

KRILL RESOURCES

Fishery Status and Trends

4.1 There has been a slight decrease in the total krill catch in 1986/87 compared with 1985/86. A synopsis of national krill landings (in tonnes) since 1982/83 is as follows:

Table 4.1: National krill landings (in tonnes) since 1982/83

Member	1982/83	1983/84	1984/85	1985/86	1986/87*
Chile	3 752	1 649	2 598	3 264	4 063
GDR	0	0	50	0	0
Japan	42 282	49 531	38 274	61 074	78 360
Republic of Korea	1 959	2 657	0	0	1 527
Poland	360	0	0	2 065	1 726
Spain	0	0	0	0	450
USSR	180 290	74 381	150 538	379 270	290 401
Total	228 643	128 218	191 460	445 673	376 527

* Preliminary figures

4.2 The total krill catch by statistical area and year since 1973 is illustrated in Figure 1.

4.3 In analysing the breakdown of 1986/87 krill landings by area, the Chairman drew attention to the reduction of the catches from Area 48 as a whole. There was also a major shift in the Soviet catch within this statistical area from Subarea 48.2 to 48.3 and 29 tonnes were taken by Japan from outside the Convention Area in Division 41.3.2 (Tierra del Fuego).

4.4 In contrast, catch from Subarea 58.4 has almost doubled (15 910 tonnes in 1985/86 and 29 557 tonnes in 1986/87).

4.5 The catch reported by Chile has increased slightly during the past year, which is consistent with the fishery having expanded (SC-CAMLR-V, paragraph 5.2).

4.6 The Spanish delegate reported that the 450 tonnes catch of *Euphausia* spp. reported for 1986/87 was in fact *E. superba* and that this had been taken in the South Orkney/Elephant Island region (Subareas 48.2 and 48.3).

4.7 Dr Y. Komaki (Japan) reported that the increase in the overall Japanese krill catch could be attributed to both an increased market demand and better fishing conditions in the 1986/87 season than in the previous season. In response to queries about Japanese fisheries activities reported in CCAMLR-VI/MA/9 Rev. 1 and SC-CAMLR-VI/BG/35, Dr Komaki

indicated that Japanese fishermen preferred to catch 'non-green' krill, i.e. krill which had not recently been feeding. Dr Lubimova (USSR) also reported that the Soviet fishery preferred to catch non-green krill.

4.8 Dr T. Lubimova indicated that the slight decrease in the overall Soviet krill catch for 1986/87 was a result of an areal redirection of the fishery.

4.9 In 1986/87, the total USSR catch of krill (290 401 tonnes) was made up as follows:

Subarea 48.1	319	tonnes	(0 t in 1985/86)
Subarea 48.2	9 731	tonnes	(224 744 t in 1985/86)
Subarea 48.3	254 480	tonnes	(141 994 t in 1985/86)
Area 88	288	tonnes	(1 884 t in 1985/86)
Area 58	25 583	tonnes	(10 648 t in 1985/86)

4.10 The great variation in the proportion of the catch taken in different areas will add to the complexities of studying the impact of the fisheries. However, a wide-ranging fishery would be valuable in improving knowledge of the processes affecting the circumpolar distribution of krill. It would be interesting to know to what extent the change in fleet distribution was a matter of choice and how much it was imposed by the need to find the localities of high krill densities.

4.11 Dr D. Vergani (Argentina) drew attention to SC-CAMLR-VI/BG/42 in which it was reported that there had been an increase in the number of fur seals around the South Orkney Islands during recent years. The Committee recognised that further research was required on the possible interactions between krill availability, predator dynamics, and fisheries.

Further Data Requirements

4.12 Concern was expressed by a number of delegates that a large proportion of the catch taken in Subarea 58.4 was reported as having come from 'area unknown'. It was emphasised that past and future data should be reported in accordance with existing decisions, by Stalant sub-area and division.

4.13 The reporting of catch data in the past year has improved to some extent. Chile and Spain submitted fine-scale catch and effort data in accordance with last year's decision of the Commission (CCAMLR-V, paragraph 66). The Soviet Union submitted fine-scale catch and effort data during the present meeting.

4.14 It was further noted that fine-scale catch and effort data were essential for the Ecosystem Monitoring Program. It was therefore recommended that wherever possible these data be reported for all CCAMLR Ecosystem Monitoring Program integrated study areas on an annual basis.

4.15 It was noted that the acquisition of additional fine-scale data (particularly in Area 48) could also be of use in the Krill Simulation Study.

Aspects of Krill Biology Relevant to Stock Assessment

4.16 Last year's meeting of the Scientific Committee recognised the following biological topics as being relevant to stock assessment of krill: stock separation, microscale density (swarming versus dispersed krill), near-surface distribution, acoustic target strength, age determination and growth (SC-CAMLR-V, paragraph 5.10).

4.17 National representatives reported on recent research on krill stock separation being conducted in their countries. Dr K. Sherman (USA) indicated that results from a study in which mitochondrial DNA was used as a genetic tracer had been promising (SC-CAMLR-VI/BG/44), and he proposed that collaborative development of such techniques with Soviet scientists could be productive. In supporting Dr Sherman's proposal, Dr T.G. Lubimova (USSR) drew attention to the forthcoming publication of a comprehensive collection of Soviet research papers on krill distribution and abundance. She also presented the Scientific Committee with two compilations of Soviet papers dealing with aspects of krill biology and distribution. The contents page and abstracts of some of the papers included in these documents are contained in SC-CAMLR-VI/BG/50.

4.18 The meeting agreed that there would be considerable value in consolidating the analytical skills related to krill stock separation and that the exchange and co-operative analysis of samples by Members should be encouraged.

4.19 Accurate estimation of krill abundance (particularly by acoustic surveys) is heavily dependent on a knowledge of the proportion of the total krill population that is dispersed as opposed to aggregated in swarms.

4.20 Similarly, the importance of detecting and quantifying krill at, or near, the surface was emphasised. The Chairman drew attention to a recent publication describing a study in which an upward-directed echo-sounder system was employed. He also highlighted on-going research being undertaken by British Antarctic Survey.

4.21 The Chairman introduced a paper dealing with the determination of acoustic target strength of krill (SC-CAMLR-VI/BG/9). It appears that little progress on this subject has been reported since the 1984 Meeting of the BIOMASS Acoustic Working Party (BIOMASS Report Series No. 40). Theoretical studies are underway in Norway and the USA, and some results from these studies are to be reported in the proceedings of the International Symposium on Fisheries Acoustics (ISFA) held in Seattle in June 1987.

4.22 Several acoustic target strength studies are being planned for the forthcoming Antarctic summer season. These include a joint British/Norwegian field investigation at South Georgia, an Australian study using an anechoic tank, and a Japanese study involving *in situ* target strength measurements in the Antarctic Peninsula region. The estimation of acoustic target strength of plankton in general, and of krill in particular, will be included on the agenda for the 1988 Meeting of the ICES Fisheries Acoustic Science and Technology Working Group.

4.23 Factors to convert length to weight are important for biomass estimation. A large number of such equations have been published and consideration needs to be given to the most appropriate ones to employ (SC-CAMLR-VI/BG/33).

4.24 The meeting agreed that given the degree of uncertainty associated with the application of suitable acoustic target strength values to krill survey data, this topic should remain a priority item for the Scientific Committee. In addition, calibration of acoustic equipment and good survey design were recognised as being important considerations in the development of fisheries-independent assessments of krill stock abundance. In this connection, the Committee noted with pleasure the joint USA/Polish/Japanese acoustic inter-calibration program planned for early 1988.

4.25 The Chairman drew attention to the recently published ICES Manual on Calibration of Acoustic Instruments (ICES Co-operative Research Report No 144, February 1987) and suggested that this might be used to standardise calibration procedures.

4.26 Research on krill growth and age determination continues in many countries and includes studies on the age pigment, lipofuscin (SC-CAMLR-VI/BG/48 USA, and Australia), the use of polymodal length compositions to estimate age and growth in five species of Antarctic euphausiids (SC-CAMLR-VI/BG/24 Federal Republic of Germany), and the effect of environmental variability on krill growth and age determination (USSR). An urgent need to co-ordinate the studies on krill growth and age determination was recognised, and the Committee agreed that inter-calibration of techniques between national laboratories (involving the exchange of samples) should be encouraged.

4.27 Prof. J.-C. Hureau (France) stated that many of the topics discussed above would be included in the jointly sponsored BIOMASS/CCAMLR paper 'Review of the biology of the Antarctic krill, *Euphausia superba* Dana' by Mr D. Miller and Mr I. Hampton (BIOMASS Scientific Series (in press)). Dr J. Croxall (UK) also indicated that some of the above topics would be addressed during the SCAR (BIOMASS) Workshop on Krill Biology and Ecology being planned for 1990/91.

4.28 Taking the above into account, the Committee acknowledged the extensive research being undertaken by Member countries and organisations (e.g. SCAR) on krill biology and ecology in general. At present, there is no forum within CCAMLR for the in-depth review of such research or the evaluation of its application in meeting the Convention's objectives.

4.29 The Scientific Committee therefore decided to establish, subject to the approval by the Commission, an Ad Hoc Working Group on Krill. The Group would be convened by Mr D. Miller (South Africa). The principal objectives of this Group would be to review and evaluate research on krill biology and ecology relevant to the work of the Scientific Committee, and to advise the Scientific Committee on the potential applications of this research to stock assessment and ecosystem monitoring.

4.30 The Group would have the following terms of reference:

- review and evaluate the results of recent studies on krill population structure, abundance estimation and stock separation;
- review and evaluate the results of krill growth and age determination studies;

- review and evaluate estimates of reproductive and mortality rates in krill;
- review and evaluate the results of studies on behaviour, distribution, and reproduction in relation to krill swarming and dispersal;
- review and evaluate existing data on the size, distribution and composition of catches of krill;
- report to the Scientific Committee on results of the Group's activities, and as appropriate, recommend actions to be taken by the Committee with respect to krill stock assessment and ecosystem monitoring.

4.31 It was recommended that the Ad Hoc Working Group on Krill communicate by correspondence during the intercessional period, and that the Convener present a report of activities to the 1988 Meeting of the Scientific Committee.

4.32 The Scientific Committee noted that the Group would need to take into account the influence of both biotic and abiotic factors. In this connection, the Committee agreed that there would be considerable value in the Group liaising with scientists involved in national research programs and programs co-ordinated by SCAR (e.g. see paragraph 4.27).

4.33 In reviewing krill catch data, it will be important to maintain close liaison with the Krill CPUE Simulation Study.

Krill CPUE Simulation Study

4.34 Dr J. Beddington briefly reported the progress made on the Krill CPUE Simulation Study during the past year. He drew attention to the documents which had been circulated to Members which described work undertaken by the two consultants appointed to the study (Dr M. Mangel, University of California at Davis and Dr D.S. Butterworth, University of Cape Town). The results of discussions held during visits by Dr Mangel to British Antarctic Survey, by Dr Butterworth to Japan, and by Drs Beddington and Everson to the USSR were summarised in a paper tabled by Dr Beddington (SC-CAMLR-VI/BG/4).

4.35 The consultant's reports were tabled as documents SC-CAMLR-VI/BG/22 (Dr Mangel) and SC-CAMLR-VI/BG/38 (Dr Butterworth). In order to review and evaluate the contents of these reports, a small task group was formed under the convenership of Dr E. Marschoff (Argentina).

4.36 The task group noted that the consultants had compared changes in several CPUE indices to a reduction in the simulated abundance of krill. The performance of each index depended on the nature of the simulated changes in krill distribution and behaviour and in fleet behaviour. However, these results are preliminary. Their similarity to alternative model parameters and configurations needs to be examined.

4.37 There was a clearly defined need to extend the studies and refine the models by:

- (i) providing a better model of behaviour, movement and distribution of krill,
- (ii) providing a better model of the operations of different fishing fleets,
- (iii) allowing for sources of variation.

4.38 The Group recommended that work on the study should proceed along the above lines, but emphasised that it was important that data already available should be utilised to the fullest possible extent.

4.39 Data pertaining to (i) above primarily comprise information on krill distribution from research surveys.

4.40 Some data relevant to (ii) above were presented in a paper on the Japanese krill fishery tabled at the meeting (SC-CAMLR-VI/BG/35). A similar paper on Soviet operations is expected to be published during the forthcoming year.

4.41 The Committee accepted the recommendations of the Group and agreed on the following timetable for continuation of the study:

1988	September	Consultants present completed report which will be circulated to all Members.
	October	SC-CAMLR-VII. Preliminary review of consultants' report and commencement of planning for an evaluation Workshop.

1989 March/April Workshop to evaluate study and formulate further recommendations.

4.42 It was recognised that budgetary provision should be made for the visit of the consultants to meetings concerned with evaluating the simulation.

4.43 The Chairman reported on activities that had been undertaken in connection with the decision by last year's meeting of the Scientific Committee to hold a joint CCAMLR/BIOMASS workshop (SC-CAMLR-V, paragraphs 5.27–5.31). The primary objective of the Workshop was to investigate the relationship between local estimates of krill abundance using CPUE, and more direct assessments of abundance over a wide area. Attention was drawn to Dr Everson's paper presented at the joint CCAMLR/IOC Seminar on Antarctic Ocean Variability, (June 1987) and entitled 'Can we satisfactorily estimate variations in krill abundance?' (SC-CAMLR-VI/BG/13).

4.44 On the basis of the Chairman's report, the Committee agreed that there was little to be gained by continuing with the workshop in the format in which it had been originally planned. However, it was noted that the commercial fisheries data available from Japan and research data from the USSR could be used as a basis for continuing work on the problem of relating local estimates of krill abundance using CPUE to assessments over wider geographical areas.

Advice to the Commission

4.45 The Scientific Committee noted the various trends apparent from the reports on krill fisheries activities. The Committee agreed that it should continue to attach high priority to gathering the types of information necessary for detecting the effects of fishing on krill stocks (paragraph 4.7). To this end, countries engaged in krill fishing should collect and submit detailed catch and effort data according to agreed procedures (paragraphs 4.12 and 9.5).