REPORT OF THE JOINT MEETING OF THE WORKING GROUP ON KRILL AND THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM

(Cape Town, South Africa, 27 July to 2 August 1994)

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INTRODUCTION

1.1 The second Joint Meeting of the Working Group on Krill (WG-Krill) and the Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP) was held at the Breakwater Lodge, Cape Town, South Africa, between 27 July and 2 August 1994, and was chaired by the Chairman of the Scientific Committee, Dr K.-H. Kock.

MEETING OBJECTIVES

2.1 The Chairman outlined the meeting objectives:

> The Joint Meeting has as its primary objective the facilitation of interaction between WG-Krill and WG-CEMP on matters of common concern. This should be primarily directed at the development of an ecosystem approach to management (SC-CAMLR-XII, paragraph 15.4). Specific items identified by the Scientific Committee for consideration include:
>
> - the development of appropriate proposals for models to evaluate the statistical performance and cost-effectiveness of possible experimental harvesting regimes designed to distinguish between natural variation in predator performance and effects due to fishing (SC-CAMLR-XI, paragraph 6.10);
>
> - the review of the scope of CEMP monitoring with respect to species (both predators and prey) being monitored (SC-CAMLR-XII, paragraphs 8.13 and 8.14);
>
> - the presentation of (i) fine-scale data from fisheries within 50 and 100 km of CEMP sites, (ii) indices of krill availability to the fishery, product quality and catch length composition, and (iii) indices of krill cohort strength and recruitment derived from length frequency data (SC-CAMLR-XII, Annex 6, paragraphs 5.33 and 5.34) in such a way as to indicate the extent to which reliable indices are actually, or potentially, available (SC-CAMLR-XII, paragraph 8.22);

- making progress on linking predator-derived indices to conventional management approaches being applied to the krill fishery (SC-CAMLR-XII, paragraph 8.29); and

- discussion of the implications of existing and projected analyses of models addressing functional relationships between krill, predators and fishery (SC-CAMLR-XII, paragraph 8.41).

2.2 The Agenda was discussed and proposals were made for amendments. Sub-item 2(iii), dealing with fisheries activities, was included. A presentation by the Convener of CEMP was included as sub-item 3(ii). With these amendments the Agenda was adopted.

2.3 The Agenda is included in this report as Appendix A, the List of Participants as Appendix B and the List of Documents submitted to the meeting as Appendix C.

2.4 The report was prepared by Drs D. Agnew (Secretariat), I. Boyd (UK), Prof. D. Butterworth (South Africa), Drs J. Croxall (UK), R. Holt (USA), T. Ichii (Japan), V. Marín (Chile), S. Nicol (Australia), E. Sabourenkov (Secretariat) and V. Siegel (Germany).

2.5 Fisheries activities were summarised by the Chairman. The total krill catch in the season 1993/94 was 82 600 tonnes and was concentrated in Statistical Area 48. The fishing pattern had been similar to previous seasons; a winter fishery took place in Subarea 48.3 and moved to Subareas 48.1 and 48.2 in summer. The fishery in Subarea 48.1 took place later in the summer, with highest catches taken in March/April. Only about 1 000 tonnes were taken in the Indian Ocean (Division 58.4.1), all by Japan.

PREY MONITORING

Data Collection Procedures

3.1 Prey monitoring undertaken using acoustics and net sampling was reviewed.

3.2 Considerable progress has been made in recent years with the development and validation of acoustic techniques. Individual or groups of targets can now be discriminated on a fine scale, and estimates of target strength have been refined. The latter may be obtained from (i) dense aggregations by echo integration followed by trawl haul to determine density, or (ii) dispersed aggregations by direct *in situ* measurement using dual- or split-beam echo sounders. In both cases net sampling is necessary for precise target identification and measurement of length distribution.

Behavioural effects associated with net sampling, e.g., avoidance, must be considered. Another problem still to be resolved is the acoustic estimation of krill near the surface.

3.3 Acoustic differentiation of krill and salps is possible in some cases by measurement at two distinct frequencies. The most commonly used single frequency is 120 kHz and this is often supplemented by measurement at 38 or 200 kHz.

3.4 Much work has been undertaken on the design of acoustic surveys. The appropriate design depends on a survey's purpose. A number of example designs have been set out in the Report of the Subgroup on Survey Design (SC-CAMLR-X, Annex 5, Appendix D). In addition, the matter has been investigated intersessionally by WG-Krill in accordance with SC-CAMLR-XII, paragraph 2.41. A major discussion topic is the relative merits of spacing transects uniformly, which maximises spatial information, as opposed to random spacing which is required for the calculation of the variance of a biomass estimate using classical statistics.

3.5 A review of world-wide studies relevant to the topic of birds as indicators of change in marine prey stocks was tabled as WG-Joint-94/13. Many aspects of this review are relevant to CCAMLR, and especially CEMP, approaches to this subject.

3.6 Results of studies by French scientists around the Kerguelen Islands (Division 58.5.1) showed good correspondence between the abundance and certain characteristics of zooplankton (mainly *Euphausia vallentini* and *Themisto gaudichaudii*) in gentoo penguin diet and in simultaneous net hauls (WG-Joint-94/11).

3.7 It was pointed out that none of the above techniques addressed the problem of collecting data on krill distribution and abundance in ice-covered areas.

Review of Available Data

Krill Biomass Estimates in the Integrated Study Regions (ISRs)

3.8 The latest information concerning the biomass estimates of krill from within ISRs is contained in the WG-Krill report (Annex 5, paragraphs 4.45 to 4.50).

3.9 In considering the availability of krill biomass estimates within ISRs, the meeting noted that boundaries for each of the three ISRs enclosed a large area. The boundaries of each ISR were originally drawn to indicate the regional areas of importance to CEMP. They were chosen *inter alia* as regions where the harvest of krill had taken place, krill surveys had been undertaken, and which were presumed to encompass important foraging areas of the predators to be monitored (see SC-CAMLR-V, Annex 6, paragraphs 11 and 12).

3.10 The meeting accepted that these boundaries were useful in the above context, but in doing so emphasised that it may not be necessary to conduct krill surveys over the whole of these regions.

3.11 The meeting noted that the application of new technology, e.g., satellite tracking and the use of time/depth recorders, has and will provide a better understanding of the foraging ranges and patterns of krill predators. This in turn should allow better definition of areas where krill surveys are required in the future, based upon the foraging areas of predators.

Fine-scale Catch Data

3.12 Fine-scale catch data for the 1992/93 season were presented in WG-Krill-94/6. The pattern of winter fishing at South Georgia followed by late summer fishing around the Peninsula was similar to that observed in previous years. It was noted that catches had been taken outside the Convention Area (in Division 41.3.2) and that these had initially been reported on STATLANT forms as having been taken in Subarea 48.1.

3.13 It was pointed out that there was a fairly consistent increase in the percentage of the krill catch taken after March in Subarea 48.1 over a 10-year period. This was caused by fishing vessels starting later and staying longer in the area. Both Chile and Japan indicated that the late start was due to operational reasons.

Fine-scale Surveys

3.14 It was noted that carefully integrated studies of krill surveys and predator foraging were being undertaken annually by the USA (WG-CEMP-94/37) near Seal Island (Antarctic Peninsula ISR) and by the UK within the South Georgia ISR.

3.15 Additional krill biomass data from ISRs in Prydz Bay (WG-Krill-94/21 and 34) and the South Shetlands (WG-Joint-94/9) were presented. In neither of these areas did the surveys cover the whole ISR. The group warned of the problems of comparing biomass estimates from different-sized areas; krill density was deemed to be more appropriate for such comparisons.

3.16 In Prydz Bay, bias in acoustic estimates of biomass and distribution of *Euphausia superba* could arise from the co-occurrence of *E. crystallorophias*. However, it is likely that the two euphausiid species can be differentiated by spatial separation, samples from net hauls and different acoustic signatures on the echo-trace. Complete differentiation between these species may not be necessary for some purposes because some predators tend to eat both species.

3.17 Paper WG-Joint-94/9 reported that the mean density of krill around Elephant Island had not changed markedly over four surveys in 1993/94, but that the distribution of krill around the island showed great variation. More importantly, the average density of krill was five times lower than the densities in the preceding four years. It was concluded that methodological variation was not responsible for the annual changes in density. In addition to low densities, a skewed age structure with a lack of young krill was observed.

3.18 In addition to the results presented in WG-Joint-94/9, it was known that surveys had been carried out by the UK around South Georgia and the South Orkneys, by South Africa around South Georgia, and by Argentina around South Georgia. Analyses of the results of these cruises were still being undertaken. The group hoped that these analyses would be presented at the next meeting.

PREDATOR MONITORING

3.19 The Convener of WG-CEMP provided a brief overview of predator monitoring being undertaken within CEMP. The main function of predator monitoring is to provide the Scientific Committee with information on dependent species within the ecosystem. To achieve this, predators, prey and environmental conditions are being studied. In particular, changes in predator performance are to be considered in light of prey and environmental changes.

3.20 Two types of work are carried out under CEMP. Firstly, directed research produces data on, for instance, predator behaviour at sea, foraging behaviour and bio-energetics. Secondly, monitoring of a number of variables, such as reproductive performance and environmental conditions produces comparable longterm data sets from different sites for a suite of predators consuming krill, *Pleuragramma antarcticum* and *E. crystallorophias*. Four sites in three ISRs have been the source of data over a period of five years.

3.21 Protocols for the collection and submission of CEMP data have been set up and predator indices are calculated annually by the Secretariat. Special attention is being given to the potential impact of local fisheries and functional relationships between krill availability and predator performance.

3.22 It was noted that investigating the location and timing of likely predator/prey interactions was important. Predator indices operating over restricted time and space scales, such as foraging duration, provide valuable information about sensitivity of predators to prey availability and environmental conditions. In addition, there is an important link between vertical distribution of krill and diving depths of predators.

3.23 Within CEMP certain types of environmental data, relating to weather conditions at monitoring sites and to the location of ice at sea near these sites, are collected using standard methods. No proposals have yet been made for the collection of any other physical or biological environmental data (e.g., that may relate to the distribution, abundance and availability of prey).

ECOSYSTEM INTERACTIONS

Distribution of Krill Fishing and Predators

4.1 Paper WG-Joint-94/17 presented a revised assessment of the impact of the krill fishery on penguins in Subarea 48.1 (WG-Krill-93/7) based on Japanese 'finer scale' catch data (10 x 10 n miles). The paper took into account the detailed spatial distribution of the fishery, likely foraging areas and foraging depths of predators and available information on krill biomass, current fields and sea-ice distribution in the South Shetland region. The authors concluded that the present fishery is unlikely to have an adverse impact on the penguin populations for the following reasons:

(i) the spatial overlap between the main fishing and foraging areas is low;

(ii) the overlap between trawling depth and foraging dive depth of penguins was also not substantial;

(iii) a difference between size distribution of krill caught by trawlers and penguins was observed; and

(iv) the current catch by the krill fishery is very low compared with the local krill biomass.

4.2 The group welcomed this analysis which represented the most detailed attempt so far to investigate interactions between penguins, fisheries and krill at this particularly appropriate scale.

4.3 However, a number of reservations were expressed concerning aspects of the approach and interpretation in WG-Joint-94/17:

(i) any analysis of spatial and temporal overlap between predators, krill and fisheries that does not incorporate the known or potential effects of krill flux cannot resolve the true nature of the impact of krill fisheries on predators. In this context, it was noted that extensive empirical data on currents, additional to those used in WG-Joint-94/17, exist for the Bransfield Strait/South Shetland Islands area;

(ii) it had already been noted that the data on penguin diving depths used in WG-Joint-94/17 were not necessarily spatially concurrent with the krill data (SC-CAMLR-XII, Annex 6, paragraphs 6.11 and 6.12). In any case, any assessment of vertical differences between foraging strata of penguins and trawler fishing depth needs to recognise that diel vertical movements of krill may result in penguins and fisheries simply exploiting the same swarm of krill, even if at different depths and times; and

(iii) the feeding studies presented suggested that the trawl fishery was capable of taking all size classes of krill eaten by penguins. The topic of size, sex and maturity stage selectivity of krill taken by penguins and fisheries was an important one for further investigation.

4.4 The group agreed that pursuing the question of the interaction of predators and the fishery was of great importance to CCAMLR. This question can be considered at many different scales, from whole subarea population interactions to individual foraging interactions, and it was agreed that research at all scales would be important.

4.5 However, it was agreed that it was equally important that collection of any data should be accompanied by theoretical work establishing how such data could be used in management. In particular, given that interpretations of present data (e.g., arising from WG-Joint-94/17) in regard to the impact of the fishery on predators are ambiguous, it was essential that future recommendations by the group for data collection should be evaluated to determine what additional observations are required to resolve the ambiguities.

4.6 At larger scales, the group encouraged continuation of modelling studies such as WG-CEMP-94/10 and 30 which examined the combined effects of fishing and krill flux on krill density in predator foraging areas (see paragraphs 4.37 to 4.39 for further discussion). It was noted that further breakdown of flux calculations at finer scales more relevant for predators may be required.

4.7 In considering this, the group acknowledged that there was considerable work still to be done in refining the estimates of krill flux at the scales currently being used, and in acquiring new data sets (Annex 5, paragraph 4.13). It was agreed that in the course of this work it was likely that a number of data sets applicable to calculation of krill flux at finer scales would become available, and, as appropriate, fine-scale investigation of flux could be made.

4.8 At smaller scales, it was suggested that studies of predator foraging should be continued to investigate detailed behavioural interactions between krill predators and their prey. In this context it was noted that three-dimensional descriptions of the prey field as presented in WG-Joint-94/12 were an innovative method of assessing krill availability to penguins.

4.9 Such studies within CEMP may contribute to the development of quantitative expressions of predator/prey interactions (see e.g., WG-CEMP-94/12) through refinement of appropriate models of functional relationships and through the development of indices of predator performance. In order for such studies to be most useful, observations of predator foraging and prey distribution should be obtained at the same place and time.

4.10 The Data Manager reminded the meeting that for the last few years the Secretariat has been asked to report the catches of krill within a 'critical foraging period-distance', defined as being within 100 km of predator colonies over the period December to March. Following the discussions at the 1993 meetings of WG-CEMP and WG-Krill, the Secretariat has taken this work forward to develop a calculation of a generalised index of predator - fishery overlap (WG-Joint-94/8). This work is in a preliminary stage, but is formulated such that predator demand in any defined area can be calculated, given species-specific foraging characteristics and energetic demands, and used together with catch data to calculate an index of the overlap between predators and the fishery taking account of the functional interaction between the two rather than the arbitrary calculations which are currently performed.

4.11 The group welcomed this initiative. It was considered, however, that the work on interaction between predators and the fisheries, as investigated in both WG-Joint-94/8 and 17, had been taken as far as possible for the moment. Further work on updating these analyses was encouraged but not considered to be a priority at this time.

4.12 In the light of these discussions, the Secretariat was requested to continue to calculate the catch of krill taken in the critical period-distance rather than provide further refinements to the model described in WG-Joint-94/8.

4.13 Given the importance that the group attached to this topic, and the comments and ongoing work outlined in paragraphs 4.3 to 4.9, it was recommended that a discussion on the full implications of these studies be held at a future meeting.

Potential Effect of Precautionary Measures

4.14 In 1992 the Scientific Committee requested the Data Manager to develop a model which would examine the effects of various management strategies on the krill fishery in Subarea 48.1. This model was presented last year as WG-Krill-93/14. As a result of comments by both WG-Krill and WG-CEMP in 1993 the model had been further developed to increase model realism and was presented to this meeting as WG-Joint-94/4.

4.15 The model now uses catch and effort data from both the Chilean and Japanese fleets to estimate the probability of encountering a fishable swarm. This probability is applied to data on fishing duration, fleet size and CPUE to calculate an estimated total catch in each of a number of fine-scale squares. The estimated numbers of penguins foraging in each of these squares is used to calculate a 'disturbance index'. The success of management scenarios is assessed according to their ability to minimise the disturbance index whilst maximising catch. The most successful scenario studied was found to be one which restricted fishing within 75 km of breeding penguins during January and February. This resulted in a 90% reduction in overlap with foraging predators and a 15 to 20% reduction in catch.

4.16 These developments in the model were welcomed by the group. Although a number of parameters are probably poorly estimated (for instance the form of the encounter probability), and the criteria for assessing performance are difficult to define, the overall structure of the model appears appropriate for estimating the impact of management measures on an established fishery. However, there were some concerns about the relationship of the model to the operational requirements of fishing.

4.17 The group recommended that further development of the model by the Secretariat was unnecessary at this stage, but encouraged interested parties to proceed with validation of the model and come forward with proposals for parameter re-definitions. For instance, the incorporation of fisheries independent information to refine some of the parameters was suggested. Development of alternative models was also encouraged.

Krill/Predator Functional Relationships

4.18 The Chairman drew the attention of the meeting to paragraphs 5.12 to 5.21 of the 1993 report of WG-Krill (SC-CAMLR-XII, Annex 4), paragraphs 7.11 to 7.39 of the 1993 report of WG-CEMP (SC-CAMLR-XII, Annex 6) and paragraphs 2.54 to 2.57 of the 1993 report of the Scientific Committee (SC-CAMLR-XII). These referred to the need for more information about the effects of krill fishing on predator populations. Attention was drawn to papers WG-Krill-94/24 and 93/43 which describe ongoing developments of a modelling approach to address this question.

4.19 Dr Butterworth explained the fundamental features of the model described in WG-Krill-94/24, emphasising the general and preliminary nature of the approach and that it would not be in the interests of the progressive development of the model to introduce too much complexity at this early stage. He reminded the meeting that an important finding of WG-Krill-93/43, reported last year, was that natural fluctuations in krill biomass make predator populations less resilient to krill fishing than deterministic evaluations would suggest.

4.20 WG-Krill-94/24 extended this work by attempting to estimate the parameters of functional relationships by using mean, variance and skewness of the observed distributions of predator survival rates and by incorporation of a term to relate these rates to the availability of krill rather than their abundance over a large area. The statistic developed to indicate the impact of krill fishing on the predator population under the model was expressed as the intensity of krill fishing which was required in order to halve the average predator population present in the absence of a krill harvest. Intensity of krill fishing was expressed as the fraction of a biomass estimate which could be set for harvest. The results suggested a surprising sensitivity of the predator populations to the harvesting of krill.

4.21 It was clear that the model had not produced realistic results in some cases (e.g., it was indicated that some species were unable to sustain themselves even in the absence of a krill fishery). Contributors of the predator data noted that this was possibly partly due to the values which had been used for juvenile survival in fitting the model. They suggested that better account should be taken of the age-dependence of survival rates where this could be estimated from data. One of the weaknesses of the approach was that the distributions of predator survival rates are not well known; even the most extensive data set, for black-browed albatrosses, contains only 15 values (one for each year), although it was acknowledged that a very substantial and sustained effort has been necessary to collect such a time series. However, it was also acknowledged that the distribution of krill biomass is even less well defined, being based upon model predictions rather than direct observations.

4.22 Even so, there remains a case for concentrating attention, by means of this modelling approach, on the predators which seem likely to show the greatest sensitivity to krill harvesting. The group noted that one of the purposes of the modelling exercise was to focus attention on the specific data needed to refine functional relationships between predator populations and their prey.

4.23 There was some discussion of the mathematical form assumed for the functional relationship between predator survival and krill biomass. There were questions as to how, with the small estimate predicted for interannual variability in krill biomass by the krill dynamics model, it was possible to derive reliable estimates of functional relationships outside this range. It was noted that many different mathematical functions could provide a reasonable representation of the survival rate data over this biomass range, but would nevertheless have very different implications for assessments of predator resilience which depended on extrapolation beyond this range. However, this extrapolation process was somewhat assisted by making further plausible assumptions: for example, that survival rates would tend to be zero for low krill biomass for a predator dependent almost entirely on krill, and would show asymptotic behaviour in the case of large krill biomass. In addition, based purely on broad ecological principles involving predators exploiting patchily-distributed prey, one would expect functional relationships of the type illustrated in WG-Krill-94/24.

4.24 The possibility of examining the functional relationship between predator survival and krill biomass directly, rather than attempting to use distributions predicted from models, was addressed. Unfortunately, although there are sufficient years (up to 20) of predator data to contribute to such an analysis, the available time series of estimates of krill biomass are much shorter (about three years, depending on location), which precludes such a direct approach.

4.25 Further discussion of the problems and technical details of the model was referred to a subgroup. This group examined four key questions: (i) whether survival data for predators had been interpreted correctly; (ii) whether the shapes assumed for the functional relationships were realistic; (iii) whether the method of modelling errors was realistic; and (iv) whether the simple empirical way in which density-dependence was introduced in the model for the predator dynamics was appropriate. The results of these discussions, which were subsequently reported to the Joint Meeting, are set out below.

4.26 It was explained that the first year survival rate values used had been derived from the fledging rates and the pup mortality rates for black-browed albatrosses and Antarctic fur seals respectively. Thereafter, in the absence of anything better, the average adult survival rate had been used even for the juvenile year classes. There are problems when applying this approach to Antarctic fur seals and black-browed albatrosses and this probably explains some of the unrealistic results of the model. Potential solutions to the problem were discussed and it was agreed that further bilateral discussions between the relevant parties would take place intersessionally on this subject.

4.27 There were some concerns regarding the functional relationship between the juvenile survival rate of predators[1] and krill biomass (e.g., WG-Krill-94/24, Figures 2i and 2ii). Dr Butterworth explained that juvenile survival rate would be expected to be a still-increasing function of krill biomass in the region of median krill biomass in the absence of exploitation. As harvesting depletes krill biomass, it is the behaviour of the relationship below rather than above this median value which is important.

4.28 There was further discussion of the shape of the functional relationship. It was agreed that a logistic model for the functional relationship would be most appropriate because it could accommodate a variety of shapes and, in particular, could represent a sharp drop in predator survival with declining krill biomass. Attention was drawn to the need to test robustness of results to a variety of slopes, which could have different implications for estimates of predator resilience to krill fishing.

4.29 The question of modelling errors was discussed briefly. Dr Butterworth outlined the necessity for dealing with errors within the structure of the model, which arises because whenever a model is fitted there will not be exact agreement with the observed data. The group considered that the estimation procedures of WG-Krill-94/24 are probably reasonably sound, and that the greatest variability ('error') would arise in the relationship between krill availability and krill biomass. It was emphasised that having only 15 years or fewer of data for some of the predator species would necessarily result in relatively imprecise estimates and, further, that some of the estimates of predator survival rate had fairly wide confidence intervals. It would be necessary to find some way of incorporating this information into the procedure for estimating the resilience of the predator populations to krill harvesting.

4.30 Finally, the equations used for modelling density-dependence (WG-Krill-94/43, equation 3) were considered. Overall, the meeting believed that this was probably the most appropriate approach as it followed conventional population dynamics models in its broad structure. There was some discussion about the appropriateness of assuming the density-dependent component to be linear. There may be value in examining the robustness of results to both concave and convex forms for this function.

4.31 The problem of the necessary levels of escapement from a krill harvest from a predator perspective was considered (WG-Krill-94/11 and WG-Krill-93/43). It was emphasised that 'escapement' did not mean the biomass of krill available after krill harvest (for possible consumption

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1 'Juvenile survival rate' in this model reflects all processes relating mature females to the number of their female offspring which survive to the end of their first year of life, i.e. pregnancy or laying rate, the fraction of births that are female, and survival over the first 12 months of life.

by predators), but rather the level to which krill would be reduced, under a steady harvest, as a fraction of its average pre-exploitation level.

4.32 The group noted that placing nominal bounds on the acceptable levels of escapement had proved to be useful in developing precautionary measures within fisheries management in the past. Usually this level is taken to be about 0.5 in a single-species fishery context, which ignores dependent and related species in contrast to the dictates of Article II. At the other extreme, the best situation for the predators is clearly provided by a value of 1.0 (i.e., no krill fishing). It was suggested that, as a starting point in the absence of more quantitative assessments of predator responses to different levels of escapement, it may be appropriate to specify a target escapement level of 0.75, being intermediate between the 0.5 and 1.0 'extremes'.

4.33 The group recognised that it was very difficult to determine the levels of escapement required to sustain predator populations without knowledge of the krill biomass available to predators. However, there was no fundamental objection to using an escapement target of 0.75 as a point from which to start making management recommendations; this target value could be revised in future in the light of new information both from the models currently being developed and from predator data.

4.34 The possible effects of prey selectivity by predators on age-dependent natural mortality of krill have been highlighted by WG-Krill (Annex 5, paragraph 4.56). Results in WG-Krill-94/23 suggest that the krill yield estimation model may be particularly sensitive to krill age-dependent mortality (the present model assumes krill natural mortality to be constant with age). Information on prey size selectivity by predators is sought from WG-CEMP.

4.35 This matter was referred to a subgroup for further discussion. This group concluded that, because many of the more important seabird and seal predators of krill chiefly consumed substantial amounts of 2+ year classes of krill, the matter warranted further investigation. As an initial step, some broadly representative krill length frequency data derived from predators would be sent to Drs Butterworth and Thomson (for comparison with the krill dynamics model predictions) by Drs Ichii, Boyd, Croxall, Bengtson, Marín, Trivelpiece and Kerry.

4.36 The meeting then considered other models concerning predator/prey interactions and, in particular, those involving spatial and flux components described in WG-CEMP-94/10 and 30.

4.37 Introducing WG-CEMP-94/30, Dr Holt described the objectives of the preliminary form of this model. The aim is to model the predator-prey system around Elephant Island. The four steps in the development of this model were: (i) to simulate the krill distribution around Elephant Island; (ii) to superimpose foraging of predators from the known foci of predators in the area; (iii) to further superimpose the impact by the krill fishery; and (iv) to simulate the effects of the fishery on predator behaviour. The model will also attempt to incorporate the flux of krill through the area and variability of the location of the ice-edge.

4.38 The group suggested that the interannual variation in krill arising from recruitment variability should be incorporated in the model to provide comparability with outputs from the krill yield model.

4.39 Regarding WG-CEMP-94/10, Dr E. Murphy (Invited Expert) explained that the origins of his model predated the deliberations of WG-Krill about modelling. The model describes a single through-flow system with flux of krill past a predator breeding colony. Distance-impact relationships are derived using variable krill transport rates into the area and retention times within the area. The model also investigates the dynamics of predator-prey interactions by addressing the effect of flux within disturbed systems. An important conclusion of the model is that coastal effects produce aggregation of krill swarms and this results in greater spatial and temporal variability within the system. Relatively small variability in oceanic krill stocks can build up to large levels locally in inshore regions.

4.40 The group commented that this was a good example of a model which incorporates prey flux and interactions with predator populations.

ECOSYSTEM ASSESSMENT

5.1 The Convener of WG-CEMP introduced this item by noting that WG-CEMP's tasks under the ecosystem assessment agenda item as directed by the Commission (CCAMLR-IX, paragraph 4.34) and Scientific Committee (SC-CAMLR-XI, paragraphs 5.4, 5.39 and 8.6) are:

- to determine annually the magnitude, direction and significance of trends in each of the predator populations being monitored;

- to evaluate annually these data by species, site and region;

- to consider conclusions in the light of relevant information on prey and the environment; and

- to formulate appropriate advice to the Scientific Committee.

5.2 Since 1992 WG-CEMP has been considering ways to undertake this assessment by:

(i) reviewing background information available to the Working Group in submitted papers; and

(ii) reviewing together predator, prey, environment and fishery data, and especially those data in the CEMP database.

5.3 The assessments made in 1992 (SC-CAMLR-XI, Annex 7, Table 5) were chiefly qualitative in nature, although many parts of the assessment of predator data were based on quantitative data from the CEMP database.

5.4 In 1993 WG-CEMP had repeated this process (SC-CAMLR-XII, Annex 6, Table 5) noting, however, the limitations of continuing to make somewhat subjective assessments for predators and an inability reliably to make even subjective assessments for all prey and most environmental data. WG-CEMP had therefore requested that WG-Krill consider the best potential indices for assessing prey data and that the whole issue also be discussed at the Joint Meeting (SC-CAMLR-XII, Annex 6, paragraph 6.40). To facilitate this process, some specific questions had been formulated (SC-CAMLR-XII, Annex 6, paragraph 5.33).

5.5 In 1993 the Scientific Committee:

(i) endorsed the view that WG-CEMP should, at least for the predator data, move to objective assessments based on analysis of the quantitative data available within the CEMP database;

(ii) noted the continuing lack of data on krill biomass within ISRs and especially in the vicinity of CEMP sites, which was hampering interannual comparisons, including those with the predator data; and

(iii) re-emphasised the need to make progress with linking the predator-derived indices to the more conventional management approaches being applied to the krill fishery. It requested that this should receive further consideration at the present Joint Meeting.

5.6 WG-CEMP in 1993 noted that it had developed a set of annual indices of predator parameters with which to monitor different aspects of predator performance. In order to combine and evaluate information from predators, prey and environmental conditions, it felt that increased attention needed to be focused on developing a series of prey indices (SC-CAMLR-XII, Annex 6, paragraph 5.30). In addition to relevant prey data from fishery-independent surveys, the annual provision of fine-scale data from the fishery, such as catch locations, CPUE and krill length frequency within ISRs, and especially in the vicinity of CEMP sites, could be very valuable in assisting these evaluations (SC-CAMLR-XII, Annex 6, paragraphs 5.31 and 5.32).

Development of Prey, Fishery and Environmental Indices

5.7 In addressing the questions posed by WG-CEMP in SC-CAMLR-XII, Annex 6, paragraph 5.33, the Joint Meeting responded as noted below.

5.8 Fine-scale fishery catch data within ISRs and/or in the vicinity of CEMP sites are summarised this year in WG-Krill-94/6. For Subarea 48.1, all data are available back to 1988 and Japan has recently submitted all its catch data for this subarea since 1980. Fine-scale effort data on all catches, except those made by Japan, are contained in the CCAMLR database.

5.9 Fine-scale catch and effort data are still needed for Subareas 48.2 and 48.3; the latter is a particular priority as it contains a CEMP ISR. Data from the fisheries of the former Soviet Union would be especially valuable in this respect and the group noted the procedure endorsed by the Scientific Committee to obtain such data (SC-CAMLR-XII, paragraph 2.87).

5.10 The derivation of reliable information on krill availability to the fishery and on krill product quality was still under active discussion within WG-Krill (SC-CAMLR-XII, Annex 6, paragraph 5.33(ii)).

5.11 The CCAMLR database has few krill length frequency data; some of these are summarised in WG-Krill-94/4.

5.12 Information on the between-year variability of krill year class strength and recruitment between 1975 and 1994, based on data from German expeditions and US AMLR cruises in the Elephant Island area, has been developed and validated (WG-Krill-94/22). The recruitment index described in WG-Krill-94/22 is based on the relative abundance of 1+ year classes. The indices derived are likely to be applicable throughout Subareas 48.1 and 48.2 but their validity for application to Subarea 48.3 needs investigation.

5.13 The group noted that reliable krill recruitment indices can be obtained from fishery-independent surveys only. Assessment of the proportional recruitment of 2+ year classes (perhaps the category of greatest relevance to most seabird and seal predators) on an ordinal scale might be feasible from fishery data.

5.14 As far as potential environmental indices were concerned, beyond those for sea-ice currently being developed by the Secretariat in conjunction with WG-CEMP, the meeting was unable to make additional specific suggestions (see paragraph 3.23). It noted, however, that data of considerable potential relevance might be forthcoming from future satellite remote sensing activities. Nevertheless, many of these data would probably require considerable validation and careful evaluation before they could provide useful indices for CEMP purposes.

5.15 In respect of the requirements for fishery-derived indices as indicated by WG-CEMP in SC-CAMLR-XII, Annex 6, paragraph 5.34, it was felt that in general there were few possibilities for deriving useful indices, beyond those from catch statistics. Although it was feasible to provide various CPUE indices, with confidence limits, it was unlikely that such values would accurately reflect changes in krill abundance/availability. It was possible, however, that some expressions of CPUE, such as catch-per-towing-time, may be useful to provide information about local concentrations/distributions of krill (e.g., WG-Krill-94/14). Nevertheless, it was felt that it is not possible to use CPUE calculated from the data currently collected as one of the indices for assessment of prey abundance/availability in the context of comparisons with the predator indices derived from CEMP.

5.16 The above assessments of the status and utility of prey indices derived from the fishery mean that, at least in the near future, the provision of prey indices relevant to the CEMP Program will depend extensively on fishery-independent information.

5.17 At present, therefore, data on prey in the vicinity of CEMP sites and/or within ISRs relevant to the types of prey indices outlined at the early meetings of CEMP (SC-CAMLR-VI, Annex 4, Table 5) are still of limited availability.

5.18 It was recalled that, although it was never expected that detailed prey data would be available for all CEMP sites, obtaining such data near at least some sites in the ISRs had been viewed as essential for understanding how predator parameters in general might respond to changes in prey availability and environmental conditions.

5.19 The need to consider the relative value of several annual surveys in restricted areas versus less frequent coordinated surveys of large areas was discussed. It was noted, however, that each of these types of survey was designed to produce very different data, although both were of great relevance to CCAMLR management objectives.

5.20 As far as the CEMP prey monitoring surveys were concerned, a minimum current requirement was for annual surveys of at least one area within each ISR.

5.21 Within ISRs and/or in the vicinity of the main sites providing data to CEMP, a series of relevant annual data is currently only available from the Elephant Island area (vicinity of Seal Island CEMP site). Although some relevant data are available for the South Georgia ISR (including the vicinity of Bird Island CEMP site) and the Prydz Bay ISR, the data are more difficult to relate directly to CEMP activities.

5.22 This suggests that there may be greater difficulties than originally envisaged in trying to integrate data for predator, prey and environment in order to evaluate changes in predators in relation to changes in prey and environment.

5.23 The group therefore felt that it was necessary to review this whole topic at its next meeting. In particular, it would be necessary to address questions of whether it is best to proceed in future by:

(i) trying to increase the number and frequency of prey surveys in ISRs and to facilitate the acquisition of complementary environmental data;

(ii) defining and developing more appropriate prey indices;

(iii) developing a suite of different approaches to management measures involving predator/prey interactions, which do not necessarily require the close linkage of data from predators, prey and environment in the same way as hitherto attempted; or

(iv) some combination of the three approaches above.

5.24 In order to improve the development of an ecosystem-based management approach, the Joint Meeting agreed that it is necessary to improve current understanding of both the structure and dynamic functioning, including temporal and spatial variability, of the Antarctic marine ecosystem.

5.25 Therefore, Members were urged to submit proposals aimed at identifying variables most likely to indicate trends in important ecosystem components, especially for prey, hydrography and weather, at various spatial (e.g., areas/subareas, ISRs, fishing grounds) and temporal (e.g., interannual, intraseasonal) scales.

5.26 The Joint Meeting noted WG-CEMP's past progress in addressing this issue specifically for predators (SC-CAMLR-VI, Annex 4, Table 5; SC-CAMLR-XII, Annex 6, paragraphs 5.33, 5.34 and Table 5) and agreed that this offered some useful examples from which to proceed.

Integrating Predator, Prey, Environmental and Fishery Indices into Ecosystem Assessments

5.27 In addition to the initiatives set in train in paragraphs 5.10 to 5.25, progress on this topic was reported by WG-CEMP (Annex 6, section 7) and WG-Krill (Annex 5, paragraphs 3.21 to 3.28).

CEMP Experimental Approaches (Experimental Fishing Regimes)

5.28 The suggestion of a need to establish an experimental fishing regime to investigate cause/effect relationships between potential fisheries impact and predator performance was formulated most recently and explicitly at the Joint Meeting in 1992 (SC-CAMLR-XI, Annex 8, paragraph 9).

5.29 Desirable though such activities might be, it was noted that they could not proceed without formalising the precise objectives of the experiment and evaluating its feasibility thoroughly. Members had been requested to undertake such tasks, but no proposals or evaluations had been forthcoming.

5.30 It was noted that continuing to measure and evaluate annual variations in predator, prey and environmental parameters would strengthen the possibility of formulating well defined hypotheses for possible future experimental perturbations. In the meantime, sharp fluctuations in the natural variability of these parameters (e.g., local krill availability) could be considered a form of natural experiment that would help to develop hypotheses for future work.

Incorporating Ecosystem Assessments into Management Advice

5.31 Given the difficulties which have become apparent in developing assessments using some combination of predator, prey and environmental data based on those submitted to the CEMP database, and the unlikelihood of the situation improving markedly in the near future, it was suggested that greater priority should be given to considering how the assessments of predator population status, trends, reproductive performance, diet and demography could on their own contribute to the formulation of management recommendations for the krill fishery.

5.32 One viewpoint was that such information should form the basis for triggering management measures to restrict krill fishing in certain circumstances. It was noted that use of information from both predators and krill was implicit in the decision rule for the selection of levels of γ in the yield model developed by WG-Krill (see Annex 5, paragraph 4.98). Formulation of operational criteria to objectively assess ecosystem variability in terms of distinguishing between potential harvest-induced impacts and natural variability could be viewed in a similar way.

5.33 This raised questions as to what methods could be used to determine the appropriate triggering criteria. One view was that this simply restated the need to estimate functional relationships and the associated implications for predators when krill fishing occurs. Another view was that there existed other approaches, complementary to this one, which needed to be investigated.

5.34 It was recollected that some papers outlining suggestions of appropriate procedures had been tabled at past CCAMLR meetings and Members were encouraged to bring these and other suggestions forward to the next meetings of appropriate Working Groups.

ORGANISATION OF FUTURE WORK

Advice on the Re-organisation of the Scientific Committee's Working Groups

6.1 The scope and complexity of the Scientific Committee's work have increased considerably in recent years. The work conducted by its Working Groups has become more interrelated as progress has been made in implementing an ecosystem approach to study and manage Antarctic marine living resources. At its Twelfth Meeting in 1993, the Scientific Committee recognised that there are areas of common interest in some Working Groups, in particular WG-Krill and WG-CEMP. The Joint Working Group considered these matters under the assumption that the Scientific Committee would continue to delegate the consideration of technical matters currently addressed by WG-Krill and WG-CEMP to one or more specialist Working Groups.

6.2 In order to avoid unnecessary duplication of work and to carry out work more efficiently, the Scientific Committee requested that during the 1993/94 intersessional period the Working Groups should:

(i) review their terms of reference;

(ii) identify elements of work currently being undertaken by Working Groups that are being addressed well and those elements which could be improved; and

(iii) suggest ways in which priority work can be accomplished most efficiently (SC-CAMLR-XII, paragraph 15.16).

6.3 Based on this review, the Scientific Committee will at its meeting in 1994 provide advice to the Commission on the appropriate structure to best accomplish its work.

6.4 Taking particular account of the specific issues being addressed by the various groups, it was further assumed that the structure of the Working Groups will be kept under review in the future. However, at present, given the greater degree of commonality of issues considered by WG-CEMP and WG-Krill, it would be preferable to initiate re-organisation between these two groups first. At this time, it would be premature to combine their work or elements of their work with that conducted by WG-FSA. However, the group reiterated that there are fields of common interest, such as the by-catch of fish in the krill fishery, which require close liaison among WG-FSA, WG-Krill and WG-CEMP or their successor(s), as has been the practise in the past.

6.5 To accomplish the work of WG-Krill and WG-CEMP more efficiently, the Joint Meeting considered two alternatives, namely to:

- keep the current structure of the two Working Groups but conduct joint sessions of the two groups to cover questions of common interest with emphasis on extending these joint sessions over the next few years as the work of the two groups becomes more integrated; or

- combine the two Working Groups into one group under one convenership. All items would be discussed within this group but the group may, as is the current practice, establish subgroups which would provide advice on specialised issues.

6.6 The group endorsed the second option. It was recognised that this option would more fully integrate the common work of the two Working Groups and still allow specialised tasks to be conducted by experts.

6.7 In recent years it has been the practice of the Working Groups that highly focused or technical topics are dealt with in subgroups. The group felt that these topics should continue to be addressed in this way. The group recalled the most recent subgroups which had addressed such topics:

(i) *ad hoc* groups on data collection methods for predator monitoring under the CCAMLR Ecosystem Monitoring Program;

(ii) *ad hoc* group on statistical methods for the analysis of predator parameters under the CCAMLR Ecosystem Monitoring Program;

(iii) *ad hoc* group for reviewing proposals for the protection of CEMP monitoring sites;

(iv) *ad hoc* subgroup on the estimation of krill biomass;

(v) workshop on acoustic survey design (Yalta, 1991);

(vi) workshop on krill flux (Cape Town, 1994); and

(vii) *ad hoc* subgroups for the evaluation of parameters used in models of krill yield and predator-krill functional interactions.

6.8 The group agreed that, as has been the practice in the past, *ad hoc* subgroups with specific tasks could be created by the new joint group, either by forming groups during the meeting or by establishing groups with intersessional tasks. The tasks identified by WG-CEMP and WG-Krill for the 1994/95 intersessional period, which will require *ad hoc* groups were:

(i) evaluation of proposals for new CEMP methods;
(ii) evaluation of new statistics and methods of analysis of CEMP data;
(iii) evaluation of any new proposals for CEMP site protection;
(iv) development of standard methods for foraging performance of predators;
(v) continuation of the analysis of krill flux;
(vi) estimation of krill biomass and evaluation of acoustic methods; and
(vii) continuation of work on yield and functional relationship models.

6.9 The group noted that in order to undertake effectively the many specialist tasks required under the proposed new Working Group structure, it would need increased participation from specialist scientists.

List of Priority Activities

6.10 In addition to the tasks referred to in paragraph 6.8, the group identified the following as priorities for future work:

- further work on the determination of krill flux in Statistical Area 48, especially in relation to predators (paragraph 4.7) and with consideration of temporal as well as spatial variation;

- investigation of options for decision rules (in addition to those implicit in the bullet following) for the calculation of appropriate levels, distribution and timing of krill harvesting (paragraph 4.33);

- further work on the functional relationship between predators and prey, especially involving further determination of the parameters for and formulation of the Butterworth/Thomson model (paragraphs 4.25 to 4.30);

- further evaluation of the significance of localised interactions between krill harvesting and krill-dependent predators and identification of suitable approaches for further research initiatives and management measures; and

- review of the links between prey, predator and environmental data within the scope of the CEMP Program (paragraphs 5.22 to 5.25).

6.11 It was agreed that further work on the Secretariat's modelling of the effect of management measures on the krill fishery in Subarea 48.1 was of low priority, and should not be continued by the Secretariat at this time.

Terms of Reference of a New Working Group on
Ecosystem Monitoring and Management (WG-EMM)

6.12 Members of the Joint Meeting reviewed the present terms of reference for WG-CEMP and WG-Krill and the present status of their work and recommended that the Scientific Committee consider the following terms of reference for the new Working Group.

(i) Formulate advice to the Scientific Committee on the management of krill fisheries, taking into account the effects of fishing on both krill and predators.

(ii) Consider other forms of predator-prey-fisheries interactions, as appropriate.

(iii) Plan, recommend and coordinate research taking into account the dynamic functioning of the Antarctic marine ecosystem, the influence of the physical environment and harvesting activities.

(iv) Gather, review and evaluate information on environmental features which may affect the distribution and abundance of predators and prey (particularly krill).

(v) Gather, review and evaluate information concerning the status and performance of predators with respect to prey (particularly krill) and environmental features.

(vi) Develop further, coordinate the implementation of and ensure continuity within the CCAMLR Ecosystem Monitoring Program.

(vii) Evaluate the impact on krill stocks, krill predators and krill fisheries of current and possible future patterns of harvesting, including specification of the data required for this evaluation.

OTHER BUSINESS

7.1 Dr Marín presented a paper (WG-Joint-94/16) describing an Environmental Information Modelling System (EIMS). The main goal of EIMS is to assess strategies for sustainable development and the monitoring of fragile ecosystems. One of the ecosystems chosen is the Antarctic marine ecosystem. The University of Chile plans to implement the system in the next three years.

Future Cooperative Research

7.2 Since the last CCAMLR meeting in Hobart, a group of scientists from several Member countries has discussed cooperative research in the Antarctic Peninsula area during the 1994/95 austral summer. Dr S. Kim (Republic of Korea) coordinated the exchange of research plans and distributed a summary table (Table 1) which describes the period, area, research vessel and major objectives of national programs.

7.3 During the present meeting, the representatives of a number of countries (Germany, Japan, Korea and USA) confirmed their oceanographic research activities. Some other participants expressed their countries' intention to conduct research in this area, but could not give details of their plans at this moment.

7.4 Four nations plan to conduct oceanographic observations near the South Shetland Islands from late November 1994 to early March 1995. It was realised that the Elephant Island area would be covered six times at roughly two-three week intervals. Therefore, the above four nations agreed to conduct multinational cooperative research activities as follows:

(i) based on bilateral agreements, each national program leader would encourage the exchange of scientists from one ship to another, if circumstances allowed;

(ii) as a common activity at least one transect line (60°S, 55°W to 61°45'S, 55°W) with five to eight environmental sampling stations at 15 n mile intervals will be completed. CTD casts should cover the vertical range from the surface down to at least 750 m. Net sampling should be carried out from the surface down to 200 m with a mesh size between 300 to 500 µm. The group noted that for the calculation of krill (or zooplankton) density, it is necessary to determine the volume of water filtered by the net. Krill length measurements should be given as 'total length' (tip of rostrum to tip of telson). Ship speed should be standardised to 10 knots between stations when hydroacoustic measurements are conducted;

(iii) additional data from upstream areas and possibly from the Chilean commercial krill fishery will be included in the analysis;

(iv) Members also agreed to hold a workshop on 'temporal changes in marine environments in the Antarctic Peninsula area during the 1994/95 austral summer' before the next WG-Krill meeting. There was consensus that Hamburg (Germany) would be the appropriate place for this workshop.

7.5 It was noted that several nations have active programs of research at land-based sites. Many of these activities are summarised in Table 1. A number of nations are collaborating in these efforts (e.g., Korea/Germany, Argentina/Germany/Netherlands, United Kingdom/ Sweden). It was recalled that cooperative research efforts are the subject of ongoing discussions within SCAR as well as CCAMLR.

ADOPTION OF THE REPORT

8.1 The report of the Joint Meeting was adopted.

CLOSE OF THE MEETING

9.1 In dosing the meeting, the Chairman thanked all participants, rapporteurs, the Secretariat and especially the South African hosts for a successful and very valuable meeting. He noted that although the work of the group had been enhanced by the participation of colleagues from 13 Member countries, a number of colleagues had not felt able to take a very active part in discussions. He strongly encouraged these colleagues to take a more active role in the discussions of the group in the future.

Table 1a: Summary table of research activities (ocean survey) in the Antarctic Peninsula area during the 1994/95 austral summer.

BA Bacteria, P Phytoplankton, Z Zooplankton, PP Primary Production, K Krill, S Salps
B Benthos, F Fish, BD Birds, MM Marine Mammals, O Oceanography, C Chemical Survey, OP Optical Survey

R Rosette, BO Bongo net, M MOCNESS, T Trawl, OT Otter Trawl
G Grab sampler, AC Acoustic, ADCP Acoustic Doppler Current Profiles, RMT Rectangular Midwater Trawl

Country (Organisation)	Ocean Survey					
	Date	Area	Ship	Major Objectives (and Instruments)	Availability to Foreign Scientists	Contact
Brazil ( )	Dec 1994 - Mar 1995	Around South Shetland Is	New oceanographic vessel	F larvae, BA, P, Z, PP, K, B, F, O (instruments not yet defined)	Unknown	Edith Fanta UFDR, Biologia Celular CXP 19031 815 31-970 Curitiba, PR, Brazil Fax: +55-41-2662042
Germany (SFRI)	29 Nov - 5 Jan 1994/95	Elephant Island	*Polarstern*	All macrozooplankton (RMT) Larvae	Probably	Volker Siegel Tel: (49) 4038905221 Fax: (49) 4038905129
Japan[1] (NRIFSF)	early Dec 1994 - early Feb 1995	Around South Shetland Is	*Kaiyo-Maru*	P, Z, PP, K, S, F, BD, MM, O, C, OP (R, AG, M, OT, ADCP)	4-5 people	Mikio Naganobu Tel: 81-543-34-0715 Fax: 81-543-35-9642 Email: naganobu@ss.enyo.affrc.go.jp
Korea (KORDI)	Early to mid Jan 1995 (possibly early to mid Dec 1994)	Bransfield Strait north of South Shetland Is	maybe *Yuzhmorgeologiya*	BA, P(R) Z(BO, MOCNESS) PP K B(G) O	Probably 1-2 people	Suam Kim KORDI, Seoul, Korea Tel: 82-345-400-6420 Fax: 82-345-408-5825 Email: suamkim@sari.kordi.re.kr

Table 1a (continued)

Country (Organisation)	Ocean Survey					
	Date	Area	Ship	Major Objectives (and Instruments)	Availability to Foreign Scientists	Contact
Spain (PNA)	early Nov - late Mar 1995 (two stages)	Bransfield Strait South Shetland Is	*Hesperides*	P, Z, PP, B (R, BI, G, OT)	Unknown	Eduardo Balguerías Tel: 34-22-549439 Fax: 34-22-549554 Email: EBG @CA.IEO.ES Marta Estrada Tel: 34-4-2216450 Fax: 34-3-2217340
USA AMLR Program (SWFC)	7 Jan - mid Mar 1995 (two stages)	Elephant Island	*Surveyor*	P, Z, PP, K, S, BD, MM, O (R, BO, AC, OT)	Probably 1-2 people	Rennie Holt Tel: 1-619-546-5601 Fax: 1-619-546-7003 Email: OMNET R. Holt
LTER Program (NSF)	9 Jan - early Feb 1995	Around Palmer Station (200 x 400 km)	*Polar Duke*	BA, P, Z, PP, K, F, BD, C, OP (R, T, AC)		Polly Penhale Tel: 1-703-306-1033 Fax: 1-703-306-0139 Email: OMNET P. PENHALE

[1] *Hokuho-Maru* will conduct a survey along 140°E

Table 1b: Summary table of research activities (land-based) in the Antarctic Peninsula area during the 1994/95 austral summer.

Country (Organisation)	Land-based Research			
	Location (and/or Station Name)	Period	Major Objectives	Contact
Argentina ( )	Jubany St, King George I Camara St, Moon Bay Brown St, Admiralty Bay	year-round 1994 summer 1993/94 summer 1994/94	Fish, birds, mammals, plankton Plankton, birds Biochemistry	Esteban Barrera-Oro Instituto Antártico Argentino Fax: 54-1-812-2039
Brazil ( )	King George I (Comandante Ferraz St)	year-round: biological research mainly from Dec - Mar	Fish, krill, birds and other groups: biology, physiology, biochemistry, predator/prey interactions	Edith Fanta UFDR, Biologia Celular CXP 19031 815 31-970 Curitiba, PR, Brazil Fax: +55-41-2662042
Chile ( )	Cape Shirreff Ardley Island Greenwich I (Prat St) South Bay (Dummer I)	Dec 1993 - Jan 1994 unknown year Jan 1994	Fur seal and beach debris survey Penguins Oceanography Fish ecophysiology	Jefe Depto. Cientifico Instituto Antártico Chileno Casilla 16521 Correo 9 Santiago Chile Fax: 56-2-2320440
Germany (AWI)	Jubany (Dallman)	Oct 1994 - May 1995	Benthic community ecology	Heinz Kloser Alfred Wegener Institute Tel: 49-471-4831-309 Fax: 49-471-4831-149
Japan (NRIFSF)	Seal Island (Elephant Island)	late Dec - late Jan	Predator/prey interaction studies	Mikio Naganobu Tel: 81-543-34-0715 Fax: 81-543-35-9642 Email: naganobu@ss.enyo.affrc.go.jp
Korea (KORDI)	King George I (King Sejong St)	year-round Nov - Feb Jan 1995	Fish Penguins Benthic organisms	Suam Kim KORDI, Seoul, Korea Tel: 82-345-400-6420 Fax: 82-345-408-5825 Email: suamkim@sari.kordi.re.kr

Table 1b (continued)

Country (Organisation)	Land-based Research			
	Location (and/or Station Name)	Period	Major Objectives	Contact
Spain (PNA)	Livingston Island (BAE Juan Carlos I)	Nov - Mar tentative dates	Penguin	Eduardo Balguerías Instituto Español de Oceanografía, Centro Oceanográfrico de Canarias Apartado de Correos 1373 Santa Cruz de Tenerife España
UK (BAS)	Bird Island	year-round	Seal biology and populations Bird biology and populations	John Croxall BAS, Cambridge, UK Tel: 44-223-251000 Fax: 44-223-62616
	Signy Island	until Mar 1995	Benthic biology Water column studies	Andrew Clarke BAS, Cambridge, UK Tel: 44-223-251000 Fax: 44-223-62616
USA AMLR Program (SWFC)	Seal Island (Elephant Island) Anvers Island (Palmer St)	early Dec - mid Mar 1 Oct - 31 Mar	Predator/prey interaction studies Adélie penguins (CEMP protocols)	John Bengtson Seattle, Wa. USA Tel: 1-206-526-4016 Fax: 1-206-526-6615 Email: bengtson@afsc.noaa.gov
LTER Program (NSF)	Palmer I (Palmer St) Admiralty Bay	1 Oct - 31 Mar	Seabirds, broad-based studies on eight species	Polly Penhale Tel: 1-703-306-1033 Fax: 1-703-306-0139 Email: OMNET P. PENHALE

APPENDIX A

AGENDA

Joint Meeting of WG-Krill and WG-CEMP
(Cape Town, South Africa, 27 July to 2 August 1994)

1. Welcome

2. Introduction
   (i) Review of Meeting Objectives
   (ii) Adoption of Agenda
   (iii) Fisheries Activities

3. (i) Prey Monitoring
      (a) Data Collection Procedures
      (b) Review of Available Data
         (i) Krill Biomass Estimates in the ISRs
         (ii) Fine-scale Catch Data
         (iii) Fishery-independent Fine-scale Surveys
   (ii) Predator Monitoring

4. Ecosystem Interactions
   (i) Potential Impacts of Localised Krill Catches
   (ii) Krill/Predator Functional Relationships

5. Ecosystem Assessment
   (i) Development of Prey, Fishery and Environmental Indices
   (ii) Integrating Predator, Prey, Environmental and Fishery Indices into Ecosystem Assessments
   (iii) CEMP Experimental Approach
   (iv) Incorporating Ecosystem Assessments into Management Advice

6. Organisation of Future Work
   (i) Review Current Working Groups' Organisation and Effectiveness
   (ii) Identification of Priority Tasks Best Addressed by Working Groups
   (iii) Working Groups' Terms of Reference and Organisation

7. Other Business

8. Adoption of Report

9. Close of Meeting.

APPENDIX B

LIST OF PARTICIPANTS

Joint Meeting of WG-Krill and WG-CEMP
(Cape Town, South Africa, 27 July to 2 August 1994)

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