

KRILL RESOURCES

FISHERY STATUS AND TRENDS

2.1 The krill catch for the 1991/92 season was 19% less than in 1990/91 and totalled 288 546 tonnes (Table 2.1).

Table 2.1: National krill landings (in tonnes) since 1984/85 based on STATLANT returns.

Member	Split-Year*							
	1985	1986	1987	1988	1989	1990	1991	1992
Chile	2598	3264	4063	5938	5329	4501	3679	6066
Germany	50	0	0	0	0	396	0	0
Japan	38274	61074	78360	73112	78928	62187	67582	74325
Republic of Korea	0	0	1527	1525	1779	4040	1211	519
Poland	0	2065	1726	5215	6997	1275	9571	8607
Spain	0	0	379	0	0	0	0	0
USSR**	150538	379270	290401	284873	301498	302376	275495	0
Russia								137310
Ukraine								61719
Total	191460	445673	376456	370663	394531	374775	357538	288546

* The Antarctic split-year begins on 1 July and ends on 30 June. The column "split-year" refers to the calendar year in which the split-year ends (e.g., 1989 refers to the 1988/89 split-year).

** Although the formal date for separation of the former USSR was 1 January 1992, statistics are compiled here for Russia and Ukraine separately for the complete split-year, i.e. 1 July 1991 to 30 June 1992 for comparative purposes.

2.2 The total krill catch by subarea and country for 1990/91 and 1991/92 is given in Table 2.2.

Table 2.2: Total krill catch in 1991/92 by area and country. The catch for 1990/91 is indicated in brackets.

Subarea /Area	Chile	Japan	Republic of Korea	Poland	Russia	Ukraine	(USSR)	Total
48.1	6066 (3679)	61598 (54720)	519 (1211)	641 (310)	8975		(4721)	77799 (64641)
48.2		272 (1924)		2742 (6020)	80142	20333	(159313)	103489 (163979)
48.3		12405 (9606)		5224 (3241)	48163	41386	(110715)	107178 (123562)
48.4								
48.5					30		(0)	30 (0)
58.4		0						0 (1329)
88		50					(746)	50 (3)
Total	6066 (3679)	74325 (67582)	519 (1211)	8607 (9571)	137310	61719	(275495)	288546 (353514)

2.3 Catches contained in reports of Members' Activities were noted to be different from some of those submitted in STATLANT returns and included in Tables 2.1 and 2.2. The Scientific Committee sought clarification from the Members concerned on the discrepancies.

2.4 An analysis of the 1991/92 catches indicate that Chile and Japan have increased their catch levels between the 1990 and 1991 seasons whereas Korea, Poland and the combined fleets of Russia and Ukraine have decreased their catch levels.

2.5 The Scientific Committee noted with concern that the Secretariat could not prepare the summary tables of total krill catches prior to the meeting because of a lack of compliance with Conservation Measure 32/X and the fact that not all STATLANT data had been received by the official submission date of 30 September. This matter is further discussed in paragraphs 3.12 and 3.13.

2.6 Dr K. Shust (Russia) confirmed that catches of krill reported by Russia and Ukraine for the 1991/92 fishing season did not include any catches taken by vessels from the Baltic states. Dr Shust also indicated that since the Baltic states do not have a large scale krill fishery, catch levels are likely to be relatively low.

2.7 Dr V. Yakovlev (Ukraine observer) confirmed that fishing was conducted during March to August with scientific observers on board the vessels.

2.8 Dr I.-Y. Ahn (Korea) reported that Korean vessels fished between 14 January and 2 February 1992 and took a total krill catch of 519 tonnes to the north of Elephant and Livingston Islands. These data were submitted to the Secretariat at the Scientific Committee meeting.

2.9 The utility of reviewing Members' intended commercial krill fishing activities for the forthcoming season was again noted (SC-CAMLR-IX, paragraph 2.11 and SC-CAMLR-X, paragraph 3.13). Delegates from Chile, Japan and Russia reported that it was very difficult to predict the number of vessels that would be involved in the forthcoming season since this was primarily driven by economic factors.

2.10 Dr Yakovlev indicated that vessels from Ukraine will be fishing in Statistical Area 48 in the 1992/93 season and that information on the number of vessels and catching capacities of the vessel could be submitted.

REPORT OF THE WORKING GROUP ON KRILL

2.11 The Fourth Meeting of the Working Group on Krill (WG-Krill) was held in Punta Arenas, Chile from 27 July to 3 August 1992. This meeting was attended by 27 participants from 11 Member countries. The objectives of the meeting are outlined in SC-CAMLR-X, paragraphs 3.23, 3.48, 3.52, 3.53, 3.82, 3.89, 3.91 to 3.94, 3.105, 6.30, 6.36 and Annex 4, paragraphs 2.1 to 2.3)

2.12 The Convener of WG-Krill, Mr Miller presented the report of the meeting. He thanked the rapporteurs, participants and Secretariat for their support.

2.13 The Working Group's report is attached at Annex 4.

2.14 In reviewing the report, the Scientific Committee thanked the Convener and participants for their input. Some 39 working and background papers were tabled at WG-Krill's meeting. A list of these documents is given in Annex 4, Appendix C.

2.15 The Scientific Committee endorsed WG-Krill's report and made use of its deliberations as a basis for discussion. In the interests of brevity and to avoid unnecessary duplication, only a brief summary of the report is presented here. Wherever paragraphs of the Working Group report were accepted with little or only minor revision, the reader is referred to the relevant paragraphs of Annex 4. Consequently, the following summary should be read in conjunction with this Annex.

Review of Fisheries Activities (Annex 4, paragraphs 3.1 to 3.23)

2.16 The Scientific Committee shared WG-Krill's concern about the lack of compliance with Conservation Measure 32/X which calls for monthly reports of krill catches. It was noted that more data had been submitted since the meeting of WG-Krill in July and it was anticipated that compliance will improve in the future (Annex 4, paragraph 3.9).

2.17 The Scientific Committee noted that it might be possible to derive a composite index of CPUE, as first defined by WG-Krill in 1989 (SC-CAMLR-VIII, Annex 4, Appendix 7), from haul-by-haul fishery data in combination with acoustic data collected on a similar scale (Annex 4, paragraph 3.12). The Scientific Committee encouraged Chile and the USA to establish cooperative research programs to work on this problem.

2.18 The Scientific Committee again noted the value of haul-by-haul data from the Russian and Chilean krill fisheries and the important role played by scientific observers aboard fishing vessels in

the collection of such data. It was agreed that the collection of biological and other data from commercial krill fishing vessels remains a top priority in WG-Krill's work.

2.19 WG-Krill indicated that it is still not possible to assess the full effect of the by-catch of larval and juvenile fish in the krill fishery. This is despite past concerns and several requests for information on this problem (SC-CAMLR-X, paragraph 3.22). The Scientific Committee urged both WG-Krill and WG-FSA to keep the matter under review.

2.20 The Scientific Committee noted WG-Krill's deliberations on the problem of assessing the mortality of krill not retained in krill trawls and endorsed the comments made by the Working Group (Annex 4, paragraph 3.22).

Estimation of Krill Yield (Annex 4, paragraphs 4.1 to 4.88)

Krill Flux in Statistical Area 48 (Annex 4, paragraphs 4.1 to 4.33)

2.21 The importance of krill movement with respect to krill distribution and the estimation of potential yield was again emphasised at the WG-Krill meeting (Annex 4, paragraph 4.1). The Working Group had provided a summary of current knowledge on water flow rates in and between subareas in Statistical Area 48 (Annex 4, Table 1).

2.22 The Scientific Committee noted that new information on water flow rates in Statistical Area 48 had only been presented for Subarea 48.1. There is still not much information available for Subarea 48.2 and no new information had been provided for Subarea 48.3 (Annex 4, paragraph 4.27). It was agreed that submissions should be encouraged for Subareas 48.2 and 48.3, as well as other statistical areas.

2.23 The Scientific Committee supported WG-Krill's view on the value of historic fine-scale fisheries data from Statistical Area 48 in the identification of areas of high krill density and the relative persistence of krill concentrations (Annex 4, paragraph 4.30). The Scientific Committee therefore urged Members to submit historical fine-scale data where possible.

2.24 Dr Shust noted that accessing the historic data from the Russian krill fishery and preparing the data for submission to CCAMLR is possible but would represent a major data processing effort. Because of the potentially large amount of historic catch data and the substantial investment of personnel time that would be required to transform the data into a format useful to CCAMLR (e.g., extracting logbook data and recording it onto computer files or standard reporting sheets), it might

be difficult to reconstruct all historical fine-scale data. However, if sufficient resources can be allocated to undertake such a project, it would probably be possible to assemble and submit historic catch data for at least some areas of particular interest.

2.25 The Scientific Committee agreed that Members holding previously unreported historic data on krill catches should be encouraged, as a matter of priority, to evaluate the current accessibility of such data. Following the completion of an initial data inventory, the feasibility of processing these data into standard formats and submitting the data to the CCAMLR Data Centre should be investigated. The historic data should be reported to CCAMLR in as fine a scale as possible.

2.26 There seem to be few difficulties in collecting fine-scale data and the Scientific Committee therefore endorsed the recommendation that fine-scale data be submitted for all Statistical areas in the Convention Area. This would imply an extension of the current requirements for Subareas 48.1, 48.2 and 48.3 to Subareas 48.4, 48.5 and 48.6, as well as, Statistical Areas 58 and 88.

2.27 WG-Krill had indicated that, for reason of convenience, the boundaries between subareas within Statistical Area 48 were used to assess the flow of water masses between subareas (Annex 4, paragraph 4.10). The Scientific Committee agreed that it will be necessary to consider whether these boundaries are indeed appropriate with respect to krill movement. If the boundaries need to be re-defined, the information necessary to do so should also be identified.

2.28 The Scientific Committee agreed that there was a need for more oceanographic models and encouraged the establishment of links between research groups and institutes working on krill population dynamics and those working on oceanographic models. It was noted that there were many oceanographic studies focusing on very different spatial and temporal scales. The Scientific Committee encouraged WG-Krill to develop outlines indicating the ranges of spatial and temporal scales (for oceanographic models) that would be most relevant to the work of WG-Krill.

2.29 The Scientific Committee's attention was drawn to publications by Prof. Hofman and colleagues on the integration of models of oceanographic factors and of krill biology. Members were requested to provide information on similar studies to the Convener of WG-Krill before the next meeting of this Working Group.

2.30 The Scientific Committee recommended that the Secretariat develop a bibliography with respect to oceanographic matters relevant to the WG-Krill. The Scientific Committee, however, also requested WG-Krill to provide outlines that would define the subjects within oceanography that are of greatest relevance to the Working Group in order to assist the Secretariat in their task. The attention of the Secretariat was drawn to the SO-GLOBEC program (CCAMLR-XI/BG/9 Rev. 1).

Estimation of Biomass (Annex 4, paragraph 4.34 to 4.71)

2.31 WG-Krill reviewed various submissions on estimating krill biomass using acoustic data. The Scientific Committee endorsed without comment, WG-Krill's call for further work regarding acoustic methods (Annex 4, paragraphs 4.40, 4.41 and 4.44).

2.32 The Scientific Committee noted that Russia had tabled a paper (SC-CAMLR-XI/BG/13) setting out an outline proposal for a project to model krill aggregation (KRAM) in relation to acoustic surveys to estimate the species abundance. While the Scientific Committee recognised that there may be some merit in the proposal, it felt that the matter should be referred to WG-Krill's next meeting. The Working Group should then evaluate the proposal in the light of its other priorities and advise the Scientific Committee accordingly.

2.33 The precautionary limit set in 1991 for krill in Statistical Area 48 (Conservation Measure 32/X) was based, in part, on calculations undertaken by WG-Krill in 1991 using estimates of krill biomass from FIBEX. The Scientific Committee had requested that the FIBEX data be re-analysed (SC-CAMLR-X, paragraph 3.78) to obtain estimates of biomass by subarea using the new acoustic target strength (TS) values adopted by the Scientific Committee (SC-CAMLR-X, paragraph 3.34). A group of scientists from several Member nations undertook this analysis and the results were reported to WG-Krill (Annex 4, paragraphs 4.47 to 4.59 and Table 2).

2.34 It was noted that the densities obtained from the new target strength relationship (see paragraph 2.32) were approximately four-times those obtained from the original target strength relationship (*BIOMASS Rept. Ser. No. 40*, 1986). There were, however, some problems with the results from one vessel (*Walther Herwig*) which used 50 kHz as its survey frequency. In Subarea 48.2 the density from the *Walther Herwig* was similar to that from other vessels, whereas in Subarea 48.1 the density from this vessel appeared very high for a survey covering such a large area of deep water. The Working Group discussed possible reasons but could not satisfactorily explain the difference.

2.35 The Scientific Committee's attention was drawn to this problem and it agreed with WG-Krill's recommendation that further evaluation of the FIBEX acoustic data for *Walther Herwig* together with net-haul data should be undertaken (Annex 4, paragraph 4.58).

2.36 In discussion it was also noted that a superswarm had been detected north of Elephant Island during the time of the FIBEX survey. Mr Miller informed the Working Group that some transects of the *Walther Herwig* cruise did cross the area where the superswarm had been detected

and that the analysis presented to WG-Krill had not correctly weighted the data from these transects. He reported that re-analysis of these data have been performed since that meeting.

2.37 Mr Balguerías informed the Scientific Committee of the establishment of a new ICES Study Group on Target Strength Methodology and suggested that the Scientific Committee follow the work of that Study Group in order to benefit from its expertise.

2.38 The Scientific Committee's attention was drawn to results of acoustic surveys, presenting estimates of krill biomass in the Ross Sea, Prydz Bay and around Elephant Island (Annex 4, paragraphs 4.59, 4.60 and 4.63 to 4.70).

Refining Calculations of Potential Yield (Annex 5, paragraphs 4.72 to 4.80)

2.39 The Scientific Committee noted that various refinements to the process used to calculate potential yield of krill were carried out during the intersessional period and presented to WG-Krill (Annex 4, paragraphs 4.73 to 4.77 and WG-Krill-92/4 and 28).

2.40 It was also noted that direct account was taken of uncertainties, particularly with respect to recruitment, mortality and the initial biomass. This approach implied that there was no further need for a discount factor as previously used (SC-CAMLR-X, paragraph 3.67).

2.41 At the WG-Krill meeting, two papers were presented containing estimates of potential yield using calculations that were very similar, though not identical (WG-Krill-92/4 and 28). Results were, however, quite different and the Working Group recommended that the calculations contained in these papers should be independently checked.

2.42 In this regard, the Scientific Committee endorsed WG-Krill's call for the establishment of a procedure whereby the Secretariat would verify the methodology, calculations and computer software used in models or assessments, particularly in situations where results from such models are used in providing management advice.

2.43 The Scientific Committee noted that estimates of potential yield obtained from the refined model developed by WG-Krill (Annex 4, paragraph 4.72 to 4.80) are sensitive to the assumption about the variability in recruitment and endorsed the Working Group's recommendation that further work, along the lines set out in Appendix D of Annex 4, be conducted to try and estimate recruitment variability from length frequency data.

Refinement of Precautionary Catch Limit Estimates
(Annex 4, paragraphs 4.83 to 4.88)

2.44 In arriving at suggestions for an overall precautionary catch limit for Subareas 48.1, 48.2 and 48.3, WG-Krill had considered four estimates based on the re-analysed FIBEX data (Annex 4, paragraph 4.84). Two biomass estimates were used, one including and the other excluding the *Walther Herwig* data, because of the problems encountered with results from this vessel (see paragraph 2.34) and the fact that the Working Group had not found a satisfactory explanation for this discrepancy.

2.45 Two methods of calculation were used, one based on the model used in 1990/91 (SC-CAMLR-X, Annex 5, paragraphs 4.32 and 6.42 to 6.55) and the other based on the refined model presented in WG-Krill-92/4, because of the problems regarding validation of the calculations (see paragraphs 2.41 and 2.42).

2.46 Dr Shust was of the opinion that the *Walther Herwig* results should be included because, although estimated densities were very high for Subarea 48.1, estimates for Subarea 48.2 are very similar to those from other vessels (paragraph 2.34).

2.47 The Working Group had suggested that the estimates of biomass used in these calculations were likely to be underestimates. The Scientific Committee, however, suggested that the estimates could also be positively biased, if recruitment had been above average in the period prior to the survey.

2.48 Seven alternative methods for allocating the precautionary limit to subareas within Statistical Area 48 were considered by WG-Krill (Annex 4, paragraph 4.87 and Table 5). The methods could be grouped into those that could be implemented immediately and those that would need more information before they could be implemented.

2.49 Prof. J. Beddington (UK) expressed his doubts about the feasibility of the method based on predator demands since it was not clear whether a positive or negative relationship between predator demands and precautionary catch level in a subarea should be applied. For example, should a high level of predator demand imply a relatively high or low catch level?

2.50 Dr Bengtson, the Convener of WG-CEMP, indicated that WG-Krill had requested WG-CEMP to consider the feasibility of this method and WG-CEMP had concluded that the method was not feasible (Annex 7, paragraph 8.7).

2.51 It was, however, noted that the possible problem of local depletion of krill and any corresponding need for supplementary management measures to ensure that not all catches were taken in the critical period and location for predators still remained (Annex 4, paragraph 4.88).

2.52 Further problems with some of the other methods were highlighted. Dividing the catch limit evenly between areas was thought to be unrealistic since biomass and productivity would tend to differ between subareas.

2.53 By contrast, the information needed to implement the method using local biomass adjusted for movement of krill is so great that once it has been obtained, a more detailed and appropriate management strategy for each subarea rather than a simple division of catches, could be developed.

Ecological Implications of Krill Fishing (Annex 4, paragraphs 5.1 to 5.53)

Location and Timing of Fishery (Annex 4, paragraphs 5.3 to 5.26)

2.54 The Scientific Committee had posed some questions regarding the ecological implications of krill fishing to WG-Krill at its 1991 meeting (SC-CAMLR-X, paragraph 6.36). WG-Krill had an extensive and valuable discussion on this topic and noted that the dialogue between scientists and those with practical experience of the fisheries had led to a better appreciation of what measures would be considered as reasonable when considering management options.

2.55 In summary, the main factors affecting the timing and location of the fishery are ice, the type of krill (e.g., feeding or non-feeding) and operational requirements (Annex 4, Table 1). The Scientific Committee endorsed the comments made by WG-Krill in this regard (Annex 4, paragraphs 5.5 to 5.8).

2.56 WG-Krill noted that in Subarea 48.1 fishing is concentrated in the months and locations that are critical to land-based predators. In Subarea 48.2 much less fishing occurs during the critical months and locations and in Subarea 48.3 the bulk of the catches are taken in the winter months (paragraph 5.29).

2.57 In considering the relation of fishing to krill predators WG-Krill focussed on two spatial scales: the Southern Ocean scale and a scale relating to localised krill/predator interactions.

2.58 Prof. Beddington suggested that there would be merit in considering a spatial scale in the middle of the range (for example, at the scale of subareas) since management decisions are currently based on the subarea scale.

Effects of Management Measures on Krill Fishing
(Annex 4, paragraphs 5.46 to 5.51)

2.59 Various management measures for controlling fishing in specific areas were discussed at WG-Krill's meeting. The Scientific Committee noted that there were advantages and disadvantages associated with all the methods.

2.60 Prof. Beddington disagreed with WG-Krill's assertion that a combination of closed areas and closed seasons was not easy to enforce. The Scientific Committee agreed that questions regarding the enforcibility of management measures was a matter for the Commission and not a problem the Working Group needs to consider.

2.61 Dr Shust suggested that although the combination of closed areas and closed seasons seems most appropriate, it would be very difficult to define appropriate areas because the predator-prey interactions are so dynamic.

2.62 Dr de la Mare noted that, with respect to land-based predators, the problem of defining appropriate 'management areas' that could be used in the closed areas management measure, is quite tractable. Biological characteristics such as foraging range could be used to define such areas. With respect to pelagic predators, the problem is far less tractable.

2.63 Further discussion on this topic is given in paragraphs 5.41 to 5.43.

Liaison with WG-CEMP (Annex 4, paragraphs 5.52 and 5.53)

2.64 The close liaison between WG-Krill and WG-CEMP was endorsed.

Advice on Krill Fisheries Management (Annex 4, paragraphs 6.1 to 6.30)

Precautionary Limits on Krill Catches (Annex 4, paragraphs 6.1 to 6.5)

2.65 The Scientific Committee took note of the calculations carried out by WG-Krill to estimate precautionary limits using the re-analysed FIBEX data and the refined model (Annex 4, paragraph 4.84), in response to a request from the 1991 meeting (SC-CAMLR-X, paragraph 3.78). The Scientific Committee endorsed the comments made by WG-Krill regarding the reservations and caveats associated with these calculations (Annex 4, paragraph 6.2).

2.66 The Scientific Committee endorsed the Working Group's recommendation that the precautionary catch limit for krill in Statistical Area 48 should remain at 1.5 million tonnes noting, however, that this level is only exceeded by one of the revised estimates.

2.67 With some reservations being made by certain Members about the revised methodology, the Scientific Committee agreed that the estimates of yield calculated by WG-Krill for Division 58.4.2 (Annex 4, paragraphs 6.1 and 6.3) could be used as a basis for setting a precautionary catch limit for this subarea and endorsed WG-Krill's recommendation (Annex 4, paragraph 6.4).

2.68 Dr M. Naganobu (Japan) stated that he endorsed the view expressed by Dr H. Hatanaka (Japan) in WG-Krill (Annex 4, paragraph 6.4). In his opinion advice could not be based on the lower figure (0.25 million tonnes) which was obtained from the revised model because of the problems associated with validation (see paragraphs 2.40 and 2.41). The higher figure (0.39 million tonnes), based on the model used at the 1991 meeting, could however, be used as a basis for setting a precautionary catch level in Division 58.4.2.

2.69 The Scientific Committee took note of WG-Krill's advice that if the validity of the FIBEX results remains in doubt, consideration would need to be given in the near future to the institution of a near-synoptic survey for krill in Statistical Area 48 as a whole. This matter is further discussed in paragraphs 2.116 to 2.118 of this report.

2.70 With respect to future refinements of these calculations, the Scientific Committee noted that the focus had been on the estimate of initial (or unexploited) biomass. The variance associated with the estimate of biomass had not really been considered and should receive more attention. The variance of recruitment assumed in the model calculations also affects results and further work to try and estimate the level of variance from data (for example, as outlined in Appendix E of Annex 4) is encouraged.

2.71 Dr D. Robertson (New Zealand) drew Members' attention to the implicit assumption that the biomass estimate from the FIBEX survey conducted in 1981 is appropriate for use as an estimate of unexploited biomass in the calculation of potential yield.

2.72 WG-Krill considered several options as the basis for allocating precautionary catch limits to subareas within Statistical Area 48 (Annex 4, paragraphs 6.6 to 6.10) and considered that, ideally, the total krill biomass in a subarea, corrected for predator demands and krill movements should be used. Some members of WG-Krill felt that an approach based on considerations of the movement of krill between subareas within the season would be most appropriate.

2.73 The Scientific Committee endorsed the view of the Working Group that since the catch in the most recent season had been well below the trigger level of 620 000 tonnes (stipulated in Conservation Measure 32/X), it would be unlikely that the implementation of an allocation scheme would become necessary in the near future. An interim approach was therefore recommended (Annex 4, paragraph 6.9).

2.74 The interim approach was based on taking the average of three percentages for each subarea:

- (i) the percentage of the total biomass, estimated from the FIBEX survey including the *Walther Herwig* data, in that subarea;
- (ii) the percentage of the total biomass, estimated from the FIBEX survey excluding the *Walther Herwig* data, in that subarea; and
- (ii) the percentage of the historical total average catch in each subarea;

The reason why the historical catch was taken into account in these calculations was because the proportion of biomass estimated in Subarea 48.3 seemed unrealistically low relative to the proportion of the catch taken in that subarea. This may have been due to the fact that only part of Subarea 48.3 was covered during the FIBEX survey (Annex 4, paragraph 4.54).

2.75 The Scientific Committee noted that there are problems with an approach based on krill biomass with an adjustment for predator demands. Firstly, krill biomass may fluctuate greatly between subareas and between years. Secondly, as indicated by CEMP (Annex 7, paragraph 7.6), it is currently impossible to estimate total consumption for all krill predators in the subareas.

2.76 The Scientific Committee also took note of the view that krill movement (or flux) should be taken into account when allocating catch limits to subareas, but agreed that much more information on oceanographic factors and krill biomass fluctuations was needed before such an approach could be implemented.

2.77 The Scientific Committee agreed that, at this stage, the most practical approach would be that recommended by WG-Krill (Annex 4, paragraph 6.10). The Scientific Committee drew the Commission's attention to the fact that this approach implies that the sum of the percentages for all subareas is greater than 100%. Implications of this recommendation, in terms of catch limits by subarea based on a total precautionary catch of 1.5 million tonnes, are set out below (in tonnes):

Antarctic Peninsula	48.1	28%	420 000
South Orkney Islands	48.2	49%	735 000
South Georgia	48.3	24%	360 000
South Sandwich Islands	48.4	5%	75 000
Weddell Sea	48.5	5%	75 000
Bouvet Island region	48.6	20%	300 000

2.78 WG-Krill again discussed the possible need for additional management measures to ensure that not all catches are concentrated within the critical times and locations for krill predators (Annex 4, paragraphs 6.11 to 6.15). The discussion in the Scientific Committee with respect to this matter is given in paragraphs 5.39 to 5.43.

2.79 The Scientific Committee endorsed the recommendation by WG-Krill that there may be a need for the definition of management regions for krill that are more appropriate than statistical subareas (Annex 4, paragraphs 6.16 and 6.17).

Refining Operational Definitions (Annex 4, paragraphs 6.18 and 6.19)

2.80 The Scientific Committee noted that the Working Group had made definite progress at its last meeting, with respect to the development of operational definitions within the context of a particular management procedure. WG-Krill had started with relatively simple models, taking uncertainty into account and using relatively arbitrary levels of probability in the calculations of potential yield. The Scientific Committee supported further work in WG-Krill to move to a more realistic set of models and biological targets.

2.81 The Scientific Committee endorsed WG-Krill's comment that advice from the Commission on policy matters may be needed in future as management procedures are developed (Annex 4, paragraph 6.19). An example of such a policy matter would be the question of how frequently and by how much catch levels can alter.

Other Possible Approaches and their Development (Annex 4, paragraphs 6.20 to 6.23)

2.82 WG-Krill highlighted the fact that essentially three types of information would be available for the development of a feedback management procedure: information from the fisheries, information independent of the fisheries (e.g., surveys) and information on krill predators. The

Scientific Committee noted the advantages and disadvantages associated with the three types of information.

2.83 The studies on CPUE by Drs Mangel and Butterworth¹ which had been endorsed by the Scientific Committee (SC-CAMLR-VIII, paragraphs 2.13 to 2.21) indicated that haul-by-haul data are essential if any changes in CPUE were to be detected. The information obtained from surveys have not yet been subjected to such rigorous examination. It would therefore be appropriate now to move on to consider the information content of data from different types of survey and the information content of data on predator responses. The latter is a more difficult exercise than the former and the functional relationships between predators and prey should first be investigated.

2.84 The Scientific Committee commended WG-Krill and WG-CEMP for taking up this task, as outlined in the report of the Joint Meeting (Annex 8).

2.85 The Japanese Delegation indicated that due to the constraints of domestic law it would be impossible for them to submit haul-by-haul data. Dr Naganobu, however, confirmed that it would be possible for Japan to report combined krill catches on a scale of 10 x 10 n miles (Annex 7, paragraph 5.29; and 5.13 of this report).

2.86 Dr Shust pointed out that although surveys are expensive, fisheries data are not collected without costs and collecting fine-scale data is also expensive. He suggested that a small fund should be created from Members' contributions to assist in covering the costs of the collection and collation of fisheries data.

2.87 Several Members also noted that more studies of the interactions between krill and the fishing fleets are needed.

Data Requirements (Annex 4, paragraphs 6.24 to 6.26)

2.88 The Scientific Committee endorsed the comments made by WG-Krill in this regard.

¹ BUTTERWORTH, D.S. 1989. A simulation study of krill fishing by an individual Japanese trawler. In: *Selected Scientific Papers. 1989 (SC-CAMLR-SSP/5)*. CCAMLR, Hobart, Australia: 1-108. BUTTERWORTH, D.S. 1989. Some aspects of the relation between Antarctic krill abundance and CPUE measures in the Japanese krill fishery. In: *Selected Scientific Papers. 1989 (SC-CAMLR-SSP/5)*. CCAMLR, Hobart, Australia: 109-126. MANGEL, M. 1989. Analysis and modelling of the Soviet Southern Ocean krill fleet. In: *Selected Scientific Papers. 1989 (SC-CAMLR-SSP/5)*. CCAMLR, Hobart, Australia: 127-236.

Scientific Observer Scheme (Annex 4, paragraphs 6.27 to 6.29)

2.89 The Scientific Committee endorsed the recommendation by WG-Krill for the trial use of the draft scientific observer manual developed by the Secretariat during the forthcoming fishing season.

2.90 The Scientific Committee also endorsed the Working Group's views expressed in paragraphs 7.2 to 7.13 regarding editorial matters. For further discussion on SC-CAMLR's publications policy see paragraphs 11.1 to 11.5.

DATA REQUIREMENTS

2.91 The Scientific Committee was pleased to note that a considerable number of papers had been tabled at WG-Krill and that these contained information relevant to the data requirements identified at the Working Group's 1991 meeting (SC-CAMLR-X, Annex 4, Table 8). In this connection, the Scientific Committee endorsed WG-Krill's updated table of information requirements (Annex 4, Table 5). The following requirements were highlighted in particular:

- the Secretariat should contact FAO and other relevant organisations to determine whether data on catches from FAO Statistical Area 41 are available, and can be added to the CCAMLR Database;
- the requirement to submit fine-scale catch and effort data from Subareas 48.1, 48.2 and 48.3 and the CEMP Integrated Study Regions (ISRs) should be expanded to apply to any catches of krill in the Convention Area. Historical fine-scale catch data should also be submitted for Statistical Area 58;
- the ongoing requirement to submit length frequency data from commercial vessels, haul-by-haul data (irrespective of proximity to CEMP sites) and information on the number/capacity of fishing vessels should remain.

2.92 With respect to the requirement to submit both catch and effort data, Japan restated that it had difficulties with the submission of fine-scale effort data. Japan indicated, however, that Japanese effort data would be, and had been, included in analyses undertaken by Japanese scientists, e.g. SC-CAMLR-XI/BG/14.

2.93 Other requirements include - reporting of monthly catches in accordance with Conservation Measure 32/X, presentation of data on krill flux in Subareas 48.2 and 48.3 as well as

other areas, examination of the precision of estimates of krill length-weight relationships and reports of experiments of krill passing through trawls during fishing.

2.94 The Scientific Committee agreed that it would still be of value if fishing Members could indicate the number of vessels that plan to fish for krill in the forthcoming season together with their catching capacities. Reservations were, however, expressed by many Members of their ability to do this.

2.95 The value of qualitative information from the fisheries was emphasised and future submissions of such information is encouraged.

FUTURE WORK OF WG-KRILL

2.96 The Scientific Committee noted that WG-Krill made significant progress in its work. In particular, the refinement of procedures to calculate potential yield, the development of alternative procedures whereby the allocation of precautionary limits to subareas in Statistical Area 48 may be achieved, and consideration of various approaches to take explicit account of predator requirements in the management of the krill fishery were seen as being noteworthy achievements.

2.97 The Scientific Committee endorsed the following topics as having the highest priority for WG-Krill in the forthcoming year:

- the continued investigation of oceanographic flux in Statistical Area 48 and other areas;
- the further estimation of total effective biomass in Statistical Area 48 and other areas;
- the further estimation, refinement and validation of methods to calculate potential yield and precautionary limits in various statistical areas and subareas, including refinements of the underlying model used to estimate yield as well as its input parameters;
- further work, in association with WG-CEMP, on models to describe functional relationships between krill, its principal predators and the fishery. Such work would include the need to take account of predator requirements in the development of management procedures for the krill fishery; and
- further work on the possible extent of krill mortality during fishing operations.

2.98 In addition the Working Group should continue to address issues associated with survey design, acoustic assessment of krill biomass, development of approaches to management and continue liaison with WG-CEMP on matters of common concern.

2.99 In order to address these issues, which are fundamental to the development of advice on krill, the Scientific Committee recommended that WG-Krill should meet during the intersessional period for approximately one week during 1993.

ADVICE TO THE COMMISSION

General Advice

2.100 WG-Krill should hold an intersessional meeting during 1993 in order to continue work on topics set out in paragraphs 2.97 and 2.98.

2.101 The Commission's attention was drawn to the fact that, because of non-compliance with the data reporting element of Conservation Measure 32/X, the Secretariat was unable to complete the tables of krill catch statistics before the Scientific Committee meeting.

2.102 Submissions are encouraged on the dynamics of krill fluxes in Subareas 48.2 and 48.3 in particular, as well as in other statistical areas (paragraph 2.22).

2.103 Consideration should be given to whether the use of CCAMLR statistical subareas is appropriate with respect to krill movement and the definition of water mass boundaries. In particular, the information necessary to define water mass boundaries should be identified (paragraph 2.27).

2.104 Fine-scale fisheries data should be submitted for all statistical areas (including Areas 58, 88 and subareas in Area 48 for which fine-scale data have not been required in the past). Such data from past seasons should also be submitted (paragraph 2.23).

2.105 Krill recruitment variability should be estimated using length distribution data from research surveys as outlined by WG-Krill (Annex 4, Appendix D) (paragraph 2.43).

2.106 Submissions to WG-Krill's next meeting on additional management measures to supplement precautionary catch limit allocations are encouraged (paragraph 2.78).

2.107 The *Walther Herwig* FIBEX data should be validated further. Should the validity of the FIBEX data remain in doubt then consideration needs to be given in the near future to the institution of a near-synoptic krill survey in Statistical Area 48 as a whole (paragraph 2.69).

2.108 A flexible scheme for designating specific management areas, fishing grounds or areas of specific ecological interest is required. As a first step such a scheme could be based on aggregates of fine-scale catch reporting units (0.5° latitude by 1° longitude) (paragraphs 2.61 and 2.62).

2.109 WG-Krill and WG-CEMP should continue their close liaison on the development of a feedback management procedure to take account of information on interactions among krill, krill predators, the fishery and the environment (paragraph 2.82).

2.110 The specific data requirements listed in paragraph 2.91 should be addressed as a matter of priority.

Specific Advice on the Status of Krill Stocks

2.111 The Scientific Committee recommended that Conservation Measure 32/X should not be amended at this time.

2.112 The average of FIBEX-based biomass estimates and historical catch levels plus 5% currently offers the most practical interim allocation procedure for apportioning the precautionary catch limit to subareas within Statistical Area 48 (paragraph 2.74).

2.113 A range of 0.25 to 0.39 million tonnes represents the best scientific advice on a precautionary catch limits for Division 58.4.2 which can be given at this time (paragraph 2.67). It was agreed that a precautionary catch limit of 0.39 million tonnes should be applied to Division 58.4.2 at this time.

2.114 As a principle, the Secretariat should be charged with checking specific calculations, particularly when these are used as a basis for management measures (paragraph 2.42).

2.115 When developing a comprehensive management procedure for krill (paragraph 2.82) it is necessary to know the magnitude and frequency by which krill catch levels may be adjusted. The Commission's guidance is sought on this matter.

2.116 The Commission's attention is drawn to the possible need for a large-scale near-synoptic survey in Statistical Area 48 (paragraph 2.69). Such a survey would involve considerable effort in coordination and involve significant costs. The Commission's guidance on the feasibility of such an exercise is sought .

2.117 The Commission's attention is drawn to the fact that the development of management procedures for krill is critically linked to the reliability and quality of information that would be used in such a procedure.

2.118 This implies, for example, that if WG-Krill could not rely on obtaining the necessary detailed data from the commercial fishery, management procedures that rely on such data would not be possible. In this circumstance, alternatives such as regular comprehensive surveys might be necessary.