KRILL RESOURCES

Fishery Status and Trends

2.1 The total krill catch for the 1988/89 season was some 6.7% larger than in 1987/88. At 395 470 tonnes this is the second largest annual catch for the past seven seasons (Table 2.1).

Table 2.1: National krill landings (in tonnes) since 1982/83

Member	Split-Year*						
	1983	1984	1985	1986	1987	1988	1989
Chile	3 752	1 649	2 598	3 264	4 063	5 938	5 394**
GDR	0	0	50	0	0	0	0
Japan	42 282	49 531	38 274	61 074	78 360	73 112	78 928
Republic of Korea	1 959	5 314	0	0	1 527	1 525	1 779
Poland	360	0	0	2 065	1 726	5 215	7 871**
Spain	0	0	0	0	379	0	0
USSR	180 290	74 381	150 538	379 270	290 401	284 873	301 498
Total	228 643	130 875	191 460	445 673	376 456	370 663	395 470

* 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. 1988 refers to the 1987/88 split-year).

** From catch data tabled during the meeting.

2.2 The total krill catch by statistical area and year since 1973 is illustrated in the Figure 2.1.

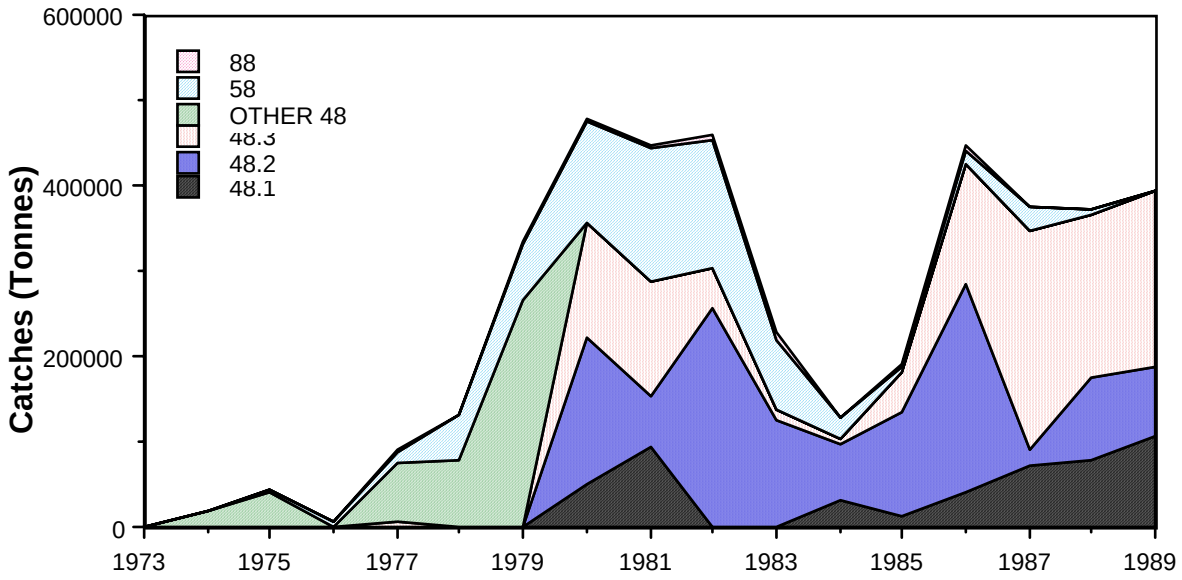

Figure 2.1: Total krill catches from 1973 to 1989. ('Other 48' refers to catches from Statistical Area 48 not allocated to Subareas 48.1, 48.2 or 48.3.)

2.3 An analysis of the 1988/89 landings by area indicated an increase in total catches from Statistical Area 48 compared with the previous year. In this regard, Soviet catches in Subareas 48.1 and 48.3 increased by approximately 20 000 and 15 000 tonnes respectively, while in Subarea 48.2 they decreased by about 13 000 tonnes (see paragraph 2.6).

2.4 In contrast to the above, there was a marked decrease of catches (from 6 490 to 217 tonnes) taken in Subarea 58.4.

2.5 With the exception of Soviet catches, which increased by some 16 600 tonnes, i.e. 6%, krill catches by most nations were similar to 1987/88 levels, although both Japanese and Polish catches increased by 5 816 tonnes, i.e. 8% and 2 656 tonnes, i.e. 50% respectively.

2.6 The total Soviet krill catch (301 498 tonnes) by area during 1988/89 was as follows:

Subarea 48.1	20 875	(0 tonnes in 1987/88)
Subarea 48.2	76 494	(89 888 tonnes in 1987/88)
Subarea 48.3	203 912	(188 391 tonnes in 1987/88)
Statistical Area 88	0	(0 tonnes in 1987/88)
Subarea 58.4	217	(6 490 tonnes in 1987/88)

2.7 Dr T. Lubimova (USSR) indicated that the increase in Soviet catches in Subarea 48.3 was as a result of the sustained presence of fishable krill concentrations in summer and autumn over the South Georgia continental slope. This was a result of the dynamics of the water circulation during the 1988/89 split-year.

2.8 Dr Lubimova indicated that for processing reasons, a priority target in krill fishing operations is krill that had not been feeding recently. Aggregations of such krill are particularly characteristic of Subarea 48.3 in the summer and autumn.

2.9 As indicated during last year's Scientific Committee meeting (SC-CAMLR-VII, paragraph 2.7), Dr Lubimova further emphasised that the continued reduction of Soviet catches in Subarea 58.4 could be attributed to unfavourable ice conditions.

2.10 In this context, Dr Y. Shimadzu (Japan) reported that the confinement of the Japanese fishery to Subareas 48.1, 48.2 and 58.4 (particularly Subarea 48.1) since 1984 was essentially the result of logistical constraints resulting from the re-direction of fishing operations from geographical areas immediately adjacent to the Convention Area.

2.11 Papers distributed at the meeting dealt with: commercial krill fishing in the Convention Area (SC-CAMLR-VIII/BG/11), the determination of krill acoustic target strength (SC-CAMLR-VIII/BG/30), the long-term distribution of krill fishing in Statistical Area 58 (SC-CAMLR-VIII/BG/21), the analysis of fine-scale data reported to the Commission (SC-CAMLR-VIII/BG/43 and 44) and Japanese krill fisheries research (SC-CAMLR-VIII/BG/28, 29, 30, 31 and 52). Dr Lubimova drew attention to various Soviet papers dealing with aspects of Soviet fishing operations and krill biology in general. Topics considered in these papers were concerned with catchability by krill trawls (SC-CAMLR-VIII/BG/9), the assessment of krill biomass in fishing grounds (SC-CAMLR-VIII/BG/4, 5, 7 and 10) and the analysis of the operating conditions of fishing vessels with respect to krill distribution, biology and behaviour (SC-CAMLR-VIII/BG/23). Various other Soviet papers dealt with the biology of krill in general (SC-CAMLR-VIII/BG/22 and 24) and population dynamics with relation to development of the fishery (SC-CAMLR-VIII/BG/21). It was agreed that detailed consideration of such papers should be referred to the next meeting of WG-Krill (see paragraph 2.29 below).

2.12 Most krill fishing nations indicated that recent trends (i.e. slight increases or decreases in catches from year to year) would continue. In this regard, Dr Shimadzu indicated that the limited market potential of krill tail meat in Japan is likely to keep Japanese krill catches at more or less current levels. Dr Lubimova reported that recent technological advances in the

Soviet Union had been made with respect to the processing of krill for human consumption and that there was some likelihood that the total krill catch from Soviet fishing would increase as operations were broadened into Statistical Areas 58 and 88 in the near future.

Report of the Workshop on the Krill CPUE Simulation Study (WS-KCPUE)

2.13 Dr J. Beddington (UK), Convener of the CPUE Simulation Study, briefly outlined the results of the Workshop on the Krill CPUE Simulation Study (Annex 4) held at the Southwest Fisheries Centre, La Jolla, USA between 7 and 13 June 1989.

2.14 The Workshop provided the opportunity for participants to work closely with the CCAMLR appointed consultants (Dr M. Mangel, University of California, Davis and Prof. D.S. Butterworth, University of Capetown) on the details of their simulations/analyses of Soviet krill survey and Japanese krill fishing operations.

2.15 Recognising limitations associated with the absence of Soviet participation in the Workshop, a substantial amount of work had been done and various conclusions reached (Annex 4, paragraphs 17 to 28). In brief, it was concluded that although the Soviet and Japanese fisheries operate in different ways, various types of catch and effort data could be utilised to obtain a Composite Index of Krill Abundance. As such, this Composite Index could be constructed from information on krill concentrations derived from USSR survey vessels and krill abundance within concentrations from Japanese fishing vessels. However, the Workshop concluded that the application of this Composite Index of Abundance is currently limited due to the small area of operation of the Japanese fishery.

2.16 The Workshop strongly emphasised that care needs to be exercised in the evaluation of the Composite Index as many of the component variables do not change in proportion to krill abundance and in addition there are considerable uncertainties with respect to how many of these variables can be best estimated. The Workshop felt, therefore, that in order to improve the applicability of the Composite Index, the collection of relevant data should, as far as possible, follow standard procedures. Furthermore, a number of suggestions were made in this regard. The Workshop agreed that certain within-krill concentration parameters (e.g. swarm size, number of swarms per unit area of concentration and inter-swarm distance) are essential for the monitoring of krill abundance and the necessary data would be best collected acoustically.

2.17 The Workshop therefore recommended the following:

(a) survey vessels operating in support of a fishing fleet should collect data in accordance with a recommended bridge log format (Annex 4, Appendix 5) and that data so obtained should be analysed to provide estimates of the size and type of krill concentrations along the lines suggested in WS-KCPUE-89/5;

(b) all catching vessels should collect haul-by-haul data in the same way as is currently done by the Japanese fishery;

(c) haul-by-haul data should be analysed to provide appropriate indices of krill abundance based on catch-per-unit searching time within krill concentrations by ten-day reporting period;

(d) the above analytical procedures should be conducted on a trial basis and reviewed after three years; and

(e) acoustic data should be used to better determine swarm size, number of swarms per unit area of concentration and inter-swarm distance within concentrations.

2.18 Dr Lubimova expressed the view that the potential utility of the Soviet research vessel data which were used to construct the model of commercial fishing operations was limited because these vessels are not operating in support of the fishery activities. In addition, a number of Soviet documents tabled at the present meeting (specifically SC-CAMLR-VIII/BG/8, 10, 21 and 23) indicated the possibility that several alternative variables could be utilised to improve current understanding and simulations of fishing operations in relation to krill abundance and distribution. Information gathered by scientists aboard Soviet fishing vessels has indicated that such information will be more objectively defined and useful than data from research vessels operating in a pre-determined way and independently of fishing vessels. Dr Lubimova also indicated that data routinely collected aboard Soviet fishing vessels were difficult to validate as it had been gathered in an unscientific manner and, as a result, its application is limited.

2.19 A further important conclusion of the Workshop was that the general properties of the Composite Index were such that small changes in krill abundance were unlikely to be detected, but any statistically significant change in the Composite Index would imply that a major change in krill abundance had occurred. Although it was possible to deduce the general properties of the Composite Index, the Workshop recognised that a detailed

understanding of the quantitative behaviour of the Composite Index is required. Accordingly, the Workshop recommended that the sensitivity of the Composite Index to variation in parameter values should be further investigated. In this connection, certain delegations felt that it was rather premature to commence evaluation of the sensitivity of the Composite Index to changes in abundance in a mechanistic way and in the absence of a better understanding of certain critical biological properties of the krill population(s) being considered (e.g. seasonal emigration or immigration from or into specific geographical areas).

2.20 With respect to the views expressed in paragraphs 2.17 and 2.18 above, it was agreed that there would be considerable merit to be gained by considering the recommendations of the Workshop in combination with those from the First Meeting of the WG-Krill (see paragraphs 2.24 to 2.36 below).

2.21 The Scientific Committee thanked Dr Beddington for organising the study and for its conduct over the past few years and for convening the concluding Workshop and study as a whole.

Report of the Working Group on Krill (WG-KRILL)

2.22 The terms of reference of the WG-Krill (SC-CAMLR-VII, paragraph 2.26) and the objectives for its first meeting (SC-CAMLR-VII, paragraph 2.29) were agreed at last year's meeting of the Scientific Committee.

2.23 The Working Group met directly after (14 to 20 June 1989) the WS-KCPUE and at the same venue. The Convener, Mr D. Miller (South Africa) briefly outlined the topics addressed and conclusions resulting from the meeting (Annex 5 and SC-CAMLR-VIII/5).

2.24 In brief, the Working Group

- reviewed available data on, and techniques to determine, krill abundance and distribution;

- defined various scales of krill distribution and developed broad definitions of the types of krill concentration most frequently fished;

- acknowledged the potential utility and limitations of the Composite Index of Krill Abundance developed by the WS-KCPUE to monitor changes in krill abundance;

- reviewed available information on current and historic patterns in commercial krill catch levels as well as the distribution of fisheries activities;

- highlighted the importance of Statistical Area 48 as a whole to the krill fishery;

- made various recommendations concerning the analysis and collection of krill fisheries data, particularly length frequency distribution data from commercial catches; and

- repeatedly emphasised the importance of studying predator-krill interactions in the context of estimating the possible impact of fishing on krill-dependent predators.

2.25 The Working Group also recognised that the Krill CPUE Simulation Study had done much to focus attention on the more pertinent aspects of data necessary for monitoring effects of fishing on krill distribution and abundance. As such, the major factors introducing variance into the estimation of krill distribution and abundance were considered by the Working Group to depend on the size of the area being considered. Similarly, the applicability of available estimation techniques is also a function of the scale(s) over which the process being investigated operates.

2.26 The Scientific Committee discussed the reports of the WG-Krill and the WS-KCPUE meetings which Soviet scientists were unable to attend for reasons beyond their control. The discussions focussed on the practicality of collecting specific data and on the constraints associated with their validation and potential utility. As a general principle, it was agreed that haul-by-haul data from survey, research and commercial fishing vessels would provide information essential to improving current understanding of krill distribution/abundance in relation to krill fishing operations.

2.27 Dr Lubimova stated that there is a practical difficulty in collecting haul-by-haul data on board USSR commercial vessels which can currently be solved only when scientific observers are on board. Such scientific observers will provide reliable information in addition to simple haul-by-haul data which would be relevant to further investigations of the Working Group.

2.28 It was felt that in view of the large number of documents tabled at the present meeting, specific details of the type of analyses to be carried out on such data should be deferred to the next meeting of the Working Group. However, the Scientific Committee did agree that

certain data collection and evaluation procedures could be initiated immediately and these are set out in paragraph 2.33 to 2.41.

2.29 Considerable discussion was also held on the development of an approved procedure to deal with the problem of uncertainty with respect to assessing the possible impact of fishing on both local and global krill stocks. In this connection, note was taken of one of the Working Group's recommendations that commercial catches should not greatly exceed current levels, particularly with respect to the potential impact of such catches on local predator populations within Statistical Area 48. A number of Members expressed their reservation with this recommendation as they considered the development of restrictive catch limits to be premature at this stage, especially in the absence of acceptable estimates of krill production and in the absence of necessary data concerning the functional relationships between krill and dependent predators.

2.30 The Scientific Committee, however, noted the views expressed in SC-CAMLR-VIII/BG/11 and 19 with respect to the possible extent of the impact of fishing on local krill resources and the formulation of a suitable protocol to deal with assessing such impact taking into account operational definitions of Article II of the Convention. The Scientific Committee recognised that this particular problem holds specific significance for the Commission's Working Group on the Development of Approaches to Conservation (WG-DAC) (this is discussed in general terms in paragraphs 7.6 to 7.17).

2.31 Taking into consideration Dr Lubimova's indication of possible increases in Soviet fishing activities (see paragraph 2.11 above), the Scientific Committee agreed that there was a considerable lack of relevant data concerning the functional relationships between krill abundance/distribution and dependent predators as well as more direct effects of fishing operations (e.g. the possible by-catch of already depleted fish species in krill trawls).

2.32 Dr Lubimova indicated that recent estimates of krill yield in the entire Antarctic were relatively high (ca. 50 million tonnes) (Hempel, 1988). Other Members raised considerable doubts as to the applicability of this estimate.

2.33 Given the views expressed in paragraph 2.30 and 2.31, certain Members were of the opinion that to minimise the potential for over-exploitation, consideration should be given by the Commission to the initiation of a general policy whereby precautionary Total Allowable Catches (TACs), may be set in certain restricted areas. This particular matter is discussed again in paragraph 2.48.

2.34 Finally, the Scientific Committee agreed that many of the items detailed above (paragraphs 2.22 to 2.30) and in the Working Group's Report (Annex 5) require the analysis and review of data. In view of the urgency of the Working Group's task (SC-CAMLR-VII, paragraph 2.28) as a whole, the timely submission of subsequent results will be necessary if the Working Group is to demonstrate any progress. For this reason the Scientific Committee recommended that a meeting of the WG-Krill be held during the next intersessional period.

2.35 The major objective of this meeting will be to further develop procedures to assess krill abundance and distribution in selected subareas of the Antarctic. A secondary objective would be to consider how such information could be utilised with a view to assessing the possible effects of changes in krill abundance and distribution with respect to both fishing operations and the possible impact on krill dependent predators (see also paragraphs 5.15 and 7.13 to 7.17). In order to achieve these objectives the Working Group will be required to review and consider:

(a) information on krill abundance and distribution (including available and relevant fisheries information/data);

(b) liaison with the CCAMLR Ecosystem Monitoring Program with respect to assessing any impact of changes in krill abundance and distribution on dependent and related species; and

(c) possible procedures to evaluate the impact on krill stocks and krill fisheries of current and future patterns of harvesting, including changes brought about through management action in order that the Scientific Committee may formulate appropriate scientific advice on krill to the Commission.

2.36 The Scientific Committee agreed that a meeting of the Working Group will be held in the Soviet Union at a time to be determined by the Chairman in consultation with Members.

Data Requirements

2.37 Review of the analyses of both past and currently available acoustic data should be undertaken in order to verify the definitions of concentration and aggregation types (Annex 5, Table 4) proposed by the WS-KCPUE and endorsed by the WG-Krill. Results of such analyses could be useful in the investigation of the possible underlying causes of the

formation and maintenance of concentrations. As far as possible, these results should be presented at the Working Group's next meeting.

2.38 Available echo-charts should be examined to gather data on krill concentration parameters and aggregations types (i.e. swarm size, number of swarms per unit area of concentration and inter-swarm distance within-concentration). This should be undertaken as soon as possible, either on a national or cooperative basis, and submissions on how such data could be accessed and analysed should be reported to the Working Group's next meeting.

2.39 Haul-by-haul data from commercial fishery vessels should be collected. It would appear (at least for the Soviet and Polish fisheries) that the utility of these data in subsequent analyses could be most readily achieved through the placement of scientific observers aboard fisheries vessels. The development of suitable reporting formats for such data is encouraged and recommendations along these lines should be submitted to the Working Group's next meeting.

2.40 The majority of Scientific Committee Members perceived some utility in the acquisition of bridge log data from krill survey and fishing vessels. The Scientific Committee recommended that Members provide information on the type and extent of data currently being collected on fishing vessels when scientific observers are present and also on research vessels in accordance with the standard formats currently used on these vessels. This should be submitted to the next meeting of the WG-Krill along with details on extent of, and procedures followed in the annotation of echo-charts aboard both survey and fisheries vessels.

2.41 Available fine-scale catch and effort data should be further analysed in order to investigate the spatial distribution of fishing activities during ten-day periods and within each season. Similarly, the necessary analyses should be undertaken (either nationally or cooperatively) as soon as possible in order to investigate possible patterns in distribution of commercial fishing operations within a season and between years. Results of such analyses should be reported to the Scientific Committee.

2.42 The reporting of fine-scale catch data should continue for Subareas 48.1, 48.2 and 48.3. The Scientific Committee noted that there is a contradiction between paragraphs 2.19 of SC-CAMLR-VII and paragraph 59 of CCAMLR-VII in this regard. For this reason, the Scientific Committee once more recommended that fine-scale catch data should be reported from Subareas 48.1, 48.2 and 48.3. Wherever possible, fine-scale catch data from other Statistical Areas should be collected.

2.43 Studies to develop standardised sampling procedures for krill catches should be undertaken. In particular, these should take account of the number and frequency at which samples of krill length distributions in commercial catches should be collected. Due account should also be taken of developing procedures to assess within-catch variances in the sampling of length distributions as well as between-catches and vessels.

2.44 As an interim measure, length samples of at least 50 krill from one haul per day per vessel should be taken by all commercial vessels. It was agreed that, where possible, more than one sample should be taken from each haul in order to provide estimates of variance. The standard length measurement to be used should be from the front of the eye to the tip of the telson. Members are urged to report any difficulties experienced with the above sampling procedure as well as on the procedures they are currently using or intending to carry out with respect to sampling krill catch length distributions (e.g. using observers aboard single commercial vessels to record length frequencies from all catches in one area). As far as possible, Members are also urged to collect krill length frequency data from commercial and scientific catches in the same area.

Advice to the Commission

2.45 The WG-Krill should hold an intersessional meeting during 1989/90 in order to develop its tasks further and in order to sustain the momentum achieved at its first meeting.

2.46 Haul-by-haul catch and effort data including the relevant operational details should be collected and prepared pending discussion at the WG-Krill on specific analyses to be performed.

2.47 The Scientific Committee recommended that fine-scale catch data should be reported for Subareas 48.1, 48.2 and 48.3. Collection of such data in other areas where commercial fishing is undertaken, should be encouraged.

2.48 There is a substantial krill fishery in Subarea 48.3. The area is favoured by commercial operators as it contains concentrations of krill which have not been feeding. The current knowledge of the effect of krill fishing on krill predators and the impact on depleted fish stocks of by-catches, during the krill fishery, is poor.

Some Members of the Scientific Committee felt that it was now appropriate for the Commission to consider the implications of imposing a precautionary limit on the krill catch in this area.

Other Members expressed doubts about this view. Krill productivity was very important for prey-predator interactions and there were no data on this. In addition, no functional relationship between krill and its dependent predators had been established.