

**REPORT OF THE TASK GROUP ON EVALUATION OF  
EXPERTS' REPORTS ON KRILL SIMULATION STUDY**

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The Group considered the models of the Soviet krill fishery presented by Dr Mangel (SC-CAMLR-VII/BG/12) and of the Japanese krill fishery by Professor Butterworth (SC-CAMLR-VII/BG/37). Certain aspects of the models were clarified in response to questions. However, because the reports presented were very long and had only become available shortly before the meeting, full and detailed consideration and discussion of them was not possible, and was postponed to the planned future workshop as discussed hereunder.

2. The operating patterns, and hence the CPUE data, are of a different nature for the two fishing fleets considered. Japanese vessels operate independently for most of the time, and each is responsible for both finding and fishing krill aggregations. However, it does seem that krill location information is shared between the Japanese ships to some extent. In contrast, the Soviet vessels work in close co-operation; usually their fishing fleet is supported by several research vessels whose specific responsibility is location of the krill aggregations. The data from these research vessels are particularly useful for larger scale distribution studies.

3. Both papers presented used identical underlying models of the krill distribution, which consisted of a 'patches within patches' structure - specifically smaller-scale 'swarms' within larger-scale 'concentrations' of krill. The parameter values used for this distribution were derived from the FIBEX surveys. Because the majority of swarms found in the FIBEX surveys were small, a 'selectivity' effect was included in the fishing operation models of both studies so that only the larger swarms were selected by the fishery. Nevertheless, this gave rise to problems in having the model of the Japanese fishery produce output typical of real commercial operations, and it was generally felt that this might be because the fisheries operated on the larger 'layers' of krill rather than on 'swarms'.

4. The distribution of krill biomass between different kinds of aggregations (such as 'swarms' and 'layers') was noted as a possible contributing difficulty to the use of CPUE indices. There is no information available on the frequencies with which different types of aggregation occur, or how these depend on environmental or biological factors. If the relative frequencies do not change with variations in the overall krill biomass, the functional relationships deduced between krill biomass and various CPUE indices would be unaffected, though the levels of precision associated with such indices would be poorer; however, any density dependent changes in these frequencies would affect the form of these relationships, and hence the assessed utility of the various CPUE indices. The consultants suggested that

the existing models might be adjusted relatively simply to take these different aggregation types into account by multiplying the existing distribution parameter values by constant factors.

5. Both models had considered only the krill distribution in the horizontal plane, on the assumption that the mouth opening of nets was sufficient to encompass the depth range of most swarms. It was suggested that this might not be an adequate approximation where layers are concerned.

6. The meeting noted that in reality the distribution of krill that are fished by vessels are ephemeral, rather than invariant in time as assumed in the models. Temporal distributional effects had not been included in the models because of the absence of appropriate quantitative survey data to parameterise them. The manner in which the simulated vessels react to bad weather situations had been used in the models to mimic concentrations dispersion, but this procedure may not provide an adequate description of these effects.

7. Difficulties in the use of CPUE as an index of abundance are not peculiar to krill fisheries; the same difficulties have already been recognised to apply to many fisheries (particularly for pelagic schooling fish) around the world. Preliminary consideration of the results of the simulation studies suggests that it may be possible for CPUE measures to provide a good index of changes in the average abundance of krill within a concentration if searching time within and between concentrations can be distinguished (for, say, Japanese fishing vessels). Data from the Japanese vessels do not appear to be able to index changes in the number and size of krill concentrations, but this may be possible using data from Soviet research vessels.

8. It was generally agreed that all the aspects above, and also further details of the models, might be appropriately discussed in the Workshop planned to culminate these simulation studies and to produce final advice on this issue.

9. This meeting should be preceded by an exchange of correspondence on the details of the models between interested members and the consultants. This will be facilitated by the Fortran source code for one of the simulation model programs already having been made available through the Secretariat.

10. Further prerequisites for the success of Workshop were identified as follows:

- (a) The krill distribution model underlying the studies may need refinement based on further analyses of existing research survey data for krill. Dr Macaulay, Mr Miller and Prof. Butterworth, and possibly other delegates, will undertake such work for presentation at the Workshop.
- (b) The practicality of collection of searching time information by Japanese vessels needs examination. Dr Shimadzu will report on the results of an exercise already carried out by Japanese vessels in this regard.
- (c) Information from Soviet research vessels (covering wider areas than typical fishing vessels) will be provided to Dr Mangel for analysis to be discussed at the Workshop.

11. The date and venue of this Workshop are to be determined by the Scientific Committee, but it was felt desirable to advise that:

- (a) The most appropriate date is between May and August; this would allow sufficient time to circulate the report of the Workshop before the next meeting of the Scientific Committee.
- (b) Computer support (mainframe) will be required at the venue so that the simulation models can be run within reasonable time periods.
- (c) Financial implications of the Workshop will need to include allowance for further work by the consultants, travelling expenses, secretarial assistance, computer time and report preparation.