abundance. He stated that if this is the case, the FIBEX krill biomass estimates (which formed the basis of WG-Krill's recent calculations on a precautionary catch limit) should be used cautiously for formulating management advice.

5.10 Most participants agreed with this interpretation of the data sets presented in WG-CEMP-91/28. They noted that the most likely interpretation of the correlations between fluctuations in penguin parameters and changes in ice cover was that they were mediated by changes in krill availability. They also agreed that if this interpretation is correct, then the

precautionary catch limits calculated by WG-Krill may be based on data for a year of relatively high krill availability to predators.

5.11 One participant noted that the conclusions concerning krill abundance in the FIBEX year in Statistical Area 48 did not necessarily follow from the results presented in WG-CEMP-91/28.

Other Relevant Matters

Potential Impacts of Localized Krill Catches

5.12 The Working Group found the two papers tabled by the Secretariat concerning analysis of fine-scale krill catch data (WG-CEMP-91/9 and 25) to be extremely useful in reviewing the proximity of krill catches to colonies of penguins and fur seals. There are clearly extensive temporal and spatial overlaps between krill harvesting and feeding by land-based predators in Subarea 48.1 during the predators' breeding season.

5.13 This overlap demonstrates the potential for competition between the fishery and krill-dependent predators, and raises questions concerning the degree to which fisheries may or may not be adversely affecting seabird and pinniped populations.

5.14 The Working Group reviewed the discussions of WG-Krill concerning approaches to defining precautionary limits on krill harvests in Statistical Area 48 and noted WG-Krill's intention to refine these estimates on a subarea basis (Annex 5, paragraph 7.4).

5.15 The Working Group noted that WG-CEMP-91/25 showed that within Subarea 48.1 at the South Shetland Islands more than 50% of the krill harvest had been taken consistently from within the foraging ranges of land-breeding predators. Additionally, preliminary estimates of krill consumption by land-breeding predators showed that the catch in some years was almost half the requirement of these predators at this time.

5.16 The Working Group noted that the concentration of the harvest in this region and its apparent stability/similarity year-to-year, indicated that Subarea 48.1 was the area where the fishery may have greatest potential impact on predators in the short-term. WG-CEMP identified several important implications arising from this situation.

5.17 First, information is required on krill biomass, production and fluxes in Subarea 48.1 generally and the area of the current fishery in particular, to interpret the magnitude and significance of interactions between krill harvest levels and predator requirements. This reinforces the urgency of conducting appropriate acoustic surveys and related directed research. It also indicates the high priority of revising and refining estimates of predator requirements in the area (paragraphs 6.1 to 6.24).

5.18 Second, undertaking CEMP activities in Subarea 48.1 is of increased importance because of the spatial and temporal overlap between the fisheries and the foraging of breeding birds and seals.

5.19 Third, although precautionary limits may be a potentially useful management procedure, restrictions on the timing and location of fisheries might be considered for providing land-breeding predators (particularly during their breeding seasons) with appropriate protection.

5.20 The Working Group therefore recommended that the Scientific Committee take steps to initiate a dialogue, especially with Members conducting fishing in the Convention Area, to explore the consequences of various types of potential conservation measures associated with a precautionary approach to management.

5.21 Studies of the geographical proximity of fisheries to foraging predators could be refined by considering haul-by-haul catch data such as those presented in WG-Krill-91/39. It was noted that at its 1990 meeting the Scientific Committee recommended that, if possible, haul-by-haul data should be collected and reported for krill catches within 100 km of land-based predator colonies. This recommendation was in turn endorsed by the Commission.

5.22 It was noted that in its previous recommendation on this topic, the intent of the Scientific Committee was to obtain haul-by-haul data for catches within 100 km (SC-CAMLR-IX, Annex 4, paragraph 113), rather than 10 km (SC-CAMLR-IX, paragraph 2.63; CCAMLR-IX, paragraph 4.41), of predator colonies. This typographical error (10 km is incorrect) should be brought to the attention of Members.

Myctophids

5.23 The recently developed fishery for *Electrona carlsbergi* in Subarea 48.3 and the lack of data on the role of myctophids in the Antarctic ecosystem were discussed by WG-FSA

(SC-CAMLR-IX, Annex 5, paragraphs 172 to 181) and the Scientific Committee (SC-CAMLR-IX, paragraph 5.20) at their 1990 meetings.

5.24 In response to the Scientific Committee's request (SC-CAMLR-IX, paragraph 5.21) that information be submitted to WG-CEMP on the significance of myctophids, especially *E. carlsbergi*, as prey for predators in the Convention Area, the Secretariat prepared and submitted WG-CEMP-91/17.

5.25 The Working Group welcomed the Secretariat's contribution, and noted that WG-CEMP-91/17 was a useful first step toward assessing the importance of myctophids in predator diets. The paper clearly identified that myctophids formed the prey of a wide range of vertebrate predators. *E. carlsbergi* and *E. antarctica* were identified as being particularly important. The paper emphasized the need to obtain quantitative data on *E. carlsbergi* as well as on other myctophids such as *E. antarctica*, which is an important prey species especially for predators in high latitudes.

5.26 It was noted that there is a body of unpublished data on this topic that was not available for inclusion in WG-CEMP-91/17. The Secretariat was requested to contact scientists having access to these data with the aim of including the data in the revision of the work. In the interim, the Working Group requested that the paper WG-CEMP-91/17 be updated with available data for presentation to the Scientific Committee as a background document.

PREY REQUIREMENTS FOR KRILL PREDATORS

6.1 This topic is currently being addressed by WG-CEMP with the following aims:

(i) assessing the significance (in terms of ecological and management implications) of geographical and temporal overlap between the commercial krill fishery and krill-dependent predators, especially at times of the year when the latter's foraging range is restricted by the need to feed dependent offspring regularly ;

(ii) contributing to management objectives under Article II of the Convention, in particular relating to:

(a) assessment of what level of krill escapement would be sufficient to meet the reasonable needs of krill predators (SC-CAMLR-IX, Annex 4, paragraph 61(iv));

(b) ensuring that any reduction of food to predators which may arise because of krill harvesting is not such that land-breeding predators with restricted foraging ranges are disproportionately affected in comparison with predators present in pelagic habitats (SC-CAMLR-IX, Annex 4, paragraph 61(iii));

(iii) contributing to estimates of potential yield of krill (Annex 5, paragraph 5.10).

Progress During the Past Year

6.2 The Commission (CCAMLR-VIII, paragraph 59) and Scientific Committee (SC-CAMLR-VIII, paragraphs 5.26 and 5.27) had already asked Members to synthesize data on breeding population size, diet and energy budgets of predators in order to provide estimates of krill requirements of predators in Integrated Study Regions (ISRs). They had also supported (CCAMLR-IX, paragraph 4.36; SC-CAMLR-IX, paragraphs 5.26 and 5.27) the development of detailed proposals for a workshop on this topic. Dr Croxall had agreed to coordinate intersessional correspondence in order to:

(i) formulate a more detailed outline of the precise models and data sets to be investigated during a workshop along the lines of that indicated in paragraph 128 of Annex 6 of SC-CAMLR-IX;

(ii) determine the necessary preparatory work required in advance of such a workshop; and

(iii) identify suitable places and times for a workshop.

6.3 Dr Croxall had circulated a letter (WG-CEMP-91/37) outlining his ideas on how best to proceed. Members discussed these suggestions, taking into account:

(i) additional relevant information presented at the meeting (e.g. WG-CEMP-91/25 and 35); and

(ii) the comments offered by WG-Krill (Annex 5, paragraphs 5.10 to 5.15).

6.4 The additional tabled information included: comparison of estimates of krill consumption by predators and commercial krill catches within parts of the Antarctic Peninsula ISR (WG-CEMP-91/25); notification of the development by a US research group of a synthesis of data on Adélie penguin for input to a model of energy and food requirements (WG-CEMP-91/35).

6.5 These initiatives were welcomed. WG-CEMP-91/25 provided an example of some of the products that the full-scale investigation of this topic is intended to provide. WG-CEMP-91/35 made a direct contribution to the synthesis of relevant data and promised to provide an additional model to use when these WG-CEMP initiatives reach the analytical stage.

6.6 In response to the suggestions by WG-Krill that pelagic predators such as whales and ice-breeding seals be included in the WG-CEMP deliberations (Annex 5, paragraph 5.11), WG-CEMP noted that these pelagic predators had always been included in discussions but that the paucity of some data important for present purposes inevitably limited what analyses could be undertaken in respect to such species. Similar problems were posed when considering incorporating data on seabirds other than penguins and on non-breeding populations of penguins and fur seals.

6.7 Additional considerations bearing on the best procedures to follow include:

(i) the increasing interest in this topic within Scientific Committee working groups; and

(ii) existing commitments of WG-CEMP participants which preclude holding a workshop before June 1993.

Future Work

6.8 The Working Group proposed that four approaches to future work be initiated/undertaken concurrently.

6.9 First, immediate attention should be given to synthesis and evaluation of relevant data on penguins and fur seals for each ISR. For the Antarctic Peninsula ISR consideration should be focused on best-studied parts of the region in addition to the whole ISR.

6.10 The initial tasks involving coordination of data synthesis and evaluation within ISRs were allocated as follows:

South Georgia:	UK
Antarctic Peninsula:	USA
Prydz Bay:	Australia.

6.11 The data required are those on breeding population size, duration and timing of breeding events, body weight, diet (% krill by weight) and energy content of that food. The data should be compiled in as much detail as possible, particularly with respect to seasonal variation in e.g. diet, body weight, and include minimum and maximum, as well as mean values for population size and other parameters as appropriate. Initially they should be assembled to conform with the inputs of data specified in WG-CEMP-90/31.

6.12 The task of compiling data on activity-specific energy budgets and foraging ranges for penguins in the ISRs would be coordinated by USA. It would be based on the approach initiated in WG-CEMP-90/30 Rev. 1, incorporating information assembled in the project described in WG-CEMP-91/35 and additional recent published data. Members aware of sources of published, and particularly unpublished, relevant data were urged to contact Dr D. Croll, National Marine Fisheries Service (NMFS) (USA).

6.13 Similar data on fur seals would be collated by the UK. The contact scientist there is Dr I. Boyd, British Antarctic Survey (BAS) (UK).

6.14 Second, the feasibility of undertaking a similar task to that outlined in paragraphs 6.9 to 6.13 in respect of crabeater (and possibly leopard) seals for appropriate ISRs should be investigated.

6.15 Drs Bengtson and T. Härkönen (Sweden) agreed to investigate and assess data relating to abundance, distribution and residence time of crabeater seals in ISRs. They also agreed to investigate the suitability of models of energy budgets of northern hemisphere phocid seals for application to data available on crabeater seals. They will report back to the Working Group on the feasibility of proceeding with the kinds of assessments and analyses envisaged for the penguin and fur seal data.

6.16 Third, discussions with the International Whaling Commission (initially by means of a letter from the Convener of WG-CEMP to the Chairman of the Scientific Committee of IWC) requesting advice on the sources of the best available data for estimating the krill requirements of baleen whales within ISRs should be started.

6.17 The minimum requirements would be quantitative data on numbers, biomass, diet (% krill) and daily energy requirements for each baleen whale species from October to March inclusive in each ISR. Any quantitative data on changes in any of these parameters within this period or on finer-scale distribution and density would be most valuable.

6.18 Fourth, the process of acquisition and collation of relevant data on seabirds other than penguins should continue. Members were encouraged to continue with this work and in particular to undertake surveys of areas and colonies for which recent data are unavailable.

6.19 Dr Croxall agreed to continue to coordinate this work. Progress on these initiatives would be reviewed by correspondence in May 1992 in order to assess what might be achieved before the next meeting of WG-CEMP.

6.20 Dr Croxall stressed that the success of the initial undertaking critically depended on the quality of the information on population size and energy requirements. Agreement on species- and activity-specific energy consumption coefficients might be impossible to achieve by correspondence (see paragraph 6.17) and a dialogue between appropriate experts might be essential. Several of these experts are likely to attend the same international meetings scheduled for June to September 1992. It was recommended that contingency funds be requested to enable two to three scientists to meet for a day in conjunction with one of these meetings to undertake final evaluations. The review of progress in May 1992 would indicate whether such a meeting would be required or not.

6.21 WG-CEMP hoped that it might be possible at least to provide the Scientific Committee in 1992 with significant interim results, in the form of a brief report, using the data on fur seals and penguins as inputs to existing models (e.g. WG-CEMP-90/30 Rev. 1, 31 and WG-CEMP-91/35).

6.22 Depending on the outcome of the evaluation of crabeater seal data it might be feasible to include some preliminary assessments in this report but it is most unlikely that any assessments will be available for baleen whales and seabirds generally.

6.23 WG-CEMP noted that an interim report to the Scientific Committee is being advocated because of the high level of current interest within CCAMLR on this topic. It emphasized, however, that an interim partial assessment on its own is no substitute for a full-scale critical evaluation, which would require an interactive workshop with multidisciplinary participation.

6.24 Such a workshop would not only have available more comprehensive and more rigorously assessed data sets but would also be in a position to investigate *inter alia*:

(i) sensitivity of models to changes in predator population size, energy consumption coefficient and foraging ranges; and

(ii) interactions between the distribution of krill catches and foraging activities of krill predators for a variety of assumptions concerning predator foraging ranges and locations and krill abundance, availability (to predators and fishery), distribution, density and movements.

Other Matters

6.25 During discussions on precautionary limits on krill catches WG-Krill had considered approaches including assessments of natural mortality (paragraph 6.57) and had referred (paragraph 5.10) to the importance of calculating required levels of krill escapement from the fishery (to meet the needs of dependent species).

6.26 WG-CEMP noted that the approach used in Annex 5, paragraph 6.57 is based solely on theoretical precepts. However, empirical determination of natural mortality and escapement levels requires estimates of krill consumption by all natural predators (e.g. whales, seals, birds, fish and squid). Prospects of realistic estimates of some of these (e.g. fish and squid) at appropriate temporal and spatial scales are remote.

GENERAL MATTERS

Integrated Analyses of Predator/Prey/Environmental Interactions

7.1 At its 1990 meeting, the Working Group discussed the potential use of geographical information systems (GIS) in assisting its efforts to undertake integrated analyses of predator, prey and environmental data.

7.2 Dr Holt presented a paper (WG-Krill-91/38) which describe such systems in more detail. GIS and Visualisation Software (VS) systems provide methods for storing data described by geographical position and investigating the relationships between different sets of similarly geo-referenced data. GIS operates two-dimensionally and has very powerful data handling and data analysis facilities. It would be of particular use to CCAMLR in the integrated analysis of large-scale environmental, survey, predator and fisheries data. VS systems operate three-dimensionally but offer fewer facilities for data analysis. Despite this restriction they may be more useful for specific analysis of research data described by position and depth.

7.3 As an example, the paper had used VS to analyze a detailed acoustic survey of krill aggregations in a 1 nautical mile square north of Elephant Island. Additional uses could include the 3-dimensional representation of krill swarms in the survey area combined with predator distributional and diving data and environmental data from vertical profiling of the water column.

7.4 The Working Group agreed that the VS described in WG-Krill-91/38 had potential. It noted, however, that the interpolations involved in this analysis required a high sampling intensity that may not be practicable on larger scales. Interpretation of the results could be complicated by the types of algorithms used in the VS, as well as the unknown effects of ship disturbance and current speed.

7.5 The Working Group agreed that whilst GIS held promise for the integrated analysis of CCAMLR data, its detailed application, the types of data to be collected and the data collection protocols would have to be established before such a system could be installed and routinely used at the Secretariat.

7.6 Members were encouraged to undertake specific research tasks to evaluate further the potential of GIS and VS, and their applicability to CEMP. Specific topics include:

(i) the relationship between krill and predator distribution established by research surveys (VS);

(ii) the effects of krill patch movement, avoidance behaviour and water current on the results of surveys involving planned fine-scale transects (VS); and

(iii) the investigation of krill patch density and the behaviour of the fishing fleet, using haul-by-haul and other appropriate data (GIS).

7.7 Drs Holt and Naganobu suggested that a cooperative research project may be initiated, involving the use of krill patch data and GIS and VS systems. Furthermore, Dr Holt indicated that the US was interested in cooperative studies with fishing nations involving analysis of haul-by-haul krill data using these systems.

Collaborative Work and Awareness of CEMP

7.8 The publication in 1991 of a brochure by CCAMLR describing the aims of CEMP was seen as an important step in publicising the Program. The poster to be presented by the Secretariat at the Antarctic Science Conference in Bremen, Germany (23 to 28 September 1991) will further promote awareness of CEMP. More detailed background on the development and current status of implementation of the program is provided in WG-CEMP-91/10.

7.9 A large number of CEMP related studies is currently under way as shown in Tables 1, 2 and 3. The Working Group noted, however, that scientists in research centres in several Member countries especially Germany, France, New Zealand and South Africa were known to be conducting research on subjects of direct interest to CEMP, but they did not participate regularly in WG-CEMP meetings or contribute data or analyses to CEMP.

7.10 The Working Group regretted that Chile, Argentina and Brazil were not represented at the present meeting, although these Members are actively involved in CEMP and have contributed significantly to past meetings of the Working Group.

7.11 The Working Group emphasized the importance of having all Members participate in CEMP, studying as many parameters at different sites as feasible and commented that the Working Group's analytical efforts will be strengthened by having increased data available for comparison.

7.12 With the aim of increasing participation in CEMP the Secretariat was asked to solicit contributions from Members not currently participating, by:

(i) writing to the ministries, directors of institutions and individual researchers at institutions known to have research programs of interest to CEMP. The Secretariat would provide details of the aims of the Program, lists of working documents at CEMP meetings and reports of the Working Group and solicit contributions to and encourage attendance at Working Group meetings; and

(ii) writing to Member contacts, pointing out the relevance of certain research programs under way in their national institutions to the work of CEMP and, through the Scientific Committee, to the work of the Commission.

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

7.13 In August 1990 the Secretary of the IWC informed CCAMLR that:

> 'the terms of reference and participants for the Joint Workshop on the Feeding Ecology of Southern Baleen Whales should be expanded to cover studies of other major predators of krill, especially those pertinent to estimates of abundance and trends and that a joint workshop should be planned for 1992 (SC-CAMLR-IX/BG/12).'

7.14 In 1990 the Scientific Committee recorded in its report that it considered it inappropriate for the terms of reference to be expanded in this way, and asked the Executive Secretary to respond to IWC to request an explanation for this expansion and reiterate the original terms of reference of the workshop.

7.15 The IWC responded to CCAMLR's concerns in section 5.1.3 of its report, contained in a letter dated 24 June 1991 from the Secretary of the IWC (WG-CEMP-91/15). The Working Group noted that the response still failed to indicate the reasons for the suggested expanded terms of reference of the proposed workshop, and that the IWC planned to consult only informally with Members of the Scientific Committee on the terms of reference of the workshop.

7.16 The Working Group recalled that CCAMLR's original interest in this workshop was to facilitate the functional evaluation of the minke whale as a potential indicator of changes likely to result from harvesting krill. However, it recognized that since 1985 the approach adopted has been to develop standard methods of data collection, submission and analysis for specific parameters. Given the success of this approach WG-CEMP agreed that the best way for it to proceed now was to request Members wishing formally to incorporate the minke whale into CEMP to prepare a specific proposal (as was done in the case of the gentoo penguin - see WG-CEMP-90/14) including a definition of appropriate parameters for consideration by WG-CEMP. In the meantime the deletion of minke whale from the list of CEMP indicator species was recommended.

7.17 The requirement in the terms of reference of the workshop to evaluate the minke whale as a potential indicator of changes resulting from krill harvesting necessitated the use and analysis of data on trends in abundance of minke whale (and possibly other baleen whale species). The need to interpret these data has apparently led IWC to the view that the so-called 'krill surplus' hypothesis needed investigating. In view of the recommendation in paragraph 7.16 the need by CCAMLR for such analyses and investigations no longer applies.

7.18 The Working Group emphasized that both it and WG-Krill maintained a strong interest in the minke whale as an important component of the Southern Ocean ecosystem. In particular the development by IWC of a workshop on the foraging ecology of baleen whales (presumably with new terms of reference taking account of paragraph 7.17) would be of considerable interest to WG-CEMP. Furthermore WG-CEMP had already directed specific questions to IWC (paragraphs 6.16 and 6.17).

7.19 From a WG-CEMP perspective the need for it to address the krill surplus hypothesis was questionable. WG-CEMP noted that very few quantitative data exist with which to review the historical situation responsible for the hypothesis. Furthermore, WG-CEMP-91/28 provided plausible arguments suggesting that recent changes in penguin populations could be explained on the basis of systematic trends in the Antarctic physical environment (with concomitant effects on trends in prey abundance) rather than by involving the 'krill surplus' hypothesis.

7.20 The Working Group recommended that the Executive Secretary write to the Secretary of the IWC advising him of the position expressed in paragraphs 7.16 to 7.19.

Workshop on Southern Elephant Seals

7.21 The SCAR Group of Specialists on Seals convened a Workshop on Southern Elephant Seals in Monterey, California, USA from 22 to 23 May 1991 with financial assistance from CCAMLR. This workshop investigated the decline of southern elephant seals and its possible causes. The report of the workshop is given in SC-CAMLR-X/BG/3.

7.22 The workshop found that most populations of the Kerguelen Islands area (Marion, Heard, Kerguelen and Crozet Islands) and Macquarie Islands area (Macquarie, Campbell and Antipodes Islands) were declining at rates of 2 to 9% annually. The status of the South Georgia stock (South Georgia, South Orkney, Falkland, Gough, King George and Nelson Islands) was uncertain. The only population confirmed to be increasing was the Valdes Peninsula population (3 to 5% per annum).

7.23 Whilst no single factor was identified as contributing to this change, the workshop indicated there was no evidence that disease, predation or competition with fisheries were causing the decline, but that climate change may be a contributing factor.

7.24 Dr Focardi commented that a promising area of research could be pollutants, such as PCBs which were implicated in northern phocid declines and offered to coordinate analyses of such pollutants at his laboratory should any investigations require them.

CCAMLR System of Observation and Inspection

7.25 The Executive Secretary introduced CCAMLR-X/7 which described a system of scientific observation being developed by the Commission. The Working Group acknowledged the importance of such a system in ensuring the reliable collection of biological data from commercial operations.

7.26 The Working Group had discussed the value of haul-by-haul data in locating the distribution of krill in relation to the foraging ranges of predators (paragraphs 5.21 and 5.22). Several Members had indicated that reliable haul-by-haul data could best be collected by trained observers.

7.27 The Working Group encouraged the placement of observers on as many fishing vessels as possible.

7.28 The Working Group noted that forms developed by WG-Krill in 1990 and endorsed by WG-CEMP for use by observers had been circulated during the intersessional period. Minor refinements had been made at the recent meeting of WG-Krill.

7.29 It was agreed that in addition to these forms, special guidelines for the collection of haul-by-haul data by observers may be required.

7.30 Dr Shust suggested that during krill and fish surveys, sightings of birds, seals and other predators of krill could be recorded to provide information on their distribution and abundance. The Working Group agreed that such information could be useful for identifying important foraging areas for these species and for investigation of relationships between predators and krill distribution.

7.31 The Working Group also noted that to undertake the latter investigations it was essential to use standard methods, preferably those developed for the BIOMASS program (BIOMASS Handbooks 1 and 18) in estimating seal and seabird abundance. The Working Group encouraged Members where possible to collect such data during their krill and fish surveys.

New and Developing Fisheries

7.32 The Working Group noted that as a result of advice from the Scientific Committee last year, the Commission had agreed on the need for a conservation measure which would ensure that the development of new fisheries did not proceed before adequate data reporting and management procedures had been initiated.

7.33 Following this decision, the Commission asked the Executive Secretary to consult Members and other international organisations and to prepare a working paper on definitions for use in the formulation of the conservation measure. The Executive Secretary's response to that request is contained in CCAMLR-X/6 which was presented to the Working Group for comment.

7.34 The Working Group agreed that the idea of predictive management, implied in such a measure, was the only logical basis for the implementation of Article II of the Convention. It was noted, in this connection, that the advice from the Scientific Committee had included requirements for assessments of the potential impacts of fisheries on dependent and related species.

7.35 It was agreed that given the focus of WG-CEMP's ongoing deliberations on the status of dependent and related species and their interactions with other components of the ecosystem, the Working Group could provide essential assessments relevant to the Scientific Committee's work on new and developing fisheries. Therefore, WG-CEMP recommended that evidence or arguments that the proposed fishery will not adversely affect dependent and associated species should be presented. The Working Group expected to be actively involved in assessing the available evidence or arguments presented.

7.36 The Working Group noted the comments of WG-Krill concerning the definitions contained in CCAMLR-X/6 (Annex 5, paragraph 7.7). It was suggested that the reliance on reported data may not be effective in identifying the start of a fishery due to non-reporting of exploratory fishing data. The Data Manager however, confirmed that the Commission currently requires reporting of all catches in the Convention Area, irrespective of species or fishing method.

OTHER BUSINESS

8.1 Dr Kerry informed the Working Group that Ms L. Denham from the Australian Antarctic Division had compiled an index of all CEMP papers from the time of the first meetings of the *ad hoc* working group. Papers were indexed under Subject, Nationality, Author and CCAMLR number. The Working Group expressed its opinion that the index was a helpful aid and accepted Dr Kerry's offer to make the index available to Members through the Secretariat.

FUTURE WORK

9.1 The Working Group reviewed progress made, work discussed and tasks identified at the meeting. The principal tasks in the coming year are as follows:

(i) to review the summaries of all predator data held at the CCAMLR Data Centre (paragraph 4.34);

(ii) to discuss indices calculated from predator data (paragraph 4.34);

(iii) to discuss summary of changes and trends in predator parameters between years and between sites and species as appropriate (paragraph 4.34);

(iv) to review progress in planning for an at-sea behaviour workshop (paragraphs 4.48 and 4.52);

(v) to discuss results of intersessional consultations, progress with data syntheses, and prospects for a future workshop on the prey requirements of predators (paragraphs 6.11, 6.12, 6.15, 6.17, 6.18 and 6.20);

(vi) to develop interim estimates and report to the Scientific Committee on the prey requirements of predators (paragraph 6.21 and 6.22);

(vii) to review the results of the pilot study on sea-ice data and recommend future actions, including discussions of appropriate sites and extent of satellite coverage (paragraph 4.93);

(viii) to formulate advice to the Scientific Committee based on discussions of predator indices (paragraph 5.2);

(ix) to discuss interactions among predator, prey, and environmental features and advise the Scientific Committee on the outcome of these discussions (paragraph 5.7); and

(x) to contribute to dialogue exploring the consequences of various potential conservation measures associated with a precautionary approach to management (paragraph 5.20).

9.2 To undertake assessments and provide advice to the Scientific Committee (items (viii) to (x) above) WG-CEMP will need extensive discussions of items (ii) and (iii); these discussions cannot be effective without a meeting.

9.3 However, effective discussions and useful advice require the availability of sufficient data. The requirement for prompt submission of due and outstanding data is strongly emphasized.

9.4 Accordingly, the Working Group recommended that it hold a meeting during the 1992 intersessional period.

Recommendations to the Scientific Committee

9.5 The Working Group made the following recommendations to the Scientific Committee:

(i) a revised draft management plan for the protection of the CEMP site at the Seal Islands, South Shetland Islands, should be reviewed by the Scientific Committee at its next meeting (paragraph 4.2);

(ii) funds should be provided for the conduct of a pilot study involving the acquisition of AVHRR satellite sea-ice imagery by the Secretariat. The aim of the project is to establish the feasibility of using satellite imagery to monitor sea-ice distribution and extent in relation to CEMP sites. The pilot study should be conducted for two CEMP sites during a two-month period for which images would be obtained and processed every five days (paragraph 4.92);

(iii) the Scientific Committee should take steps to initiate a dialogue, especially with Members conducting fishing in the Convention Area, to explore the consequences of various types of potential conservation measures associated with a precautionary approach to management (paragraph 5.20);

(iv) contingency funds should be provided to enable two or three scientists to meet for a day to consider the initial parameters necessary for the review of prey requirements for krill predators. The meeting, which would be necessary to identify relevant species and activity-specific energy consumption coefficients would take place in conjunction with one of the already-scheduled international meetings in July to September 1992 (paragraph 6.20);

(v) minke whales should be deleted from the list of CEMP indicator species (paragraph 7.16);

(vi) the Executive Secretary should be asked to write to the Secretary of the IWC advising him of the current CCAMLR position in respect of the Workshop on the Feeding Ecology of Southern Baleen Whales expressed in paragraphs 7.16 to 7.19;

(vii) in connection with the Scientific Committee's work on new and developing fisheries, the Working Group recommended that:

(a) evidence or arguments should be presented that the proposed fishery would not adversely affect dependent and associated species; and

(b) WG-CEMP should be invited to comment on the available evidence and arguments presented (paragraph 7.35);

(viii) WG-CEMP should hold a meeting during the 1992 intersessional period (paragraph 9.4).

CLOSE OF THE MEETING

10.1 The Report of the Meeting was adopted.

10.2 The Convener thanked participants, rapporteurs, subgroups, the Secretariat and staff of the Instituto Español de Oceanografía for their work during the meeting at which considerable progress had been made. The quality and relevance of working papers prepared during the intersessional period by the Secretariat and by participants had contributed significantly to this progress.

10.3 Particular thanks and gratitude were extended to the organizers, and the Instituto Español de Oceanografía, for hosting and providing the facilities for an efficient, productive and delightful meeting in Santa Cruz de Tenerife.

Table 1: Summary of Members' CEMP activities on monitoring approved predator parameters.

Method Sheet Number	Parameter	Species: A-Adélie penguin M-Macaroni penguin C-Chinstrap penguin G-Gentoo penguin B-Black-browed albatross F-Fur seal						Country	Site Name/ Integrated Study Region/ Network Site	Site Location	Year Started	1989/90 Data Submission	1990/91 Data Submission
		A	M	C	G	B	F						
-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
Penguins													
A1	Weight on arrival at breeding colonies	X						Australia	Magnetic Is Davis Station/ Prydz Bay	68°33'S 77°54'E	1983/84	Being prepared	Being prepared
		X						Argentina	King George Is Stranger Point/ S. Shetland Is	62°14'S 58°30'W	1987/88	Being prepared	Being prepared
		X						Argentina	Laurie Is Mossman Peninsula/ S. Orkney Is	60°45'S 44°44'W	1987/88	Being prepared	Being prepared
								Argentina	Esperanza Station/ Ant. Peninsula	63°24'S 57°00'W	1990/91		
		X						Germany	Ardley Is/ Ant. Peninsula	62°11'S 58° 55'W	1990/91		
			X					UK	Bird Is/ South Georgia	52°00'S 38°02'W	1988/89	Submitted	Submitted
A2	Length of the first incubation shift	X						Australia	Magnetic Is Davis Station/ Prydz Bay	68°33'S 77°54'E	1983/84	Submitted	Submitted
		X						Australia	Béchervaise Is/ Mawson/Prydz	67°36'S 62°53'E	1990/91		Submitted
		X						Argentina	King George Is Stranger Point S. Shetland Is	62°14'S 58°30'W	1987/88	Being prepared	Being prepared
								Argentina	Esperanza Station/ Ant. Peninsula	63°24'S 57°00'W	1990/91		
		X						Germany	Ardley Is/ Ant. Peninsula	62°11'S 58° 55'W	1990/91		
A3	Annual trends in breeding population size	X						Australia	Magnetic Is Davis Station/ Prydz Bay	68°33'S 77°54'E	1983/84	Being prepared	Being prepared
		X						Argentina	King George Is Stranger Point/ S. Shetland Is	62°14'S 58°30'W	1987/88	Being prepared	Being prepared
			X	X				Brazil	Elephant Is S. Shetland Is/ Ant. Peninsula	61°04'S 55°21'W	1986	No inf. available	No inf. available
		X		X				Chile	Ardley Is S. Shetland Is/ Ant. Peninsula	62°11'8"S 58°55'W	1982	Being prepared	Being prepared
		X						Japan	Syowa Station/ Network site	69°00'S 39°30'E	1970	No inf. available	No inf. available
			X		X			UK	Bird Is/ South Georgia	52°00'S 38°02'W	1975/76	Submitted	Submitted
		X		X	X			UK	Signy Is/ Network site	60°43'S 45°38'W	1978/79	Submitted	Submitted
		X						Germany	Ardley Is/ Ant. Peninsula	62°11'S 58° 55'W	1990/91		
A4	Demography			X				Chile	Ardley Is S. Shetland Is/ Ant. Peninsula	62°11'8"S 58°55'W	1982	Being prepared	Being prepared
			X	X				Brazil	Elephant Is S. Shetland Is/ Ant. Peninsula	61°04'S 55°21'W	1986	Data not requested	Data not requested
			X	X				USA	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5'S 55°24.5'W	1987/88	Data not requested	Data not requested
		X						USA	Anvers Is Palmer Station/ Ant. Peninsula	64°06'S 64°03'W	1987/88	Data not requested	Data not requested
A5	Duration of foraging trips	X						Australia	Magnetic Is Davis Station/ Prydz Bay	68°33'S 77°54'E	1983/84	Being prepared	Being prepared
				X				USA	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5'S 55°24.5'W	1987/88	Submitted	Submitted
		X						USA	Anvers Is Palmer Station/ Ant. Peninsula	64°06'S 64°03'W	1989/90	Submitted	Submitted

Table 1 (continued)

-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
A6	Breeding success	X						Australia	Magnetic Is Davis Station/ Prydz Bay	68°33’S 77°54’E	1983/84	Being prepared	Being prepared
		X						Argentina	King George Is Stranger Point/ S. Shetland Is	62°14’S 58°30’W	1987/88	Being prepared	Being prepared
			X	X				Brazil	Elephant Is S. Shetland Is/ Ant. Peninsula	61°04’S 55°21’W	1986	Submitted	Submitted
				X				Chile	Ardley Is S. Shetland Is/ Ant. Peninsula	62°11’8”S 58°55’W	1982	Being prepared	Being prepared
			X		X			UK	Bird Is/ South Georgia	52°00'S 38°02'W	1975/76	Submitted	Submitted
		X		X	X			UK	Signy Is/ Network site	60°43'S 45°38'W	1978/79	Submitted	Submitted
			X	X				USA	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5’S 55°24.5’W	1987/88	Proc.A sub. Proc.C(b,c) submitted	Proc.A sub. Proc.C(b,c) submitted
		X						USA	Anvers Is Palmer Station/ Ant. Peninsula	64°06’S 64°03’W	1987/88	Submitted	Submitted
		X						Germany	Ardley Is/ Ant. Peninsula	62°11’S 58° 55’W	1990/91		
A7	Fledging weight	X						Australia	Magnetic Is Davis Station/ Prydz Bay	68°33'S 77°54'E	1983/84	Being prepared	Being prepared
		X						Argentina	King George Is Stranger Point/ S. Shetland Is	62°14’S 58°30’W	1987/88	Being prepared	Being prepared
		X						Argentina	Laurie Is Mossman Peninsula/ S. Orkney Is	60°45’S 44°44’W	1987/88	Being prepared	Being prepared
								Argentina	Esperanza Station/ Ant. Peninsula	63°24’S 57°00’W	1990/91		
			X	X				Brazil	Elephant Is S. Shetland Is/ Ant. Peninsula	61°04’S 55°21'W	1986	Submitted	
			X		X			UK	Bird Is/ South Georgia	52°00'S 38°02'W	1988/89	Submitted	Submitted
				X				USA	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5’S 55°24.5’W	1987/88	Proc. A submitted	Proc. A submitted
		X						USA	Anvers Is Palmer Station/ Ant. Peninsula	64°06’S 64°03’W	1987/88	Submitted	Submitted
		X						Germany	Ardley Is/ Ant. Peninsula	62°11’S 58° 55’W	1990/91		
A8	Chick diet	X						Australia	Magnetic Is Davis Station/ Prydz Bay	68°33’S 77°54’E	1983/84	Being prepared	Being prepared
		X						Australia	Béchervaise Is/ Mawson/ Prydz Bay	67°36’S 62°53’E	1990/91		Submitted
		X						Argentina	King George Is Stranger Point/ S. Shetland Is	62°14’S 58°30’W	1987/88	Being prepared	Being prepared
		X						Argentina	Laurie Is Mossman Peninsula/ S. Orkney Is	60°45’S 44°44’W	1987/88	Being prepared	Being prepared
								Argentina	Esperanza Station/ Ant. Peninsula	63°24’S 57°00’W	1987/88	Being prepared	Being prepared
			X	X				Brazil	Elephant Is S. Shetland Is/ Ant. Peninsula	61°04’S 55°21’W	1986	Submitted	
				X				Chile	Ardley Is S. Shetland Is/ Ant. Peninsula	62°11’8”S 58°55’W	1982	No inf. available	No inf. available
			X		X			UK	Bird Is/ South Georgia	52°00'S 38°02'W	1985/86	Submitted	Submitted
				X				USA	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5’S 55°24.5”W	1987/88	No info available	No info available
		X						USA	Anvers Is Palmer Station/ Ant. Peninsula	64°06’S 64°03’W	1987/88	Submitted	Being prepared
		X						Germany	Ardley Is/ Ant. Peninsula	62°11’S 58° 55’W	1990/91		

Table 1 (continued)

-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
A9	Breeding chronology	X						Australia	Magnetic Is Davis Station/ Prydz Bay	68°33’S 77°54’E	1983/84	Being prepared	Being prepared
		X						Australia	Béchervaise Is/ Mawson/ Prydz Bay	67°36’S 62°53’E	1990/91		Submitted
		X						Argentina	Laurie Is Mossman Peninsula/ S. Orkney Is	60°45’S 44°44’W	1987/88	Being prepared	Being prepared
				X				USA	Seal Is Anvers Is S. Shetland Is/ Ant. Peninsula	60°59.5’S 64°06’S 55°24.5’’W	1987/88	Submitted	Submitted
Flying Birds													
B1	Breeding population size					X		UK	Bird Is/ South Georgia	52°00'S 38°02'W	1976/77	Being prepared	Being prepared
B2	Breeding success					X		UK	Bird Is/ South Georgia	52°00'S 38°02'W	1976/77	Being prepared	Being prepared
B3	Age-specific annual survival and recruitment					X		UK	Bird Is/ South Georgia	52°00'S 38°02'W	1976/77	Being prepared	Being prepared
Seals													
C1	Cow foraging/ attendance						X	Chile	Cape Shirreff/ Ant. Peninsula	62°27’S 60°47’W	1987/88	No inf. available	No inf. available
	cycles						X	UK	Bird Is/ South Georgia	52°00'S 38°02'W	1978/79	Submitted	Submitted
							X	USA	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5’S 55°24.5W	1987/88	Proc. A submitted	Proc. A submitted
C2	Pup Growth						X	Chile	Cape Shirreff/ Ant. Peninsula	62°28’S 60°47”W	1984/85	No inf. available	No inf. available
							X	UK	Bird Is/ South Georgia	52°00'S 38°02'W	1972/73 1977/78	Submitted	Submitted
							X	USA	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5’S 55°24.5’W	1987/88	Proc. B submitted	Proc. B submitted

Table 2: Summary of Members' directed programs on assessing the utility of potential predator parameters.

Parameter	Areas[a] from which data are available for analysis/ evaluation	Members' Research Activity					
		Undertaken 1989/90		Undertaken 1990/91		Proposed for 1991/92	
		Analysis of existing data	Acquisition of new data	Analysis of existing data	Acquisition of new data	Analysis of existing data	Acquisition of new data
-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-
Penguins[b]							
- Incubation shift (M)	2,4,5,11,14	Brazil(2)	Brazil (2)	S.Africa (14,M)	S.Africa (14,M)		
- Weight prior to moult (M)	2,15,14,4,5?	Brazil (2)	Brazil (2)	S.Africa (14,M)	S.Africa (14,M)		
- At-sea diving behaviour and activity patterns (A,C,M)	2,4,6	Australia (6,A) UK (4,M,G) USA (2,C,M) Germany (11,A)	Australia (6,A) USA (2,C,M,G) Germany (11,A)	Australia (6,A) USA (2,C,M) Germany (11,A,G)	 UK (4,M) USA (2,C,M) Germany (11,A,G)	Australia (6,A) UK (4,M) USA (2,C,M) Germany (11,A,G)	Australia (6,A) UK (4,G) USA (2,C,M) Germany (11,A,C,G)
- Weight recovery during incubation (A,C,M)	4,6	Australia (6,A)	Australia (6,A)	Australia (6,A)			
- Survival (A,C,M)	1,2,6,11	Australia (6,A) UK (4,M,G) USA (2,C;11,A)	Australia (6,A) UK (4,M,G) USA (2,C;11,A)	 UK (4,M) USA (2,C;11,A)	 UK (4,M,G) USA (2,C;11,A)	 USA (2,C)	 UK (4,M,G) USA (2,C)
- Chick growth rate	2,11	UK (4,M,G) USA (2,C;11,A)	USA (2,C;11,A)	Spain (2,C)	UK (4,G)	 USA (2,C)	UK (4,G) USA (2,C)
- Bioenergetics				Spain (2,C) USA (2,C,M;11,A)	USA (2,C,M)	USA (2,C,M)	USA (2,C,M)
- Reproductive strategies (C)	2			Spain (2,C)			

Table 2 (continued)

-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-
Flighted seabirds							
Black-browed albatross							
- Breeding population size	4,9?,15		UK (4)		UK (4)	UK (4)	UK (4)
- Breeding success	4,9?,15		UK (4)		UK (4)	UK (4)	UK (4)
- Duration of foraging trips	4		UK (4)			UK (4)	UK (4)
- Activity budget at sea	4		UK (4)				UK (4)
- Prey characteristics (diet)	4		UK (4)				UK (4)
Antarctic/Cape petrel							
- Breeding success	2,3,6,8,11		UK (3,CP)		UK (3,CP)	USA (2,CP)	USA (2,CP)
- Chick weight at fledging	2,6,8,11	Brazil (2)	Brazil (2)			USA (2,CP)	USA (2,CP)
- Prey characteristics (diet)	2,6,8,11	Brazil (2)	Brazil (2)				
Fur seals							
- Reproductive success	4,2		UK (4) USA (2)		UK (4) USA (2)	UK (4)	USA (2)
- Prey characteristics (diet)	4,2	USA (2)	UK (4) USA (2)	USA (2)	UK (4) USA (2)	USA (2)	USA (2)
- At-sea diving behaviour and activity pattern	2,4	UK (4) USA (2)	UK (4) USA (2)	UK (4) USA (2)	UK (4) USA (2)	USA (2)	USA (2)
- Bioenergetics					UK (4)		UK (4)
- Indices of physiological condition	11		UK (4)				UK (4)
- Fine structure of teeth	4	UK (4)	UK (4)		UK (4)		
Crabeater seal							
- Reproductive rates	2,3,8,10-12	USA (11,12) Sweden (11,12)	USA (12)	USA (11,12) Sweden (11,12)		USA (11,12) Sweden (11,12)	
- Age at sexual maturity	2,3,8,10-12	USA (10,11,12) Sweden (11,12)	USA (12)	USA (11,12) Sweden (11,12)		USA (11,12) Sweden (11,12)	
- Cohort strength	2,3,8,10-12	USA (10,11,12)	USA (12)	USA (11,12)		USA (11,12)	

Table 2 (continued)

-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-
- Indices of physiological condition	11,12	USA (11,12)	USA (12)			USA (11,12)	
- Instantaneous growth rate	11,12		USA (12)				
- Prey characteristics (diet)	11,12	USA (11)	USA (11)	USA (11)		USA (11,12)	
- At-sea diving behaviour and activity pattern	11,12	USA (11,12)	USA (11,12)	USA (11,12)		USA (11,12)	
- Satellite telemetry		USA (11,12)	USA (11,12)	USA (11,12)		USA (11,12) Sweden (11,12)	
Minke whales							
- Reproductive rate	13,1	Japan	Japan	Japan	Japan	Japan	Japan
- Age of sexual maturity	13,1	Japan	Japan	Japan	Japan	Japan	Japan
- Cohort strength	13,1	Japan	Japan	Japan	Japan	Japan	Japan
- Analyses of existing data:							
- stomach contents	13,1	Japan	Japan	Japan	Japan	Japan	Japan
- blubber thickness	13,1	Japan	Japan	Japan	Japan	Japan	Japan
- density/patchiness	13,1	Japan	Japan	Japan	Japan	Japan	Japan
- school size	13,1	Japan	Japan	Japan	Japan	Japan	Japan
- Feeding activity patterns	13,1	Japan	Japan	Japan	Japan	Japan	Japan

(a) Areas:

1. Ross Sea
2. South Shetland Is
3. S. Orkney Is
4. S. Georgia Is
5. Macquarie Island
6. Davis Station
7. Syowa Station
8. Dumont d'Urville Sea
9. Crozet Island
10. Balleny Is
11. Antarctic Peninsula
12. Weddell Sea
13. Mainly from the Indian Ocean (IWC Areas III and IV)
14. Marion Is
15. Kerguelen Is

(b) Penguin species: A - Adélie, C - Chinstrap, M - Macaroni/Royal, G - Gentoo

(c) Petrel species: CP - Cape petrel, AP - Antarctic petrel

Table 3: Summary of Members' directed research on predator parameters required to provide essential background information needed to interpret changes in monitored predator parameters.

Research Topic	Countries Proposing Directed Research	
	Programs Currently Underway	Programs Proposed to Commence (season of initiation)
PENGUINS		
- Foraging areas	Chile, Japan USA, South Africa	Australia (1990/91)
- Energy requirements	USA, UK, Germany	UK (1990/91)
- Seasonal movements	South Africa	
- Relationships between monitored parameters and physical environment (e.g. distribution and structure of sea ice and frontal systems)	Chile UK/USSR USA South Africa (Frontal systems)	Australia (1990/91) UK (1992/93)
FUR SEALS		
- Local abundance/population structure	Argentina, Chile, UK, USA	Brazil Chile (1990/91)
- Energy requirements/life history	UK	USA (1991/92)
- Foraging areas	Chile, USA	UK (1992/93) Japan (1990/91, with USA)
- Relationships between monitored parameters and physical environment (e.g. distribution and structure of sea-ice and frontal systems)	Chile (partial), USA UK/USSR	
CRABEATER SEALS		
- Foraging areas	USA	USA (1991/92, with Sweden)
- Energy requirements/life history	USA, Sweden	USA (1991/92)
- Stock discreteness/seasonal movements	USA	USA (1991/92, with Sweden)
- Relationships between monitored parameters and physical environment (e.g. distribution and structure of sea-ice and frontal systems)	USA	

APPENDIX A

AGENDA

Working Group for the
CCAMLR Ecosystem Monitoring Program
(Santa Cruz de Tenerife, Spain, 5 to 13 August 1991)

1. Opening of the Meeting

2. Adoption of the Agenda

3. Review of Members' Activities
   - 3.1 Monitoring
   - 3.2 Directed Research
   - 3.3 Plans for Future Field Work

4. Monitoring Procedures
   - 4.1 Predator Monitoring
     - 4.1.1 Sites and Species
       - 4.1.1.1 Proposals for Site Protection
       - 4.1.1.2 Other Proposals
     - 4.1.2 Proposals for New Procedures
       - 4.1.2.1 Data Collection Methods
       - 4.1.2.2 Processing/Analysis Methods
       - 4.1.2.3 Reporting Formats and Requirements
     - 4.1.3 Field Research Procedures
   - 4.2 Prey Monitoring
     - 4.2.1 Review of WG-Krill and SGSD Reports
     - 4.2.2 Other Species
   - 4.3 Environmental Monitoring
     - 4.3.1 Land-Based Observations
     - 4.3.2 Remote Sensing

5. Ecosystem Assessment
    5.1 Review of Monitoring Results
        5.1.1 Predator Data
        5.1.2 Prey Data
        5.1.3 Environmental Data
    5.2 Formulation of Advice and Recommendations to the Scientific Committee

6. Estimates of Prey Requirements for Krill Predators
    6.1 Review of Current Information
    6.2 Status of Proposed Workshop

7. General Matters
    7.1 Approaches to Integrated Analyses of Predator/Prey/Environmental Data
    7.2 Review of Opportunities for Collaborative CEMP Studies
    7.3 Workshop on the Feeding Ecology of Southern Baleen Whales
    7.4 Workshop on Southern Elephant Seals
    7.5 CCAMLR Scheme of International Scientific Observation
    7.6 New and Developing Fisheries

8. Other Business

9. Summary of Recommendations and Advice

10. Adoption of the Report

11. Close of the Meeting.

APPENDIX B

LIST OF PARTICIPANTS

Working Group for the
CCAMLR Ecosystem Monitoring Program
(Santa Cruz de Tenerife, Spain, 5 to 13 August 1991)

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APPENDIX C

LIST OF DOCUMENTS

Working Group for the
CCAMLR Ecosystem Monitoring Program
(Santa Cruz de Tenerife, Spain, 5 to 13 August 1991)

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WG-CEMP-91/3	LIST OF DOCUMENTS
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WG-CEMP-91/5	THE USE OF MORPHOMETRIC PARAMETERS FOR THE DETERMINATION OF SEX OF ADELIE PENGUINS K.R. Kerry, D.J. Agnew, J.R. Clarke and G.D. Else (Australia)
WG-CEMP-91/5 Rev. 1	THE USE OF MORPHOMETRIC PARAMETERS FOR THE DETERMINATION OF SEX OF ADELIE PENGUINS K.R. Kerry, D.J. Agnew, J.R. Clarke and G.D. Else (Australia)
WG-CEMP-91/6	CHANGES TO STANDARD METHODS REQUIRED BY THE INCLUSION OF GENTOO PENGUIN Secretariat
WG-CEMP-91/7	DRAFT MANAGEMENT PLAN FOR THE PROTECTION OF SEAL ISLANDS, SOUTH SHETLAND ISLANDS, AS A SITE INCLUDED IN THE CCAMLR ECOSYSTEM MONITORING PROGRAM Delegation of the USA
WG-CEMP-91/8	A PROPOSAL FOR CEMP PREDATOR PARAMETER INDICES Secretariat
WG-CEMP-91/9	ACQUISITION AND ARCHIVING OF SATELLITE IMAGERY OF SEA-ICE DISTRIBUTION Data Manager (CCAMLR)
WG-CEMP-91/10	DEVELOPMENT OF THE CCAMLR ECOSYSTEM MONITORING PROGRAM 1985 TO 1991 Secretariat
WG-CEMP-91/11	AMLR 1990/91 FIELD SEASON REPORT Delegation of the USA

WG-CEMP-91/12 REPORT OF THE WORKSHOP ON SOUTHERN ELEPHANT SEALS
SCAR Group of Specialists on Seals

WG-CEMP-91/13 TEMPORAL VARIABILITY IN ANTARCTIC MARINE ECOSYSTEMS: PERIODIC FLUCTUATIONS IN THE PHOCID SEALS
J.W. Testa *et al.* (USA)

WG-CEMP-91/14 SURVEYS OF BREEDING PENGUINS AND OTHER SEABIRDS IN THE SOUTH SHETLAND ISLANDS, ANTARCTICA JANUARY-FEBRUARY 1987
W.D. Shuford and L.B. Spear (USA)

WG-CEMP-91/15 CCAMLR/IWC WORKSHOP ON THE FEEDING ECOLOGY OF SOUTHERN BALEEN WHALES PROGRESS REPORT
Secretariat

WG-CEMP-91/16 INTERACTIONS OF ANTARCTIC MARINE MAMMALS AND BIRDS WITH FISHERIES
K.-H. Kock (Germany)

WG-CEMP-91/17 MYCTOPHIDS IN THE DIET OF ANTARCTIC PREDATORS
E. Sabourenkov (CCAMLR Secretariat)

WG-CEMP-91/18 DIVING PATTERN AND PERFORMANCE IN RELATION TO FORAGING ECOLOGY IN THE GENTOO PENGUIN, *PYGOSCELIS PAPUA*
T.D. Williams *et al.* (UK)

WG-CEMP-91/19 DIVING PATTERNS AND PROCESSES IN EPIPELAGIC AND BENTHIC FORAGING SUB-ANTARCTIC SEABIRDS
T.D. Williams *et al.* (UK)

WG-CEMP-91/20 ANNUAL VARIATION IN RETURN RATE, MATE AND NEST-SITE FIDELITY IN BREEDING GENTOO AND MACARONI PENGUINS
T.D. Williams and S.R. Rodwell (UK)

WG-CEMP-91/21 AGE DISTRIBUTION OF BREEDING FEMALE ANTARCTIC FUR SEALS IN RELATION TO CHANGES IN POPULATION GROWTH RATE
I.L. Boyd *et al.* (UK)

WG-CEMP-91/22 PUPPING-SITE FIDELITY OF ANTARCTIC FUR SEALS AT BIRD ISLAND, SOUTH GEORGIA
N.J. Lunn and I.L. Boyd (UK)

WG-CEMP-91/23 DIVING BEHAVIOUR OF LACTATING ANTARCTIC FUR SEALS
I.L. Boyd and J.P. Croxall (UK)

WG-CEMP-91/24 TIME BUDGETS AND FORAGING CHARACTERISTICS OF LACTATING ANTARCTIC FUR SEALS
I.L. Boyd *et al.* (UK)

WG-CEMP-91/25 KRILL CATCHES AND CONSUMPTION BY LAND-BASED PREDATORS IN RELATION TO DISTANCE FROM COLONIES OF PENGUINS AND SEALS IN THE SOUTH SHETLANDS AND SOUTH ORKNEYS, 1987-1990
D.J. Agnew (Secretariat)

WG-CEMP-91/26 INVESTIGATION OF THE MARINE LIVING RESOURCES IN ANTARCTIC WATERS: A COLLECTION OF SHORT PAPERS
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WG-CEMP-91/27 PROSPECTS FOR A WORKSHOP ON METHODS TO STUDY AT-SEA BEHAVIOR OF MARINE MAMMALS AND BIRDS
J.L. Bengtson, Convener, WG-CEMP

WG-CEMP-91/28 INCREASES IN ANTARCTIC PENGUIN POPULATIONS: REDUCED COMPETITION WITH WHALES OR A LOSS OF SEA-ICE DUE TO ENVIRONMENTAL WARMING?
W.R. Fraser *et al.* (USA)

WG-CEMP-91/29 CENSUS TECHNIQUES FOR GREY SEAL POPULATIONS
A.J. Ward *et al.* (UK)

WG-CEMP-91/30 MIXED FUNCTION OXIDASE ACTIVITY AND CHLORINATED HYDROCARBON RESIDUES IN ANTARCTIC SEABIRDS: SOUTH POLAR SKUA (*CATHARACTA MACCORMICKI*) AND ADELIE PENGUIN (*PYGOSCELIS ADELIAE*)
S. Focardi *et al.* (Italy)

WG-CEMP-91/31 IDENTIFICATION OF SEX OF ADELIE PENGUINS FROM OBSERVATION OF INCUBATING BIRDS
K.R. Kerry *et al.* (Australia)

WG-CEMP-91/32 ESTIMATION OF PRIMARY ORGANIC MATTER PRODUCTION INTENSITY AND ITS INTERANNUAL CHANGEABILITY IN THE COOPERATION SEA REGION
A.T. Kochergin (USSR)

WG-CEMP-91/33 FORAGING BEHAVIOR AND REPRODUCTIVE SUCCESS IN CHINSTRAP PENGUINS: THE EFFECTS OF TRANSMITTER ATTACHMENT
Delegation of the USA

WG-CEMP-91/34 ACTIVITIES RELATED TO CEMP
Delegation of Spain

WG-CEMP-91/35 MODELING THE ENERGETICS OF ADELIE PENGUIN POPULATIONS
Delegation of the USA

WG-CEMP-91/36 COMMENTS OF WG-CEMP-91/8 BY DR P. ROTHERY (BAS)

WG-CEMP-91/37 ESTIMATES OF PREY REQUIREMENTS FOR KRILL PREDATORS
J. Croxall (UK)

OTHER DOCUMENTS

WG-KRILL-91/7 CHARACTERISTICS OF KRILL SWARMS FROM PRYDZ BAY
D.J. Agnew (Secretariat) and I.R. Higginbottom (Australia)

WG-KRILL-91/9 FINE-SCALE CATCHES OF KRILL IN AREA 48 REPORTED TO CCAMLR 1989 TO 1990
Secretariat

WG-KRILL-91/10 ON CONSTRUCTION OF MULTIDISCIPLINARY AND STOCK ASSESSMENT SURVEYS AS WELL AS ON COLLECTION OF MATERIAL ON *EUPHAUSIA SUPERBA* AND ENVIRONMENTAL CONDITIONS IN THE FISHING AREAS AND ADJACENT WATERS
R.R. Makarov and V.V. Maselnnikov (USSR)

WG-KRILL-91/11 PECULIARITIES OF *EUPHAUSIA SUPERBA* SIZE COMPOSITION IN STATISTICAL SUBAREA 48.2 (SOUTH ORKNEY ISLANDS)
V.I. Latogursky and R.R. Makarov (USSR)

WG-KRILL-91/12 REPORT OF THE BIOLOGIST-OBSERVER FROM THE COMMERCIAL TRAWLER *GRIGORY KOVTUN*, SEASON 1989/90
A.V. Vagin (USSR)

WG-KRILL-91/14 OCEANIC CONDITION AND ZOOPLANKTON DISTRIBUTION/ABUNDANCE IN BRANSFIELD STRAIT DURING AUSTRAL SUMMER 1989/90
S.M. Kim and M.S. Suk (Korea)

WG-KRILL-91/15 ESTIMATION OF KRILL (*EUPHAUSIA SUPERBA*) MORTALITY AND PRODUCTION RATE IN THE ANTARCTIC PENINSULA REGION
Delegation of Germany

WG-KRILL-91/22	KRILL (*EUPHAUSIA SUPERBA*) DISTRIBUTION IN RELATION TO WATER MOVEMENT AND PHYTOPLANKTON DISTRIBUTION OFF THE NORTHERN SOUTH SHELTAND ISLANDS Delegation of Japan
WG-KRILL-91/23	BRIEF REPORT OF THE SIXTH ANTARCTIC SURVEY CRUISE OF JFA R/V *KAIYO MARU* Mikio Naganobu, Taro Ichii and Haruto Ishii (Japan)
WG-KRILL-91/27	KRILL AGGREGATION CHARACTERISTICS IN SOUTH ORKNEY ISLAND AREA IN APRIL 1990 P.P. Fedulov *et al.* (USSR)
WG-KRILL-91/34	KRILL DISTRIBUTIONS AND THEIR DIURNAL CHANGES M. Godlewska and Z. Klusek (Poland)
WG-KRILL-91/37	CPUES AND BODY LENGTH OF ANTARCTIC KRILL WITHIN COMMERCIAL HAULS OF POLISH TRAWLER FV *LEPUS* IN THE FISHING GROUND OFF SOUTH ORKNEYS IN JANUARY AND FEBRUARY 1991 I. Wójcik and R. Zaporowski (Poland)
WG-KRILL-91/38	VOLUMETRIC ANALYSES OF ANTARCTIC MARINE ECOSYSTEM DATA Delegation of the USA
WG-KRILL-91/39	CHILEAN KRILL FISHERY: ANALYSIS OF THE 1991 SEASON Victor H. Marín *et al.*
CCAMLR-X/6	NEW AND DEVELOPING FISHERIES Executive Secretary
CCAMLR-X/7	CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION Executive Secretary
SC-CAMLR-X/4	REPORT OF THE THIRD MEETING OF THE WORKING GROUP ON KRILL (Yalta, USSR, 22 to 30 July 1991)

APPENDIX D

REPORTS OF MEMBERS' ACTIVITIES WITH REGARD TO CEMP

This appendix contains descriptions of Members' activities in relation to CEMP that were either submitted to the meeting by participants (reports of Australia, Italy, Japan, Korea, Norway, Spain, Sweden, USSR, UK and USA) or by correspondence with the Convener (Germany and New Zealand).

2. Australia has two major programs that concern CEMP. The first, the 'Prydz Bay Adélie penguin/prey stock interaction program', investigates the predator-prey interaction in the Adélie penguin population of Magnetic Island, Princess Elizabeth Land, and its food sources in Prydz Bay. The following parameters are being studied: A1, A2, A3, A5, A6, A7 and A8. In addition nest-specific survival, chick growth rates, energy budgets, diving behaviour and foraging location are being investigated. Data for some parameters have been collected at the site since 1980/81 and the data are expected to be made available to CEMP at the completion of the current research project (1992/93).

3. The second Australian project is the deployment at Béchervaise Island near Mawson Station of an automated system for weighing and recording tagged birds within breeding colonies. The system will be used to monitor Adélie penguins, in accordance with CEMP Standard Methods.

4. The program has the following elements: installation, testing, modification and calibration of the existing automated monitoring system; development of methods for determining sex of birds of all ages but particularly chicks; evaluation of the performance of the birds when carrying various accoutrement associated with the program including flipper bands, electronic tags glued to feathers, radio or satellite tracking devices etc.; evaluation of the results obtained by the automated system by comparison with similar data gathered by manual means as described in the CEMP Standard Methods; studies on the food and foraging area by satellite tracking of the birds in the monitored colony; evaluation of new tagging systems including implanted tags for ease of operation, for least trauma to the birds and least effect on the monitored parameter; and installation of the full monitoring system at a number of additional sites along the coast, initially at Davis and Mirny.

5. Additional routine monitoring has been conducted on Béchervaise Island, near Mawson Station, MacRobertson Land, during the 1989/90 and 1990/91 seasons. Data from the project have been submitted to CCAMLR.

6. Germany continues directed research in the Antarctic Peninsula area on the at-sea diving behaviour of Adélie and gentoo penguins. At Ardley Island modelling of the energetics of locomotion and the food requirement of penguins and studies on the relationship between monitored parameters and the physical environment are currently underway. Studies on foraging areas are planned for the future. The feasibility of collecting data for predator parameters A5 (Adélies) and A1 to A8 (gentoos) at Ardley Island is currently being evaluated. Data on abundance of the gentoo and Adélie penguins are available for the last 10 years.

7. Studies by Italy in 1990/91 of interest to CEMP were concentrated on the time-space variability of zooplankton communities in the Strait of Magellan, focusing on their species composition and ecological differences. During the next two to three years zooplankton research will be directed at modelling and system analysis of upper levels of the planktonic food chain in this area and the investigation of pelagic living resources, particularly of *Euphausia superba*, in the Ross Sea using hydroacoustic methods.

8. Italy is using biomarkers to evaluate the exposure to, and long-term ecological effects of contaminants on Antarctic organisms. Attention is focused on higher vertebrates, particularly birds and mammals, belonging to the upper trophic levels of the marine food chain, and consequently more exposed to damage from xenobiotic elements. Studies on Adélie penguin and South Polar skua were conducted in Ross Island in cooperation with New Zealand.

9. Japan continues to monitor the annual trends in breeding population size of Adélie penguins near Syowa Station. In the 1990/91 season, a survey of krill distribution in the vicinity of the South Shetland Islands and Elephant Island together with the collection of data on some hydrological parameters was conducted by the RV *Kaiyo Maru*. At the same time, the foraging areas of fur seals and penguins breeding ashore at Seal Island were investigated in collaboration with US scientists. A Japanese scientist also participated with Australian scientists in a survey of the zooplankton in the Prydz Bay area in the 1990/91 season.

10. Japan continues to investigate the biology and population size of minke whales through selective catching in the Southern Ocean. Studies of krill ecology in relation to

hydrological parameters as well as on survey design will continue. Japan intends to continue cooperative work on CEMP monitoring and directed research with US scientists.

11. Korea conducted a meso-scale multidisciplinary survey between December 1990 and January 1991 to investigate the changes and fluctuation in the distribution and the biomass of marine organisms. A total of 37 stations were chosen from Bransfield Strait and Gerlache Strait. Bacteria, phytoplankton, micro-zooplankton, zooplankton and benthos were collected. Samples are presently being analyzed. Preliminary results show low biomass of micro-phytoplankton but high biomass of nano-phytoplankton. Of the microzooplankton, flagellates were dominant, ranging from 10^2 to 10^4 cells/ml.

12. It was noted that several New Zealand research projects were under way at Ross Island, investigating foraging behaviour of Adélie penguins, and the effects of tagging on penguin foraging performance. In association with a US collaborator, research into factors affecting the foraging trips of Adélie penguins during the incubation period is underway. This work has included behavioural observations, manipulations of physiological status prior to foraging, assaying levels of steroid hormones from blood samples and the use of satellite telemetry to monitor the movements of penguins at sea. During the 1990/91 season the feeding behaviour of chicks was investigated in cooperation with US scientists. Satellite transmitters to track the movements of penguins during the winter period were also deployed.

13. Norway does not conduct any routine monitoring of CEMP parameters directly. However, a Norwegian expedition monitored the populations of seals and penguins on Bouvetøya (Bouvet Island) in December/January 1989/90. The penguin numbers were estimated by counts from aerial photographs and direct counts in 4 to 5 m transects by walking through the colonies. Populations of fur seal and elephant seal were also monitored and for all colonies except at Nyrøysa, counts were done from aerial photographs. Results indicated that since the previous censuses in 1979/80 elephant seal abundance has declined whereas the breeding population of Antarctic fur seals has increased.

14. Norwegian scientists investigated the diet of penguins and seals at Bouvetøya. Samples of stomach contents of chinstrap and macaroni penguins were collected using a stomach pump (five samples from each species). Faeces were collected from 21 fur seals. In addition, investigations were carried out on small petrels to identify species and their population sizes.

15. During the 1990/91 austral summer, Spain conducted a CEMP related program at Deception Island (South Shetlands). Investigations mainly focused on reproductive strategies

of chinstrap penguins (*Pygoscelis antarctica*). The specific investigations carried out were sex determination using discriminant analysis, breeding success studies, genetics studies and blood analyses.

16. A prey survey was conducted by Spain near the South Orkney Islands (Subarea 48.2) in January and February 1991. The aim of the survey was to evaluate the state of fish stocks occurring in this subarea using the 'swept area method'. The results of the cruise will be submitted to the next meeting of the CCAMLR Working Group on Fish Stock Assessment.

17. Sweden does not currently participate in routine monitoring as part of CEMP. However, it is conducting research at South Georgia on southern elephant seals and king penguins, in collaboration with the UK, and studies of crabeater seals in collaboration with the US.

18. The elephant seal research (currently in its fourth year) involves work on reproductive energetics and behaviour, demography, foraging behaviour and diet, genetics and pollutants (see WG-CEMP-91/12, Appendix 4). The project on king penguins, due to commence in 1992, will focus on breeding and foraging strategies.

19. The crabeater seal research includes work on vital population parameters pertinent for evaluation and modelling of population dynamics of phocid seals. The studies focus on establishing better criteria for estimating age specific fertility rates including mean age at first parturition, and causes for sterility in older year classes.

20. The CEMP-related work of the Soviet Union includes surveys of krill and fish as predators of krill around Prydz Bay, Lazarev Sea and Enderby Land (SC-CAMLR-IX, Annex 4, paragraphs 27 and 28). These surveys have been performed each year since 1986. The Soviet Delegation indicated that the results, which will include an analysis of the relative consumption of *Euphausia crystallorophias* and *E. superba* by fish will be presented at a future WG-CEMP meeting. In addition, two krill surveys will be performed around the South Shetlands and South Georgia (1991/92) and will include an investigation of fish as predators of krill. The collection of haul-by-haul and biological data from the krill fishery will continue in the 1991/92 seasons with at least two observers being present on commercial krill vessels.

21. The United Kingdom land-based research in support of CEMP is conducted at Signy Island, South Orkney Islands, and Bird Island, South Georgia. At Signy Island, parameters A3 and A6 are monitored for Adélie, chinstrap and gentoo penguins, and breeding success

continues to be monitored for Cape (and snow) petrels. At Bird Island, parameters currently monitored are A1, A3, A6, A7, A8 (macaroni penguin), A3, A6, A7, A8 (gentoo penguin), B1 to B3 (black-browed albatross), C1 and C2 (Antarctic fur seal). In addition, comprehensive demographic programs are conducted annually on grey-headed and wandering albatrosses and Antarctic fur seal. Some standardized demographic data are obtained annually for gentoo and macaroni penguins.

22. There are currently no bird or seal research programs at Signy Island. The current Bird Island penguin research program was concluded in early 1991. Of the papers tabled last year, WG-CEMP-90/13, 16, 17, 18 (on inter-annual variation in breeding chronology and biology and chick fledging weight and intra-annual variation in diet) are now published. New material of particular interest to CCAMLR concerns at-sea diving and activity budgets (WG-CEMP-91/18, 19) and inter-annual variation in survival and mate and site fidelity (WG-CEMP-91/20) in penguins.

23. The field component of the project on reproductive performance of fur seals was completed in 1991; initial outputs from this concern population age structure (WG-CEMP-91/21) pupping and site fidelity (WG-CEMP-91/22). Of particular relevance to CEMP are detailed analyses of relationships between time and activity budgets at sea and foraging-attendance cycle duration (WG-CEMP-91/24) and studies of diving pattern and performance (WG-CEMP-91/23).

24. Studies of activity-specific energy budgets of fur seals, gentoo penguins and albatrosses started in 1991. Further research on black-browed albatross at-sea activity budgets and chick growth patterns ashore will be conducted in 1993 as a prelude to more extensive research in conjunction with the predator-prey research cruise in 1994.

25. Although there has been no UK research aimed at CEMP prey monitoring, surveys around South Georgia in January/February 1991 provided observations that give an indication of the status of krill in this area. In general, krill standing stock was low at this time, particularly at the west end of the island. The largest krill concentrations were found off the northeast coast.

26. Results from a UK fish stock assessment survey around South Georgia in January/February 1991 indicated that the standing stock of icefish, *Champsocephalus gunnari*, was approximately one quarter of last year's level. Although krill is a major component in the diet of icefish only a small proportion of these fish (about 20%) were feeding on krill suggesting that krill were scarce during the period of the survey.

27. United States CEMP related activities in 1990/91 consisted of three components:

(i) land-based predator studies at Seal Island, near Elephant Island and at Palmer Station, Anvers Island;

(ii) predator tracking studies in collaboration with Japanese and Chilean scientists; and

(iii) repeated surveys of hydrographic conditions, phytoplankton production, and krill distribution in the waters surrounding Elephant Island.

28. At Seal Island, directed research and monitoring activities were conducted on fur seals, chinstrap penguins, and macaroni penguins. The following parameters were monitored: A5, A6a and c, A7, A8, A9, C1 and C2. In addition, directed research was completed on foraging areas for seals and penguins, energy requirements of penguins, relationships between krill predators and physical environment (e.g. sea-ice, frontal systems), and crabeater seal satellite telemetry.

29. Fur seals and macaroni and chinstrap penguins at Seal Island were instrumented with radio transmitters and time/depth recorders and followed during foraging trips to sea. This collaborative work was conducted aboard the Japanese research vessel *Kaiyo Maru* (in January) and the Chilean research vessel *Alcazar* (in February). Complementary observations of the distribution of prey were obtained with acoustic equipment and plankton nets.

30. At Palmer Station, parameters A5, A6a and c, A7, A8 and A9 were monitored for Adélie penguins. A Long-Term Ecological Research (LTER) project, soon to be initiated at this station, will investigate the interactions between oceanographic features, predators (including Adélie penguins and skuas) and prey (krill and *Pleuragramma antarcticum*). This project is expected to generate an entire suite of new predator parameters.

31. Two 30-day cruises were conducted aboard the NOAA Ship *Surveyor* from mid-January to mid-March, 1991. Chlorophyll-*a* concentrations, primary production rates, organic carbon concentrations, phytoplankton species compositions, nutrient concentrations, and solar irradiance were measured and mapped around Elephant, King George, and Clarence Islands. In addition, the distribution and abundance of krill were measured with acoustic instrumentation.

32. Anticipated field work in 1991/92 will include penguin and fur seal monitoring at Seal Island and at Palmer Station. Shipboard surveys of hydrographic conditions, phytoplankton production, krill distribution and abundance, and krill demography will be conducted around Elephant Island. Other studies may include detailed mapping of selected krill aggregations and a census of fur seal and seabird colonies in the South Shetland Islands.

APPENDIX E

TEMPORAL AND SPATIAL SCALES FOR MONITORING CEMP PREDATOR PARAMETERS (WG-CEMP)

Summary of temporal and spatial scales relevant to monitoring
of land-based predators, using approved Standard Methods
in each of the Integrated Study Regions.
Updated at the 1991 meeting of WG-CEMP.

Parameter[1]	Integrated Study Region	Species	Time of Year of Measurement[2]	Duration of Measurement[3]	Integration Period[4]	Foraging Range/Area[5] (km)	Foraging Depth Mean (m)	Foraging Depth Max (m)	Comments
A1 Adult Arrival Weight	Prydz Bay	Adelie	15-30 October	20 days	6-7 months	100s	30	175	
	Antarctic Peninsula	Adelie (A*)	1 Oct - 30 Oct	20 days	6-7 months	100s	30-50	~ 100	
		(B**)	20 Oct	1 day	6-7 months	100s	30-50	~ 100	
		Chinstrap (A)	23 Oct - 12 Nov	20 days	6-7 months	100s	40	120	
		(B)	~ 2 Nov	1 day	6-7 months	100s	40	120	
		Macaroni (A)	15 Oct - 5 Nov (M) 22 Oct - 11 Nov (F)	20 days	6-7 months	100s	40 ~ 100		
		(B)	~ 20 Oct (M) ~ 8 Oct (F)	1 day	6-7 months	100s	40 ~ 100		
	South Georgia	Macaroni (A)	14 Oct - ~ 5 Nov	1 day each	6-7 months	100s	20-30	150	
		(B)	~ 28 Oct ~ 8 Nov						
A2 Duration of First Incubation Shift	Prydz Bay	Adelie	Nov - Dec	8-20 days	7-8 months	~ 100-150	30	175	
	Antarctic Peninsula	Adelie	20 Oct - 15 Nov	8-20 days	7-8 months	~ 100	30-50	~ 100	
		Chinstrap	20 Nov - 5 Dec	5-10 days	7-8 months	25-50	40	120	
		Macaroni	15 Nov - 5 Dec (M) 1 Dec - 20 Dec (F)	~ 15 days	7-8 months	25-50	40 ~ 100		
	South Georgia	Macaroni	23 Nov - 6 Dec	9-12 days	7-8 months	50-100?	20-30	150	

Parameter[1]		Integrated Study Region	Species	Time of Year of Measurement[2]	Duration of Measurement[3]	Integration Period[4]	Foraging Range/Area[5] (km)	Foraging Depth Mean (m)	Foraging Depth Max (m)	Comments
A3	Breeding Population Size	Prydz Bay	Adelie	22 Oct - 15 Nov	1 week	> 1 year	100s	30	175	
		Antarctic Peninsula	Adelie	27 Oct - 15 Nov	1 day	> 1 year	100s	30-50	~ 100	
			Chinstrap	15 Nov - 5 Dec	1 day	> 1 year	100s	40	120	
			Macaroni	15 Nov - 5 Dec	1 day	> 1 year	100s	40	~ 100	
			Gentoo							
		South Georgia	Macaroni	~ 30 Nov	1 day	> 1 year	100s	20-30	150	
			Gentoo							
A4	Age Specific Survival	Prydz Bay	Adelie					30	175	
		Antarctic Peninsula	Adelie							
			(A)	15 Oct - 15 Nov	2 months	1 year	100s	30-50	~ 100	
			(B)	15 Oct - 5 Feb	4.5 months	1 year	100s	30-50	~ 100	
			Chinstrap							
			(A)	23 Oct - 5 Dec	2.5 months	1 year	100s	40	120	
			(B)	23 Oct - 2 Feb	4.5 months	1 year	100s	40	120	
			Macaroni							
			(A)	15 Oct - 5 Dec	2 months	1 year	100s	40 ~ 100		
			(B)	15 Oct - 15 Feb	4 months	1 year	100s	40 ~ 100		
			Gentoo							
		South Georgia	Macaroni	14 Oct - Feb	3-4 months	1 year	100s	20-30	150	
			Gentoo							

Parameter[1]	Integrated Study Region	Species	Time of Year of Measurement[2]	Duration of Measurement[3]	Integration Period[4]	Foraging Range/Area[5] (km)	Foraging Depth Mean (m)	Foraging Depth Max (m)	Comments
A5 Foraging Trip Duration	Prydz Bay	Adelie	December - February	2 months	2 months	50	30	175	
	Antarctic Peninsula	Adelie	10 Dec - 5 Feb	2.5 months	2.5 months	50	30-50	~ 100	
		Chinstrap	1 Jan - 15 Feb	2 months	2 months	25	40	120	
		Macaroni	1 Jan - 15 Feb	2 months	2 months	35	40 ~ 100		
	South Georgia	Macaroni	January - February	2 months	2 months	50	20-30	150	
A6 Breeding Success	Prydz Bay	Adelie	October - February	2 months	~ 4 months	100s	30	175	
	Antarctic Peninsula	Adelie (A)	25 Dec - 7 Jan	1 day	1 year	100s	?	?	
		(B)	20 Oct - 15 Jan	2 months	2 months	100s	?	?	
		(C)	20 Oct - 15 Jan	2 months	2 months	100s	?	?	
		Chinstrap (A)	15 - 21 Jan	1 day	1 year	100s	40	120	
		(B)	15 Nov - 1 Feb	2 months	2.5 months	25	40	120	
		(C)	15 Nov - 1 Feb	2 months	2.5 months	25	40	120	
		Macaroni (A)	10 Jan - 30 Jan	1 day	1 year	100s	40 ~ 100		
		(B)	15 Nov - 30 Jan	2 months	2.5 months	35	40 ~ 100		
		(C)	15 Nov - 30 Jan	2 months	2.5 months	35	40 ~ 100		
		Gentoo							
	South Georgia	Macaroni (C)	~ 16 Feb	1 day	3 months	50 - 100	20-30	150	
		Gentoo							

Parameter[1]		Integrated Study Region	Species	Time of Year of Measurement[2]	Duration of Measurement[3]	Integration Period[4]	Foraging Range/Area[5] (km)	Foraging Depth Mean (m)	Foraging Depth Max (m)	Comments
A7	Chick Fledging Weight	Prydz Bay	Adelie	February	3-4 weeks	2 months	50	30	175	
		Antarctic Peninsula	Adelie (A)	15 Jan - 10 Feb	25 days	2 months	50	30-50	~ 100	
			(B)	~ 30 Jan	1 day	2 months	50	30-50	~ 100	
			Chinstrap (A)	1 Feb - 28 Feb	25 days	2 months	25	40	120	
			(B)	10 Feb - 25 Feb	1 day	2 months	25	40	120	
			Macaroni (A)	10 - 20 Feb	25 days	2 months	35	40 ~ 100		
			(B)	~ 14 Feb	1 day	2 months	35	40 ~ 100		
			Gentoo							
		South Georgia	Macaroni	~18 Feb	1 day	2 months	50	20-30	150	
			Gentoo							
A8	Chick Diet	Prydz Bay	Adelie	Jan - Feb	2 months	2 months	50	30	175	
		Antarctic Peninsula	Adelie (A,B)	10 Dec - 30 Jan	2 months	2 months	50	30-50	~ 100	
			Chinstrap (A,B)	1 Jan - 15 Feb	2 months	2 months	25	40	120	
			Macaroni (A,B)	1 Jan - 15 Feb	2 months	2 months	35	40 ~ 100		
		South Georgia	Macaroni	25 Jan - 15 Feb	1.5 months	1 month	50	20-30	150	

Parameter[1]		Integrated Study Region	Species	Time of Year of Measurement[2]	Duration of Measurement[3]	Integration Period[4]	Foraging Range/Area[5] (km)	Foraging Depth Mean (m)	Foraging Depth Max (m)	Comments
B1	Breeding Population Size	South Georgia	Black-browed albatross	19 Oct - 11 Nov	1 month	> 1 year	100s - 1 000s			
B2	Breeding Success	South Georgia	Black-browed albatross	19 Oct - 9 May	7 months	7 months	100s			
B3	Age-Specific Annual Survival	South Georgia	Black-browed albatross	19 Oct - 11 Nov	1 month	1 year	100s - 1000s			
C1	Foraging Trip Duration	Antarctic Peninsula	Fur seal (A,B)	1 Dec - 10 Feb	60-70 days	60-70 days	25-250	25	120	
		South Georgia	Fur seal (A,B)	~ 5 Nov - ~ 20 March	80 - 100 days	80 - 100 days	20 - 100	30	150	
C2	Pup Growth	Antarctic Peninsula	Fur seal (A)	1 Dec - 30 Mar	120 days	120 days	25-250	25	120	
			(B)	10 Jan - 30 Mar	80 days	80 days	25-250	25	120	
		South Georgia	Fur seal (A)	~ 5 Dec - 30 Mar	110 days	110 days	20 - 100	30	150	
			(B)	~ 5 Jan - 5 Mar	60 days	60 days	20 - 100	30	150	

1 Use separate sheet for each parameter

2 Calendar date of start and finish

3 In days, months etc

4 Timespan over which parameter potentially integrates prey abundance/availability

5 Foraging range at the time of measuring parameter

* General Procedure A

** General Procedure B