ANNEX 5

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT
(Hobart, Australia, 8 to 19 October 2001)

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INTRODUCTION

1.1 The meeting of WG-FSA was held at CCAMLR Headquarters, Hobart, Australia, from 8 to 19 October 2001. The Convener, Mr R. Williams (Australia), chaired the meeting.

ORGANISATION OF THE MEETING AND ADOPTION OF THE AGENDA

2.1 The Convener welcomed participants to the meeting. He advised, with regret, that colleagues Drs E. Barrera-Oro, E. Marschoff and O. Wöhler from Argentina, and Prof. G. Duhamel from France, would be unable to attend this year's meeting.

2.2 The Convener introduced the Provisional Agenda which had been circulated prior to the meeting. Following discussions, it was agreed that the following subitems be added:

- 3.2.3a 'Potential for Toothfish Fisheries';
- 3.2.4a 'Structure of Scientific Observer Reports';
- 3.3.1 'Workshop on Estimating Age in Patagonian Toothfish';
- 3.3.2 'Results of WAMI relating to Biology, Demography and Ecology';
- 4.2.4 '*Dissostichus eleginoides* Prince Edward and Marion Islands (Subarea 58.7)';
- 4.2.5 'Results of WAMI relating to the Assessment and Management of *Champsocephalus gunnari*'; and
- 11.3 'Publication Matters'.

Consequently, existing subitems '*Champsocephalus gunnari* South Georgia (Subarea 48.3)' and '*Champsocephalus gunnari* Heard Island (Division 58.5.2)' were renumbered as 4.2.6 and 4.2.7 respectively.

2.3 With these changes the Agenda was adopted.

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

2.5 The report was prepared by Mr B. Baker (Australia), Dr E. Balguerías (Spain), Dr M. Belchier (UK), Dr A. Constable (Australia), Mr J. Cooper (South Africa), Prof. J. Croxall (UK), Dr I. Everson (UK), Dr R. Gales (Australia), Dr S. Hanchet (New Zealand), Dr R. Holt (USA), Mr C. Jones (USA), Dr G. Kirkwood (UK), Dr K.-H. Kock (Germany), Dr D. Miller (South Africa), Ms J. Molloy (New Zealand), Dr G. Parkes (UK), Ms K. Rivera (USA), Dr K. Sainsbury (Australia), Mr N. Smith (New Zealand), Ms E. van Wijk (Australia) and the Secretariat.

REVIEW OF AVAILABLE INFORMATION

Data Requirements Endorsed by the Commission in 2000

3.1 Dr D. Ramm (Data Manager) reported on the availability of data at the meeting and major developments in the CCAMLR Data Centre during the intersessional period.

3.2 Reconciliation of catch and effort reports with fine-scale data from CCAMLR fisheries in the 2000/01 season was undertaken during the year to assess the completeness of the fishery datasets. The majority of the fishery and observer data from the 2000/01 season was available at the meeting, and details were reported in WG-FSA-01/6, 01/20, 01/21, 01/42, WAMI-01/15 Rev. 1 and CCAMLR-XX/BG/7 Rev. 1.

3.3 All catch and effort reports, fine-scale data and scientific observer logbooks and reports had been submitted for the 2000/01 season, with the exception of:

(i) two five-day catch and effort reports (September A and B) from a Russian trawler operating in the fishery for *C. gunnari* in Subarea 48.3;

(ii) one monthly catch and effort report (August) from the Polish fleet trawling for krill in Area 48;

(iii) fine-scale catch and effort data from the fishery for *D. eleginoides* in Subarea 48.3 (Chile: 1 monthly period; Republic of Korea: 4 monthly periods, Russia: 3 monthly periods and Ukraine: 4 monthly periods); and

(iv) observer data from fisheries for *D. eleginoides* in Subarea 48.3 (1 logbook), Subarea 88.1 (1 logbook and 1 report) and Division 58.5.2 (1 logbook and 2 reports).

3.4 A number of vessels fished late in the 2000/01 season, or are still fishing, in some of the fisheries, and data from these operations are yet to be submitted.

3.5 Major work in the Data Centre in support of WG-FSA and ad hoc WG-IMALF during the 2000/01 intersessional period has included:

- assistance with the development and operation of the CDS database – this work included further development of the database structure and the addition of a web-based interface;

- further development and consolidation of data processing and extraction routines – this work included the initial development of a routine to transfer data from the electronic data forms to the database;

- further development of data queries in the research survey database to facilitate extraction of data for CMIX and TrawlCI for all surveys; and

- further transfer and validation of data from old or non-CCAMLR formats to the new research survey database.

3.6 As reported previously (e.g. WG-FSA-00/11), the use of CCAMLR research survey data has been impeded, historically, by:

- storage of data in the format used for holding fine-scale catch and effort data, with the resultant loss of research-specific fields (e.g. ground distance, trawl net width);

- the lack of an agreed CCAMLR format for submitting research data; and

- the absence of a mechanism whereby data originators can provide corrections and updates to the CCAMLR data.

Further work is planned in 2001/02 on the new research survey database so as to complete the transfer and validation of available data in old or non-CCAMLR formats to the new format, develop a CCAMLR format for the submission of research data, and liaise with data originators so that corrections and updates may be provided as a routine. The Working Group's priority for future data requirements is described under 'Future Work'.

Fisheries Information

Catch, Effort, Length and Age Data Reported to CCAMLR

3.7 Eight fisheries, including three exploratory fisheries, were prosecuted under conservation measures in force during the fishing season of 2000/01 (CCAMLR-XX/BG/7 Rev. 1):

- exploratory jig fishery for *Martialia hyadesi* in Subarea 48.3;
- exploratory longline fishery for *Dissostichus* spp. in Subarea 88.1;
- exploratory trawl fishery for *Chaenodraco wilsoni* in Division 58.4.2;
- longline and pot fishery for *D. eleginoides* in Subarea 48.3;
- trawl fishery for *C. gunnari* in Division 58.5.2;
- trawl fishery for *C. gunnari* in Subarea 48.3;
- trawl fishery for *D. eleginoides* in Division 58.5.2; and
- trawl fishery for *Euphausia superba* in Area 48.

3.8 With the exception of the fisheries for krill in Divisions 58.4.1 and 58.4.2 (for which the 2000/01 season started on 1 July 2000 and ended on 30 June 2001), all fishing seasons in 2000/01 fell between 1 December 2000 and 30 November 2001. Catches of target species reported by the start of the meeting are summarised in Table 1.

3.9 Catches reported from the Convention Area during the 2000/01 split-year (1 July 2000 to 30 June 2001) are summarised in Table 2. These catches, reported in STATLANT data submitted by 7 October, included catches taken within South Africa's EEZ in Subareas 58.6 and 58.7, and within France's EEZ in Subarea 58.6 and Division 58.5.1 which are not subject to conservation measures. WG-FSA agreed that the presentation and/or utilisation of information contained in Table 2 by the Working Group and the Scientific Committee would be reviewed at the Working Group's next meeting.

3.10 Catches of target species for the immediate past fishing season (1999/2000) reported to WG-FSA in 2000 (SC-CAMLR-XIX, Annex 5, Table 1) were based on catch and effort reports submitted to the Secretariat by 7 October 2000. WG-FSA agreed that revised catches from the immediate past season be presented at future meetings.

3.11 Length-frequency data submitted during 2000/01 were collected mostly by scientific observers, and submitted in their logbooks and reports. No age data were submitted.

Estimates of Catch and Effort from IUU Fishing

Landings and Catches from the Regulated and Unregulated Fishery

3.12 The green weight of *Dissostichus* spp. caught by Members and Acceding States both within and outside the Convention Area was reported as 43 531 tonnes for the 2000/01 split-year (Table 3). This constituted an increase of 11 773 tonnes from the 1999/2000 split-year (31 758 tonnes) (SC-CAMLR-XIX, Annex 5, Table 3). However, the latter did not include a reported catch of 5 765 tonnes of *D. eleginoides* provided by Mauritius immediately following the Commission meeting in 2000. It was not possible to allocate this catch either within or outside the Convention Area.

3.13 Reported catches for 2000/01 from waters outside the Convention Area totalled 30 152 tonnes (Table 3) compared with 11 553 tonnes in 1999/2000. Much of the former reported catch appears attributable to increased catch reporting (especially from Area 41) arising from entry into force of the CDS in May 2000.

3.14 WG-FSA again used the approach employed in recent years to estimate the magnitude of IUU fishing effort and catches in various subareas and divisions during the 2000/01 split-year. The results of this analysis are presented in Tables 4 and 5. The estimated total catch for all subareas and divisions within the Convention Area in 2000/01 was 20 870 tonnes, comprising 13 271 tonnes of reported catch and 7599 tonnes of estimated unreported catch (Table 5). These figures compared with a total estimated catch of 19 937 tonnes, a reported catch of 14 441 tonnes and an estimated unreported catch of 6 546 tonnes for 1999/2000. The estimated unreported catch within the Convention Area was some 39% of the total catch in 2000/01 compared with 32% in 1999/2000.

3.15 The estimated catch outside the Convention Area in 2000/01 was 30 151 tonnes, giving a total estimated catch of *Dissostichus* spp. of 51 129 tonnes including 108 tonnes from an unknown area (Table 5).

3.16 Reported, estimated unreported and estimated total catches since the 1996/97 split-year in various subareas and years are presented in Table 6. The estimated total catch from the Indian Ocean during that period was 122 136 tonnes compared with 19 597 tonnes at South Georgia (Table 7). The proportion of unreported catches in the two areas is 54% and 36% of the reported catches respectively.

CDS-derived Catches by Area

3.17 CDS-reported landings from Area 51 (Indian Ocean adjacent to the Convention Area boundary) in the 2000/01 split-year are presented in Table 8. Some 73% of these landings were confined to Port Louis. The Working Group noted that this information has improved knowledge on the potential location of the fishery as well as its operational characteristics. Such information is extremely valuable in improving estimates of total removals of *Dissostichus* spp. from both within the Convention Area and adjacent areas.

3.18 The Working Group agreed that it would be useful to extract such information from the CDS as that presented in Table 8 for ports close to Areas 41 and 87.

3.19 Subject to the views expressed in paragraph 3.17 above, WG-FSA agreed that available information from the CDS suggests that Area 51 has assumed importance as a source of *D. eleginoides*. It was not possible to conclude whether this observation was a true indication of increased catch in Area 51 or whether it was a reflection of improved information on catch location arising from improved reporting through the CDS.

3.20 Estimated live weights of *Dissostichus* spp. from CDS data by month for 2000 and 2001 are detailed in Table 9. The areas with the highest attributed catches in 2001 were in Area 51 (12 028 tonnes) followed by Area 41 (7 115 tonnes), Subarea 48.3 (3 992 tonnes), Area 87 (3 681 tonnes), Division 58.5.1 (2 585 tonnes) and Division 58.5.2 (1 614 tonnes).

3.21 The Working Group agreed that the data in Table 9 are potentially useful as they highlight the contribution of the CDS to improving information on the origin of *Dissostichus* spp. These data indicate significant levels of catch during 2000/01 from outside the Convention Area, in particular Area 51. The Working Group noted that it would be important to separate catches taken outside the Convention Area into those taken within national EEZs, and those taken on the high seas. For example, the bulk of the catches reported for Area 41 is from EEZs in the Southwest Atlantic, while catches reported for Area 51 are apparently from the high seas.

3.22 The Working Group noted that the mean CPUE for *D. eleginoides* implied by CDS data for Area 51 was some 23% higher than that in Subarea 48.3, and 44% higher than in Subarea 58.6 (a CCAMLR subarea adjacent to Area 51) during both 2000 and 2001. This suggests that Area 51 may be more productive than other areas. However, compared with other potential toothfish fishing grounds within the Convention Area, Table 10 shows that areas of likely toothfish productivity in Area 51 are relatively small. The Working Group agreed that there may be some inaccuracies in the CDS-reported *Dissostichus* spp. catches from Area 51. CDS-reported catches from Area 51 may be misreporting of catches taken elsewhere. This could imply transhipment of catches at sea rather than accounting for catches actually originating in Area 51.

3.23 The Working Group was unable to comment further on possible links between the productivity of Area 51 and reported catches attributed thereto. Members were urged to examine the situation further and the Working Group agreed to review the matter at its 2002 meeting.

3.24 The Working Group noted the apparent time lag associated with reporting of CDS data. For example, there was a total of 879 tonnes reported for Subarea 48.3 in September

2001 after the closure (on 31 August) of the longline fishery in that area. Time lags in the compilation of CDS data compared with reported catches for *D. eleginoides* in Area 48 during 2000 and 2001 are shown in Table 11. Substantive agreement is also shown between reported catch and CDS landings data, especially for 2001. This suggests that CDS landings (at least in Area 48) serve as a useful proxy for information on catches.

3.25 The Working Group recommended that future examination of information of the type presented in Table 9 would be useful to highlight possible cycles in fishing patterns.

Total IUU Catch and IUU Catches in Assessments

3.26 WG-FSA noted that, consistent with its observation last year (SC-CAMLR-XIX, Annex 5, paragraph 3.27), illegal activities around the Prince Edward Islands have fallen to very low levels. This is probably the result of very low *D. eleginoides* stock levels resulting in decreasing catches within the South African EEZ (see paragraph 4.121). It was agreed that any future recovery of such stocks around the Prince Edward Islands will be crucially dependent on the extent of future IUU catches in the region.

3.27 Illegal fishing still persists in the waters adjacent to the Crozet and Kerguelen Islands as well as around Heard Island.

3.28 As already noted, the total IUU catch for *Dissostichus* spp. in the Convention Area was 7 599 tonnes in 2000/01 compared with 6 546 tonnes in 1999/2000 (Table 5).

3.29 The Working Group agreed that the introduction of the CDS, and the submission of additional data by Mauritius in particular, are likely to have improved estimates of total toothfish removals and IUU catches.

3.30 It was also agreed that estimates of IUU catches of *Dissostichus* spp. are still only minimum estimates. Any potential relationship between current IUU estimates and catches attributed to Area 51 (paragraph 3.22) increases the uncertainty of present estimates. Therefore IUU estimates for 2000/01 should again only be compared with previous years with caution.

3.31 The IUU input assessments for *D. eleginoides* fisheries used the estimates of unreported catches of 300 tonnes for Subarea 48.3 (South Georgia) and 1649 tonnes for Division 58.5.2 (Heard Island).

Recommendations to the Scientific Committee

3.32 The Secretariat should be tasked with providing information in time for the Working Group's 2002 meeting similar to that used here to estimate the extent of *Dissostichus* spp. catches both within and outside the Convention Area using CDS, vessel sightings and reported catch data.

3.33 The Scientific Committee's and Commission's attention is drawn to the persistent high levels of unreported *Dissostichus* spp. catches, although the general level of uncertainty surrounding estimation of such catches appears to have been reduced as a result of the implementation of the CDS.

3.34 The Scientific Committee's and Commission's attention is also drawn to the apparent and growing attribution of *Dissostichus* spp. catches to Area 51.

Scientific Observer Information

3.35 The available information collected by scientific observers was summarised in WG-FSA-01/20, 01/21, 01/22 and 01/42. International and national scientific observers provided 100% coverage of fishing operations of vessels targeting *Dissostichus* spp., *C. gunnari*, *C. wilsoni*, *E. superba* and *M. hyadesi* in the Convention Area during 2000/01. Reports and logbook data were submitted from a total of 60 cruises, comprising 38 longliners, 16 trawlers, 5 pot vessels and 1 jigger. These cruises covered longlining in Subareas 48.3, 58.6, 58.7 and 88.1; trawling in Area 48, Subareas 48.1, 48.3 and Divisions 58.4.2 and 58.5.2; and 'potting' and jigging in Subarea 48.3. Scientific observers were deployed by 12 Members: Argentina (1), Australia (6), Brazil (1), Chile (2), France (2), Japan (1), New Zealand (2), South Africa (16), Spain (3), Ukraine (4), UK (18) and Uruguay (4). Details of the observations are given in Table 12.

3.36 All but four of the logbooks (two from the longline fishery and two from the trawl fishery), and all but five of the observer cruise reports (one from the longline fishery and four from the trawl fishery) were submitted before the start of the meeting. All logbooks were prepared using the standard CCAMLR format and most of them were presented using the CCAMLR electronic logbook forms (Excel spreadsheet format) that allowed a faster entry into the CCAMLR database.

3.37 The Working Group also noted the good quality of all the observer cruise reports which were submitted in accordance with the guidelines laid out in Part 1, Section 5 of the *Scientific Observers Manual*. These reports contained detailed information on vessel characteristics, cruise itinerary, fishing gear and fishing operations, meteorological conditions and biological observations carried out on fish. Comprehensive information on seabird incidental mortality, marine mammal observations, garbage disposal and loss of fishing gear at sea is also provided (see Section 7).

3.38 Despite the quality and the utility of the information contained in the abovementioned cruise reports, the Working Group felt that there was a need for improving their precision and clarity in order to obtain a better and quicker understanding of fishing operations as well as of compliance with conservation measures in force (see paragraphs 7.94 to 7.99). A subgroup was therefore tasked to look at different types of presentation to improve the current format of the observer report.

3.39 The subgroup reviewed the guidelines for the observer report as set out in Part 1, Section 5 of the *Scientific Observers Manual*. A new mixed format of tick-boxes that must be filled in with key relevant information for the Working Group, and free text boxes where the observers may express their observations in a more extended way, was recommended. The first draft of this observer report template should be prepared by the Secretariat by the end of November 2001 for comments from technical coordinators and members of the Working Group particularly involved or interested in the work of observers. The final version of the template should be available to technical coordinators for use by scientific observers by the end of February to be tested in the field.

3.40 The subgroup also noted that feedback on issues such as the use of various materials supplied by CCAMLR (see paragraph 7.5) could also easily be built into such a standard report.

3.41 The Working Group acknowledged the results of the subgroup deliberations and recognised the utility of the proposed approach. However it was noted that the optimisation of the new format could not be concluded immediately and that several Working Group meetings may be needed before obtaining the desired product.

3.42 The Working Group also noted the need for the correct understanding of the information that is requested from the observers and therefore recommended that the new observer report template, as well as the CCAMLR electronic logbooks should be translated into all the official languages of the Commission. This would also better facilitate rapid adoption of the new forms across all Members. The tick-box elements of the form could also be rapidly summarised across languages without translation.

3.43 Collection of biological samples of fish by observers continued to be done in accordance with research priorities identified by the Scientific Committee in previous years (by-catch, length frequency, weight at length, maturity, CF, otolith/scales).

3.44 Considering the tables prepared by the Secretariat which contain summaries of the data and biological material gathered by scientific observers during the last season (Table 13) and accumulated over the years of scientific observations (Table 14), it is clear that the amount of information and material already held at the CCAMLR database or deposited at the different laboratories in the Member countries is huge.

3.45 This information and material concerns not only target species but also by-catch and discarded species in the different fisheries and areas, subareas and divisions within the Convention Area. Their quality and quantity is not homogeneous and there are even data and material from species that have been identified only to a genus, family or higher taxonomic level.

3.46 The Working Group recognised the great importance of this information and discussed its usefulness as a basis for studies relevant to the objectives of the Commission and for academic studies that may be carried out by research institutions. Nevertheless, the Working Group was unable to comment further on this matter and recommended that a workshop should be held prior to, or during, next year's meeting to adequately discuss the priorities of the observers' tasks and the use of the information and the material collected by them.

3.47 The issue of the observers' priority tasks was also discussed by WG-IMALF. Details of their deliberations are contained in Section 7.

3.48 There were no significant problems reported by observers on the use of the *Scientific Observers Manual*. Some observers continued to report problems with the completion of

Forms L3 'Daily Work Schedule of Observers' and L4 'Estimating Seabird and Marine Mammal Abundance'. However, for the two last years it has been stated that the completion of these forms is not compulsory (SC-CAMLR-XVIII, Annex 5, paragraphs 3.44(ix) and (x); SC-CAMLR-XIX, Annex 5, paragraph 3.46). It was reiterated that technical coordinators should continue to bring these changes to the attention of the observers.

3.49 Other feedback from some observers in their reports related to the question of the random sampling of the longline during the hauling (SC-CAMLR-XIX, Annex 5, paragraph 3.48) and the need for simple keys for the identification of fish, similar to those already prepared and in use for seabirds. Both matters have been specifically addressed in the course of the Working Group by two ad hoc subgroups. The results of the deliberations of these groups are contained in paragraphs 3.53 to 3.67 and 4.287 to 4.297.

3.50 The Working Group thanked all scientific observers for their work during the 2000/01 fishing season and for the great deal of very useful information and material collected. In doing so, it also recognised the importance of technical coordinators participating at the meetings of the Working Group. The Working Group discussed the opportunity of organising a workshop for technical coordinators and scientific observers to deal with matters of their common interest, including the revision of the list of priorities of the observers' tasks.

3.51 The Working Group recommended that the participation of technical coordinators should be encouraged for future meetings and that other modalities of cooperation, such as the exchanges of training manuals prepared at a national level, the participation of technical coordinators in training courses conducted by other Members etc., should be sought as a goal to try to harmonise as much as possible the methods and the criteria followed by the observers in their work.

3.52 Finally, the Working Group highlighted the potential for the use of observers in all longline, trawl, pot and jigging fisheries under the CCAMLR Scheme of International Scientific Observation and congratulated the Secretariat for the excellent job carried out during the intersessional period in processing and analysing the information related to this Scheme. This assisted considerably the work of the Working Group at the meeting.

Sampling Catches from Longlines

3.53 In 1999 WG-FSA recognised that there were a number of different sampling protocols in use for observer subsampling of longline catches. Some use 'gear-unit' based approaches, based on WG-FSA-98/60, in which units of the longline are defined and randomly sampled as they are hauled. Others use 'time-unit' based approaches, based on WG-FSA-98/58, in which the expected haul time is divided into units and randomly sampled. In 1999 WG-FSA also received reports that some observer teams had experienced difficulties with the implementation of the gear-unit based approach, which is generally more complex than the time-unit approach. In 2000 WG-FSA requested that these issues be examined so as to allow revision and standardisation of the methods used by observers for sampling longline catches.

3.54 An intersessional subgroup of WG-FSA compiled information on the current practices by observers (reported in WG-FSA-01/50) and the issues relating to sampling protocols were further examined by a subgroup at this year's meeting of WG-FSA.

3.55 Current practices for observer sampling of longline catches differ among observers designated by various Members. There were many reports of difficulties in finding a practical work plan for sampling the longline catch and in finding a reasonable division of effort between sampling of the target species and sampling for by-catch and other ecological interactions (i.e. the interactions with, or effects of, fishing on other species).

3.56 The subgroup identified the need to develop specific recommendations for WG-FSA in 2002 on three issues:

(i) the subsampling protocol;
(ii) the sampling fraction; and
(iii) the balance of observer effort directed towards fishery target species versus ecological interactions.

3.57 An outline of the intersessional work needed to address each of these was developed. The subgroup also identified some interim advice for observers to use.

3.58 It was recommended that the subgroup develop the parameters that will be calculated from the observer program to support the work of WG-FSA, the statistical properties that are desired in each parameter, and the priority assigned to each parameter. These parameters would be reviewed each year. WG-FSA should receive a standard report each year providing the estimates from the observer program for the elements identified to support the review and update process each year.

3.59 Intersessional analysis on the subsampling protocol should address the question of whether the gear-unit based approach, as described in WG-FSA-01/7 and WG-FSA-98/60, is a statistically sound methodology but difficult to implement, while the time-unit based approach is more easily implemented but may not sample the catch randomly. The existing data should be analysed, and used in conjunction with theoretical considerations, to determine for the time-unit based approaches:

(i) the extent of bias under current longline operations and possible future operations;

(ii) the appropriate methods to account for varying sampling fractions across hauls; and

(iii) whether there is a reasonable method of statistically correcting for the bias, if the level of bias is important under current or possible future longline operations.

The subgroup was requested to advise on the application of the gear-unit versus the time-unit based approaches.

3.60 A major use of the information from longline subsampling is to estimate the quantity of by-catch and whether the by-catch exceeds a specified limit. Scientific advice is required on the sampling fraction (i.e. the proportion of longline hauls that are observed and the proportion of each individual observed haul that is subsampled) to reasonably meet this need. The existing data should be analysed to determine the relationship between the sampling fraction and:

(i) the precision of the estimated number caught; and
(ii) the probability of concluding that the number caught is greater than the specified limit.

3.61 This analysis should be repeated for the key by-catch species, and the specified limits should be based on CCAMLR recommendations where these exist, or on reasonable interpretation of the CCAMLR by-catch principles where these specific CCAMLR limits have not yet been set.

3.62 Based on these analyses the subgroup should recommend a subsampling fraction for use in general, and provide procedures for varying it in certain circumstances as necessary.

3.63 There are two related issues regarding the balance of observers' effort directed to fishery or ecological interactions:

(i) the allocation of time between sampling the fishery target species and sampling to measure ecological interactions; and

(ii) specification of the sampling activities within each.

3.64 This recognises that the sampling of target and by-catch species mostly draws from the aggregated catch from a haul, is concerned with estimating properties that are not expected to vary systematically within hauls (e.g. the distribution of age conditional on length), and uses the total catch to scale up estimates. By contrast, the ecological interactions sampling does rely strongly on observing and subsampling portions of the haul and scaling up the observations by measures of fishing effort. Consequently, the issue of observing and subsampling portions of the haul is important in this context.

3.65 Evaluation of the appropriate balance of effort requires full specification of the statistical requirements for all the proposed monitoring (e.g. level of precision required). Rather than attempt to determine the balance based on these requirements, which are poorly known at this stage, the analysis should, in the first instance, examine the consequences of the balance that has evolved over the past few years in situations of one and two observers. In both cases the effort is about equally divided between observing fishery target species and ecological interactions.

3.66 The Working Group requested the subgroup to identify the high-priority observations for each fishery target species and ecological interactions, and calculate the statistical properties of the parameters of interest, based on about equal effort to the two types of sampling and for one and two observers. The resulting estimates can then be compared with the statistical requirements with respect to these parameters. This would provide the basis for identifying major failings of the present sampling protocols and effort allocations, and for suggesting desired changes.

Interim Advice to Observers

3.67 Until such time as the intersessional work above is completed, it is recommended that observer sampling be based on the following:

(i) For most biological aspects of the target species (e.g. length and age at length) which are unlikely to show systematic variation within a gear unit and are aimed at providing an estimate relating to the aggregated catch from each haul, two alternative methods of sampling are appropriate:

(a) based on sampling from the aggregate catch, e.g. samples taken from the aggregated catch in the processing room and weighted up to the total catch of that haul; or

(b) a simplified method of sampling gear units, for example sampling the first *n* fish from sampling unit *y* (where *y* is randomly selected and *n* is a constant number).

(ii) Most sampling for by-catch and ecological interactions is aimed at providing an estimate of a catch rate per set, which is then to be weighted up by the number of sets to represent the total catch and must ensure that the samples are representative of the full extent of the longline. The sampling protocol would be all hooks in gear unit *y* are observed (where *y* is randomly selected).

(iii) Where gear-unit based sampling is undertaken, a form is needed that records the number of gear units in the haul, the number of gear units observed and the elements that were observed in that for each observed gear unit (e.g. birds, fish by-catch, invertebrate by-catch, bait condition, hook loss), and the units of measurement for each element observed (e.g. numbers, weight, presence/absence).

(iv) Based on accumulated experience to date, the time allocation should be about 60% observing target species and 40% observing ecological interactions.

(v) A table of the parameters to be estimated from data collected by the observer program, as outlined in paragraph 3.66, should be provided and updated by WG-FSA each year.

Sampling Catches from Trawlers

3.68 A protocol to use for random subsampling catches from research trawl surveys was described in WG-FSA-01/68. The Working Group considered that this might also have some application for observers sampling in commercial trawl fisheries. The subgroup was requested to investigate this and other components of sampling from trawl catches.

Conversion Factors

3.69 Analyses carried out on about 6 000 CF records for individual fish (CCAMLR observer database) show that the data are highly variable, with values mostly ranging from around 1.2 to around 2.5. This variability is apparently not explained by differences in CFs between products (HAG and HGT), sexes or years. The highest variability is observed at the vessel level (Figure 1) and a definite trend is noticeable according to month, with values reaching a maximum in August (Figure 2). There are also differences in the mean CF values by statistical area.

3.70 High variability in the CFs may result in part from inter-vessel differences in processing practices. At least two types of cuts have been identified for removing the head of the fish: a 'straight cut' or a 'V cut' (WG-FSA-01/66). The increasing trend of CF values within a season may reflect the stage of sexual maturity of the fish. Differences in CFs between statistical areas may be due to the effect of one or more of the factors discussed above and/or to the existence of different populations.

Differences between Vessel and Observer Values of CFs

3.71 At the 1998 meeting of the Working Group it was noted that differences between CFs calculated by observers and those used by the fishing vessels to report their catches might cause a significant error in estimates of catches (SC-CAMLR-XVII, Annex 5, paragraphs 3.74 to 3.76). A draft protocol for collecting observer data on CFs was prepared at that meeting (SC-CAMLR-XVII, Annex 5, Appendix D). The Scientific Committee endorsed this proposal and the procedure was evaluated during the next fishing season (SC-CAMLR-XVII, paragraph 3.6).

3.72 Analyses were carried out using those data during the Working Group meeting in 1999. Results showed that there were no significant differences in CFs between male and female fish or between headed and gutted product (HAG) and headed, gutted and tailed product (HGT) (SC-CAMLR-XVIII, Annex 5, paragraphs 3.86 and 3.87). However, differences between CFs used by the vessels and those calculated by the observers remained important.

3.73 The Working Group considered that the differences might be due to differences in definitions of products by vessel skippers as opposed to scientific observers and agreed that the fish being sampled by the observers should be subject to the same processing methods as used during commercial processing of the catch (SC-CAMLR-XVIII, Annex 5, paragraphs 3.90 and 3.91). It also recommended that the Scientific Committee consider steps to ensure that appropriate CFs were used when reporting catches to CCAMLR (SC-CAMLR-XVIII, Annex 5, paragraph 3.93).

3.74 As a result of those requests, the Scientific Committee recommended that vessel skippers adopt the procedure set out in the *Scientific Observers Manual* to calculate CFs at the beginning of the season (SC-CAMLR-XVIII, paragraph 5.50). This resulted in a better agreement between the vessel and the observer CFs in the 1999/2000 fishing season (SC-CAMLR-XIX, Annex 5, paragraph 3.63).

3.75 Information provided by scientific observers on the CFs during the 2000/01 fishing season is summarised in Table 15. Only 45 cruise reports of the 60 cruises conducted during the season contained information on CFs. Among them 30 reports included data provided by both the vessel skipper and the observer, 14 provided only the observer CFs and one provided only the vessel CF. The comparison between the 30 simultaneous values of vessel and observer CFs shows that only three were equal and that in most of the cases (20), the CFs calculated by the observers were higher than those used by the vessels. Only seven of the CFs used by the vessels were higher than their corresponding observer CFs (Figure 3).

3.76 The Working Group noted that the reported data indicate that differences remain between CFs calculated by vessel skippers and observers. The Working Group also recognised with concern the potential difficulties inherent in inconsistent CFs and the implications of this problem for the calculation of accurate catch levels, which is particularly relevant to the assessment work.

3.77 The Science Officer also noted that the use of CFs is important for the analysis of CDS data. Green weight is being used as a standard unit in the analysis. This is related to the necessity to reconcile weights of landings with weights of fish exported and re-exported. Landed fish comprise a number of fish products, each having a specific CF. At present, the CDS uses a set of standard CFs agreed by the Scientific Committee in the past. Therefore, information that CFs of fish products vary between fishing companies is of importance. If more information becomes available, it would allow the CDS to use area/subarea/division-specific CFs. The Science Officer also recalled that the use of green weight as a standard unit assists in the evaluation of the total catch of *Dissostichus* spp. and, in particular, in the evaluation of levels of IUU fishing for *Dissostichus* spp. inside and outside the Convention Area.

3.78 The Working Group reiterated that specific guidelines were provided to both the observers and the vessel skippers for calculating CF values, namely:

(i) the continuation of the program by observers using the current format as in the *Scientific Observers Manual* and concentrating efforts on the product constituting the largest fraction of the fish being processed (SC-CAMLR-XIX, Annex 5, paragraph 3.64);

(ii) to conduct the calculations of CFs reported by scientific observers on a fish-by-fish basis (SC-CAMLR-XIX, Annex 5, paragraph 3.65);

(iii) the procedure set out in the *Scientific Observers Manual* should be adopted by vessel skippers as a standard method for measuring CFs and the cooperation between scientific observers and vessel skippers should be encouraged in the establishment of CFs to avoid duplication of work and possible inconsistencies in results (SC-CAMLR-XVIII, paragraph 5.50); and

(iv) CFs estimated at the start of each fishing trip using the standard procedure should be used in the calculation of total catches to be reported to the Commission during the season (SC-CAMLR-XVIII, paragraph 5.51).

3.79 The Working Group urged observers and skippers to strictly follow the above guidelines. Observers were also urged to record the values of CFs used by the vessel along with their own observations, and submit these in their scientific observer reports.

3.80 The Working Group recommended that forms dealing with CFs in the *Scientific Observers Manual* should be modified to avoid misunderstandings on the processing types and to consider different methods within the same process (e.g. types of cuts).

3.81 The Working Group encouraged Members to undertake detailed analyses of CFs reported by vessels and observers during the intersessional period to better understand the patterns of differences and what factors may be causing them. It also recommended theoretical studies to be carried out in an effort to derive better estimates of the sampling precision of procedures to be applied in CF calculation.

3.82 The Working Group recognised that potential deviations may occur in the estimation of actual green weight catches by fishing vessels during the fishing season because the CFs seem to change according to the maturity stage of fish. Several options for periodically updating CFs during the season were discussed, along with procedures for timely submission of these data to the Secretariat.

3.83 The Working Group therefore recommended that the Scientific Committee consider steps to ensure that CFs are regularly and routinely evaluated throughout the season in order to adequately convert catches reported to CCAMLR into their corresponding green weight.

Research Surveys

3.84 WG-FSA-01/72 presented the results of a pilot bottom trawl survey carried out in the South African EEZ around the Prince Edward Islands in April 2001. The maximum operating depth of the survey vessel was 1500 m. Over 90% of the survey area was deeper than 1 500 m and could not be surveyed by bottom trawl. Depths less than 1 500 m were mainly restricted to 28 hills and seamounts. This, in combination with a paucity of bathymetric data and the roughness of the seabed, meant that a random stratified trawl survey could not be conducted. Fifty-five trawls were completed in as representative a manner as possible by dividing the area into four sectors. There was a strong relationship between density and latitude. A preliminary biomass estimate of 1118 tonnes of *D. eleginoides* was obtained. Due to problems with the survey design, this estimate should not be regarded as either absolute or representative of the area as a whole. Bottom trawl surveys may provide usable estimates of recruits for this area, but the survey design will need to be modified if abundance estimates are required.

3.85 WG-FSA-01/33 details a US bottom trawl survey undertaken during March 2001 around the South Shetland Islands (Subarea 48.3). The survey was undertaken within the 500 m depth contour to provide biomass estimates for eight species of finfish. Species and size composition, diet and spatial distribution were also recorded. Acoustic data was logged during the survey to define the distribution of krill and seabed characteristics. The biomass estimates derived from this survey were compared to those from the 1998 US AMLR survey. The biomass of most species had decreased slightly when compared to the 1998 survey, although the 95% confidence limits were considerably decreased for most species. There was no evidence that stocks of *Notothenia rossii* had recovered to historic levels even in the absence of commercial fishing for the past 20 years. The abundance of finfish determined in this study would not support a reopening of the commercial fishery.

3.86 WG-FSA-01/04 detailed the results of a trawl survey conducted in May 2001 in Division 58.5.2 to determine the abundance of *C. gunnari*. This survey was conducted at the same time of year and with the same gear types as the 2000 survey. The 2-year-old fish determined in the 2000 survey were identified in this survey as a less abundant cohort of 3-year-olds. A new age-2 cohort was also evident, although this was not as abundant as the age-2 cohort noted in the 2000 survey.

3.87 WG-FSA-01/73 described the results for *D. eleginoides* from the 2001 survey in Division 58.5.2. Stratum areas were slightly different compared to those of previous surveys. The biomass on Shell Bank is no different from previous estimates. Over the series of surveys, lower biomass is evident in the shallow areas of the Heard Island Plateau with greater biomass in deeper water. This is probably a result of the size distribution of *D. eleginoides* (with a positive relationship between size and depth). The survey stratification is now well described and will most likely not change in the near future. As with icefish, age classes in the stock appear to have reasonably predictable distribution in space.

3.88 The data presented in these papers were referred to the subgroups on assessment of *D. eleginoides* and *C. gunnari* to determine how they might be used in assessments for this year.

Mesh/Hook Selectivity and related Experiments affecting Catchability

3.89 A declining trend in the mean lengths of toothfish caught around South Georgia and Shag Rocks from 1995 to 1999 was noted at last year's meeting. Mean lengths of toothfish were reanalysed in WG-FSA-01/48 and the same declines in mean lengths were found from 1997 to 1999. A GLM analysis showed that depth and area explained part of the variation over time, but not all of it. Mean lengths appear to be variable both within and between seasons but with no clear trend. The analysis suggests that both toothfish length distribution and fishing effort distribution is spatially and temporally heterogeneous. Effort distribution by area and depth has a significant effect on the overall length-specific selectivity of toothfish. If the fishery changes its depth of operations from year to year, then different size components of the stock are targeted, which will lead to different length-specific selectivity curves applying in different years. This paper provided preliminary estimates of length-specific selectivity curves for each year from 1997 to 2000. A consistent feature was that larger fish had a lower relative selectivity than smaller fish.

3.90 The Working Group noted that this information will be taken into account in assessments for Subarea 48.3. In addition, it noted that the results of this study would have implications for the simulation studies presented in WG-FSA-01/17 which estimates length at age of the population from commercial fishery information (see paragraphs 3.143 to 3.150).

Conversion Factors

3.91 CFs are considered in paragraphs 3.69 to 3.83.

Review of Fish, Squid and Crab Biology/Demography/Ecology

Dissostichus eleginoides

Age and Growth

3.92 During WG-FSA in 2000 it had been thought that some of the differences in length-at-age information might be due to variations in the methods for preparing and reading otoliths that were in use. Dr Everson had been invited to organise a program to investigate this problem. He had prepared SC CIRC 00/21 arising from which it had been agreed that an otolith exchange project should be set in train immediately, leading to a workshop meeting to consider *inter alia* the results.

3.93 Three laboratories, the Central Ageing Facility (CAF) in Australia, the Centre for Quantitative Fisheries Ecology (CQFE) in the USA and the National Institute of Water and Atmospheric Research (NIWA) in New Zealand, offered to participate in the exchange program and had submitted prepared otolith samples. Each otolith was given a reference number and no further information was given to the individual readers. All otoliths in the scheme were read at each institute. The results were collated centrally and discussed at the workshop.

3.94 The Workshop on Estimating Age in Patagonian Toothfish took place from 23 to 27 July 2001 at CQFE, Old Dominion University, Norfolk, Virginia, USA. Dr Everson introduced the report of the meeting (Appendix H). The main aims of the workshop were to consider and advise WG-FSA on:

(i) otolith collection protocols;
(ii) otolith preparation protocols;
(iii) agreed definitions of otolith structures used for age determination;
(iv) quality control and quality assurance; and
(v) validation.

3.95 The workshop advised WG-FSA that:

(i) although age determination of *D. eleginoides* was difficult, it could be achieved using otolith sections;

(ii) key features to be taken into account when reading otoliths are set out in Appendix H, paragraphs 4.9 to 4.15;

(iii) three otolith preparation protocols had been discussed and were all considered suitable for the purpose;

(iv) a routine program to exchange otoliths between laboratories should be established;

(v) all protocols for age determination should be subject to quality assurance and quality control;

(vi) reference sets of otoliths should be prepared in order to monitor the precision of experienced and new readers; and

(vii) a revised otolith collection protocol should be initiated for the CCAMLR Scheme of International Scientific Observation.

These views were endorsed by the Working Group.

3.96 The workshop had agreed that further research was needed on the following topics:

(i) determine more precisely the time interval between the formation of the primordium and the formation of the distal edge of the first translucent zone or the edge of the nucleus;

(ii) validation of the timing of annulus deposition through Marginal Increment Analysis (MIA);

(iii) develop other validation methods specifically to estimate accuracy; and

(iv) follow modal progression of length density of pre-recruits from a single area with otolith ground truthing, with the aim of better defining their growth.

The Working Group endorsed these views.

3.97 In order to further the tasks identified by the workshop and outlined in paragraphs 3.95 and 3.96 above, the workshop had proposed to establish a CCAMLR Otolith Network (CON) to which all participants at the workshop, along with anyone interested in studies on otoliths of Southern Ocean fish, could join. It was noted that CON would meet initially through email correspondence, although meetings might be arranged in the margins of symposia or CCAMLR meetings. Dr K. Krusic-Golub (CAF, Australia) had initially agreed to lead CON.

3.98 The Working Group thanked Dr Everson for organising the workshop and thanked the participants for their cooperation and input.

3.99 The analysis of the age composition of juvenile *D. eleginoides* caught during the 2000 UK groundfish survey at South Georgia is reported in WG-FSA-01/16. This study directly follows the recommendation in paragraph 3.96(iv). The age of fish estimated from otolith readings closely matched modal size groups from length-frequency distributions. It was confirmed that one annulus band on the otolith corresponded to one year's growth in juvenile fish.

3.100 Several members, whilst agreeing that it was clear that successive bands were likely to indicate annual growth, suggested that the length, 19.8 cm, of the '0+' group was larger than might be expected for the first year's growth of the species of Antarctic fish. Dr Everson noted that this reflected the timing of formation of the first annulus and was in line with the workshop proposal set out in paragraph 3.96(i). Dr Kock noted that examination of scales of smaller juvenile fish revealed a weak annulus at about 10 cm length and a stronger one at about 20 cm. This would indicate that fish of about 20 cm were age class 1+. Several members suggested that this might also be investigated through examination of otolith micro-increments, larval fish otoliths and the scales of juvenile fish.

3.101 The study reported in WG-FSA-01/16 had been restricted to juvenile fish and it was noted that further work was required to validate growth in older fish. It was noted that the workshop report contained information on a mark–recapture experiment in which Strontium

Chloride had been used to provide a clear marker in otoliths. Mr Williams reported on progress with this study which had indicated that successive annuli were representative of annual growth. He further noted that a report on the study should be available to WG-FSA in 2002.

3.102 A summary of the findings of a study of age and growth in *D. eleginoides* undertaken by Dr J. Ashford at CQFE was presented in WG-FSA-01/70.

Population Structure

3.103 The population structure of *D. eleginoides* at three locations in Division 58.5.2 and two locations at Macquarie Island (outside the Convention Area) were compared with a small sample of fish from Subarea 48.3 by using mitochondrial and micro-satellite analyses and was reported in WG-FSA-01/38. Marked heterogeneity between the populations was observed suggesting restricted gene flow between the locations.

Tagging

3.104 The results of the tagging program for *D. eleginoides* in Division 58.5.2 were described in WG-FSA-01/76. Approximately 10% of the releases have been recaptured. The aims of the program were to:

(i) investigate the extent of movement of *D. eleginoides* within the Heard Island fishing area and beyond;

(ii) estimate the growth rate of fish between release and recapture; and

(iii) provide an alternative method of stock assessment through mark–recapture techniques.

3.105 A large number of tag–recaptures were obtained (>500). The majority of fish were shown to have dispersed over relatively small distances (up to 15 miles). However three fish were observed to have dispersed over much greater distances to Kerguelen and Crozet Islands.

3.106 The management implications of the movement of fish between fishing grounds was discussed and it is hoped that further work to be undertaken on the genetics of fish from these areas will provide further insight into the subject.

3.107 Tagging of small numbers of *D. eleginoides* had been undertaken on board New Zealand vessels in Subarea 88.1 during the tagging program for *D. mawsoni* (see paragraph 3.111).

Dissostichus mawsoni

General

3.108 Fishery data obtained during the 2001 season from the exploratory fishery for *D. mawsoni* in the Ross Sea (Subarea 88.1) were presented in WG-FSA-01/63. Heavy ice meant that the 2001 fishery occurred in different locations and depths to previous years. *D. mawsoni* were recorded caught at depths ranging from 300 to 1900 m but were most abundant at depths between 600 and 1 300 m. Otolith age estimations obtained from 500 *D. mawsoni* suggested that fish aged 5–20 years dominated the catch. Fish of both sexes appear to be fully selected by age 8. Von Bertalanffy parameters and length–weight coefficients were updated.

Reproduction

3.109 The first recorded spawning activity of *D. mawsoni* was reported from studies on gonad maturation in *D. mawsoni* in WG-FSA-01/51. The spawning season appears to begin in late May and extends through the winter months. A histological investigation of ovaries from 84 randomly selected fish was undertaken. Continuing discrepancies between macroscopic and microscopic staging were reported. It was also noted in this study that the spawning locations were further north than had been expected. Microscopical investigations suggested an L_{m50} for females of 100 cm. Pending further studies on maturity stages, the Working Group agreed that L_{m50} of 100 cm was appropriate for both sexes.

Population Structure

3.110 The results of a study on the genetic diversity within and between geographically disparate populations of *D. mawsoni* were presented in WG-FSA-01/69. High levels of genetic similarity were observed within and between fish obtained from McMurdo Sound (Subarea 88.1) and Brabant Island (Subarea 48.1). However, significant population structure was observed, including fixed differences among populations.

Tagging

3.111 WG-FSA-01/64 described the commencement of a tagging program for *D. mawsoni* in the Ross Sea (Subarea 88.1). In the 2000/01 fishing season, 259 *D. mawsoni* and 67 *D. eleginoides* were tagged from New Zealand vessels operating in the Subarea 88.1 exploratory fishery. Two tagged *D. mawsoni* were recaptured this season. One had been at liberty for only three days. The other fish had been at liberty for at least 10 years having been double-tagged by US scientists at McMurdo Sound. It was recaptured north of 72°S, over 350 miles from the location of tagging. The program has the short-term aim of providing information on movement and growth of toothfish species in the Ross Sea. A longer-term aim is to provide an alternative method of stock assessment through mark–recapture techniques, and New Zealand encouraged other countries participating in the fishery to carry out tagging studies.

Champsocephalus gunnari

3.112 New information on aspects of icefish biology, demography and ecology were presented and discussed at WAMI. The available information is summarised in the WAMI report (Appendix D, paragraphs 5.1 to 5.18).

3.113 The Working Group thanked Drs Kock and Parkes for convening the workshop and all the participants for their input.

Mortality

3.114 There have been several studies attempting to estimate natural mortality (M) in *C. gunnari*. A review of mortality estimation methodologies was presented in WAMI-01/7. There appear to be large differences between estimates using different methods. Nevertheless, it is not known how reliable these estimates are. The methodologies considered to be most reliable by the authors of WAMI-01/7 resulted in a range of estimates of M from 0.7 to 0.87, with a mean value of 0.76.

3.115 The workshop agreed that the value of M for *C. gunnari* is considerably higher than in other Antarctic fish species. However, the value of M is not likely to be constant and may vary in areas, such as South Georgia, between years. At South Georgia, annual variation in M may change as influenced by ‘good’ and ‘poor’ krill years.

3.116 The workshop agreed that M is likely to be age specific. Young fish are more likely to have a higher M rate. This probably decreases during age 2–3 and then increases again at older ages when post-spawning mortality contributes to M.

Reproduction

3.117 Historical information on the distribution of spawning and larval *C. gunnari* in Subarea 48.3 (South Georgia and Shag Rocks) is assessed in Everson et al. (2001). It is concluded that there is strong evidence of inshore spawning at South Georgia during April within and close to the bays on the north side of the island. Some spawning almost certainly occurs over much of the island shelf, although this appears to be at a very much lower intensity than inshore. There is some evidence of spawning at Shag Rocks. There are also indications of a possible second spawning season in January, although the evidence is weak. Concentrations of larval *C. gunnari* within Cumberland Bay are an order of magnitude higher than in adjacent coastal waters and their density declines exponentially offshore. All this evidence indicates that the most important spawning locations are within the bays.

3.118 Differences in spawning seasonality for the Heard Plateau and Shell Bank were described in WAMI-01/4. The spawning season at Shell Bank appears to take place in April and May, whereas spawning at Heard Plateau and Gunnari Ridge occurs in August and September.

Shelf Distribution and Movements

3.119 WAMI-01/6 and 01/10 analysed the relationship between the spatial distribution of *E. superba* and the distribution of *C. gunnari*. Both studies concluded that the spatial distribution of krill is highly influential on the distribution of *C. gunnari*. WAMI-01/10 modelled the relationship between the spatial distribution of prey density with the distributions of *C. gunnari* abundance, mean size, and average stomach fullness, and found significantly positive relationships between these factors and krill density.

3.120 The workshop recommended that during finfish trawl surveys, a component for krill acoustic surveys should be incorporated into the experimental design. This can provide important insight into a potentially important mechanism that influences spatial distribution of *C. gunnari*.

3.121 WAMI-01/4 presented evidence that there are two separate stocks around Heard Island. More stocks may have existed on other banks, such as Pike or Discovery Bank, which now appear to be absent. Around Kerguelen there appear to be two stocks (Kerguelen Shelf, Skif Bank) as well. Spawning times between stocks may differ by five months, such as on the Kerguelen Shelf and Skif Bank, and Heard Island and Shell Bank. Results from recent DNA studies indicate that all populations in the Indian Ocean sector may be genetically homogeneous. This suggests that separation into the various populations could have occurred only recently or that there is a limited exchange of individuals between the populations.

3.122 The workshop recommended that additional DNA samples should be collected from as many areas as possible to further elucidate stock identity and structure in *C. gunnari*.

3.123 WAMI-01/8 described vertical and horizontal patterns of distribution of *C. gunnari* around South Georgia. There are strong seasonal effects on the distribution, with the winter season yielding no fishable concentrations. The seasonal changes in temperature appear to be one of the important factors that influence the formation of concentrations. The workshop recommended that it would be useful to collect CTD data on as many trawl stations as possible in order to help understand the role of the physical environment in the formation of aggregations.

3.124 Diurnal changes in the vertical distribution of *C. gunnari* around Heard Island were investigated in WAMI-01/5 using a bottom trawl in conjunction with acoustic methods. The results indicate that vertical distribution is linked to the diel light signal (dusk, dawn). The study suggests that bias in abundance estimates of *C. gunnari* from bottom trawl surveys is negligible if hauls are conducted only during daylight hours between sunrise and sunset. *C. gunnari* tend to leave the bottom layers at sunset.

3.125 The workshop recommended, where possible, the use of acoustic devices in conjunction with bottom trawls to obtain information on the proportion of fish off the bottom.

3.126 Factors that influence the horizontal distribution of *C. gunnari* in the South Shetland Islands were presented in WAMI-01/10. In this analysis, a relationship was drawn between the depth, krill availability and bathymetry.

3.127 There appear to be segregations of size and age classes around South Georgia Island, and there is evidence that in certain regions, fishing may be occurring on only one age class spanning a limited length range. This is likely to have an important effect on the assessment of the stock. WAMI-01/16 examined the depth distribution of *C. gunnari* from nine bottom trawl surveys. Results indicate that the depth of maximum abundance increased as fish size increased. Small icefish tend to be congregated in the shallow water and there is a progressive increase in size with increasing water depth. The workshop recommended that future surveys should be designed to provide a uniform sampling intensity over the depth range from 100 to 300 m. WAMI-01/4 provided similar results for the Heard Island region.

Crabs

3.128 Large numbers of crabs (*Paralomis* spp.) again appeared in the experimental pot fishery for *D. eleginoides* conducted in Subarea 48.3. WG-FSA-01/32 provided further information on the distribution, demography and discard mortality of crabs caught in the experimental pot fishery. Crabs accounted for 69.5% of the total catches by weight (including *D. eleginoides*) and made up 98.2% of the total catch by number of individuals caught.

Distribution

3.129 Two species of crab were recorded in high numbers in catches. Large numbers of *Paralomis spinosissima* occurred in shallow water, generally less than 700 m, whereas *P. formosa* was present at high densities at a depth of 800–1 400 m. Differences were noted in the sex and size of crabs with depth. Three other species of crab were recorded in catches of which *P. anamerae* was the most abundant.

Sizes

3.130 Very few crabs were males above the legal landing size limits as described by Conservation Measure 181/XVIII. Only 5.7% of *P. spinosissima* and 11.6% of *P. formosa* were greater than 102 mm and 90 mm carapace width respectively. Male size at maturity (S_{m50}) for the Shag Rocks area was determined at 67.3 mm and 64 mm carapace length (CL) for *P. spinosissima* and *P. formosa* respectively. Based on these figures, the authors suggest a revision of minimum landing size of 83 mm and 78 mm carapace width for *P. spinosissima* and *P. formosa* respectively for the Shag Rocks.

Survivorship

3.131 Most crabs were lively on arrival on deck after pot hauling (99% *P. spinosissima*, 97% *P. formosa* and >90% of *P. anamerae*). Mortality rates estimated from reimmersion experiments indicated that on the vessel which emptied pots directly onto the factory conveyor belt, 85–90% of crabs would survive discarding, whereas survival was reduced on the vessel where crabs were emptied down a vertical chute prior to sorting (39–58% survivorship).

Martialia hyadesi

3.132 The results of an exploratory jig fishery for squid (*M. hyadesi*) in Subarea 48.3 undertaken jointly by the Republic of Korea and the UK in June 2001 were described in WG-FSA-01/31. A total of 2154 kg of *M. hyadesi* was caught, principally in the Polar Frontal Zone and in temperatures of 2–2.5°C, although some squid were also caught to the south and north of this area. The largest catches were associated with the Polar Frontal Zone and not with the South Georgia shelf as in previous years. It was concluded that the fishery for *M. hyadesi* in Subarea 48.3 remains at an exploratory stage, and catch rates appear to be highly variable. There is little indication at present of significant commercial interest in the fishery.

Skates

3.133 Information on methods of age determination for two species of Antarctic skates (*Bathyraja eatonii* and *Amblyraja georgiana*) from the Ross Sea were described in WG-FSA-01/52. Best results were obtained from X-radiographs of thorns and vertebral half-centra. Difficulties in identifying the first band or annulus in thorns and vertebrae were highlighted, however, both species were shown to grow at similar rates and reach at least 10 years of age.

3.134 The distribution of *A. georgiana* in Subarea 48.3 was described in WG-FSA-01/37. Two sequential groundfish surveys undertaken in January–February 2000 revealed different patterns of distribution of *A. georgiana*. In the first survey, 18 rays ranging in length from 177 to 950 mm TL were caught, whereas during the second survey nine specimens with a size range of 173 to 206 mm TL were caught. The authors suggest that larger fish may have migrated off the shelf in the period between surveys, thus giving rise to the observed differences in length distributions.

3.135 Further information on the tagging program for skates in Subarea 88.1, as described in WG-FSA-00/55, was outlined in WG-FSA-01/65. During the 2000/01 and 1999/2000 seasons 1017 and 2058 skates respectively were tagged on board New Zealand vessels. Also, during the 2000/01 season 68 skates were tagged from South African vessels in Subarea 88.1. Further tagging studies are proposed for the 2001/02 season. One skate was recovered in the 2000/01 season that had been tagged in the previous season, further indicating that at least some skates survive recapture and release. Most of the areas in which skates were tagged in 1999/2000 were not fished in 2000/01 making it difficult to draw further conclusions.

3.136 The Working Group discussed the need to standardise length measurements of skates and rays. It was suggested that total length and total width ‘wingspan’ should be recorded for all specimens measured.

Macrourids

Age and Growth

3.137 Preliminary results from a project to determine age and growth estimates of the main macrourid by-catch species from the toothfish fishery in the Ross Sea were presented in WG-FSA-01/43. The majority of fish were identified as *Macrourus whitsoni* following expert examination, however the difficulties observers experience in correctly identifying macrourids was highlighted.

3.138 Otolith readings gave an observed, unvalidated maximum age of 55 years suggesting that fish are slow growing and have a high age of maturity. Growth curves fitted to *M. whitsoni* length-at-age data gave rise to the following von Bertalanffy growth parameters:

males L_8 = 78.3 cm, k = 0.050 and t_0 = -5.30
females L_8 = 87 cm, k = 0.068 and t_0 = 1.34.

Best estimates of instantaneous M based on the minimum age of the oldest 1% of fish in the longline catch were 0.08 for males and 0.09 for females. However because of the uncertainty associated with these estimates, a range of 0.05 to 0.12 is recommended.

3.139 Because of the uncertainties that exist over the identification of macrourids, the authors suggested that observers should randomly select two fish from each set for further meristic and morphometric investigation over the next fishing season.

3.140 Information on otolith size/fish size relationships for *Macrourus holotrachys* caught as by-catch in the Subarea 48.3 longline toothfish fishery was presented in WG-FSA-01/39. The authors note that otolith mass can provide a good index of fish length. A length–weight relationship for this species was also provided.

Other Species

3.141 Information on the ecology of seven fish species caught as by-catch in the toothfish and icefish fisheries at Kerguelen was given in WG-FSA-01/34. Biological information on two shark species (*Lamna nasus* and *Somniosus microcephalus*), three species of ray (*Bathyraja murrayi*, *B. eatonii* and *B. irrasa*), a macrourid (*M. whitsoni*) and *Muraenolepis marmorata* was presented.

3.142 Information on the diversity of by-catch species collected during the 2000/01 exploratory fishery for toothfish in Subarea 88.1 were described in WG-FSA-01/45. Fifty-four species from 16 families were described, although identification to species was difficult for nearly half (20) of the species. Two new species were described as well as two new records for the Ross Sea.

3.143 WG-FSA-01/48 presented a preliminary method for estimating length-specific fishing selectivities from longline catch data based on the relative proportions in the catch of fish at length. The method and its application to the South Georgia longline fishery for *D. eleginoides* are discussed in detail in paragraphs 4.94 to 4.99. The Working Group welcomed this development as it takes better account of changes in the size structure of catches in the South Georgia fishery. It accepted the use of the method for assessments of that fishery and looked forward to further development of the method for application in the future.

3.144 The Working Group noted that the term 'fishing vulnerability' provides an independent term that encapsulates the combination of availability of fish to the fishery (i.e. the relative locations of the fishery and different parts of the stock) and gear selectivity, and agreed to use this term when discussing the final inputs to assessments that are a combination of availability and selectivity.

3.145 Another preliminary method for estimating fishing vulnerability was presented in WG-FSA-01/73, based on a model of vulnerability at age. This method combines estimates of length at age, the variation of mean length at age and a recruitment series to compare expected frequencies at length in the population at a given time with the observed length-frequency information from the fishery at that time. The method uses a least-squares approach to minimise the differences between observed and expected frequencies based on an age-based vulnerability function. The assessment software is currently written in a Mathcad worksheet. The Working Group welcomed this development, noting that a number of refinements are required, including estimates of fishing mortality in deriving numbers at age. Nevertheless, the Working Group accepted this approach as a means for revising fishing vulnerability for the *D. eleginoides* fishery in Division 58.5.2.

3.146 The effect of vulnerability on the estimates of growth parameters, particularly L_{∞}, are described in WG-FSA-01/17 which shows through simulation trials that the growth rate can be overestimated and L_{∞} underestimated if the effects of length-based selectivity are not taken into account. The Working Group thanked Dr Everson for his work in highlighting this problem.

3.147 WG-FSA-01/73 provides a negative log-likelihood method for estimating von Bertalanffy growth parameters, while taking account of fishing vulnerability (age-based availability and length-based selectivity) and the likelihood of observing individuals at age. The function also endeavoured to provide a method for pooling a number of different types of samples, including samples taken from different age–length ranges of the stock and targeted samples, such as from the taking of as many large fish as possible. The Working Group evaluated the method in WG-FSA-01/73 and suggested that the method for combining samples might be made more explicit in the likelihood function. Dr Constable provided an alternative likelihood model to better account for weighting of different samples, particularly length-at-age data that cannot be weighted by catch data. He provided an addendum to WG-FSA-01/73 to describe the revised approach and to illustrate the importance of different elements of the model to take account of the biases discussed in WG-FSA-01/73 and in WG-FSA-01/17. The Working Group welcomed the introduction of this approach to its work and encouraged further refinements for taking account of the biases in length-at-age samples. The method was approved for use in estimating a length at age for the toothfish stock in Division 58.5.2.

3.148 WG-FSA-01/54 presented an assessment of *D. eleginoides* in the Prince Edward Islands EEZ of South Africa based on an age-structured production model (ASPM). The Working Group recalled its discussions surrounding the application of this method to the South Georgia toothfish fishery last year (WG-FSA-00/46). It welcomed the potential application of new methods to CCAMLR fisheries and encouraged members to undertake evaluations of different methods (SC-CAMLR-XIX, Annex 5, paragraphs 4.104 to 4.105). The Working Group noted the sensitivity trials undertaken by the authors to examine the effects of different parameter values on the outcome, including the steepness parameter *h* that describes stock recruitment and the estimates of M and growth parameters. The Working Group noted the sensitivity of the results to these parameters and encouraged members to further evaluate this method before adopting the method as a routine assessment tool. The Working Group agreed that this paper provided a useful first assessment for considering management options for this fishery.

3.149 WG-FSA-01/75 provided a description of modifications to 'Fish Heaven', which was first introduced to the Working Group last year (SC-CAMLR-XIX, Annex 5, paragraphs 3.121 to 3.122). The software has been developed to assess research strategies in exploratory longline fisheries given various spatial structures to the preferred fish habitat and methods of fishing that might be employed. The Working Group welcomed the enhancements to this software, discussing its application further in paragraphs 4.30 to 4.38.

3.150 WG-FSA-01/74 detailed revisions to the GYM (version 3.04) to provide for re-estimating the recruitment series from survey data for each value of M used in the assessments, whenever it is altered over the range of uncertainty in M that is factored into the assessment process. Outputs from mixture analyses from surveys are now input to the GYM in raw form. Consequently, endeavouring to predetermine the recruitment series with an average value of M is no longer necessary for inputting to the GYM. In addition, provision is now made for inputting different fishing selectivity functions for different years in the assessment model as requested last year (SC-CAMLR-XIX, Annex 5, paragraph 4.128). The Working Group endorsed the use of this new version of the GYM in this year's assessments but requested that it be further validated by the Secretariat.

ASSESSMENTS AND MANAGEMENT ADVICE

New and Exploratory Fisheries

New and Exploratory Fisheries in 2000/01

4.1 Fourteen conservation measures relating to exploratory fisheries were in force during 2000/01, but fishing only occurred in respect of four of these. Information on active exploratory fisheries during 2000/01 is summarised in Table 16.

4.2 In most of the active exploratory fisheries, the numbers of days fished and the catches reported were small. As was the case last year, the notable exception was the exploratory fishery for *Dissostichus* spp. in Subarea 88.1 conducted under Conservation

Measure 210/XIX. During 2000/01, 417 vessel days of effort were reported, taking 658 tonnes of *Dissostichus* spp. Vessels from New Zealand, South Africa and Uruguay participated in this fishery.

4.3 The catches of by-catch species in the exploratory longline fishery for *Dissostichus* spp. in Subarea 88.1 all fell within the catch limits set in Conservation Measure 200/XIX (see CCAMLR-XX/BG/7 Rev. 1, Table 5).

4.4 The Working Group noted that the western boundary for SSRU D in Subarea 88.1 does not extend to the Antarctic Coast. The Working Group recommended that the western boundary be moved to 160°E.

4.5 Conservation Measure 200/XIX also requires that, once the catch in a SSRU has exceeded a trigger level, then research hauls must be carried out and the results reported to CCAMLR. CCAMLR-XX/BG/7 Rev. 1, Table 5 summarises the catches and number of research hauls undertaken in accordance with this conservation measure.

4.6 Data collected from the New Zealand exploratory longline fishery in Subarea 88.1 during the last four seasons are described and analysed in detail in WG-FSA-01/63. The Working Group agreed that sufficient data had been accumulated for this subarea for an assessment to be attempted (see paragraphs 4.17 to 4.48). An assessment was also attempted for Division 58.4.4 (see paragraphs 4.49 to 4.57).

New and Exploratory Fisheries Notified for 2001/02

4.7 A summary of new and exploratory fisheries notifications for 2001/02 is given in Table 17. The intended catches, numbers of vessels and gear for the notifications for new and exploratory fisheries for *Dissostichus* spp. in 2001/02 are shown, grouped by subarea or division, in Table 18. All notifications had been received by the Secretariat on or before the due date. Dr Ramm advised that minor amendments had been made to the New Zealand (CCAMLR-XX/12) and Japanese (CCAMLR-XX/10) notifications. These are reflected in Table 17 and amendments to the associated tables in SC-CAMLR-XX/BG/10.

4.8 In addition to these tables, the Working Group agreed that it would be useful to prepare an overall summary table for all fisheries, whether they be new, exploratory or established. This is given in Table 19.

4.9 The Working Group noted that two Members (Japan and Russia) had made notifications of new or exploratory fisheries for the first time this year. However, it also noted that none of the notifications this year referred to fisheries or regions that have not been considered previously by the Working Group.

4.10 As was the case last year, there were multiple notifications of exploratory fisheries for *Dissostichus* spp. for several subareas or divisions (see Table 18). While this is of potential concern, the Working Group also noted that the experience of previous years suggested that a number of these may not be activated.

4.11 Reviewing Table 18, the Working Group observed that there remained inconsistencies in the way in which different notifications specified intended catches. As last year, some notifications attempted to specify realistic levels of intended catches, while others simply specified an intended catch that was equal to the current precautionary catch limit. While this inconsistency continues, the task of assessing the likely effects of multiple new or exploratory fisheries in an area is made much more difficult. In the time available, the Working Group was unable to develop criteria for determining whether the information contained in the notifications regarding intended catches was acceptable, as had been requested by the Scientific Committee last year (SC-CAMLR-XIX, Annex 5, paragraph 9.30).

4.12 Once more this year, there has been a large number of notifications for Division 58.4.4 (five notifications for a maximum of up to 10 vessels). If the precautionary catch limit remains at a level similar to last year (370 tonnes), there is a clear potential for the catch limit to be taken in a very short time or to be overshot.

4.13 Dr Miller noted that, as in previous years, some of the notifications for new or exploratory fisheries in Division 58.4.4 have still neglected to specify that they applied only to areas outside national EEZs.

4.14 With regard to provision of advice on precautionary catch limits for stocks likely to be subject to new or exploratory fisheries in 2001/02, the Working Group agreed that this would only be possible this year for Subarea 88.1 and Division 58.4.4, as these were the only areas for which sufficient data were available.

4.15 However, in the light of the assessment of *D. eleginoides* in the Prince Edward Islands EEZ in WG-FSA-01/54, which suggested that the stock in that area had been greatly reduced from its unexploited level primarily by IUU fishing, the Working Group agreed that this raised concerns about the status of *D. eleginoides* stocks throughout Subarea 58.6. In this respect, the Working Group agreed that a current assessment of the stock around the Crozet Islands would be extremely valuable. Unfortunately, the fine-scale data necessary for carrying out such an assessment have not been submitted to CCAMLR, so the Working Group was unable to undertake such an assessment.

4.16 In view of these concerns, the Working Group recommended that France should be requested to submit fine-scale haul-by-haul data from the area around Crozet Island so that such an assessment may be carried out.

Precautionary Catch Limits for Subarea 88.1

4.17 An exploratory longline fishery by New Zealand, South Africa and Uruguay for *D. mawsoni* and *D. eleginoides* took place in Subarea 88.1 in 2000/01. The precautionary catch limit of *Dissostichus* spp. in Subarea 88.1 for the 2000/01 season was 2 063 tonnes, comprising catch limits of 175 tonnes north of 65°S and 472 tonnes in each of the four SSRUs to the south of 65°S (Conservation Measure 210/XIX).

4.18 Totals of 626 tonnes of *D. mawsoni* and 34 tonnes of *D. eleginoides* were caught during the 2000/01 season. The catch limits were not reached in any of the SSRUs. The majority of the catch (93%) was taken by New Zealand vessels, some of which have now been involved in this exploratory fishery for the past four seasons. During that time, the total catches have been 41 tonnes in 1998, 296 tonnes in 1999, 745 tonnes in 2000 and 659 tonnes in 2001 (CCAMLR-XX/BG/7 Rev. 1).

4.19 A total of 25 tonnes was taken in 81 hauls by two South African vessels, and a total of 23 tonnes was taken in 51 hauls by two Uruguayan vessels which only fished the northern SSRUs. The remaining catch of 590 tonnes was taken from New Zealand vessels which fished in all five SSRUs.

4.20 New Zealand vessels completed a total of 204 research sets, South African vessels 42 research sets and Uruguay 21 research sets in the 2000 season (CCAMLR-XX/BG/7 Rev. 1).

4.21 Research activities associated with the New Zealand exploratory fishery are summarised in WG-FSA-01/63, which also includes a comprehensive analysis of data collected by this fishery from 1997/98 to 2000/01.

4.22 The exploratory fishery over the last four seasons has seen a widespread distribution of effort with at least four SSRUs and from 28 to 91 fine-scale rectangles fished each year, and a total of 150 fine-scale rectangles fished overall (WG-FSA-01/63). This has contributed significantly to the knowledge and distribution of both *Dissostichus* spp. and other fish fauna in this subarea.

4.23 Observer length-frequency data for *D. mawsoni* were examined for variation in area, trip and set type (commercial/research), and were then stratified and scaled up to the commercial catch for each of the past three seasons (WG-FSA-01/63). The resulting catch-weighted length frequencies are shown in Figure 4. Most fish in the catch ranged from 70 to 160 cm, with two broad modal peaks at 80–110 cm and 130–140 cm.

4.24 About 500 otoliths have been read from *D. mawsoni* each year and the resulting ages have been compiled into year-specific age–length keys. These were then applied to the scaled length-frequency distributions to produce catch-at-age distributions for each year (WG-FSA-01/63) (Figure 5). Most *D. mawsoni* in the catch were from 8 to 16 years old (range 3–35 years).

4.25 Last year the Working Group developed a new approach for calculating precautionary catch limits for Subarea 88.1 (SC-CAMLR-XIX, Annex 5, paragraphs 4.20 to 4.33). Yields were estimated by relating the CPUE from research sets and biological parameters for *D. mawsoni* to the CPUE, biological parameters and yield estimate for *D. eleginoides* in Subarea 48.3. For this year's assessment, the Working Group agreed to use the same approach for Subarea 88.1.

4.26 The formula used for estimating the precautionary long-term yield was

Yield = ?B_0.

CPUE was assumed to be an index of biomass density. These can be combined to give the formula relating yields in Subareas 48.3 and 88.1:

$$Y_{881} = \frac{g_{881} f_{881} A_{881}}{g_{483} f_{483} A_{483}} Y_{483}$$

where γ is the precautionary pre-exploitation harvest level for each area, f is the relative density (a function of CPUE and fishing selectivity), A is the seabed area, and Y is the long-term precautionary yield. This assumes that the catchability and the relationship between CPUE and actual density is the same for the species/fisheries in Subareas 48.3 and 88.1.

4.27 While the general approach adopted was similar to last year, there were several key improvements. The first was that for Subarea 88.1, separate yield estimates were calculated for each SSRU. Following last year's assessment, the Working Group agreed to base the proportional adjustment on the actual fished area (Table 20). However, it also noted that this should be regarded as a minimum estimate of the area of *Dissostichus* spp. habitat.

4.28 The area fished was derived by inputting all the New Zealand catch and effort data into a GIS system to determine polygons of fished area, and applying a bathymetric grid using Lambert_Azimuthal equal area projection, to calculate the amount of seabed area over which *Dissostichus* spp. were located. Preliminary analysis of the data showed that catches of *Dissostichus* spp. outside the 600–1 800 m depth range were minimal. Therefore, the area fished outside those depths was excluded. The CPUE analysis below was also restricted to data from this depth range.

4.29 The Working Group noted that the known distribution area for *D. mawsoni* in Subarea 88.1 has been substantially increased between 1999/2000 and 2000/01 from 49 692 km^2 to 63 879 km^2 as a result of the exploratory fishery. It is expected the distribution area will be expanded again in 2001/02.

4.30 The second major improvement was in the estimation of relative fish density between the subareas. About 367 research and 1 484 commercial sets have now been completed in Subarea 88.1. The research sets have a stipulated minimum separation of 10 n miles (Conservation Measure 200/XIX). However, the commercial sets were known to include a mixture of exploratory sets and targeted commercial sets. Taking only research sets as a measure of mean fish density in the entire SSRU could bias the results because they may only have been done in a small part of the total fished area. To do so would also mean that the exploratory sets made in this fishery would be ignored. To make sure the entire fished area was used in the estimation of mean fish density (CPUE), all the research and commercial data were used in the analysis, provided that a minimum separation distance between sampling points was retained.

4.31 A computer program called 'Dataloser' was written to sample the combined research and commercial dataset. The program and documentation have been lodged with the Secretariat. As in Conservation Measure 200/XIX, the location of the set was defined as the geographic midpoint of the set. Sets were randomly chosen from the combined data, provided a minimum distance separated them.

4.32 The choice of the minimum separation distance involved a trade-off between ensuring that hot-spots would not be over-represented in the analysis and avoiding the removal of too much data from the dataset. To determine the appropriate separation distance, two approaches were used. The first was the generation of covariograms of the catches across the region. The second was the examination of the CPUE for varying separation distances.

4.33 For the covariogram approach, the CPUE data were combined for all SSRUs in Subarea 88.1. Covariograms for the years 2000 and 2001 were generated using the spatial statistics module in S-Plus. The range of possible separation distances that were of interest were those smaller than 20 n miles and the output was restricted to that range (Figure 6).

4.34 The results show that a separation distance of 10 n miles is satisfactory. After that the benefit gained from increasing the separation distance diminishes. They also show that the minimum separation distance should be no less than 5 n miles; below that the covariation begins to get relatively large.

4.35 The other method used to examine the question of suitable separation distance combined the data from every year into a single dataset. Separation distances from 1 to 20 n miles were tested and the resulting CPUE (total catch over total effort) and average CPUE per set were calculated.

4.36 The CPUE and average CPUE decreased with increasing separation, because at low separation distances they include many commercial sets located at areas with a high catch rate (Figure 7). As the separation distance increased, the proportion of sets of this type decreased. This is a similar pattern to that predicted in WG-FSA-01/75. A separation distance of 5 n miles appeared to be large enough to avoid the apparent bias that occurs with smaller values.

4.37 The Working Group agreed that a minimum separation distance of 5 n miles appeared to be appropriate for an analysis of this kind. They also noted that it could be a useful minimum separation distance for research sets in the longline fishery (see paragraphs 4.61 to 4.63). The minimum distance was applied to the CPUE data from Subarea 88.1 but not from Subarea 48.3. The Working Group also agreed to apply the minimum separation distance criterion to Subarea 48.3 in future years.

4.38 The CPUE estimates from each SSRU were then resampled with replacement, averaged and the ratio of CPUE between the areas was calculated. This was repeated 10 000 times and the one-sided lower 95% confidence bound of this ratio was calculated.

4.39 As in last year's assessment, a third adjustment was made to adjust for fishing selectivity. The ratio of total biomass to recruited biomass was calculated from each of the fisheries using the appropriate biological parameters. The fishing selectivity was estimated from the left side of the scaled commercial length-frequency distributions for each SSRU (and all SSRUs combined – see Figure 8) in Subarea 88.1 and the earliest reliable commercial length-frequency data (from 1995) for Subarea 48.3.

4.40 The final adjustment was made by comparing the precautionary pre-exploitation harvest levels (?) between the areas. These were calculated using the biological and fishery parameters for each of the areas. Biological and fishery parameters for *D. eleginoides* were the same as that used for the Subarea 48.3 assessment (Table 28). However, the fishing selectivity pattern was again taken from the left side of the 1995 commercial length-frequency distribution for Subarea 48.3. The corresponding mean fishing selectivities (and ranges) are given for each area in Table 20.

4.41 Updated biological parameters for *D. mawsoni* were provided in WG-FSA-01/63. Biological and fishery parameters used for *D. mawsoni* in the GYM calculations are shown in Table 21.

4.42 Estimates of ? from the GYM for *D. mawsoni* and *D. eleginoides* are given in Table 20.

4.43 The pre-exploitation precautionary yield for Subarea 48.3 was calculated using the recruitment parameters from the results of the CMIX analyses, together with the other biological parameters used for the calculations of ?, using zero catches. This yield (5 000 tonnes) was then adjusted by the ratio of γs, densities (a function of CPUE and fishing selectivity), and seabed areas to give estimates of precautionary yield for *D. mawsoni* in Subarea 88.1.

4.44 It was noted that the catch in SSRU A in Subarea 88.1 comprised a mixture of *D. mawsoni* and *D. eleginoides*. It was difficult to apportion areas fished between the two species in this subarea, so for the purposes of the assessment the yields were calculated assuming the selectivity patterns and biological parameters for *D. mawsoni*, and the combined CPUE from both species.

4.45 The resulting estimates of precautionary yields are given by SSRU in Table 20. Equivalent estimates of yields, the catch limits adopted and the catches actually taken from each SSRU in 2000/01 are shown in Table 22.

4.46 The Working Group accepted the methods used to estimate the precautionary yields and agreed that catch limits should be set for each individual SSRU.

4.47 The Working Group noted that whilst the current assessment incorporates several improvements over earlier assessments of this area, there was still considerable uncertainty about the assessments. This stems from uncertainty in biological and fishery parameters for both *Dissostichus* spp. and the assumed relationship between CPUE and density. Furthermore, the assessment still bases estimates of productivity for Subarea 88.1 on comparisons with those for Subarea 48.3. On these grounds, the Working Group agreed that the current assessment of Subarea 88.1 remained less rigorous than those conducted for Subarea 48.3.

4.48 In light of this, the Working Group agreed that a discount factor needs to be applied to the results of this assessment. In this respect, the Working Group noted that a discount factor of 0.5 was used for *D. mawsoni* in Subarea 88.1 last year. If the same factor were to be used again this year, the resulting catch limits by SSRU would be as shown in the last column of Table 22.

Precautionary Catch Limits for Division 58.4.4

4.49 The same approach as taken above for Subarea 88.1 was used for calculating precautionary catch limits for *D. eleginoides* in Division 58.4.4.

4.50 The formula used for calculating precautionary yields was that given in paragraph 4.26, but with the values for Subarea 88.1 in the equation being replaced with the relevant values for Division 58.4.4.

4.51 In calculating relative densities between Subarea 48.3 and Division 58.4.4, a minimum separation distance of 5 n miles for selecting CPUE values was adopted for Division 58.4.4, as for Subarea 88.1.

4.52 The adjustment made for fishing selectivity was estimated using the left side of the scaled commercial length-frequency distribution for the 2000 season for Division 58.4.4 (Figure 9), and the earliest reliable commercial length-frequency data (from 1995) for Subarea 48.3.

4.53 A final adjustment was made by comparing the precautionary pre-exploitation harvest levels (?) between Subarea 48.3 and Division 58.4.4. These were calculated from the biological and fishery parameters for each of the areas. Biological and fishery parameters for *D. eleginoides* were the same as that used for the Subarea 48.3 assessment (Table 28). However, the fishing selectivity pattern was again taken from the left side of the 2000 commercial length-frequency distribution for Division 58.4.4. The corresponding mean fishing selectivities (and ranges) are given for each area in Table 20.

4.54 The pre-exploitation long-term precautionary yield for Subarea 48.3 was calculated using the recruitment parameters from the results of the CMIX analyses, together with the other biological parameters used for the calculations of ?, using zero catches. This yield (5 000 tonnes) was then adjusted by the ratio of γs, densities (a function of CPUE and fishing selectivity), and seabed areas to give estimates of yield for *D. eleginoides* in Division 58.4.4.

4.55 The resulting estimate of precautionary yield in Division 58.4.4 is given in Table 20. Equivalent estimates of yield, the catch limit adopted and the catch actually taken from each SSRU in 2000/01 are shown in Table 22.

4.56 In comparison with the assessment of Subarea 88.1, the Working Group noted that there is even more uncertainty about the assessment for Division 58.4.4. The Working Group agreed that a discount factor needs to be applied. If the same factor used last year (0.5) were to be used again this year, the resulting catch limit for Division 58.4.4 would be as shown in the last column of Table 22.

4.57 The precautionary yield estimated for Division 58.4.4 for 2001/02 is nearly 50% lower than that listed in Table 22 for 2000/01 (actually this estimate was first obtained for 1999/2000). There have been some improvements and adjustments to the estimation methods used, however the primary reason for the reduction is that the CPUEs in this division for the most recent season are considerably lower than those in 1999/2000. Such a reduction in CPUE is not unexpected, given the IUU activity in the region in recent years.

Subarea 88.2

4.58 Seabed areas for Subarea 88.2 were revised to include data from 72° to 80°S, to include the eastern Ross Sea. The analysis was prepared by Seabed Mapping International using ETOPO5 data and recorded depths from research vessels. The permanent ice-shelf boundary was taken from GMT version 3.0 coastline. The area in the 600–1 800 m depth range has increased from 30 986 km^2 to 175 180 km^2. The revised areas have been lodged with the Secretariat.

Comments on Research Plans

4.59 In each of the exploratory fishery notifications, the research plans proposed at least met the minimum requirements specified in Conservation Measure 200/XIX. However, the notifications by Australia (CCAMLR-XX/5, XX/6 and XX/7) and New Zealand (CCAMLR-XX/11 and XX/12) contained detailed research plans that in some aspects exceeded the requirements in Conservation Measure 200/XIX and in one aspect suggested amendments to them.

4.60 The Working Group welcomed and endorsed the additional research activities proposed in the Australian and New Zealand notifications over the minimum set out in Conservation Measure 200/XIX.

4.61 Both Australia and New Zealand experienced practical difficulties with the minimum 10 n mile distance separation currently specified for research sets or trawls in Conservation Measure 200/XIX. This is particularly a problem when fishing is carried out on small seamounts and narrow ridges, and has led to the setting of research sets in sub-optimal areas. An alternative approach to avoid these problems would be to reduce the minimum distance between sets, whilst maintaining an effort-spreading criterion.

4.62 The Working Group agreed that the analysis carried out on Subarea 88.1 data (paragraphs 4.30 to 4.37) suggested that the minimum distance could be reduced to 5 n miles.

4.63 To maintain the effort-spreading objective of the conservation measure, the Working Group agreed that a maximum number of research sets also needed to be applied for each fine-scale rectangle. However, it noted that it had no information available to it at the moment to allow specification of such a maximum number. The Working Group agreed that this matter should be examined during the next intersessional period.

4.64 Currently, Conservation Measure 200/XIX specifies a minimum number of hooks per research longline set (3 500) but no maximum. The Working Group agreed that a maximum of 10 000 hooks should also be prescribed for research sets.

4.65 The Working Group agreed that the value of including a research component in Conservation Measure 200/XIX has been demonstrated by the use of the CPUE estimates from the research, exploratory and commercial sets in the assessments of *D. mawsoni* in Subarea 88.1, and of *D. eleginoides* in Division 58.4.4. The Working Group agreed that further collection of data from research sets would be essential for any assessments that are undertaken next year. This use of research sets was considered to be vital both for Subarea 88.1 and Division 58.4.4, and for other new and exploratory fisheries generally. Members were also requested to investigate further during the intersessional period the application of research set data in assessments.

4.66 The Working Group agreed that it would be desirable to develop a time series of research sets in the various areas to provide indices of abundance. The simulation program reported in WG-FSA-01/75 will provide a very useful tool for examining the optimal design to the further implementation of the research sets. The Working Group encouraged the further development during the intersessional period of the work initiated in that paper.

4.67 The Working Group also agreed that tagging studies initiated early in the fisheries would help in long-term assessments.

Apportioning Catch Limits between Trawl and Longline Fisheries

4.68 As there were no cases this year where trawl and longline fisheries for *D. eleginoides* were notified for the same area or division, the Working Group did not consider further the difficult problem of how to apportion precautionary catch limits between these gears.

Advice to the Scientific Committee

4.69 Fourteen conservation measures relating to exploratory fisheries were in force during 2000/01, but fishing only occurred in respect of four of these. In most of the active exploratory fisheries, the numbers of days fished and the catches reported were small. The notable exception was the exploratory fishery for *Dissostichus* spp. in Subarea 88.1 conducted under Conservation Measure 210/XIX. During 2000/01, 417 vessel days of effort were reported, taking 658 tonnes of *Dissostichus* spp. Vessels from New Zealand, South Africa and Uruguay participated in this fishery.

4.70 Thirteen notifications of new or exploratory fisheries were made for 2001/02 (see Table 17). Two Members (Japan and Russia) had made notifications of new or exploratory fisheries for the first time this year. However, none of the notifications this year referred to fisheries or regions that have not been considered previously by the Working Group.

4.71 As was the case last year, there were multiple notifications of exploratory fisheries for *Dissostichus* spp. for several subareas or divisions (see Table 18). While this is of potential concern, and takes considerable time to consider, the Working Group also noted that the experience of previous years suggested that many of these may not be activated.

4.72 Inconsistencies remained in the way in which different notifications specified intended catches. As was the case last year, some notifications attempted to specify realistic levels of intended catches, while others simply specified an intended catch that was equal to the current precautionary catch limit. While this inconsistency continues, the task of assessing the likely effects of multiple new or exploratory fisheries in an area is made much more difficult. In the time available, the Working Group was unable to develop criteria for determining whether the information contained in the notifications regarding intended catches was acceptable.

4.73 Again, there has been a large number of notifications for Division 58.4.4 (five notifications for a maximum of up to 10 vessels). As the recommended precautionary catch limit is only 103 tonnes, there is a clear potential for the catch limit to be taken in a very short time or to be overshot.

4.74 With regard to provision of advice on precautionary catch limits for stocks likely to be subject to new or exploratory fisheries in 2001/02, the Working Group agreed that this would only be possible this year for Subarea 88.1 and Division 58.4.4, as these were the only areas for which sufficient data were available. For all the other subareas and divisions for which notifications have been made, the Working Group is unable to provide any new advice on precautionary catch limits.

4.75 The assessment of *D. eleginoides* in the Prince Edward Islands EEZ in WG-FSA-01/54, which suggested that the stock in that area had been greatly reduced from its unexploited level primarily by IUU fishing, raises major concerns about the status of *D. eleginoides* stocks throughout Subarea 58.6. The Working Group recommended that France should be requested to submit fine-scale haul-by-haul data from the area around the Crozet Islands so that an assessment of the stock in this area can be carried out to determine whether the same problems may exist throughout the subarea.

4.76 Using new data resulting from the exploratory fishery in Subarea 88.1 (primarily from New Zealand), estimates of precautionary yields for this subarea have been calculated by SSRU. These estimates are given in Table 20.

4.77 While the current assessment incorporates several improvements over earlier assessments of this subarea, there is still considerable uncertainty about it. In light of this, a discount factor still needs to be applied. If the same discount factor as used last year (0.5) is used, the resulting catch limit for *Dissostichus* spp. in Subarea 88.1 is shown in the last column of Table 22.

4.78 Using a similar method, an estimate of precautionary yield for Division 58.4.4 has also been calculated. This estimate, which is subject to even more uncertainty than those for Subarea 88.1, is given in Table 20. If the same discount factor as used last year (0.5) is used, the resulting catch limit for *D. eleginoides* in Division 58.4.4 is as shown in the last column of Table 22.

4.79 The Working Group noted that the western boundary for SSRU D in Subarea 88.1 does not extend to the Antarctic Coast. The Working Group recommended that the western boundary of this SSRU be moved to 160°E.

4.80 The Working Group welcomed and endorsed the additional research activities proposed in the Australian and New Zealand notifications over the minimum set out in Conservation Measure 200/XIX.

4.81 Conservation Measure 200/XIX currently requires that research sets or trawls must be separated by a minimum of 10 n miles. Experience in both the Australian and New Zealand exploratory fisheries suggests that this requirement may be too restrictive, given the topography of the areas being fished. The Working Group recommended that the minimum distance between research hauls should be reduced to 5 n miles. In making this recommendation, the Working Group recognised that this may compromise the effort-spreading objective of the conservation measure. The Working Group agreed that a maximum number of research sets also needed to be applied for each fine-scale rectangle. However, no information is available at the moment to allow specification of such a maximum number. This matter needs to be examined during the next intersessional period.

4.82 Currently, Conservation Measure 200/XIX specifies a minimum number of hooks per research longline set (3 500) but no maximum. The Working Group agreed that a maximum of 10 000 hooks should also be prescribed for research sets.

4.83 The value of including a research component in Conservation Measure 200/XIX has been amply demonstrated by the use of CPUE estimates from research, exploratory and commercial sets in the assessments of *Dissostichus* spp. in Subarea 88.1, and of *D. eleginoides* in Division 58.4.4. Further collection of data from research sets will be essential for any assessments that are carried out next year.

Assessed Fisheries

Dissostichus spp.

4.84 This year the Working Group assessed the fisheries for *D. eleginoides* in Subarea 48.3 and Division 58.5.2. New methods for estimating demographic and fishery-related parameters of *D. eleginoides* are described in paragraphs 3.143 to 3.150. Background papers on the biology and ecology of the species are described in paragraphs 3.92 to 3.111. In addition, a number of papers were available to the Working Group which were directly related to the assessment of these species.

Dissostichus eleginoides

South Georgia (Subarea 48.3)

4.85 The catch limit for the fishery for *D. eleginoides* in Subarea 48.3 in the 1999/2000 season was 5 310 tonnes (Conservation Measure 179/XVIII). The total catch of *D. eleginoides* from this fishery, as reported in the five-day catch and effort reporting system (Conservation Measure 51/XIX), was 5228 tonnes and the fishery was closed on 21 July 2000. Fine-scale catch and effort data and STATLANT data, now available for the complete fishing season, reported a total catch of *D. eleginoides* of 5068 tonnes and 4941 tonnes respectively.

4.86 The catch limit for the fishery for *D. eleginoides* in Subarea 48.3 in the 2000/01 season is 4500 tonnes (Conservation Measure 196/XIX). The total catch of *D. eleginoides* from this fishery, as reported by 7 October 2001 in the catch and effort reporting system, was 4 050 tonnes, of which 3 991 tonnes were taken by longline and 59 tonnes were taken by pot (Table 1). The longline fishing season closed on 31 August 2001, and the pot fishing season will remain open until 30 November 2001 or until the catch limit is reached, whichever is the sooner.

Standardisation of CPUE

4.87 Haul-by-haul catch and effort data for Subarea 48.3 were submitted on C2 forms (fine-scale data) for the 1991/92 to 2000/01 fishing seasons. GLM analyses were conducted using this dataset (updated to August 2001), except for data for the first season (1985/86), when fishing had been restricted to very shallow depths (mainly less than 300 m). WG-FSA agreed last year that data for all months be included in the analyses.

4.88 CPUE in kg/hook was used as the response variable, and nationality, season, month, area (east South Georgia, northwest South Georgia, South Georgia, west Shag Rocks and Shag Rocks) (SC-CAMLR-XVIII, Annex 5, Figure 5), depth and bait type were considered as predictor variables. Depth information was additionally treated as a categorical variable with four levels (0–500 m, 500–1 000 m, 1 000–1 500 m, 1 500 m and deeper). GLM analyses were conducted on positive CPUE data only, with an adjustment for zero catches being made afterwards. Because of the frequency of hauls for which catch numbers were not reported, no analyses were conducted using CPUE in numbers/hook as the response variable.

4.89 The approach used to fit the GLMs was the same as that used last year, with a square root transformation being applied and a robust quasi-likelihood form of GLM fitted. Models were first fitted using all listed predictor variables as main effects. Of these, the statistically significant predictors were nationality, season and depth. Models incorporating area, month, and bait and interactions between predictor variables were not considered, as these factors provided no statistically significant contributions to the GLM. Thus the model form used was *cpue ~ season + nationality + depth.class,family = robust(quasi(link = sqrt))*. A QQ-plot of residuals from the fitted model (Figure 10) revealed some departures from the assumed error model, but these were not sufficient to reject the fit. As was noted last year, the dataset remains very unbalanced in terms of the seasonal fishing patterns, and there remains doubt about how well the relative levels of standardised CPUEs in early and later seasons have been estimated.

4.90 The standardised time series of CPUEs in kg/hook is plotted in Figure 11 and given in Table 23. The standardisation is with respect to Chilean vessels fishing at depths of 1 000–1 500 m. This time series has also been adjusted for the presence of hauls with zero catches, by multiplying the standardised CPUEs predicted from the GLMs by the proportions of non-zero catches given in Table 24. Adjusted standardised catch rates have fluctuated around a relatively constant level between 1986/87 and 1994/95. As was seen last year, the adjusted standardised catch rates declined substantially between 1994/95 and 1996/97, increased each season until 1999/2000, and decreased very slightly in 2000/01. However, the magnitude of changes in the last few years has been minimal, and trajectories suggest very little change in abundance since the 1996/97 season.

4.91 Examination of the distributions of depths fished in Subarea 48.3 by season and area reveals that the trend in recent seasons towards increased longline effort at shallow depths (300–700 m) noted in the 1999/2000 season was not observed in the 2000/01 season. Histograms of depths fished (sets) by season are shown in Figure 12. The decrease in the number of sets in more shallow depths in 2000/01 was particularly apparent in areas north of Shag Rocks. The depth distribution of effort by area around South Georgia for the 1999/2000 and 2000/01 seasons are presented in Figure 13.

Determination of Long-term Annual Yields using the GYM

4.92 The Working Group noted the trials undertaken last year to investigate the sensitivity of the assessments to different mortality and growth parameters (SC-CAMLR-XIX, Annex 5, paragraphs 4.143 to 4.147). It decided to use the final parameters in Table 34 of SC-CAMLR-XIX, Annex 5 as a starting point for this year's assessment. The revised assessment included three changes compared to last year:

- the estimation of the different fishing vulnerabilities (selectivity);
- refinements to the recruitment estimates; and
- an updated time-series of catches and standardised CPUE estimates.

As last year, the assessment assumes that the pot fishery has the same fishing pattern as the longline fishery.

Growth

4.93 Estimates of the von Bertalanffy parameters were obtained from the analysis conducted in 1999 (SC-CAMLR-XVIII, Annex 5, paragraph 4.116) of length-at-age data first used in 1995. The Working Group examined the data and analyses available, such as in WG-FSA-01/16, but found these insufficient to estimate new growth parameters. It noted that an analysis of length at age based on the otoliths available from the observer program is a high priority.

Trends in Fishing Vulnerability

Estimating Age-specific Vulnerabilities for Subarea 48.3

4.94 At its 2000 meeting, WG-FSA assumed in its calculation of long-term annual yields for the longline fishery for *D. eleginoides* in Subarea 48.3 that all fish above 79 cm were fully selected. For fish below that length, a length-specific selectivity ogive operated, with zero selectivity at 55 cm.

4.95 WG-FSA-01/48 presented a preliminary method for estimating length-specific vulnerabilities that attempted to take account of the observed increases of mean lengths of fish taken in depth zones of increasing depth and the different amounts of fishing effort expended in different areas and depth zones around South Georgia and Shag Rocks. Application of this method suggested that the relative selectivity of fish of different lengths has varied since 1997. In recent years, there has been a greater tendency for fish smaller than 80 cm to be vulnerable to the fishery, and a reduced tendency for larger fish to be taken. These changes have largely been driven by changes in the effort distribution by depth zone and area.

4.96 The results presented in WG-FSA-01/48 used only three depth zones (200–600 m, 600–1 600 m and 1 600–2 000 m). During the current meeting, the analysis was repeated using a fuller set of depth zones (every 200 m from 200–2 000 m). Coping with this larger set of depth zones also necessitated an adjustment to the method, to allow for strata where there was no fishing. Essentially, this involved assuming that the annual proportions of the population in the different depth zones for each area and length class were equal to those estimated in 2000, when all depth zones and areas were fished. Due to time constraints, the areas of fishable seabed found in each depth zone and area were also assumed equal, unlike the approach taken in WG-FSA-01/48.

4.97 Examination of the results suggested that the assumptions used last year for length-specific selectivity would be appropriate for 1997, and earlier years when no data were available to apply the method directly. However, from 1998 onwards, the conclusions of WG-FSA-01/48 were generally confirmed. Accordingly, an average length-specific vulnerability curve was estimated for the years 1998 to 2000, along with an approximate equivalent age-specific curve. The length-specific curve is shown in Figure 14 and the age-specific curve in Figure 15. Estimates of vulnerability at age for possible use in the GYM are given in Table 25.

4.98 In discussing these results, the Working Group agreed with the general conclusions regarding possible changes in length-specific vulnerability outlined in paragraphs 4.96 and 4.97. It also agreed, however, that the ad hoc method of analysis used during the meeting required considerable further development and evaluation before the reliability and likely precision of estimates of selectivity it provides could be evaluated. It also noted that several simplifying assumptions had been necessary for the work to be completed during the meeting (e.g. ignoring differences between areas of seabed of different depth zones and the use only of year 2000 data when estimating proportions at depth).

4.99 Nevertheless, the Working Group agreed that the estimated age-specific vulnerabilities should be used at this year's meeting when estimating long-term annual yields using the GYM for this stock, along with the selectivity assumptions used last year. This sensitivity test would allow preliminary evaluation of the likely effects of changes in vulnerability of the type envisaged.

Recruitment and Natural Mortality

4.100 No new data were available to add to the time series of recruitments following the inclusion of data from the 2000 survey around South Georgia by the UK (SC-CAMLR-XIX, Annex 5, paragraphs 4.130 to 4.138). The results last year suggested that the growth rates may be slower than that described by the current von Bertalanffy growth function. A reassessment of the cohort strengths should be done once a length-at-age relationship is estimated based on otolith data.

4.101 In the interim, the Working Group agreed to use the estimates of cohort strengths from last year based on $k = 0.066$ year^{-1}. On re-examining the results of mixture analyses performed last year, the Working Group noted that some cohort abundances may have been poorly estimated. Some of the previous analyses had resulted in the standard deviations of length at age declining or remaining the same with increasing age. This result is contrary to the expectation of variation in length at age as reported for *D. eleginoides* at Heard Island in WG-FSA-01/73. Consequently, the Working Group agreed to re-estimate cohort strength from three surveys affected by this problem: the surveys by Argentina in 1996 and 1997 and the survey by the UK in 1997. The Working Group recommended that a complete revision be undertaken when the von Bertalanffy parameters have been re-estimated, based on new age–length data.

4.102 The results of the mixture analyses performed this year are shown in Figure 16, compared to the 1999 results. There is little variation between the two results but some cohorts are now better represented. The overall mixture outputs are given in Table 26. These are incorporated directly into the GYM assessment. The results can be compared to those from last year in SC-CAMLR-XIX, Annex 5, Table 31.

4.103 Although the cohort strength data are input directly into the GYM (paragraph 3.150), the time series of recruitments for M = 0.165 year^{-1} is given in Table 27 for comparison with previous years. Other than the revised surveys, the Working Group decided that recruitment inputs to the assessment would not include the cohorts estimated to be age 2 from the current growth parameters. The evidence from Heard Island indicates that this age class is not fully available to the surveys of the shelf area. As a consequence, the large recruitment of age 4 fish in 1992, previously estimated in the 1999 assessment, has reappeared in the time series as well as a reduction in the time series by one year. The mean recruitment is similar to the 1999 estimate. The Working Group noted that the actual age class may be revised in the future, e.g. WG-FSA-01/16, when the age of these fish is confirmed by current research in this area.

4.104 The Working Group noted that ages of fish in this report are derived from the relationship between length at age estimated using the current growth parameters. Designation of age classes will be reviewed at the next meeting. The Working Group agreed that the assessments this year are not affected by this issue.

4.105 In the absence of estimates of M, the Working Group accepted that the range between 2*k* and 3*k* from the von Bertalanffy growth function would be used this year. The Working Group reiterated the urgent priority for obtaining estimates of M independently from the estimation of the growth parameter, *k*, such as by using the methods presented to the Working Group last year (WG-FSA-00/52).

Assessment

4.106 In light of the new analyses, a new assessment of yield was undertaken using the GYM. The parameters used in the assessment are given in Table 28. The other input parameters are for cohort strength (Table 26) and the fishery information, including fishing vulnerabilities and the catch history (Table 29).

4.107 Three assessment trials were undertaken to determine how the new parameters affect the assessment of yield:

(i) revised recruitment series based on mean M = 0.165 year^{-1}, as per last year, with all other parameters remaining the same as last year;

(ii) input data on cohort strength for determination of recruitments using each value of M chosen across the range during the assessment process, i.e. M is integrated across a range for each trajectory, while all other parameters remain the same as last year; and

(iii) input data on cohort strength alter the fishing vulnerability such that the old length-based function is retained for each year up to and including 1997, thereafter the new vulnerability function applies.

4.108 The results of these trials are given in Table 30, which shows, as expected from the similarities in the recruitment series, that the revised recruitment series provides similar yield estimates to the 1999 assessment and greater than last year's assessment. The trial where the cohort strengths were input to ensure internal consistency between estimates of recruitment and M shows an increase in yield. The final trial was with the new vulnerability parameters. This shows a lower yield, probably because of the greater proportion of smaller fish vulnerable to the fishery.

4.109 As in previous years, the decision rule concerning the probability of depletion was binding. The Working Group agreed that the estimate of yield based on the input of cohort densities and the revised fishing vulnerability represented the best scientific evidence available.

4.110 The large increase in yield from the first to the second trial resulted from using the cohort densities directly so as to vary the recruitment series whenever the value of M is changed. This is compared to estimating the recruitment series using a mean value of M prior to the assessments. The Working Group noted that the depletion rule was the binding rule for this fishery. As such, the change to the new treatment of recruitments has reduced the likelihood of triggering the depletion rule. This might arise because the estimate of recruitment at age 4 is generated by projecting older cohorts observed in surveys back to the year of the age 4 birthday. In so doing, the initial abundance of the cohort may be underestimated from the pre-processed recruitment series based on a mean M, when the M in a simulation trial is higher than the mean. Consequently, the probability of that cohort becoming depleted is inadvertently higher. The Working Group agreed that work should continue on understanding how changes in the input parameters influence estimates of yield.

Integration of CPUE into Assessment

4.111 The Working Group agreed that the procedure used last year for integrating the time series of standardised CPUE for Subarea 48.3 into the long-term yield assessment should be used again this year (see SC-CAMLR-XIX, Annex 5, paragraphs 4.148 to 4.152). This procedure involved weighting each of the 1 001 trajectories simulated by the GYM by their likelihood with respect to the standardised CPUE time series, rather than giving them equal weights as was done in past assessments. A histogram of weights assigned to each of the 1 001 trajectories is shown in Figure 17, which indicates that a greater proportion of the trajectories are similar to the CPUE series.

4.112 The effect of using this procedure was to increase the estimate of the long-term yield to 5 820 tonnes, with an adjusted median escapement of 0.54. As indicated last year, there was an increase in yield compared to the unadjusted estimate because the trials given least weight are those with a generally upwards trajectory (in contrast to the CPUE) and are most likely to have started near to or below 0.2 of the pre-exploitation median spawning biomass. Given their reduced weight in the assessment, the probability of depletion for the unadjusted estimate is reduced, thereby resulting in a slight increase in yield.

4.113 The Working Group noted that the estimated long-term annual yield was higher than in 2000 primarily because under-represented young fish were omitted from the estimation of the recruitment series and the inclusion of the cohort densities. The Working Group agreed that this procedure was likely to provide a more accurate time series of recruitments in each simulation trial.

4.114 Summary box and whisker plots of the time series of spawning biomass, vulnerable biomass and recruitments are shown in Figure 18. It should be noted that the changes in vulnerable biomass parallel the changes in CPUE. The stepwise changes in the box plots reflect the changes in the vulnerability function. The box plot present in the middle of the known recruitment series is due to the missing observation.

Management Advice for *D. eleginoides* (Subarea 48.3)

4.115 The Working Group welcomed the progress made at this year's meeting in refining the inputs on fishing vulnerability and recruitments into the GYM. The Working Group reiterated its advice from last year that the development of methods to integrate different indicators of stock status into assessments is a high priority.

4.116 The Working Group agreed that the catch limit for the 2001/02 season should be 5 820 tonnes. The remaining provisions of Conservation Measure 196/XIX should be carried forward for the 2001/02 season.

4.117 Any catch of *D. eleginoides* taken in other fisheries (such as the pot fishery) in Subarea 48.3 should be counted against this catch limit.

South Sandwich Islands (Subarea 48.4)

4.118 Despite a catch limit of 28 tonnes for *D. eleginoides* (Conservation Measure 180/XVIII), no fishing in this subarea was reported to the Commission during the 2000/01 season. No new information was made available to the Working Group on which to base an update of the assessment. The Working Group was also unable at this year's meeting to consider the period of validity of the existing assessment.

Management Advice for *D. eleginoides* and *D. mawsoni* (Subarea 48.4)

4.119 The Working Group recommended that Conservation Measure 180/XVIII be carried forward for the 2001/02 season. As last year, it was also recommended that the situation in this subarea be reviewed with a view to considering the period of validity of the existing assessment. Given the high workload at its meetings, the Working Group agreed that it was unlikely to be able to review this measure in the near future.

Subareas 58.6 and 58.7

Prince Edward Islands EEZ

4.120 A first assessment of *D. eleginoides* in the South African EEZ around the Prince Edward Islands was presented in WG-FSA-01/54 (see also paragraph 3.148). A trawl survey of the EEZ was also undertaken in April 2001 (WG-FSA-01/72 and paragraph 6.5).

4.121 The Working Group noted that this assessment indicated that *D. eleginoides* stocks in the EEZ since 1996 have been subject to high levels of illegal catch and a sharp decline in the longline CPUE. It also showed that spawning stock biomass has been depleted to only a few percent of the pre-exploitation level at most.

4.122 It was further noted that projections based on the results presented in WG-FSA-01/54 suggest that the annual allowable catch in the Prince Edward Islands EEZ should be reduced to about 400 tonnes at most. Such reduction may have some implications for the presence of licensed vessels in the EEZ as a means to bolster efforts to monitor illegal fishing.

Crozet Islands EEZ

4.123 No assessment of *D. eleginoides* in the French EEZ around the Crozet Islands was available to the Working Group. France was encouraged to undertake such an assessment and inform WG-FSA of the results.

Management Advice

4.124 Following advice of recent years, the Scientific Committee and Commission's attention is again drawn to the high levels of uncertainty associated with estimates of *D. eleginoides* stock levels in Subareas 58.6 and 58.7 in general. The negative role of illegal and unregulated fishing in increasing such uncertainty is also re-emphasised.

4.125 Given the prevailing circumstances, the prohibition of directed fishing for *D. eleginoides* in Subarea 58.7 (Conservation Measure 160/XVII) should continue.

4.126 Annual allowable catches of *D. eleginoides* in both the Crozet and Prince Edward Islands EEZs should be reduced to a few hundred tonnes until such time that assessments improve. In the former case, this would also be subject to the availability of catch and effort data (see paragraph 4.75) and an assessment of *D. eleginoides* in the Crozet Islands EEZ.

Kerguelen Islands (Division 58.5.1)

4.127 The Working Group discussed the role of WG-FSA in assessment and management decisions regarding Kerguelen. At present, WG-FSA is not able to conduct assessments or give advice concerning *D. eleginoides* population status or exploitation in Division 58.5.1. There is currently no capacity to revise the stock assessment because recent haul-by-haul data have not been provided. The Working Group recommended that these data should be made available for assessment purposes, as well as any other information that would help determine the current stock status.

4.128 The Working Group agreed that the presence of a French scientist and comprehensive information from the fishery at WG-FSA is essential for undertaking an assessment of the state of *Dissostichus* spp. stocks in Division 58.5.1 and other adjacent areas such as the Crozet Island region (see also paragraph 4.126).

Heard and McDonald Islands (Division 58.5.2)

4.129 The catch of *D. eleginoides* for the trawl fishery in the 1999/2000 CCAMLR fishing season was 3 566 tonnes (catch limit = 3 585 tonnes, Conservation Measure 176/XVIII).

4.130 The catch limit of *D. eleginoides* in Division 58.5.2 for the 2000/01 season was 2 995 tonnes (Conservation Measure 197/XIX) for the period from 1 December 2000 to the end of the Commission meeting in 2001. The catch reported for this division at the time of the 2001 WG-FSA meeting was 2 490 tonnes. Two Australian vessels are participating in the fishery.

Determination of Long-term Annual Yields using the GYM

4.131 Two papers were submitted this year that provided information for consideration in assessing the long-term annual yield for *D. eleginoides* in Division 58.5.2. WG-FSA-01/76 provided background information on the results of a tagging program undertaken during the commercial fishery. The authors cited that tagged toothfish of total length 600–900 mm can grow up to 50 mm per annum. WG-FSA-01/73 presented a number of new analyses including estimates of abundance from the recent survey in 2001, an analysis of length at age, revision of the recruitment time series based on length at age, an estimate of M and an approach for estimating age-specific selectivities for *D. eleginoides* in the trawl fishery. The results presented in these papers were used to help revise the input parameters to the GYM.

4.132 Following modifications to the negative log-likelihood function for estimating von Bertalanffy growth parameters (paragraph 3.147, WG-FSA-01/73 Addendum), the growth parameters were re-estimated with the same rationale as provided in WG-FSA-01/73. The results are illustrated in Figure 19 and included in Table 28. L_8 = 2 465 mm, k = 0.029 year^{-1}, t_0 = -2.56 and CV of length at age = 0.12. The Working Group agreed that these parameters provided reliable estimates of length at age for the size ranges of the fish sampled, and accordingly can be used in the GYM assessment. It was encouraged by the similarity between the annual growth increment predicted by the model and the estimated growth increment from the tagging study. However, the relatively flat likelihood profiles suggest that L_8 and k are likely to vary with the addition of new data, particularly in the lower size ranges. While this would not affect greatly the mean lengths at age estimated from these data, the Working Group agreed that the use of the k value as a guide to the value of M would be inappropriate at this stage.

4.133 As a result of the revised growth parameters, the mixture analyses used to determine cohort densities were re-assessed using the approach described in WG-FSA-01/73. This analysis resulted in a revised set of cohort densities from those in that paper. The results are displayed in Figure 20 and Table 31. The Working Group noted the improved fits of the mixture components to the observed data. On the basis of the distribution of the different age classes described in WG-FSA-01/73, the Working Group agreed that only fish in the age range 3–8 years should be included in the assessment of the recruitment series because older and younger fish are likely to be poorly represented in the samples. In addition, the Working Group agreed to include only age 3 fish from the 1992 and 2000 surveys as the older fish were unlikely to have been well sampled because of the exclusion of the deep stratum (500–1 000 m) from these surveys.

4.134 WG-FSA-01/73 also applied the method for estimating M from last year (SC-CAMLR-XIX, Annex 5, paragraphs 3.130 and 3.131), which uses repeated observations of a number of cohorts to jointly estimate M and recruitment strength. As the cohort densities had been re-estimated, the method was reapplied to the cohorts observed in both the 1990 and 1992 surveys. While this analysis is limited to only three cohorts (age 4 in 1989, 1990 and 1991) the resultant value of M = 0.165 year^{-1} was the same as the implied M in Subarea 48.3 (which had been derived at WG-FSA-1995 and had been implied from the range of 2–3 k). The results are presented in Figure 21, which shows that M might vary quite widely.

4.135 The Working Group agreed that, in the absence of other independent assessments of M, this estimate provides a guide as to what magnitude of M might be influencing this stock. It decided to apply a range of M in the assessment. Given the consistency with the value of M in Subarea 48.3, the Working Group agreed to use a range of M between 0.13 and 0.2, the same as for the assessment in Subarea 48.3. It also agreed to run a sensitivity trial to see what the outcome might be with a lower range of M (0.1–0.16 year^{-1}). The Working Group recommended that further studies to estimate M independently of the growth parameters should have a high priority.

4.136 Although the assessment now uses the direct estimates of cohort density directly in order to keep the parameters for each simulation trial consistent, a calculation of the time series of recruitments based on M = 0.165 year^{-1} was undertaken in order to compare the revised time series with the time series of recruitments from last year. This is presented in Table 32. The resultant time series of recruitments is very similar, although less variable overall and a mean recruitment of approximately 5% less than that estimated last year.

4.137 The proposed method for estimating age-based fishing vulnerability detailed in WG-FSA-01/73 and evaluated in paragraph 4.133 was applied to the available catch data for Division 58.5.2, using the revised growth and mortality parameters. The catch-weighted length frequencies from each voyage between 1997 and 2000 were used in the assessment. An age-based fishing vulnerability function was estimated for each year of the fishery. The results are displayed in Figure 22 and functions presented in Table 33. The Working Group encouraged the further development of this method to take account of fishing mortality but noted that the results for this year improve the function applied in previous years because it takes better account of the presence of large fish in the catch.

4.138 A comparison of the maturity-at-length functions between South Georgia and Heard Island showed no difference between them. Consequently, the simpler function from South Georgia was adopted for the Heard Island assessments.

4.139 The analysis of long-term annual yield was updated with these parameters, which are collated in Table 28.

4.140 As for Subarea 48.3, a sequence of trials was undertaken to determine the effect of these revised parameters on the estimate of yield. The results of the trials are presented in Table 34. The first trial is to incorporate all the new parameters, including the cohort densities, except for the revised vulnerability functions. This revision showed a decline in estimated yield since last year of approximately 680 tonnes. The effect of having the IUU catch from 1996/97 as coming from the trawl fishery when it is was caught by longlining could now be explored by setting the IUU catch to the previous year in which no fishing occurred. The selectivity function from Subarea 48.3 was applied to the IUU catch (see Table 29). This constituted the second trial and showed that the IUU catch had little effect on the outcome, although its effect is immediately apparent in causing a decline in the spawning stock (Figure 23).

4.141 The third trial was to have a complete updated set of parameters including annual variation in the vulnerability function and the application of the 2000 vulnerability function to the forward projection. This differs from last year by including larger age classes in the catch. This resulted in a yield estimate of 2 815 tonnes which was approximately 20% higher than the yield from trials 1 and 2.

4.142 A sensitivity trial to examine the effect of a lower M on the estimate of yield was undertaken as a fourth trial. This showed that a lower range of M would result in a higher yield.

4.143 Summary box plots of spawning biomass, vulnerable biomass and the recruitment series for the catch level of 2 815 tonnes are shown in Figure 23. The illustrated decline in spawning biomass over the last five years may have resulted from the effects of IUU fishing. The effects of the strong recruitments in the mid-1990s is evident in the predicted upward trend of the spawning biomass after 2005, at which time the known recruitment series will explain much of the abundance of the spawning stock (indicated by the declining variation until that time). The pattern of vulnerable biomass is very much influenced by the changing vulnerability function over the course of the fishery. The large biomass in 1995 is due to the vulnerability function for the longline fishery, while the subsequent small biomasses are due to the vulnerability function taking only ages 6- to 8-year-old fish. The vulnerability function used to project the stock forward includes fish from ages 4 to 15 years. The trend in vulnerable biomass is due to the passage of the strong recruitments into the vulnerable part of the stock and out again over the next five years.

Assessment

4.144 The input parameters for the GYM are shown in Table 28, giving the updated parameters as derived above. The decision rule concerning escapement was binding in this assessment, although the yields for this and the depletion rule were very similar. The yield at which median escapement is 50% of the median pre-exploitation spawning biomass level over 35 years was 2 815 tonnes. The yield for which there is a 0.1 probability of depletion below 20% of the pre-exploitation median spawning biomass was 2 959 tonnes.

Management Advice for *D. eleginoides* (Division 58.5.2)

4.145 The Working Group recommended that the catch limit by trawling for Division 58.5.2 in the 2000/01 season be revised to 2815 tonnes, representing the long-term annual yield estimate from the GYM.

4.146 The remaining provisions of Conservation Measure 197/XIX should be carried forward for the 2001/02 season.

General Advice

4.147 The Working Group noted the general advice of the Scientific Committee to the Commission at its last meeting (SC-CAMLR-XIX, paragraphs 5.64 to 5.71) and wished to advise the Scientific Committee of achievements and further recommendations arising from consideration of that advice.

4.148 The Working Group has made progress this year on methods for reducing uncertainty in important assessment parameters. It noted that the yield estimates are sensitive to the values of M (paragraph 4.142; SC-CAMLR-XIX, Annex 5, paragraphs 4.143 to 4.146). The Working Group emphasised that a reassessment of growth and M for Subarea 48.3 remains a very high priority as well as the estimation of M in Division 58.5.2. It recommended that continued survey and other research be given a high priority for providing the data for estimating these parameters. In addition, it recommended that the potential differences in the growth rates of male and female toothfish be considered in relation to the consequence of such differences for assessments (SC-CAMLR-XIX, Annex 5, paragraphs 4.122 to 4.123).

4.149 The Working Group has made much progress in estimating fishing vulnerability functions (availability combined with selectivity) for both trawl and longline fisheries with the application of two new methods. Both methods are in the early stages of development and the Working Group encouraged further development of these methods in time for assessments next year.

4.150 The Working Group wished to advise the Scientific Committee that, apart from natural variations in recruitment strength, the application of new methods in these fisheries will cause some variation from time to time in the estimates of parameters and, consequently, estimates of yield. The inter-dependence of estimates of recruitment, growth, selectivity and M means that estimating these parameters cannot be undertaken in isolation. The Working Group endeavoured to ensure that all input parameters to the assessment process are consistent. The further developments of the GYM this year has meant that the interdependence of recruitment estimates and M is now incorporated directly into the assessment process. Similarly, changes to growth parameters can be readily incorporated into the analysis of length-density data used for estimating cohort strength. The Working Group recommended that further progress be made on methods to ensure consistency in the estimation of these parameters.

4.151 The Working Group noted the recognition of the Scientific Committee that the assessment process for *D. eleginoides* has become quite complex. It wished to advise the Scientific Committee that the development of new methods for assessing these stocks is continuing. The Working Group noted in particular that the assessment of *D. eleginoides* in Subarea 48.3 involves the use of many sources of data from the fishery and research surveys, including estimates of recruitment strength, standardised CPUE and other biological samples. As a result, there is the potential for the Working Group to examine whether conventional methods for estimating yield could be applied such that assessments might be expected to revise yield according to short-term sustainable levels of harvest rather than estimating long-term annual yields. Consequently, the assessments of this species using the standard methods of assessment will be compounded by the evaluation of new methods as happened this year.

4.152 The Working Group recommended that an intersessional forum be established to prepare a program of work for the next meeting, in parallel to the process of developing the agenda, that takes account of the likely submission of new data, the need to evaluate new methods if they are being developed and the need to complete the assessments in a thorough, accurate and timely way.

4.153 The Working Group agreed that the presence of a French scientist and comprehensive information from the fishery at WG-FSA is essential for undertaking an assessment of the state of *Dissostichus* spp. stocks in Division 58.5.1 and other adjacent areas such as the Crozet Island region (see also paragraph 4.126).

4.154 The Working Group also recommended that a framework for evaluating assessment methods be developed in order to be confident that results arising from the application of these methods will be robust to the uncertainties surrounding the management of fisheries on these species. The Working Group requested that this be given a high priority for coordination and assistance by the Secretariat, including validation of assessment methods and software, peer review and archiving of documentation (see also SC-CAMLR-XIX, paragraph 5.70).

4.155 In this context, it was noted that assessments of krill are undertaken in WG-EMM and that there would be merit in coordinating these assessments with those undertaken by WG-FSA. This might be achieved by a meeting of specialists around the time of WG-EMM's 2002 meeting, which could also provide an opportunity to discuss, develop and validate assessment methods generally.

Champsocephalus gunnari

Workshop on Approaches to the Management of Icefish

4.156 In accordance with SC-CAMLR-XIX, paragraphs 5.91 and 5.92, the Workshop on Approaches to the Management of Icefish (WAMI) was held in Hobart from 3 to 5 October 2001. A total of 14 participants from seven countries took part in the meeting and 16 papers were submitted for consideration. The papers discussed by the workshop were made available to the Working Group as necessary for the completion of assessments at this year's meeting. A report from this meeting was presented to the Working Group and is attached as Appendix D.

4.157 The workshop addressed the terms of reference agreed by the Scientific Committee at meetings between 1997 and 2000. The assessment and management of *C. gunnari* was discussed under the following headings:

(i) Review and Characterisation of Fisheries;

(ii) Management Needs and Current Measures;

(iii) Review of Data on Biology and Demography, Age, Growth, Mortality, Reproduction, Diet and Stock Identity and Structure;

(iv) Ecosystem Considerations, including Ecosystem Changes since the Start of the Fishery (early 1970s);

(v) Assessment Methods; and

(vi) Management Procedures.

4.158 Each part of the report of the meeting was presented to the Working Group under the appropriate item on the Working Group's agenda. Items discussed under point (iii) are reported in paragraphs 3.112 to 3.127. Items discussed under the remaining points are reported below.

Review and Characterisation of Fisheries

4.159 The Working Group noted that fisheries for *C. gunnari* in Subarea 48.3 and Divisions 58.5.1 and 58.5.2 share many characteristics in common. These fisheries may be characterised by:

(i) large fluctuations in catch;

(ii) periods of low or zero commercial catches;

(iii) a recent resurgence in interest in the fishery in the mid- to late 1990s with modest levels of fishing effort and catches in Subarea 48.3 and Division 58.5.2;

(iv) reliance of the commercial fishery on a few age classes: mainly ages 3 and 4; and

(v) age 5+ fish are poorly represented in survey and commercial catches, suggesting an age-specific increase in M.

The Working Group endorsed the recommendation of the workshop that the recently compiled bibliography on *C. gunnari* should be developed as an electronic database (Appendix D, paragraph 2.1), and that this could be expanded to include papers on other species of importance to WG-FSA such as toothfish.

4.160 The workshop had discussed time series of catch-weighted length frequencies for *C. gunnari* for Subarea 48.3 and Division 58.5.2 presented in WAMI-01/15 Rev. 1. The Working Group recognised the value of these data, and the need to extend these time series so as to include the periods of high catches from the fisheries during the 1970s and 1980s. It was understood that data from this early period of fishing in Subarea 58.5 were collected and that the raw data are now held by Dr V. Herasymchuk, State Committee for Fisheries of Ukraine. The Working Group discussed how these important data might be processed and made available to CCAMLR. This matter was referred to the Scientific Committee for further consideration.

Management Needs and Current Measures

4.161 The Working Group agreed that the main objective of the management of *C. gunnari* in the Convention Area is to provide rational and sustainable use of the *C. gunnari* resource with the following three requirements, in accordance with Article II of the Convention:

(i) maintenance of spawning stock at a size that recruitment is not impeded;

(ii) maintenance of the ecological relationships between harvested, dependent and related species; and

(iii) prevention of changes in the ecosystem that are not reversible over 20 to 30 years.

4.162 The Working Group noted that these objectives have been implemented using measures available to the Commission under Article IX. These include catch limits, by-catch limits, closed seasons, closed areas, gear regulations and minimum fish sizes. The workshop report described how these measures have been used (Appendix D, paragraphs 4.2 to 4.11). The Working Group confirmed that these types of measures were appropriate means by which to achieve the stated objectives and that assessment work should continue to be focused on generating management advice on such measures for forthcoming seasons.

4.163 The history of different methods used by the Working Group to develop advice on catch limits is described in Appendix D, paragraphs 4.2 to 4.5 and 7.1 and 7.2. The short-term projection, used since 1997, represented a change in management approach from the management of the population as a whole (with associated biological reference points) to the management of individual cohorts. An important aspect of this approach is that the yield estimate is still conditional on the maintenance of the spawning biomass and on the escapement of a certain percentage of the population. In line with the management of krill, an escapement level of 75% has been used to leave a notional amount for predators. However, as for krill, the predator requirements for this species need to be reviewed as data become available in order to determine the appropriate level of escapement that takes account of ecosystem interactions (paragraphs 4.165 to 4.175).

4.164 The Working Group endorsed the following recommendations of the workshop with respect to current management measures:

(i) the Fishery Plan for each area needs to list the information (research) requirements for the management approach adopted. The currency of the assessment should also be stated (Appendix D, paragraph 3.7);

(ii) reporting requirements must be met to enable catch limits to be monitored (Appendix D, paragraphs 4.2 to 4.6);

(iii) where possible, WG-FSA should update the short-term projections annually (Appendix D, paragraphs 4.4 and 4.5); and

(iv) where stock structure is uncertain, stocks should be managed as smaller units (Appendix D, paragraph 5.21).

Ecosystem Considerations

4.165 The Working Group noted the workshop's brief review of predator–prey relationships and the importance of *C. gunnari* in the diets of land-based marine predators in the southern Scotia Arc, and at South Georgia and Heard Island.

4.166 At last year's meeting the Working Group discussed whether a closed season might be appropriate during peak periods of foraging activity and requested that this be considered further at the workshop.

4.167 The workshop described how fur seals at South Georgia may take *C. gunnari* at various times throughout the year depending on the availability of krill. Both fur seals and penguins can switch their feeding preferences, feeding on krill in periods of high krill abundance, and increasing the proportion of *C. gunnari* in periods of low krill abundance. Analysis of otoliths present in scats indicates that male fur seals present around South Georgia in winter target their foraging on both krill and fish associated with krill aggregations, with *C. gunnari* being the most important component of the fish portion of the diet (Reid, 1995).

4.168 Dietary studies of Antarctic fur seals and king penguins at Heard Island indicate that both these species feed on *C. gunnari* at certain times of the year. However, fur seals at Heard Island, and also in the Kerguelen Islands, feed mainly on myctophids.

4.169 Regarding predator–prey interactions, the Working Group noted the conclusions of the workshop that:

(i) there is a strong relationship between krill, *C. gunnari* and land-based predators at South Georgia;

(ii) the importance of *C. gunnari* in the diet of land-based predators may be high in years of low krill abundance at South Georgia; and

(iii) *C. gunnari* may be an important prey item during critical phases of the life history of some predators, particularly in the Indian Ocean sector.

4.170 The Working Group further noted the conclusions of the workshop with respect to changes in the ecosystem in the recent past that may be affecting the dynamics of *C. gunnari* stocks. In particular, the Working Group noted:

(i) increases in populations of fur seals and some species of penguins at South Georgia;

(ii) increases in populations of fur seals and king penguins in the Indian Ocean;

(iii) increases in mean annual air temperature at the Antarctic Peninsula; and

(iv) decreases in the mean annual extent of sea-ice in the southern Scotia Arc.

4.171 The Working Group agreed that, in the context of Article II, it is possible that a change has occurred in the ecosystem which may not be reversible over two or three decades. However, the workshop recognised the high variability in the size of *C. gunnari* stocks, and the potential for recovery following an event of high recruitment.

4.172 The Working Group noted the review by the workshop of information on the incidental catches, and associated mortality, of seabirds taken in the fishery for *C. gunnari* in Subarea 48.3 in the 1998/99 and 2000/01 seasons (WG-FSA-01/30). This issue was considered further by WG-IMALF (paragraphs 8.5 to 8.23).

4.173 With respect to the by-catch of young *C. gunnari* in krill trawls, the Working Group noted the discussion in the workshop report, including new information on the abundance of *C. gunnari* in the by-catch from the krill fishery in Subarea 48.2, reported in WAMI-01/11. Dr Everson commented that the occurrence of *C. gunnari* was relatively low, but that occurrence levels may be related to water depth. The paper did not indicate the depth of water in the area where the samples were taken. It is rare to find *C. gunnari* in plankton hauls over deep water.

4.174 The Working Group noted the discussion of the workshop with respect to the rationale behind the ban on bottom trawling in Subarea 48.3. Concern about the impact of fishing gear on the seabed, and the potential taking of species of depleted stocks of demersal fish, such as *N. rossii*, led to the prohibition of bottom trawling in this region. As a result, commercial fisheries for *C. gunnari* in Subarea 48.3 operate midwater trawls. In contrast, the use of bottom trawls in commercial fishing is permitted and does occur in other parts of the Indian Ocean, including Divisions 58.5.1 and 58.5.2. Although the workshop noted that the composition of the fish fauna, and potential for by-catch taken by trawl in Division 58.5.2 was different to those in Subarea 48.3, Dr Everson pointed out that whilst the fish species may be different, the types of fish found in the two areas are quite similar. Dr Parkes also noted the occurrence of rays in the by-catch in Division 58.5.2, which does not occur in Subarea 48.3.

4.175 The Working Group endorsed the following recommendations of the workshop regarding ecosystem interactions between the *C. gunnari* fishery, *C. gunnari* and its predators and prey and other elements of the ecosystem:

(i) Studies are needed to further quantify the relationship between krill, *C. gunnari* and land-based predators. Possible interactions between the *C. gunnari* fishery, *C. gunnari* and its predators should be examined, including quantification of any overlap which may occur. WG-EMM has previously determined an overlap index for krill. Predator-dependence studies are required to determine how important *C. gunnari* are to predators (seals, penguins etc.) (Appendix D, paragraph 6.7). Foraging ranges of predators should be provided (Appendix D, paragraphs 5.11 to 6.7).

(ii) Further work was needed to compile information on long-term, large-scale changes in populations and the environment in Areas 48 (Atlantic Ocean) and 58 (Indian Ocean) (Appendix D, paragraph 6.10). A comparison over time should be made of the population abundance of predators–icefish–krill in each area (Appendix D, paragraph 5.11). Information is needed on the likely effects on the ecosystem of the observed increase in temperature and other ecological changes over the last 20 years (Appendix D, paragraph 6.10). The Working Group requested assistance from WG-EMM in addressing these issues.

(iii) Simulation studies were also needed to examine plausible scenarios which could lead to observations on the abundance of *C. gunnari*, krill and the predators (Appendix D, paragraph 6.10). A simulation study of the impact of seal predation may help determine what future work is required (empirical studies) (Appendix D, paragraph 6.7).

(iv) WG-FSA should review commercial by-catch rates in each fishery and review survey by-catch rates in each area (analyse trends) (Appendix D, paragraph 6.12). A consistent approach to by-catch issues should be taken across the various fisheries (Appendix D, paragraphs 6.13 to 6.15).

(v) Further information is required from the krill fishery on by-catch rates of juvenile *C. gunnari* (Appendix D, paragraph 6.15).

(vi) WG-IMALF should consider development of a protocol for observers concerning seabird interactions with trawl fisheries (see paragraph 8.20). The relative vulnerability of each species to trawl fisheries should be determined (Appendix D, paragraph 6.17).

Assessment Methods

Survey Techniques

4.176 Regarding assessment methods, there was extensive discussion by the workshop of the design of surveys used to measure the abundance of *C. gunnari* (Appendix D, paragraphs 7.17 to 7.29). The Working Group recalled discussion from last year's meeting regarding survey designs that would avoid bias in abundance estimates resulting from the variable distribution of *C. gunnari* in the water column above the level sampled by the bottom trawl (SC-CAMLR-XIX, Annex 5, paragraphs 4.198 to 4.203). Two proposals were put before the Working Group in 2000; a preliminary acoustic survey aimed at assessing the distribution and movements of fish in the water column, and the undertaking of bottom trawl surveys during the winter season (in South Georgia) when previous observations suggested that the vertical migration of fish is much less pronounced.

4.177 The Working Group agreed that research surveys need to be as representative as possible of the true status of the stock as they are now the primary means of measuring the current status of the stock and form the starting point for the subsequent calculation of catch limits using the short-term projection method. Although there are limitations to the bottom trawl method, it is important to continue these surveys as they provide a continuous time series conducted using similar techniques.

4.178 In terms of the seasonality of vertical migration behaviour in *C. gunnari*, evidence was presented in WAMI-01/8 which suggests that in winter the fish feed poorly and do not appear to form large aggregations. During spring, *C. gunnari* begin to form aggregations near the bottom and to migrate vertically in order to feed more intensively. In summer, fish appear to perform extensive vertical and horizontal migrations and are intensively feeding, densely aggregating in some years. Finally, in autumn, fish are near the bottom areas and feeding intensity decreases significantly when fish approach spawning. Thus, seasonality can bias the indices of abundance and potentially also affect the estimates of mortality derived from survey data.

4.179 The Working Group noted that evidence presented to the workshop in WAMI-01/5 indicated that at Heard Island (Division 58.5.2), providing bottom trawls were conducted between the times of sunrise and sunset, bias should not be a problem.

4.180 Regarding future surveys, the workshop had discussed the design of a combined trawling/acoustic survey of the *C. gunnari* stock in Subarea 48.3 planned by Russia for January–February 2002. The survey will aim to improve quantitative assessments for *C. gunnari* by combining an acoustic and bottom trawl survey to resolve the pelagic and benthic components of the stock respectively. The original bottom trawl survey design used in previous years will be repeated to maintain continuity of the time series. The Working Group agreed that there were many issues that would need to be resolved before quantitative estimates of *C. gunnari* biomass could be derived from acoustic data (listed in Appendix D, paragraph 7.23), and discussion would be necessary at next year's meeting to determine ways in which abundance estimates from the bottom trawl and acoustic surveys might be combined.

4.181 The Working Group was advised that the UK also plans to carry out a bottom trawl survey in Subarea 48.3 in January 2002. To maintain continuity of the data series, the survey design will be the same as that used previously, but will also collect acoustic information using a hull-mounted EK500 echosounder.

4.182 The Working Group recognised the value of combined acoustic and trawl surveys and encouraged discussion between the UK and Russia to explore options to coordinate the two surveys in Subarea 48.3. A two-vessel collaborative survey collecting concurrent acoustic and trawl data would yield a very valuable dataset that may address issues such as bias and the most appropriate survey techniques for *C. gunnari*. There might also be a valuable opportunity to conduct an experiment with the two vessels fishing in a small area at the same time to investigate their relative catchabilities (Appendix D, paragraphs 7.11 to 7.13).

4.183 The Working Group also agreed that whenever possible, continuous acoustic recording should be undertaken during bottom trawl surveys for *C. gunnari* to allow potential bias to be determined in survey catch rates.

Setting Catch Limits

Biological Reference Points

4.184 WAMI-01/13 presented the results of an analysis of *C. gunnari* catch-at-age data from the early phase of the fishery in Subarea 48.3 (ending in 1990) using Extended Survivors Analysis (XSA), which provided estimates of biological reference points (RPs) (Appendix D, paragraphs 7.7 to 7.10). The Working Group thanked the author, Dr P. Gasiukov (Russia), for his work noting that this technique is very useful in giving an overview of stock dynamics. In particular, these techniques can be used to derive recruitment time series and estimates of catchability, although it was noted that the diagnostics suggested that many of the problems encountered by WG-FSA in its previous attempts to perform VPA using ADAPT remained with the XSA approach.

Short-term Projection

4.185 The Working Group endorsed the continued use of the current short-term projection method to provide advice on catch limits for *C. gunnari* and noted the lack of alternative methods. It also noted that with the fishery based on two age classes, the currency of assessments is two years. If there is no survey information from the most recent two seasons, the advice on catch limits becomes unreliable.

Management Procedures incorporating Longer-term Approaches

4.186 The Working Group noted the discussion by the workshop regarding decision rules and operational objectives required to develop a management procedure incorporating stock dynamics and ecological relationships over the longer term (Appendix D, paragraphs 8.1

to 8.7). Previous attempts to use the GYM to undertake long-term projections to estimate precautionary catch limits for *C. gunnari* have not provided useable results. High recruitment variability, and consequently highly variable stock size, even in the absence of fishing, result in very low precautionary catch limits using a constant yield strategy under current assumptions regarding predator requirements and target escapement (75%).

4.187 The Working Group agreed that issues such as the importance of *C. gunnari* as a prey species and the consequences to predators of a fluctuating availability of this species need to be investigated in more detail in order to guide future applications of this approach (paragraph 4.175).

4.188 The Working Group agreed that the types of assessment methods and decision rules that could be used for *C. gunnari* should be evaluated in a simulation framework to test the performance of the procedures before suggesting modifications to the current management system. Evaluation requires the elaboration of plausible models of the ecological and fishery system against which the performance of management procedures can be measured. In this regard, the Working Group endorsed the program of work proposed by the workshop in Appendix D, paragraph 8.4.

4.189 The Working Group also endorsed the evaluation of alternative approaches to management proposed by the workshop in Appendix D, paragraph 8.6:

(i) the development of decision rules that take account of changes in the relative status of the stock in order that assessments of long-term annual yield can be made;

(ii) the development of short-term methods that take account of uncertainty in parameters such as M;

(iii) consideration of the components of the existing decision rule for the short-term assessments, such as the confidence bound on the biomass estimate and the escapement of the cohorts following fishing, to identify whether any part of the decision rule could be made less stringent while still ensuring a high probability of maintaining productivity of the stock and its predators;

(iv) consideration of medium-term assessment methods such as those used in ICES that endeavour to account for the probability of recruitment success in subsequent years;

(v) consideration of closed seasons to safeguard predators and therefore not require a specific provision for predators in the decision rule; and

(vi) consideration of how to ensure the conservation of the stock if the fishery pursues the catch limit after the assessed cohorts have disappeared. (The workshop noted the risk of exploiting unassessed cohorts if they enter the fishery at this time.)

South Georgia (Subarea 48.3)

Fishery in 2000/01

4.190 The 2000/01 season for the commercial fishery for *C. gunnari* around South Georgia (Subarea 48.3) was split into two periods: the first from 1 December 2000 to 28 February 2001 and the second from 1 June 2001 to 30 November 2001. There was a closed season from 1 March to 31 May to protect spawning concentrations. The catch limit agreed by the Commission for the 2000/01 season was 6 760 tonnes (Conservation Measure 194/XIX). Several other conditions applied to this fishery, including overall by-catch limits (Conservation Measure 95/XIV), per haul by-catch limits, a provision to reduce the catch of small (<24 cm) fish and data reporting on a haul-by-haul basis. All vessels carried international scientific observers designated in accordance with the CCAMLR Scheme of International Scientific Observation, and observer reports and data were submitted to the Secretariat.

4.191 The reported catch during the first part of the season was 1 427 tonnes of *C. gunnari*, taken by four trawlers: one from France, one from Chile and two from the UK. Fishing in the second part of the season was very limited. There was no fishing taking place at the time of the Working Group meeting. The Russian trawler *Zakhar Sorokin* fished for just 10 days from 1 to 9 September taking negligible catch. As in the 1999/2000 season, fishing was concentrated primarily on the shelf to the west and northwest of South Georgia. Catch rates were again highly variable, ranging from zero to more than 7 tonnes per hour towed.

2000/01 Assessment

4.192 The catch limit for the 2000/01 season was calculated using the short-term cohort projection method first performed at the 1997 meeting of WG-FSA (paragraph 4.231; SC-CAMLR-XVI, Annex 5, paragraphs 4.179 to 4.182). The starting point for this projection was an abundance and age structure estimated from two surveys in January and February 2000 by the UK and Russia respectively. The projection was used to calculate catch limits for a period of two years: 2000/01 and 2001/02.

4.193 The estimated catch limit for 2001/02 was 5 135 tonnes.

New Information Available in 2001

4.194 Although the Working Group in 2000 had provided advice on a catch limit for the forthcoming season, there was a range of new information available at this year's meeting that could be used to reassess the status of the *C. gunnari* stock in Subarea 48.3 and revise this advice. No new survey had been conducted in 2000/01, however, there were revised estimates of growth parameters and M presented in WAMI-01/7. In addition, the commercial catch in 2000/01 was well below the catch limit, hence actual fishing mortality was probably lower than that projected at last year's meeting.

Age Composition of Commercial Fishing

4.195 A catch-weighted length distribution for the first part of the 2000/01 fishing season is provided in Figure 24. On the basis of age estimates from previous analyses and the age–length key from the Russian survey in February 2000 (WG-FSA-00/51), the length distributions indicate that the bulk of the catch was composed of fish aged 3 and 4.

Growth Parameters

4.196 A von Bertalanffy growth curve was fitted to age–length data arising from readings of otoliths collected during the Russian survey in February 2000 (WG-FSA-00/51 and WAMI-01/7) using a least squares fit. Two curves were fitted: one using all data and a second using data up to age 8+ only. Another curve was fitted to age–length data arising from readings by Polish scientists of otoliths collected during the UK/Polish and UK surveys in 1989, 1990, 1991 and 1992. These data and curves are plotted in Figure 25, alongside the growth curve used for the short-term projection at last year's meeting. The parameters of the four curves are given in Table 35.

4.197 The Working Group noted a marked difference between the Russian and UK/Polish age–length datasets and the growth curves fitted to them. These differences were considered to be too great to be due to changes in growth characteristics over the period between the surveys, but were more likely due to differences in the interpretations of rings on the otoliths.

4.198 Substantial differences were also noted between the curves fitted at this year's meeting and the growth curve used previously. These differences were so great that the Working Group agreed that irrespective of whether the Russian or Polish age readings were correct, the growth parameters used previously were no longer representative of the growth of *C. gunnari* in Subarea 48.3 and should not be used in the short-term projection.

4.199 The Working Group was unable to reconcile the differences between Russian and Polish age reading. They felt, however, that the Russian age readings tended to be more reliable and were more in line with results from age determinations using modes in length-frequency distributions followed over a number of months and seasons.

4.200 The Working Group reiterated the importance of obtaining reliable age determinations in *C. gunnari*.

4.201 In order to develop a more reliable approach to ageing, the Working Group recommended that an otolith exchange program should be started among interested scientists as a first step in 2002. The exchange program will be organised by AtlantNIRO in Kaliningrad, Russia. The program will be based on otoliths collected during a cruise in January–February 2002 at South Georgia and will start in late spring 2002. An interim report will be submitted to the 2002 meeting of WG-FSA. No financial support is needed from CCAMLR for the exchange program.

4.202 A second step will be a 'Workshop on Age Reading Methods and their Application in *C. gunnari*' envisaged to take place in summer 2003. This workshop should provide ample opportunity to discuss the several approaches of ageing *C. gunnari* and come up with an agreed method to be used inside CCAMLR. Details of the organisation of the workshop and financial implications for CCAMLR are currently under consideration.

4.203 The Working Group noted that estimates of growth parameters depend on how many ages classes are included in the calculations. If ages as high as 11 are included L_8 is close to the observed value of L_{max}. If only ages up to 8 are used, k increases while L_8 consequently decreases (Table 35).

4.204 Dr Kock pointed out that only a small fraction of the population of *C. gunnari* at South Georgia survive to ages 6 and 7. In addition, there are very few age–length data for fish older than these ages. In practice, there was little difference between the two curves fitted to the Russian age–length data up to age 7+, after which the curves deviated moderately. The Working Group agreed that the growth curve fitted to data up to age 8 should be used to describe the growth of the population in the short-term projection.

4.205 Parameters for growth curves fitted previously by various authors are presented in Table 36. These curves are compared with the curves fitted to the Russian and Polish age–length datasets in Figure 26.

4.206 In addition to their use in the projection, the growth parameters are also used to set reasonable bounds on the means of distributions of length at age in the analysis of length-density data using the CMIX program. The Working Group decided to undertake the mixture analyses using the growth curves from both the Russian and Polish age–length datasets to set these bounds. This would provide a test of which was most consistent with the modes in the length-density data. The results of these analyses are described in paragraphs 4.222 and 4.223.

Mortality

4.207 WAMI-01/7 also provided new estimates of M using several different methods to analyse survey data from the 1999/2000 season. These analyses were based on the premise that with the virtual absence of commercial fishing since January 1990, the population sampled by surveys in that year was unaffected by fishing mortality. The paper investigated the application of seven different methods: Baranov, 1918; Beverton and Holt, 1956; Rikhter-Efanov, 1976; Pauly, 1980; Alverson-Carney, 1975; Heincke, 1913; Robson-Chapman, 1961. These methods were applied to data from the UK survey in 1997, the Russian survey in 2000 and the combined UK and Russian survey dataset used at last year's meeting of WG-FSA. Four of the methods applied yielded results: Beverton and Holt, Heincke, Robson-Chapman and Baranov. The authors rejected the values from the UK survey in 1997 as being unrealistically high compared to the others. The range of all the other values was 0.57 to 0.99, with an average of 0.76.

4.208 The Working Group agreed that the results of the analysis of catchability discussed by WAMI (Appendix D, paragraphs 7.12 to 7.16) indicated that the UK and Russian survey data should not be considered to have the same catchability. Some adjustment is needed if they are to be combined for use in the assessment. This issue is discussed further in relation to the assessment in paragraphs 4.211 to 4.217. However, the Working Group agreed that in light of these new results, it was no longer appropriate to use the combined dataset from last year's meeting. Hence, the mortality estimates derived from that dataset should not be used. The remaining values in WAMI-01/7 were estimated from the Russian survey in 2000. The Working Group agreed that of these values, the result for ages 1 to 6 (M average 0.71) was likely to be more representative of the age classes considered in the short-term projection.

4.209 An attempt was made to estimate M from data obtained during surveys in Division 58.5.2. Several surveys were available in successive years in two periods: the early 1990s and the late 1990s to early 2000s. Using these data it may be possible to track the decline of numbers in individual cohorts over time, in a period when the stock was relatively unaffected by fishing mortality. However, due to some gaps in the survey series, only three cohorts could be used in the analysis and no reliable estimates of M could be obtained.

4.210 The Working Group was concerned about the likely sensitivity of the short-term projection to differences in M and agreed to run the assessment this year using two estimates: the value used at last year's meeting (0.42) and the value presented in WAMI-01/7 (0.71) estimated for fish of ages 1 to 6 from the Russian survey in 2000.

Survey Catchability

4.211 At last year's meeting WG-FSA combined trawl data from different vessels to obtain a single dataset from which to derive abundance and biomass estimates. The assumption in this approach was that the survey vessels fished with equal efficiency. A combined ranking of the catch densities indicated that the densities of fish encountered over the shelf were broadly similar between the two surveys, with the exception of a few large catches. The Working Group had taken this to indicate that combining the two surveys was a valid approach. However, following discussion at WAMI, the Working Group agreed that it is unlikely that the two surveys would sample with equal efficiency, due to differences including vessel size, gear size and operation, experience of crew etc.

4.212 The Working Group noted discussions at the WAMI meeting regarding the relative catchabilities of survey series in Subarea 48.3 and ways in which data from different surveys could be combined (Appendix D, paragraphs 7.12 to 7.16). Following the advice of the workshop, this issue was considered further by the Working Group. The GLM analysis presented in WAMI-01/12 was reworked using survey data available in the CCAMLR database from Russia, former USSR and UK surveys for the years 1974, 1975, 1984 to 1989, 1991, 1992, 1998 and 2000. The set of survey data for 1990 were excluded due to abnormally high values of CPUE in that season. The GLM assumed that surveys have been stratified as in the WG-FSA-2000 assessment (SC-CAMLR-XIX, Annex 5, Figure 24).

4.213 The GLM used had the following form:

glm(Cpue ~ Country + SplitYear + Stratum, data = Rv1,

family = robust(quasi(power(x)))),

where the exponent in a link function was 0.1, 0.3, 0.5. The last value transformed the link function to the *sqrt*.

4.214 Akaike information criterion (AIC) was used for model selection:

Link Function	Power (0.1)	Power (0.3)	*Sqrt*
AIC	28 224	27 330	26 184

which was a GLM with *sqrt* link function. The ANOVA table from the model (Table 37) shows that all factors were significant.

4.215 The diagnostics of the model are provided in Figure 27 and the QQ-plot in Figure 28. The time series of standardised CPUE indices with two options for the factor country (UK and Russia) are presented in Figure 29. This analysis indicated that the catchability of the Russian survey series for the 2000 season was 2.59 times that of the UK series.

4.216 The Working Group discussed possible reasons for this apparently large difference between the surveys. The surveys are of a similar design and the sampling gear (i.e. a bottom trawl) is also similar. Vessel effects are known to be responsible for differences in some time series, but the UK and Russian surveys have used a variety of different vessels, hence it is unlikely that such effects are the sole cause of the differences. The Working Group recommended more detailed studies of the design and implementation of these surveys to investigate why the difference between them might be so great. The Working Group also endorsed the advice of WAMI that an experiment be designed to compare the results of two vessels fishing in the same small area at the same time could provide useful information to solve this problem.

4.217 The Working Group welcomed this first attempt to estimate relative differences in catchability and noted that it is very important to provide methods that can reconcile data from different surveys. The Working Group agreed to use the factor of 2.59 when undertaking analyses on the combined dataset from the UK and Russian surveys in 2000 at this year's meeting.

Assessment at this Year's Meeting

4.218 The Working Group followed the short-term projection approach used previously to reassess catch limits for the 2001/02 season, with the new information discussed in the preceding paragraphs. The data inputs required for the short-term assessment are biomass estimate, distribution of numbers at age, an estimate of M, a selection function, von Bertalanffy growth parameters, a weight–length relationship and known catches since the time of the biomass estimate.

4.219 Biomass estimates were available from two surveys in 2000. Concern had been expressed at last year's meeting over the small number of stations sampled by the UK survey on the South Georgia shelf, and whether it was possible to obtain a reliable estimate of stock status from such a small number of hauls. The short-term projection had therefore been based on a biomass estimate and age structure from the combined survey dataset. Following concerns over this approach expressed in paragraph 4.221, the Working Group decided to consider three biomass estimates for starting the projections, derived from:

- the UK survey;
- the Russian survey; and
- a combined survey dataset, combined using the relative catchability factor of 2.59 to increase the catch densities recorded on the UK survey.

4.220 The stratification, number of stations in each stratum and the results of the bootstrap analysis to estimate the one-sided lower 95% confidence bound for each of these datasets are presented in Table 38. The geographic distribution of the strata is illustrated in Figure 24 of last year's report (SC-CAMLR-XIX, Annex 5).

4.221 The bootstrap on the combined dataset was performed using the same method as used to analyse the UK and Russian surveys separately at last year's meeting. The Working Group noted the increase in the single-sided lower 95% confidence bound of the combined dataset (42 807 tonnes) compared to last year (35 085 tonnes). This resulted from the standardisation of the catchabilities to the Russian survey.

4.222 Length densities from all three survey datasets were analysed using the CMIX program to estimate numbers of fish at age. Initial bounds on the means of the distributions of length at age were set according to two growth curves (curves 1 and 3 in Table 35). In all cases, the fitting routine did not converge on a result when using the bounds given by the growth curve fitted to the Polish age–length readings from the UK surveys (curve 3 in Table 35). This implies that this curve is incompatible with the modal lengths in the distributions from the surveys in 2000. The Working Group agreed that the growth curve fitted to the Russian age readings (curve 1 in Table 35), was the most appropriate to use for the assessment at this year's meeting.

4.223 The results of the CMIX analysis are presented in Table 39 and Figure 40. The means of the mixture components from Table 39 are compared with the growth curve in Figure 31.

4.224 The data inputs for the short-term projection are presented in Table 40. The Working Group noted that the catch level for 2000/01 used in the projection assumed that there would be no additional catch taken between the time of the meeting and the end of the season on 30 November 2001.

4.225 The Working Group considered these various input data, noting that three estimates of biomass and two levels of M would result in six possible outcomes of the projection. The Working Group agreed that it was important to discuss criteria which could be used to select the best option for providing recommendations on the catch level at South Georgia in the forthcoming season.

4.226 Regarding the biomass estimate, the Working Group recalled the discussion at last year's meeting that led to the decision to combine the data from the two surveys (SC-CAMLR-XIX, Annex 5, paragraphs 4.189 to 4.192 and 4.205 to 4.209), and agreed that this rationale was still valid. The difference at this year's meeting was that the Working Group had undertaken an analysis of the relative catchabilities of the survey series by the UK and Russia and thereby developed an improved approach to combining the two surveys. There were some problems indicated in the analysis, as shown by the diagnostics of the GLM

(Table 37 and Figure 28), which might be solved through a refined analysis. However the Working Group agreed that for the purposes of the assessment at this meeting, the surveys should be combined using the factor of 2.59 to adjust the results of the UK survey.

4.227 The Working Group agreed that a high priority should be given to further analyses looking at the catchabilities of different vessels and gears. In addition, countries planning to undertake surveys in Subarea 48.3 in 2001/02 were requested to consider ways in which survey plans could include comparative hauls by different vessels fishing in the same small area at the same time to provide direct information on relative catchability.

4.228 Regarding the value of M, the Working Group noted the limited amount of data from which it was possible to estimate M for *C. gunnari* at the current time. The Working Group also noted the large difference between the estimates available for the assessment, and the high level of uncertainty in this parameter. Dr Gasiukov expressed concern regarding the level of 0.42, which had been estimated on the basis of very few data (Everson, 1998). It was also noted that the level of 0.71 appeared to be high in view of the current estimate of k, which is 0.17.

4.229 The Working Group noted that the higher level of M would result in a lower level of yield projected for the forthcoming year, because a larger number of fish would be assumed to have died between the time of the survey and the time of fishing. This would therefore be the more precautionary of the two options available. The Working Group agreed that the value of 0.71 should be used for the short-term projection at this year's meeting. Analyses to refine the estimate of M, and the incorporation of uncertainty in M into the short-term projection remain a high priority.

4.230 The output of the short-term projections are provided in Table 41. The catch limit for 2001/02 satisfying the previously agreed criteria and using the data inputs agreed this year by the Working Group is 5 557 tonnes.

4.231 The Working Group recalled its discussions from previous years, and discussion by WAMI regarding the conservative nature of the short-term projection method used currently to assess catch levels for *C. gunnari*. The Working Group agreed that this method is essentially an interim approach and further analysis of the operational objectives and overall management procedures for *C. gunnari* remained a high priority. A number of recommendations had been made by WAMI to investigate the appropriateness of the various assumptions in the decision rule as it is currently applied (Appendix D, paragraph 8.6). The Working Group agreed that these issues be given a high priority for consideration at next year's meeting.

Closed Season

4.232 At its meetings in 1999 and 2000, the Working Group discussed measures to protect spawning concentrations of *C. gunnari* in Subarea 48.3 (Parkes, 2000; SC-CAMLR-XVIII, Annex 5, paragraph 4.183; SC-CAMLR-XIX, Annex 5, paragraph 4.214). In 1999 the Commission adopted a change in the closed season for the *C. gunnari* fishery in Subarea 48.3, based on a review of information regarding the timing of the spawning season. In the 2000/01 season the fishery was closed between 1 March and 31 May 2001.

4.233 At this year's meeting the Working Group considered new information regarding the distribution of spawning and larval *C. gunnari* (paragraph 3.117; Everson et al., 2001). There is strong evidence that spawning is concentrated mainly in the inshore areas and bays of South Georgia (Kock, 1981). A complete closure of Subarea 48.3 during the spawning season may therefore be unnecessary. Substantial protection of spawning concentrations would be provided by preventing fishing from taking place in the bays and near-shore areas.

4.234 The Working Group noted, however, that although spawning on the shelf is considered to be of much lower intensity than that occurring inshore, it is presently unknown to what extent Shag Rocks is important as a spawning area. Fish have been found in near-spawning condition in this area, but larvae and early juvenile stages have very rarely been observed in plankton hauls.

4.235 In view of the need for information on the condition of fish offshore during the spawning season, the Working Group agreed that detailed biological information should be collected from catches by all vessels fishing in Subarea 48.3 during this period. This information would be more useful if it came from an area wider than just areas where fish concentrations, and therefore target fishing, might occur. The Working Group proposed a scheme of distribution of fishing effort that would require all vessels fishing in Subarea 48.3 during the spawning season to undertake a limited number of tows for scientific purposes in specific areas. The proposed scheme is set out in paragraphs 4.236 to 4.240.

4.236 All fishing vessels taking part in the fishery for *C. gunnari* in Subarea 48.3 between 1 March and 31 May 2002 should be required to conduct a minimum of 20 research hauls, to be completed during that period. Twelve research hauls should be carried out in the Shag Rocks–Black Rocks area. These should be distributed between the four sectors illustrated in Figure 32: four each in the NW and SE sectors, and two each in the NE and SW sectors. A further eight research hauls should be conducted on the northwestern shelf of South Georgia over water less than 300 m deep, as illustrated in Figure 32.

4.237 Each research haul should be at least 5 n miles distant from all others. The spacing of stations is intended to be such that both areas are adequately covered in order to provide information on the length, sex, maturity and weight composition of *C. gunnari*.

4.238 If concentrations of fish are located en route to South Georgia, they should be fished in addition to the research hauls.

4.239 The duration of research hauls should be of a minimum of 30 minutes with the net at fishing depth. During the day, the net should be fished close to the bottom.

4.240 The catch of all research hauls should be sampled by the international scientific observer on board. Samples should comprise at least 100 fish, sampled using standard random sampling techniques. All fish in the sample should be at least examined for length, sex and maturity determination, and where possible weight. More fish should be examined if the catch is large and time permits.

4.241 Dr Holt expressed concern that some disruption of spawning might occur if fishing effort were concentrated on the shelf during the spawning period (1 March to 31 May). To address this concern, it was suggested that some means of limiting the level of catch that can be taken within the spawning period could be considered.

4.242 The Working Group agreed that with these measures in place, it would be appropriate to leave the *C. gunnari* fishery open throughout the 2001/02 season, or until the catch limit is taken. However, it would still be necessary to devise some mechanism of preventing fishing in inshore areas during the spawning season, such as a closed area around the island. The Working Group recalled a conservation measure previously adopted by the Commission (Conservation Measure 1/III), which closed the area around South Georgia up to 12 n miles offshore. Such a closure during the spawning season would provide protection to spawning concentrations in the bays and near-shore area.

Management Advice for *C. gunnari* (Subarea 48.3)

4.243 The Working Group agreed that the total catch limit should be revised to 5 557 tonnes for the period from 1 December 2001 to 30 November 2002.

4.244 The Working Group agreed that there should not be a closed season for *C. gunnari* in Subarea 48.3 during the 2001/02 season. Each vessel intending to undertake fishing in Subarea 48.3 between 1 March and 31 May 2002 should conduct 20 research hauls in the manner described in paragraphs 4.236 to 4.240.

4.245 The Working Group recommended that a closed area within 12 n miles of South Georgia be established to protect spawning concentrations during the spawning season (1 March to 31 May) and to limit the catch that can be taken during the spawning period (paragraph 4.241).

4.246 The remaining provisions in Conservation Measure 194/XIX should be carried forward for the 2001/02 season.

Kerguelen Islands (Division 58.5.1)

4.247 No commercial fishing for *C. gunnari* took place in Division 58.5.1 during the 2000/01 season and no surveys were reported.

4.248 The Working Group recalled that the most recent data available remain from a brief survey conducted in February 1998 which indicated that the previous cohort which formed the backbone of the fishery in 1995 had disappeared. A new year 1+ cohort (~170 mm long fish) was present in some abundance in 1997/98. A survey in the 1998/99 season revealed practically zero biomass on the traditional northeastern fishing ground. Only a few mature specimens (36 cm cohort) and some immature fish (22 cm cohort) were caught from late April to early May.

4.249 More recent information from this division is missing. There appears to be little prospect of a fishery for *C. gunnari* during the 2001/02 season.

Management Advice for *C. gunnari* (Division 58.5.1)

4.250 In the absence of recent data from this division, the Working Group is unable to offer any new management advice. It is strongly recommended that a survey of *C. gunnari* abundance is conducted and the results analysed by the Working Group before commercial fishing is recommenced.

Heard and McDonald Islands (Division 58.5.2)

Commercial Catch

4.251 The commercial fishery for *C. gunnari* around Heard Island (Division 58.5.2) was open from the end of the Commission meeting in November 2000 to 30 November 2001. The catch limit agreed by the Commission for this period was 1 150 tonnes to be taken on the Heard Island Plateau area only (Conservation Measure 195/XIX). This conservation measure included several other conditions to be applied to this fishery, including per haul by-catch limits, a provision to reduce the catch of small (<24 cm) fish, data reporting on a haul-by-haul basis, and the presence of a scientific observer on every vessel. Overall by-catch limits covering all fishing activities in Division 58.5.2 also applied (Conservation Measure 198/XIX).

4.252 The commercial catch in the 2000/01 fishing season was 938 tonnes up to 7 October 2001, although the fishing season will remain open until 30 November 2001. This fishery was based on the strong cohort, now aged 3, that was detected as 2 year olds in a survey in May 2000.

Surveys

4.253 A survey was conducted on the Heard Island Plateau and Shell Bank in May 2001 to assess the abundance and size structure of the *C. gunnari* populations. The abundance by stratum is listed in Table 42. This survey used the same methodology as previous surveys in this area in 1997, 1998 and 2000 and detected a high abundance of 3-year-old fish on the Heard Plateau that were seen as 2 year olds in the previous year, and a lower abundance of 2 year olds. As in the 2000 survey, very few fish were detected on Shell Bank (WAMI-01/04). As in previous years, fish were concentrated on the southeast part of the plateau, including Gunnari Ridge.

Assessment at this Year's Meeting

4.254 An assessment of short-term yield over the next two years using the same methods as applied for Subarea 48.3 was performed during the Working Group meeting. Biomass was estimated from a survey conducted by Australia in 2001. New growth parameters for *C. gunnari* in Division 58.5.2 were provided in WAMI-01/04. Estimates of yield for Shell Bank were not made because of the very low abundance of this population. The results of the mixture analysis are presented in Figure 33. Data inputs for the short-term projection are provided in Table 43. The Working Group noted that the catch level for 2000/01 used in the projection assumed that there would be no additional catch taken between the time of the meeting and the end of the season on 30 November 2001.

4.255 With a projected fishing mortality of 0.14 for 2001/02 and 2002/03, the catch limit satisfying the agreed criteria is 1 600 tonnes over two years. This is made up of 885 tonnes in the first year and 715 tonnes in the second year.

Management Advice for *C. gunnari* (Division 58.5.2)

4.256 The Working Group agreed that the total catch limit should be revised to 885 tonnes for the period from 1 December 2001 to 30 November 2002.

4.257 The remaining provisions in Conservation Measure 195/XIX should be carried forward to the 2001/02 season.

Other Fisheries

Other Finfish Fisheries

Antarctic Peninsula (Subarea 48.1) and South Orkney Islands (Subarea 48.2)

4.258 Standing stock biomass estimates of finfish from the 2001 US AMLR bottom trawl survey of the South Shetland Islands (Subarea 48.1) were presented in WG-FSA-01/33. The authors concluded that the overall abundance of finfish in the South Shetland Islands has yet to reach a level at which commercial exploitation would be advisable.

4.259 A bottom trawl survey around Elephant Island and the lower South Shetland Islands originally planned for November–December 2001 by Germany will now take place during January and February 2002.

Management Advice

4.260 There appears to be little scope to reopen the fisheries in the two subareas in the near future given the comparatively low biomass of the abundant fish species. The Working Group therefore recommended that Conservation Measures 72/XVII and 73/XVII should remain in force.

South Sandwich Islands (Subarea 48.4)

4.261 No new information was made available to the Working Group on which an update of the assessment could be based.

Management Advice

4.262 The Working Group recommended that Conservation Measure 180/XVIII be retained until new information becomes available and a new assessment could be attempted.

Antarctic Coastal Areas of Divisions 58.4.1 and 58.4.2

4.263 A notification for the 2001/02 season was submitted for Division 58.4.2 by Australia. Details of the plan can be found in CCAMLR-XX/5.

Crabs

4.264 Five species of crabs currently occur in catches around South Georgia: *P. spinosissima*, *P. formosa*, *P. anemerae*, *Neolithodes diomedeae* and *Lithodes murrayi*. Only the three species of the genus *Paralomis* are of interest to the crab fishery.

4.265 Conservation measures in force in the crab fishery are Conservation Measure 214/XIX which regulates the experimental harvest regime on crabs, and Conservation Measure 215/XIX which sets limits on the catch at 1 600 tonnes green weight per season of all species combined and limits the number of vessels to one per country.

4.266 Japan has notified its intention to conduct crab fishing in the 2001/02 season; Japan has not carried out an experimental harvest regime as set out in Conservation Measure 214/XIX and so will be obliged to conduct this experimental regime this season. It was highlighted that there is a requirement to carry a CCAMLR international observer on board every vessel that participates in the crab fishery.

4.267 WG-FSA-01/32 presented further information on the distribution, demography and discard mortality of crabs caught as by-catch in an experimental pot fishery for toothfish in Subarea 48.3. Biological data on crabs are presented in paragraphs 3.128 to 3.131.

4.268 The Working Group addressed concerns about the potential spatial overlap of the crab fishery and toothfish pot fishery in Subarea 48.3. Data were presented indicating that previous crab fishing had taken place at shallower depths than those currently fished by the exploratory pot fishery for toothfish. The Working Group agreed that the small overlap in areas targeted by the two fisheries was not likely to be a cause for concern.

4.269 The Working Group reviewed minimum legal landing sizes for *Paralomis* spp. for Subarea 48.3. Conservation measures have continued, largely unchanged, since they were first introduced at CCAMLR-XI in 1992 (Conservation Measure 60/XI). The basis for the selection of the current minimum legal landing sizes, as described in WG-FSA-92/29, was discussed. It was noted that existing size limits for *P. spinosissima* (102 mm carapace width) were established largely on the catch processing requirements of the fishery at that time.

4.270 Data and methodologies used to attain the minimum size limits for crabs suggested in WG-FSA-01/32 were compared to those derived using the same criteria in 1992 (WG-FSA-92/29). These comparisons are shown in Table 44. The Working Group agreed that, given the similarities in the recommended size limits, the reduction in size limit would be supportable. WG-FSA-01/32 was only able to produce results for Shag Rocks hence it was deemed appropriate to use the WG-FSA-92/29 values for a revision of legal minimum size.

4.271 There is currently no minimum size limit specified for *P. anamerae*. The Working Group was unable to suggest a minimum landing size for this species, as new data were unavailable.

4.272 It was noted that the survivorship of discarded crabs was highly influenced by the catch processing and discard methods employed by vessels (WG-FSA-01/32). Mortality was greater when crabs were unloaded into a chute prior to processing.

Management Advice

4.273 The Working Group agreed that the minimum legal landing size for male *P. spinosissima* should be reduced from 102 mm carapace width to 95 mm carapace width for South Georgia and Shag Rocks whilst the legal size for *P. formosa* males should remain unchanged at 90 mm carapace width.

4.274 All other conservation measures are to be retained.

Squid

4.275 Conservation Measure 213/XIX is currently in force to regulate this fishery. The UK and the Republic of Korea have advised that they would be undertaking an exploratory fishery on *M. hyadesi* in waters north of South Georgia (Subarea 48.3) in the 2000/01 season (WG-FSA-01/31). It was concluded that the fishery for *M. hyadesi* in Subarea 48.3 remains at an exploratory stage, and catch rates appear to be highly variable. There is little indication at present of significant commercial interest in the fishery.

Management Advice

4.276 There was no notification of intention to conduct a fishery for the 2001/02 season. All conservation measures are to be retained.

Subgroup on By-catch

Estimated Catches

4.277 The subgroup on by-catch extracted data from the CCAMLR databases in order to try and estimate total removals of by-catch species for trawl and longline fisheries by fine-scale area and split-year. Due to the problems experienced by the group and the limitations of the data, this was not achieved. The issues are discussed below.

4.278 Data on by-catch are available in three different formats, STATLANT data, observer reports and fine-scale catch and effort data.

4.279 The by-catch subgroup noted that there were differences between countries in the data submitted via STATLANT reports. STATLANT data are presented in the CCAMLR *Statistical Bulletin* and should be a complete record of total catches for the split-year for both commercial and by-catch species. It is unclear how many countries are submitting the correct data. For example, Australia has only submitted commercial catches and very little information on by-catch via STATLANT reports for the 2000/01 split-year.

4.280 The data that are recorded and submitted to CCAMLR on fish and invertebrate by-catch in the observer reports varies between countries. Two specific examples are:

- New Zealand – observers record the percentage of each set observed for fish by-catch and scale up all records so that they represent total removals for the fishery.

  The data are submitted as total by-catch estimates to CCAMLR, however the Secretariat was not aware that the data had already been scaled up.

- Australia – observers record for all hauls whether they are observed and whether catch-composition information of fish and invertebrate by-catch is recorded. A double flag is needed because in some instances a haul may be observed, i.e. for length–weight information on a target species but no by-catch is recorded. This is an easy method of discriminating between hauls with zero by-catch and hauls where by-catch is not recorded. However the catch-composition flag does not appear in the CCAMLR version of the Australian observer database and it is therefore not possible to determine the correct proportion of hauls that are observed for fish by-catch. In addition, the data from the last trip in the 2000/01 split-year has not yet been submitted and thus the dataset is incomplete.

4.281 Additional problems that apply to the by-catch data from the observer database are:

(i) In some cases no information is provided as to what percentage of hauls/sets are observed. In other cases, information on the percentage of longline sets/hauls is provided but no record is made as to what that set was observed for, i.e. bird interactions, fish by-catch, biologicals of target species etc. Hence by-catch can not be scaled up to the total fishery.

(ii) It is also unclear in some cases how many fish are discarded or lost before being brought on board. In the case of skates that are discarded or lost during longline fishing, survival is uncertain. These concerns do not apply to tagging studies, such as are currently being undertaken in Subarea 88.1, where skates and rays are tagged and released in the water, thus minimising damage to the mouth of the fish.

(iii) Within a haul that is observed for by-catch, amounts can be recorded as either weights or numbers. The information provided in numbers can not be used at present as length–mass keys are not available for a number of species.

4.282 Similar problems that exist in the observer data also apply to the fine-scale catch and effort data.

4.283 Tables 14 and 15 in Annex 5 of SC-CAMLR-XIX have been provided every year in the Working Group report. Fifty-four fish species are recorded as by-catch in the targeted fisheries for *C. gunnari*, *D. eleginoides* and *D. mawsoni*. The information in these tables comes from the observer reports submitted to CCAMLR. When constructing Table 14, only records with weights are used, hence all information on by-catch provided as numbers is not included. Given the problems noted above, the subgroup flagged that these tables are really only an indication of presence/absence of by-catch species in a given area. The updated tables have been prepared at the meeting but have not been included in the report. They have been retained along with other data extracted for the by-catch subgroup in a reference file at the Secretariat.

4.284 Tables 45 and 46 are derived from the fine-scale catch and effort data supplied by vessels. These by-catch values are likely to provide minimum estimates.

4.285 It is not possible at present to determine the total removals of by-catch species. The subgroup noted that if the Scientific Committee wanted advice on by-catch species, then these problems would need to be resolved first. The subgroup discussed various methods for improving the quality and usefulness of the data provided to CCAMLR.

4.286 The Working Group recommended that:

(i) observers be asked to indicate the number of longline sets and trawl hauls actually observed for by-catch;

(ii) observers be asked to indicate the proportion of each longline set actually observed for by-catch;

(iii) observer reports should clearly indicate the type of observation being made at a particular time;

(iv) by-catch sampling should be according to the same regime as that applied to target species;

(v) revised species identification sheets be prepared to assist observers in making accurate identification of species; and

(vi) a revision of the *Scientific Observers Manual* and the electronic observer logbook be undertaken intersessionally to improve the information collected on fish and invertebrate by-catch in all fisheries.

Species Identification Sheets

4.287 To assist observers in making accurate identifications of target and by-catch species, WG-FSA had decided to develop species identification sheets. The main requirement of these sheets was that they should be clear and concise and enable observers to identify individual fish accurately and quickly in the field. A subgroup, led by Dr Everson, had been tasked with preparing draft identification sheets in time for distribution to observers for the 2000/01 longline season.

4.288 Drawing on information provided by the subgroup and taking illustrations from published taxonomic keys, draft identification sheets had been prepared and sent to the Secretariat. Unfortunately, these do not appear to have been received by technical coordinators in time to be distributed to observers for the past 2000/01 season. In spite of a request for feedback on the utility of the identification sheets, no comments appeared in any of the observers' reports. WG-FSA-01/32 does make mention of the need for such sheets and from the comments in that report it appears that most of the problems associated with identification of lithodid crabs taken during that cruise might have been resolved had the identification sheets been available.

4.289 The content and presentation of the identification sheets was discussed.

4.290 Very little information on geographical distribution of individual species had been included in the sheets. In circumstances where the distribution had been well described from earlier research surveys, it was felt that such information could assist observers by reducing the options for individual species. However, much of the current fishery activity is using longlines in deep water with the result that new geographical distributions are being discovered for certain species. Geographical information for such poorly described species might introduce bias and consequently affect the ability of observers to make accurate identifications.

4.291 The Working Group agreed that a record should be kept by WG-FSA of the localities in which individual species have been reported by observers, so that over a period of time descriptions of the distribution of these species could be developed. For those species for which there is strong evidence that their distribution is restricted, to for example shelf regions, it was thought useful to include a note on the range on the identification sheets.

4.292 Mr B. Watkins (South Africa) noted that large numbers of slickheads (Alepocephalidae) had been caught in a recent deep-water trawl survey off the Prince Edward Islands. It was agreed that these and chimaerids should be included when the identification sheets are revised.

4.293 It was noted that species such as macrourids and *Muraenolepis* spp. present major problems for identification even for experienced taxonomists. To address this problem Dr Hanchet has arranged for observers working in Area 88 to collect two *Macrourus* specimens from each longline set, these to be frozen for examination in a laboratory ashore (WG-FSA-01/63). Dr Belchier indicated that specimens of macrourids and skates from Subarea 48.3 could be analysed at the new UK Research Station at King Edward Point, South Georgia.

4.294 The Working Group discussed the use of photographs in the identification sheets. It was agreed that good photographs depicting key diagnostic characters would be very useful. However it was recognised that suitable photographs are currently not available for many of the species. Members were encouraged to provide to the Secretariat good quality photographs for consideration in revising the sheets. Such photographs should include, as a minimum, dorsal and lateral views of the fish and in addition detailed pictures of key diagnostic features. Developments in photographic equipment mean that detailed digital images can now be produced. It was suggested that in the future a collection of such images might be prepared on CD ROM to be given to observers.

4.295 The Working Group agreed to revise the draft identification sheets prepared for the 2000/01 season for circulation to observers via technical coordinators. It was also agreed that observers should be encouraged to provide comments on the identification sheets.

4.296 The text on the species identification sheets currently is in English. It was noted that some of the terms used were of a technical nature and not clear to observers whose mother tongue was not English. The Working Group agreed that the text should be simplified and, if possible, translated into the four official CCAMLR languages.

4.297 It was agreed that some simple revisions should be made to the identification sheets. Dr Everson agreed to undertake this task and provide revised versions to the Secretariat by the end of December 2001. Members were encouraged to provide suitable amendments to Dr Everson as soon as possible.

Standardisation of Measurement

4.298 The Working Group discussed the length measurements in use and agreed that:

(i) for macrourids, because the tail is very often damaged, the length measurement to be used should be from the tip of the snout to the anus; and

(ii) for all other fish species the total length should be reported.

Advice to the Scientific Committee

4.299 The Working Group recommended that revised versions of the species identification sheets be prepared and copies sent to technical coordinators. These identification sheets are to be laminated in waterproof material. The Working Group recommended that sufficient funds be included in the budget for this purpose.

4.300 Copies of the species identification sheets should be included in the *Scientific Observers Manual.*

4.301 The Working Group recommended that the standardised body length measurement to be used for *Macrourus* spp. should be from the tip of the snout to the anus.

Skates and Rays

Population Parameters

4.302 Population parameters needed for assessing the precautionary pre-exploitation harvest level (γ) in Subarea 48.3 for skate and ray species were based on several sources. Most sources were specific to skate and ray species from South Georgia. Where no information was available, the Working Group relied on recent research on skates conducted around the Falkland/Malvinas Islands.

4.303 The estimates of the length of 50% recruitment ($L_{50\%}$) was set at 70 cm, and the length at 50% maturity ($L_{m50\%}$) was 85 cm. These estimates were based on information collected during toothfish longlining operations in Subarea 48.3 during 2000, and were reported in WG-FSA-00/59. The age at 50% maturity was set at 8 years, based on length at age from the assumed growth parameters.

4.304 The length–weight regression relationship used was $W = 0.00000646 * L^{3.06}$, based on information collected for the ray species *Raja georgiana* collected around South Georgia, and reported in WG-FSA-00/22.

4.305 Growth parameters were particularly difficult to estimate. Although there was some information on growth of *B. eatonii* and *A. georgiana* presented in WG-FSA-01/52, there were no von Bertalanffy parameters estimated. The Working Group relied on the largest (total) length for all skates from observations presented in WG-FSA-00/59 for an estimate of L_8 (= 150 cm). The growth parameter k was estimated at 0.1, and was drawn from averaging estimates taken from three species of skates in the Falkland/Malvinas Islands fishery (Agnew et al., 2000). The t_0 was assumed to be 0. The natural mortality used was M = 0.2, also drawn from estimates around the Falkland/Malvinas Islands.

Determination of Precautionary Pre-exploitation Harvest Level (γ) in Subarea 48.3

4.306 The decision rule used to assess the precautionary pre-exploitation harvest level (γ) was that the median escapement of the spawning stock at the end of 20 years of exploitation is 75% of the pre-exploitation spawning stock biomass, and the probability of depletion below 20% of the median pre-exploitation spawning biomass is no greater than 0.1 over a 20-year period. The parameters and simulation characteristics used to compute γ are presented in Table 47.

4.307 Meeting the conditions of the two-part decision rule is influenced by a number of factors. One of the necessary measures with the greatest uncertainty was the estimate of the coefficient of variation for B_0. The estimates of CV were computed from the combined skate and ray by-catch reported in haul-by-haul longline data from Subarea 48.3. These estimates ranged from 2.009 for the entire data series to 1.006 for the year 2000. A plot of the effect of various levels of B_0 CV with increasing levels of γ reveals extremely high sensitivity on levels of median escapement (Figure 34). However, the probability of depletion is insensitive to B_0 CV > 0. Thus, the probability of depletion appears to be a better rule in terms of estimation of γ for skates and rays.

4.308 The resulting estimate of γ for skates and rays in Subarea 48.3 is 0.026, which under a B_0 CV of 1.003 results in a median escapement of 0.749 and probability of depletion of 0.094.

4.309 Estimating a precautionary yield for skates and rays in Subarea 48.1 using γ requires an estimate of B_0 for the population. Because there are currently no estimates of this parameter, the Working Group discussed various options of how this could be estimated using other B_0 estimates for skates and rays from other areas of the Southern Ocean. Values of B_0 have been computed from Heard Island (Constable et al., 1998), and the Falkland/Malvinas Islands (Agnew et al., 2000). The Working Group considered the feasibility of using these values and pro-rating the estimate to the area of seabed in Subarea 48.3. However, both estimates of B_0 were derived over shelf areas <500 m, and the data obtained using trawl gear. The South Georgia skate and ray distribution is likely to be very different than that over Heard Island or the Falkland/Malvinas Islands. Further, since the skate by-catches from longline gear in Subarea 48.3 occur largely off the shelf >500 m, the Working Group felt that the estimates of B_0 derived from the other areas were not sufficiently compatible for pro-rating to seabed areas within Subarea 48.3. Thus, the Working Group was not in a position to compute a precautionary yield with the available information.

4.310 The Working Group recommended that the decision rule regarding the probability of depletion below 20% of the median pre-exploitation spawning biomass be re-examined for skates and rays. Skates and rays have low fecundity and therefore are likely to have a stronger stock–recruit relationship than teleosts. Arising from this, it may be appropriate to adjust the 20% depletion rule upwards.

4.311 It was agreed that insufficient information was available to make assessments of skates and rays in any of the current fisheries. Key topics for further investigation are:

(i) estimation of standing stock;

(ii) length–mass relationships covering a good representation of all size classes – particularly at the lower end of the spectrum;

(iii) tagging studies to investigate migration and growth;

(iv) estimation and validation of age leading to estimation of growth parameters and age–length keys;

(v) taxonomy; and

(vi) biological information, in particular observations on sex, maturity stage and fecundity.

It was noted that the information for (ii), (v) and (vi) could be derived from existing sampling by observers.

Advice to the Scientific Committee

4.312 The Working Group recommended that further steps be taken to estimate standing stocks of skates and rays in order to generate estimates of precautionary yield.

4.313 In the absence of any formal estimates of precautionary yield for skates and rays, the Working Group recommended that interim precautionary measures be adopted (see paragraph 4.332).

Macrourus spp.

4.314 The subgroup considered available information on macrourids suitable for incorporation in assessments models. The information is summarised in Table 48.

4.315 It was agreed that insufficient information was available to make assessments of these species in any of the current fisheries. It was agreed that further information would be essential before assessments could be made. Key topics for further investigation are:

- length–mass relationships covering a good representation of all size classes – particularly at the lower and upper end of the size spectrum;
- otolith collection in order to develop age–length keys over the full size range of the species. Ultimately this will need to be supported by validation studies; and
- biological information, in particular observations on sex and maturity stage.

It was noted that much of this information could be derived from the observer program.

Advice to the Scientific Committee

4.316 The Working Group recommended that further steps be taken to estimate standing stocks of macrourids in order to generate estimates of precautionary yield.

4.317 In the absence of any formal assessments of macrourids, the Working Group recommended that interim precautionary measures be adopted (see paragraph 4.332).

Consideration of Management Measures for By-catch Species

4.318 The Working Group discussed the questions from the Commission on possible steps to be taken in the management of by-catch (CCAMLR-XIX, paragraph 9.39).

4.319 The Working Group agreed that at this time the research requirements aimed at assessing by-catch are unlikely to be in conflict with commercial fishing activities (CCAMLR-XIX, paragraph 9.39(ii)).

4.320 In relation to links between by-catch provisions and specific areas (CCAMLR-XIX, paragraph 9.39(i)), it was noted that the problems of making by-catch assessments are exacerbated by the number of species involved. The Working Group agreed that some simplification in the approach would be essential. Accordingly, for the purposes of making assessments, species would be amalgamated into groups such as 'Rajids' for all skate and ray species and 'Macrourids' for all *Macrourus* spp. In spite of this, biological information will still need to be analysed by species.

4.321 The Working Group had insufficient information available to make assessments on individual species or groups. Attention was therefore focussed on a consideration of the general approaches that might be used to develop management measures.

4.322 Accepting that fishing on target species will result in some by-catch, the Working Group considered action that should be taken in the absence of information with which to make an assessment. It was agreed that any such measures will of necessity be somewhat arbitrary but should take account of the following criteria:

(i) the fishery should not adversely impact the by-catch species;

(ii) measures should not constrain fishing on the target species without due cause; and

(iii) data and samples from the by-catch should be used in support of future assessments.

4.323 It was also noted that the Commission had indicated that management measures should be such as to ensure that the productivity of by-catch species is not adversely affected. It was also noted that management measures should aim to minimise the risk of local depletion of by-catch stocks (CCAMLR-XIX, paragraph 9.39).

4.324 With this in mind, the Working Group agreed that management measures for by-catch species should contain two major components. Firstly a limit on the total catch of each species or group and secondly a 'move on' rule to minimise the risk of local depletion.

Total Catch Limits for By-catch Species

4.325 Information in Tables 45 and 46 indicate that there are major differences in the reported by-catch from season to season and also between fishing grounds. Such differences might arise due to differences in fishing method, the fishable grounds as well as fish density and production. Accordingly a single figure, whether expressed as a percentage of the target species catch or a total by-catch tonnage, was considered inappropriate. The Working Group therefore recommended that, using Tables 45 and 46 as a guide, limits for by-catch species be set for each subarea and division based on a percentage of the total catch by mass in the fishery.

4.326 As is the case with the target fisheries, decisions on the closure of a particular fishery would be made using the reported catches. Providing the observer program is implemented in line with the recommendations set out in paragraph 4.286, information from that program could be used by the Working Group to determine how effectively by-catch had been reported.

Minimisation of the Risk of Local Depletion

4.327 The Working Group agreed that the most effective mechanism by which local depletion of by-catch species could be minimised was through the imposition of a rule whereby if an individual set or haul caught more than a set amount of given by-catch species, the vessel should move to a position at least some specified distance away before recommencing fishing. Furthermore, the vessel should not return to the locality at which the high by-catch was made for a specified period.

4.328 With this in mind, the Working Group recommended that in order to minimise the risk of local depletion of by-catch species, the following measure should be applied to all vessels operating in longline, pot or trawl fisheries:

> If any vessel catches more than 1 tonne of a by-catch species in a longline or pot set or individual trawl haul, it must move its fishing position (defined as the midpoint of the set or haul) by at least 5 n miles. It may not return to the position of the high by-catch to fish within five days.

Application to New and Exploratory Fisheries

4.329 The Working Group noted the by-catch provisions of Conservation Measure 200/XIX in relation to the proposals set out in paragraphs 4.326 and 4.328. The Working Group had no scientific basis on which to recommend any changes to this conservation measure.

Advice to the Scientific Committee

4.330 The Working Group recommended that the Scheme of International Scientific Observation be amended to incorporate the proposals set out in paragraph 4.286.

4.331 Revised species identification sheets should be prepared and circulated to all observers (paragraph 4.286).

4.332 The Working Group recommended that, as interim measures for the forthcoming year, the following management measures with respect to by-catch species in assessed fisheries be introduced:

(i) for each assessed fishery, a by-catch limit for each species group be set at a percentage of the total catch by mass of all species within the fishery; the percentage to be based on the information in Tables 45 and 46; and

(ii) if any vessel catches more than 1 tonne of any by-catch species group in a longline or pot set or individual trawl haul, it must move its fishing position (defined as the midpoint of the set or haul) by at least 5 n miles. It may not return to the position of the high by-catch to fish within five days.

The Working Group had no scientific basis on which to recommend any changes to Conservation Measure 200/XIX in its application to new and exploratory fisheries.

Management Under Uncertainty

Unified Regulatory Framework

4.333 Over the past three years the Scientific Committee and Commission have been developing a unified framework for providing management advice on all fisheries in the Convention Area (CCAMLR-XVII, paragraphs 10.3 to 10.7; SC-CAMLR-XIX, paragraphs 7.2 to 7.20). At last year's meeting the Commission agreed that a key component of the generalised mechanism was a new reference document prepared and maintained by the Secretariat for each fishery in the Convention Area, to be known as the Fishery Plan (CCAMLR-XIX, paragraphs 10.2 to 10.8). It also agreed that the Secretariat should develop two example fishery plans, one for the krill fishery in Area 48 and the other for the *C. gunnari* fishery in Subarea 48.3.

4.334 The draft Fishery Plan for the *C. gunnari* fishery in Subarea 48.3 (WAMI-01/15 Rev. 1) was reviewed by WAMI. After incorporating WAMI suggestions, the revised plan was presented to WG-FSA (Appendix E).

4.335 The Working Group expressed appreciation to the Secretariat for completing the draft plan and felt it was an excellent approach to accomplish the Commission objective.

4.336 Participants felt the fishery plan will allow its work relative to the many new and exploratory fisheries notifications to be conducted in a standard form. The final plan should allow information to be retained in a concise and standard format until it needs to be modified.

4.337 Participants looked forward to seeing similar plans completed for all fisheries which would also incorporate information over the last several years of the fishery.

4.338 The Working Group advised the Scientific Committee that the method used to present the information to the Commission should be considered. For example, it might be in the style of the *Statistical Bulletin* and/or on the CCAMLR website.

Review of CCAMLR Conservation Measures

4.339 In 2000 the Commission recognised that the suite of conservation measures that it regularly reviews and adopts had become large and extremely complex. The Commission agreed that there was considerable merit in reviewing the structure of the conservation measures and their presentation, and remitted the task to an intersessional group including the Secretariat (CCAMLR-XIX, paragraph 9.72).

4.340 During the 2000/01 intersessional period, the Secretariat reviewed the development and structure of conservation measures adopted by the Commission (CCAMLR-XX/BG/4). Based on that review, it concluded that some of the work of the Commission may be simplified by the use of standard text in conservation measures dealing with many of the fisheries within the Convention Area. It then developed two alternative options for simplifying the process of drafting conservation measures (CCAMLR-XX/20 Rev. 1).

4.341 The Secretariat document proposed two methods for simplifying the process of drafting conservation measures dealing with fisheries. The first method would identify relevant standard paragraphs and the specifications to be used in each fishery conservation measure. It would also include 'non-standard' requirements, if any. The paragraphs, specifications, and special requirements, if any, would then be combined to produce the conservation measure in a format similar to that used in previous years.

4.342 In the second method, relevant standard paragraphs, specifications and 'non-standard' requirements, if any, for each fishery would be identified but would be listed in table format.

4.343 The Working Group welcomed the work completed by the Secretariat. In particular, the proposed changes would help simplify the work of WG-FSA. To complement the new approach, the Working Group could develop a standard format for management advice, perhaps in the form of a checklist, which would address the standard provisions of conservation measures.

4.344 Participants, however, also cautioned that management advice must have the flexibility to include non-standard approaches and diverse opinions where agreements are not reached.

Standardisation of Management Measures across all CCAMLR Fisheries

4.345 Participants noted that management advice for all fisheries in the Convention Area, except the krill fishery, was provided by WG-FSA. Participants recommended that, as is the case with all finfish, crab and squid fisheries, it would be desirable for the krill fishery to also be managed under standardised rules common to other fisheries.

CONSIDERATIONS OF ECOSYSTEM ASSESMENT

Interactions with WG-EMM

By-catch of Young Fish in the Krill Fishery

5.1 WG-FSA considered a single contribution documenting the by-catch of juvenile *C. gunnari* in the krill fishery at the South Orkney Islands from May to July 1999 (WAMI-01/11). The by-catch was not large and was usually in the range of a few tens of fish per haul to several thousands of fish in one haul.

5.2 Few papers on the by-catch of fish in the krill fishery have been submitted to CCAMLR since a major review was undertaken of available information and the amount of fish by-catch in krill fishing activities in 1995 (Iwami et al., 1996). CCAMLR encouraged Members to submit more observations on the by-catch of fish in krill fisheries.

Other Information arising from WG-EMM's Deliberations of relevance to WG-FSA

5.3 *C. gunnari* can become an important food item in the diet of predators in certain months as, for example, in king penguins at Heard Island (Moore et al., 1998) or Antarctic fur seals at South Georgia in years when krill is scarce around the island, as in 1990/91 (Everson et al., 1999). This has been discussed at some length in the report of WAMI which preceded the meeting of WG-FSA. Readers are referred to this report for further information on this matter (Appendix D).

5.4 WG-EMM has recently considered a draft fishery plan which the Secretariat had prepared for the krill fishery in Area 48. Another fishery plan was drafted by the Secretariat for the fishery for *C. gunnari* in Subarea 48.3. WG-FSA reviewed the progress made by the Secretariat to this end, and incorporated a number of changes and amendments to the current version of the plan (Appendix D).

5.5 Information on effects of squid fishing was briefly discussed. This discussion is provided in more detail in paragraph 3.132.

Ecological Interactions

5.6 More attention needs to be paid to quantifying the interactions of krill, *C. gunnari* and Antarctic fur seals at South Georgia to follow up an initial study by Everson et al. (1999). Antarctic fur seals, which number more than 1 million at South Georgia for most of the year, may contribute significantly to natural mortality in *C. gunnari*, particularly in those years when krill tends to be scarce around the island. This needs to be taken into consideration in stock assessments of *C. gunnari*. The consumption of more fish by fur seals may mean that less fish are available for the fishery in a particular year.

5.7 Some consideration has been given to include *C. gunnari* and *Pleuragramma antarcticum* as indicator species to be monitored by CEMP. Sufficient data are being collected on an annual basis to justify the inclusion of *C. gunnari* although certain requirements, such as a data collection plan, need to be developed before the species can be considered for incorporation into the CEMP activities.

5.8 *P. antarcticum* was considered as a potential indicator species when CEMP was established in the mid-1980s, because of its importance as a prey item for various predators such as penguins and seals. However, the suggestion to include *P. antarcticum* never went beyond that stage and very few data on *P. antarcticum* have been submitted to CCAMLR since then. If *P. antarcticum* is to be considered seriously as a possible CEMP species, a considerable amount of work will have to be done in order to develop regular sampling programs for the species in key areas and a data collection plan to fulfil CCAMLR requirements. The Ross Sea might be an area where this is possible.

Interactions of Marine Mammals with Fishing Operations

5.9 This item is considered in more detail in section 7.

The Benthic Fauna in relation to Fishing

5.10 WG-FSA-01/33 provided some information on seafloor mapping and the distribution of the benthic fauna in the South Orkney Islands and the Elephant Island–South Shetland Islands collected during the US AMLR demersal fish surveys in 1999 and 2001. The two broad communities could be separated from each other on the Elephant Island shelf: one on the western shelf was considered to be young and still maturing, while old and mature communities were present on the eastern part of the shelf. This is consistent with past fishing activities. These took part mostly on the northern and western part of the shelf and most of the area has been trawled once if not more often according to fishing maps available from the area. This would have damaged or destroyed a considerable amount of benthos. Comparatively little trawling was done on the eastern part of the shelf where fish biomass was found to be considerably lower.

General Considerations

5.11 The item 'Ecosystem Considerations to Management' has been on the agenda of WG-FSA for a considerable amount of time. More and more aspects have been discussed under other items of the agenda, such as Item 3 (Fish and Squid Biology/Demography/ Ecology) or Item 7 (IMALF), leaving little to discuss under this agenda item. The Working Group suggested that the Scientific Committee should delete this item from the forthcoming agenda of WG-FSA and refer relevant discussions to relevant sections of the report, such as section 3 or 7.

5.12 The objective of the CCAMLR Convention is to protect ecosystems in their entirety and its primary aim is not to protect single stocks from over-exploitation. It was felt that WG-FSA should increase its effort in the near future to consider groups of species in its assessments for an area rather than individual stocks. This would better comply with the ecosystem approach to be followed in CCAMLR.

5.13 Attempts for a more ecosystem-orientated approach have been made in the past when considering the fishery in the South Orkney Islands–South Shetland Islands. The fishery was closed eventually to protect by-catch species such as *Gobionotothen gibberifrons* or *Chaenocephalus aceratus* which could only sustain a low level of fishing. The prohibition of bottom trawling when fishing for *C. gunnari* at South Georgia offers another example of a more ecosystem-driven approach.

RESEARCH SURVEYS

Simulation Studies

6.1 A method of examining the efficacy of various toothfish longline survey patterns is described in WG-FSA-01/75. The paper presents a spatially explicit model that can be used to identify optimal patterns of set locations and attempts to illustrate how different survey designs, including minimum set distances and number of hauls, quantify population and fishery characteristics in a simulated environment.

6.2 A protocol for ensuring random subsampling on board research trawl surveys is described in WG-FSA-01/68. Using hierarchical methods, a simple, flexible methodology is described that provides a foundation for estimation of parameters while optimising for logistical constraints such as available amount of labour and size of haul without a loss of statistical rigour.

Recent and Proposed Surveys

6.3 Studies were undertaken by Australia, South Africa, Ukraine and the USA. Four research surveys were undertaken in the Convention Area in 2000/01, covering Subareas 48.1 and 58.7, and Divisions 58.4.4 and 58.5.2.

6.4 The Australian bottom trawl survey in Division 58.5.2 on board the *Southern Champion* studied the abundance and length distribution of *C. gunnari* and pre-recruit *D. eleginoides* (WAMI-01/4, WG-FSA-01/73).

6.5 A bottom trawl survey of *D. eleginoides* resources within the South African EEZ of Subarea 58.7 was conducted by South Africa. The results of this survey are presented in WG-FSA-01/72 and the population assessed in WG-FSA-01/54.

6.6 A longline survey of *D. eleginoides* was conducted by Ukraine in Division 58.4.4.

6.7 The results of a bottom trawl survey of Subarea 48.1 conducted by the USA are presented in WG-FSA-01/33 and WAMI-01/10. Biological information and biomass estimates were presented for eight species of finfish: *C. gunnari*, *C. aceratus*, *Chionodraco rastrospinosus*, *G. gibberifrons*, *Lepidonotothen larseni*, *Lepidonotothen squamifrons*, *Notothenia coriiceps* and *N. rossii*.

Proposed Surveys

6.8 Australia plans to repeat the *C. gunnari* and *D. eleginoides* pre-recruit survey in Division 58.5.2 during the coming season. Experimental toothfish pot trials will also be conducted in Divisions 58.4.2 and 58.4.3.

6.9 Germany plans to conduct a bottom trawl survey and other finfish and benthic investigations in Subarea 48.1 on the RV *Polarstern*.

6.10 Russia has notified that it will conduct a trawl and acoustic survey of *C. gunnari* resources in Subarea 48.3.

6.11 The UK intends to conduct a bottom trawl survey for *C. gunnari* and pre-recruit *D. eleginoides* in Subarea 48.3. Some tagging work and larval sampling are planned as well during the forthcoming year.

6.12 Other tagging experiments will be conducted by New Zealand in Subarea 88.1 on *Dissostichus* spp. and skates, and South Africa in Subarea 58.6 on *D. eleginoides*.

INCIDENTAL MORTALITY ARISING FROM LONGLINE FISHING

Intersessional Work of Ad Hoc WG-IMALF

7.1 The Secretariat reported on the intersessional activities of ad hoc WG-IMALF according to the agreed plan of intersessional activities for 2000/01 (SC-CAMLR-XIX, Annex 5, Appendix D). The report contained records of all activities planned and their results. These were reviewed and appropriate details appear in the 2001/02 plan of intersessional activities of WG-IMALF (Appendix F).

7.2 The Working Group noted the extensive work accomplished intersessionally by ad hoc WG-IMALF, details of which were presented in a number of tabled papers. The Working Group thanked the Science Officer for his work on the coordination of IMALF activities and the technical coordinators for their extensive support. It also thanked the Scientific Observer Data Analyst for his work on the processing and analysis of data submitted to the Secretariat by international and national observers during the course of the 2000/01 fishing season.

7.3 The Working Group concluded that most tasks planned for 2000/01 had been successfully implemented. In reviewing the report, it noted that responses from Members had been poor to requests concerning information on population, genetics and foraging data for albatrosses and petrels, particularly in the format requested. The response to the standing request on national research programs had also been poor and all Members were asked to provide both reports in full next year.

7.4 The Working Group also noted the lack of response to a number of standing requests to technical coordinators of scientific observation programs, in particular, on the development and use of fisheries-related methods for the avoidance of incidental mortality of seabirds. The Working Group urged all technical coordinators to respond to such requests, even if they are unable to report progress.

7.5 The Working Group noted the continuing absence of any feedback on the use on board longline vessels of the book *Identification of Seabirds of the Southern Ocean*, published jointly by CCAMLR and New Zealand in 1999. The Secretariat reported a continued demand for the book from many CCAMLR Members. For this reason the book has already been reprinted in English. Mr Smith advised that crews of fishing vessels had expressed interest in having the book on board. Scientific observers nominated by New Zealand regularly used the book at sea in conjunction with their national bird identification field guide.

7.6 The Working Group welcomed a report from Brazil of the planned publication of educational material based on the CCAMLR book *Fish the Sea Not the Sky.*

7.7 The membership of ad hoc WG-IMALF was reviewed. The updated list of members has been placed on the CCAMLR website (Scientific Committee ? Fisheries Interaction ? Membership). The Working Group especially welcomed Ms Rivera who attended the meeting for the first time. However the Working Group noted that some CCAMLR Member countries which are involved in longline fishing and/or seabird research in the Convention Area (e.g. Chile, France, European Community, Ukraine and Uruguay) were not, or were still not, represented at meetings of ad hoc WG-IMALF. Members were asked to review their representation on WG-IMALF intersessionally, to suggest additional members and to facilitate the attendance of their representatives at the meetings.

Research into the Status of Seabirds

7.8 Following last year's request for information summarising national research on seabirds (albatrosses and *Macronectes* and *Procellaria* petrels) vulnerable to longline fisheries interactions, papers were presented by the USA (WG-FSA-01/36), France (WG-FSA-01/41), Australia (WG-FSA-01/47), UK (WG-FSA-01/67) and New Zealand (WG-FSA-01/77). Reference to research on albatrosses by South Africa is included in WG-FSA-01/10, 01/11, 01/12 and 01/14. Of the countries known to be conducting relevant research on these species, no reports were received from Argentina and Chile.

7.9 All Members were requested to table annual updates on the current status of relevant research programs to next year's meeting of the Working Group.

7.10 Previously it was noted that the information regarding seabird population dynamics and foraging ranges was insufficient for comparisons with levels of by-catch and fishing effort. Consequently Members were requested to provide additional detail to enable these important assessments (SC-CAMLR-XIX, Annex 5, paragraphs 7.10 and 7.11). A proforma of the information requested was circulated intersessionally. The UK and Australia were the only Members to provide the information requested, although New Zealand provided additional information on their albatross population research programs.

7.11 The information provided is summarised in Tables 49 and 50, which update Table 47 in SC-CAMLR-XIX, Annex 5. All Members were requested to provide the details of population dynamics studies and foraging ranges as requested last year. Complete submission of the population and foraging research proformas to next year's meeting of the Working Group will enable a timely and comprehensive review of the level of information available for each population.

7.12 The most recent assessments (using the IUCN criteria) of the global status of albatrosses, giant petrels and *Procellaria* petrels are included in Table 49 as extracted from the information contained in WG-FSA-01/55. Given the population trends for some species, the status assessments are likely to require revision.

7.13 Of particular relevance to CCAMLR is a current application to IUCN (via BirdLife International) to upgrade the status of the black-browed albatross from Near-Threatened to Vulnerable. This reassessment is based on recent data from the Falkland/Malvinas Islands (which contain 70% of the world population), where it is estimated that the breeding population has declined by 25% (from 506 000 to 382 000 pairs) over the last 20 years. In the last five years this population has declined from 468 000 to 382 000 pairs, a decrease of 18% (Huin, 2001).

7.14 To enable revisions of the status of albatross and petrel populations vulnerable to fishery-related mortality in the Convention Area, Members are required to provide information on the most recent assessment of population size (year and population size estimate and population trend) for each population, wherever this information is available. This information should be tabled at next year's meeting of the Working Group.

7.15 A review of population trends of albatrosses and petrels at Marion Island (WG-FSA-01/11) illustrates the requirement for timely review of trends of vulnerable populations. The authors report on the dramatic recent population declines of five species (wandering and grey-headed albatrosses, northern and southern giant petrels, and white-chinned petrels). The albatross and giant petrel populations were all stable or decreasing during the 1980s, prior to a recovery period during the early 1990s. The population recoveries have subsequently halted or reversed in all four of these species. Wandering albatrosses increased in numbers steadily between 1990 and 1997, after which the population has decreased at -8.2% p.a. The grey-headed albatross population has been variable during the 1990s but the 1999/2000 data showed a 28% decrease from the previous season. The late 1990s also showed dramatic declines for both northern giant petrels (-11.3% p.a. since 1997) and southern giant petrels (-14.6% p.a. since 1995). White-chinned petrels have been monitored annually since the 1996/97 season, during which time the population has decreased by an alarming 34%, at an annual rate of -14.1%. Continued monitoring is essential to determine if the recent population decreases are sustained.

7.16 The population trends of the five species at Marion Island are similar to trends of wandering albatrosses at other Indian Ocean breeding locations, suggesting a common underlying cause, possibly changes in effort in the Southern Ocean tuna fisheries. A recent increase in tuna longlining, as well as recent large-scale IUU longline fishing for *D. eleginoides* (including in areas close to the breeding grounds), are likely contributing to the recent population decreases (WG-FSA-01/11).

7.17 The results of the South Georgia research program on white-chinned petrels, reported verbally last year (SC-CAMLR-XIX, Annex 5, paragraph 7.8), were made available at the meeting (WG-FSA-01/26 Rev. 1). A decline of over 28% in the breeding numbers for this population between 1981 and 1998 was attributed to changes in the marine environment, particularly relating to incidental mortality in longline fisheries. The results of analyses of the foraging range of white-chinned petrels breeding at South Georgia (WG-FSA-01/25) confirmed that they are amongst the most wide ranging of seabirds (travelling 3 000 to 8 000 km between incubation bouts). This wide-ranging dispersal places this population at substantial risk of high mortality rates in Southern Ocean longline fisheries, both in waters within, and adjacent to, the Convention Area. Importantly for by-catch considerations, this study also confirmed that nocturnal and diurnal activity of this species was approximately equal.

7.18 Tristan albatrosses, breeding only on the Gough and Tristan da Cunha group of islands, are the most genetically distinct of the wandering albatross complex, and are currently listed as Endangered. WG-FSA-01/14 provided data on population demographic parameters, including age at return to the island (4–5 years of age), modal age of first breeding (8 years), and average breeding success (63% in 1999/2000). The study reports that of the nine birds recovered away from the island, at least four were killed by longline fishing. Despite mortality on longlines, the authors suggest that the population may not have declined dramatically since the early 1980s and that its Threatened status might be revised to Vulnerable. The Working Group, however, felt that more caution may be warranted for this, the third rarest of all albatross species, given the lack of repeatable surveys to date, the small size of the annual breeding population (<1 200 pairs) and the restricted number of breeding sites (essentially one).

7.19 With the exception of the satellite tracking studies of the Macquarie Island albatrosses and the survey of Tristan albatrosses, no research programs focussing on relevant populations have been initiated since 1999. Assessments of population size and trends of many populations and species affected by longline fishing remain absent. The most detailed studies are for *Diomedea* albatrosses, with considerably less known for *Thalassarche*, *Phoebetria*, *Macronectes* and *Procellaria* species (in that order). It is unfortunate that, of all the species killed on longlines in southern waters, our understanding of the population size, trends and foraging ranges are most deficient for white-chinned petrels, the species most commonly killed in the Convention Area.

7.20 A summary of foraging distributions as determined by satellite tracking was attempted to enable an assessment of the foraging ranges of affected populations (at different times of year and stages of the breeding cycle), adequate to assess overlap with areas used by longline fisheries, and ultimately, to compare at-sea distributions with data on fishing effort (Table 50). Incomplete provision of information prevented the completion of this task. Compilation of the CCAMLR areas prospected by the different populations, with an indication of level of use, will enable better estimates of ranges of relevance to regional risk assessments (see SC-CAMLR-XX/BG/11).

7.21 In respect of the deficiencies resulting from the lack of relevant research into population dynamics and foraging ecology of most populations, little has changed since last year (SC-CAMLR-XIX, Annex 5, paragraph 7.10). If sufficient information is provided to the Working Group next year, it should be possible to provide assessments of the state of knowledge at a population level.

7.22 The foraging interactions between wandering albatrosses breeding on Marion Island and longline fisheries in the southern Indian Ocean were explored in WG-FSA-01/10. Adults tracked during the summer months showed affinity to mesoscale oceanographic features, as well as seasonal and gender differences in foraging behaviours. During the shorter foraging trips made during chick rearing, the authors noted a greater spatial overlap with the local *D. eleginoides* fishing area, as well as an increased reliance on offal produced by these vessels. During 1997 almost 60% of samples contained fisheries-related items (offal and fisheries litter). Fisheries-related debris observed to occur in the regurgitates from chicks has increased significantly, occurring in 25% of the samples collected in 1997. The most frequently occurring pollutants derived from fisheries were toothfish hooks (17% of samples) and rope nooses used when processing toothfish (8% of samples). Consistent with other populations of this species, the females foraged both further afield and in more northern waters. Although this population is exposed to a wide range of longline fisheries, the authors suggest that it is the mortality experienced by adult females in more temperate tuna fisheries which is the single most important factor compromising the conservation status of this population. The Working Group, however, noted with alarm the increasing incidence of toothfish hooks in regurgitates and were seriously concerned about the combined impact of fisheries on this population.

7.23 In 1999 and 2000 the Working Group requested information from Members on genetic research relevant to determining the provenance of birds killed in longline fisheries. Despite the knowledge that relevant studies have been conducted in Australia, New Zealand, South Africa, UK and the USA, detailed information was only provided by the UK. All other Members were again requested to supply relevant information on their research.

7.24 The results of research on population genetics of black-browed and grey-headed albatrosses (WG-FSA-01/19) are extremely relevant to the characterising of the profiles of these species, as well as to the ability to ascribe provenance to by-catch samples. Black-browed albatrosses form three distinct groups: Falklands/Malvinas; Diego Ramirez, South Georgia and Kerguelen; and Campbell Island (*Thalassarche impavida*). *T. melanophrys* from Campbell Island contain genetic markers from all of the three groups, indicating high levels of mixture and hybridisation. In contrast, grey-headed albatrosses form one globally panmictic population. Ability to ascribe provenance for this species is therefore limited at present.

7.25 In recognition of the importance of validating the species of birds killed, as well as determining their sex, age, and where possible provenance, scientific observer logbooks were modified in 1996 to require an entry indicating the place of deposition and the scientists responsible for the material (SC-CAMLR-XV, Annex 5, paragraph 7.20).

7.26 The Working Group felt it was now appropriate to assess the number and location of specimens and samples retained from seabird by-catch. It requested the Secretariat to correspond with the scientists responsible in order to obtain summary data on the number and nature of specimens in their collections.

7.27 WG-FSA-01/18 reported the results of relating population data for wandering albatrosses at South Georgia and the Crozet Islands to longline effort data for tuna fisheries south of 30°S. The model from this paper predicted reasonably closely the observed data from the Crozet Islands, but the fit to the South Georgia population was substantially poorer. This probably reflects:

(i) greater overlap in the Indian Ocean than in the Atlantic Ocean between the main areas of tuna longline fishing and the foraging ranges of wandering albatrosses from the Crozet Islands and South Georgia respectively; and

(ii) greater impact of poorly documented longline fisheries, especially the tuna fisheries in the South Atlantic and the *D. eleginoides* fisheries (outside the CCAMLR Convention Area) within the foraging range of wandering albatrosses from South Georgia.

7.28 The model results suggest that the marked decline in both populations (late 1960s to c. 1986), and subsequent recovery of the Crozet Islands population (but not the continued decline of the South Georgia population), can be explained by the tuna longline by-catch. The model indicates that populations may be able to sustain some level of incidental mortality. However, the likely under-reporting of fishing effort (especially in non-tuna longline fisheries) and the delicate balance between a sustainable level of by-catch for these long-lived populations suggest great caution in any such application of the findings.

7.29 The Working Group commended this initiative, involving collaboration between Australian, UK and French scientists, which addressed issues of particular interest to CCAMLR. The results had a direct bearing on the question, posed by the Scientific Committee last year, as to the potential impact of longline fishing (including IUU fishing) on albatross populations in the Convention Area (see SC-CAMLR-XIX, paragraph 4.29).

7.30 The Working Group noted that although the approach in WG-FSA-01/18 could be refined by using recently available data on the distribution of effort within the foraging range of wandering albatrosses, the deficiencies noted above in the fishing effort data made it unlikely that significant improvements in model fit would result.

7.31 Given that the albatross data used in this study came from the most detailed and longest-running studies worldwide and that fishing effort data for tuna longline fisheries are relatively well documented by the standards of international waters fisheries, the Working Group noted the inevitable limitations for other attempts to establish causal relationships between incidental mortality in longline fisheries and responses by albatross populations in the Convention Area. The study also indicated that attempts to correlate seabird population changes with fishing effort are likely to be limited by the quality of the latter data. This is likely to be particularly true in respect of data for IUU fishing, despite the very large seabird by-catches potentially involved.

Incidental Mortality of Seabirds during Regulated Longline Fishing in the Convention Area

2001 Data

7.32 Data were available from 38 longline cruises conducted within the Convention Area during the 2000/01 season (for details see WG-FSA-01/21; Tables 12 and 51).

7.33 The Working Group noted that the average proportion (percentage with range in parentheses) of hooks observed was similar to last year (SC-CAMLR-XIX, paragraph 7.28), except in Subarea 88.1 where it was 23% higher, viz: Subarea 48.3 – 24 (10–81); Subareas 58.6/58.7 – 39 (6–61); Subarea 88.1 – 56 (37–89).

7.34 There were still concerns that the proportions of hooks observed on some vessels/cruises were unacceptably low (e.g. *Isla Graciosa* (6% and 8%) and *No. 1 Moresko* (10% on second cruise)).

7.35 WG-FSA-01/40 indicated that when bird catches are at low levels, it does not necessarily follow that increased observer coverage will increase the accuracy of bird by-catch estimates. The paper showed that when scientific observer coverage is about 20%, the absolute level of confidence intervals attached to estimates of mean bird catch are low when catch rates are less than 0.01 birds/thousand hooks (c. 8 birds per vessel per 100 days fishing). As a result, efforts to increase observer coverage beyond c. 20% should be balanced against perceived gains in the absolute accuracy of bird by-catch estimates rather than gains in the relative (CV) accuracy.

7.36 Problems with incorrect reporting of the proportions of hooks observed were much reduced compared with last year (SC-CAMLR-XIX, paragraph 7.29), with only the values for *Polarpesca I* (81%) and *Isla Gorriti* (89%) giving cause for concern.

7.37 The total observed catch rate was calculated using the total number of hooks observed and the total seabird mortality observed (Table 51). The estimated total catch of seabirds by vessel was calculated using the vessel's observed catch rate multiplied by the total number of hooks set.

Subarea 48.3

7.38 The overall catch rate of birds killed in Subarea 48.3 was 0.002 birds/thousand hooks, essentially the same as last year. All birds were killed during night setting; that no birds were killed during day setting presumably reflects the very small proportion (c. 5%) of sets starting in daylight.

7.39 The total estimated seabird mortality in Subarea 48.3 was 30 birds (Table 52), compared with 21 last year. Of the six birds observed killed, three were southern giant petrels, two were black-browed albatrosses and one was a cape petrel (Table 53).

South African EEZs in Subareas 58.6 and 58.7

7.40 For Subareas 58.6 and 58.7, the overall observed catch rate of birds killed was 0.018 birds/thousand hooks from 11 fishing voyages (Table 51). The night-time rate was lower (0.014 birds/thousand hooks) than during the day (0.037 birds/thousand hooks). The catch rate was slightly less than the previous year (0.022 birds/thousand hooks).

7.41 The total estimated seabird mortality in Subareas 58.6 and 58.7 for this year was 199 seabirds (Table 54), a marked decrease from the 516 estimated killed in the previous year. The white-chinned petrel was, as in previous years, the most commonly observed of three species reported killed, comprising 92% of the total observed mortality, with black-browed albatross and grey petrel each comprising 4% (Table 53).

7.42 Further analysis of seabird by-catch in the South African EEZ around the Prince Edward Islands in 2000/01 was presented in WG-FSA-01/61. This paper reported on observer data from 12 fishing voyages, eight of which were also included in the Secretariat's report (WG-FSA-01/21), setting a total of 8.07 million hooks. A total of 76 birds of six species was reported killed, substantially less than the 268 reported in the previous season. Most birds reported killed were white-chinned petrels (86%), with very small numbers of grey-headed and black-browed albatrosses, giant petrels, grey petrels and macaroni penguins (*Eudyptes chrysolophus*).

7.43 The average catch rate was 0.009 birds/thousand hooks, considerably lower than in the previous season (0.036), and also lower than in three earlier seasons (1998/99 (0.016), 1997/98 (0.117) and 1996/97 (0.289)). Catch rate per voyage varied from zero to 0.046 birds/thousand hooks. Most birds were killed during the summer months.

7.44 Most birds killed were hooked on the wing or body during setting. A total of 81 birds was released alive after being caught during hauling, mainly white-chinned petrels and southern giant petrels. This is an increase from 17 in 1999/2000 and was thought to be due to increased observer vigilance.

7.45 The observed reduction in bird mortality is thought to be due to vessels targeting seamounts at a distance from and to the west of the Prince Edward Islands where fewer birds were present.

7.46 The Working Group noted differences between WG-FSA-01/21 and 01/61 which reflected that:

(i) as in the previous season, WG-FSA-01/61 included reports of dead birds not directly recorded by the observer, resulting in higher by-catch totals; and

(ii) only eight fishing voyages were common to the two datasets. Three recent voyages covered by WG-FSA-01/21 were not available to the authors of WG-FSA-01/61 at the time of writing.

7.47 WG-FSA-01/8 reviewed seabird by-catch around the Prince Edward Islands over the four-year period 1996 to 2000. Observers were present on all but two of 52 voyages by 12 vessels.

7.48 During this period, the annual by-catch rate decreased from 0.19 birds/thousand hooks to 0.034 birds/thousand hooks. White-chinned petrels were the most frequently killed species (80% of 1 761) over the period, with albatrosses, particularly grey-headed albatrosses, being killed in numbers only in the first year. Improved compliance with CCAMLR regulations and an increasing distance of fishing from the islands were thought responsible for the reduction in by-catch over time.

7.49 Birds were caught almost exclusively during their breeding seasons, primarily during the austral summer. Mortality of white-chinned petrels was almost exclusively restricted to the months of October to April from 1996 to 2000. Most birds killed were breeding adult males, assumed to be from the Prince Edward Islands. Albatrosses were caught closer to the islands than white-chinned petrels. Most petrels were foul-hooked, whereas albatrosses were mainly hooked by their bills.

7.50 WG-FSA-01/8 estimated that about 7 000 seabirds were killed around the Prince Edward Islands from 1996 to 2000, when the estimated numbers of birds killed by IUU fishing (5 239 birds) were added to those killed by the regulated fishery (1 761 birds). This level of mortality was considered to have had significant impacts on the breeding populations of several species of albatrosses and petrels at the islands (see WG-FSA-01/11).

7.51 The Working Group recollected its recommendation of the two previous years (SC-CAMLR-XVIII, Annex 5, paragraph 7.46 and SC-CAMLR-XIX, Annex 5, paragraph 7.44) to prohibit fishing within 200 n miles of the Prince Edward Islands during the months of January to March inclusive, especially to reduce further by-catch of the summer-breeding white-chinned petrel.

7.52 In view of information provided by South Africa (paragraphs 7.12 and 7.47 to 7.50) on timing of mortality of white-chinned petrels, the Working Group recommended that fishing within 200 n miles of the Prince Edward Islands be prohibited in the months of September to April inclusive, in line with its advice for all other areas of the highest risk of seabird incidental mortality. However, if South Africa still considered it necessary to maintain a regulated fishing presence within its EEZ around the Prince Edward Islands in order to deter IUU fishing (WG-FSA-01/8), then regulated fishing within 200 n miles of the islands (which would include the seamounts to the west) should be prohibited at least from January to April.

Subarea 88.1

7.53 No incidental mortality of seabirds was observed in Subarea 88.1. The only bird caught (by *San Aotea II*) apparently came on board independently of the longlining operation and was released alive.

General

7.54 Table 55 summarises data on seabird by-catch and by-catch rates for the last five years (1997–2001), for the best documented subareas. There has been no seabird by-catch in the new and exploratory longline fishery in Subarea 88.1 in the three years (1999–2001) since this fishery commenced.

7.55 In Subarea 48.3, by-catch rate and estimated total seabird by-catch were, for the second successive year, at negligible levels. This has been achieved in large part by restricting fishing to winter months, but consistently improving compliance with Conservation Measure 29/XIX, particularly in respect of night setting and line weighting in 2000/01.

7.56 In the fisheries within the South African EEZ in Subareas 58.6 and 58.7, the by-catch rate in 2000/01 was the lowest yet reported (an order of magnitude lower than in 1997/98) and the total estimated seabird by-catch is, at 199 birds, close to the lowest total ever (156 birds in 1998/99). The improvements this year are due in part to improved compliance with Conservation Measure 29/XIX, but also to vessels targeting areas further from and to the west of the Prince Edward Islands where fewer seabirds occur (paragraph 7.45).

1999 and 2000 Data

French EEZs in Subarea 58.6 and Division 58.5.1

7.57 Information on seabird by-catch from within its EEZs around the Crozet (Subarea 58.6) and Kerguelen (Division 58.5.1) Islands was supplied by France for 1998/99 and 1999/2000 (WG-FSA-01/21, Appendix 1). A total of 11.57 million hooks was set in the two years.

7.58 The Working Group welcomed this information, coming as it does from areas identified as being of the highest risk for seabird mortality (SC-CAMLR-XX/BG/11), and also because such information had not been provided to CCAMLR for several years. However, it noted that the data had not been supplied in the standard format and that none of the original data had been submitted to the CCAMLR database as requested (SC-CAMLR-XIX, paragraph 4.22). In addition, the lack of information on mitigation measures in use in this fishery made interpretation difficult.

7.59 The data presented revealed most alarming by-catch rates, reaching as high as 8.584 birds/thousand hooks in one month, when no less than 3 226 birds were killed around Kerguelen. Overall, by-catch rates were 0.736 birds/thousand hooks for 1998/99 and 0.184 birds/thousand hooks for 1999/2000 for Crozet Islands and 2.937 birds/thousand hooks for 1998/99 and 0.304 birds/thousand hooks for 1999/2000 for the Kerguelen Islands. The reason for the reduction in by-catch rate at the two island groups from 1998/99 to 1999/2000 is not known.

7.60 A total of 8 491 white-chinned petrels was reported killed. In both years and at both islands, this species formed over 99% of all birds reported killed. The few other species were nearly all albatrosses and giant petrels. More birds (6 848) were killed around the Kerguelen Islands than around the Crozet Islands (1 686).

7.61 By-catch occurred in nearly all months of fishing, which was spread over most of the year at both island groups, but levels were highest in the summer months of January to April, when white-chinned petrels are rearing chicks. However, appreciable numbers of white-chinned petrels were also killed, especially at the Kerguelen Islands, in October to December, when the species is prospecting and incubating.

7.62 The Working Group noted that the total of 2 241 birds estimated killed in the French EEZs in 1999/2000 is 4.2 times greater than the combined total (537 birds) for Subarea 48.3 (21 birds) and for the South African fishery in Subareas 58.6 and 58.7 (516 birds) for that year. Similar figures for 1998/99 are 6 293 birds estimated killed in the French EEZs, 17.2 times greater than the combined total of 366 birds estimated killed in Subarea 48.3 and by the South African fishery in Subareas 58.6 and 58.7.

7.63 The by-catch rates within the French EEZs in some cases exceeded those that are used to estimate by-catch for these areas in the IUU fishery (1.049 and 1.88 birds/thousand hooks; SC-CAMLR-XIX, Annex 5, Table 56).

7.64 It was noted that the mortality of white-chinned petrels would have been reduced from 8 491 to only 32 birds if fishing had not taken place during the eight months of high mortality during summer. The Working Group therefore recommended that longline fishing within the French EEZs should be prohibited during the months of September to April inclusive, in line with its advice for all other areas of the highest risk of seabird incidental mortality.

7.65 The Working Group requested France to supply the original data for 1999 and 2000, together with data for 2001, to CCAMLR at the earliest opportunity, together with information on by-catch mitigation measures in use in each of these three years.

Compliance with Conservation Measure 29/XIX

7.66 Compliance with this conservation measure, as set out in WG-FSA-01/22, is summarised in Table 56 in comparison with similar data from previous years, when Conservation Measures 29/XV and 29/XVI applied. The only substantive difference between Conservation Measures 29/XVI and 29/XIX is that the line weighting specification was relaxed from 6 kg at 20 m to 8.5 kg at 40 m.

Streamer Lines

7.67 This year 66% of the streamer lines deployed complied fully with the specifications in Conservation Measure 29/XIX (Table 57). In the last four years the highest compliance was 33% in 1999/2000, so this year there has been a substantial improvement. It was noted that several vessels complied fully with the streamer line specifications on some cruises but not on others. All vessels fishing in Subarea 88.1 used streamer lines that fully complied with the specifications.

7.68 Several vessels still have persistently poor compliance with this element of Conservation Measure 29/XIX (see Table 58), notably *Isla Santa Clara*, *No. 1 Moresko*, *Argos Helena*, *Aquatic Pioneer* and *Eldfisk*. It was disappointing that several vessels new to the fishery (*Polarpesca I*, *Suidor One* and *Rustava*) have failed to comply with this simple and important measure.

7.69 As in previous years the element of the conservation measure that was most commonly not met was length of streamer line. In Subareas 58.6 and 58.7 only 64% of the lines complied with the 150 m requirement and in Subarea 48.3 only 53% complied. Streamer line length in combination with height of attachment of the line both have an important bearing on the aerial length of the streamer line. Because the aerial section acts as a protection zone for seabirds, streamer line length is very important and the Working Group re-emphasised the importance of compliance with this element of the measure.

7.70 The Working Group noted that the observer reports for four vessels fishing in Subarea 48.3 did not provide full details of streamer line specifications (Table 57). It is essential that observers do this and it was recommended that the instructions to observers should emphasise this.

Offal Discharge

7.71 All vessels fishing in the Convention Area except one (*Maria Tamara* in Subarea 48.3) complied with the requirement to either hold offal on board or discharge on the opposite side to where the line is hauled and not discharge during setting. In 1999/2000 all vessels in Subareas 58.6, 58.7 and 88.1 complied with this conservation measure and in Subarea 48.3 four vessels contravened the measure so there has been a significant improvement. The case of the *Maria Tamara* is complicated by the fact that comments in the observer report are not entirely consistent with the logbook entry. This requires further investigation.

7.72 Although Conservation Measure 29/XIX calls for avoiding the discharge of offal during the haul, attempts to comply with this have been inconsistent. Thus, in Subarea 88.1 (where it is mandatory under Conservation Measure 210/XIX), no vessel discharged during the haul. In Subareas 48.3, 58.6 and 58.7, on four cruises (*Isla Camila*, *Viking Bay*, *Eldfisk*, *Isla Graciosa*), no offal was discharged during hauls; on the other 25 cruises there was discharge during hauls at an average of 91% of sets. Paradoxically, some vessels discharged at the haul on some cruises but not on others. It is not clear what factors are contributing to this.

Night Setting

7.73 In accordance with Conservation Measure 29/XIX, longline setting shall occur at night only. Daylight is defined as the period from nautical dawn through to nautical dusk. If more than 20% of the set occurs in daylight hours, it is then considered to be a daylight set.

7.74 Compliance with night setting has improved in Subarea 48.3 from 87% in 1999/2000 to 95% in 2000/01. On five cruises, no sets were made in the daytime, on 12 cruises between two and nine sets were set in the daytime and on two cruises 18 and 34 sets were made in the daytime (on *Isla Alegranza* and *RK-1* respectively).

7.75 In Subareas 58.6 and 58.7 compliance, at 78%, remained about the same as in 1999/2000 (77%). The South African Government permit conditions for the *Eldfisk* allowed this vessel to fish during the daytime if a Mustad underwater funnel was used. This vessel deployed 50%, 64% and 94% of sets at night over three cruises. The *Koryo Maru 11* deployed a significant number of sets (47%) during daylight hours on one cruise and caught the highest number of seabirds of any vessel fishing in these subareas.

7.76 Fishing in Subarea 88.1 (where only 18% of lines were set at night) operated under Conservation Measure 210/XIX which contained an exemption from night setting requirements for vessels fishing south of 65°S in order to conduct line weighting trials (see paragraph 7.80).

Line Weighting – Spanish System

7.77 In 2000 the Commission accepted WG-IMALF's recommendation for an alternative line weighting regime for vessels using the Spanish method of longline fishing. Conservation Measure 29/XIX requires vessels to use either 8.5 kg weights spaced at no more than 40 m or 6 kg weights at no more than 20 m. The addition of the option of 8.5 kg weights at no more than 40 m was made because of concern that the existing regime placed practical constraints on fishers.

7.78 Line weighting that complied with the new conservation measure was used on four (21%) cruises in Subarea 48.3 and two (18%) cruises in Subareas 58.6 and 58.7 (Figure 35). It was reported that one vessel (*Isla Alegranza*) operating a Spanish longline system in Subarea 88.1 complied with the measure, using line weighting equivalent to about 12 kg at 40 m intervals (and a setting speed of 7 knots).

7.79 Eight other vessels used a line weighting regime that was close to that required in Conservation Measure 29/XIX on at least one cruise (Figure 35). This situation compares to 1999/2000 when no vessels complied with the line weighting requirement that was in place at the time (6 kg at no more than 20 m).

7.80 The Working Group concluded from this year's results that the new alternative line weighting requirement could be complied with. It recommended to the Scientific Committee and the Commission that vessels unable to meet the line weighting requirement of Conservation Measure 29/XIX should be prohibited from fishing in the Convention Area.

Line Weighting – Autoline System

7.81 In Subarea 88.1 vessels fishing south of 65°S in daylight were required to use line weights to achieve a consistent minimum line sink rate of 0.3 m/s (Conservation Measure 210/XIX). The Working Group noted that all vessels complied with this measure.

Thawed Bait

7.82 All except three vessels (*Eldfisk*, *Ural, No. 1 Moresko*) complied with the requirement to use thawed bait on all occasions. This compared to last year when all but two vessels used thawed bait (WG-FSA-01/22).

General

7.83 Table 58 summarises compliance with Conservation Measure 29/XIX regarding night setting, streamer lines, line weighting and offal discharge on a vessel-specific basis.

7.84 Four vessels (*Isla Gorriti*, *Janas*, *San Aotea II* and *Sonrisa*) all complied fully with the elements of the conservation measures that were applicable in the areas they fished. The Working Group commended the efforts of these vessels and noted that these vessels were particularly suitable for involvement in new and exploratory fisheries.

7.85 Table 59 provides more detail, in an attempt to quantify performance, on the extent to which each vessel complied with each element of Conservation Measure 29/XIX in 2000/01. In addition to the vessels that fully complied with night setting, five vessels completed 95% or more of their sets at night.

7.86 Historical compliance data and reports received by CCAMLR from observers and fishers indicate that all practical constraints relating to streamer line use and line weighting have now been overcome. There is now no reason why all vessels cannot fully comply with these measures.

7.87 The Working Group therefore recommended that vessels which do not fully comply with night setting, streamer line, offal discharge and line weighting measures should be prohibited from fishing in the CCAMLR Convention Area.

7.88 It recollected that the Scientific Committee (SC-CAMLR-XIX, paragraph 4.41(i)) had made a similar recommendation last year (excluding line weighting for which the conservation measure was being modified).

7.89 Particular attention is drawn to vessels that have not complied with two or more of the elements of Conservation Measure 29/XIX for two or more consecutive years. These are: *Isla Camila*, *Isla Santa Clara*, *Koryo Maru 11*, *No. 1 Moresko*, *Argos Helena*, *Aquatic Pioneer* and *Isla Alegranza*. In addition, vessels in their first year in the fishery that failed to comply with two or more measures are *Polarpesca I*, *Suidor One*, *Maria Tamara*, *In Sung 66* and *Rutsava*.

7.90 It was noted that several vessels narrowly failed to achieve compliance with Conservation Measure 29/XIX, particularly in relation to streamer line design and night setting. It was recommended that technical coordinators be reminded of the precise specifications of these elements of the conservation measure and given encouragement to ensure that all vessels for which they have responsibility are able to comply with the stipulated provisions as a minimum. Improvements to the instructions and recording sheets for scientific observers should help to ensure comprehensive and accurate reporting on by-catch mitigating measures in use on each vessel (paragraph 7.96).

Fishing Seasons

7.91 Last year the Scientific Committee advised the Commission that once full compliance with Conservation Measure 29/XVI was achieved, together with negligible levels of seabird by-catch, any relaxation of closed seasons should proceed in a step-wise fashion (e.g. similar to the process by which the closed season was extended) and the results of this carefully monitored and reported (SC-CAMLR-XIX, paragraph 4.42).

7.92 On the basis of the data for the 2000/01 fishing season in Subarea 48.3, seabird by-catch levels were negligible, for the second successive season. However, full compliance with Conservation Measure 29/XIX was not achieved so it is not possible to recommend an extension to the fishing season for 2001/02 in Subarea 48.3.

7.93 However, the Working Group noted that full compliance would have been achieved:

(i) if the offal discharge by the *Maria Tamara* had been on the opposite side from the haul (or if she had been excluded from the fishery as recommended by the Commission (CCAMLR-XVII, paragraph 6.42(i)), or if she was configured so as to be unable to discharge on the opposite side);

(ii) with small improvements in setting of lines at night, notably by the *RK-1*, *Polarpesca I* and *Isla Alegranza*;

(iii) with relatively small improvements to the line weighting regimes of all vessels, except *Argos Georgia* and *Ural*. It was noted that the *Isla Graciosa* and *No. 1 Moresko* achieved the standard on at least one cruise and *Viking Bay* only failed to do so by 0.6 kg; and

(iv) with very minor improvements to the use and specification of streamer lines by *Argos Helena*, *Isla Camila*, *Isla Santa Clara*, *Polarpesca I* and *No. 1 Moresko.*

Scientific Observer Reports

7.94 In reviewing the Secretariat summaries of observations on board vessels operating in the Convention Area during the 2000/01 season (WG-FSA-01/20, 01/21 and 01/22), the following observer-related issues were noted (see also paragraphs 3.35 to 3.52).

Defining Incidental Mortality Events

7.95 One incident of seabird interaction in the longline fishery was reported as both an entanglement and an incidental capture. The Working Group noted that this type of confusion could be resolved by the development of a standard format for the written observer report.

Using Observer Data for Compliance Purposes

7.96 As the reporting of compliance with conservation measures is increasingly scrutinised, the accuracy of the data provided by observers becomes more crucial. This was highlighted in discussion of the accuracy of measurement of the length of streamer lines, and failure to report on specifications relating to certain elements of Conservation Measure 29/XIX (see paragraph 7.70) resulting in blanks in the tables in WG-FSA-01/22. The Working Group noted that observers needed to be clearly instructed by technical coordinators on the elements of conservation measures that they are reporting on.

Monitoring Line Sink Rate

7.97 CCAMLR observers reported on the implementation of Conservation Measure 210/XIX in relation to line sink rate prior to entering the Subarea 88.1 exploratory fishery and whilst participating in the Subarea 88.1 fishery in their written reports. However, the line sink rate data from both the pre-fishery testing and the in-fishery monitoring were not reported. The Working Group recommended that observer forms be modified to capture these data in future.

Determining Nautical Twilight in High Latitude Areas

7.98 Feedback was received from technical coordinators that observers had difficulty in determining nautical twilight in high latitude areas as current tables provided to observers stop at 75 degrees of latitude. The Working Group recommended that in future, tables covering the full extent of the Convention Area are provided to observers, preferably degree by degree rather than in 5 degree blocks.

Recording Seabird Interaction Data in Trawl Fisheries

7.99 The trawl forms currently used by observers do not capture seabird-interaction data in the same way as the longline forms. This lack of data makes the analysis of seabird–trawl interactions difficult (see paragraphs 8.19 and 8.20). The Working Group recommended that the observer trawl forms should be modified to capture the data needed for analysis of these interactions in a similar way to the current longline forms.

Use of Video Monitoring

7.100 WG-FSA-01/57 reported on recent developments in the use of video monitoring. The Working Group noted that the use of video monitoring systems is developing rapidly in fisheries for a variety of purposes. It was noted that such systems had the potential advantage of providing greater levels of coverage of fisheries for seabird interactions whilst allowing observers more time to work on other tasks.

7.101 Current video monitoring systems, so long as the camera is correctly positioned, should adequately record all incidents of seabird capture on demersal longline vessels. However, such systems leave at least four unresolved issues: data storage (tape or digital) on long trips, viewing of tapes to check for incidental captures, identification of the seabird species captured, and collection of specimens.

7.102 Rapid advances in digital video and data warehousing should resolve the data storage issue in the near future. Onshore viewing of tapes is possible, but likely expensive and time consuming. This needs further investigation, including assessment of costs. It is hoped that video recognition software may resolve this issue within the next few years (WG-FSA-01/57). Future advances in video recognition software may also allow rapid identification to the level of genus; however, species identification will likely require collection of actual specimens for quite some time. By collecting the required specimens, either observers or fishers could resolve this issue.

7.103 In summary, current systems do not yet appear able entirely to replace observer coverage with respect to assessing the incidental mortality of seabirds. However the Working Group noted that systems are being developed that may allow video monitoring systems to be used to assess the incidental mortality of seabirds in the near future and urged Members to report on such developments and any trials undertaken.

Incidental Mortality of Seabirds during Unregulated Longline Fishing in the Convention Area

Unregulated Seabird By-catch

7.104 As no information is available on seabird by-catch rates from the unregulated fishery, estimates have been made using both the average catch rate for all cruises from the appropriate period of the regulated fishery and the highest catch rate for any cruise in the regulated fishery for that period. Justification for using the worst catch rate from the regulated fishery is that unregulated vessels accept no obligation to set at night, to use streamer lines or to use any other mitigation measure. Therefore catch rates, on average, are likely to be considerably higher than in the regulated fishery. For Subarea 48.3, the worst-case catch rate was nearly four times the average value and applies only to a single cruise in the regulated fishery. Using this catch rate to estimate the seabird catch rate of the whole unregulated fishery may produce a considerable overestimate.

7.105 In view of the fact that:

(i) seabird by-catch rates in the regulated fishery have been reduced substantially since 1997, due to much better compliance with CCAMLR conservation measures, including those relating to closed seasons; and

(ii) it is unreasonable to assume that the unregulated fishery made comparable improvements to the timing and practice of its operations;

the Working Group decided that it should continue to use the seabird by-catch rates from 1997, as was done in this assessment for the last three years. The assessment this year, therefore, followed the identical procedure to that used last year (SC-CAMLR-XIX, Annex 5, paragraphs 7.66 to 7.68).

Unregulated Effort

7.106 To estimate the number of hooks deployed by the unregulated fishery, it is assumed that the fish catch rate in the regulated and unregulated fisheries is the same. Estimates of fish catch rate from the regulated fishery and estimated total catch from the unregulated fishery can then be used to obtain an estimate for the total number of hooks using the following formula:

$$\text{Effort(U)} = \text{Catch(U)/CPUE(R)},$$

where U = unregulated and R = regulated.

Catch rates for Divisions 58.4.4 and 58.5.2 were assumed to be identical to those for Division 58.5.1.

7.107 The fishing year was divided into two seasons, a summer season (S: September to April) and a winter season (W: May to August), corresponding to periods with substantially different bird by-catch rates. There is no empirical basis on which to split the unregulated catch into summer and winter components. Three alternative splits (80:20, 70:30 and 60:40) were used.

7.108 The seabird by-catch rates used were:

Subarea 48.3 –
summer: mean 2.608 birds/thousand hooks; maximum 9.31 birds/thousand hooks;
winter: mean 0.07 birds/thousand hooks; maximum 0.51 birds/thousand hooks.

Subareas 58.6, 58.7, Divisions 58.5.1 and 58.5.2 –
summer: mean 1.049 birds/thousand hooks; maximum 1.88 birds/thousand hooks;
winter: mean 0.017 birds/thousand hooks; maximum 0.07 birds/thousand hooks.

Division 58.4.4 –
summer: mean 0.629 birds/thousand hooks; maximum 1.128 birds/thousand hooks;
winter: mean 0.010 birds/thousand hooks; maximum 0.042 birds/thousand hooks.

Results

7.109 The results of these estimations, based on estimates of IUU catches in Tables 3 to 11, are shown in Tables 60 and 61.

7.110 For Subarea 48.3, depending on the proportionate split of catches into summer and winter, estimates of the seabird by-catch in the unregulated fishery range from a lower level (based on the mean by-catch rate of regulated vessels) of 1 600–2 100 birds in summer (and 10–30 in winter) to a potentially higher level (based on the maximum by-catch rate of regulated vessels) of 5 600–7 400 birds in summer (and 100–200 in winter).

7.111 For Subareas 58.6 and 58.7 combined, depending on the proportionate split of catches into summer and winter, estimates of the seabird by-catch in the unregulated fishery range from a lower level (based on the mean by-catch rate of regulated vessels) of 11 900–15 800 birds in summer (and 70–130 in winter) to a potentially higher level (based on the maximum by-catch rate of regulated vessels) of 21 200–28 300 birds in summer (and 260–530 in winter).

7.112 For Divisions 58.5.1 and 58.5.2, depending on the proportionate split of catches into summer and winter, estimates of the seabird by-catch in the unregulated fishery range from a lower level (based on the mean by-catch rate of regulated vessels) of 13 200–17 600 birds in summer (and 70–150 in winter) to a potentially higher level (based on the maximum by-catch rate of regulated vessels) of 23 700–31 500 birds in summer (and 300–590 in winter).

7.113 For Division 58.4.4, depending on the proportionate split of catches into summer and winter, estimates of the seabird by-catch in the unregulated fishery range from a lower level (based on the mean by-catch rate of regulated vessels) of 9 200–12 300 birds in summer (and 50–100 in winter) to a potentially higher level (based on the maximum by-catch rate of regulated vessels) of 16 500–22 100 birds in summer (and 210–410 in winter).

7.114 The overall estimated totals for the whole Convention Area (Tables 60 and 61) indicate a potential seabird by-catch in the unregulated fishery of 36 000–69 000 (lower level) to 48 000–90 000 birds (higher level) in 2000/2001.

7.115 This compares with totals of 17 000–27 000 (lower level) to 66 000–107 000 (higher level) in 1996/97; 43 000–54 000 (lower level) to 76 000–101 000 (higher level) in 1997/98; 21 000–29 000 (lower level) to 44 000–59 000 birds (higher level) in 1998/99; and 33 000–63 000 (lower level) to 43 000–83 000 birds (higher level) in 1999/2000. Attempts to draw inferences regarding changes in by-catch levels in the IUU fishery should be viewed with caution, given the uncertainties and assumptions involved in these calculations.

7.116 Note that the overall total figures for 1999/2000 have been adjusted to take into account revised figures for estimated unregulated *Dissostichus* spp. catch in Subarea 48.3 (396 tonnes in place of 350 tonnes) and revised figures for the regulated catch rates of *Dissostichus* spp. in Subarea 48.3 (0.31 in place of 0.32), Subarea 58.6 (0.09 in place of 0.081), Subarea 58.7 (0.10 in place of 0.13) and Divisions 58.4.4, 58.5.1 and 58.5.2 (0.24 in place of 0.063, 0.236 and 0.236 respectively).

7.117 The composition of the estimated potential seabird by-catch based on data since 1997 is set out in Table 62. This indicates a potential by-catch in 2000/01 of 10 000–19 000 albatrosses, 1 700–3 000 giant petrels and 26 000–49 000 white-chinned petrels in the unregulated fishery in the Convention Area.

7.118 As in the last four years, it was emphasised that the values in Tables 60 to 62 are very rough estimates (with potentially large errors). The present estimates should only be taken as indicative of the potential levels of seabird mortality occurring in the Convention Area due to unregulated fishing and should be treated with caution.

7.119 Nevertheless, even taking this into account, the Working Group endorsed its conclusions of recent years that such levels of mortality remain entirely unsustainable for the populations of albatrosses and giant and white-chinned petrels breeding in the Convention Area. Recent decreases in populations of these species in Subareas 58.6 and 58.7 (paragraphs 7.15 and 7.16), a region particularly affected by IUU fishing, are potential evidence of this.

7.120 The Working Group noted that substantial IUU catches of toothfish had been reported from Area 51 (adjacent to CCAMLR Subareas 58.6 and 58.7). If these catches represented mis-reporting of catches actually taken within the Convention Area, then the estimated by-catch of seabirds would be commensurately higher than estimated. On the other hand, if the provenance of the toothfish catches was accurately reported, then the associated seabird by-catch is likely to include substantial numbers of birds breeding in the Convention Area.

Summary Conclusion

7.121 Ad hoc WG-IMALF once again urgently drew the attention of WG-FSA, the Scientific Committee and the Commission to the numbers of albatrosses and petrels being killed by unregulated vessels fishing in the Convention Area. In the last five years an estimated total of 276 000 to 438 000 seabirds have been killed by these vessels. Of these:

(i) 40 500 to 89 500 were albatrosses, including individuals of four species listed as globally threatened (Vulnerable) using the IUCN threat classification criteria (BirdLife International, 2000);

(ii) 7 000–14 600 were giant petrels, including one globally threatened (Vulnerable) species; and

(iii) 109 000–235 000 were white-chinned petrels, a globally threatened (Vulnerable) species.

7.122 These levels of loss of birds from the populations of these species and species-groups are broadly consistent with such data as exist on the population trends of these taxa (paragraphs 7.15 and 7.16), including deterioration in conservation status as measured through the IUCN criteria.

7.123 These and several other albatross and petrel species are facing potential extinction (e.g. as measured by the IUCN criteria) as a result of longline fishing. The Working Group again urgently requested the Commission to take all action possible to prevent further seabird mortality by unregulated vessels in the forthcoming fishing season.

Incidental Mortality of Seabirds in relation to New and Exploratory Fisheries

Assessment of Risk in CCAMLR Subareas and Divisions

7.124 As in previous years, concerns were raised relating to the numerous proposals for new fisheries and the potential for these new and exploratory fisheries to lead to substantial increases in seabird incidental mortality.

7.125 In order to address these concerns the Working Group reviewed its assessments for relevant subareas and divisions of the Convention Area in relation to:

(i) timing of fishing seasons;
(ii) need to restrict fishing to night time; and
(iii) magnitude of general potential risk of by-catch of albatrosses and petrels.

7.126 The Working Group again noted that the need for such assessments would be largely unnecessary if all vessels were to adhere to all elements of Conservation Measure 29/XIX. It is considered that these measures, if fully employed, and if appropriate line weighting regimes could be devised for autoliners, should permit longline fishing activities to be carried out in any season and area with negligible seabird by-catch.

7.127 In 1999 the Working Group carried out comprehensive assessments on the potential risk of interaction between seabirds, especially albatrosses, and longline fisheries for all statistical areas in the Convention Area. These assessments were combined into a background document for use by the Scientific Committee and Commission (SC-CAMLR-XVIII/BG/29) and it was agreed that a similar document should be tabled annually for the Scientific Committee.

7.128 This year new data on at-sea distribution of albatrosses and petrels from satellite-tracking and other studies was provided in WG-FSA-01/10, 01/11, 01/12, 01/25, 01/26 and 01/67. This information was used to update the assessment of potential risk of interaction between seabirds and longline fisheries for Statistical Areas 48.6, 58.4.4, 58.5.1, 58.5.2, 58.6 and 58.7. The revised assessments are incorporated in full into SC-CAMLR-XX/BG/11; changes are noted below:

(i) Subarea 48.6:

Breeding species known to visit this area: <u>wandering albatross and grey-headed albatross from Marion Island</u>.

Breeding species inferred to visit this area: wandering albatross, <u>grey-headed albatross</u> and light-mantled albatross from Prince Edward Island; <u>light-mantled</u>

albatross from Marion Island; black-browed albatross, grey-headed albatross, sooty albatross, white-chinned petrel from elsewhere within the Convention Area.

(ii) Division 58.4.4:

Breeding species known to visit this area: wandering albatross, light-mantled albatross from the Crozet Islands, wandering albatross and grey-headed albatross from Marion Island.

(iii) Division 58.5.1:

Breeding species known to visit this area: wandering albatross from the Crozet Islands, wandering albatross from Marion Island, black-browed albatross from the Kerguelen Islands, Amsterdam albatross from Amsterdam Island.

Breeding species inferred to visit this area: all the remaining species breeding at the Kerguelen Islands; most, if not all, species breeding at Heard/McDonald Islands; many species breeding at the Crozet Islands, wandering albatross from Prince Edward Island.

(iv) Division 58.5.2:

Breeding species known to visit this area: wandering albatrosses from the Crozet Islands; wandering albatross from Marion Island; black-browed albatrosses from the Kerguelen Islands; Amsterdam albatross from Amsterdam Island.

Breeding species inferred to visit this area: all species breeding at Heard/McDonald Islands; wandering albatross, grey-headed albatross, yellow-nosed albatross, sooty albatross, light-mantled albatross, northern giant petrel, white-chinned petrel from the Kerguelen Islands; yellow-nosed albatross from Amsterdam Island; wandering albatross from Prince Edward Island.

(v) Subarea 58.6:

Breeding species known to visit this area: wandering albatross, sooty albatross, light-mantled albatross from the Crozet Islands; wandering albatross from Marion Island.

Breeding species inferred to visit this area: in addition to all the Crozet Islands breeding species, wandering albatross from Prince Edward Island and the Kerguelen Islands; black-browed, yellow-nosed, sooty, light-mantled albatrosses, northern giant petrel, southern giant petrel, white-chinned petrel, grey petrel from the Prince Edward Islands; grey-headed albatross, white-chinned petrel, grey petrel from the Kerguelen Islands.

(vi) Subarea 58.7:

Breeding species known to visit this area: wandering albatross from the Crozet Islands; wandering albatross from Marion Island.

The Working Group noted that there had been no changes to the advice to the Scientific Committee on the levels of risk of seabird by-catch for any part of the Convention Area.

New and Exploratory Longline Fisheries Operational in 2000/01

7.129 Of the 36 proposals last year for new and exploratory longline fisheries, only three were actually undertaken: by New Zealand, South Africa and Uruguay, all in Subarea 88.1.

7.130 No seabird by-catch was reported to have been observed in any of these fisheries. Clearly the strict adherence in Subarea 88.1 to Conservation Measure 29/XIX and to the specific requirements set out in Conservation Measure 210/XIX with respect to line weighting regimes, combined with fishing in an area of average-to-low, and average risk, proved successful in eliminating the incidental by-catch of seabirds in Subarea 88.1 to date.

New and Exploratory Fisheries Proposed for 2001/02

7.131 The areas for which proposals for new and exploratory longline fisheries were received by CCAMLR in 2001 were:

Subarea 48.6	(Japan, New Zealand, South Africa, Uruguay)
Division 58.4.1	(Japan)
Division 58.4.3	(France, Japan)
Division 58.4.4	(France, Japan, New Zealand, South Africa, Uruguay)
Subarea 58.6	(Chile, France, Japan, South Africa)
Subarea 88.1	(Japan, New Zealand, Russia, South Africa)
Subarea 88.2	(Japan, New Zealand, Russia, South Africa)

7.132 All the areas listed above were assessed in relation to the risk of seabird incidental mortality according to the approach and criteria set out in paragraph 7.125, SC-CAMLR-XX/BG/11 and paragraph 7.128. A summary of risk level, risk assessment, IMALF recommendations relating to fishing season and any inconsistencies between these and the proposals for new and exploratory longline fisheries in 2001/02, is set out in Table 63.

7.133 In summary, the main issues to be resolved in relation to seabird incidental mortality are:

(i) to check that France intends to comply with Conservation Measure 29/XIX, rather than Conservation Measure 29/XVI as indicated, for Subarea 58.6 and Divisions 58.4.3 and 58.4.4;

(ii) whether or not Japan intends to comply with Conservation Measure 29/XIX and to use an international scientific observer in Subareas 48.6, 58.6, 88.1 and 88.2, and Divisions 58.4.1, 58.4.3 and 58.4.4;

(iii) clarification of fishing season in respect of South Africa's applications for Subarea 58.6 and Division 58.4.4; and

(iv) applications for variations from Conservation Measure 29/XIX (e.g. similar to Conservation Measure 210/XIX) for Subareas 48.6, 88.1, 88.2 and Division 58.4.4.

7.134 Mr T. Inoue (Japan) stated that Japan would be tabling an addendum to its notification (CCAMLR-XX/10) for new and exploratory fisheries in 2001/02, indicating its intention to use international scientific observers and to comply with Conservation Measure 29/XIX.

7.135 In previous years vessels fishing in exploratory fisheries in Subarea 88.1 have received a variation from the requirement of Conservation Measure 29/XIX to set longlines at night. This variation was given providing that vessels complied fully with measures specified in Conservation Measure 210/XIX, designed to ensure that a line sink rate of at least 0.3 m/s was achieved during daytime fishing operations.

7.136 All vessels participating in the exploratory fisheries in Subarea 88.1 reported no seabird mortalities. The Working Group attributed this result largely to strict adherence to Conservation Measure 210/XIX, although low levels of seabird abundance and associated risk of incidental mortality are likely to have contributed, especially at higher latitudes. The Working Group recommended that Conservation Measure 210/XIX should be continued in 2001/02.

7.137 The Working Group believed that the provisions of Conservation Measure 210/XIX could be extended to other vessels undertaking new or exploratory fishing in areas of similar classification of risk of seabird mortality (risk levels 1, 2 or 3). The Working Group recommended that conservation measures analogous to Conservation Measure 210/XIX (including Annex A) should be applied to exploratory fisheries proposed for Subareas 48.6 (risk level 2), 88.2 (risk level 1), and Division 58.4.4 (risk level 3) in 2001/02. It was noted that South Africa had indicated, in their proposals for exploratory fishing in each of these subareas and divisions in 2001/02, their preparedness to conduct line weighting experiments as approved by the Scientific Committee.

7.138 The Working Group emphasised, however, that it would be premature to extend similar provisions to exploratory fisheries in areas of higher risk of seabird by-catch.

7.139 The Working Group recommended that in any conservation measures, analogous to Conservation Measure 210/XIX, developed for new and exploratory fisheries, a strict precautionary limit on seabird by-catch should be set, which, if attained would result in the vessel reverting to night setting. It felt that a limit of three birds per vessel would still be appropriate.

7.140 The Working Group noted that WG-FSA-01/46 provided details of an alternative, simpler method to the use of TDRs for testing line sink rates. The working group recommended that Annex A of Conservation Measure 210/XIX be revised to incorporate use of this method. Draft text of an appropriate revision of Annex A of Conservation Measure 210/XIX is provided in Appendix G.

7.141 The Working Group noted that the revised paragraphs 2 to 4 and 5 to 10 of Appendix G could apply equally to the use of TDRs. A summary of the TDR information required for equivalent paragraphs 6 to 8 is contained in WG-FSA-01/44.

Incidental Mortality of Seabirds during Longline Fishing
outside the Convention Area

7.142 The Working Group considered papers reporting on seabird mortality from fisheries conducted outside the CCAMLR Convention Area but which affected birds that breed within it.

7.143 WG-FSA-01/28 reported on seabird by-catch by tuna longline fisheries within the EEZ of South Africa from 1998 to 2000. Information was collected by observers on domestic and foreign-licensed vessels from Japan and Taiwan. A total of 11.85 million hooks was set, of which South African vessels set only 0.46 million.

7.144 The number of observed hooks was 143 000 (1.2% of the total). By-catch was high at 0.77 birds/thousand hooks in the domestic fishery and very high at 2.64 birds/thousand hooks by Japanese vessels. No information was available for Taiwanese vessels.

7.145 Most of the 229 birds recorded by observers as killed were albatrosses and white-chinned petrels, including a number of species that breed within the CCAMLR Convention Area, notably black-browed albatrosses and white-chinned petrels. Based on the 1998/99 fishing effort, it was estimated that 19 000–30 000 seabirds, of which 70% are albatrosses, are killed annually in South Africa's EEZ.

7.146 The Working Group noted that compliance with required mitigation measures was reported as being incomplete, including the failure to use streamer lines.

7.147 The continued collection of data by observers in the South African fishery was encouraged. Further information from foreign-licensed vessels, including those of Taiwan, would be most valuable in assessing the mortality in South African waters of seabirds originating from the CCAMLR Convention Area.

7.148 Pelagic and demersal longline fisheries, chiefly targeting tuna and ling in New Zealand waters during 1999/2000, continued to cause mortality of seabirds, including some breeding within the CCAMLR Convention Area (WG-FSA-01/59).

7.149 A description of plans to quantify and mitigate seabird by-catch around the Falkland/Malvinas Islands was presented in WG-FSA-01/79. Initial observations reported a low by-catch of three black-browed albatrosses in five months of fishing during winter by two vessels. Seabirds from the Convention Area, including wandering albatrosses and white-chinned petrels, are known to visit this area (WG-FSA-01/25).

7.150 During 1999 all pelagic longline fishing in the Australian Fishing Zone (AFZ) was performed by domestic vessels (WG-FSA-01/82). The effort by these vessels continues to increase, with almost 14 million hooks set in 1999, an increase of 48% compared with the 1998 effort. This fishery is carried out in the absence of an observer scheme, and levels of by-catch are unknown. Seabirds from the Convention Area are known to have been killed in the AFZ in the past.

7.151 During 1999 most observations in the AFZ were focused on investigations of efficacy of mitigation measures (WG-FSA-01/80 and 01/81). Therefore by-catch rates were not sampled randomly, nor extrapolated across fishing zones.

7.152 Spatio–temporal trends in longline fisheries in the Southern Ocean adjacent to the CCAMLR Convention Area since the late 1960s show a marked increase in effort, especially by Taiwanese pelagic vessels, although Japanese effort decreased in the 1990s (WG-FSA-01/49). The data presented in this review paper are potentially highly relevant for analyses of by-catch of seabirds breeding within the CCAMLR Convention Area in relation to their foraging ranges and to fishing effort.

7.153 Dr E. Fanta (Brazil) reported that Brazilian scientists were investigating seabird by-catch which included birds from within the CCAMLR Convention Area, from longline fisheries within its waters. It was understood that information on by-catch was also being collated for Argentinean waters. These and other CCAMLR Members were encouraged to report the results of such initiatives to future meetings of the Working Group.

7.154 The Working Group recollected the inquiry initiated last year into by-catch mitigation measures on Japanese vessels in respect of by-catch of Convention Area birds in Tristan da Cunha waters (SC-CAMLR-XIX, Annex 5, paragraphs 7.104 to 7.106; SC-CAMLR-XIX, paragraph 4.35).

7.155 The Secretariat had, as requested, contacted Japan to seek to clarify the current obligations of Japanese longline fishing vessels relating to the use of mitigating measures in respect of seabird by-catch.

7.156 The response to the Secretariat to date was that Japan did not regard this as a CCAMLR matter; however, it would respond to the Scientific Committee and may indicate that it follows measures under ICCAT and CCSBT.

7.157 The Working Group noted that the mortality of birds from the Convention Area in fisheries outside the area was highly relevant to CCAMLR. It was disappointed not to have appropriate information from Japan, particularly as this was also relevant to the seabird mortality in South African waters reported in WG-FSA-01/28. It hoped that the Japanese report to the Scientific Committee would indicate the precise nature of the mitigation measures in use in each of the relevant longline fisheries and the extent to which the use of these measures is voluntary or mandatory.

7.158 The Working Group recollected its comments last year (SC-CAMLR-XIX, Annex 5, paragraph 7.11) and noted increasing evidence this year of the importance of seabird by-catch in areas adjacent to the Convention Area. It considered that it was now very timely to request all Members and other countries conducting or permitting longline fishing in areas outside the CCAMLR Convention Area where seabirds from the Convention Area are killed, to provide summary data on:

(i) longline fishing effort (at least at the scale of FAO area) in each type of longline fishery;

(ii) rates of incidental mortality of seabirds associated with each longline fishery and details of the species involved;

(iii) mitigating measures in use in each fishery and the extent to which any of these are voluntary or mandatory; and

(iv) nature of observer programs, including observer coverage, associated with each fishery.

7.159 The Working Group agreed also to summarise data on the above topics which had previously been submitted to CCAMLR and to review this at its next meeting.

Research into and Experiences with Mitigation Measures

Night Setting

7.160 WG-FSA-01/08 reported that around the Prince Edward Islands (Subarea 58.7) seabird mortality rates were significantly higher for lines set during the day (0.106 birds/thousand hooks) than those set at night (0.073 birds/thousand hooks). This was due to the large difference in mortality rates of albatrosses and giant petrels during the day (0.031 birds/thousand hooks) compared to the night (0.004 birds/thousand hooks). There was no significant difference in the mortality rates of white-chinned petrels during the night and day. This demonstrates that night setting continues to be one of the most effective and simple methods of reducing albatross mortalities. Although night setting is one of the most efficient means to reduce incidental seabird mortalities, it is insufficient in isolation to reduce white-chinned petrel mortalities.

Offal

7.161 WG-FSA-01/60 reported on the use of scupper screens to prevent discharge of offal and bait from a vessel while processing catch. This measure acts to reduce the attractiveness of vessels to seabirds. The Working Group recommended that vessels ensure scupper screens are clean and functional, made of a material suitable for the saltwater environment, and kept clear to avoid vessel stability hazards. Dual scupper screens on board are recommended to allow scuppers to remain covered whilst dirty screens are cleaned. Spare covers should be on board in the event that one is lost. The Working Group also recommended that vessels install a tray below the baiting head to collect unused baits and install screens over scuppers to collect baits that are on the floor.

7.162 SC-CAMLR-XX/BG/7 reported the incidence of hooks and associated lines found in regurgitates, diet samples and around nests of several albatross and other species at Bird Island, South Georgia, and that the numbers of hooks found had steadily increased over several years to an all-time high in 2000/01. Hooks were chiefly those used in the toothfish fishery. Mr Cooper indicated that hooks are increasingly common in similar situations at the Prince Edward Islands (WG-FSA-01/10 and paragraph 7.22). It was likely that the main source of hooks was from heads discarded by longliners, including vessels operating in the regulated fisheries in Subareas 48.3 and 58.6/58.7 (WG-FSA-01/22, Table 2). Such potential hazards to albatrosses could be easily avoided by the removal of hooks from the fish heads prior to their discard. The Working Group proposed that such a recommendation be added to existing conservation measures.

Streamer Lines

7.163 WG-FSA-01/44 and 01/60 both provided detailed diagrams of the boom and bridle system used by the New Zealand vessel *San Aotea II*. This system allows the skipper and crew to move the position of the streamer line either to the starboard or port so that it is always directly over the longline, irrespective of the wind direction. A short video demonstrating the system had been prepared by the skipper of the vessel. The Working Group recommended that a final edited version of the video be made available to the Secretariat for distribution to technical coordinators to provide to longline fishers in the Convention Area. WG-FSA-01/60 reported that two new innovations are being investigated: a line shaker (termed a 'gigolo') and two long poles with streamers that extend directly aft from both stern quarters. The Working Group requested reports on the new innovations prior to its next meeting.

7.164 Last year the Working Group noted (SC-CAMLR-XIX, paragraphs 7.123 and 7.139) that the use of paired streamer lines should provide additional longline protection when setting gear in crosswinds and urged Members to investigate this, particularly for vessels which fish in summer in Subareas 58.6 and 58.7. WG-FSA-01/35 reported on a study in the Alaskan demersal longline fishery to evaluate the effectiveness of various deterrent devices tested, including paired streamer lines. Experiments conducted over two years in the Pacific cod autoliner fleet (over 6 million hooks, almost 500 sets) indicated that paired streamer lines reduced seabird by-catch rates by 88% to 100% relative to controls with no deterrents. Single streamer lines were slightly less effective at reducing seabird by-catch (71%). Seabird abundance and attack rates during single streamer sets were not significantly different from controls of no deterrent. This research suggests that paired streamer lines may be more effective than single streamer lines at reducing seabird mortalities in the Convention Area. WG-FSA-01/29 suggested the testing of paired streamer lines in Spanish longline systems used in the Convention Area. The Working Group encouraged this and recommended that Members support testing of paired streamer lines in the Convention Area.

Bait

7.165 The use of artificial bait in longline fisheries may help reduce the incidental mortality of seabirds. From a mitigation perspective at least two potential advantages exist with artificial bait: the colour of the bait can be altered to make it less attractive or visible to seabirds, and the bait could be manufactured so that it is negatively buoyant.

7.166 Mr Smith reported that some trials with artificial bait had been undertaken in New Zealand domestic autoline fisheries. Initial results indicated lower fish catch rates when using artificial bait. Colouring artificial bait blue was also attempted by using a dye post-thawing. Unfortunately, the artificial bait was not robust enough to survive the soak in the dye solution required to colour the bait blue. New Zealand fishers are in contact with the manufacturers of the bait and are attempting to resolve fish catch rate issues initially, prior to progressing alterations to bait colour and buoyancy.

7.167 The Working Group noted the trials conducted to date in New Zealand and encouraged any further research be reported to it next year.

7.168 Dr Fanta reported to the Working Group that tests are currently being conducted on dyed bait (see paragraph 7.185) to determine if the colour reduces the visibility of the bait to birds during pelagic longline fishing, thereby reducing the likelihood of birds becoming hooked. The Working Group requested that Brazil report the results of this study to it next year.

7.169 WG-FSA-01/08 reported that a high proportion (76%) of white-chinned petrels caught on vessels fishing around the Prince Edward Islands were foul hooked in their wings and bodies. WG-FSA-01/44 reported similar observations with grey petrels and suggested that intense feeding activity on loose baits made these birds vulnerable to getting caught on nearby hooks. This behaviour is characterised by feeding on a trail of unused loose baits that forms behind the vessel during setting. On occasion this trail may drift over the setting longline. The trail is formed from baits flicked off hooks after passing through the autobaiter. This represents an additional means by which birds are attracted to the vessel and hooked. The Working Group recommended that, in circumstances where a dedicated seabird observer is present, appropriate data are collected on the baits that are flicked off to understand better the nature of the problem and to help devise potential solutions.

Underwater Setting

7.170 Further information on the effectiveness of the Mustad underwater setting funnel (lining tube) is contained in WG-FSA-01/35. This study, which was undertaken on autoline vessels in Alaskan waters, found that the funnel reduced seabird captures by 69% compared to the control of no mitigation measures. The authors report that results of a similar study in the Norwegian demersal longline fishery were highly variable and that this may have been due to the funnel delivering the line at shallow depths when the vessel hull lifted out of the water in rough conditions. The dominant seabird species caught in both of these studies is the northern fulmar, which is primarily a surface feeder. Because many of the seabird species vulnerable to incidental capture in the CCAMLR Convention Area are proficient divers, the results of these studies may not apply. However, it appears that the *Eldfisk* has continued to use the Mustad funnel with success in Subareas 58.6 and 58.7 in 2000/01 during day sets. When the funnel was used in conjunction with a streamer line during day sets, the seabird catch rate was 0.008 birds/thousand hooks. This compared to 0.005 birds/thousand hooks for night sets with streamer lines.

7.171 Results of preliminary trials of an underwater setting device in the Australian domestic pelagic tuna fishery were reported last year in WG-FSA-00/64. WG-FSA-01/80 reported on final results for the testing at sea of two underwater setting devices – a chute and a capsule. Both devices adequately demonstrated their capacity to minimise seabird interactions during line setting in pelagic longline fishing. Both showed dramatically lower rates of baits taken (0.3 baits/thousand hooks for the chute, 1.5 baits/thousand hooks for the capsule) in comparison to baited hooks set in the standard manual way (8.0 baits/thousand hooks). Most or all baits that were taken were the direct result of tangles on board the vessel. Once operational problems encountered during the first cruise were corrected, no birds were taken in the second cruise. The chute is currently being trialled at sea on 10 vessels. The Working Group requested that results of these sea trials be reported to it next year and encouraged the further development of the underwater setting capsule.

Line Shooter

7.172 Norwegian trials (WG-FSA-01/78) examined the effect of a line shooter on line sink rate. The line shooter is a pair of hydraulically operated wheels that pull the line through the auto-baiter and deliver the line into the water in a slack state rather than under tension. This means the line enters the water directly behind the vessel and begins sinking immediately, thus reducing the time during which the hooks are available to seabirds. This study found that the time for the line to reach 3 m was 4 seconds (15%) faster with the shooter than without. In Alaskan trials (WG-FSA-01/35), the line shooter significantly increased the rate of seabird by-catch (54%, fulmars and shearwaters) compared to a control of no deterrent. The authors cited a Norwegian study whereby seabird by-catch rates were reduced with the line shooter (59%), but not as much when compared to streamer lines (98–100%) or an underwater setting funnel (72–92%). Birds were able to take baits when the line shooter was in use. The Working Group noted that the line shooter's ability to set slack line is impeded when the hull of the vessel lifts on a wave, and that this could be overcome if the shooter speed was controlled by a governor. The Working Group encouraged the manufacturer to address this problem, after which further testing of the line shooter was recommended.

Line Weighting

7.173 Significant progress had been made during 2000/01 in the implementation of a practical line weighting regime for vessels using the Spanish longline system. The new line weighting regime prescribed in Conservation Measure 29/XIX (8.5 kg weights spaced at no more than 40 m) was used during five cruises. On eight other cruises, the weighting regimes were close to that prescribed but not fully in compliance. One vessel using the Spanish longline system complied with the requirement to attain a sink rate of 0.3 m/s while daylight setting in Subarea 88.1, using weights equivalent to about 12 kg every 40 m.

7.174 Of vessels which complied with the line weighting provisions of Conservation Measure 29/XIX, on only one cruise (by the *Koryo Maru 11* in summer around the Prince Edward Islands) of seven was any seabird mortality reported (8 birds at 0.014 birds/thousand hooks), compared with on six of 15 cruises of vessels not complying with the measure (involving 37 birds at rates of 0.003 to 0.212 birds/thousand hooks).

7.175 A new simple means of measuring line sink rate has been devised (WG-FSA-01/46). The Working Group recommended that measurements of line sink rate be made by observers using this simple technique ('bottle test' described in WG-FSA-01/46; see Appendix G). This will provide data that can be used to develop a predictive sink rate model for the Spanish longline system similar to that developed for autoline fishing gear (WG-FSA-01/56).

7.176 WG-FSA-01/44 reported on an experiment undertaken in New Zealand waters on autoline vessels to determine the sink rate of unweighted lines, and of lines with 5 kg weights spaced 400 m apart. The results show that the sink rate of the line is not significantly increased with this weighting regime, and for both treatments, the line is only between 2 and 5 m deep at the end of aerial section of the streamer line. This means that baited hooks are still available to a number of albatross and petrel species despite the use of a streamer line.

Line weighting experiments in Subarea 88.1 have subsequently found that weights of around 5 kg need to be 30 to 40 m apart to achieve the sink rate requirement of 0.3 m/s (WG-FSA-01/56).

7.177 WG-FSA-01/35 reported on experiments to assess the effectiveness of a number of mitigation measures in the Alaskan demersal longline fisheries, including line weighting on autoline vessels. Line sink rates were measured with unweighted lines, and compared with lines with 4.5 kg weights spaced 90 m apart. This weighting regime did not significantly increase line sink rate and vessel speed had a much greater influence on the distance at which longlines were vulnerable to bird attacks. This result is in accord with all line sink rate research reported to CCAMLR to date (Robertson, 2000, Figure 3). The authors concluded that for weighting to be practical and effective at reducing seabird by-catch, the weight must be integrated into the line.

7.178 Integrated line weighting should allow target sink rates to be achieved for autoline vessels without the manual addition of weights. Integrated line weighting would therefore alleviate the labour and safety issues raised by fishers with respect to manual line weighting (WG-FSA-01/60).

7.179 One of the autoline equipment manufacturers, Fiskevegn (Norway), has agreed to make samples of longline with the weight integrated into the backbone. Five different weights of longline will be manufactured for testing in New Zealand domestic fisheries. The first aim of this project is to test the prototype line for operational effectiveness and fishing efficiency.

7.180 If the operational effectiveness and fishing efficiency of heavy longline are proven, seabird specialists will then be used to design and conduct an experiment to determine the effectiveness of this gear in the reduction of incidental seabird mortality. The Working Group supported this initiative and requested to be kept informed of progress.

7.181 WG-FSA-01/81 reported on tests to investigate the effects of line weighting on sink rates of pelagic longline gear in the Australian tuna and billfish fisheries. The report concludes that the addition of an 80 g weight within 3 m of the hook, or 40 g at the hook, will achieve a sink rate of 0.26 to 0.30 m/s. Mr Baker indicated that at-sea trials will soon be commencing in the tuna fleet. The Working Group requested that the at-sea trial results be reported to it next year.

7.182 WG-FSA-01/56 reported on continued progress of analysis of longline sink rates of autoline vessels fishing in Subarea 88.1. This initiative was strongly supported by the Working Group (SC-CAMLR-XIX, paragraph 7.148) and preliminary results were reported in 1999/2000 (SC-CAMLR-XIX, paragraph 7.128). A model was developed which identified a range of values required to achieve the minimum required sink rate with 90–95% confidence; use of this model at sea may eliminate the need for routine deployment of TDRs in this or other fisheries. The 2001 preliminary predictive model comprised two variables that explained 60% of the overall variability in sink rate to 15 m, due to added weight (45%) and setting speed (15%). This is less than the variability accounted for by these two variables and swell height in last year's model run (72%). The change is probably attributable to recent changes in fishing gear (increased diameter of backbone) and calm weather conditions during much of the 2000/01 season. This preliminary model will be investigated further intersessionally. WG-FSA-01/56, Figure 7, illustrates the added weights which should be used at various vessel setting speeds. Weights should be spaced approximately 30 to 40 m apart. To monitor the accuracy of this predictive model, bottle tests (see paragraph 7.183) should be conducted to provide real-time feedback on the actual line sink rate achieved.

7.183 WG-FSA-01/46 reported on the 'bottle test', a simple alternative method to measure line sink rate. TDRs have been used in Subarea 88.1 for three years to measure the line sink rate as required in Conservation Measure 210/XIX. Observers reported that calculating line sink rates with TDRs can be time consuming, technical problems are frequent, and the interpretation of results can be difficult. Additionally, fishers have raised concerns about the costs involved with the high loss rate of TDRs. In contrast to TDRs, the bottle test is inexpensive, simple to use, and provides real-time data.

7.184 The Working Group discussed the potential for seabird mortalities associated with an autoline gear malfunction commonly referred to as 'hookups'. Hookups occur when hooks on the autoline magazine racks get out of order and cause the autobaiting and hook deployment system to malfunction. When this occurs, the deploying line is lifted out of the water, greatly reducing its sink rate and increasing the exposure of baited hooks to seabirds. The Working Group encouraged gear manufacturers to address this gear malfunction and to develop an engineering solution.

7.185 Dr Fanta reported that a collaborative project in Brazil involving government and university scientists and fishers is under way to test multiple deterrent measures. Five measures have been suggested for testing: streamer lines, bait colour, underwater setting, artificial bait and night setting. Tests are currently being conducted on dyed bait (see paragraph 7.168) to determine if the colour reduces the visibility of the bait to the birds, thereby reducing the likelihood of a bird becoming hooked. The Working Group requested a report on this research, when available.

Research Needs relating to the Spanish Method of Longline Fishing

7.186 Although Conservation Measure 29/XIX details a number of measures required of vessels using the Spanish method, insufficient information exists on the effectiveness of these measures, singly or in combination. The Spanish system is the most common gear deployment system in the Convention Area as well as commonly used in adjacent non-Convention waters frequented by Southern Ocean albatrosses and petrels.

7.187 The Scientific Committee noted last year (SC-CAMLR-XIX, paragraph 4.41(iv)) that:

(i) its goal of fisheries management as it relates to seabird by-catch in the Convention Area will be to allow fishing at any time of day without seasonal closure of fishing grounds;

(ii) current indications are that allowing fishing in summer, at night, using streamer lines, proper offal discharge practices and c. 40 m between weights on longlines (existing practice for Spanish system vessels), will still result in unacceptably high mortality of seabirds; and

(iii) further experimentation into the effectiveness of line weighting concepts and underwater setting devices with the Spanish system is important.

The Working Group noted that such experimentation is also critical if the by-catch of foraging seabirds in adjacent non-Convention Areas is to be addressed effectively.

7.188 WG-FSA-01/29 proposed and outlined such experiments. It suggested that the effects of measures for reducing seabird mortalities, used singly or in combination, should be determined in a rigorous controlled experiment conducted on a chartered commercial vessel across a range of sea and wind conditions. Mitigation measures to be tested, each at multiple levels, include: time of day, streamer lines, line weights, and bait and snood colour. The Working Group strongly supported this experimentation and recommended that Members facilitate the planning and undertaking of this study.

Industry Involvement in Research Initiatives

7.189 The Working Group noted and commended several collaborative research efforts, particularly projects in Australia, Brazil, New Zealand and the USA, involving direct input and participation by fishers (paragraphs 7.163, 7.164, 7.166 and 7.171).

International and National Initiatives relating to Incidental Mortality of Seabirds in relation to Longline Fishing

IV Marine Science Congress

7.190 The IV Marine Science Congress, held in Argentina in September 2000, included presentations on seabird and marine mammal by-catch in fisheries, and the use of the Patagonian Shelf by South Atlantic seabirds. Selected abstracts are included in WG-FSA-01/27.

International Fishers' Forum

7.191 The International Fishers' Forum on Solving the Incidental Capture of Seabirds in Longline Fisheries was held in Auckland, New Zealand, in November 2000. The report on the forum is available in English at www.fishersforum.org, and in Spanish from jmolloy@doc.govt.nz. The forum was attended by fishers, scientists, technologists and government representatives from 12 countries, including 10 CCAMLR Members (SC-CAMLR-XX/BG/19).

7.192 The forum discussed mitigation measures to reduce seabird by-catch, agreeing that the use of multiple measures was the most effective approach to adopt. The need for effective education campaigns and observer programs was also highlighted. Participants agreed to share the results of research programs. Members of WG-IMALF who attended the forum indicated that it had facilitated highly constructive dialogue with fishers and fishery managers, including representatives from countries which infrequently attend such meetings (e.g. China, Taiwan).

7.193 Specific commitments made by participants are listed in the forum's report. Participants agreed to undertake such activities over a two-year period and to communicate via a listserver and by reporting to a second forum, planned to be held in Hawaii, USA, in late 2002.

7.194 Members were encouraged to disseminate information on the forum by way of articles in fishery magazines and journals.

Agreement on the Conservation of Albatrosses and Petrels

7.195 The final negotiation meeting for the Agreement on the Conservation of Albatrosses and Petrels (ACAP) was held in Cape Town, South Africa, in January/February 2001 (SC-CAMLR-XX/BG/17 and BG/20). Twelve range states and five international organisations, including CCAMLR, attended the meeting that successfully adopted by consensus the text of an Agreement and associated action plan (see www.ea.gov.au/biodiversity/international/index.html and wcmc.org.uk/cms/nw012906.htm). The Agreement, originally intended to be restricted to the Southern Hemisphere, allows for the later expansion to include albatrosses and petrels of the Northern Hemisphere, although it is intended that the focus will remain in the Southern Hemisphere in the short- to medium-term. Currently, the Agreement covers all the Southern Hemisphere albatrosses and all members of the genera *Macronectes* (giant petrels) and *Procellaria*.

7.196 In its role as Interim Secretariat, Australia arranged for the Agreement to be open for signature at a ceremony in Canberra, Australia, on 19 June 2001. Seven countries then signed (Australia, Brazil, Chile, France, New Zealand, Peru and the UK). Australia became the first range state to ratify the Agreement on 27 September 2001. The Agreement will enter into force upon ratification by five countries.

7.197 The Agreement's Action Plan (ACAP) describes conservation measures to be implemented by the parties. These include research and monitoring, reduction of seabird by-catch by fisheries, eradication of non-native species at breeding sites (especially cats and rats), reduction of disturbance and habitat loss and reducing pollution.

7.198 The Working Group recognised that the development of the ACAP was a most significant step to the further protection of albatrosses and petrels breeding within the CCAMLR Convention Area. CCAMLR Members who are range states (including distant-water fishing nations that interact with Southern Hemisphere albatrosses and petrels on the high seas) were encouraged to sign and ratify the Agreement and adopt its action plan provisions as soon as is feasible.

BirdLife International Seabird Conservation Programme

7.199 The intention of BirdLife South Africa to submit a medium-sized grant proposal to the Global Environment Facility to conduct activities to reduce the levels of mortality due to longlining throughout the range of those species of globally threatened seabirds that occur in southern African waters was noted (WG-FSA-01/13). This initiative follows an international workshop held in Cape Town, South Africa, in April 2001. The workshop was attended by invitees from nine countries, all Members of CCAMLR.

7.200 A South American regional workshop held by BirdLife International in Montevideo, Uruguay, in September 2001 further developed the GEF proposal (WG-FSA-01/13). The Working Group asked that the Secretariat request a report of this meeting to consider at its 2002 meeting.

7.201 The Working Group noted that this proposal could lead to the adoption of measures that would improve the conservation status of seabirds that are affected by longlining and that breed within the CCAMLR Convention Area.

7.202 The Working Group requested information from BirdLife International on relevant activities of its seabird conservation program and its 'Save the Albatross Campaign' to consider at its next meeting.

FAO International Plan of Action for Reducing Incidental
Catch of Seabirds in Longline Fisheries

7.203 The Working Group recollected the Commission's request (CCAMLR-XVII, paragraph 6.27; CCAMLR-XVIII, paragraph 6.15) that Members implement by 2001 their NPOAs in support of the FAO IPOA–Seabirds. Last year the information available (SC-CAMLR-XIX, paragraphs 4.43 and 4.44) was that:

(i) New Zealand and the USA already had draft plans available for consultation and that Australia's Threat Abatement Plan contained the essence of its NPOA (which would be prepared in due course);

(ii) Brazil and Chile were commencing to prepare plans; and

(iii) Japan was working to finalise its NPOA through dialogue with fishers and industries and intended to submit it to the FAO COFI meeting in 2001.

The Working Group encouraged other Members, particularly the European Community, which it was understood had only just embarked on the assessment process, to develop and implement their plans as soon as possible.

7.204 Progress on developing National Plans of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries (NPOA–Seabirds) was reported by Member States at the 24th Session of FAO COFI (WG-FSA-01/62).

7.205 At the COFI session, progress to produce NPOA–Seabirds was reported by several CCAMLR Members. These included Australia, Brazil, the European Community, Japan, New Zealand, Norway, South Africa, USA and Uruguay. Argentina stated that it did not consider it needed to produce a NPOA–Seabirds. Namibia stated that it would require funding to produce its NPOA–Seabirds. No report was given by Chile.

7.206 The Working Group considered it essential that Argentina and Chile develop NPOA–Seabirds, based on high levels of seabird incidental mortality known to occur in their waters. It requested CCAMLR Members to submit reports of their progress towards developing and implementing NPOA–Seabirds to the Working Group at its next meeting.

7.207 The final USA plan was adopted in February 2001 (www.fakr.noaa.gov/protectedresources/seabirds/npoa/npoa.pdf) and was provided to the Working Group by the Secretariat as a reference document. Although not intended to cover seabird by-catch in the Southern Hemisphere, the USA's NPOA–Seabirds can serve as a valuable source of information on mitigation measures, especially for reducing by-catch of albatrosses and petrels, for CCAMLR fishing Members.

7.208 Intersessionally, Working Group members had had the opportunity to consider the draft New Zealand NPOA–Seabirds, which is also intended to cover trawling operations. It was noted that the document was a thorough, appropriate and detailed one, and that it is now under revision. Members intending to produce their own NPOA–Seabirds were encouraged to consult the draft document.

7.209 The Working Group reviewed a document entitled 'Japan's National Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries', supplied as a reference document by the Secretariat via its FAO Observer. This document had been made available to attendees at the 24th COFI Session, but its current status was uncertain.

7.210 The Working Group noted that the document did not refer specifically to fishing within the Convention Area, clearly a significant omission, considering Japan's activities within CCAMLR. However, it did address longlining for southern bluefin tuna within the Southern Hemisphere, a fishery known to kill many seabirds originating from the Convention Area. No information was given on longlining for other species of tuna in the Southern Hemisphere fisheries, several of which also kill seabirds from the Convention Area (see WG-FSA-01/28).

7.211 The Japanese NPOA–Seabirds contained no assessment of the scale of the past and current by-catch by Japanese longliners. It also contained some errors of fact, for example on sizes of albatross populations.

7.212 It was unclear whether the application of any of the mitigation measures described was other than purely voluntary. Further, the Working Group considered that the mitigation measures described were generally inadequate to reduce seabird by-catch to acceptably low levels, especially in areas frequented by seabirds from the Convention Area.

7.213 The Working Group noted that several research activities relevant to mitigation of seabird by-catch, especially underwater setting, were mentioned in the Japanese NPOA–Seabirds; it requested that Japan supply the Working Group with details for its next meeting. It also requested further information on the status of mitigation measures in all Japanese fisheries relevant to Convention Area seabirds, together with clarification as to whether these measures were mandatory or voluntary.

Tuna Commissions

7.214 The report of the CCAMLR Observer to two CCSBT meetings held in 2000 and 2001 did not mention any activities relevant to seabird by-catch (CCAMLR-XX/BG/6). However, it did note that the CCSBT Ecologically-Related Species Working Group planned to reconvene in late 2001, after a long break, when it was expected that seabird by-catch would be discussed. The Working Group looked forward to receiving a detailed report in due course on mitigating measures in use and relevant observer programs in fisheries under the jurisdiction of CCSBT.

7.215 The Working Group was informed by a BirdLife International observer to a recent meeting of ICCAT's Scientific Committee that discussions of by-catch had been confined to shark and non-target fish species. The Working Group recommended that the Secretariat should be asked to write to ICCAT to place the issue of seabird by-catch and mitigating measures in use in fisheries under its jurisdiction on the agenda of the next meeting of its Scientific Committee. The Working Group would correspond intersessionally to provide an appropriate background paper for that meeting.

7.216 The Working Group considered it appropriate to receive information from the IOTC as seabird by-catch is known to occur in fisheries under its jurisdiction. The Working Group recommended that CCAMLR nominate an observer to meetings of the IOTC.

7.217 The Working Group requested the Scientific Committee to review interactions with fishery organisations, particularly newly established bodies, with responsibility for the conduct of fisheries in areas adjacent to the Convention Area, with a view to enhancing communication and collaboration with CCAMLR, particularly on seabird by-catch issues.

Advice to the Scientific Committee

General

7.218 (i) The plan of intersessional work (Appendix F) summarises requests to Members and others for information of relevance to the work of the Working Group (paragraphs 7.1 to 7.5).

(ii) Members are particularly invited to review the membership of the Working Group, to suggest additional members and to facilitate attendance of their representatives at meetings (paragraph 7.7).

Research into the Status of Seabirds at Risk

7.219 The review of the submitted data on:

(i) size and trends of populations of albatross species and of *Macronectes* and *Procellaria* petrels vulnerable to interactions with longline fisheries;

(ii) the foraging ranges of populations of these species adequate to assess overlap with areas used by longline fisheries; and

(iii) genetic research relevant to determining the origin of birds killed in longline fisheries;

concluded that a comprehensive review of any of these topics cannot be completed until more Members have submitted details of their data. Relevant data are urgently requested for next year's meeting (paragraphs 7.3, 7.14, 7.21 and 7.23).

7.220 Important results from submitted information on the above topics are:

(i) a 25% decline in the population of black-browed albatrosses at the Falkland/Malvinas Islands, 18% in the last five years, is likely to result in the global conservation status of this species being changed from Near-Threatened to Vulnerable (paragraph 7.13);

(ii) substantial recent (1990s) declines (of 8–15%) are reported in populations of wandering and grey-headed albatrosses, northern and southern giant petrels and white-chinned petrels at Marion Island. The main causes are believed to be increased mortality in the recently increasing tuna longline fisheries in areas adjacent to the Convention Area and the recent large-scale IUU fisheries for toothfish close to the breeding site (paragraphs 7.15 and 7.16);

(iii) substantial (28%) declines of white-chinned petrel populations at South Georgia since the mid-1980s, attributed to similar causes to the above (paragraph 7.17);

(iv) the suggestion that mortality of adult female wandering albatrosses from Marion Island in temperate Southern Hemisphere tuna longline fisheries is the single most important factor compromising the conservation status of this population (paragraph 7.22);

(v) potential problems in ascribing origins of grey-headed albatrosses to any particular island population and of black-browed albatrosses beyond distinguishing specimens from the Falkland/Malvinas Islands and Campbell Island from other breeding sites (paragraph 7.23); and

(vi) declines in wandering albatross populations at Crozet and South Georgia and the recovery since 1986 of the Crozet population, both correlate with data on tuna longline fishing effort in adjacent regions of the Convention Area. The continuing decline of the South Georgia population is attributed to some combination of longline fishing for tuna in the poorly documented South Atlantic and for toothfish both inside and outside the Convention Area. Attempts to correlate seabird population changes with fishing effort are likely to be limited by the quality of the latter data (paragraphs 7.27 to 7.31).

Incidental Mortality of Seabirds during Regulated
Longline Fishing in the Convention Area in 2001

7.221 (i) Prompt submission by observers of good quality data ensured comprehensive analysis of this year's data (Tables 51 to 55).

(ii) For Subarea 48.3 the total estimated seabird by-catch was only 30 birds at a rate of 0.0014 birds/thousand hooks (paragraphs 7.38 and 7.39), very similar to last year's values; fishing season restrictions and continued improved compliance with Conservation Measure 29/XIX have kept by-catch in the regulated fishery in this subarea to negligible levels for the second successive year (paragraph 7.55).

(iii) For fishing within the South African EEZ in Subareas 58.6 and 58.7, the total estimated seabird by-catch was 199 birds (a 61% reduction over last year) at a rate of 0.018 birds/thousand hooks (compared with 0.022 birds/thousand hooks last year) (paragraphs 7.40 and 7.41). Reduced by-catch this year was mainly due to changes in fishing area (paragraph 7.45), but improved compliance with Conservation Measure 29/XIX also contributed (paragraph 7.56).

(iv) Based on analysis of timing of seabird incidental mortality in Subareas 58.6 and 58.7, the Working Group recommended that fishing within 200 n miles of the Prince Edward Islands be prohibited in the months of September to April inclusive. However, if South Africa still considered it necessary to maintain a regulated fishing presence within its EEZ around the Prince Edward Islands in order to deter IUU fishing, then regulated fishing within 200 n miles of the islands should be prohibited at least from January to April (paragraphs 7.49 to 7.52).

7.222 (i) Data from longline fishing within the French EEZs in Subarea 58.6 and Division 58.5.1 in the 1999 and 2000 seasons revealed a very serious seabird by-catch situation.

(ii) Overall by-catch rates were 0.736 birds/thousand hooks for 1998/99 and 0.184 birds/thousand hooks for 1999/2000 for the Crozet Islands and 2.937 birds/thousand hooks for 1998/99 and 0.304 birds/thousand hooks for 1999/2000 for the Kerguelen Islands (paragraph 7.59).

(iii) A total of 8 491 white-chinned petrels (99% of all birds) was reported killed (paragraph 7.60).

(iv) The totals of birds killed in the French EEZs in 1999 and 2000 were 17.2 and 4.2 times greater, respectively, than the total estimated seabird by-catches for the rest of the Convention Area; some monthly seabird by-catch rates exceed those used to estimate by-catch in the IUU fishery (paragraphs 7.62 and 7.63).

(v) The Working Group recommended that longline fishing within the French EEZs should be prohibited during the months of September to April inclusive (paragraph 7.64).

(vi) Submission to CCAMLR of the original data for 1999 and 2000, together with data from 2001, including information on mitigation measures in use in all three years, was requested (paragraph 7.65).

7.223 No incidental mortality of seabirds was observed in Subarea 88.1 for the fourth successive year due to strict compliance with conservation measures (paragraph 7.53).

Compliance with Conservation Measure 29/XIX

7.224 (i) Overall compliance with this conservation measure this year, compared to last year, was substantially improved in all subareas and divisions and was again complete in Subarea 88.1 (Table 56).

(ii) Streamer lines – compliance with streamer line design was 66%, double that last year. Vessels which have not complied with this element of the conservation measure over at least the last two years include *Argos Helena*, *Eldfisk*, *Isla Santa Clara*, *No. 1 Moresko* and *Aquatic Pioneer* (Tables 54 and 58 and paragraphs 7.67 to 7.69). Several vessels new to the fishery (*Polarpesca I*, *Suidor One* and *Rustava*) failed to comply with this simple and important measure (Table 58).

(iii) Offal discharge – in the whole Convention Area only the *Maria Tamara* (Subarea 48.3) failed to comply with the requirement either to hold offal on board, or to discharge on the opposite side to where the line was hauled; in Subareas 58.6, 58.7 and 88.1 there was again 100% compliance in this regard (Table 59 and paragraph 7.71). Although Conservation Measure 29/XIX requests vessels in Subareas 48.3, 58.6 and 58.7 to avoid the discharge of offal during the haul, on 86% of cruises there was discharge during hauls on an average of 91% of sets (paragraph 7.72). In Subarea 88.1 no vessels discharged offal at any time, as required under Conservation Measure 210/XIX.

(iv) Night setting – compliance improved in Subarea 48.3 from 87% last season to 95% and was maintained at 78% in Subareas 58.6 and 58.7. The *Koryo Maru 11* made 47% of sets during daylight hours on one cruise in Subareas 58.6 and 58.7 and caught more seabirds than any other vessel fishing in these subareas (paragraphs 7.73 to 7.75).

(v) Line weighting (Spanish system) – unlike all previous years when no vessel complied with the use of weights of 6 kg spaced at 20 m intervals, weights of 8.5 kg at 40 m were used on 21% of cruises in Subarea 48.3 and 18% of cruises in Subareas 58.6 and 58.7. Eight other vessels used line weightings that were close to compliance. One vessel complied with the 0.3 m/s line sink rate required in Subarea 88.1 (paragraphs 7.77 to 7.80 and Figure 35).

(vi) Line weighting (autoline system) – the requirement to achieve a line sink rate of 0.3 m/s when fishing in daylight in Subarea 88.1 south of 65°S was met by all vessels (paragraph 7.81).

7.225 (i) Four of 24 vessels (*Isla Gorriti*, *Janas*, *San Aotea II* and the *Sonrisa*) complied fully with all elements of the conservation measures that were applicable in the areas they fished (Table 59 and paragraph 7.84).

(ii) Historical compliance data (Table 59) and reports received by CCAMLR from observers and fishers indicate that all practical constraints relating to night setting, offal discharge, streamer line use and line weighting have now been overcome (paragraph 7.86).

(iii) Particular attention is drawn to vessels that have not complied with two or more of the elements of Conservation Measure 29/XIX for two or more consecutive years. These are: *Isla Camila*, *Isla Santa Clara*, *Koryo Maru 11*, *No. 1 Moresko*, *Argos Helena*, *Aquatic Pioneer* and *Isla Alegranza*. In addition, vessels in their first year in the fishery that failed to comply with two or more measures are *Polarpesca I*, *Suidor One*, *Maria Tamara*, *In Sung 66* and *Rutsava* (paragraph 7.89).

(iv) The Working Group recommended that vessels which do not comply with all elements of Conservation Measure 29/XIX should be prohibited from fishing in the CCAMLR Convention Area (paragraphs 7.87 and 7.88).

Fishing Seasons

7.226 On the basis of the data for the 2000/01 fishing season in Subarea 48.3, seabird by-catch levels were negligible for the second successive season. However, full compliance with Conservation Measure 29/XIX was not achieved so it was not possible to recommend an extension to the fishing season for 2001/02 in Subarea 48.3 (paragraphs 7.91 and 7.92). Nevertheless, full compliance should readily be achievable next year with small improvements to operational practice (paragraph 7.93).

Assessment of Incidental Mortality of Seabirds during Unregulated Longline Fishing in the Convention Area

7.227 (i) The estimates of potential seabird by-catch by area for 2001 (paragraphs 7.109 to 7.113, Tables 60 and 61) were:

Subarea 48.3:	1 600–2 100 to 5 900–7 700 seabirds;
Subareas 58.6 and 58.7:	12 100–16 000 to 22 000–29 000 seabirds;
Divisions 58.5.1 and 58.5.2:	13 500–17 800 to 24 600–32 400 seabirds; and
Division 58.4.4:	9 300–12 500 to 17 100–22 700 seabirds.

(ii) The overall estimated totals for the whole Convention Area (paragraph 7.114 and Table 61) indicate a potential seabird by-catch in the unregulated fishery of 36 000–69 000 (lower level) to 48 000–90 000 birds (higher level) in 2000/01. This compares with totals of 17 000–27 000 (lower level) to 66 000–107 000 (higher level) in 1996/97, 43 000–54 000 (lower level) to 76 000–101 000 (higher level) in 1997/98, 21 000–29 000 (lower level) to 44 000–59 000 (higher level) in 1998/99, and 33 000–63 000 (lower level) to 43 000–83 000 (higher level) in 1999/2000.

(iii) The species composition of the estimated potential seabird by-catch (Table 62) indicates a potential by-catch of 40 500–89 500 albatrosses, 7 000–15 000 giant petrels and 109 000–275 000 white-chinned petrels in the IUU fishery in the Convention Area over the last five years (paragraph 7.120).

(iv) The Working Group endorsed its conclusions of recent years that such levels of mortality remain entirely unsustainable for the populations of albatrosses, giant petrels and white-chinned petrels breeding in the Convention Area (paragraph 7.122), many of which are declining at rates where extinction is possible.

(v) The Working Group recommended that the Commission take even more stringent measures to combat IUU fishing in the Convention Area (paragraph 7.123).

Incidental Mortality of Seabirds in relation to New and Exploratory Fisheries

7.228 (i) Of the seven exploratory longline fisheries approved for 2000/01, only that in Subarea 88.1 was operational in 2000/01; no seabird by-catch was reported in this fishery (paragraphs 7.129 and 7.130).

(ii) The assessment of potential risk of interactions between seabirds and longline fisheries for all statistical areas in the Convention Area was reviewed, revised and provided as advice to the Scientific Committee and Commission in SC-CAMLR-XX/BG/11. There had been no changes to this advice in relation to levels of risk of seabird by-catch for any part of the Convention Area (paragraph 7.128).

(iii) The 24 proposals by eight Members for new and exploratory longline fisheries in 14 subareas/divisions of the Convention Area in 2001/02 were addressed, in relation to advice in SC-CAMLR-XX/BG/11 and Table 63.

(iv) The potential problems which need resolving (paragraphs 7.133 to 7.137) are:

(a) to check that France intends to comply with Conservation Measure 29/XIX, rather than Conservation Measure 29/XVI as indicated, for Subarea 58.6 and Divisions 58.4.3 and 58.4.4;

(b) whether or not Japan intends to comply with Conservation Measure 29/XIX and to use an international scientific observer in Subareas 48.6, 58.6, 88.1 and 88.2, and Divisions 58.4.1, 58.4.3 and 58.4.4 (note that Japan’s intention is clarified, positively, in paragraph 7.134);

(c) clarification of fishing season in respect of South Africa's applications for Subarea 58.6 and Division 58.4.4; and

(d) applications for variations from Conservation Measure 29/XIX (e.g. similar to Conservation Measure 210/XIX) for Subareas 48.6, 88.1, 88.2 and Division 58.4.4.

7.229 (i) The Working Group recommended the continuation of Conservation Measure 210/XIX for exploratory fishing in Subarea 88.1 (paragraph 7.136).

(ii) It recommended that similar conservation measures should be developed for exploratory fishing in Subareas 48.6 and 88.2 and Division 58.4.4, retaining a strict precautionary limit on seabird by-catch (paragraphs 7.137 to 7.139).

(iii) It recommended the adoption of a simpler method for testing line sink rates (paragraph 7.140 and Appendix G).

Incidental Mortality of Seabirds during Longline Fishing outside the Convention Area

7.230 (i) Japanese and Taiwanese vessels longline fishing for tuna in the South African mainland EEZ are estimated to kill annually 19 000–30 000 seabirds, including black-browed albatrosses and white-chinned petrels from the Convention Area. By-catch rates on Japanese vessels were 2.64 birds/thousand hooks; failure to use streamer lines was reported (paragraphs 7.143 to 7.146).

(ii) Reports were received from New Zealand and the Falkland/Malvinas Islands on low levels of seabird by-catch observed in domestic longline fisheries; a report from Australia indicated a 48% increase in tuna longline fishing effort in the AFZ in 1999, but without observers no reliable by-catch data were available for this fishery (paragraphs 7.148 to 7.150).

(iii) The Working Group recommended that responses be sought by the Secretariat on seabird by-catch levels, mitigation measures in use (and whether voluntary or mandatory) and observer programs from all Members and other countries conducting or permitting longline fishing in areas where seabirds from the CCAMLR Convention Area are killed (paragraph 7.158).

Research into and Experience with Mitigating Measures

7.231 (i) Offal discharge – scupper screens should be used to prevent discharge of offal and bait from vessels while processing catch (paragraph 7.161). Hooks, increasingly abundant in regurgitates from albatross chicks, should be removed from fish heads prior to discard; this recommendation should be added to appropriate conservation measures (paragraph 7.162).

(ii) Streamer lines – a video of the successful New Zealand boom and bridle system should be circulated to fishers via technical coordinators (paragraph 7.163); paired lines have proved superior to single lines when tested in Alaskan demersal longline fisheries and should be tested in the Convention Area (paragraph 7.164).

(iii) Bait – further trials (paragraphs 7.165 to 7.168) are endorsed and more data requested on circumstances of bait loss (paragraph 7.169).

(iv) Underwater setting – *Eldfisk* continues to use the Mustad funnel with success on day sets in the Convention Area and the same device performed well in Alaskan trials (paragraph 7.170); full trials of the Australian chute system are in progress on 10 vessels, earlier trials giving a 96% reduction in baits taken (paragraph 7.171).

(v) Line weighting –

(a) several vessels fishing in the Convention Area last year were able to comply with the revised line weighting system of 8.5 kg at 40 m intervals (paragraphs 7.75 to 7.78 and 7.173); when complying, only one of seven cruises recorded seabird by-catch, whereas six of 15 cruises recorded seabird by-catch when not complying (paragraph 7.174);

(b) all autoliners (and one Spanish system vessel) fishing in Subarea 88.1 achieved line sink rates of 0.3 m/s. The predictive model of sink rate was further developed (paragraphs 7.173 and 7.182);

(c) a new simple means of measuring line sink rate should enable predictive sink rate models to be developed for the Spanish longline system (paragraphs 7.176 and 7.183);

(d) several reports of other investigations of line sink rates were received, all broadly confirming existing results for the Convention Area (paragraphs 7.176, 7.177 and 7.181); and

(e) trials in New Zealand of a Norwegian-manufactured sample integrated autoline weighting system will take place shortly (paragraphs 7.179 and 7.180).

7.232 In response to the Scientific Committee's request last year, a proposal has been developed for rigorous experiments on the effects of the different elements of Conservation Measure 29/XIX, when applied to the Spanish longline system, in reducing seabird mortality. The Working Group strongly requested Members to support this proposed study (paragraphs 7.186 to 7.188).

International and National Initiatives relating to Incidental Mortality of Seabirds in relation to Longline Fishing

7.233 (i) International Fishers' Forum – Members were encouraged to disseminate information on this successful meeting by way of articles in fishery magazines and journals (paragraphs 7.191 to 7.194).

(ii) Agreement on the Conservation of Albatrosses and Petrels – CCAMLR Members who are range states (including distant-water fishing nations that interact with Southern Hemisphere albatrosses and petrels on the high seas) were encouraged to sign and ratify the agreement as soon as possible (paragraphs 7.195 to 7.198).

(iii) FAO NPOA–Seabirds – concern was expressed at the lack of progress by CCAMLR Members towards implementation of NPOAs (requested by the Commission for February 2001), with the exception of Japan, New Zealand and the USA, who had either adopted or developed plans, and Australia, whose Threat Abatement Plan serves in lieu for the time being. The other relevant CCAMLR Members were urged to produce, adopt and implement plans as soon as possible (paragraphs 7.195 to 7.206). The Japanese plan was regarded as inadequate, in respect of mitigation measures, to reduce seabird by-catch to acceptably low levels, specifically in areas frequented by seabirds from the Convention Area (paragraphs 7.209 to 7.212); further details were requested in this regard (paragraph 7.213).

(iv) Tuna Commissions – details of seabird by-catch, mitigation measures in use and relevant observer programs were requested from forthcoming meetings of CCSBT, ICCAT and IOTC (paragraphs 7.214 to 7.216).

(v) Other fishery organisations – request to develop links with organisations responsible for fisheries in areas adjacent to the Convention Area (paragraph 7.217).

OTHER INCIDENTAL MORTALITY

Longline Vessels – Marine Mammals

8.1 One unidentified marine mammal drowned after becoming entangled by the *Suidor One* in Subarea 58.7 (WG-FSA-01/22 and Table 64).

8.2 Interactions with marine mammals resulting in observed loss of fish were reported in Subareas 48.3 and 58.6/58.7 (WG-FSA-01/22 and Table 64). These are summarised below in comparison with values for 1999/2000:

		Cruises where Interaction Occurred	Killer Whale	Sperm Whale	Seal	Unknown
Subarea 48.3	1999	13 of 17	12	1	5	0
	2000	9 of 26	6	3	3	1
Subareas 58.6/58.7	1999	9 of 12	6	4	0	3
	2000	9 of 11	7	6	0	2

No such interactions were reported for Subarea 88.1, despite sightings of killer whales from the fishing vessels on most cruises.

Trawl Fishing – Marine Mammals and Seabirds

8.3 No entanglements or incidental mortality of marine mammals or seabirds were reported by vessels engaged in krill fishing in Area 48 (WG-FSA-01/20).

8.4 In respect of trawl fisheries for *C. gunnari* and *D. eleginoides* in Division 58.5.2 and *C. wilsoni* in Division 58.4.2, there was only one report of incidental mortality – that of a single Antarctic fur seal (WG-FSA-01/22 and Table 64).

8.5 In respect of trawl fisheries for *C. gunnari* in Subarea 48.3, there were no reports of marine mammal entanglement or incidental mortality. However, a total of 132 seabird entanglements was reported, of which 92 were fatal, 40 birds being released alive (WG-FSA-01/20). The Working Group noted, however, that scientific observer reports indicated that many of the birds released alive were in poor condition; at least one quarter were thought unlikely to survive.

8.6 The majority (98%) of the bird deaths occurred on two vessels: the *Betanzos* (2 grey-headed albatrosses, 21 black-browed albatrosses and 30 white-chinned petrels (misidentified as great-winged petrels)) and the *Argos Vigo* (1 grey-headed albatross, 25 black-browed albatrosses and 11 white-chinned petrels). All the incidental mortality for the *Argos Vigo* was on its February cruise, none on its December cruise, the same observer being on board on both occasions. The *Zakhar Sorokin* reported no birds caught, dead or alive, and the *Saint Denis* only 2 grey-headed albatrosses dead and 2 black-browed albatrosses alive. No data had yet been received from the *Sil* but its observer report indicated that no incidental mortality had been observed.

8.7 The Working Group noted that the vessels involved had fished for different periods and durations. The *Argos Vigo* fished for six days (12 tows) in December (with no seabird by-catch) and 20 days (68 tows) in February (average seabird by-catch of 1.8 birds/day), the *Betanzos* for 53 days (165 tows) in November–February (average seabird by-catch of 1 bird/day), the *Saint Denis* for 13 days (113 tows) in December/January (average seabird by-catch of 0.15 birds/day) and the *Zakhar Sorokin* for 9 days (18 tows) in September (with no seabird by-catch). It also noted that the *Zakhar Sorokin* had fished extensively in the 1999/2000 season in Subarea 48.3 without any reported seabird by-catch.

8.8 The circumstances of seabird by-catch in the icefish fishery in Subarea 48.3 was investigated further in WG-FSA-01/30. This preliminary analysis suggested that month and vessel were significant factors affecting the probability of a haul catching birds. There were, however, insufficient data statistically to resolve the situation further.

8.9 The Working Group noted that although WG-FSA-01/30 had failed to find any correlation between seabird by-catch and fish catch, it was interesting that in December the *Argos Vigo* caught almost no fish and no birds, whereas in February its fish catches were substantially higher (averaging at least 500 kg/hour), as was its seabird by-catch.

8.10 The scientific observer reports on the *Betanzos* and *Argos Vigo* provide additional relevant information. On the *Betanzos* during setting, white-chinned petrels were seen to dive through the larger meshes with wings folded, becoming entrapped subsequently. Although most seabird activity was at the codend, the meshes there were too small for birds to enter and become trapped. Most entanglement occurred in the larger mesh areas of the net, despite these having apparently been cleaned of enmeshed fish. On hauling, birds fought to free fish from the codend but were rarely, if ever, entangled there. Most entanglements of white-chinned petrels resulted from birds diving through the large mesh portion. Black-browed albatrosses were usually entangled by the *Betanzos* when sitting on the water above the net and were caught when it lifted as the vessel pitched.

8.11 The report from the *Argos Vigo* was similar, indicating birds being caught in meshes of about 400 mm with the wings and mouth of the net being the main sites. The observer noted that faster hauling of the trawl and complete extraction of the enmeshed fish before resetting could substantially improve the situation.

8.12 The Working Group felt it unlikely that seabird abundance in the vicinity of vessels would have changed substantially over the months of fishing. It seemed likely, therefore, that the high seabird by-catches were related to specific aspects of vessel (or cruise) operations.

8.13 The Working Group recollected that WG-FSA-99/72 had demonstrated very low levels of incidental mortality associated with trawl fishing in Divisions 58.4.2 and 58.5.2; experience in subsequent years has confirmed this. Vessels trawl fishing in these areas are required to have an on-board processing plant.

8.14 Dr V. Senioukov (Russia), who had been a scientific observer on the *Zakhar Sorokin*, noted three characteristics of this vessel which may contribute to its having no records of entangled seabirds. First, no fish offal is produced, fish being frozen whole. Second, low levels of deck illumination are used. Third, it is a much larger vessel (7 765 GRT) than the other trawlers (1 100–2 200 GRT) operating in the area. Its more powerful engine enables it to steam during hauling, permitting an unbroken and faster operation. Gear configuration is also different, particularly to that of the *Betanzos*.

8.15 The offal production and disposal characteristics of the other trawlers fishing in Subarea 48.3 is unknown. It is possible that their offal discharge practices might attract birds during the set and haul. The slow rate of hauling of the trawl of the *Argos Vigo* had been identified by the scientific observer as potentially contributing to the attraction and entanglement of seabirds.

8.16 WG-FSA-01/59 reported incidental mortality of seabirds in midwater trawl fisheries in the New Zealand region, especially involving albatrosses and sooty shearwaters. Mr Smith indicated that many albatrosses were entangled following collision with the trawl warp, whereas most shearwaters were caught when diving into the mouth of the net to retrieve fish at the haul. The problem with the trawl warp is being addressed by using streamer lines and other devices to restrict access to the danger area.

8.17 New Zealand was encouraged to circulate intersessionally and to table next year further details of its mitigation work on trawl fishing vessels.

8.18 In reviewing the overall situation, the Working Group noted with concern that the incidental mortality due to trawl fishing in Subarea 48.3 in 2000/01 was three times the estimated mortality caused by the longline fishery in the same subarea in 2000/01. It recollected that the *Betanzos* was the vessel responsible for all the seabird trawl by-catch (19 black-browed albatrosses) in Subarea 48.3 last year and the concern at this expressed by the Scientific Committee and Commission (SC-CAMLR-XIX, paragraph 4.49 and CCAMLR-XIX, paragraph 6.28).

8.19 However the Working Group noted that, without more data and information, it was difficult to determine the cause of the high level of seabird by-catch associated with certain vessels fishing for icefish in Subarea 48.3. It was therefore difficult to propose appropriate remedies at this time.

8.20 Accordingly, the Working Group requested that provision be made in the *Scientific Observers Manual*, logbook, data recording and reporting sheets (see paragraph 7.99) and instructions to scientific observers, for recording:

(i) the nature and timing of offal discharge (noting that Conservation Measure 173/XVIII prohibits this during shooting and hauling of trawl gear);

(ii) the location, level and direction of deck lighting in use during hauling operations (for which recommendations are made in Conservation Measure 173/XVIII); and

(iii) any other details relevant to entanglement and mortality of seabirds, including video recording as feasible, together with suggestions as to how these could be avoided.

8.21 The Working Group also recommended that details of the mitigating measures used on New Zealand vessels (paragraph 8.16) be obtained by the Secretariat and circulated to technical coordinators with the request that trials of similar devices be undertaken on trawl vessels fishing for icefish in Subarea 48.3 in 2001/02 and the results be reported to the Working Group.

8.22 Until it is possible to recommend appropriate measures to mitigate seabird by-catch in midwater trawl fisheries for icefish in Subarea 48.3, the Working Group recommended that each vessel entering this fishery be subject to a limit on seabirds killed, and on reaching such limit, fishing by that vessel would cease.

8.23 Given the potential significance of seabird by-catch associated with trawl fishing, the Working Group recommended that the Secretariat should seek to acquire recent data on seabird by-catch for French trawl fisheries in Division 58.5.1 and in any other relevant parts of the Convention Area.

Squid and Pot Fishing

8.24 WG-FSA-01/42 reported that no instances of incidental mortality of marine mammals or seabirds had been recorded for the exploratory squid fishery or the *D. eleginoides* pot fishery in Subarea 48.3.

Advice to the Scientific Committee

8.25 (i) In the Convention Area in 2001, one unidentified marine mammal was killed by a longline vessel and one Antarctic fur seal by a trawl vessel (paragraphs 8.1 and 8.4).

(ii) No instances of incidental mortality of seabirds were reported from trawl fisheries in Divisions 58.4.2 and 58.5.2 in 2000/01 (paragraph 8.4).

8.26 (i) In trawl fishing for icefish in Subarea 48.3, 132 seabirds were entangled, at least 92 fatally, a total three times the estimated total seabird by-catch mortality for all regulated longline fishing in the Convention Area in 2001 (paragraphs 8.5 to 8.6 and 8.18).

(ii) The Working Group recommended that:

(a) new data recording and reporting arrangements be devised for scientific observers on trawl vessels fishing in Subarea 48.3, in order to determine the nature of offal discharge and deck lighting and other details relevant to incidental entanglement and mortality of seabirds (paragraph 8.20);

(b) mitigation measures, similar to those in use in New Zealand trawl fisheries, be trialled on vessels trawl fishing for icefish in Subarea 48.3 in 2001/02 (paragraph 8.21); and

(c) seabird by-catch limits be placed on each vessel trawl fishing for icefish in Subarea 48.3 in 2001/02 (paragraph 8.22).

(iii) The Working Group recommended that the Secretariat should seek to acquire recent data on seabird by-catch for French trawl fisheries in Division 58.5.1 and in any other relevant parts of the Convention Area (paragraph 8.23).

(iv) No instances of incidental mortality of marine mammals or seabirds had been recorded for the squid fishery or the *D. eleginoides* pot fishery in Subarea 48.3 (paragraph 8.24).

CCAMLR WEBSITE

9.1 WG-FSA reviewed its usage of the CCAMLR website. It was agreed that the website had evolved into a useful tool, and that the present format and contents of material on the website met the needs of the Working Group. WG-FSA also noted a marked increase in the connection speed and access times to the website since the 2000 meeting; faster download times had provided better access to meeting material. The Secretariat was thanked for these further developments.

FUTURE WORK

Research Needs for *C. gunnari*

10.1 The Working Group recognised that there continues to be a substantial number of additional research needs for *C. gunnari* stocks. At this year's meeting a number of specific issues arose during discussions of the assessment of *C. gunnari* that would benefit from additional investigations. These included:

(i) sensitivity trials of natural mortality rates on currently used methods of assessment to better understand the consequences of changes and uncertainties in this population parameter;

(ii) further refinement of methods for assessing standing stock of *C. gunnari*, including the use of acoustic survey techniques;

(iii) age and growth studies of *C. gunnari*. Drs Kock and K. Shust (Russia) recommended setting up an otolith exchange network similar to what was carried out for *D. eleginoides* last year;

(iv) a compilation of historical catch-weighted length frequencies for the Indian Ocean Sector (paragraph 4.160);

(v) ecosystem interactions (paragraph 4.175); and

(vi) alternative approaches to management (paragraph 4.189).

Total Removals of Toothfish

10.2 The Working Group recommended that the Secretariat compile tables of total toothfish removals as up-to-date as possible prior to WG-FSA following the approach used this year (see paragraph 3.32 and Tables 3 to 11). These tables should be compiled by season, as well as by split-year (as defined in the context of conservation measures) for Subarea 48.3 and Division 58.5.2.

Intersessional Work of Subgroups

10.3 The Working Group reviewed the activities of subgroups that had worked during the intersessional period. These subgroups, with the support of the Secretariat, had produced valuable work and information that had contributed to the assessments and review of information available at the meeting. WG-FSA agreed that the activities of several of these groups should be extended during the 2001/02 intersessional period. Where possible, each subgroup would focus on a small number of key issues. The subgroups would also provide a conduit for information on a wide range of related research. In addition, other tasks were specifically assigned to the Secretariat and/or Members.

10.4 The Working Group reminded participants that the membership to the subgroups was open, and that the reason for nominating coordinators and others at the meeting was to facilitate the establishment of subgroups.

10.5 WG-FSA assigned some of the major tasks arising from the 2001 meeting to the following groups:

(i) A subgroup to review observer reports and information, coordinated by Dr Balguerías and Mr Smith.

(ii) A subgroup to continue developing assessment methods coordinated by Dr Constable. This subgroup will interact and coordinate activities in the middle of the year (well prior to WG-FSA). There are two primary tasks of this subgroup:

(a) explore and test any new quantitative assessment procedures, identify data requirements, and establish a general work plan to be followed at the subsequent WG-FSA meeting. Individuals who plan to table new assessment techniques or new estimates of population parameters are highly encouraged to participate in the intersessional activities of the subgroup; and

(b) circulate and discuss the most likely population input parameters that will be used during the upcoming assessment. A list of these parameters should be made available at least two weeks prior to the WG-FSA meeting.

(iii) A subgroup to review, and where necessary assess, the biology and demography of species considered by the Working Group. The subgroup was tasked with:

(a) coordinating the *C. gunnari* otolith exchange network: Drs Gasiukov, Shust and Kock;

(b) continuing the development of guidelines for determining maturity stage in *D. mawsoni* (paragraph 3.78): Mr G. Patchell (New Zealand); and

(c) continuing the development of fish identification guides for scientific observers: Dr Everson.

(iv) Dr Everson will prepare a file containing all working papers on by-catch developed at this meeting; the file to be deposited at the Secretariat. This information will be considered by a subgroup on by-catch to be coordinated by Ms van Wijk.

(v) A subgroup to continue refining methods used by scientific observers to subsample by-catch and collect information on ecological interactions from longline and trawl fisheries, coordinated by Dr D. Agnew (UK), Dr Ashford and Mr Watkins.

(vi) A subgroup to identify in conjunction with the SCAR EVOLANTA Program up-to-date information on stock identity for species within the Convention Area, to be coordinated by Dr Fanta.

10.6 Each subgroup was requested to develop a work plan for the intersessional period, in consultation with the appropriate colleagues and with the Convener of WG-FSA and the Chair of the Scientific Committee.

10.7 The responsibilities for coordinating the intersessional activities of ad hoc WG-IMALF are set out in Appendix F.

Other Intersessional Work

10.8 The Working Group identified a number of tasks that should be carried out by participants and the Secretariat during the intersessional period. The main tasks are listed below with reference to paragraphs in the report that contain details of these tasks; routine tasks are not included.

10.9 The following tasks were identified as part of the development of the Scheme of International Scientific Observation:

Secretariat:

(i) Consult with technical coordinators and seek their comments and proposals on solutions to difficulties experienced in the completion of the observer duties (paragraph 3.48).

Members:

(ii) Request that scientific observers submit data on electronic logbooks developed in Microsoft Excel format by the CCAMLR Secretariat (paragraph 3.42).

(iii) Encourage technical coordinators to continue to bring changes and updates of the *Scientific Observers Manual* to the attention of the scientific observers (paragraph 3.48).

(iv) Encourage scientific observers to label and store, deep frozen, all specimens whose identification was uncertain, for subsequent forwarding to appropriate taxonomists (paragraph 4.293).

(v) Encourage scientific observers and fishing masters to continue collecting information on CFs using the CCAMLR format and concentrating on product which constitutes the largest fraction of the fish processed (paragraph 3.78).

(vi) Remind scientific observers that data on CFs should be collected on a fish-by-fish basis (paragraph 3.78).

10.10 Various other tasks were identified as follows:

Secretariat:

(i) Maintain a watching brief on IUCN, CITES and FAO in relation to new developments in the Red List (paragraph 11.6), and report these to the Working Group during the intersessional period.

(ii) Examine the feasibility of creating a database of CCAMLR working documents that could be indexed by keywords and accessed by Members when requested.

Members:

(iii) Consider options for reorganising the work of the Working Group during its meetings (paragraphs 11.1 to 11.5).

(iv) Submit documents electronically to the Secretariat at least one week prior to the start of the 2002 meeting of WG-FSA. The Working Group agreed that papers submitted after this deadline will not be considered during the course of the WG-FSA meeting.

(v) Submit data on by-catch which can be used to estimate catch rates in terms of both numbers and weight per unit of effort (paragraph 4.286).

Secretariat Support at Future Meetings

10.11 The Working Group recognised the difficulties under which the Secretariat operates when several meetings are taking place simultaneously at the CCAMLR Headquarters. The Working Group noted that the assessments have been ending on Thursday for the past few years, and agreed that every effort should continue to be made in the future to complete all activities of WG-FSA by Wednesday. The attention of the Scientific Committee was drawn to this scheduling.

10.12 Dr Ramm updated the Working Group on recent progress made toward the CCAMLR Research Survey Database, including the transfer and validation of data to the new format. Future work will include:

(i) development of a pro-forma for survey data; and
(ii) a method of allowing contributors to make corrections to their survey database.

10.13 The Working Group suggested that it would be valuable to integrate data validation routines into the data query process used by the Working Group.

10.14 The Working Group suggested that the Secretariat create a standardised research survey database that would be available to Members who conduct research surveys.

OTHER BUSINESS

Options for Reorganising the Work of WG-FSA

11.1 The Working Group discussed strategies that could streamline the organisation of WG-FSA. It was noted that the data facilities available at the Secretariat have improved, and this has helped facilitate the work of WG-FSA.

11.2 The performance and success of various intersessional activities that took place prior to WG-FSA were discussed. The Working Group noted that certain intersessional activities, such as the otolith exchange program and toothfish ageing workshop, were very successful while some other intersessional activities had more limited results. The Working Group recognised that the success of various activities was related, in part, to how well the tasks were defined to the subgroups. The need to clearly define the tasks of intersessional groups was underscored. Dr Constable suggested that it would be useful to develop a framework for evaluating the success of intersessional activities.

11.3 The Working Group noted that there are substantial difficulties added to the work of the assessment subgroup when new quantitative methodologies are introduced and incorporated into assessments undertaken during the time of WG-FSA. Issues related to the current procedures and new assessment techniques should be introduced to the assessment subgroup and tested prior to WG-FSA. The Working Group suggested that the best way to achieve this is for the assessment subgroup to have intersessional communication to identify and discuss concerns, requirements and new methods. The activities of the assessment subgroup should be prioritised before the meeting to increase the efficiency and quality of the assessments.

11.4 The specific activities of WG-FSA under the present framework were reviewed with respect to whether the Working Group should focus tasks towards a more strict assessment agenda. The Working Group agreed that the present organisational philosophy is satisfactory, and that no major changes should be made to the broad structure of the tasks undertaken at WG-FSA. However, it would be valuable for conveners and subgroup conveners to exchange ideas and identify key questions that may modify the structure of future WG-FSA activities.

11.5 Dr Holt recommended that items contained in the current agenda should be reviewed. Elements of the agenda may be consolidated, and some should be eliminated if they are no longer of consequence to WG-FSA.

IUCN List of Globally Threatened Species

11.6 The IUCN's Red List of endangered and vulnerable species was reviewed. There are currently no fish species in the Red List that are considered by WG-FSA. However, Dr Miller noted that the CITES list for marine species is currently being finalised. As was recommended last year, the Secretariat was requested to monitor any new developments in endangered and vulnerable species listings that pertain to Antarctic fish, as restrictions placed by CITES have the potential to affect the work undertaken by WG-FSA.

Publication Matters

11.7 Dr Gasiukov raised concerns expressed by several non-English speaking scientists at WG-FSA that there are language difficulties for non-English speakers when preparing and submitting papers for potential publication in *CCAMLR Science*. He further expressed concern that *CCAMLR Science* may not accept valuable scientific contributions due to poor English composition. There was agreement by the Working Group that this was a valid concern. The Working Group noted that this problem is not necessarily limited to the work of WG-FSA, but to all participants who could potentially make scientific contributions to *CCAMLR Science*.

11.8 The Working Group agreed that it would be beneficial to set aside part of the CCAMLR budget that could be earmarked to fund translation of scientific papers into high quality English prior to submission to *CCAMLR Science*. However, the Working Group agreed that caution should be used if the scope of other reports currently used by CCAMLR participants needs to be altered in order to fund translations for *CCAMLR Science*.

11.9 The Editor of *CCAMLR Science*, Dr E. Sabourenkov, acknowledged that there is a problem, and pointed out that a number of papers submitted to the journal often have to be heavily edited for English even before sending them to reviewers. It takes considerable time, and results in delaying in publication of such papers, often for a year. He offered several steps that could be useful in overcoming the problem with papers whose authors prefer to write in English although this is not their primary language, and for those authors whose papers are first written in other languages and then translated into English:

(i) request authors first to write papers in their own language and then subject them to thorough scientific editing within their own scientific community;

(ii) papers should then be translated into the best quality English within the means of the authors;

(iii) both copies of the paper, in the original language and the translation, should be submitted to the Secretariat;

(iv) extra funding should be allocated to the Secretariat to deal with language editing which often includes retranslation into English of the most poorly written sections from the original in the other language; and

(v) reviewers of papers should also be requested to assist in further editing and English improvement.

11.10 It was agreed that the solutions to these problems were largely outside the scope of WG-FSA. Dr Holt noted budgeting requests for translations must be presented to, and approved by, the Commission. He suggested that it would be worthwhile to conduct a cost analysis of the labour required to perform the translations at the Secretariat.

11.11 The Working Group agreed that the English composition of a *CCAMLR Science* submission is much less important than the scientific content, and that it is important that steps be taken to ensure submissions of high scientific quality reach a broad audience through publication.

ADOPTION OF THE REPORT

12.1 The report of the meeting was adopted.

CLOSE OF THE MEETING

13.1 In closing the meeting, the Convener thanked the participants and the Secretariat for another very successful meeting. All had worked long hours and made major contributions to the discussions, work of the subgroups and preparation of the report. Mr Williams confirmed that this meeting marked the end of his three-year term as Convener. Dr Holt, Chair of the Scientific Committee, thanked Mr Williams for leading the Working Group since 1999; his contribution had been very much appreciated.

13.2 Dr Miller, on behalf of WG-FSA, presented Mr Williams with a gift as a token of the Working Group's appreciation. The Working Group also joined in thanking Dr Everson, who would be retiring in 2001, for his contribution to the work of WG-FSA and CCAMLR. The Working Group also presented a small gift to Dr Everson.

13.3 The meeting was closed.

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Table 1: Catches (tonnes) of target species by region and gear reported for the 2000/01 fishing season. Source: catch and effort reports submitted by 7 October 2001.

Fishery and Target Species	Conservation Measure	Region	Gear	Catch (tonnes) of Target Species			
				Limit	Fishery	Other[1]	Total
Chaenodraco wilsoni (exploratory fishery)							
	212/XIX	58.4.2	Trawl	500	11	0	11
Champsocephalus gunnari							
	194/XIX	48.3	Trawl	6 760	1 427	0	1 427
	195/XIX	58.5.2	Trawl	1 150	938	0	938
Dissostichus spp.							
	196/XIX	48.3	Pot	4 500[2]	59	3 991	4 050
	196/XIX	48.3	Longline	4 500[2]	3 991	59	4 050
	180/XVIII	48.4	Longline	28	0	0	0
	197/XIX	58.5.2	Trawl	2 995	2 058	5	2 063
		58.5.1 (French EEZ)	Trawl	-	-	-	2 834[3]
		58.5.1 (French EEZ)	Longline	-	-	-	2 381[3]
		58.6 (French EEZ)	Longline	-	-	-	1 419[3]
		58.6 (South African EEZ)	Longline	-	-	-	18
		58.7 (South African EEZ)	Longline	-	-	-	206
Dissostichus spp. (exploratory fisheries)							
	202/XIX	48.6 north of 60°S	Longline	455	0	0	0
	202/XIX	48.6 south of 60°S	Longline	455	0	0	0
	203/XIX	58.4 BANZARE Bank	Trawl	150	0	0	0
	204/XIX	58.4 BANZARE Bank	Longline	300	0	0	0
	207/XIX	58.4.2	Trawl	500	0	0	0
	206/XIX	58.4.3 Elan Bank	Longline	250	0	0	0
	205/XIX	58.4.3 Elan Bank	Trawl	145	0	0	0
	208/XIX	58.4.4 North of 60°S	Longline	370	0	0	0
	209/XIX	58.6	Longline	450	0	0	0
	210/XIX	88.1 north of 65°S	Longline	175	66	0	66
	210/XIX	88.1 south of 65°S	Longline	1 889	592	0	592
	211/XIX	88.2 south of 65°S	Longline	250	0	0	0
Electrona carlsbergi							
	199/XIX	48.3	Trawl	109 000	0	0	0
Euphausia superba							
	32/XIX	48	Trawl	4 000 000	95 919	0	95 919
	106/XIX	58.4.1	Trawl	440 000	0	0	0
	45/XIV	58.4.2	Trawl	450 000	0	0	0
Lithodidae							
	214/XIX	48.3	Pot	1 600	0	14	14
Martialia hyadesi (exploratory fishery)							
	213/XIX	48.3	Jig	2 500	2	0	2

[1] Other fisheries in the region
[2] Combined (pot and longline) catch limit of 4 500 tonnes
[3] 1 July 2000 to 30 June 2001, reported in STATLANT data

Table 2: Catches (tonnes) by species and region reported for the 2000/01 split-year (1 July 2000 to 30 June 2001). Source: STATLANT data submitted by 7 October 2001.

Species Name	All Regions	Region								
		48.1	48.3	58.4.2	58.4.4	58.5.1	58.5.2	58.6	58.7	88.1
Elasmobranchs										
Amblyraja georgiana	7									7
Bathyraja eatonii	1		<1							<1
Bathyraja murrayi	<1								<1	
Bathyraja spp.	<1								<1	
Rajiformes	91	<1	13			58		12	7	
Bony Fishes										
Antimora rostrata	26		<1					7	15	4
Chaenocephalus aceratus	1	1								
Chaenodraco wilsoni	11	<1		11						
Champsocephalus gunnari	1 890	1	959				930			
Channichthyidae	3	<1	<1							3
Channichthys rhinoceratus	1						1			
Chionodraco rastrospinosus	1	1								
Dissostichus eleginoides	12 645		3 259		164	5 215	1 765	1 476	732	34
Dissostichus mawsoni	626	<1								626
Gobionotothen gibberifrons	2	2	<1							
Macrourus spp.	252		2			31		84	128	6
Macrourus whitsoni	48		<1							48
Muraenolepis microps	<1								<1	<1
Muraenolepis spp.	3									3
Notothenia neglecta	2	2								
Notothenia rossii	<1	<1								
Notothenia squamifrons	<1	<1	<1				<1			
Nototheniidae	2	<1	<1	<1						1
Nototheniops nudifrons	<1	<1								
Osteichthyes	<1	<1							<1	
Pleuragramma antarcticum	<1	<1								
Pogonophryne permitini	<1									<1
Pseudochaenichthys georgianus	6	<1	6							
Trematomus spp.	<1	<1								
Crustaceans										
Euphausia superba	97 602	77 858	19 744							
Lithodes murrayi	<1							<1	<1	
Lithodidae	<1							<1	<1	
Paralomis aculeata	<1								<1	
Molluscs										
Martialia hyadesi	2		2							
Other										
Asteroidea	2									2
Total	113 225	77 866	23 986	12	164	5 304	2 696	1 579	883	735

Table 3: Reported catches (tonnes) of *Dissostichus eleginoides* and *Dissostichus mawsoni* by Members and Acceding States, and estimates of unreported catches by Members and Acceding States in the 2000/01 split-year. Catches for the 1999/2000 split-year are given in parentheses. The information in this table may be incomplete[1].

Flag State	Outside Convention Area		Convention Area: Reported Catch		Convention Area: Estimates of Unreported Catches by Members		Estimated Catch All Areas	
Chile	9 044	(2 704)	531	(1 609)	0	(0)	9 575	(4 313)
Argentina	6 413	(4 667)	0	(0)	0	(0)	6 413	(4 667)
France	0	(0)	6 634	(5 503)	0	(0)	6 634	(5 503)
Australia	26	(82)	1 765	(2 579)	0	(0)	1 791	(2 661)
South Africa	0	(180)[2]	1 040	(1 239)	0	(0)	1 040	(1 419)
UK	1 286[3]	(3 919)[3]	900	(1 221)	0	(0)	2 186	(5 140)
Uruguay	4 359	(0)	582	(767)	0	(0)	4 941	(767)
Ukraine	24	(0)	164	(128)	0	(0)	188	(128)
Spain	213	(0)	487	(264)	0	(0)	700	(264)
Rep. of Korea	3 170	(0)	467	(380)	0	(0)	3 637	(380)
Peru	167	(0)	0	(0)	0	(0)	167	(0)
New Zealand	0	(<1)	612	(751)	0	(0)	612	(751)
Russia	2 612	(-)	89	(-)	0	(-)	2 701	(-)
Seychelles	2 838						2 838	
Various countries							108[4]	
Unknown								(5 765)[5]
All countries	30 152	(11 553)	13 271	(14 441)	0	(0)	43 531	(31 758)[5]

1 Data from CDS and CCAMLR catch reports
2 Catch in EEZ
3 From Falkland/Malvinas Islands and St Helena
4 CDS data, area of catch not known
5 Revised estimate to include landing data reported by Mauritius for January–October 2000 after WG-FSA-2000, pro-rated for the relevant portion of the split-year. Catch areas are an unknown combination of inside and outside the CCAMLR Convention Area.

Table 4: Estimated effort, mean catch rates/day and total catches by subarea/division in the unregulated fishery on *Dissostichus eleginoides* in the 2000/01 split-year. Estimates for the 1999/2000 split-year are given in parentheses. The total estimated unreported catch in 2000/01 is 7 599 tonnes. The total reported catch for the CCAMLR Convention Area in 2000/01 is 13 271 tonnes. The estimated total catch for the CCAMLR Convention Area in 2000/01 is 20 870 tonnes.

Area/ Subarea/ Division	Estimated Start of Unregulated Fishery	No. of Vessels Sighted in Unregulated Fishery[4,5]		No. of Licensed Fishing Vessels		Estimated No. of Vessels Fishing Illegally		No. of Days Fishing per Fishing Trip	No. of Trips/Year	Estimated Effort in Days Fishing[2] (1)		Mean Catch Rate per Day[3] (tonnes) (2)	Estimated Unreported Catch (1) x (2)		Estimated Total Catch[1]	
48.6	No info															
48.3	1991	0	(5)	15	(18)	1	(5)	40	2.5	100	(180)	3.0	300[6]	(396)	3 559	(5 090)
58.7	Apr–May 1996	1[7]	(1)	4	(3)	1	(2)	40	2.5	100	(200)	1.5	150	(220)	882	(940)
58.6	Apr–May 1996	5[7]	(7)	6	(5)	6[8]	(11)[2]	40	2.5	600	(1 100)	1.1	660	(1 980)	2 136	(2668)
58.5.1	Dec 1996	18	(7)	0	(0)	11	(7)	40	2.5	1 100	(700)	3.0	3 300	(2 100)	8 515	(7 109)
58.5.2	Feb–Mar 1997	5	(2)[9]	2[10]	(2)	5	(4)						1 649[11]	(800)	3 414	(3 379)
58.4.4	Sep 1996	0	(1)	1	(1)	7[12]	(7)	40	2.5	700	(700)	2.2	1 540	(1 050)	1 704	(no data)
88.1															660	(751)
Total													7 599	(6 546)	20 870	(19 937)

1 Estimated total catch = estimated unreported catch plus reported catch
2 Calculated as number of vessels fishing illegally x number of fishing days/trip x number of trips/year
3 Data from Secretariat. Subareas 58.7/58.6 based on data from South Africa's EEZ
4 Vessel sightings (sources): Prof. G. Duhamel (France), observers (South Africa), AFMA
5 This may include more than one sighting of the same vessel
6 Estimated upper limit
7 Minimum number vessels detected on radar
8 Estimated number of vessels not in area throughout period, but moving between areas
9 Two vessels sighted; one with 125 tonnes on board and the other estimated to have 346 tonnes on board
10 Trawl fishery by sanctioned vessels
11 Calculated from verified catch weights of two arrested vessels and an estimated catch of 1 290 tonnes from three unidentified vessels with an estimated hold capacity of 430 tonnes green weight. By contrast, by applying a similar estimation procedure as for other subareas, an estimated catch of 600 tonnes was obtained assuming a fishing trip duration of 40 days, a catch per day of 2 tonnes and 2.5 fishing trips per year.
12 No sightings, but reports of vessels in area

Table 5: Estimated total catch (tonnes) by subarea/division of *Dissostichus eleginoides* and *Dissostichus mawsoni* inside[1] and outside[2] the Convention Area for the 2000/01 split-year. Estimates for the 1999/2000 split-year, where available, are in parentheses.

Subarea/ Division	Estimated Total Catch		Reported Catch 2000/01		Estimated Unreported Catch		Unreported Catch as % of the Estimated Total Catch
48.1	-	(-)	0	(-)	probably low		
48.2	-	(-)	0	(-)	probably low		
48.3	3 559	(5 090)	3 259	(4 694)	300	(396)	9
58.4.4	1 704	(-)	164	(-)	1 540	(1 050)	90
58.5.1	8 515	(7 109)	5 215	(5 009)	3 300	(2 100)	39
58.5.2	3 414	(3 379)	1 765	(2 579)	1 649	(800)	48
58.6	2 136	(2 668)	1 476	(688)	660	(1 980)	31
58.7	882	(940)	732	(720)	150	(220)	17
88.1	660	(751)	660	(751)	probably low		
CCAMLR subareas[1]	20 870[1]	(19 937)[1]	13 271	(14 441)	7 599	(6 546)	39
41	11 839[3]						
47	292						
51	9 469[4]						
57	731						
81	27						
87	7 793						
Non-CCAMLR subareas[2]	30 151						
Unknown area	108	(5 765)[5]					
Total all subareas	51 129	(25 702)	13 271	(14 441)	7 599	(6 546)	

1 CCAMLR catch report data
2 Data from CDS, rounded to the nearest tonne
3 Includes 1 412 tonnes reported by Chile
4 Includes an undetermined catch from the portion of the South African EEZ around the Prince Edward Islands which falls within Area 51.
5 5 765 tonnes reported by Mauritius at CCAMLR-XIX after WG-FSA-2000

Table 6: Catches by subarea and year for reported, estimated unreported and estimated total catches (tonnes) of *Dissostichus eleginoides*.

Year	Reported	Estimated Unreported	Estimated Total
Subarea 58.6			
1996/97	333	18 900	19 233
1997/98	175	1 765	1 940
1998/99	1 852	1 748	3 600
1999/00	688	1 980	2 668
2000/01	1 476	660	2 136
Total	4 524	25 053	29 577
Subarea 58.7			
1996/97	2 229	11 900	14 129
1997/98	576	925	1 501
1998/99	205	140	345
1999/00	720	220	940
2000/01	732	150	882
Total	4 462	13 335	17 797
Division 58.5.1			
1996/97	4 681	2 000	6 681
1997/98	4 751	11 825	16 576
1998/99	5 402	620	6 022
1999/00	5 009	2 100	7 109
2000/01	5 215	3 300	8 515
Total	25 058	19 845	44 903
Division 58.5.2			
1996/97	837	7 200	8 037
1997/98	2 418	7 000	9 418
1998/99	5 451	160	5 611
1999/00	2 579	800	3 379
2000/01	1 765	1 649	3 414
Total	13 050	16809	29 859
Subarea 48.3			
1996/97	2 389	0	2 389
1997/98	3 328	0	3 328
1998/99	4 581	350	4 931
1999/00	4 694	396	5 090
2000/01	3 559	300	3 859
Total	18 551	1 046	19 597

Table 7: Reported, estimated unreported and estimated total catches (tonnes) of *Dissostichus eleginoides* by subarea/division for the period 1996/97 to 2000/01.

Subarea/Division	Reported	Estimated Unreported	Estimated Total
Subarea 58.6	4 524	25 053	29 577
Subarea 58.7	4 462	13 335	17 797
Division 58.5.1	25 058	19 845	44 903
Division 58.5.2	13 050	16809	29 859
Total	47 094	75 042	122 136
Subarea 48.3	18 551	1 046	19 597

Table 8: Reported *Dissostichus* spp. landings in FAO Area 51 by Flag State and port of landing for the 2000/01 split-year. (CDS data from the Secretariat.)

Port	No. of Flag States	No. of Landings	Verified Product Weight Landed (tonnes)[2]	Estimated[1] Live Weight (tonnes)[2]
Port Louis	4	5	4 704	6 887
Jakarta	1	1	248	397
Singapore	1	1	575	577
Walvis Bay	2	2	260	369
Montevideo	1	2	216	274
Priok	1	1	602	965
Total	6	12	6 605	9 469

1 Conversion factors used were FLT = 2.3, GUT = 1.1, HAG = 1.6, HAT = 1.7, HGT = 1.7, OTH = 0, WHO = 1

2 Rounded to the nearest whole tonne

Table 9: Estimated live weight (tonnes) of *Dissostichus* spp. reported in the CDS data for the 2000 and 2001 calendar years.

Year/Month	Area/Subarea/Division																			Total
	41	47	47.4	48	48.3	48.4	48.5	51	57	58.4.4	58.5.1	58.5.2	58.6	58.6/7	58.7	81	83	87	88.1	
2000																				
January	9											518						351		877
February	367																	781		1 148
March	465										489							444	670	2 069
April	564	308							6		234	1 096						147		2 355
May	635				36						542		419		44			212		1 888
June	862	28		258	1 847			657			1 227	1 007	4	221				198		6 309
July	578				2 001			560	83		1 035							168		4 424
August	1 368				1 461	36		982	8	98	280		219		131			352		4 936
September	1 238												330	41				404		2 013
October	2 231	287						630	189	21	499	442			82			1 337		5 717
November	2 535							928	141		751	82	144	109	94			1 090		5 875
December	1 081							87			750		488		61			1 201		3 668
Total for 2000	11 933	624	0	258	5 345	36	0	3 844	427	118	5 807	3 144	1 603	371	412	0	0	6 685	670	41 280
2001																				
January	1 075							1 853	168	34	69		369					941		4 508
February	351							220			587	609						562		2 329
March	1 279	5			9			867			292					1	1	482	314	3 249
April	657				8			4 182	292		989		210	13	42			524	223	7 139
May	1 396				130			361			274	607	122	1		26		243	62	3 223
June	728				800							205		31				547		2 310
July	422		71		1 088			1 823			373	193	8		75			137		4 190
August	777				1 076			1 886	340						35			176		4 291
September	429				879			837						33				71		2 249
Total for 2001	7 115	5	71	0	3 992	0	0	12 028	799	34	2 585	1 614	708	78	152	27	1	3 681	599	33 489

Table 10: Seabed areas within the geographic range of *Dissostichus eleginoides*. Bathymetry data source: Sandwell and Smith 2 x 2 minute grids; analysis of seabed areas within the CCAMLR Convention Area: *Statistical Bulletin*, Vol. 13 (2001); analysis of seabed areas outside the CCAMLR Convention Area: CCAMLR Secretariat, April 1999.

Ocean	Area	Boundaries				Seabed Area (km^2) within depth range		
		North	South	West	East	0–500 m	500–600 m	600–1 800 m
Within the CCAMLR Convention Area								
Southwest Atlantic	48.3 Maurice Ewing Bank	50°S	52.3°S	50°W	30°W	0	0	34 608
Southwest Atlantic	48.3 south of Maurice Ewing Bank	52.3°S	57°S	50°W	30°W	0	2 415	32 025
Western Indian	58.7	45°S	50°S	30°E	40°E	1 650	273	12 655
Western Indian	58.6	45°S	50°S	40°E	60°E	18 148	1 964	71 295
Western Indian	58.5.1	45°S	49–53°S	60°E	80°E	117 768	31 416	124 428
Western Indian	58.5.2	49–53°S	55°S	60°E	80°E	46 627	10 974	111 106
Total						184 193	47 042	386 117
Outside the CCAMLR Convention Area								
Western Indian	51	40°S	45°S	30°E	80°E	2	12	30 007
Southwest Atlantic	41	50°S	60°S	70°W	50°W	416 586	18 233	115 838
Total						416 588	18 245	145 845

Table 11: Reported catch versus landed weights (tonnes) for *Dissostichus eleginoides* in Area 48 for the 2000 and 2001 calendar years. It should be noted that the CDS entered into force in May 2000 and no information on landings is therefore available prior to that date. In addition, there is likely to be a time lag between catch reports and landing reports from the CDS.

Year/Month	Catch	Cumulative Catch	Landing	Cumulative Landing
2000				
March	4	4	0	0
April	13	17	0	0
May	1 698	1 715	36	36
June	2 211	3 926	2 105	2 141
July	1 303	5 229	2 001	4 142
2001				
January	4	4	0	0
February	6	10	0	0
March	7	17	9	9
April	20	37	8	17
May	1 294	1 331	130	147
June	989	2 320	800	947
July	970	3 290	1 088	2 035
August	748	4 038	1 076	3 111
September	11	4 049	879	3 990
October	1	4 050	0	3 990

Table 12: Summary of observations on fisheries conducted in the 2000/01 season by designated CCAMLR scientific observers. OTB – bottom trawl, OTM – midwater trawl, LLS – longline system, * – national observers.

Flag State	Vessel	Fishing Method	Observer	Subarea/ Fishery	Period of Observation	Report/Date Submitted	Data Reported
Longline fisheries							
Chile	*Isla Camila*	LLS Spanish	Y. Marín Uruguay	48.3 *D. eleginoides*	1/5–3/6/01	Logbook 23/7/01 Report 4/7/01	Cruise, vessel and IMALF details
Chile	*Isla Camila*	LLS Spanish	C. Tambasco Uruguay	48.3 *D. eleginoides*	9/6–17/8/01	Logbook 2/10/01 Report 2/10/01	Cruise, vessel and IMALF details
Chile	*Isla Santa Clara*	LLS Spanish	S. Hutton UK	48.3 *D. eleginoides*	25/4–1/7/01	Logbook 18/9/01 Report 13/9/01	Cruise, vessel and IMALF details
Chile	*Isla Santa Clara*	LLS Spanish	S. Miney UK	48.3 *D. eleginoides*	1/7–18/7/01	Logbook 24/9/01 Report 13/9/01	Cruise, vessel and IMALF details
Chile	*Maria Tamara*	LLS Spanish	C. Berriolo Uruguay	48.3 *D. eleginoides*	28/6–30/8/01	Logbook 2/10/01 Report 2/10/01	Cruise, vessel and IMALF details
Chile	*Polarpesca I*	LLS Spanish	M. Lozano Uruguay	48.3 *D. eleginoides*	11/6–28/8/01	Logbook 2/10/01 Report 2/10/01	Cruise, vessel and IMALF details
Spain	*Ibsa Quinto*	LLS Spanish	M. Gandolfi UK	48.3 *D. eleginoides*	3/5–12/7/01	Logbook 18/9/01 Report 13/9/01	Cruise, vessel and IMALF details
Spain	*Viking Bay*	LLS Spanish	M. Endicott UK	48.3 *D. eleginoides*	1/5–30/8/01	Logbook 5/10/01 Report 9/10/01	Cruise, vessel and IMALF details
UK	*Argos Georgia*	LLS Spanish	M. Purves South Africa	48.3 *D. eleginoides*	23/4–2/8/01	Logbook 4/10/01 Report 23/9/01	Cruise, vessel and IMALF details
UK	*Argos Helena*	LLS Spanish	G. Morano Spain	48.3 *D. eleginoides*	1/5–29/8/01	Logbook 26/9/01 Report 26/9/01	Cruise, vessel and IMALF details
Korea, Rep. of	*In Sung 66*	LLS Spanish	M. Durham UK	48.3 *D. eleginoides*	26/4–7/7/01	Logbook 13/9/01 Report 13/9/01	Cruise, vessel and IMALF details
Korea, Rep. of	*In Sung 66*	LLS Spanish	N. Mynard UK	48.3 *D. eleginoides*	8/7–11/9/01	Logbook 4/ 10/01 Report 5/10/01	Cruise, vessel and IMALF details
Korea, Rep. of	*No. 1 Moresko*	LLS Spanish	J. Hooper UK	48.3 *D. eleginoides*	30/4–21/7/01	Logbook 13/9/01 Report 22/8/01	Cruise, vessel and IMALF details
Korea, Rep. of	*No. 1 Moresko*	LLS Spanish	J. Bailey UK	48.3 *D. eleginoides*	13/7–11/9/01	Logbook 13/9/01 Report 3/10/01	Cruise, vessel and IMALF details

(continued)

Table 12 (continued)

Flag State	Vessel	Fishing Method	Observer	Subarea/ Fishery	Period of Observation	Report/Date Submitted	Data Reported
New Zealand	*Janas*	LLS Auto	B. Fairhead South Africa	88.1 *Dissostichus* spp.	3/1–28/3/01	Logbook 19/4/01 Report 16/5/01	Cruise, vessel and IMALF details
New Zealand	*San Aotea II*	LLS Auto	M. Dixon South Africa	88.1 *Dissostichus* spp.	2/1–23/5/01	Logbook 30/5/01 Report 30/5/01	Cruise, vessel and IMALF details
New Zealand	*Sonrisa*	LLS Auto	F. Stoffberg South Africa	88.1 *Dissostichus* spp.	10/1–10/3/01	Logbook 9/4/01 Report 18/4/01	Cruise, vessel and IMALF details
Russia	*Rutsava*	LLS Spanish	Z. Uvajeniem Ukraine	48.3 *D. eleginoides*	17/5–25/5/01	Logbook 2/10/01 Report 2/10/01	Cruise, vessel and IMALF details
Russia	*Ural*	LLS Spanish	A. Williams UK	48.3 *D. eleginoides*	22/4–22/8/01	Logbook 18/9/01 Report 28/9/01	Cruise, vessel and IMALF details
Ukraine	*RK-1*	LLS Auto	R. Gater UK	48.3 *D. eleginoides*	21/4–23/6/01	Logbook 13/9/01 Report 13/9/01	Cruise, vessel and IMALF details
Ukraine	*RK-1*	LLS Auto	A. Watson UK	48.3 *D. eleginoides*		Report 9/10/01	Cruise details
Uruguay	*Isla Alegranza*	LLS Spanish	C. Remaggi Argentina	88.1 *Dissostichus* spp.	6/3–18/3/01	OVERDUE	
Uruguay	*Isla Alegranza*	LLS Spanish	H. Hernández Chile	48.3 *D. eleginoides*	1/5–30/8/01	Logbook 4/10/01 Report 4/10/01	Cruise, vessel and IMALF details
Uruguay	*Isla Gorriti*	LLS Auto	C. Vera Chile	88.1 *Dissostichus* spp.	14/1–19/3/01	Logbook 5/6/01 Report 23/8/01	Cruise, vessel and IMALF details
South Africa	*Aquatic Pioneer*	LLA Auto	L. Koen* South Africa	58.6, 58.7 *D. eleginoides*	20/9–20/11/00	Logbook 22/12/00 Report 22/12/00	Cruise, vessel and IMALF details
South Africa	*Eldfisk*	LLS Auto	Stander, Van de Berg* South Africa	58.6, 58.7 *D. eleginoides*	29/11/00–1/1/01	Logbook 9/3/01 Report 9/3/01	Cruise, vessel and IMALF details
South Africa	*Eldfisk*	LLS Auto	M. Saunders New Zealand	88.1 *Dissostichus* spp.	5/2–17/3/01	Logbook 3/5/01 Report 16/5/01	Cruise, vessel and IMALF details
South Africa	*Eldfisk*	LLS Auto	B. Fairhead, H. Crous* South Africa	58.6, 58.7 *D. eleginoides*	2/9–12/11/00	Logbook 22/12/00 Report 22/12/00	Cruise, vessel and IMALF details

(continued)

Table 12 (continued)

Flag State	Vessel	Fishing Method	Observer	Subarea/ Fishery	Period of Observation	Report/Date Submitted	Data Reported
South Africa	*Eldfisk*	LLS Auto	B. Fairhead, H. Crous* South Africa	58.6, 58.7 *D. eleginoides*	7/8–6/9/01	Logbook 11/9/01 Report 5/ 10/01	Cruise, vessel and IMALF details
South Africa	*Eldfisk*	LLS Auto	F. Stoffberg, L. Koen* South Africa	58.6, 58.7 *D. eleginoides*	6/5–11/7/01	Logbook 24/8/01 Report 31/7/01	Cruise, vessel and IMALF details
South Africa	*Isla Graciosa*	LLS Spanish	M. Vercueil* South Africa	58.6, 58.7 *D. eleginoides*	2/10–17/12/00	Logbook 2/4/01 Report 11/1/01	Cruise, vessel and IMALF details
South Africa	*Isla Graciosa*	LLS Spanish	N. Du Plooy* South Africa	58.6, 58.7 *D. eleginoides*	1/4–1/6/01	Logbook 6/7/01 Report 17/7/01	Cruise, vessel and IMALF details
South Africa	*Isla Graciosa*	LLS Spanish	P. Kenney New Zealand	88.1 *Dissostichus* spp.	24/2–26/3/01	Logbook 26/3/01 Report 25/6/01	Cruise, vessel and IMALF details
South Africa	*Isla Graciosa*	LLS Spanish	D. Cole* South Africa	58.6, 58.7 *D. eleginoides*	11/6–7/8/01	Logbook 14/8/01 Report 30/8/01	Cruise, vessel and IMALF details
South Africa	*Koryo Maru 11*	LLS Spanish	H. Crous* South Africa	58.6, 58.7 *D. eleginoides*	24/1–9/4/01	Logbook 24/4/01 Report 24/4/01	Cruise, vessel and IMALF details
South Africa	*Koryo Maru 11*	LLS Spanish	M. Dixon* South Africa	58.6, 58.7 *D. eleginoides*	16/10–6/12/00	Logbook 27/3/01 Report 21/12/00	Cruise, vessel and IMALF details
South Africa	*Koryo Maru 11*	LLS Spanish	L. Fearnehough UK	48.3 *D. eleginoides*	1/5–13/9/01	Logbook 28/9/01 Report 2/10/01	Cruise, vessel and IMALF details
South Africa	*Suidor One*	LLS Spanish	J. Newton* South Africa	58.6, 58.7 *D. eleginoides*	30/7–17/9/01	Logbook 4/10/01 Report 5/10/01	Cruise, vessel and IMALF details
Pot fisheries							
UK	*Argos Georgia*	Pot	M. Purves South Africa		20/1–22/2/01	Logbook 3/4/01 Report 3/4/01	Cruise, vessel and IMALF details
UK	*Argos Helena*	Pot	G. Moreno Spain		15/1–13/2/01	Logbook 3/4/01 Report 3/4/01	Cruise, vessel and IMALF details
UK	*Argos Helena*	Pot	G. Moreno Spain		6/4–26/4/01	Logbook 26/9/01 Report 26/9/01	Cruise, vessel and IMALF details

(continued)

Table 12 (continued)

Flag State	Vessel	Fishing Method	Observer	Subarea/ Fishery	Period of Observation	Report/Date Submitted	Data Reported
Uruguay	*Viking Sky*	Pot	K. Passfield UK		9/3–2/4/01	Logbook 9/5/01 Report 10/5/01	Cruise, vessel and IMALF details
Uruguay	*Viking Sky*	Pot	N. Lock UK		18/5–12/7/01	Logbook 24/9/01 Report 22/8/01	Cruise, vessel and IMALF details
Jig fisheries							
Korea, Rep. of	*In Sung 707*	Jig	S. Miney UK		6/6–1/7/01	Logbook 13/9/01 Report 13/9/01	Cruise, vessel and IMALF details
Trawl fishery							
Australia	*Austral Leader*	OTB	M. Baron* Australia	58.5.2 *D. eleginoides*	12/8–19/10/00	Logbook 22/1/01 Report 30/5/01	Cruise, vessel and IMALF details
Australia	*Austral Leader*	OTM	L. Pshenichnov Ukraine	58.4.2	15/1–26/2/01	Logbook 16/3/01 Report 16/3/01	Cruise, vessel and IMALF details
Australia	*Austral Leader*	OTB	M. Tucker* Australia	58.5.2 *D. eleginoides*	27/2–15/4/01	Logbook 28/6/01 Report 9/10/01	Cruise, vessel and IMALF details
Australia	*Austral Leader*	OTB	J. Taylor* Australia	58.5.2 *D. eleginoides* *C. gunnari*	11/5–17/6/01	Logbook 28/8/01 Report 24/9/01	Cruise, vessel and IMALF details
Australia	*Southern Champion*	OTB	J. Parkinson* Australia	58.5.2 *D. eleginoides* *C. gunnari*	9/10–3/11/00	Logbook 22/1/01 Report 28/9/01	Cruise, vessel and IMALF details
Australia	*Southern Champion*	OTB	B. Stanley* Australia	58.5.2	13/12/00–1/3/01	Logbook 27/7/01	Cruise, vessel and IMALF details
Australia	*Southern Champion*	OTB/OTM	M. Baron* Australia	58.5.2 *D. eleginoides* *C. gunnari*	9/5–26/6/01	OVERDUE	
Chile	*Betanzos*	OTM	J. Bailey UK	48.3 *C. gunnari*	7/12/00–26/2/01	Logbook 3/4/01 Report 4/4/01	Cruise, vessel and IMALF details
France	*Saint Denis*	OTM	M. Endicott UK	48.3 *C. gunnari*	4/12/00–18/1/01	Logbook 5/3/01 Report 6/3/01	Cruise, vessel and IMALF details

(continued)

Table 12 (continued)

Flag State	Vessel	Fishing Method	Observer	Subarea/ Fishery	Period of Observation	Report/Date Submitted	Data Reported
Japan	*Niitaka Maru*	OTM	T. Hatashi* Japan	48	1/12/00–26/1/01	Logbook 31/7/01	Cruise, vessel and IMALF details
Russia	*Zakhar Sorokin*	OTM	E. McManus UK	48.3 *C. gunnari*	1/9–8/9/01	Logbook 26/9/01 Report 9/10/01	Cruise, vessel and IMALF details
UK	*Argos Vigo*	OTM	R. Verge France	48.3 *C. gunnari*	21/12/00– 20/1/01	Logbook 7/5/01 Report 7/5/01	Cruise, vessel and IMALF details
UK	*Argos Vigo*	OTM	R. Verge France	48.3 *C. gunnari*	1/2–20/2/01	Logbook 7/5/01 Report 7/5/01	Cruise, vessel and IMALF details
UK	*Sil*	OTM	R. Wahrich Brazil	48.3 *C. gunnari*	1/6–13/6/01	Logbook 24/9/01 Report 24/9/01	Cruise, vessel and IMALF details
Ukraine	*Foros*	OTM	M. Savich* Ukraine	48	1/5/01–28/10/01		
USA	*Top Ocean*		V. Bibik Ukraine	48.1 *E. superba*	20/5–28/6/01	Logbook 20/6/01 Report 2/10/01	Cruise, vessel and IMALF details

Table 13: Total number of biological records collected by scientific observers during the 2000/01 season.

Species	Length Count	Length range (cm) Min.	Length range (cm) Max.	Weight Count	Sex Count	Maturity Count	Otolith Count
Subarea 48.3							
Amblyraja georgiana	1 066	8	186	962	1 069	473	0
Bathyraja eatonii	5	114	135	5	4	4	0
Bathyraja maccaini	1	15	15	1	1	1	0
Bathyraja meridionalis	199	58	165	185	197	58	0
Bathyraja spp.	2	100	126	2	2	0	0
Raja taaf	266	5	110	266	266	250	0
Rajiformes	6	90	139	6	5	1	0
Electrona carlsbergi	55	9	27	50	26	23	0
Gymnoscopelus nicholsi	15	13	18	0	15	1	0
Myctophidae	16	13	26	16	16	15	0
Muraenolepis microps	11	25	41	7	7	7	0
Muraenolepis spp.	58	22	50	16	2	2	0
Antimora rostrata	289	23	72	105	99	90	24
Macrourus holotrachys	1 331	16	83	409	656	562	175
Macrourus spp.	385	44	85	328	290	283	62
Macrourus whitsoni	65	46	76	40	20	20	0
Dissostichus eleginoides	74 952	42	220	19 252	26 339	26 233	8 475
Gobionotothen gibberifrons	931	27	46	575	863	567	0
Notothenia rossii	40	21	73	38	39	38	0
Notothenia squamifrons	145	28	44	52	12	12	5
Nototheniidae	24	15	52	22	19	18	0
Nototheniops larseni	32	14	23	32	32	28	0
Nototheniops nudifrons	2	20	21	2	2	2	0
Parachaenichthys georgianus	29	13	49	29	29	20	0
Patagonotothen brevicauda	35	11	38	28	31	30	0
Trematomus spp.	1	22	22	1	1	1	0
Chaenocephalus aceratus	220	13	70	215	218	181	0
Chaenodraco wilsoni	99	15	68	99	99	87	0
Champsocephalus gunnari	3 855	10	50	3 378	3 808	3 181	0
Pseudochaenichthys georgianus	792	13	61	773	792	761	0
Mancopsetta maculata	10	19	41	2	1	1	0
Elasmobranchii	4	198	209	4	4	0	0
Osteichthyes	1	39	39	1	1	1	0
Lithodes murrayi	58	10	133	30	58	10	0
Lithodes spp.	14	83	142	14	14	0	0
Lithodidae	11	84	146	11	11	1	0
Paralithodes spp.	479	35	91	55	498	0	0
Paralomis aculeata	27	48	94	11	27	11	0
Paralomis formosa	3 054	5	160	1 435	5 013	1 947	0
Paralomis anamerae	47	6	85	46	60	11	0
Paralomis spinosissima	2 004	39	114	1 240	2 668	604	0
Ommastrephes, Illex	7	12	26	4	0	0	0
Subareas 58.6 and 58.7							
Dissostichus eleginoides	25 224	37	200	19 536	25 179	23 706	3 509
Division 58.4.2							
Bathyraja maccaini	2	61	62.5	2	2	0	0
Macrourus whitsoni	16	38.8	63.4	16	16	16	0
Dissostichus mawsoni	52	32	57.8	52	52	52	0
Notothenia kempi	106	11	41	53	53	53	0

(continued)

Table 13 (continued)

Species	Length Count	Length range (cm) Min.	Max.	Weight Count	Sex Count	Maturity Count	Otolith Count
Division 58.4.2 (continued)							
Pagothenia hansoni	3	23.4	27.6	3	3	3	0
Pleuragramma antarcticum	192	11.5	24.4	43	43	43	0
Trematomus eulepidotus	384	15.4	30.9	232	200	200	0
Trematomus lepidorhinus	6	16.4	29.4	6	4	4	0
Chaenodraco wilsoni	1 381	23	34.6	464	423	423	0
Chionodraco hamatus	25	29.9	45	17	17	17	0
Division 58.5.2							
Somniosus pacificus	1	15.2	15.2	1	1	0	0
Bathyraja eatonii	668	0	119	664	663	0	0
Bathyraja irrasa	136	21.4	139	135	136	0	0
Bathyraja maccaini	4	45.1	104.4	4	4	0	0
Bathyraja murrayi	307	0	88.5	307	304	0	0
Bathyraja spp.	3	31.4	42.4	3	2	0	0
Rajiformes	6	26.4	44.8	6	6	0	0
Macrourus carinatus	199	19.5	67	199	198	162	0
Dissostichus eleginoides	19 636	20	168	19 633	14 986	14 969	0
Champsocephalus gunnari	6 591	17.6	37.7	5 639	1 419	1 418	0
Channichthys rhinoceratus	28	33.3	51.1	28	5	5	0
Subarea 88.1							
Rajiformes	46	41	102	46	44	0	0
Muraenolepis spp.	70	29	54	49	64	64	32
Antimora rostrata	101	39	69	60	70	70	19
Macrourus spp.	1 629	29	94	468	962	962	168
Dissostichus eleginoides	7 028	45	188	6 812	7 028	6 852	2 502
Dissostichus mawsoni	9 353	51	198	8 675	8 490	7 880	3 022
Notothenia kempi	13	29	33.5	13	13	13	13
Nototheniidae	2	42	46	1	0	0	0
Channichthyidae	113	30	61	36	90	90	17

Table 14: Total count of all biological records collected by scientific observers (1996–2001).

Species	Length Count	Length range (cm) Min.	Max.	Weight Count	Sex Count	Maturity Count	Otolith Count
Subareas 48.1 and 48.2							
Dissostichus eleginoides	80	37	168	77	77	77	0
Dissostichus mawsoni	51	41	164	51	51	51	0
Subarea 48.3							
Amblyraja georgiana	1 139	8	186	1 037	1 145	483	29
Bathyraja eatonii	22	69	135	22	21	7	6
Bathyraja irrasa	2	117	124	2	2	0	2
Bathyraja maccaini	8	15	127	8	8	2	1
Bathyraja meridionalis	217	58	165	202	215	58	18
Bathyraja murrayi	45	52	104	45	45	17	8
Bathyraja spp.	2	100	126	2	2	0	0
Raja taaf	266	5	110	266	266	250	0
Rajiformes	20	73	139	52	51	15	0
Electrona carlsbergi	55	9	27	50	26	23	0
Gymnoscopelus nicholsi	15	13	18	0	15	1	0
Myctophidae	16	13	26	16	16	15	0
Muraenolepis microps	11	25	41	7	7	7	0
Muraenolepis spp.	58	22	50	16	2	2	0
Antimora rostrata	327	23	72	142	129	120	53
Moridae	1	46	46	1	1	1	0
Macrourus carinatus	15	59	84	9	10	7	9
Macrourus holotrachys	1 364	16	84	430	670	570	188
Macrourus spp.	588	44	85	530	424	414	188
Macrourus whitsoni	494	44	86	154	171	164	8
Dissostichus eleginoides	352 869	31	240	81 022	127 118	100 382	46 501
Gobionotothen gibberifrons	939	27	46	583	871	575	0
Notothenia neglecta	11	38	67	11	11	11	11
Notothenia rossii	77	21	89	75	76	75	0
Notothenia squamifrons	195	16	44	87	47	47	5
Nototheniidae	117	15	66	22	19	18	0
Nototheniops larseni	32	14	23	32	32	28	0
Nototheniops nudifrons	2	20	21	2	2	2	0
Pagothenia hansoni	1	26	26	1	0	0	0
Parachaenichthys georgianus	29	13	49	29	29	20	0
Patagonotothen brevicauda	90	11	38	83	86	79	0
Trematomus spp.	1	22	22	1	1	1	0
Chaenocephalus aceratus	319	13	70	296	299	261	0
Chaenodraco wilsoni	99	15	68	99	99	87	0
Champsocephalus gunnari	11 897	10	50	11 419	11 850	11 217	0
Pseudochaenichthys georgianus	1 104	13	61	1 085	1 104	1 073	1
Mancopsetta maculata	10	19	41	2	1	1	0
Elasmobranchii	4	198	209	4	4	0	0
Osteichthyes	1	39	39	1	1	1	0
Euphausia spp.	1	76	76	1	1	1	0
Lithodes murrayi	58	10	133	30	58	10	0
Lithodes spp.	14	83	142	14	14	0	0
Lithodidae	11	84	146	11	11	1	0
Paralithodes spp.	479	35	91	55	498	0	0
Paralomis aculeata	27	48	94	11	27	11	0
Paralomis formosa	3 055	5	160	1 435	5 014	1 947	0
Paralomis anamerae	47	6	85	46	60	11	0
Paralomis spinosissima	2 004	39	114	1 240	2 668	604	0
Ommastrephes, Illex	7	12	26	4	0	0	0

(continued)

Table 14 (continued)

Species	Length Count	Length range (cm) Min.	Max.	Weight Count	Sex Count	Maturity Count	Otolith Count
Subareas 58.6 and 58.7							
Rajiformes	29	59	100	0	29	0	0
Antimora rostrata	106	41	68	0	0	0	0
Macrourus whitsoni	24	47	73	0	0	0	0
Dissostichus eleginoides	164 793	33	223	62 439	11 8258	90 226	20 277
Divisions 58.5.2 and 58.4.3							
Bathyraja eatonii	239	43	114.7	239	239	65	0
Bathyraja irrasa	8	81	137	8	8	5	0
Bathyraja murrayi	87	21	48.3	87	87	47	0
Macrourus whitsoni	50	40.6	73.7	50	50	50	0
Dissostichus eleginoides	3 890	30.8	141	3 890	3 890	3 890	0
Dissostichus mawsoni	3	61.4	83.9	3	3	3	0
Notothenia rossii	1	55.3	55.3	1	1	1	0
Pleuragramma antarcticum	3	15.8	20.8	3	3	3	0
Trematomus eulepidotus	59	19.4	24.8	59	59	59	0
Chaenodraco wilsoni	43	23.1	34.1	43	43	43	0
Champsocephalus gunnari	1 544	19.5	64.1	1 544	1 544	1 544	0
Channichthys rhinoceratus	195	31.7	62.8	195	195	195	0
Chionodraco hamatus	11	28.4	34	11	11	11	0
Neopagetopsis ionah	13	34.3	51.1	13	13	13	0
Division 58.4.2							
Bathyraja maccaini	2	61	62.5	2	2	0	0
Macrourus spp.	410	44	101	184	149	159	0
Macrourus whitsoni	16	38.8	63.4	16	16	16	0
Dissostichus eleginoides	2 171	41	185	301	1 227	1 227	318
Dissostichus mawsoni	52	32	57.8	52	52	52	0
Notothenia kempi	106	11	41	53	53	53	0
Pagothenia hansoni	3	23.4	27.6	3	3	3	0
Pleuragramma antarcticum	192	11.5	24.4	43	43	43	0
Trematomus eulepidotus	384	15.4	30.9	232	200	200	0
Trematomus lepidorhinus	6	16.4	29.4	6	4	4	0
Chaenodraco wilsoni	1381	23	34.6	464	423	423	0
Chionodraco hamatus	25	29.9	45	17	17	17	0
Division 58.5.2							
Somniosus pacificus	1	15.2	15.2	1	1	0	0
Bathyraja eatonii	1 128	9	150	1 126	1 123	9	0
Bathyraja irrasa	200	21.4	139	199	200	8	0
Bathyraja maccaini	15	9.4	140	5	15	1	0
Bathyraja murrayi	449	9.4	105	434	439	6	0
Bathyraja spp.	3	31.4	42.4	3	2	0	0
Rajiformes	6	26.4	44.8	6	6	0	0
Macrourus carinatus	199	19.5	67	199	198	162	0
Dissostichus eleginoides	59 665	19.2	172	56 603	44 401	43 886	0
Notothenia squamifrons	1 884	8.2	87.4	1 360	1 321	1 196	0
Champsocephalus gunnari	20 211	9.6	88.7	8 780	5 106	4 998	0
Channichthys rhinoceratus	2 623	9.8	77	1 342	681	664	0
Chionodraco rastrospinosus	13	12.6	34.3	0	0	0	0
Subarea 88.1							
Rajiformes	46	41	102	46	44	0	0
Muraenolepis spp.	70	29	54	49	64	64	32
Antimora rostrata	94	39	68	55	67	67	19
Macrourus spp.	1 629	29	94	468	962	962	168

(continued)

Table 14 (continued)

Species	Length Count	Length range (cm)		Weight Count	Sex Count	Maturity Count	Otolith Count
		Min.	Max.				
Subarea 88.1 (continued)							
Dissostichus eleginoides	7 118	45	188	6 871	7 112	6 933	2 582
Dissostichus mawsoni	32 335	45	205	23 796	31 332	26 727	6 381
Notothenia kempi	13	29	33.5	13	13	13	13
Nototheniidae	2	42	46	1	0	0	0
Channichthyidae	113	30	61	36	90	90	17

Table 15: Conversion factors (CFs) obtained from scientific observers and vessel skippers during the 2000/01 fishing season.

Vessel	Dates	Observer CF	Vessel CF	Observations
Subarea 48.3				
Argos Georgia	7/6–25/7/01	1.67	1.67	Averaged value
Argos Helena	4/5–21/8/01	1.73	1.64 1.74	Start and end of the season
Ibsa Quinto	3/5–11/7/01	1.74	1.64 1.74	Start and end of the season
In Sung 66	1/5–6/7/01	1.8	1.64 1.74	Start and end of the season
In Sung 66	8/7–11/9/01	1.88	1.74	
Isla Alegranza	1/5–30/8/01	1.72	1.64 1.74	Start and end of the season
Isla Camila	12/6–20/7/01	1.52	1.43	
Isla Camila	1/5–28/5/01	1.53	1.43	
Isla Santa Clara	30/6–17/7/01	1.91	1.74	
Isla Santa Clara	1/5–30/6/01	1.8	1.64 1.74	Start and end of the season
Koryo Maru 11	21/5–31/8/01	1.74	1.64 1.74	Start and end of the season
Maria Tamara	14/7–20/7/01	1.53	1.43	
No. 1 Moresko	17/7–30/8/01	1.9	1.74	
No. 1 Moresko	5/5–6/7/01	1.71	1.64 1.74	Start and end of the season
Polarpesca I	10/6–27/6/01	1.69	1.69	
RK-1	4/5–19/6/01	1.67	1.64	Averaged value
RK-1	24/6–30/8/01	1.71	1.74	
Rutsava	17/5–25/5/01		1.56	
Ural	6/5–7/8/01	1.68	1.64 1.74	Start and end of the season
Viking Bay	1/5–30/8/01	1.84	1.64 1.74	Start and end of the season
Subareas 58.6 and 58.7				
Aquatic Pioneer	25/9–12/11/00	1.67	1.6	
Eldfisk	7/9–6/11/00	1.76	1.6	
Eldfisk	11/5–4/7/01	1.6	1.65	
Eldfisk	9/8–11/9/ 01	1.67	1.7	
Eldfisk	4/12–10/12/00	1.56		
Isla Graciosa	7/10–11/12/00	1.7		
Isla Graciosa	22/4–25/5/01	1.8		
Isla Graciosa	15/6–30/7/01	1.84		
Koryo Maru 11	5/2–2/4/01	1.77		
Koryo Maru 11	20/10–29/11/00	1.71		
Suidor One	30/7–7/9/01	1.69	1.7	
Viking Sky	16/3–4/4/01	1.59		Averaged value
Viking Sky	18/5–14/7/01	1.57		
Subarea 88.1				
Eldfisk	20/2–17/3/01	1.56		
Isla Alegranza	6/3–18/3/01			Report overdue
Isla Gorriti	29/1–3/3/01	1.57	1.57	
Isla Graciosa	12/3–18/3/01	1.84		
Janas	14/1–26/3/01	1.51	1.6	
San Aotea II	14/1–17/5/01	1.56		
Sonrisa	22/1–28/2/01	1.61	1.75	
Sonrisa	22/1–28/2/01	1.67	1.6	
Division 58.5.2				
Austral Leader	27/2–7/5/01	1.69		
Austral Leader	12/8–19/10/00	1.77	1.74	Averaged value
Austral Leader	11/5–20/6/01	1.75	1.74	
Southern Champion	9/10–5/11/00	1.8		
Southern Champion	9/10–5/11/00	1.78		

Table 16: Total catches (tonnes) for exploratory fisheries of target species reported from CCAMLR fisheries managed under conservation measures in force in 2000/01. Source of data: 5-day, 10-day or monthly catch and effort reports submitted by 7 October 2001 (COMM CIRC 01/61).

Target Species	Region	Fishery Gear	Fishing Season		Conservation Measure	Catch (tonnes) of Target Species				Catch (% Limit)
			Start	End		Limit	Fishery	*Other	Total	
Chaenodraco wilsoni	58.4.2	Trawl	1 Dec 00	30 Nov 01	212/XIX	500	11	0	11	2
Dissostichus spp.	48.6 north of 60°S	Longline	1 Mar 01	31 Aug 01	202/XIX	455	0	0	0	0
Dissostichus spp.	48.6 south of 60°S	Longline	15 Feb 01	15 Oct 01	202/XIX	455	0	0	0	0
Dissostichus spp.	58.4 BANZARE Bank	Trawl	1 Dec 00	30 Nov 01	203/XIX	150	0	0	0	0
Dissostichus spp.	58.4 BANZARE Bank	Longline	1 May 01	31 Aug 01	204/XIX	300	0	0	0	0
Dissostichus spp.	58.4.2	Trawl	1 Dec 00	30 Nov 01	207/XIX	500	0	0	0	0
Dissostichus spp.	58.4.3 Elan Bank	Longline	1 May 01	31 Aug 01	206/XIX	250	0	0	0	0
Dissostichus spp.	58.4.3 Elan Bank	Trawl	1 Dec 00	30 Nov 01	205/XIX	145	0	0	0	0
Dissostichus spp.	58.4.4 north of 60°S	Longline	1 May 01	31 Aug 01	208/XIX	370	0	0	0	0
Dissostichus spp.	58.6	Longline	1 May 01	31 Aug 01	209/XIX	450	0	0	0	0
Dissostichus spp.	88.1 north of 65°S	Longline	1 Dec 00	31 Aug 01	210/XIX	175	66	0	66	38
Dissostichus spp.	88.1 south of 65°S	Longline	1 Dec 00	31 Aug 01	210/XIX	1 889	592	0	592	31
Dissostichus spp.	88.2 south of 65°S	Longline	15 Dec 00	31 Aug 01	211/XIX	250	0	0	0	0
Martialia hyadesi	48.3	Jig	1 Dec 00	30 Nov 01	213/XIX	2 500	2	0	2	0

* Other fisheries in the region

Table 17: Summary of notifications for new and exploratory fisheries in 2001/02. The reference to the individual notifications is included. These notifications are summarised in SC-CAMLR-XX/BG/10.

Member	Subarea/Division	Target Species	Fishery	Notification
Australia	58.4.2	*Macrourus* spp.	New bottom trawl	CCAMLR-XX/7
Australia	58.4.2	*C. wilsoni* *L. kempi* *T. eulepidotus* *P. antarcticum*	Exploratory midwater trawl	CCAMLR-XX/5
Australia	58.4.2	*Dissostichus* spp.	Exploratory bottom trawl	CCAMLR-XX/6
Chile	58.6	*D. eleginoides*	Exploratory longline	CCAMLR-XX/8
France	58.4.3, 58.4.4, 58.6	*D. eleginoides*	Exploratory longline	CCAMLR-XX/9
Japan	48.6, 58.4.1, 58.4.3, 58.4.4, 58.6, 88.1, 88.2	*Dissostichus* spp.	Exploratory longline	CCAMLR-XX/10[b]
New Zealand	88.1, 88.2	*Dissostichus* spp.	Exploratory longline	CCAMLR-XX/11[b]
New Zealand	48.6, 58.4.4, 88.3[a]	*Dissostichus* spp.	Exploratory longline	CCAMLR-XX/12[b]
Russia	88.1	*Dissostichus* spp.	Exploratory longline	CCAMLR-XX/13
Russia	88.2	*Dissostichus* spp.	Exploratory longline	CCAMLR-XX/14
South Africa	48.6, 58.4.4, 58.6, 88.1, 88.2	*Dissostichus* spp.	Exploratory longline	CCAMLR-XX/15
Uruguay	48.6	*Dissostichus* spp.	Exploratory longline	CCAMLR-XX/16
Uruguay	58.4.4	*Dissostichus* spp.	Exploratory longline	CCAMLR-XX/17

[a] Notification withdrawn for this subarea
[b] See also addendum

Table 18: Summary of intended catches and number of vessels per area in new and exploratory fisheries notifications for *Dissostichus* spp. in the 2001/02 season. In each cell: top figure – number of vessels nominated; middle letter L – longline, T – trawl; bottom figure – intended catch; N – north, S – south. Figures in parentheses in the 'Total notifications' and 'Maximum no. of vessels' rows are values for the 2000/01 season notifications.

Country	48.1	48.2	48.4	48.6	58.4.2	58.4.1/58.4.3	58.4.4	58.5.1	58.5.2	58.6	58.7	88.1	88.2	88.3	Intended Catch
Australia					2 T 500 t										
Chile										1 L[a] 200 t					
France						2 L[b]	2 L			2 L[a]					CCAMLR-XX
Japan				1 L 250 t (N) 250 t (S)		1 L 100 t	1 L 60 t			1 L 100 t		1 L 60 t (N) 500 t (S)	1 L 60 t		
New Zealand				2 L 455 t (N) 455 t (S)			2 L 370 t					4 L 175 t (N) 1 889 t (S)	3 L 250 t	2 L 455 t	
Russia												4 L 175 t (N) 1 889 t (S)	1 L 250 t		
South Africa				Up to 3 L 250 t (N) 250 t (S)			Up to 3 L 60 t			Up to 3 L[a] 100 t		Up to 2 L 60 t (N) 500 t (S)	Up to 2 L 100 t		
Uruguay				1 or 2 L 400 t			1 or 2 L 400 t								
Total notifications	0 (1)	0 (2)	0 (1)	4 (3)	1 (2)	2 (3)	5 (6)	0 (3)	0 (2)	4 (3)	0 (1)	4 (4)	4 (3)	1 (2)	
Maximum no. of vessels	0 (3)	0 (5)	0 (2)	8 (8)	2 (5)	3 (8)	10 (14)	0 (8)	0 (5)	7 (9)	0 (3)	11 (10)	7 (7)	2 (5)	
Catch limit set at CCAMLR-XIX	0	0	28 t	455 t (N of 60°S) 455 t (S of 60°S)	Trawl 500 t	Trawl: 145 t Elan 150 t BANZARE Longline: 250 t Elan 300 t BANZARE	370 t (N of 60°S)	0[c]	0[c]	450 t	0	175 t (N of 65°S) 1 889 t (S of 65°S)	250 t (S of 65°S)	0	

[a] Outside EEZs
[b] French proposal is for Division 58.4.3 only
[c] Based on Scientific Committee advice that these fisheries are unlikely to be viable

Table 19: Fishery summary. ANI – *Champsocephalus gunnari*, ELC – *Electrona carlsbergi*, GRV – *Macrourus* spp., KCX – Lithodidae, KRI – *Euphausia superba*, MZZ – *Osteichthyes* spp., NOS – *Lepidonotothen squamifrons*, NOT – *Patagonotothen guntheri*, SQS – *Martialia hyadesi*, TOP – *Dissostichus eleginoides*, TOT – *Dissostichus* spp., T – trawl, L – longline, P – pot, J – jig.

Subarea/ Division	Target Species	Fishery Type	Year of Notification(s)	First Year of Reported Catches	Mean Annual Catch[a]	Most Recent Assessment	Year of Assessment	Assessment Currency	Fishery Plan	Current Year			
										No. of Notifications	No. of Vessels Notified	Recommended Catch Limit (tonnes)	Modifications to Existing CMs
48	KRI	T		1972	91 676	GYM	2000	Multi-year in absence of surveys	Yes				
48.1	TOT	L	1997, 2000	1997	1	Prospecting default arrangement	1997	Multi-year in absence of surveys or fishery-based research information	No				
48.2	TOT	L	1997, 2000	1997	<1	Prospecting default arrangement	1997	Multi-year in absence of surveys or fishery-based research information	No				
48.3	ANI	T		1972	1 452	Short-term Assessment	2000	2 years following survey	Yes			5 557	No closed season, research hauls, closed area, see paragraphs 4.244 to 4.246
48.3	ELC	T		1992	0				No				
48.3	KCX	P	1993	1995	3				No			1 600	Change in minimum legal size, see paragraph 4.273
48.3	NOT	T	1990						No				
48.3	SQS	J	1995, 1996, 1997, 2000	1995	81				No			2 500	
48.3	TOP	L		1987	4 024	GYM	2000	Multi-year in absence of surveys	No			5 820	
48.3	TOP	P		2000	60	GYM – combined with longline	2000	Multi-year in absence of surveys	No				
48.4	TOP	L		1993	0				No			28	Validity of existing assessment, see paragraph 4.118
48.6	TOP	L	1996, 1997, 1998, 1999, 2000, 2001	1998	<1	Prospecting default arrangement	2000	Multi-year in absence of surveys or fishery-based research information	No	4	8	[b]	
58.6	TOP	L	1996, 1997, 1998, 1999, 2000, 2001	1997	3	Prospecting default arrangement	2000	Multi-year in absence of surveys or fishery-based research information	No	4	7	[b]	Concern about stock, see paragraph 4.15
58.7	TOP	L	1995, 1996, 1997, 1998, 2000	1997	<1	Fishery closed		Until survey and reassessment	No				
88.1	TOT	L	1996, 1997, 1998, 1999, 2000, 2001	1996	348	Prospecting default arrangement	2000	Multi-year in absence of surveys or fishery-based research information	No	4	11	2 508	Boundary of SSRU D, see paragraph 4.79

(continued)

Table 19 (continued)

Subarea/ Division	Target Species	Fishery Type	Year of Notification(s)	First Year of Reported Catches	Mean Annual Catch [a]	Most Recent Assessment	Year of Assessment	Assessment Currency	Fishery Plan	Current Year			
										No. of Notifications	No. of Vessels Notified	Recommended Catch Limit (tonnes)	Modifications to Existing CMs
88.2	TOT	L	1996, 1997, 1999, 2000, 2001	1996	<1	Prospecting default arrangement	2000	Multi-year in absence of surveys or fishery-based research information	No	4	7	[b]	
88.3	TOT	L	1997, 2000	1997	<1				No				
58.4.1	KRI	T		1976	0				No				
58.4.1	TOT	L	2000						No				
58.4.1	TOT	T	1998	1998	<1				No				
58.4 BANZARE (58.4.1/58.4.3)	TOT	T	1999, 2000	1999	<1	Prospecting default arrangement	2000	Multi-year in absence of surveys or fishery-based research information	No				
58.4 BANZARE (58.4.1/58.4.3)	TOT	L	1999, 2000, 2001			Prospecting default arrangement	2000	Multi-year in absence of surveys or fishery-based research information	No	1	2	[b]	
58.4.2	KRI	T		1974	0				No				
58.4.2	GRV	T	2001						No	1	2	[b]	
58.4.2	TOT	L	2000			Prospecting default arrangement	2000	Multi-year in absence of surveys or fishery-based research information	No				
58.4.2	mix [c]	T	1999, 2000	1999	5	Prospecting default arrangement	2000	Multi-year in absence of surveys or fishery-based research information	No	1	2	[b]	
58.4 Elan (58.4.3)	TOT	L	1996, 1997, 1998, 1999, 2000			Prospecting default arrangement	2000	Multi-year in absence of surveys or fishery-based research information	No	2	3	[b]	
58.4 Elan (58.4.3)	TOT	T	1995, 1996, 1997, 1998, 2000	1996	<1	Prospecting default arrangement	2000	Multi-year in absence of surveys or fishery-based research information	No				
58.4.4	NOS	T	1991		0				No				
58.4.4	TOP	L	1997, 1998, 1999, 2000, 2001	1999	50	Prospecting default arrangement	2000	Multi-year in absence of surveys or fishery-based research information	No	5	10	103	
58.5.1	TOP	L	2000										
58.5.2	ANI	T		1999		Short-term assessment	2000	2 years following survey	No			885	
58.5.2	TOP	L	2000										
58.5.2	TOP	T		1996		GYM	2000	Multi-year in absence of surveys	No			2 815	
58.5.2	MZZ	T	1995, 1996	1995	<1				No				

Table 20: Assessment of precautionary long-term annual yield for the exploratory fishery by SSRU for *Dissostichus* spp. in Subarea 88.1 and for all SSRUs combined for *Dissostichus eleginoides* in Division 58.4.4 based on fished seabed area.

	88.1					58.4.4	48.3
	A	B	C	D	E		
Fished seabed area (km^2)	3 109	12 197	10 141	27 347	11 085	10 893	32 035
Selectivity (mean)	135	100	115	80	80	55	75
Selectivity (range)	30	80	50	20	20	30	20
Ratio total: recruited biomass	2.550	1.393	1.651	1.131	1.131	1.056	1.158
γ	0.0485	0.040	0.042	0.038	0.038	0.032	0.034
CPUE ratio	0.225	0.259	0.520	0.348	0.479	0.133	1.0
Precautionary yield	342	698	1 450	1 621	905	206	(5 000)

Table 21: Parameters input to the GYM for evaluation of γ for the exploratory fishery for *Dissostichus mawsoni* in Subarea 88.1.

Category	Parameter	*D. mawsoni* Longline
Age structure	Recruitment age	4
	Plus class accumulation	35
	Oldest age in initial structure	55
Recruitment	SD $\log_e$ (recruits)	0.803
Natural mortality	Mean annual M	0.15–0.22
von Bertalanffy growth	t_0	0.04
	L_8	180.2
	k	0.095
Weight at age	Weight–length parameter – A	0.000007
	Weight–length parameter – B	3.0965
Maturity	L_{m50}	100.0
	Range: 0 to full maturity	30.0
Spawning season		01/08
Simulation characteristics	Number of runs in simulation	1 001
	Depletion level	0.2
	Seed for random number generator	-24 189
Characteristics of a trial	Years to remove initial age structure	1
	Observations to use in median SB_0	1 001
	Year prior to projection	1997
	Reference start date in year	01/12
	Increments in year	180
	Years to project stock in simulation	35
	Reasonable upper bound for annual F	5.0
	Tolerance for finding F in each year	0.000001
Fishing mortality	Length, 50% recruited	80.0
	Range over which recruitment occurs	30.0

Table 22: Summary of precautionary yields, catch limits and catches for *Dissostichus* spp. in Subarea 88.1 and *Dissostichus eleginoides* in Division 58.4.4 for the 2000/01 and 2001/02 seasons.

	2000/01			2001/02	
	Yield[1]	Catch limit	Catch	Yield	Yield*0.5
Subarea 88.1					
SSRU A	175	175	67	342	171
SSRU B	1 889	472	287	698	349
SSRU C		472	184	1 450	725
SSRU D		472	46	1 621	811
SSRU E		472	75	905	453
Total	2 063	2 063	659	5 016	2 508
Division 58.4.4					
Total	(370)	370	164	206	103

[1] Yield in 2000/01 multiplied by a 0.5 discount factor

Table 23: Standardised series of CPUEs in kg/hook for *Dissostichus eleginoides* in Subarea 48.3.

Season	Std. CPUE	SE
1986/87	0.582	0.025
1987/88	0.739	0.057
1988/89	0.537	0.027
1989/90	-	-
1990/91	0.529	0.023
1991/92	0.648	0.015
1992/93	0.771	0.018
1993/94	0.635	0.025
1994/95	0.615	0.012
1995/96	0.362	0.007
1996/97	0.280	0.006
1997/98	0.280	0.006
1998/99	0.320	0.007
1999/00	0.347	0.006
2000/01	0.338	0.007

Table 24: Proportion of non-zero catches by season in the haul-by-haul data for *Dissostichus eleginoides* in Subarea 48.3.

Season	Proportion
1985/86	0.977
1986/87	0.976
1987/88	0.975
1988/89	1.000
1989/90	-
1990/91	0.960
1991/92	0.965
1992/93	0.973
1993/94	0.946
1994/95	0.993
1995/96	0.978
1996/97	0.977
1997/98	0.981
1998/99	0.988
1999/00	0.983
2000/01	0.994

Table 25: Average age-specific vulnerabilities from 1998 to 2001 for Subarea 48.3.

Age	Vulnerability
4–5	0.00
5–6	0.29
6–7	0.89
7–8	1.00
8–9	1.00
9–10	1.00
10–11	0.97
11–12	0.91
12–13	0.85
13–14	0.79
14–15	0.73
15–16	0.67
16–17	0.64
17–18	0.64
18–19	0.64
19–20	0.64
20+	0.64

Table 26: Cohort strengths of *Dissostichus eleginoides* from surveys undertaken in Subarea 48.3 since 1987. Observed and expected data, the closeness of which indicates the quality of the fit, are from the mixture analyses.

Survey Year	Country	Time (years) since previous 1 December	Area (km^2)	Observed	Expected	Age 3		Age 4		Age 5		Age 6		Age 7	
						Density ($n.km^{-2}$)	SE	Density ($n.km^{-2}$)	SE	Density ($n.km^{-2}$)	SE	Density ($n.km^{-2}$)	SE	Density ($n.km^{-2}$)	SE
1987	USA/Poland	0.99	40 993	49.8	47.3	20.5	7.1	26.9	4.4						
1988	USA/Poland	0.08	40 993	21.3	22.1			14.5	11.3	8.7	12.6				
1990	UK	0.17	40 993	468.5	473.3	165.1	116.8	195.9	105.1	85.1	42.0	32.3	19.7		
1992	UK	0.17	40 993	287.6	281.2	281.4	174.4								
1994	Argentina	0.25	40 993	48.0	49.6	2.6	2.7	47.4	9.3						
1994	UK	0.17	40 993	122.5	125.9	36.3	20.1	89.8	32.6						
1995	Argentina	0.25	40 993	60.5	65.6	8.3	5.2	21.9	9.2	35.7	8.8				
1996	Argentina	0.33	40 993	167.9	165.3	114.6	44.2	16.9	6.0	22.7	9.8	18.5	10.0		
1997	Argentina	0.33	40 993	122.9	124.8	25.0	8.2	45.8	15.5	15.6	9.2	17.5	6.0	8.6	6.4
1997	UK	0.82	40 993	100.4	111.3	51.0	33.7	37.2	37.3	24.2	37.1				
2000	UK	0.17	40 993	140.3	126.0	38.2	11.6								

Table 27: Time series of recruitments (millions of fish) for *Dissostichus eleginoides* in Subarea 48.3 from the assessments over the last three years. The year indicates the year at the birthday of the fish, which is likely to be the calendar year before the survey. These recruitment series are estimated from cohort densities in Table 16 based on a value for natural mortality, M = 0.165 y^{-1}.

Year Age 4 Birthday	Assessment 1999	Assessment 2000	Assessment 2001
1986	1.146	1.108	1.347
1987	0.722	0.747	0.980
1988	4.106	4.377	4.187
1989	8.055	8.282	8.174
1990	5.786	5.739	5.842
1991	no obs	no obs	no obs
1992	10.19	5.815	10.287
1993	2.061	2.053	1.888
1994	0.961	1.006	0.950
1995	0.701	0.718	0.633
1996	2.649	2.405	2.652
1997	1.119	0.962	1.037
1998		0.386	no obs
1999		no obs	no obs
2000		1.496	1.522
2001		1.927	
Mean	3.185	2.517	3.292
CV	1.01	0.95	0.97

Table 28: Input parameters for the GYM to assess the long-term annual yield of *Dissostichus eleginoides* taken by longline and pots in Subarea 48.3 and by trawl in Division 58.5.2.

Category	Parameter	Subarea 48.3 Longline and Pots	Division 58.5.2 Trawl
Age structure	Recruitment age	4	4
	Plus class accumulation	35	35
	Oldest age in initial structure	55	55
Recruitment		See Table 26	See Table 32
Natural mortality	Mean annual M	0.132–0.198	0.132–0.198
von Bertalanffy growth	t_0	-0.21 years	-2.46[1] years
	L_∞	1 946 mm	2 465 mm
	k	0.066 year^{-1}	0.029 year^{-1}
Weight at age	Weight–length parameter – A (kg)	3.96E-08 kg	2.59E-09 kg
	Weight–length parameter – B	2.8	3.2064
Maturity	L_{m50}	930	930
	Range: 0 to full maturity	780–1 080	780–1 080
Spawning season		1 Aug–1 Aug	1 Jul–1 Jul
Simulation characteristics	Number of runs in simulation	1 001	1 001
	Depletion level	0.2	0.2
	Seed for random number generator	-24 189	-24 189
Characteristics of a trial	Years to remove initial age structure	1	1
	Observations to use in median SB_0	1 001	1 001
	Year prior to projection	1988	1985
	Reference start date in year	01/12	01/12
	Increments in year	365	365
	Vector of known catches	See Table 29	See Table 29
	Years to project stock in simulation	35	35
	Reasonable upper bound for annual F	5.0	5.0
	Tolerance for finding F in each year	0.000001	0.000001
Fishing mortality		See Table 29	See Table 29

[1] Adjusted from estimated parameter of t_0 = -2.56 years to start of fishing season on 1 December

Table 29: Catch history and fishing vulnerabilities for *Dissostichus eleginoides* in Subarea 48.3. Year corresponds to first year of season. A single-vulnerability function to be applied over a number of years is only shown in the first year of that series.

First Year of Season	Catch (Reported and IUU) (tonnes)	2000 Assessment Single Function for Whole Catch Series	2001 Assessment
1989	8 501	mm (vuln) 550 (0), 790 (1)	mm (vuln) 550 (0), 790 (1)
1990	4 206		
1991	7 309		
1992	5 589		
1993	6 605		
1994	6 171		
1995	4 362		
1996	2 619		age (vuln) 0–4 (0), 5–6 (0.29), 6–7 (.89), 7–10 (1.0), 10–11 (.97), 11–12 (.91), 12–13 (.85), 13–14 (.79), 14–15 (.73), 15–16 (.67), 16+ (.64)
1997	3 201		
1998	4 300		
1999	5 337		
2000	4 354		

Table 30: Results of assessments of yield according to the CCAMLR decision rules for *Dissostichus eleginoides* in Subarea 48.3 using the GYM.

Trial	Lowest Catch giving 0.1 Probability of Depletion to 20% (tonnes)	Median Escapement
1. Only revised recruitment series based on mean M = 0.165 year^{-1}, last year's selectivity	4 438	0.54
2. Cohort densities used in place of recruitment series (internal consistency with M)	5 868	0.56
3. Cohort densities plus varying fishing vulnerability after 1997	5 675	0.55
– with CPUE adjustment	5 820	

Table 31: Cohort strengths of *Dissostichus eleginoides* from surveys undertaken in Division 58.5.2 since 1990. Observed and expected data are from the mixture analyses, the closeness of which indicates the quality of the fit.

Survey Year	Time	Area (km^2)	Observed	Expected	Age 3		Age 4		Age 5		Age 6		Age 7		Age 8	
					Density ($n.km^{-2}$)	SE	Density ($n.km^{-2}$)	SE	Density ($n.km^{-2}$)	SE	Density ($n.km^{-2}$)	SE	Density ($n.km^{-2}$)	SE	Density ($n.km^{-2}$)	SE
1990	0.58	97 106	107.2	108.1	8.1	5.9	33.5	13.6	20.2	11.3	0.8	11.5	25.2	14.1		
1992	0.25	70 271	51.7	51.8	14.1	5.2	13.2	7.0	14.5	7.9	3.4	4.5	0.02	5.5	2.1	3.3
1993	0.85	71 555	97.4	1 14.7	13.6	8.8	38.3	18.2	8.2	13.5	17.0	12.6	3.1	30.3	20.9	16.3
1999	0.41	85 428	366.2	357.9	17.7	7.9	16.2	13.3	138.1	42.7	56.8	55.3	60.9	50.9	40.3	38.2
2000	0.55	41 145	185.0	179.5	28.1	5.3	22.0	8.0	47.8	14.9	59.1	20.6	7.6	15.1	11.0	11.4
2001	0.56	85 170	247.5	252.4	19.5	7.8	34.0	12.9	38.2	20.5	45.5	30.8	32.2	42.4	16.7	41.1

Table 32: Time series of recruits (millions of fish) for *Dissostichus eleginoides* in Division 58.5.2 based on a mean M of 0.165 $year^{-1}$.

Year at Age 4 Birthday	WG-FSA (2000)	Revised Time Series based on New Growth Parameters
1986		4.321
1987	1.550	0.120
1988	1.590	2.586
1989	3.649	3.790
1990	1.956	1.118
1991	1.793	0.667
1992	4.575	1.447
1993	2.435	0.825
1994	2.944	7.205
1995	5.674	9.226
1996	9.548	7.295
1997	21.557	15.043
1998	3.440	3.487
1999	1.059	2.291
2000	0.241	1.465
2001	0.152	1.632
Mean	4.144	3.907
CV	1.297	1.021

Table 33: Catch history and fishing vulnerabilities for *Dissostichus eleginoides* in Division 58.5.2. Year corresponds to first year of season. A single-vulnerability function to be applied over a number of years is only shown in the first year of that series.

First Year of season	2000 Assessment		2001 Assessment	
	Catch (Reported and IUU) (tonnes)	Vulnerability (vuln.) Single Function for Whole Catch Series	Catch (Reported and IUU) (tonnes)	Vulnerability (vuln.)
1995		age (vuln) 0(0.), 3(0), 3.92(0.016), 4.88(0.207), 5.54(0.473), 5.88(0.512), 6.57(0.708), 7.29(0.886), 7.65(0.909), 8.02(0.745), 8.40(0.691), 8.78(0.642), 9.56(0.485), 9.96(0.325), 10.37(0.222), 11.2(0.099), 11.63(0.066), 12.07(0.049), 12.51(0.033), 13.43(0.014), 14.87(0.011), 16.40(0.008), 21.04(0.005), 25.21(0.002), 31.0(0.0)	17 094	mm (vuln) 550 (0), 790 (1)
1996	18 960		1 866	age (vuln) 0.0 (0), 6.0 (0.0), 7.0 (1), 7.9 (1), 8.0 (0)
1997	3 913		3 913	age (vuln) 0.0 (0), 6.0 (0.0), 10.0 (1), 10.0 (1),12.0 (0)
1998	3 628		3 628	age (vuln) 0.0 (0), 5.5 (0.0), 6.0 (1), 13.0 (1), 15.0 (0)
1999	4 385		4 385	age (vuln) 0.0 (0), 4.0 (0.0), 8.0 (1), 14.0 (1), 15.0 (0)
2000	4 644		4 644	

Table 34: Results of assessments of yield according to the CCAMLR decision rules for *Dissostichus eleginoides* in Division 58.5.2 using the GYM.

Trial	Lowest Catch giving 0.1 Probability of Depletion to 20% (tonnes)	Median Escapement is 50% (tonnes)
1. New parameters with vulnerability from last year; IUU included with trawl catch in 1996/97.	2 574	2 314
2. As for 1. but IUU separated from 1996/97 catch and projected in 1995/96 year with 48.3 selectivity from that time, trawl fishery has vulnerability as applied last year.	2 521	2 395
3. As for 2. but with trawl fishery having separate vulnerabilities each year.	2 959	2 815
4. As for 3. but with M = 0.1–0.16.	3 750	3 369

Table 35: Growth parameters for *Champsocephalus gunnari* in Subarea 48.3 estimated during the 2001 meeting and used previously by WG-FSA for the short-term projection.

Parameters	Curve Fitted to Russian Data Age 8+	Curve Fitted to Russian Data Age 11+	Curve Fitted to Polish Age Readings	Curve used 1997–2000
t_0	-0.58	-0.98	-0.63	0.00
L_∞	55.76	65.33	83.54	45.50
k	0.17	0.12	0.12	0.33

Table 36: Growth parameters reported previously for *Champsocephalus gunnari* in Subarea 48.3 and methods used.

Parameters	Olsen 1955, Ford-Walford	Kock 1981, Ford-Walford	Kock 1981, Non-linear Regression	Shust and Kochkin 1985, Hohendorf	Frolkina and Dorovskich 1991, Non-linear Regression
t_0	-1.36	0.38	0.27	-0.67	-0.28
L_∞	43.10	65.10	64.30	64.30	68.90
k	0.40	0.16	0.15	0.13	0.13

Table 37: Standardisation of catchability for Russian and UK surveys of *Champsocephalus gunnari* in Subarea 48.3: ANOVA table for GLM with the link function *sqrt*. Terms added sequentially from first to last.

	Df	Deviance	Resid. Df	Resid. Dev.	F Value	Pr(F)
NULL			1 250	70 276e+6		
Country	1	17 713e+6	1 249	52 564e+6	1 331.8	0
Split-year	10	19 668e+6	1 239	32 895e+6	147.9	0
Stratum	14	9 221e+6	1 225	23 674e+6	49.5	0

Table 38: Lower one-sided 95% confidence bounds of biomass of *Champsocephalus gunnari* from the UK, Russian and combined survey datasets (2000). Results for the UK and Russian surveys are the same as those calculated at the 2000 meeting. Results for the combined survey dataset include the factor of 2.59 for standardising the UK survey (paragraphs 4.212 to 4.217).

Stratum	Mean Biomass	SE	Two-sided Lower 95% CI	Two-sided Upper 95% CI	One-sided Lower 95% Confidence Bound
UK survey January 2000					
SR1	12 555.4	12 007.9	155.9	36 478.0	180.0
SR2	1 315.2	1 026.4	75.4	3 405.3	117.7
SR3	3.0	3.0	0.0	6.0	0.0
SG1	1 925.9	878.1	722.5	3 731.5	818.3
SG2	7 639.8	3 463.9	3 159.1	15 092.7	3 394.8
SG3	1 371.1	591.6	409.3	2 547.2	531.2
SR	13 873.6	12 015.3	520.4	38 667.8	726.8
SG	10 936.9	3 679.5	5 578.1	19 131.8	6 051.0
Total	24 810.5	12 432.7	7 933.0	52 941.4	**8 916.0**
Russian survey February 2000					
S1	2 573.3	1 614.6	47.7	5 578.7	729.7
S2	3 736.1	2 216.0	220.7	8 456.0	426.6
S3	5 314.1	5 168.3	85.0	15 675.9	99.7
S4	15 338.7	10 191.2	2 685.4	35 257.5	2 718.3
S5	4 696.8	3 458.6	486.5	11 886.5	577.0
S6	10 892.5	2 681.2	5 828.9	16 069.7	6 683.9
S8	2 001.0	1 420.0	334.8	4 905.3	394.6
S9	540.0	389.8	66.4	1 350.3	87.2
S10	1 652.4	1 414.9	104.7	4 510.6	137.8
S11	1 062.4	1 062.4	0.0	3 187.1	0.0
SG	45 092.5	13 288.0	23 306.0	73 812.0	26 036.6
SR	2 714.8	1 686.6	162.7	6 270.9	231.0
Total	47 807.3	13 448.6	25 624.3	77 242.7	**28 098.1**
Combined surveys 2000 with UK survey * 2.59					
S1	194.7	95.9	39.0	376.0	50.4
S2	25 103.4	12 527.7	6 764.2	51 014.5	8 365.5
S3	3 903.5	1 773.2	2 130.3	5 676.6	2 130.3
S4	4 050.7	1 682.8	1 296.6	7 683.3	1 553.1
S5	4 219.2	2 638.4	580.3	9 723.4	796.6
S6	2 421.4	1 554.5	540.1	5 644.2	608.4
S8	13 587.4	3 466.0	7 271.1	20 524.4	8 173.3
S9	13 694.5	12 473.1	261.0	39 096.3	519.0
S10	2 593.1	1 546.5	317.4	5 870.3	469.4
S11	1 896.2	659.8	788.3	3 315.3	935.4
Georgia	67 174.9	19 182.4	34 962.7	109 265.4	38 639.7
Shag	4 489.2	1 730.8	1 766.3	8 359.2	2 025.7
Total	71 664.1	19 601.7	38 956.6	114 459.3	**42 806.6**

Table 39: Cohort strength from surveys undertaken in Subarea 48.3 in 2000 estimated from the mixture analysis for *Champsocephalus gunnari*.

ANI00V4 combined UK and Russian surveys 2000						
Sum of the observed densities =	16 803.5					
Sum of the expected densities =	16 151.6					
	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
Means of mixture components	148.648	221.553	272.153	321.232	367	381
Standard deviations of mixture components	9.83139	14.1627	17.169	20.0848	22.804	23.6357
Total density of each mixture component	468.766	8 804.08	3 777.17	2 157.99	658.397	307.061
SD of each mixture component density	448.38	2 762.54	1 118.56	740.809	1 078.37	781.624
	Rescaled expected densities					
Parameters of linear standard deviations	Age 1	Age 2	Age 3	Age 4+		
Intercept = 1.00000	487.69	9 159.42	3 929.62	3 249.51		
Slope = 0.594114E-01						
ANI00V5A Russian survey 2000						
Sum of the observed densities =	17 624.7					
Sum of the expected densities =	17 802.8					
	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
Means of mixture components	153.111	225.544	272.624	320.658	368	
Standard deviations of mixture components	8.85106	12.5652	14.9794	17.4424	19.87	
Total density of each mixture component	5.9562	9 412.47	5 086.02	1 582.21	1 813.46	
SD of each mixture component density	2.64244	3 426.22	1 952.31	762.582	1 173.97	
	Rescaled expected densities					
Parameters of linear standard deviations	Age 1	Age 2	Age 3	Age 4+		
Intercept = 1.00000	5.90	9 318.31	5 035.14	3 361.70		
Slope = 0.512771E-01						
ANI00V6 UK survey 2000						
Sum of the observed densities =	5 100.12					
Sum of the expected densities =	4 703.03					

(continued)

Table 39 (continued)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
Means of mixture components	147.588	214.979	265.477	316.845	360.957	395.995
Standard deviations of mixture components	10.919	15.4482	18.8421	22.2944	25.2591	27.6139
Total density of each mixture component	383.466	2 199.91	692.989	1 114.85	286.16	35.353
SD of each mixture component density	463.307	1 285.94	403.105	569.404	475.468	184.491
	Rescaled expected densities					
Parameters of linear standard deviations	Age 1	Age 2	Age 3	Age 4+		
Intercept = 1.00000	415.84	2 385.65	751.50	1 557.64		
Slope = 0.672077E-01						

Table 40: Data inputs for short-term projections of *Champsocephalus gunnari* in Subarea 48.3.

		UK Survey January 2000	Russian Survey February 2000	Combined Surveys with UK * 2.59
Lower single-sided 95% CI (tonnes)		8 916	28 098	42 807
Numbers at age	1	17 046 781.31	241 721.663	19 991 859
	2	97 795 853.28	381 988 163.9	375 475 030
	3	30 806 465.07	206 406 973	161 088 157
	4+	63 852 769.07	137 807 158.9	133 208 323
	Total	209 501 869	726 444 017	689 763 369
		%	%	%
	1	8	0	3
	2	47	53	54
	3	15	28	23
	4+	30	19	19
Method		Length Density + CMIX	Length Density + CMIX	Length Density + CMIX
Natural mortality		0.42 or 0.71	0.42 or 0.71	0.42 or 0.71
Age when fully selected		3	3	3
Age when selection begins		2	2	2
Von Bertalanffy	birthday (days since start of year)	245	245	245
	t_0	-0.58	-0.58	-0.58
	L_8	55.76	55.76	55.76
	k	0.17	0.17	0.17
Weight length	a (kg)	6.17E-10	6.17E-10	6.17E-10
	b	3.388	3.388	3.388
Survey timing: days since start of year		15	45	31
Catch since survey	between survey and first year of projection	144	144	144
	between first and second years of projection	1 283	1 283	1 283

Table 41: Results of short-term projections for *Champsocephalus gunnari* in Subarea 48.3 undertaken at the 2001 year meeting. The projected fishing mortality in 2001/02 is 0.14. The recommended catch limit is 5 557 tonnes, corresponding to the combined survey biomass projected using an M of 0.71.

	Lower 95% CI Biomass in 2000	Actual Catch in 2000/01	Projected Catch in 2002 Natural Mortality	
			0.42	**0.71**
UK survey January 2000	8 916	1 427	1 635	1 053
Russian survey February 2000	28 098	1 427	5 466	3 555
Combined surveys with UK * 2.59	42 807	1 427	8 533	**5 557**

Table 42: Estimates of abundance (kg) of *Champsocephalus gunnari* at Heard and McDonald Islands in 2001 (from WAMI-01/4).

Stratum	No. of Hauls	Value	SE	Lower CI	Upper CI
Plateau southeast	15	22 070 400	16 104 700	4 469 740	442 820 000
Plateau west	3	3 479 340	2 987 150	405 145	1 558 030 000
Gunnari Ridge	10	6 331 510	4 747 920	1 193 960	199 443 000
Shell Bank	13	740	502	131	1 950
All strata combined		31 882 000	17 053 700	9 855 650	1 586 410 000

Table 43: Data inputs for short-term projections of *Champsocephalus gunnari* in Division 58.5.2 (Heard Plateau population).

Category	Parameter	*C. gunnari* Heard Plateau
Survey details	Survey date	30 May 2001
	Biomass – lower 95% bound	7 052 tonnes
Mean length at age at time of survey	Age 2	245
	Age 3	305
	Age 4	348
Age structure (density n.km^2)	Age 2	105
	Age 3	1 834
	Age 4	150
Biological parameters	Birthday	1 November
von Bertalanffy growth	t_0	0.358
	L_8	457 mm
	k	0.323
Weight at age	Weight–length parameter A	2.629 x 10^{-10} kg
	Weight–length parameter B	3.515
Natural mortality	Mean annual M	0.4
Fishery parameters	Season	1 Dec–30 Nov
Selectivity	Age fully selected	3
	Age first selected	2.5
	Catch since last year	5 tonnes

Table 44: Comparison of estimates of minimum legal size of male crabs (*Paralomis* spp.).

Source	*P. spinosissima*		*P. formosa*	
	South Georgia	Shag Rocks	South Georgia	Shag Rocks
WG-FSA-92/29	94	84	90	
WG-FSA-01/32		83		78

Table 45: Reported by-catch (tonnes) of major species groups by fine-scale area and split-year from longline fisheries targeting *Dissostichus eleginoides* in the Convention Area.

Fine-scale Area	Split-year	Total Catch of Target Species	Total Catch of *D. eleginoides* (tonnes)	Total Catch of *D. mawsoni* (tonnes)	Total By-catch (tonnes)	By-catch as % of Total Catch	Skates/ Rays	*Macrourus* spp.
48.3	1986	96.7	96.7	0.0	6.9	6.7	6.3	0.0
48.3	1987	184.3	184.3	0.0	7.1	3.7	6.7	0.0
48.3	1988	101.2	101.2	0.0	3.1	3.0	3.0	0.1
48.3	1989	767.5	767.5	0.0	13.0	1.7	11.9	1.1
48.3	1990	8 156.0	8 156.0	0.0	0.0	0.0	0.0	0.0
48.3	1992	4 017.0	4 017.0	0.0	6.4	0.2	5.0	1.4
48.3	1993	3 765.9	3 765.9	0.0	1.7	0.0	0.6	1.1
48.3	1994	927.2	927.2	0.0	14.6	1.6	12.3	2.1
48.3	1995	3 260.9	3 260.9	0.0	111.2	3.3	89.9	10.8
48.3	1996	3 107.8	3 107.8	0.0	83.3	2.6	48.0	34.9
48.3	1997	2 575.0	2 575.0	0.0	63.8	2.4	35.1	25.1
48.3	1998	2 940.4	2 940.4	0.0	52.4	1.7	21.3	28.2
48.3	1999	4 159.5	4 159.5	0.0	32.3	0.8	16.6	15.3
48.3	2000	4 665.2	4 665.2	0.0	29.7	0.6	12.2	14.7
48.3	2001	3 943.5	3 943.5	0.0	12.9	0.3	10.4	1.9
48.3	2002*	510.9	510.9	0.0	0.0	0.0	0.0	0.0
48.3	Total	43 179.0	43 179.0	0.0	438.3	1.0	279.4	136.7
58.5.1	1996	1 271.7	1 271.7	0.0	0.5	0.0	0.5	0.0
58.5.1	1997	449.5	449.5	0.0	3.4	0.8	0.6	0.0
58.5.1	1998	1 117.7	1 117.7	0.0	24.3	2.1	12.1	11.9
58.5.1	1999	1 575.0	1 575.0	0.0	10.3	0.6	9.2	1.1
58.5.1	2000	2 615.0	2 615.0	0.0	336.2	11.4	164.4	169.5
58.5.1	2001	2 377.9	2 377.9	0.0	326.4	12.1	221.4	105.0
58.5.1	Total	9 406.6	9 406.6	0.0	701.1	6.9	408.2	287.4
58.6	1997	192.6	192.6	0.0	0.0	0.0	0.0	0.0
58.6	1998	247.2	247.2	0.0	13.0	5.0	0.6	12.0
58.6	1999	1 762.4	1 762.4	0.0	44.3	2.5	5.5	36.9
58.6	2000	489.1	489.1	0.0	78.9	13.9	21.3	49.3
58.6	2001	1 448.8	1 448.8	0.0	169.8	10.5	35.2	128.8
58.6	Total	4 140.1	4 140.1	0.0	306.0	6.9	62.6	226.9
58.7	1997	1 765.5	1 765.5	0.0	0.0	0.0		0.0
58.7	1998	737.3	737.3	0.0	1.6	0.2	0.7	0.0
58.7	1999	85.6	85.6	0.0	0.0	0.0		0.0
58.7	2000	13.2	13.2	0.0	0.4	2.7		0.4
58.7	2001	288.0	288.0	0.0	40.4	12.3	0.3	36.5
58.7	2002*	17.2	17.2	0.0	3.8	18.2		3.8
58.7	Total	2 906.7	2 906.7	0.0	46.2	1.6	1.1	40.7
88.1	1997	0.1	0.1	0.0	0.0	0.8	0.0	0.0
88.1	1998	41.5	0.5	41.0	14.9	26.4	4.8	9.3
88.1	1999	296.8	0.6	296.2	45.1	13.2	18.8	21.7
88.1	2000	752.3	0.0	752.2	118.3	13.6	41.2	70.1
88.1	2001	650.1	45.8	604.3	83.7	11.4	8.8	61.3
88.1	Total	1 740.8	47.1	1 693.7	262.0	13.1	73.6	162.4

* 2001/02 split-year data are incomplete

Table 46: Reported by-catch (tonnes) of major species groups by fine-scale area and split-year from trawl fisheries in the Convention Area. GRV – *Macrourus* spp., NOR – *Notothenia rossii*, NOS – *Lepidonotothen squamifrons*, TOP – *Dissostichus eleginoides*, ANI – *Champsocephalus gunnari*, SSI – *Chaenocephalus aceratus*, LXX – Myctophidae, NOG – *Gobionotothen gibberifrons*, NOT – *Patagonotothen guntheri*, SGI – *Pseudochaenichthys georgianus*.

Target Species	Fine-scale Area	Split-year	Total Catch of ANI	Total Catch of TOP	Total By-catch (tonnes)	By-catch as % of Total Catch	Skates/ Rays	GRV	NOR	NOS	TOP	ANI	SSI	LXX	NOG	NOT	SGI
ANI	48.3	1987	804		26	3							10.5		15.3		
ANI	48.3	1988	29 453		10 102	26			47.1	746.9	1 027.2		114.8	2 570.0	3 249.9	1 366.0	78.0
ANI	48.3	1990	8 030		288	3			2.0	24.0				1 07.0	10.0	143.0	
ANI	48.3	1991	41		0	0											
ANI	48.3	1998	6		0	0											
ANI	48.3	1999	265		9	3							0.0	5.2		3.7	0.1
ANI	48.3	2000	4 041		0	0										0.2	
ANI	48.3	2001	1 433		7	0							0.0		0.1		6.2
ANI	48.3	Total	44 073		10 432	19			49.1	770.9	1 027.2		125.4	2 687.2	3 275.3	1 512.9	84.4
ANI	58.5.2	1997	207		5	2	0.5	0.0			0.8						
ANI	58.5.2	1998	19		7	28	0.0	0.0			1.6						
ANI	58.5.2	1999	72		6	8	0.0	0.0			1.6						
ANI	58.5.2	2000	81		3	4	0.2	0.0			0.2						
ANI	58.5.2	2001	829		6	1	0.2	0.0			4.8						
ANI	58.5.2	Total	1 208		28	2	1.0	0.0			8.8						
TOP	58.5.2	1997		808	12	1	2.3	0.4		1.3		0.3					
TOP	58.5.2	1998		2 262	29	1	0.0	0.0				28.0					
TOP	58.5.2	1999		5 195	15	0	3.4	0.8		7.5							
TOP	58.5.2	2000		2 543	10	0	2.8	3.3		0.1		0.0					
TOP	58.5.2	2001		1 362	11	1	4.3	1.0		3.6		0.3					
TOP	58.5.2	Total		12 170	78	1	12.8	5.6		12.5		28.6					

Table 47: Input parameters for generalised yield model (GYM) to assess γ (yield = γ B_0) of skates and rays in Subarea 48.3 based on parameters as described in paragraphs 4.303 to 4.305.

Category	Parameter	Estimate
Age structure	Minimum age in stock	1
	Maximum age (plus class)	20
	Years in plus class	11
Times within year	Number of increments	360
Natural mortality	Mean annual M	0.2
Fishing mortality	Length, 50% recruited to fishery	700 mm
	Upper bound for fishing mortality	5.0
	Tolerance (error) for determining fishing mortality each year	1E-05
Fishing season		All Year
von Bertalanffy growth	t_0	0
	L_8	1 500 mm
	k	0.1
Weight–length	a	6.46E-6
$W = aL^b$	b	3.06
Maturity	L_{m50}	850 mm
	Length range over which maturity occurs	-
	Age of first maturity	8
	Increment in year when spawning occurs	1 March
Recruitment	Coefficient of variation	0.4–0.5
	Proportion of median SB_0 when depletion begins to occur	0.0
Total biomass	Coefficient of variation	1.006[1]
Simulation characteristics	Number of runs in simulation	1 001
	Depletion level	0.2
	Seed for random number generator	-24 189
Characteristics of a trial	Years to remove initial age structure	1
	Years to project stock in simulation	20

1 Refer to Figure 34

Table 48: Demographic information on *Macrourus* spp.

Growth	*M. carinatus*	*M. whitsoni*			*M. holotrachys*
		Sexes combined Refn (M)	Male Refn (M)	Female Refn (M)	
L_8	1 000 (G, C)	857	783	870	
k	No info	0.048	0.05	0.068	
t_0	No info	-3.89	-5.3	1.34	
Max length	950 (V)				
Max age	19 years	55 years			
Natural mortality (based on oldest 1% of fish on longlines)	No info		0.08	0.09	
Length to mass W(kg)=aL(mm)^b					
A	1.546E-09 (V)				8×10^{-9} (B)
B	3.168 (V)				2.930 (B)
Spawning					
Season	May – Sept (Falkland/Malvinas) (A)				
L_{m50}	580–590 (A)				
L_{m100}	700–710 (A)				

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Table 49: Summary of data on seabird species at risk from longline fisheries in the Convention Area, indicating the level of information available on population parameters, DNA profile and conservation status (BirdLife International (2000) and WG-FSA-01/55). (Information extracted from documents cited in SC-CAMLR-XVIII, Annex 5; SC-CAMLR-XIX, Annex 5; SC-CAMLR-XX, Annex 5; also Gales, 1998; Marchant and Higgins, 1990).

Species	Conservation Status	Study Location	DNA Profile	Population Information					
				Annual Pairs	Year Started	Population Estimate	Trend	Adult Survival	Juvenile Survival
Wandering albatross	Vulnerable	South Georgia	√	2 178	1972	√	√	√	√
Diomedea exulans		Marion	√	1 794	1998	√	√		
		Prince Edward	√	1 277	1979	√			
		Crozet	√	1 734	1966	√	√	√	√
		Kerguelen		1 455	1973	√	√	√	√
		Macquarie	√	10	1994	√	√	√	
Antipodean albatross	Vulnerable	Auckland	√	65	1991	√	√	√	
Diomedea antipodensis		Adams		5 762					
		Antipodes	√	5 148	1994	√	√	√	
Amsterdam albatross	Critically Endangered	Amsterdam		13	1983	√	√	√	√
Diomedea amsterdamensis									
Southern royal albatross	Vulnerable	Campbell	√ ?	7 800	1995	√	√		
Diomedea epomophora		Auckland Islands	√ ?	<100					
Northern royal albatross	Endangered	Chatham	√ ?	5 200	1990s	√	√	check	check
Diomedea sanfordi		Taiaroa	√ ?	18	1950s	√	√	√	√
Grey-headed albatross	Vulnerable	Diego Ramirez	√	10 000	1999	√			
Thalassarche chrysostoma		South Georgia	√	54 218	1976	√	√	√	√
		Marion	√	6 217	1984	√	√	√	√
		Prince Edward		1 500					
		Crozet		5 946	1980				
		Kerguelen	√	7 900					
		Macquarie	√	84	1994	√	√	√	
		Campbell	√	6 400	1987	√			

(continued)

Table 49 (continued)

Species	Conservation Status	Study Location	DNA Profile	Population Information					
				Annual Pairs	Year Started	Population Estimate	Trend	Adult Survival	Juvenile Survival
Black-browed albatross *Thalassarche melanophrys*	Near-Threatened	Diego Ramirez	√	32 000	1999	√			
		Falklands/Malvinas	√	550 000	1990	√	√	√	√
		South Georgia	√	96 252	1976	√	√	√	√
		Crozet		980					
		Kerguelen	√	3 115	1978	√	√	√	√
		Heard, McDonald		750					
		Macquarie	√	38	1994	√	√	√	
		Campbell	√	<30	1995				
		Antipodes		100	1995	√			
Campbell albatross *Thalassarche impavida*	Vulnerable	Campbell	√	26 000	1987	√		√	
Atlantic yellow-nosed albatross *Thalassarche chlororhynchos*	Near-Threatened	Tristan da Cunha	√	27 000					
		Gough	√	46 000	1982		√	√	
Indian yellow-nosed albatross *Thalassarche carteri*	Vulnerable	Amsterdam		25 000	1978	√	√	√	√
		Prince Edward		7 000					
		Crozet		4 430					
Buller's albatross *Thalassarche bulleri*	Vulnerable	Snares		8 460	1992	√	√	√	
		Solander		4 000–5 000	1992	√			
Chatham albatross *Thalassarche eremita*	Critically Endangered	Chatham	√	4 000	1998	√			
Salvin's albatross *Thalassarche salvini*	Vulnerable	Bounty		76 000	1998	√			
		Ile des Pingouins, Crozet		4					
		Snares		4 650					
White-capped albatross *Thalassarche steadi*	Vulnerable	Antipodes	√	75	1972	√	√		
		Disappointment	√	72 000					
		Adams	√	100					
		Auckland		3 000	1994	√			

(continued)

Table 49 (continued)

Species	Conservation Status	Study Location	DNA Profile	Population Information					
				Annual Pairs	Year Started	Population Estimate	Trend	Adult Survival	Juvenile Survival
Light-mantled albatross *Phoebetria palpebrata*	Near-Threatened	South Georgia		6 500					
		Marion		201					
		Prince Edward							
		Crozet		2 151	1966	√	√	√	√
		Kerguelen		3 000–5 000	1994	√	√	√	
		Heard, McDonald		500–700					
		Macquarie	√	1 100	1993	√	√	√	
		Campbell		>1 500	1995	√	√		
		Auckland		5 000	1972	√			
		Antipodes		<1 000	1995	√			
Sooty albatross *Phoebetria fusca*	Vulnerable	Tristan da Cunha		2 750					
		Gough		5 000–10 000	2000	√			
		Marion		2 055					
		Prince Edward		700					
		Crozet		2 298	1968	√	√	√	√
		Amsterdam		300–400	1992	√	√	√	
Southern giant petrel *Macronectes giganteus*	Vulnerable	Antarctic Peninsula		1 125					
		Enderby Land		no estimate					
		Frazier		250					
		Adélie Land		9–11	1964	√			
		South Shetland		7 185					
		South Orkney		8 755	1976	√			
		South Sandwich		800					
		Falklands/Malvinas		5 000					
		South Georgia		5 000	1980	√	√	√	
		Gough							
		Marion		1 500	1984	√	√		
		Prince Edward							
		Crozet		1 017	1981	√	√		
		Kerguelen		3–5					
		Heard		2 350					
		Macquarie		2 300	1994	√	√		

(continued)

Table 49 (continued)

Species	Conservation Status	Study Location	DNA Profile	Population Information					
				Annual Pairs	Year Started	Population Estimate	Trend	Adult Survival	Juvenile Survival
Northern giant petrel	Near-	South Georgia		3 000	1980	√	√	√	
Macronectes halli	Threatened	Marion		350	1984	√	√		
		Prince Edwards							
		Crozet			1981	√			
		Kerguelen		1 450–1 800	1986	√			
		Macquarie		1 313	1994	√	√		
		Campbell		230+					
		Auckland		no estimate					
		Antipodes		320					
		Chatham		no estimate					
White-chinned petrel	Vulnerable	Falklands/Malvinas		1 000–5 000					
Procellaria aequinoctialis		South Georgia		2 000 000	1995	√	√		
		Prince Edwards		10 000s	1996	√	√		
		Crozet		10 000s	1968	√	√		
		Kerguelen		100 000s					
		Auckland, Campbell, Antipodes							
Grey petrel	Near-	Tristan da Cunha		1 000s					
Procellaria cinerea	Threatened	Gough		100 000s					
		Prince Edwards		1 000s					
		Crozet		1 000s					
		Kerguelen		1 000s					
		Macquarie		<100					
		Campbell		10 000s					
		Antipodes		10 000s					

Table 50: Summary of data on seabird species at risk from longline fisheries in the Convention Area, indicating the level of information available on foraging ecology in respect of years of study, stage of breeding cycle, CCAMLR areas visited and risk assessment (SC-CAMLR-XX/BG/11) of these areas. (Information extracted from documents cited in SC-CAMLR-XVIII, Annex 5; SC-CAMLR-XIX, Annex 5; SC-CAMLR-XX, Annex 5; also Gales, 1998; Marchant and Higgins, 1990). nr – not recorded.

Species	Study Location	Foraging Ecology					CCAMLR Area Prospected (*IMALF risk assessment*)																	
		Data	Years	Trips			48.1	48.2	48.3	48.4	48.5	48.6	58.4.1	58.4.2	58.4.3	58.4.4a	58.4.4b	58.5.1	58.5.2	58.6	58.7	88.1	88.2	88.3
				Incubation	Chick Brood	Non-Breeding	*3*	*2*	*5*	*3*	*1*	*2*	*3*	*2*	*3*	*3*	*3*	*5*	*4*	*5*	*5*	*3*	*1*	*1*
Wandering albatross	South Georgia	v	1990–2000	15	152		●	●	●	●		●												●
Diomedea exulans	Marion	v	1996–1998	nr	nr																			
	Prince Edward																							
	Crozet	v	nr	nr	nr									●	●	●		●	●	●	●			
	Kerguelen	v	nr	nr	nr																			
	Macquarie																							
Antipodean albatross	Auckland	v	nr																					
Diomedea antipodensis	Adams																							
	Antipodes	v	nr																					
Amsterdam albatross	Amsterdam	v	nr															●	●					
Diomedea amsterdamensis																								
Southern royal albatross	Campbell	v	nr																					
Diomedea epomophora	Auckland Islands																							
Northern royal albatross	Chatham	v	nr																					
Diomedea sanfordi	Taiaroa	v	nr																					
Grey-headed albatross	Diego Ramirez																							
Thalassarche chrysostoma	South Georgia	v	1991–2000	4	240		●	●	●	●		●												
	Marion	v	1997–1998	nr	nr																			
	Prince Edward																							
	Crozet																							
	Kerguelen																							
	Macquarie	v	2000–2001	9	3																	●		
	Campbell																							
Black-browed albatross	Diego Ramirez	v	1999	nr	nr																			
Thalassarche melanophrys	Falklands/Malvinas	v	nr	nr	nr																			
	South Georgia	v	1993–1994	11	73		●	●	●	●														
	Crozet																							
	Kerguelen	v	nr	nr	nr																			
	Heard, McDonald																							
	Macquarie	v	2000–2001	10	5																	●		
	Antipodes																							
	Campbell																							
Atlantic yellow-nosed albatross	Tristan da Cunha																							
Thalassarche chlororhynchos	Gough																							
Campbell albatross	Campbell	v	1995	nr	nr																			
Thalassarche impavida																								

(continued)

Table 50 (continued)

Species	Study Location	Foraging Ecology					CCAMLR Area Prospected (*IMALF risk assessment*)																	
		Data	Years	Trips			48.1	48.2	48.3	48.4	48.5	48.6	58.4.1	58.4.2	58.4.3	58.4.4a	58.4.4b	58.5.1	58.5.2	58.6	58.7	88.1	88.2	88.3
				Incubation	Chick Brood	Non-Breeding	*3*	*2*	*5*	*3*	*1*	*2*	*3*	*2*	*3*	*3*	*3*	*5*	*4*	*5*	*5*	*3*	*1*	*1*
Indian yellow-nosed albatross	Prince Edward																							
Thalassarche carteri	Crozet																							
	Amsterdam	v	nr	nr	nr																			
Buller's albatross	Snares	v	nr	nr	nr																			
Thalassarche bulleri	Solander	v	nr	nr	nr																			
Chatham albatross	Chatham	v	nr	nr	nr																			
Thalassarche eremita																								
Salvin's albatross	Ile des Pingouins, Crozet																							
Thalassarche salvini	Bounty																							
	Snares																							
White-capped albatross	Antipodes																							
Thalassarche steadi	Disappointment																							
	Adams																							
	Auckland																							
Light-mantled albatross	South Georgia																							
Phoebetria palpebrata	Marion																							
	Prince Edward																							
	Crozet	v	nr	nr	nr																			
	Kerguelen																							
	Heard, McDonald																							
	Macquarie	v	1993	nr																				
	Campbell																							
	Auckland																							
	Antipodes																							
Sooty albatross	Tristan da Cunha																							
Phoebetria fusca	Gough																							
	Marion																							
	Prince Edward																							
	Crozet	v	nr	nr	nr																			
	Amsterdam																							

(continued)

Table 50 (continued)

Species	Study Location	Foraging Ecology					CCAMLR Area Prospected (*IMALF risk assessment*)																	
		Data	Years	Trips			48.1	48.2	48.3	48.4	48.5	48.6	58.4.1	58.4.2	58.4.3	58.4.4a	58.4.4b	58.5.1	58.5.2	58.6	58.7	88.1	88.2	88.3
				Incubation	Chick Brood	Non-Breeding	*3*	*2*	*5*	*3*	*1*	*2*	*3*	*2*	*3*	*3*	*3*	*5*	*4*	*5*	*5*	*3*	*1*	*1*
Southern giant petrel	Antarctic Peninsula																							
Macronectes giganteus	Enderby Land																							
	Frazier																							
	Adélie Land																							
	South Shetland																							
	South Orkney																							
	South Sandwich																							
	Falklands/Malvinas																							
	South Georgia	v	1996–1998	13		1	●	●	●	●		●				●								
	Gough																							
	Marion																							
	Prince Edward																							
	Crozet																							
	Kerguelen																							
	Heard																							
	Macquarie																							
Northern giant petrel	South Georgia	v	1998	18				●	●	●		●												
Macronectes halli	Marion																							
	Prince Edward																							
	Crozet																							
	Kerguelen																							
	Macquarie																							
	Campbell																							
	Auckland																							
	Antipodes																							
	Chatham																							
White-chinned petrel	Falklands/Malvinas																							
Procellaria aequinoctialis	South Georgia	v	1996–1998	5	20			●	●	●														
	Prince Edwards	v	nr	nr	nr																			
	Crozet	v	nr	nr	nr																			
	Kerguelen																							
	Auckland, Campbell, Antipodes																							
Grey petrel	Tristan da Cunha																							
Procellaria cinerea	Gough																							
	Prince Edwards																							
	Crozet																							
	Kerguelen																							
	Macquarie																							
	Campbell																							
	Antipodes																							

Table 51: Incidental mortality of seabirds in the longline fisheries for *Dissostichus* spp. in Subareas 48.3, 58.6, 58.7 and 88.1 during the 2000/01 season. Sp – Spanish method; Auto – autoliner; N – night setting; D – daylight setting (including nautical dawn and dusk); O – opposite side to hauling; S – same side as hauling; * – information obtained from cruise report; + – all daylight settings in Subarea 88.1 were in compliance with the provisions of Conservation Measure 210/XIX.

Vessel	Dates of Fishing	Method	Sets Deployed				No. of Hooks (thousands)			Hooks Baited (%)	No. of Birds Caught						Observed Seabird Mortality (birds/1 000 hooks)			Streamer Line in Use (%)		Offal Discharge during Haul (%)
			N	D	Total	%N	Obs.	Set	% Observed		Dead N	Dead D	Alive N	Alive D	Total N	Total D	N	D	Total	N	D	
Subarea 48.3																						
Argos Georgia	7/6–25/7/01	Sp	212	2	214	99	229.5	1 083.3	21	100	0	0	1	0	1	0	0	0	0	92	100	O (83)
Argos Helena	4/5–21/8/01	Sp	171	0	171	100	299.3	1 343.6	22	100	3	0	11	0	14	0	0.010	0	0.010	99		O (100)
Ibsa Quinto	3/5–11/7/01	Sp	115	0	115	100	190.2	1 161.1	16	100	2	0	8	0	10	0	0.011	0	0.011	100		O (85)
In Sung 66	1/5–6/7/01	Sp	101	4	105	96	148.1	795.9	18	100	0	0	0	0	0	0	0	0	0	99	100	O (98)
In Sung 66	8/7–11/9/01	Sp	88	5	93	95	111.4	729.2	15	100	0	0	0	0	0	0	0	0	0	92	100	O (96)
Isla Alegranza	1/5–30/8/01	Sp	161	18	179	90	380.1	1 550.9	24	100	1	0	6	0	7	0	0.003	0	0.003	25	17	O (99)
Isla Camila	12/6–20/7/01	Sp	40	2	42	95	53.1	205.1	25	100	0	0	0	0	0	0	0	0	0	89	0	O (0)
Isla Camila	1/5–28/5/01	Sp	52	2	54	96	67.5	359.8	18	100	0	0	0	0	0	0	0	0	0	96	100	O (96)
Isla Santa Clara	30/6–17/7/01	Sp	40	2	42	95	43.2	259.8	16	100	0	0	0	0	0	0	0	0	0	100	100	O (93)
Isla Santa Clara	1/5–30/6/01	Sp	106	9	115	92	131.7	855.0	15	100	0	0	0	0	0	0	0	0	0	95	89	O (96)
Koryo Maru 11	21/5–31/8/01	Sp	218	8	226	96	265.9	1 769.6	15	100	0	0	0	0	0	0	0	0	0	93	100	O (76)
Maria Tamara	14/7–20/7/01	Sp	5	0	5	100	21.0	66.6	31	100	0	0	0	0	0	0	0	0	0	100		S (100)
No. 1 Moresko	17/7–30/8/01	Sp	76	0	79	100	142.4	646.1	22	100	0	0	4	0	4	0	0	0	0	96		O (99)
No. 1 Moresko	5/5–6/7/01	Sp	83	6	89	93	79.4	779.6	10	100	0	0	0	0	0	0	0	0	0	98	100	O (87)
Polarpesca I	10/6–27/6/01	Sp	23	3	26	88	152.5	187.9	81	100	0	0	0	0	0	0	0	0	0	100	100	O (88)
RK-1	4/5–19/6/01	Auto	173	34	207	84	220.5	739.2	29	82	0	0	0	0	0	0	0	0	0	2	68	O (11)
*RK-1**	24/6–30/8/01	Auto			304		236.6	1 070.4	22		0	0	0	0	0	0	0	0	0			O (0)
Rutsava	17/5–25/5/01	Sp	10	0	10	100	49.7	119.5	41	100	0	0	0	0	0	0	0	0	0	100		O (80)
Ural	6/5–7/8/01	SP	125	2	127	98	114.8	842.7	13	100	0	0	0	0	0	0	0	0	0	99	100	O (96)
Viking Bay	1/5–30/8/01	Sp	150	9	159	94	226.3	1 066.7	21	100	0	0	1	0	1	0	0	0	0	96	89	O (0)
Total						95	2 926.6	14 561.6	24								0.002	0	0.002			
Subareas 58.6 and 58.7																						
Aquatic Pioneer	25/9–12/11/00	Sp	52	0	52	100	165.2	629.8	26	89	13	0	2	0	15	0	0.079	0	0.079	100		O (96)
Eldfisk	7/9–6/11/00	Auto	129	127	256	50	290.2	778.1	37	89	0	2	2	0	2	2	0	0.009	0.004	99	100	O (95)
Eldfisk	11/5–4/7/01	Auto	163	92	255	64	447.3	880.2	58	89	1	0	0	0	1	0	0.005	0	0.003	100	100	O (98)
Eldfisk	9/8–11/9/01	Auto	63	4	67	94	143.8	234.2	61	81	1	0	0	0	1	0	0.007	0	0.007	100	100	O (100)
Eldfisk	4/12–10/12/00	Auto	4	28	32	13	34.2	104.0	32	85	1	1	0	2	1	3	0.250	0.033	0.058	100	100	O (0)
Isla Graciosa	7/10–11/12/00	Sp	80	0	80	100	625.5	1 062.2	58	100	1	0	5	0	6	0	0.002	0	0.002	100		O (100)
Isla Graciosa	22/4–25/5/01	Sp	39	0	39	100	43.6	627.7	6	100	0	0	0	0	0	0	0	0	0	100		O (0)
Isla Graciosa	15/6–30/7/01	Sp	41	3	44	93	39.5	492.2	8	100	0	0	4	0	4	0	0	0	0	100	100	O (98)
Koryo Maru 11	5/2–2/4/01	Sp	97	1	98	99	559.0	878.9	63	100	8	0	36	0	44	0	0.014	0	0.014	100	100	O (100)
Koryo Maru 11	20/10–29/11/00	Sp	20	18	38	53	89.6	593.3	15	100	6	13	4	1	10	14	0.144	0.270	0.212	100	100	O (100)
Suidor One	30/7–7/9/01	Sp	30	1	31	97	169.4	280.1	60	100	0	0	6	0	6	0	0	0	0	100	100	O (100)
Total						78	2 607.3	6 560.7	39								0.014	0.037	0.018			
Subarea 88.1+																						
Eldfisk	20/2–17/3/01	Auto	25	44	69	36	90.5	234.0	37	79	0	0	0	0	0	0	0	0	0	100	100	(0)
Isla Alegranza	6/3–18/3/01	Sp																				
Isla Gorriti	29/1–3/3/01	Auto	2	36	38	5	251.4	280.8	89	86	0	0	0	0	0	0	0	0	0	100	100	(0)
Isla Graciosa	12/3–18/3/01	Sp	3	9	12	25	32.5	45.0	72	100	0	0	0	0	0	0	0	0	0	100	100	(0)
Janas	14/1–26/3/01	Auto	13	199	212	6	454.8	1 069.0	42	89	0	0	0	0	0	0	0	0	0	100	100	(0)
San Aotea II	14/1–17/5/01	Auto	85	180	265	32	595.7	1 317.7	45	88	0	0	0	1	0	1	0	0	0	100	100	(0)
Sonrisa	22/1–28/2/01	Auto	3	71	74	4	136.2	275.5	49	75	0	0	0	0	0	0	0	0	0	100	100	(0)
Total						18	1 561.1	3 222	56								0	0	0			

Table 52: Estimated total seabird mortality by vessel for Subarea 48.3 during the 2000/01 season.

Vessel	Hooks Observed (thousands)	Hooks Set (thousands)	% Hooks Observed	% Night Sets	Estimated Number of Birds Caught Dead		
					Night	Day	Total
Argos Georgia	229.5	1 083.3	21	99	0	0	0
Argos Helena	299.3	1 343.6	22	100	13	0	13
Ibsa Quinto	190.2	1 161.1	16	100	13	0	13
In Sung 66	148.1	795.9	18	96	0	0	0
In Sung 66	111.4	729.2	15	95	0	0	0
Isla Alegranza	380.1	1 550.9	24	90	4	0	4
Isla Camila	53.1	205.1	25	95	0	0	0
Isla Camila	67.5	359.8	18	96	0	0	0
Isla Santa Clara	43.2	259.8	16	95	0	0	0
Isla Santa Clara	131.7	855.0	15	92	0	0	0
Koryo Maru 11	265.9	1 769.6	15	96	0	0	0
Maria Tamara	21.0	66.6	31	100	0	0	0
No. 1 Moresko	142.4	646.1	22	100	0	0	0
No. 1 Moresko	79.4	779.6	10	93	0	0	0
Polarpesca I	152.5	187.9	81	88	0	0	0
RK-1	220.5	739.2	29	84	0	0	0
RK-1	236.6	1 070.4	22		0	0	0
Rutsava	49.7	119.5	41	100	0	0	0
Ural	114.8	842.7	13	98	0	0	0
Viking Bay	226.3	1 066.7	21	94	0	0	0
Total	2 926.6	14 561.6	24	90	30	0	30

Table 53: Species composition of birds killed in longline fisheries in Subareas 48.3, 58.6 and 58.7 during the 2000/01 season. N – night setting; D – daylight setting (including nautical dawn and dusk); DIM – black-browed albatross; MAI – southern giant petrel; PRO – white-chinned petrel; DAC – cape petrel; PCI – grey petrel; () – % composition.

Vessel	Dates of Fishing	No. Birds Killed by Group						Species Composition (%)				
		Albatross		Petrels		Total						
		N	D	N	D	N	D	DIM	MAI	PRO	DAC	PCI
Subarea 48.3												
Argos Georgia	7/6–25/7/01	0	0	0	0	0	0					
Argos Helena	4/5–21/8/01	0	0	3	0	3	0		3 (100)			
Ibsa Quinto	3/5–11/7/01	2	0	0	0	2	0	2 (100)				
In Sung 66	1/5–6/7/01	0	0	0	0	0	0					
In Sung 66	8/7–11/9/01	0	0	0	0	0	0					
Isla Alegranza	1/5–30/8/01	0	0	1	0	1	0				1 (100)	
Isla Camila	12/6–20/7/01	0	0	0	0	0	0					
Isla Camila	1/5–28/5/01	0	0	0	0	0	0					
Isla Santa Clara	30/6–17/7/01	0	0	0	0	0	0					
Isla Santa Clara	1/5–30/6/01	0	0	0	0	0	0					
Koryo Maru 11	21/5–31/8/01	0	0	0	0	0	0					
Maria Tamara	14/7–20/7/01	0	0	0	0	0	0					
No. 1 Moresko	17/7–30/8/01	0	0	0	0	0	0					
No. 1 Moresko	5/5–6/7/01	0	0	0	0	0	0					
Polarpesca 1	10/6–27/6/01	0	0	0	0	0	0					
RK-1	4/5–19/6/01	0	0	0	0	0	0					
RK-1	24/6–30/8/01	0	0	0	0	0	0					
Rutsava	17/5–25/5/01	0	0	0	0	0	0					
Ural	6/5–7/8/01	0	0	0	0	0	0					
Viking Bay	1/5–30/8/01	0	0	0	0	0	0					
Total %		2	0	4	0	6	0	2 (33)	3 (50)		1 (17)	
Subareas 58.6 and 58.7												
Aquatic Pioneer	25/9–12/11/00	0	0	0	13	0	13			13 (100)		
Eldfisk	7/9–6/11/00	1	0	0	1	1	1	1 (50)		1 (50)		
Eldfisk	11/5–4/7/01	0	0	1	0	1	0					1 (100)
Eldfisk	9/8–11/9/01	0	0	1	0	1	0					1 (100)
Eldfisk	4/12–10/12/00	0	0	1	1	1	1			2 (100)		
Isla Graciosa	7/10–11/12/00	1	0	0	0	1	0	1 (100)				
Isla Graciosa	22/4–25/5/01	0	0	0	0	0	0					
Isla Graciosa	15/6–30/7/01	0	0	0	0	0	0					
Koryo Maru 11	20/10–29/11/00	0	0	6	13	6	13			19 (100)		
Koryo Maru 11	5/2–2/4/01	0	0	8	0	8	0			8 (100)		
Suidor One	30/7–7/9/01	0	0	0	0	0	0					
Total %		2	0	17	28	19	28	2 (4)		43 (92)		2 (4)

Table 54: Estimated total seabird mortality by vessel for Subareas 58.6 and 58.7 during the 2000/01 season.

Vessel	Hooks Observed (thousands)	Hooks Set (thousands)	% Hooks Observed	% Night Sets	Estimated Number of Birds Caught Dead		
					Night	Day	Total
Aquatic Pioneer	165.2	629.8	26	100	50	0	50
Eldfisk	290.2	778.1	37	50	0	4	4
Eldfisk	447.3	880.2	58	64	3	0	3
Eldfisk	143.8	234.2	61	94	2	0	2
Eldfisk	34.2	104.0	32	13	3	3	6
Isla Graciosa	625.5	1 062.2	58	100	2	0	2
Isla Graciosa	43.6	627.7	6	100	0	0	0
Isla Graciosa	39.5	492.2	8	93	0	0	0
Koryo Maru 11	559.0	878.9	63	99	12	0	12
Koryo Maru 11	89.6	593.3	15	53	45	75	120
Suidor One	169.4	280.1	60	97	0	0	0
Total	2 607.3	6 560.7	39	78	117	82	199

Table 55: Total estimated seabird by-catch and by-catch rate (birds/thousand hooks) in longline fisheries in Subareas 48.3, 58.6 and 58.7 from 1997 to 2001.

Subarea	Year				
	1997	1998	1999	2000	2001
48.3					
Estimated by-catch	5 755	640	210*	21	30
By-catch rate	0.23	0.032	0.013*	0.002	0.002
58.6, 58.7					
Estimated by-catch	834	528	156	516	199
By-catch rate	0.52	0.194	0.034	0.046	0.018

* Excluding *Argos Helena* line-weighting experiment cruise.

Table 56: Summary of compliance with Conservation Measure 29/XV (1996/97), Conservation Measure 29/XVI (1997/98 to 1999/2000) and Conservation Measure 29/XIX (2000/01), based on data from scientific observers, for the 1996/97, 1997/98, 1998/99, 1999/2000 and 2000/01 seasons. Values in parentheses are % of observer records that were complete. na – not applicable.

Subarea/ Time	Line Weighting (Spanish System Only)				Night Setting (% Night)	Offal Discharge (%) Opposite Haul		Streamer Line Compliance (%)										Total Catch Rate (Birds/1 000 Hooks)	
	Compliance %		Median Weight (kg)	Median Spacing (m)				Overall		Attached Height		Length		No. Streamers		Distance Apart		Night	Day
Subarea 48.3																			
1996/97	0	(91)	5	45	81	0	(91)	6	(94)	47	(83)	24	(94)	76	(94)	100	(78)	0.18	0.93
1997/98	0	(100)	6	42.5	90	31	(100)	13	(100)	64	(93)	33	(100)	100	(93)	100	(93)	0.03	0.04
1998/99	5	(100)	6	43.2	80[1]	71	(100)	0	(95)	84	(90)	26	(90)	76	(81)	94	(86)	0.01	0.08[1]
1999/00	1	(91)	6	44	92	76	(100)	31	(94)	100	(65)	25	(71)	100	(65)	85	(76)	<0.01	<0.01
2000/01	21	(95)	6.8	41	95	95	(95)	50	(85)	88	(90)	53	(94)	94	94	82	(94)	<0.01	0
Division 58.4.4																			
1999/00	0	(100)	5	45	50	0	(100)	0	(100)	100	(100)	0	(100)	100	(100)	100	(100)	0	0
Subareas 58.6 and 58.7																			
1996/97	0	(60)	6	35	52	69	(87)	10	(66)	100	(60)	10	(66)	90	(66)	60	(66)	0.52	0.39
1997/98	0	(100)	6	55	93	87	(94)	9	(92)	91	(92)	11	(75)	100	(75)	90	(83)	0.08	0.11
1998/99	0	(100)	8	50	84[2]	100	(89)	0	(100)	100	(90)	10	(100)	100	(90)	100	(90)	0.05	0
1999/00	0	(83)	6	88	72	100	(93)	8	(100)	91	(92)	0	(92)	100	(92)	91	(92)	0.03	0.01
2000/01	18	(100)	5.8	40	78	100	(100)	64	(100)	100	(100)	64	(100)	100	(100)	100	(100)	0.01	0.04
Subarea 88.1																			
1996/97	Auto only		na	na	50	0	(100)	100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0
1997/98	Auto only		na	na	71	0	(100)	100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0
1998/99	Auto only		na	na	1[3]	100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0
1999/00	Auto only		na	na	6[4]	No Discharge		100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0
2000/01	1	(100)	12	40	18[5]	No Discharge		100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0

1 Includes daylight setting – and associated seabird by-catch – as part of line-weighting experiments on *Argos Helena* (WG-FSA-99/5).

2 Includes some daylight setting in conjunction with use of an underwater-setting funnel on *Eldfisk* (WG-FSA-99/42).

3 Conservation Measure 169/XVII allowed New Zealand vessels to undertake daylight setting south of 65°S in Subarea 88.1 to conduct a line-weighting experiment.

4 Conservation Measure 190/XVIII allowed New Zealand vessels to undertake daylight setting south of 65°S in Subarea 88.1 to conduct a line-weighting experiment.

5 Conservation Measure 210/XIX allows vessels to undertake daylight setting south of 65°S in Subarea 88.1, if they can demonstrate a sink rate of 0.3 m/s.

Table 57: Compliance, as reported by scientific observers, of streamer lines with the minimum specifications set out in Conservation Measure 29/XIX during the 2000/01 season. Y – yes, N – no, - – no information; A – autoliner, Sp – Spanish; CHL – Chile, ESP – Spain, GBR – United Kingdom, KOR – Republic of Korea, NZL – New Zealand, RUS – Russia, UKR – Ukraine, URY – Uruguay, ZAF – South Africa.

Vessel Name (Nationality)	Dates of Trip	Fishing Method	Compliance with CCAMLR Specifications	Compliance with Details of Streamer Line Specifications: Attachment, Height above Water (m)	Total Length (m)	No. Streamers per Line	Spacing of Streamers per Line (m)	Length of Streamers (m)	Spare Streamers on Board
Subarea 48.3									
Argos Georgia (GBR)	23/4–2/8/01	Sp	Y	Y (6)	Y (150)	Y (7)	Y (5)	Y (3.5-1)	Y
Argos Helena (GBR)	3/5–29/8/01	Sp	N	Y (4.5)	N (85)	Y (14)	Y (5)	N (1-1.5)	Y
Ibsa Quinto (ESP)	25/4–16/7/01	Sp	Y	Y (7)	Y (160)	Y (5)	Y (7)	-	-
In Sung 66 (KOR)	26/4–7/7/01	Sp	Y	Y (4.5)	Y (165)	Y (10)	Y (5)	-	Y
In Sung 66 (KOR)	7/7–6/9/01	Sp	Y	Y (6)	-	Y (5)	Y (5)	-	-
Isla Alegranza (URY)	28/4–5/9/01	Sp	Y	-	Y (160)	-	-	-	-
Isla Camila (CHL)	1/5–29/5/01	Sp	N	Y(7)	N (90)	Y (13)	Y (3)	Y (3.2-2)	Y
Isla Camila (CHL)	8/6–17/8/01	Sp	N	Y (7)	N (80)	Y (30)	Y (2.5)	-	-
Isla Santa Clara (CHL)	25/4–1/7/01	Sp	N	N (3)	Y (150)	Y (6)	Y (5)	-	-
Isla Santa Clara (CHL)	1/7–24/7/01	Sp	Y	Y (6)	Y (150)	Y (5)	Y (5)	-	-
Koryo Maru II (ZAF)	19/4–13/9/01	SP	N	N (2.5)	N (120)	Y (8)	N (2)	-	-
Maria Tamara (CHL)	30/6–31/8/01	SP	Y	Y (5)	Y (150)	Y (5)	Y (5)	Y (3.5-1)	Y
No. 1 Moresko (KOR)	1/5–12/7/01	Sp	N	Y (5.2)	N (95)	Y (5)	N (4)	-	Y
No. 1 Moresko (KOR)	13/7–6/9/01	Sp	N	Y (5.2)	N (95)	Y (5)	N (4)	-	Y
Polarpesca I (CHL)	7/6–27/8/01	Sp	N	Y (4.5)	N (125)	Y (20)	Y (3)	-	-
RK-1 (UKR)	21/4–23/6/01	A	Y	Y (15)	Y (150)	Y (25)	Y (4)	-	-
RK-1 (UKR)	23/6–5/9/01	Auto	Y	-	Y (150)	Y (7)	-		-
Rutsava (RUS)	25/4–12/6/01	Sp	N	Y (5)	N (100)	N (4)	Y (5)	-	-
Ural (RUS)	22/4–22/8/01	Sp	Y	-	Y (150)	Y (5)	Y (5)	Y (3.5-1)	Y
Viking Bay (ESP)	13/5–31/8/01	Sp	Y	Y (5)	Y (150)	Y (50)	Y (2)	-	-
Subareas 58.6 and 58.7									
Aquatic Pioneer (ZAF)	20/9–20/11/00	Sp	N	Y (7.5)	N (117)	Y (6)	Y (5)	Y (3-2)	-
Eldfisk (ZAF)	2/9–12/11/00	A	Y	Y (6)	Y (151.5)	Y (7)	Y (5)	Y (3.5)	Y
Eldfisk (ZAF)	29/11–3/1/01	A	N	Y (6)	N (100)	Y (5)	Y (5)	Y (2-6)	Y
Eldfisk (ZAF)	5/5–11/7/01	A	Y	Y (5)	Y (150)	Y (6)	Y (2.5)	Y (5-1)	-
Eldfisk (ZAF)	4/8–6/9/01	A	Y	Y (6)	Y (155)	Y (12)	Y (2)	Y (3-1.5)	Y
Isla Graciosa (ZAF)	2/10–17/12/00	Sp	Y	Y (5)	Y (150)	Y (5)	Y (5)	-	Y
Isla Graciosa (ZAF)	28/3–1/6/01	Sp	Y	Y (7.5)	Y (160)	Y (12)	Y (1.25)	Y (4-1)	-
Isla Graciosa (ZAF)	11/6–7/8/01	Sp	Y	Y (5)	Y (155)	Y (8)	Y (3.5)	-	-
Koryo Maru 11 (ZAF)	16/10–6/12/00	Sp	N	Y (8)	N (115)	Y (8)	Y (5)	-	Y
Koryo Maru 11 (ZAF)	24/1–9/4/01	Sp	Y	Y (8)	Y (155)	Y (8)	Y (5)	-	Y
Sudior One (ZAF)	24/7–17/9/01	Sp	N	Y (4.5)	N (125)	Y (5)	Y (5)	Y (3.5-1)	Y
Subarea 88.1									
Eldfisk (ZAF)	20/2–17/3/01	A	Y	Y (5)	Y (150)	Y (9)	Y (5)	Y (3.5-1)	-
Isla Gorriti (URY)	14/1–19/3/01	A	Y	Y (4.5)	Y (150)	Y (5)	Y (5)	-	Y
Isla Graciosa (ZAF)	25/2–27/3/01	Sp	Y	Y (5)	Y (199)	Y (7)	Y (2.5)	-	Y
Janas (NZL)	1/1–3/4/01	A	Y	Y (8)	Y (200)	Y(16)	Y (4)	Y (5-1.5)	-
San Aotea II (NZL)	2/1–23/5/01	A	Y	Y (6)	Y (150)	Y (25)	Y (5)	-	Y
Sonrisa (NZL)	6/1–1/3/01	A	Y	Y (11)	Y (150)	Y (5)	Y (5)	Y (4.5-2)	-

Table 58: Summary of compliance with Conservation Measure 29/XVI (1998 to 2000) and Conservation Measure 29/XIX (2000/01) regarding night setting, correct configuration and use of streamer lines and offal discharge practices in the Convention Area, from 1998 to 2001. Vessels with a history of non-compliance (at least two elements of the conservation measure in two consecutive years, including the current year) with a conservation measure are indicated in bold. Vessels in their first year in the fishery that failed to comply with two elements of the conservation measures are indicated in italics in the column for the current year (2001). Nationality: CHL – Chile, ESP – Spain, GBR – United Kingdom, KOR – Republic of Korea, NZL – New Zealand, RUS – Russia, UKR – Ukraine, URY – Uruguay, ZAF – South Africa, Y – complied, N – did not comply, - – did not fish, na – not applicable.

Vessel (Nationality)	Subarea/ Division	Night Setting				Streamer Line				Offal Discharge				Line Weighting			
		1998	1999	2000	2001	1998	1999	2000	2001	1998	1999	2000	2001	1998	1999	2000	2001
***Aquatic Pioneer* (ZAF)**	**58.6, 58.7**	**Y**	**N**	**Y**	**Y**	**N**	**N**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**N**	**N**	**N**	**N**
Argos Georgia (GBR)	48.3	-	-	Y	N	-	-	N	Y	-	-	Y	Y	-	-	N	Y
***Argos Helena* (GBR)**	**48.3**	**Y**	**Y**	**Y**	**Y**	**Y**	**N**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**N**	**N**	**N**	**N**
***Eldfisk* (ZAF) #**	**58.6, 58.7**	-	**N**	**N**	**N**	-	**N**	**N**	**N**	-	**Y**	**Y**	**Y**	**N**	**N**	**na**	**na**
Ibsa Quinto (ESP)	48.3	-	Y	Y	Y	-	Y	N	Y	-	Y	Y	Y	-	N	N	N
In Sung 66 (KOR)	48.3	-	-	-	*N*	-	-	-	*Y*	-	-	-	*Y*	-	-	-	*N*
***Isla Alegranza* (URY)**	**48.3**	-	-	**N**	**N**	-	-	**N**	**Y**	-	-	**N**	**Y**	-	-	**N**	**N**
***Isla Camila* (CHL)**	**48.3**	**Y**	**N**	**N**	**N**	**N**	**N**	**Y**	**N**	**N**	**N**	**N**	**Y**	**N**	**N**	**N**	**N**
Isla Gorriti (URY)	48.3/88.1	-	N/-	N/-	-/na	-	N/-	N/-	-/Y	-	Y/-	Y/-	-/Y	-	na	na	-/Y
Isla Graciosa (ZAF)	58.6, 58.7/88.1	-/-	-/-	-/-	N/na	-/-	-/-	-/-	Y	-/-	-/-	-/-	Y	-/-	-/-	-/-	-/Y
***Isla Santa Clara* (CHL)**	**48.3**	-	-	**N**	**N**	-	-	**N**	**N**	-	-	**Y**	**Y**	-	-	**N**	**N**
Janas (NZL)	88.1	-	na	na	na	-	Y	Y	Y	-	Y	Y	Y	-	na	na	Y
***Koryo Maru II* (ZAF)**	**58.6, 58.7/48.3**	**Y/-**	**Y/Y**	**N/Y**	**N/N**	**N/-**	**N/Y**	**N/Y**	**N/N**	**Y/Y**	**Y/Y**	**Y/Y**	**Y/Y**	**N/N**	**N/Y**	**N/Y**	**N/N**
Maria Tamara (CHL)	48.3	-	-	-	*Y*	-	-	-	*Y*	-	-	-	*N*	-	-	-	*N*
***No. 1 Moresko* (KOR)**	**48.3**	-	**N**	**N**	**N**	-	**N**	**N**	**N**	-	**Y**	**Y**	**Y**	-	**N**	**N**	**N**
Polarpesca 1 (CHL)	48.3	-	-	-	*N*	-	-	-	*N*	-	-	-	*Y*	-	-	-	*N*
RK-1 (UKR)	48.3	-	-	Y	N	-	-	Y	Y	-	-	Y	Y	-	-	na	na
Rutsava (RUS)	48.3	-	-	-	*Y*	-	-	-	*N*	-	-	-	*Y*	-	-	-	*N*
San Aotea II (NZL)	88.1	-	na	na	na	-	Y	Y	Y	-	Y	Y	Y	-	na	na	Y
Sonrisa (NZL)	88.1	-	-	na	na	-	-	Y	Y	-	-	Y	Y	-	-	na	Y
Suidor One (ZAF)	58.6, 58.7	-	-	-	*N*	-	-	-	*N*	-	-	-	*Y*	-	-	-	*N*
Ural (RUS)	48.3	-	-	-	N	-	-	-	Y	-	-	-	Y	-	-	-	Y
Viking Bay (ESP)	48.3	-	-	-	N	-	-	-	Y	-	-	-	Y	-	-	-	Y

\# *Eldfisk* set all lines during the day using an underwater setting funnel in Subareas 58.6 and 58.7, in accordance with South African fishing permit conditions.

Table 59: Vessel compliance (%) with Conservation Measure 29/XIX during the 2000/01 season. Values for night setting and streamer line setting are absolute proportions for all sets by each vessel. Values for offal discharge, line weighting and streamer line design are averages across all cruises by each vessel.

Vessel	Number of Cruises	Night Setting	Offal Discharge	Line Weighting	Streamer Line Setting	Streamer Line Design
Subarea 48.3						
Argos Georgia (GBR)	1	99	100	100	92	100
Argos Helena (GBR)	1	100	100	0	99	0
Ibsa Quinto (ESP)	1	100	100	0	100	100
In Sung 66 (KOR)	2	96	100	0	96	100
Isla Alegranza (URY)	1	90	100	0	24	100
Isla Camila (CHL)	2	96	100	0	91	0
Isla Santa Clara (CHL)	2	94	100	0	96	50
Koryo Maru 11 (ZAF)	1	96	100	0	93	0
Maria Tamara (CHL)	1	100	0	0	100	100
No. 1 Moresko (KOR)	2	97	100	50	95	0
Polarpesca I (CHL)	1	88	100	0	100	0
RK-1 (UKR)	2	84	100	Autoline	13	100
Rutsava (RUS)	1	100	100	0	100	0
Ural (RUS)	1	98	100	100	99	100
Viking Bay (ESP)	1	94	100	100	96	100
Subareas 58.6 and 58.7						
Aquatic Pioneer (ZAF)	1	100	100	0	100	0
Eldfisk (ZAF)#	4	69	100	Autoline	100	75
Isla Graciosa (ZAF)	3	98	100	34	100	100
Koryo Maru 11 (ZAF)	2	76	100	50	100	50
Suidor One (ZAF)	1	97	100	0	100	0
Subarea 88.1						
Eldfisk (ZAF)*	1	36	100	Autoline	100	100
Isla Alegranza (URY)*	1	No data	No data	No data	No data	No data
Isla Gorriti (URY)*	1	5	100	Autoline	100	100
Isla Graciosa (ZAF)*	1	25	100	100	92	100
Janas (NZL)*	1	6	100	Autoline	100	100
San Aotea II (NZL)*	1	32	100	Autoline	100	100
Sonrisa (NZL)*	1	74	100	Autoline	100	100

* Conservation Measure 210/XIX allows fishing in Subarea 88.1 during daylight periods if the vessel can demonstrate a minimum sink rate of 0.3 metres per second.

\# *Eldfisk* set all lines during the day using an underwater setting funnel in Subareas 58.6 and 58.7, in accordance with South African fishing permit conditions.

Table 60: Estimate of seabird by-catch in the unregulated *Dissostichus* spp. fishery in Subareas 48.3, 58.6 and 58.7 and Divisions 58.4.4, 58.5.1 and 58.5.2 in 2000/01. S – summer, W – winter.

Subarea/ Division	Total Unregulated Catch (tonnes)	Split S:W		Unregulated Catch (tonnes)		*Dissostichus* spp. Regulated Catch Rate (kg/hooks)	Unregulated Effort (1 000 hooks)		Seabird By-catch Rate (birds/1 000 hooks)				Estimated Total Unregulated Seabird By-catch			
									Mean		Max		Mean		Max	
		S	W	S	W		S	W	S	W	S	W	S	W	S	W
48.3	300	80	20	240	60	0.301	797	199	2.608	0.07	9.31	0.51	2 079	14	7 423	102
	300	70	30	210	90	0.301	698	299	2.608	0.07	9.31	0.51	1 820	21	6 495	152
	300	60	40	180	120	0.301	598	399	2.608	0.07	9.31	0.51	1 560	28	5 567	203
58.4.4	1 540	80	20	1 232	308	0.063	19 556	4 889	0.629	0.01	1.128	0.042	12 300	49	22 059	205
	1 540	70	30	1 078	462	0.063	17 111	7 333	0.629	0.01	1.128	0.042	10 763	73	19 301	308
	1 540	60	40	924	616	0.063	14 667	9 778	0.629	0.01	1.128	0.042	9 225	98	16 544	411
58.5.1	3 300	80	20	2 640	660	0.236	11 186	2 797	1.049	0.017	1.88	0.07	11 735	48	21 031	196
	3 300	70	30	2 310	990	0.236	9 788	4 195	1.049	0.017	1.88	0.07	10 268	71	18 402	294
	3 300	60	40	1 980	1 320	0.236	8 390	5 593	1.049	0.017	1.88	0.07	8 801	95	15 773	392
58.5.2	1 649	80	20	1 319	330	0.236	5 590	1 397	1.049	0.017	1.88	0.07	5 864	24	10 509	98
	1 649	70	30	1 154	495	0.236	4 891	2 096	1.049	0.017	1.88	0.07	5 131	36	9 195	147
	1 649	60	40	989	660	0.236	4 192	2 795	1.049	0.017	1.88	0.07	4 398	48	7 882	196
58.6	660	80	20	528	132	0.04	13 200	3 300	1.049	0.017	1.88	0.07	13 847	56	24 816	231
	660	70	30	462	198	0.04	11 550	4 950	1.049	0.017	1.88	0.07	12 116	84	21 714	347
	660	60	40	396	264	0.04	9 900	6 600	1.049	0.017	1.88	0.07	10 385	112	18 612	462
58.7	150	80	20	120	30	0.064	1 875	469	1.049	0.017	1.88	0.07	1 967	8	3 525	33
	150	70	30	105	45	0.064	1 641	703	1.049	0.017	1.88	0.07	1 721	12	3 084	49
	150	60	40	90	60	0.064	1 406	938	1.049	0.017	1.88	0.07	1 475	16	2 644	66

Note: No data are available for longline fishing in Divisions 58.4.4, 58.5.1 and 58.5.2 in 2000/01. The figures used for CPUE (kg/hook) are derived from fine-scale catch and effort data (C2), and are revised figures for 1999/2000.

Table 61: Estimates of potential seabird by-catch in unregulated longline fishing in the Convention Area in 2000/01.

Subarea/ Division	Potential By-catch Level	Summer	Winter	Total[1]
48.3	Lower (mean)	1 600–2 100	10–30	1 600–2 100
	Higher (max)	5 600–7 400	100–200	5 800–7 500
58.4.4	Lower	9 200–12 300	50–100	9 300–12 400
	Higher	16 500–22 100	210–410	16 900–22 300
58.5.1	Lower	8 800–11 700	50–100	8 900–11 800
	Higher	15 800–21 000	200–390	16 200–21 200
58.5.2	Lower	4 400–5 900	20–50	4 500–5 900
	Higher	7 900–10 500	100–200	8 100–10 600
58.6	Lower	10 400–13 800	60–110	10 500–13 900
	Higher	18 600–24 800	230–460	19 100–25 000
58.7	Lower	1 500–2 000	10–20	1 500–2 000
	Higher	2 600–3 500	30–70	2 700–3 500
Total	Lower	35 900–67 000[1]	200–900[1]	36 000–69 000[2]
	Higher	47 800–89 300[1]	400–1 700[1]	48 000–90 000[2]

1 Rounded to nearest hundred birds
2 Rounded to nearest thousand birds

Table 62: Composition of estimated potential by-catch in unregulated longline fisheries in the Convention Area from 1997 to 2001.

Area/Year		Estimated Total Potential Seabird By-catch[1] (lower level above, higher level below)	Composition of Potential Seabird By-catch[2] Albatrosses	Giant Petrels	White-chinned Petrels
Subarea 48.3[3]					
	1996/97	-	-	-	-
	1997/98	-	-	-	-
	1998/99	3 000–4 000	1 505	70	1 680
		12 000–16 000	6 020	280	6 720
	1999/00	1 900–2 600	967	45	1 080
		7 200–9 300	3 547	165	3 960
	2000/01	1 600–2 100	795	37	888
		5 800–7 500	2 860	133	3 192
Divisions 58.5.1, 58.5.2[4]					
	1996/97	-	-	-	-
	1997/98	34 000–45 000	8 690	1 580	24 885
		61 000–81 000	15 620	2 840	44 730
	1998/99	2 000–3 000	550	100	1 575
		4 000–5 000	990	180	2 835
	1999/00	7 800–10 300	1 991	362	5 701
		14 100–18 600	3 597	654	10 300
	2000/01	13 400–17 700	3 421	622	9 796
		24 300–31 800	6 171	1 122	17 671
Division 58.4.4[4]					
	1996/97	-			
	1997/98	-			
	1998/99	3 000–5 000	880	160	2 520
		4 000–7 000	1 210	220	3 465
	1999/00	6 400–8 400	1 628	296	4 662
		11 600–15 100	2 937	534	8 410
	2000/01	9 300–12 400	2 387	434	6 835
		16 900–22 300	4 312	784	12 348
Subareas 58.6, 58.7[4]					
	1996/97	17 000–27 000	4 840	880	13 860
		66 000–107 000	19 030	3 460	54 495
	1997/98	9 000–11 000	2 200	400	6 300
		15 000–20 000	3 850	700	11 025
		24 000–32 000	6 160	1 120	17 640
	1998/99	13 000–17 000	3 300	600	9 450
	1999/00	16 700–22 000	4 257	774	12 190
		30 200–39 600	7 678	1 396	21 987
	2000/01	12 000–15 900	3 069	558	8 788
		21 800–28 500	5 533	1 006	15 844
Total	1996/97	17 000–27 000	4 840	880	13 860
		66 000–107 000	19 030	3 460	54 495
	1997/98	43 000–54 000	10 890	1 980	30 185
		76 000–101 000	19 470	3 540	55 755
	1998/99	21 000–29 000	6 235	930	15 225
		44 000–59 000	14 380	1 800	30 660
	1999/00	33 000–63 000	8 843	1 477	23 633
		43 000–83 000	17 759	2 749	44 657
	2000/01	36 000–69 000	9 672	1 651	26 307
		48 000–90 000	18 876	3 045	49 055
Overall Total		147 000–237 000	40 480	6 918	109 210
		276 000–438 000	89 515	14 594	234 622

[1] Rounded to nearest thousand birds
[2] Based on averages for lower (above) and higher (below) level values
[3] Based on 43% albatrosses, 2% giant petrels, 48% white-chinned petrels (7% unidentified petrels) (SC-CAMLR-XVI, Annex 5, Table 44).
[4] Based on 22% albatrosses, 4% giant petrels, 63% white-chinned petrels (10% unidentified petrels) (SC-CAMLR-XVI, Annex 5, Table 42).

Table 63: Summary of IMALF risk level and assessment in relation to proposed new and exploratory longline fisheries in 2001/02.

Area	Risk Level	IMALF Risk Assessment (see SC-CAMLR-XX/BG/11)	Notes
48.6	2	Average to low risk (southern part of area (south of c. 55°S) of low risk). No obvious need for restriction of longline fishing season. Apply Conservation Measure 29/XIX as a seabird by-catch precautionary measure.	• Japan (CCAMLR-XX/10) proposes to fish on 'dates as established by CCAMLR'. **Intent to comply with Conservation Measure 29/XIX not specified. Observer coverage to be provided by Japanese monitoring observer, contrary to existing practice and Conservation Measure 200/XIX.** • New Zealand (CCAMLR-XX/12) proposes to fish from 1 December 2001 to 30 November 2002, both south and north of 55°S. Intends to comply fully with Conservation Measure 29/XIX. Proposal does not conflict with advice provided. • South Africa (CCAMLR-XX/15) proposes to fish during a season to be established at CCAMLR-XX. States intent to comply with Conservation Measure 29/XIX, and to conduct line-weighting experiments, as approved by the Scientific Committee e.g. as per Conservation Measure 210/XIX (Annex). Proposal does not conflict with advice provided. • Uruguay (CCAMLR-XX/16) proposes to fish from 1 March to 31 August 2002 and to comply with Conservation Measure 29/XIX. Proposal does not conflict with advice provided.
58.4.1	3	Average risk. Apply all elements of Conservation Measure 29/XIX. Much of the risk to seabirds in this area arises in the region of the BANZARE Rise in the west of the region, adjacent to Division 58.4.3.	• Japan (CCAMLR-XX/10) proposes to fish on 'dates as established by CCAMLR'. **Intent to comply with Conservation Measure 29/XIX not specified. Observer coverage to be provided by Japanese monitoring observer, contrary to existing practice and Conservation Measure 200/XIX.**
58.4.3	3	Average risk. Prohibit longline fishing during the breeding season of albatrosses, giant petrels and white-chinned petrels (September to April). Maintain all elements of Conservation Measure 29/XIX.	• France (CCAMLR-XX/9) proposes to fish from 1 May to 31 August 2002 and to comply with Conservation Measure 29/XVI, **not Conservation Measure 29/XIX**. • Japan (CCAMLR-XX/10) proposes to fish on 'dates as established by CCAMLR'. **Intent to comply with Conservation Measure 29/XIX not specified. Observer coverage to be provided by Japanese monitoring observer, contrary to existing practice and Conservation Measure 200/XIX.**

(continued)

Table 63 (continued)

Area	Risk Level	IMALF Risk Assessment (see SC-CAMLR-XX/BG/11)	Notes
58.4.4	3	Average risk. Prohibit longline fishing during the main breeding season of albatrosses and petrels (September to April). Maintain all elements of Conservation Measure 29/XIX.	• France (CCAMLR-XX/9) proposes to fish from 1 May to 31 August 2002 and to comply with Conservation Measure 29/XVI, **not Conservation Measure 29/XIX** • Japan (CCAMLR-XX/10) proposes to fish on 'dates as established by CCAMLR'. **Intent to comply with Conservation Measure 29/XIX not specified. Observer coverage to be provided by Japanese monitoring observer, contrary to existing practice and Conservation Measure 200/XIX.** • New Zealand (CCAMLR-XX/12) **proposes to fish from 1 December 2001 to 30 November 2002, both south and north of 55°S**. States intent to comply with Conservation Measure 29/XIX. • South Africa (CCAMLR-XX/15) proposes to fish during a season to be established at CCAMLR-XX. States intent to comply with Conservation Measure 29/XIX, and to conduct line-weighting experiments, as approved by the Scientific Committee e.g. as per Conservation Measure 210/XIX (and Annex A). Proposal does not conflict with advice provided, **assuming that fishing season is between 1 May and 31 August.** • Uruguay (CCAMLR-XX/17) proposes to fish from 1 May to 31 August 2002 and to comply with Conservation Measure 29/XIX. Proposal does not conflict with advice provided.
58.6	5	High risk. Prohibit longline fishing during the main albatross and petrel breeding season (i.e. September to April). Ensure strict compliance with Conservation Measure 29/XIX.	• Chile (CCAMLR-XX/8) proposes to fish from 1 May to 31 August 2002 and comply with Conservation Measure 29/XIX. Proposal does not conflict with advice provided. • France (CCAMLR-XX/9) proposes to fish from 1 May to 31 August 2002 and to comply with Conservation Measure 29/XVI, **not Conservation Measure 29/XIX.** • Japan (CCAMLR-XX/10) proposes to fish on 'dates as established by CCAMLR'. **Intent to comply with Conservation Measure 29/XIX not specified. Observer coverage to be provided by Japanese monitoring observer, contrary to the Convention and Conservation Measure 200/XIX.** • South Africa (CCAMLR-XX/15) proposes to fish during a season to be established at CCAMLR-XX. States intent to comply with Conservation Measure 29/XIX, and to conduct line-weighting experiments, as approved by the Scientific Committee e.g. as per Conservation Measure 210/XIX (and Annex A). Proposal does not conflict with advice provided, **assuming that fishing season is between 1 May and 31 August.**

(continued)

Table 63 (continued)

Area	Risk Level	IMALF Risk Assessment (see SC-CAMLR-XX/BG/11)	Notes
88.1	3	Average risk overall. Average risk in northern sector (*D. eleginoides* fishery), average to low risk in southern sector (*D. mawsoni* fishery). Longline fishing season limits of uncertain advantage. Ensure strict adherence to the provisions of Conservation Measures 29/XIX and 210/XX including Annex A.	• Japan (CCAMLR-XX/10) proposes to fish on 'dates as established by CCAMLR'. **Intent to comply with Conservation Measure 29/XIX or Conservation Measure 210/XIX not specified. Observer coverage to be provided by Japanese monitoring observer, contrary to existing practice and Conservation Measure 200/XIX.** • New Zealand (CCAMLR-XX/11) proposes to fish from 1 December 2001 to 31 August 2002. States intent to comply with Conservation Measures 29/XIX and 210/XIX. Proposal does not conflict with advice provided. • Russia (CCAMLR-XX/13) proposes to fish from 1 December 2001 to 31 August 2002. States intent to comply with Conservation Measure 29/XIX. **Compliance with Conservation Measure 210/XIX not mentioned.** • South Africa (CCAMLR-XX/15) – proposal does not conflict with advice provided. Fishing season to be as established at CCAMLR-XX. States intent to comply with Conservation Measure 29/XIX and to conduct line-weighting experiments, as approved by the Scientific Committee e.g. as per Conservation Measure 210/XIX (and Annex A).
88.2	1	Low risk. No obvious need for restriction of longline fishing season. Apply Conservation Measure 29/XIX as a seabird by-catch precautionary measure.	• Japan (CCAMLR-XX/10) proposes to fish on 'dates as established by CCAMLR'. **Intent to comply with Conservation Measure 29/XIX not specified. Observer coverage to be provided by Japanese monitoring observer, contrary to existing practice and Conservation Measure 200/XIX.** • New Zealand (CCAMLR-XX/11) proposes to fish from 1 December 2001 to 31 August 2002. States intent to comply with Conservation Measures 29/XIX and 210/XIX. Proposal does not conflict with advice provided. • Russia (CCAMLR-XX/14) proposes to fish from 1 December 2001 to 31 August 2002. States intent to comply with Conservation Measure 29/XIX. **Compliance with Conservation Measure 210/XIX not mentioned.** • South Africa (CCAMLR-XX/15) – proposal does not conflict with advice provided. Fishing season to be as established at CCAMLR-XX. States intent to comply with Conservation Measure 29/XIX and to conduct line-weighting experiments, as approved by the Scientific Committee e.g. as per Conservation Measure 210/XIX (and Annex A).

Table 64: Marine mammal incidental mortality and interactions with fishing operations reported by observers during the 2000/01 season. Y – yes; N – No; DLP – dolphin; KIW – killer whale; SPW – sperm whale; SEA – Antarctic fur seal; MIW – minke whale; UNK – unknown. Nationality: AUS – Australia, CHL – Chile, ESP – Spain, GBR – United Kingdom, KOR – Republic of Korea, NZL – New Zealand, RUS – Russia, UKR – Ukraine, URY – Uruguay, USA – United States of America, ZAF – South Africa.

Vessel Name (Nationality)	Dates of Trip	Observation Reported	Mammal Killed	(Species) Entangled	Fish Loss Observed (Species)
Subarea 48.3					
Argos Georgia (GBR)	17/1–25/2/01	Y	N	N	N
Argos Georgia (GBR)	23/4–2/8/01	Y	N	N	Y (KIW, SPW)
Argos Helena (GBR)	12/1–11/3/01	Y	N	N	N
Argos Helena (GBR)	3/5–29/8/01	Y	N	N	Y (SEA)
Argos Helena (GBR)	2/4–28/4/01	Y	N	N	N
Argos Vigo (GBR)	21/12–26/12/00	Y	N	N	N
Argos Vigo (GBR)	1/2–20/2/01	Y	N	N	N
Betanzos (CHL)	26/11/00–27/2/01	Y	N	N	N
Ibsa Quinto (ESP)	25/4–16/7/01	Y	N	N	Y (KIW)
In Sung 66 (KOR)	26/4–7/7/01	Y	N	Y (SEA)	Y
In Sung 66 (KOR)	7/7–6/9/01	Y	N	N	N
In Sung 707 (KOR)	6/6–1/7/01	Y	N	N	N
Isla Alegranza (URY)	28/4–5/9/01	Y	N	N	Y (SPW,KIW)
Isla Camila (CHL)	1/5–29/5/01	Y	N	N	N
Isla Camila (CHL)	8/6–17/8/01	Y	N	N	N
Isla Santa Clara (CHL)	25/4–1/7/01	Y	N	N	N
Isla Santa Clara (CHL)	1/7–24/7/01	Y	N	N	N
Koryo Maru 11 (ZAF)	19/4–13/9/01	Y	N	N	Y (KIW,SEA)
Maria Tamara (CHL)	30/6–31/8/01	Y	N	N	N
No. 1 Moresko (KOR)	1/5–12/7/01	Y	N	Y (SPW)	N
No. 1 Moresko (KOR)	13/7–6/9/01	Y	N	N	N
Polarpesca I (CHL)	7/6–27/8/01	Y	N	N	Y (SPW)
RK-1 (UKR)	21/4–23/6/01	Y	N	N	N
RK-1 (UKR)	23/6–5/9/01	Y	N	N	N
Rutsava (RUS)	25/4–12/6/01	Y	N	N	N
Saint Denis (FRA)	6/12/00–18/1/01	Y	N	N	N
Sil (GBR)	1/6–13/6/01	Y	N	N	N
Ural (RUS)	22/4–22/8/01	Y	N	N	Y (KIW)
Viking Bay (ESP)	13/5–31/8/01	Y	N	N	Y (KIW,SEA)
Viking Sky (GBR)	16/3–4/4/01	Y	N	N	N
Viking Sky (URY)	18/5–12/7/01	Y	N	N	N
Zakhar Sorokin (RUS)	22/8–14/9/01	Y	N	N	N
Subarea 58.6 and 58.7					
Aquatic Pioneer (ZAF)	20/9–20/11/00	Y	N	N	Y
Eldfisk (ZAF)	2/9–12/11/00	Y	N	Y (SPW)	Y (KIW, SPW)
Eldfisk (ZAF)	29/11/00–3/1/01	Y	N	N	Y
Eldfisk (ZAF)	5/5–11/7/01	Y	N	N	Y (KIW, SPW)
Eldfisk (ZAF)	4/8–6/9/01	Y	N	N	Y (KIW, SPW)
Isla Graciosa (ZAF)	2/10–17/12/00	Y	N	N	Y (KIW, SPW)
Isla Graciosa (ZAF)	28/3–1/6/01	Y	N	N	N
Isla Graciosa (ZAF)	11/6–7/8/01	Y	N	N	Y (KIW, SPW)
Koryo Maru 11 (ZAF)	16/10–6/12/00	Y	N	N	Y(KIW, SPW)
Koryo Maru 11 (ZAF)	24/1–9/4/01	Y	N	N	Y (KIW)
Suidor One (ZAF)	24/7–17/9/00	Y	Y (UNK)	Y	N

(continued)

Table 64 (continued)

Vessel Name (Nationality)	Dates of Trip	Observation Reported	Mammal Killed	(Species) Entangled	Fish Loss Observed (Species)
Subarea 88.1					
Eldfisk (ZAF)	20/2–17/3/01	Y	N	N	N
Isla Gorriti (URY)	14/1–19/3/01	Y	N	N	N
Isla Graciosa (ZAF)	25/2–27/3/01	Y	N	N	N
Janas (NZL)	1/1–3/4/01	Y	N	N	N
San Aotea II (NZL)	2/1–23/5/01	Y	N	N	N
Sonrisa (NZL)	6/1–1/3/01	Y	N	Y (MIW)	N
Division 58.5.2					
Austral Leader (AUS)	12/8–19/10/00	Y	Y (SEA)	Y (SEA)	N
Austral Leader (AUS)	11/5–26/6/01	Y	N	N	N
Austral Leader (AUS)	27/2–7/5/01	Y	N	Y (SEA)	N
Southern Champion (AUS)	9/10–3/11/00	Y	N	N	N
Division 58.4.2					
Austral Leader (AUS)	20/12/00–23/2/01	N			
Subarea 48.1					
Top Ocean (USA)	25/5–3/7/01	Y	N	N	N

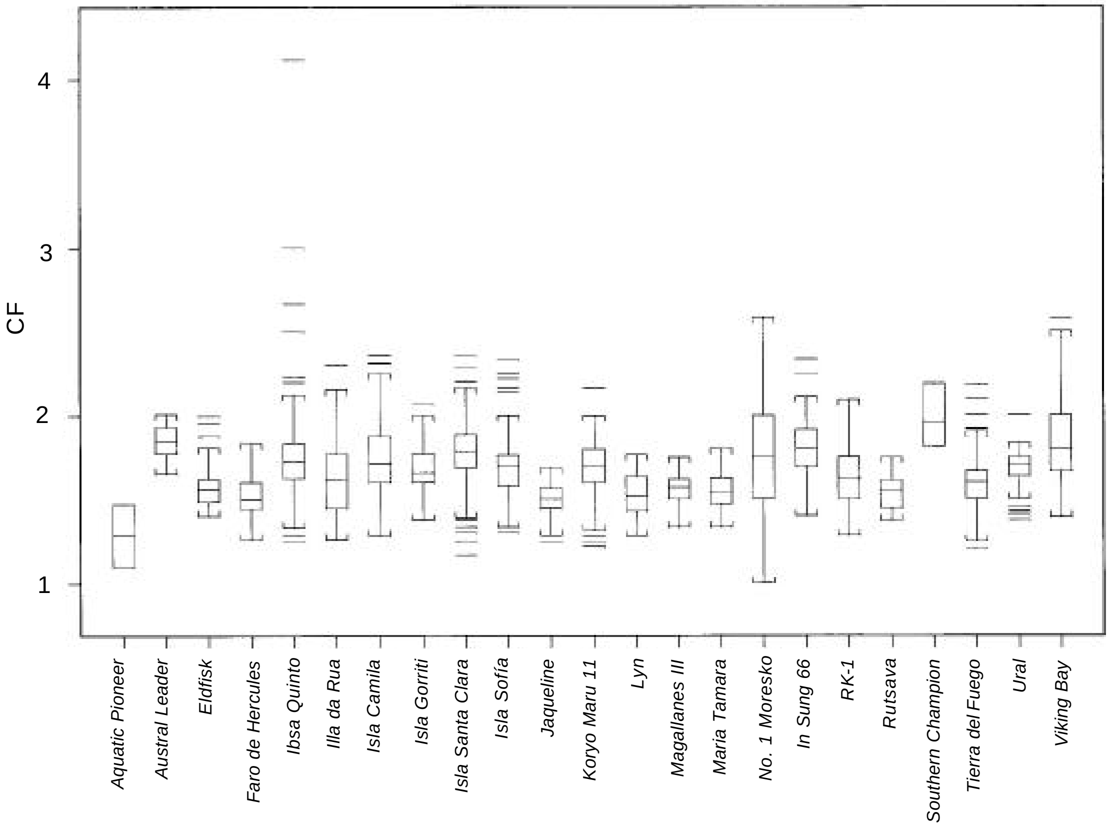


Figure 1: Box plot of CFs obtained by scientific observers on board vessels fishing in the Convention Area. CFs refer to headed and gutted (HAG) and headed, gutted and tailed (HGT) products.

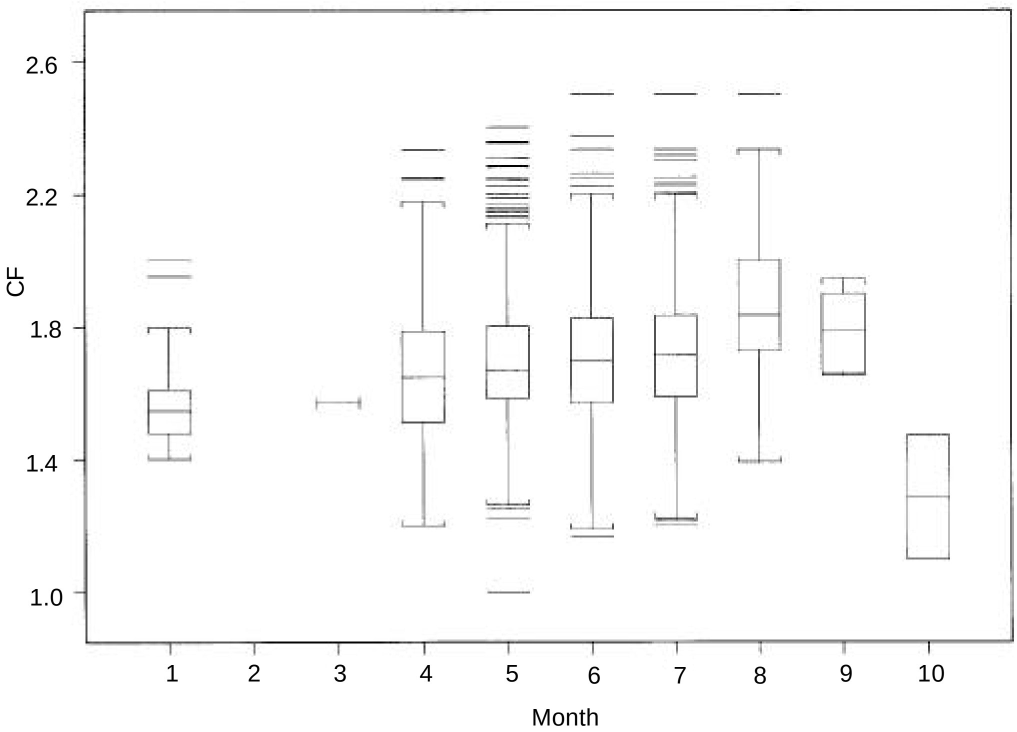


Figure 2: Box plots of monthly CFs obtained by scientific observers. CFs refer to headed and gutted (HAG) and headed, gutted and tailed (HGT) products.

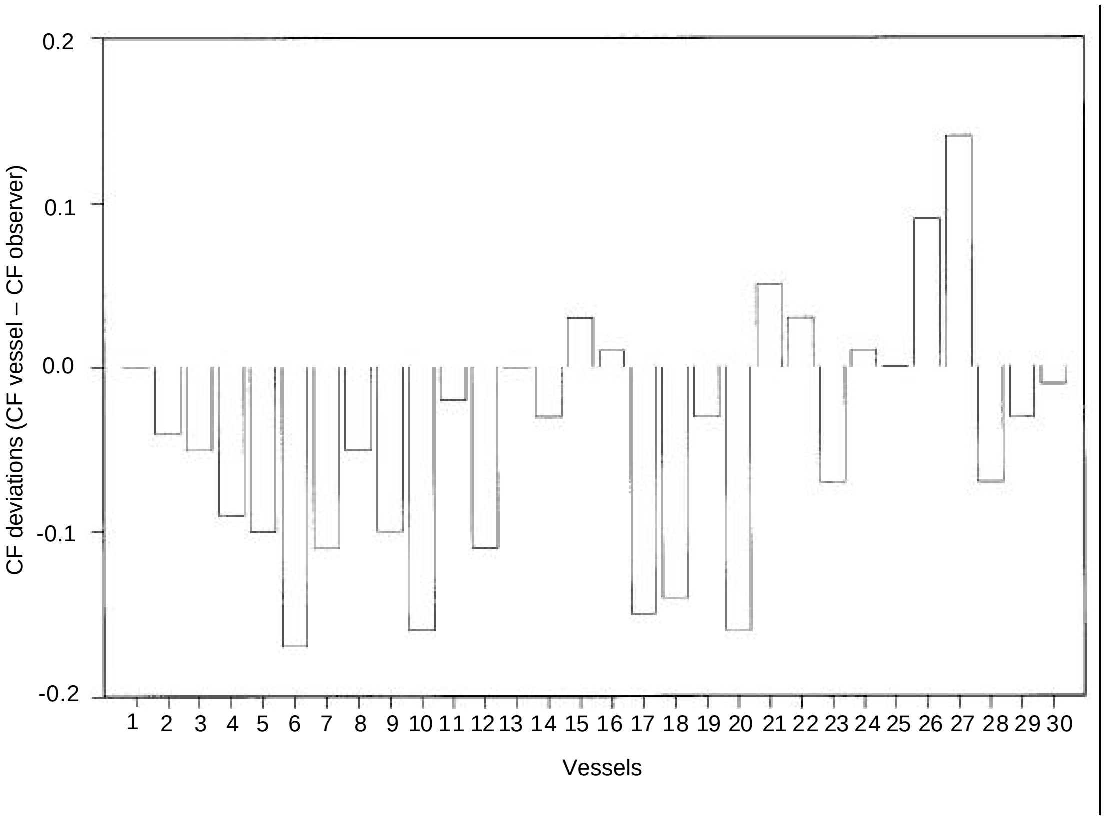


Figure 3: Deviations of CFs obtained by scientific observers and by vessel skippers during the 2000/01 fishing season.

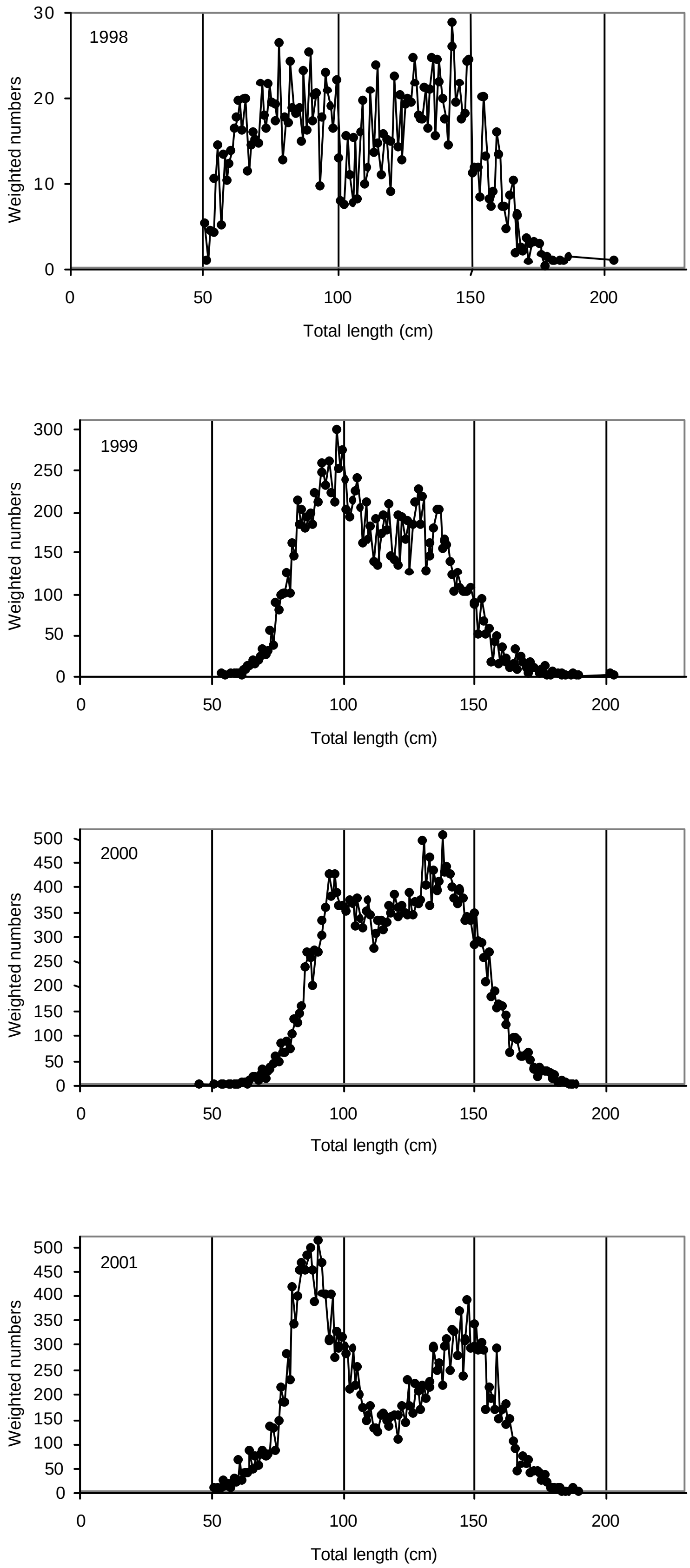


Figure 4: Catch-weighted length frequencies of *Dissostichus mawsoni* by year in the exploratory longline fishery in Subarea 88.1.

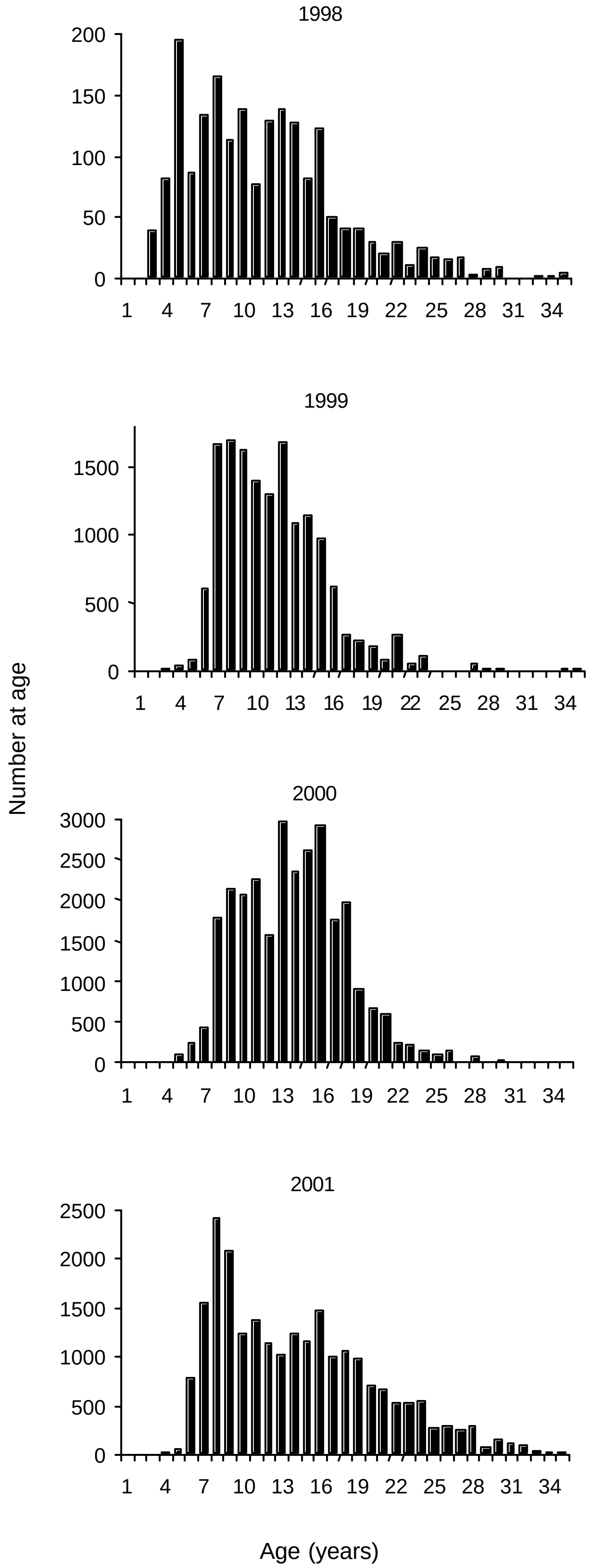


Figure 5: Estimated numbers at age of *Dissostichus mawsoni* by year in the exploratory longline fishery in Subarea 88.1.

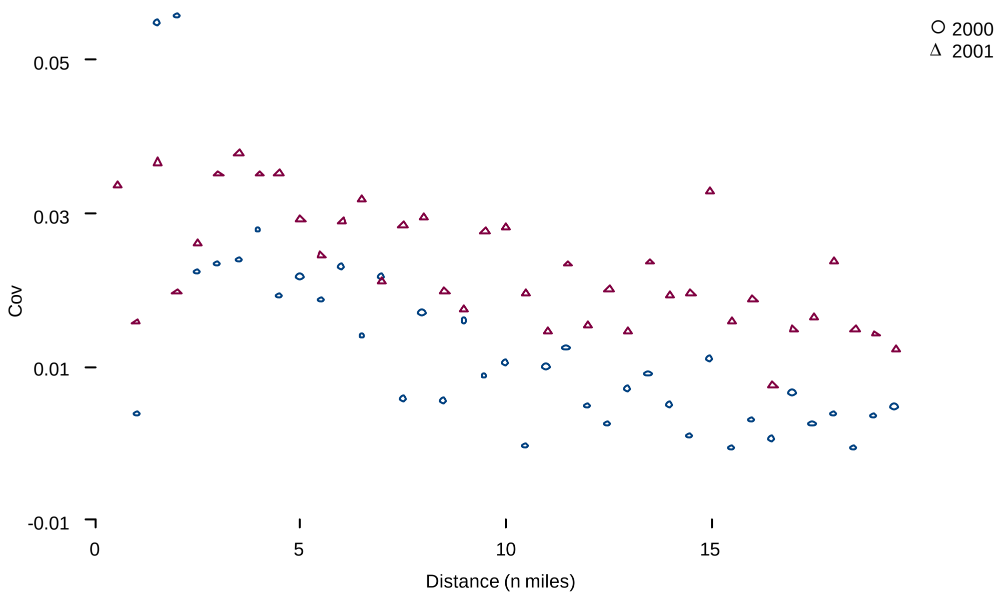


Figure 6: The covariagram of CPUE of *Dissostichus mawsoni* in Subarea 88.1 in 2000 and 2001.

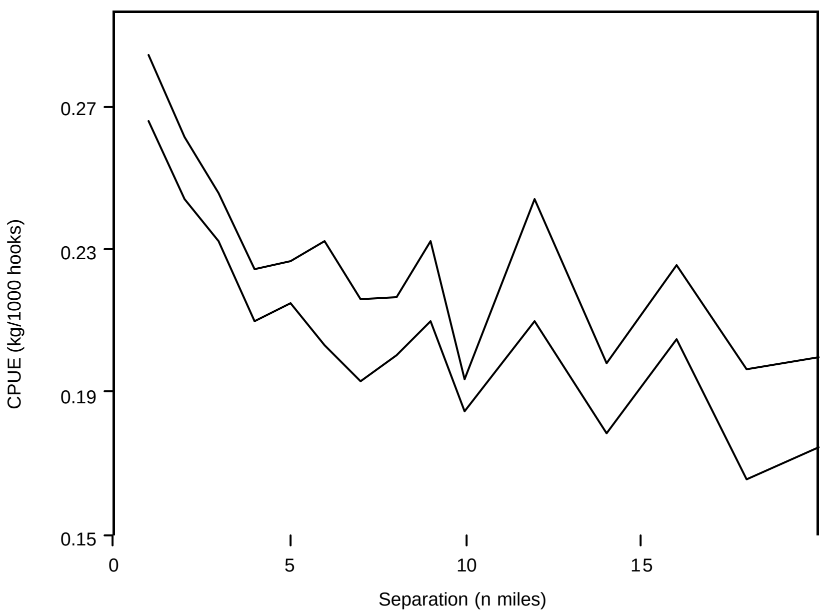


Figure 7: The result of sampling at different densities for *D. mawsoni* in Subarea 88.1. The top line is the CPUE from the sample (total catch over total effort), the bottom is the average of the CPUEs from each catch.

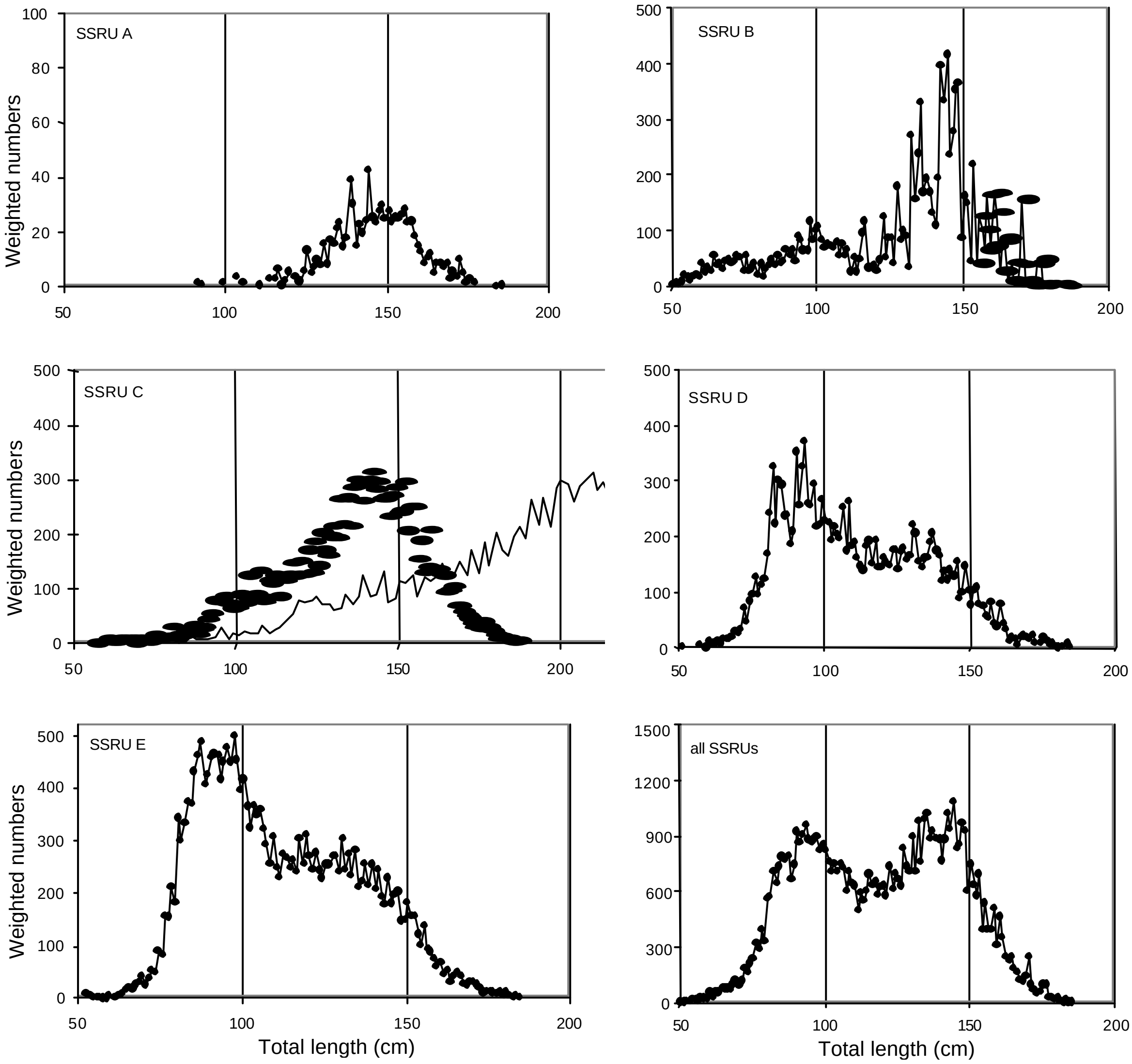


Figure 8: Scaled length-frequency distributions of *Dissostichus mawsoni* in Subarea 88.1 by SSRU.

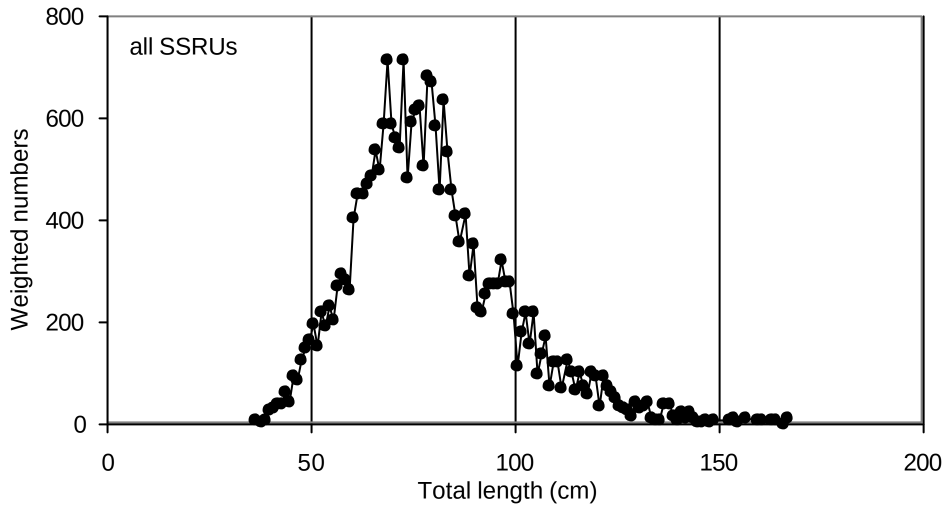


Figure 9: Catch-weighted length frequency for *Dissostichus eleginoides* caught by longline in Division 58.4.4 in the 2000 season for all SSRUs combined.

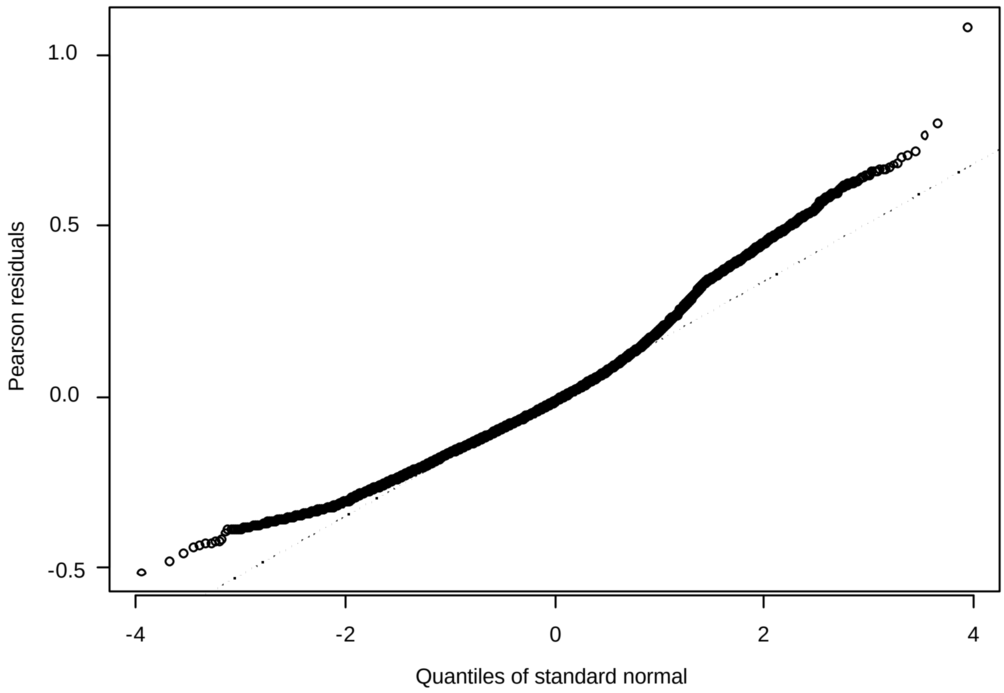


Figure 10: QQ plot of standardised residuals for the GLM fitted to CPUEs (kg/hook), for *Dissostichus eleginoides* in Subarea 48.3 using a robust GLM with the quasi distribution and a square root link.

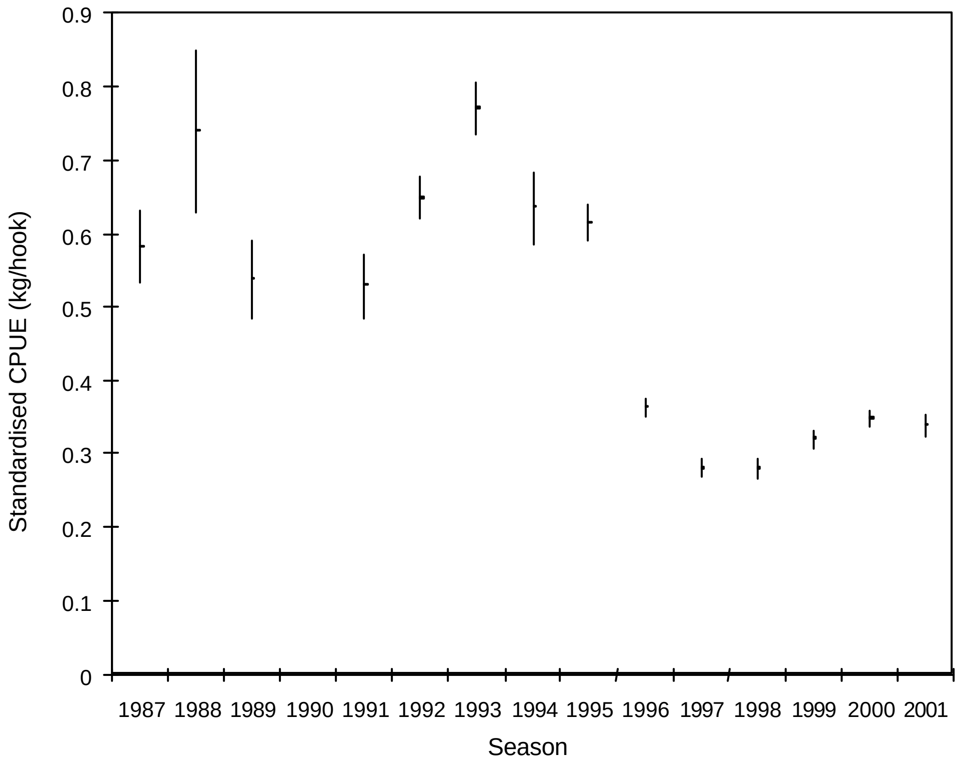
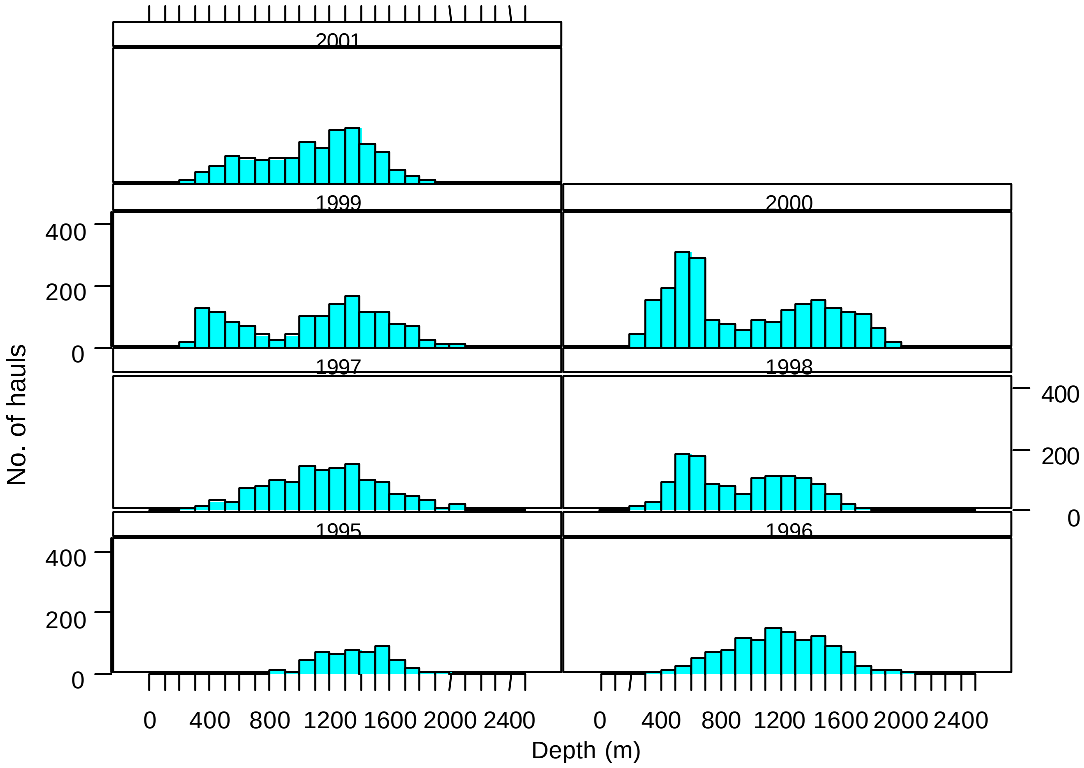


Figure 11: Standardised CPUEs and 95% confidence intervals in kg/hook for *Dissostichus eleginoides* in Subarea 48.3.



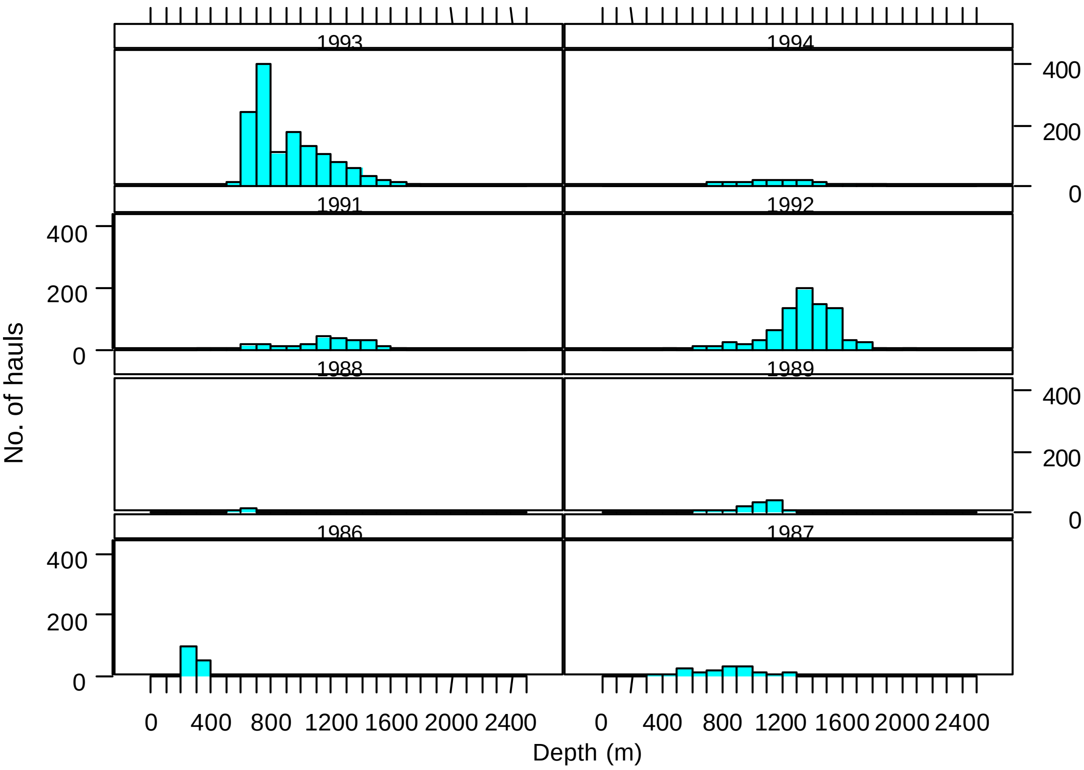
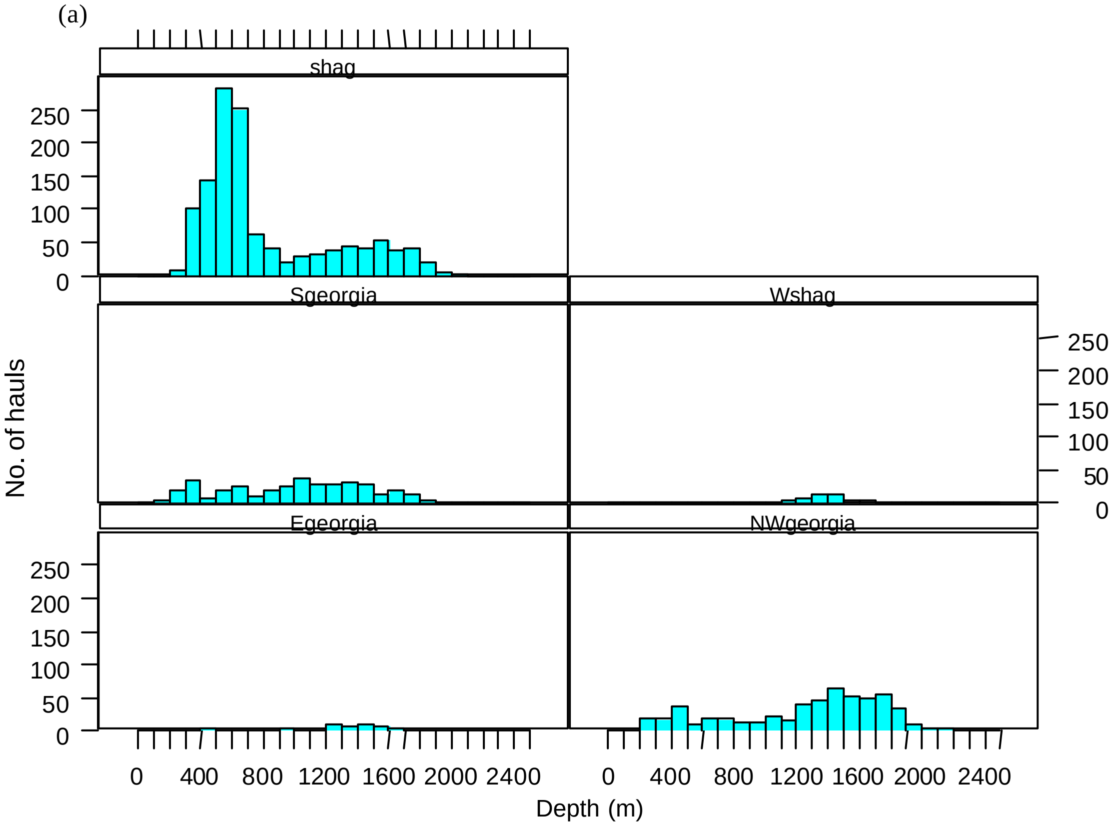


Figure 12: Histograms of number of hauls by depths fished by season for *Dissostichus eleginoides* in Subarea 48.3.

(a)



(b)

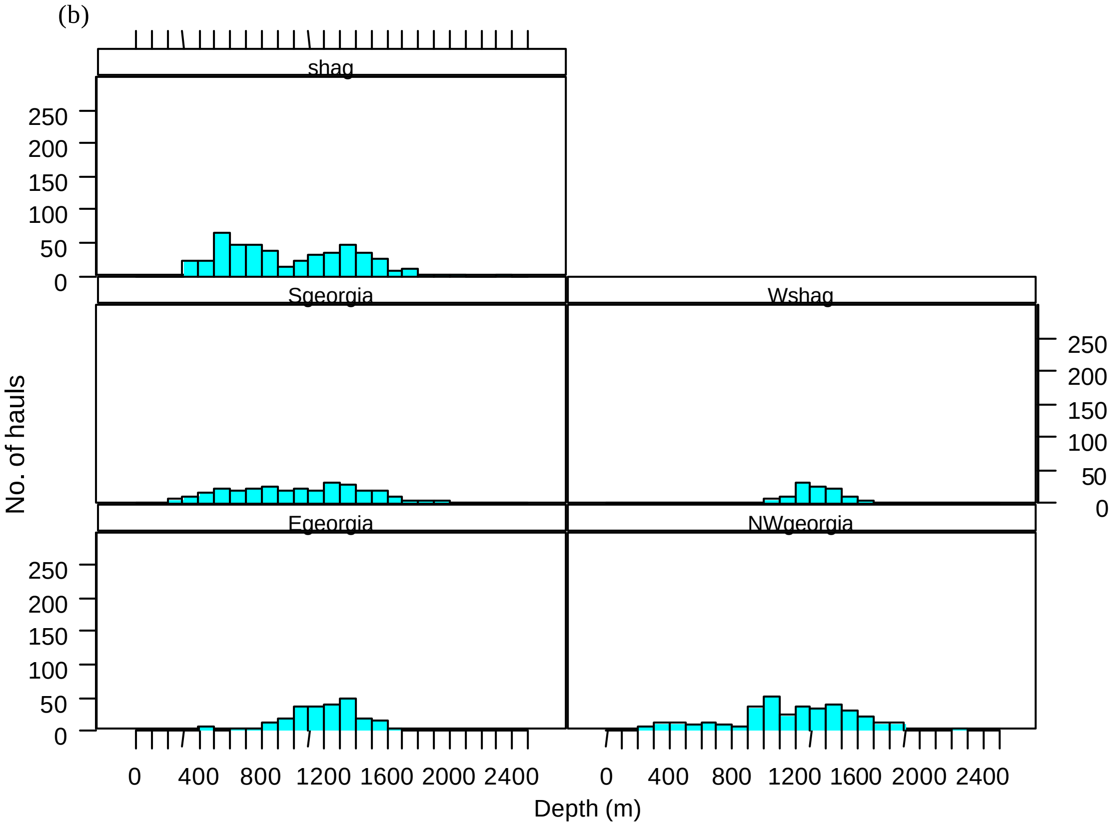


Figure 13: Depth distributions of effort for *Dissostichus eleginoides* around South Georgia for (a) the 1999/2000 season, and (b) for the 2000/01 season.

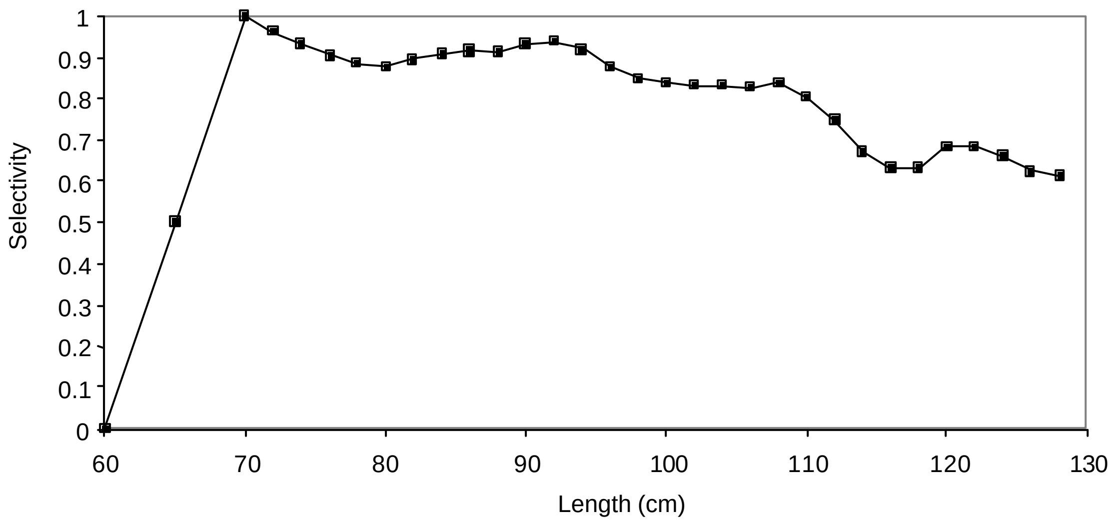


Figure 14: Average length-specific vulnerabilities for *Dissostichus eleginoides* in Subarea 48.3 from 1988 to 2001.

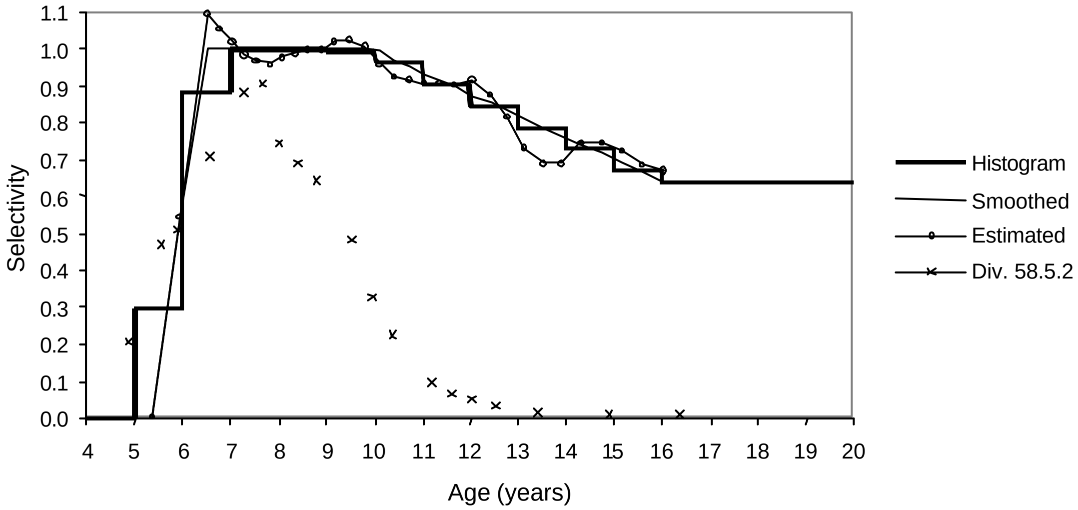


Figure 15: Average age-specific vulnerabilities for *Dissostichus eleginoides* in Subarea 48.3 from 1988 to 2001.

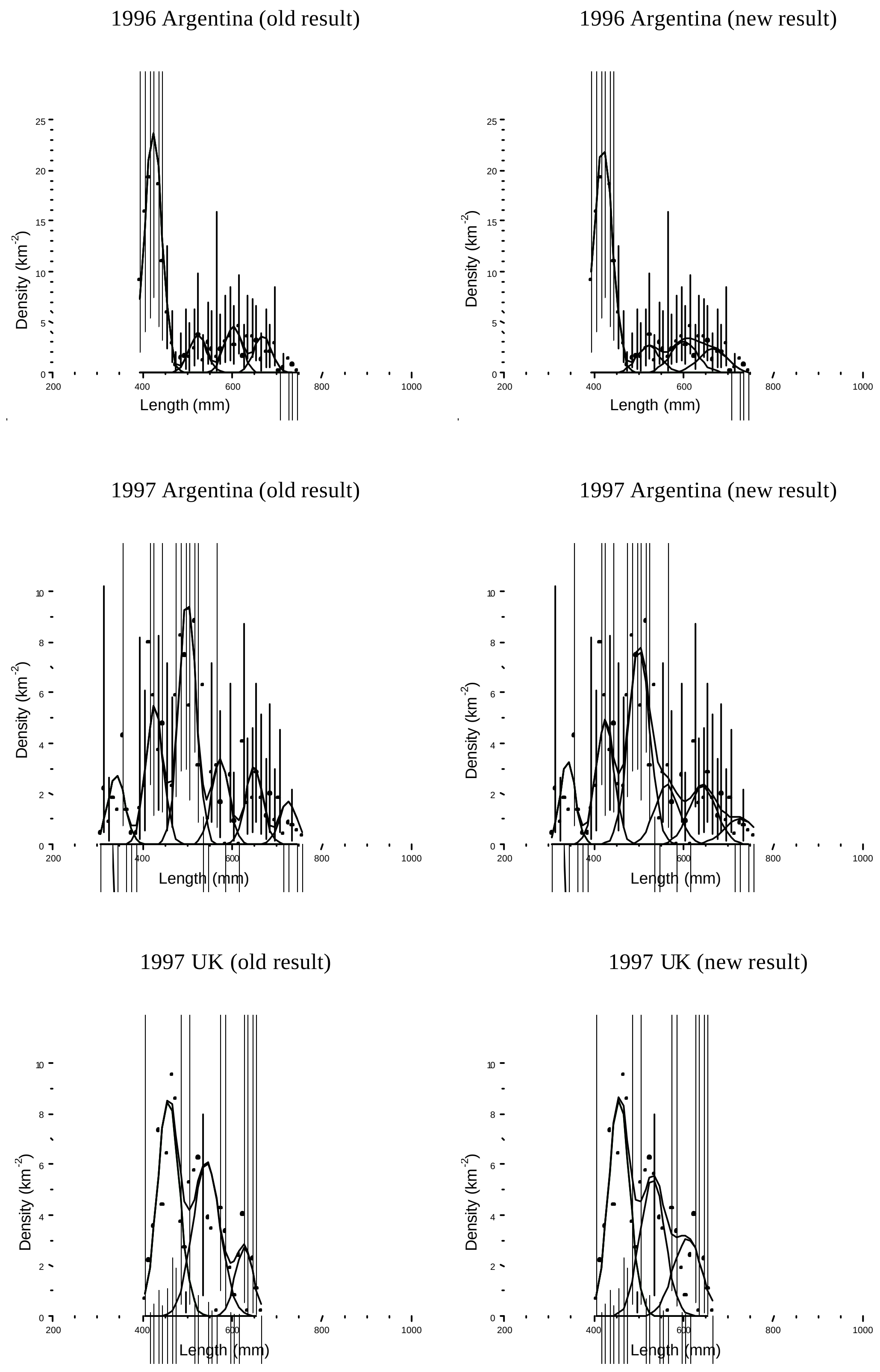


Figure 16: Revised assessments of cohort strength for three surveys of *Dissostichus eleginoides* at South Georgia, based on the 1999 analysis and growth parameters with a von Bertalanffy K = 0.066.

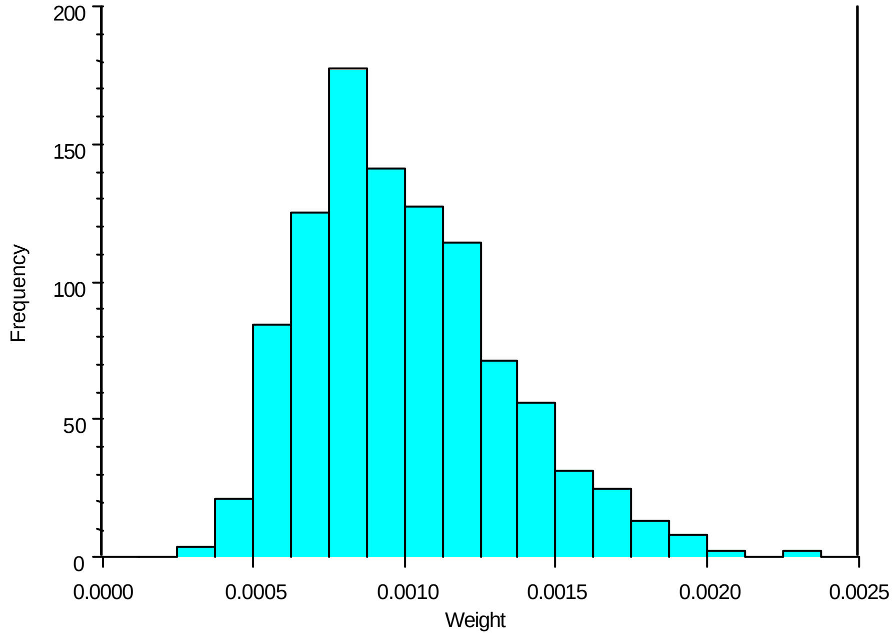
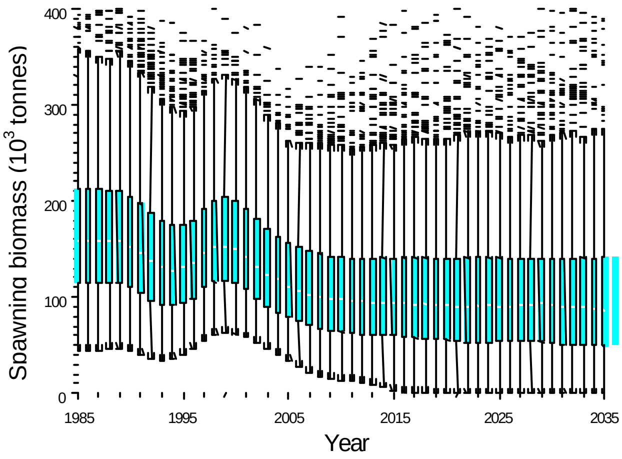
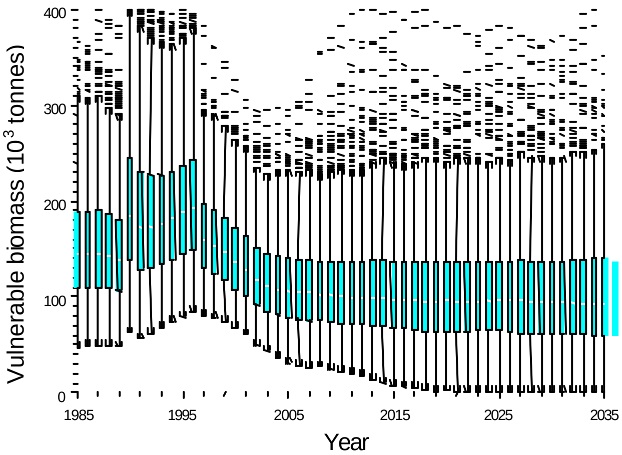


Figure 17: Histogram of estimated statistical weights based on the standardised CPUE series for Subarea 48.3 GYM trajectories of *Dissostichus eleginoides*.





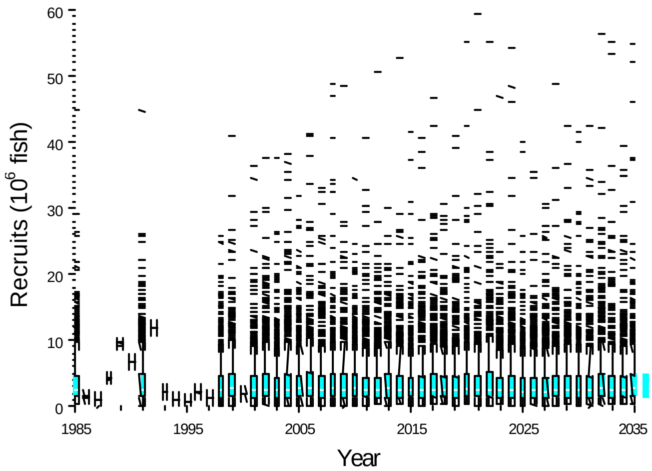


Figure 18: Time series of spawning biomass, vulnerable biomass and recruitments summarised from a GYM assessment of constant annual yield (5 820 tonnes) for *Dissostichus eleginoides* in Subarea 48.3. Each box and whisker plot summarises the status of the variable for a year over 1 001 trials. The recruitment and known catch period are up to and including 2001. The remaining period is the forward projection for determining yield. The constant annual yield taken in this projection is 5 820 tonnes.

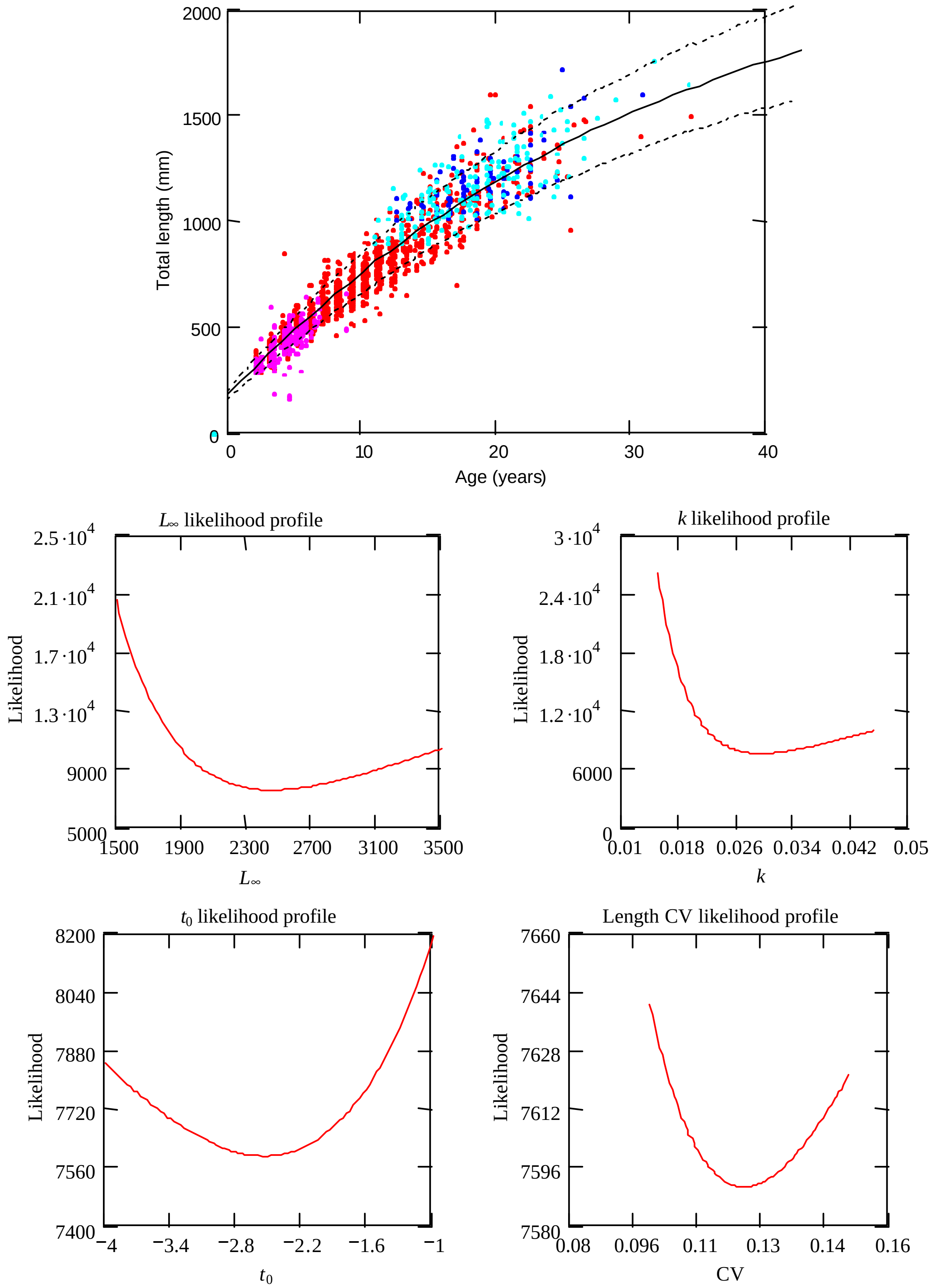


Figure 19: Length at age for *Dissostichus eleginoides* in Division 58.5.2. Data are from commercial and research voyages since 1990. The von Bertalanffy growth curve has the parameters: L_8 = 2 465 mm, K = 0.029 year^{-1}, t_0 = -2.46 years. Likelihood profiles are shown to indicate how well each parameter is estimated (a flat bottom profile shows a large error around the estimate).

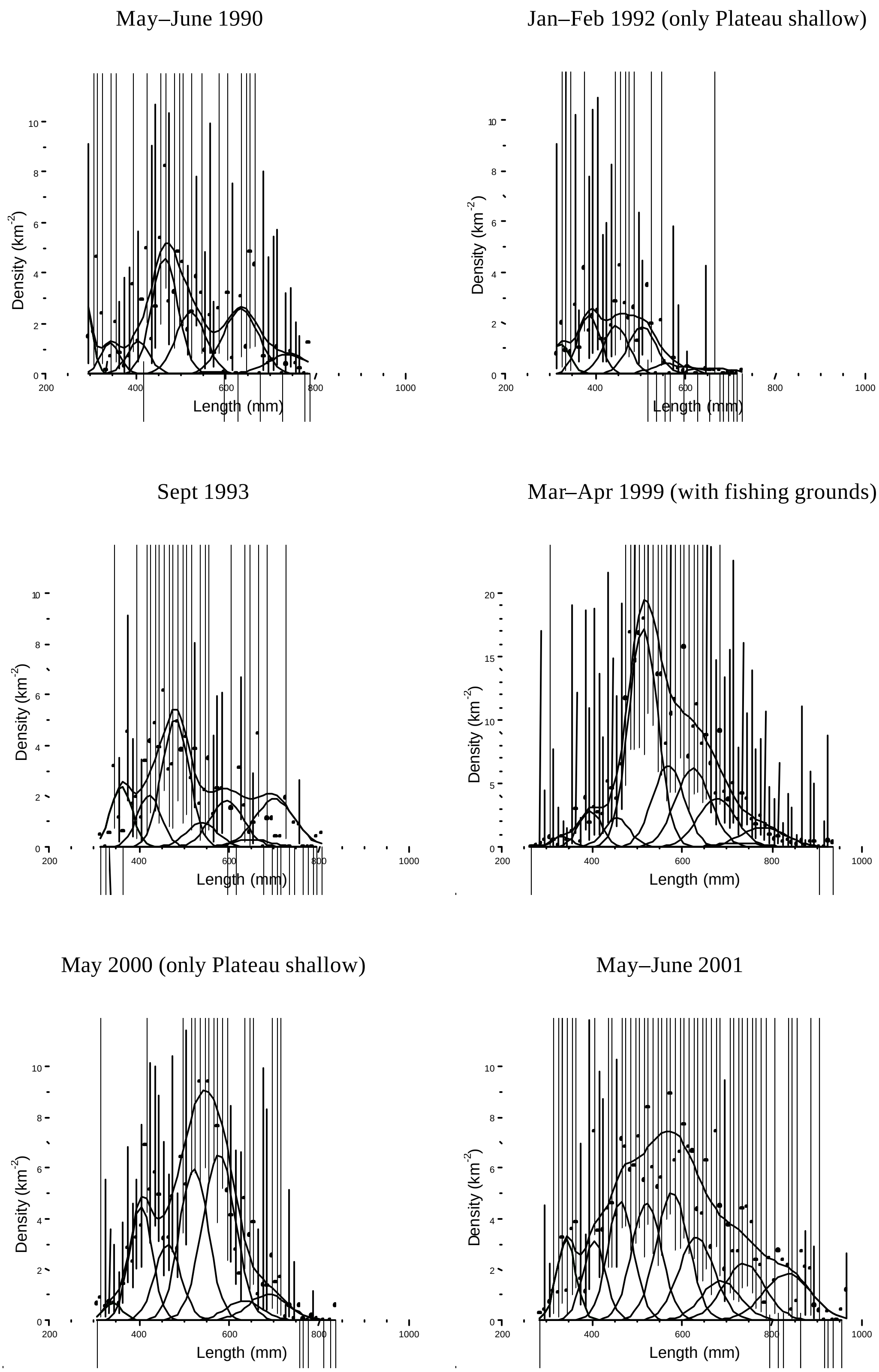


Figure 20: Results of mixture analyses estimating cohort densities of *Dissostichus eleginoides* sampled in research voyages in Division 58.5.2. Mean lengths at age of these analyses are based on growth parameters L_∞ = 2 465 mm, K = 0.029 and t_0 = -2.54 years (see WG-FSA-01/73 for a description of the method).

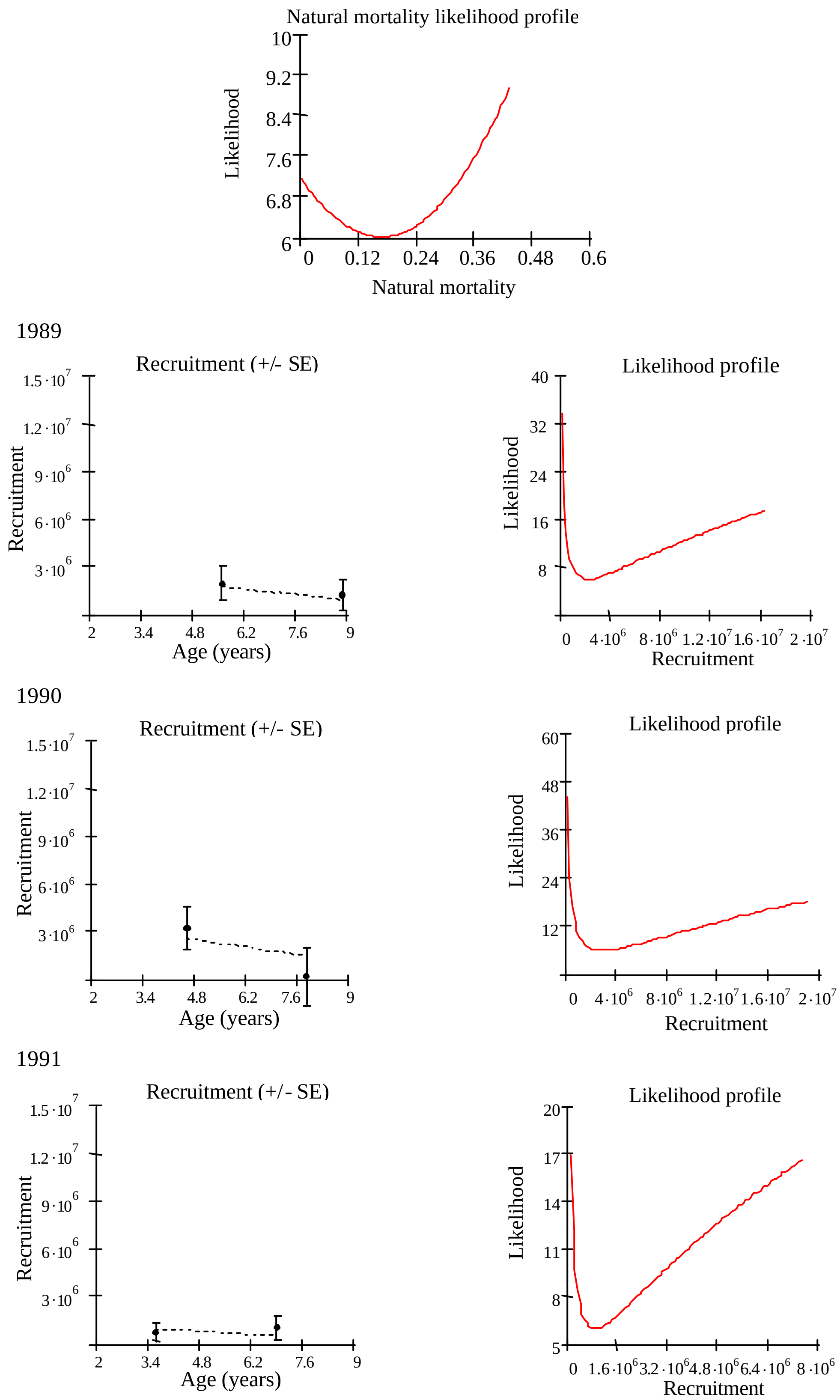
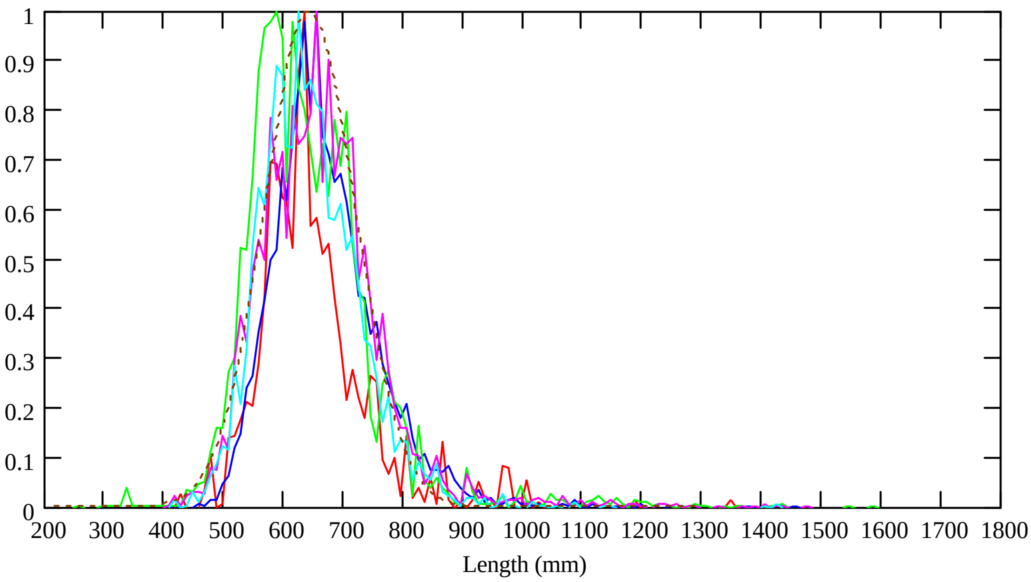


Figure 21: Estimated projections of three cohorts used to estimate natural mortality (0.165 $year^{-1}$) in *Dissostichus eleginoides* in Division 58.5.2. Cohorts were observed in both the 1990 and 1993 surveys. The likelihood profiles for each estimated parameter are shown.

1997



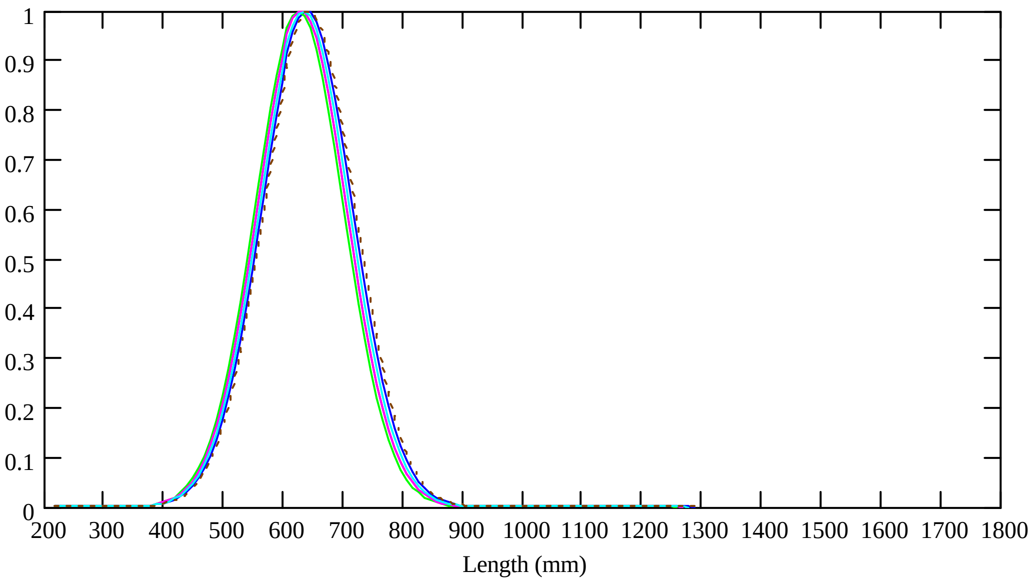
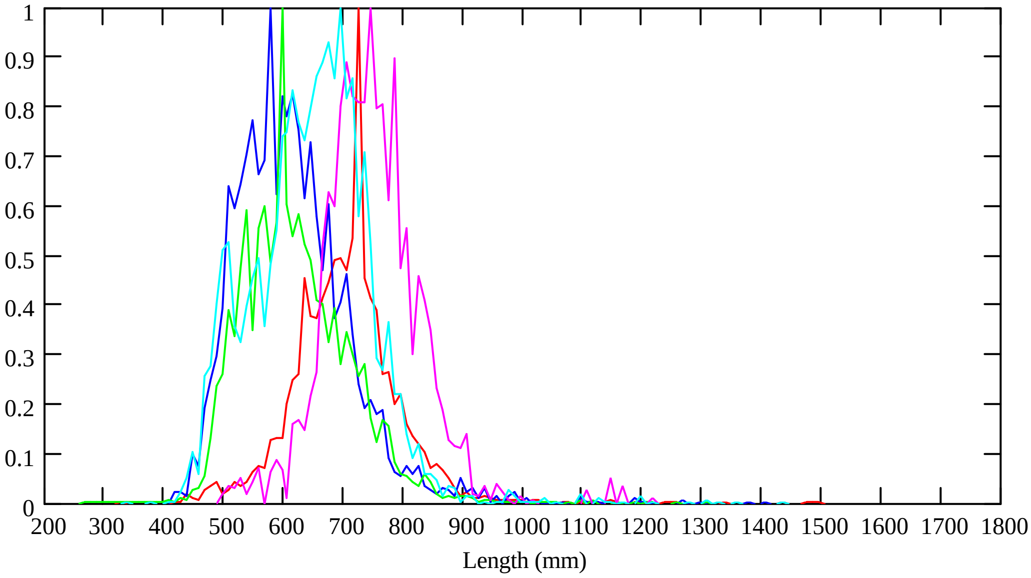


Figure 22: Catch-weighted length frequencies (top panel) for each of four years for *Dissostichus eleginoides* in the trawl fishery in Division 58.5.2. Each line represents a voyage of approximately eight weeks duration. The lower panel for each year is the estimated age-based fishing vulnerability function plotted as it is represented at the time of each voyage. (See WG-FSA-01/73 for details of the method.)

(continued)

1998



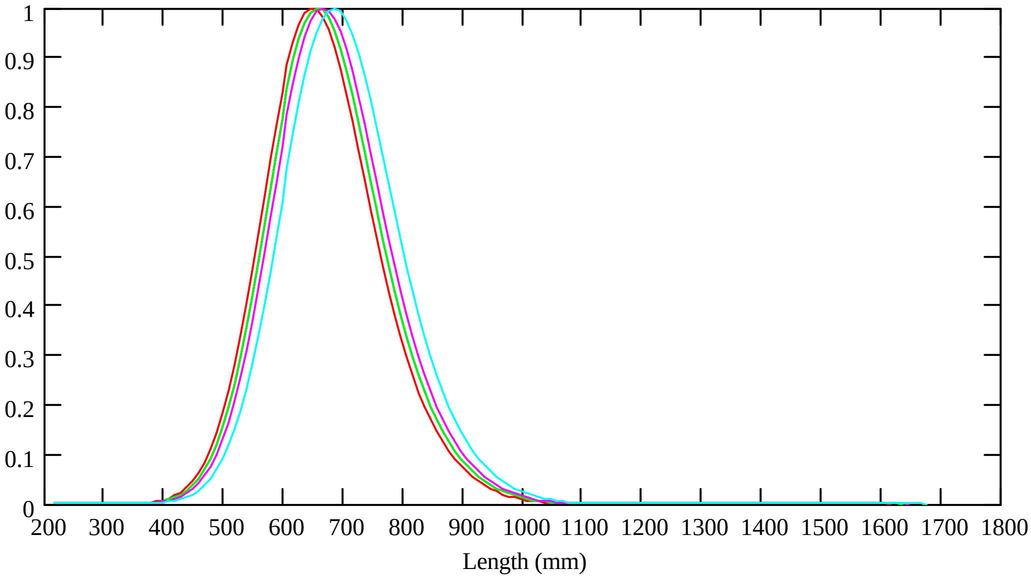
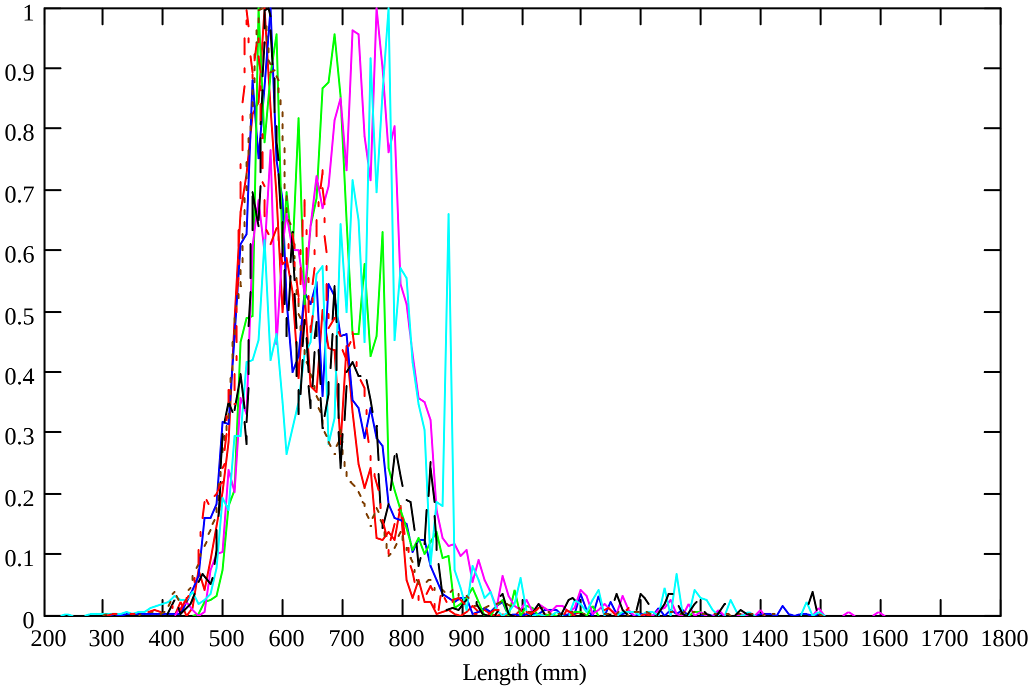


Figure 22 (continued)



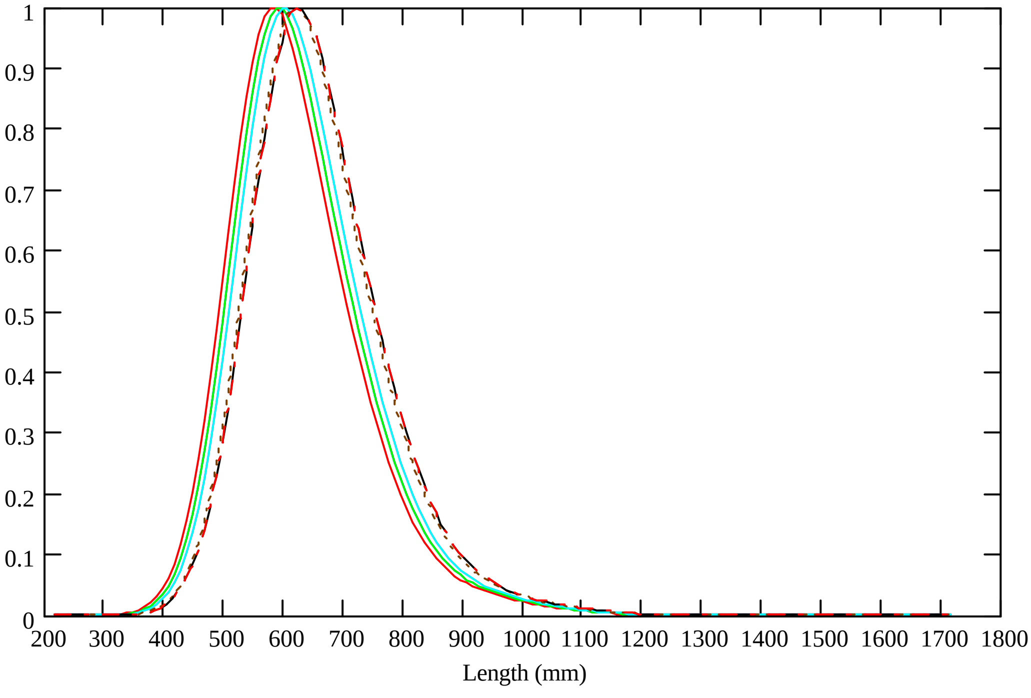
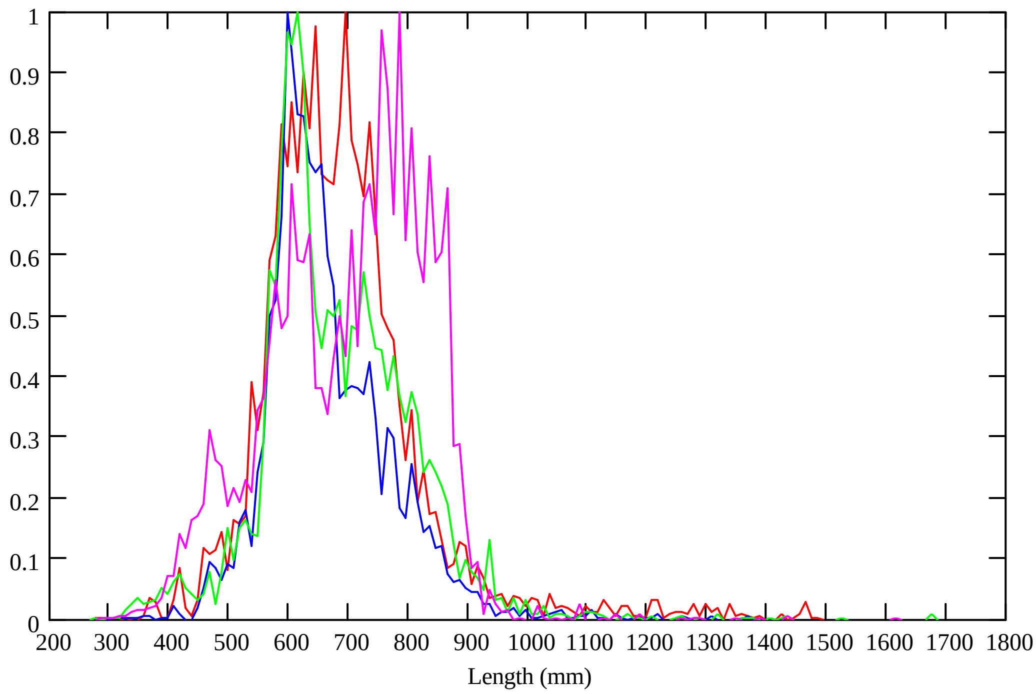


Figure 22 (continued)



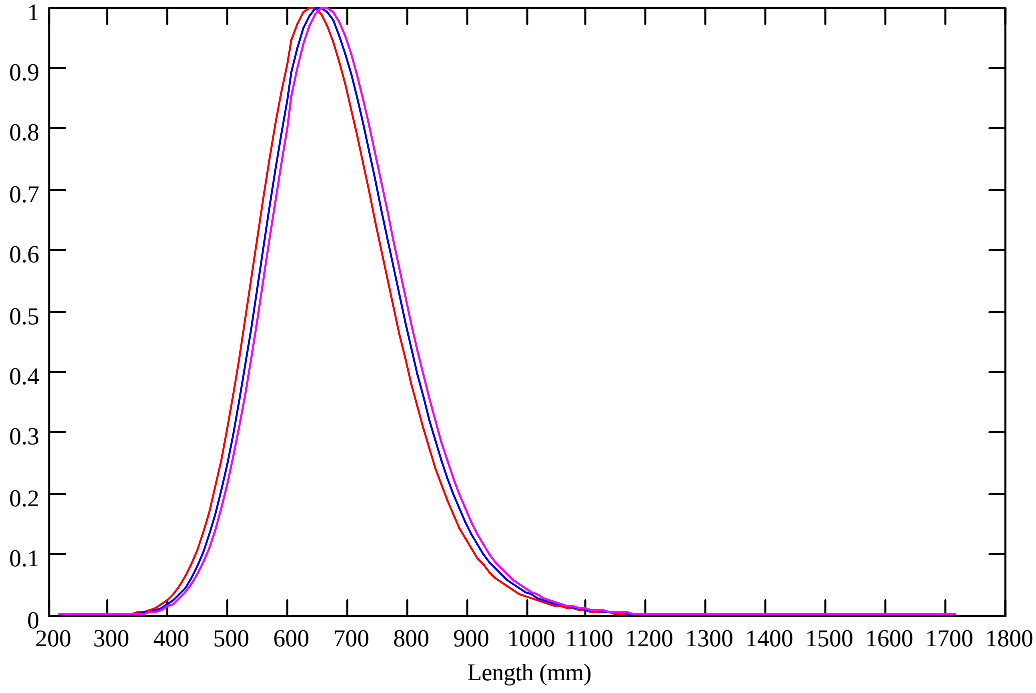


Figure 22 (continued)

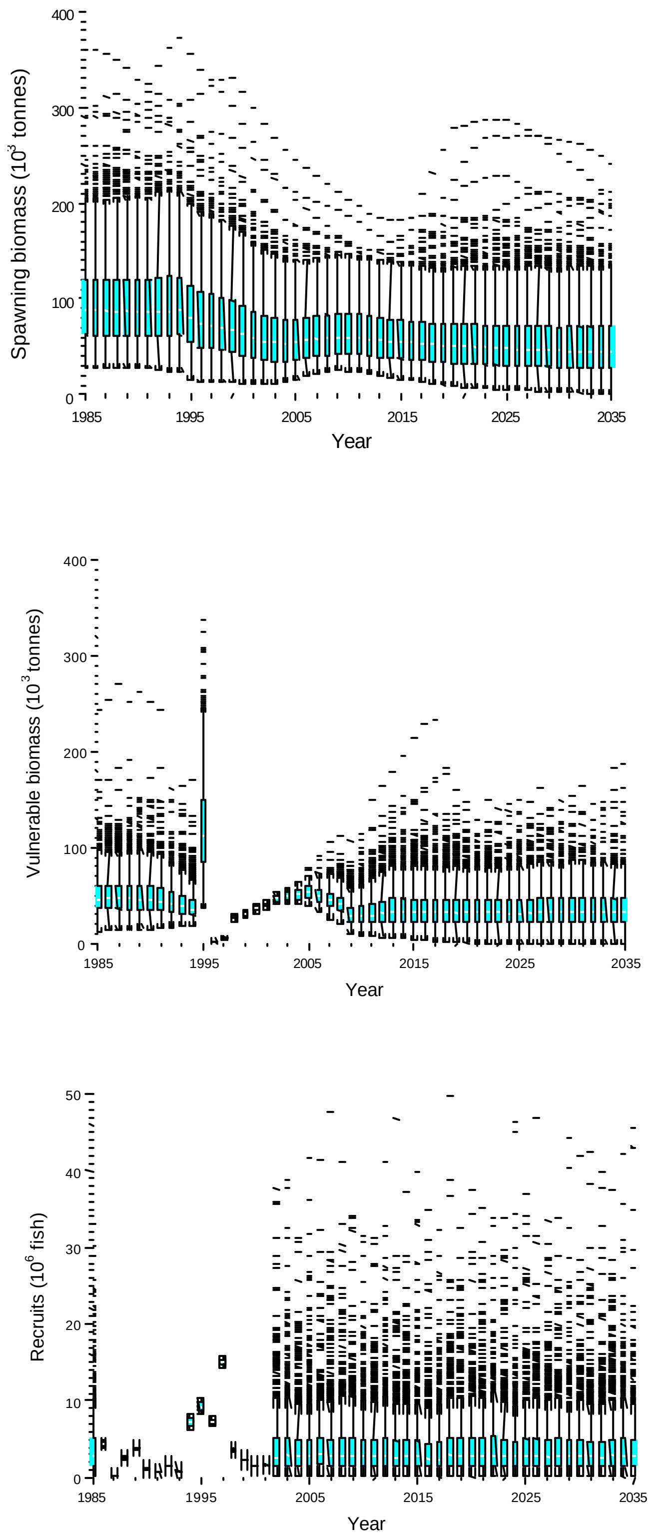


Figure 23: Time series of spawning biomass, vulnerable biomass and recruitments summarised from a GYM assessment of constant annual yield for *Dissostichus eleginoides* in Division 58.5.2. Each box and whisker plot summarises the status of the variable for a year over 1 001 trials. The recruitment and known catch period are up to and including 2001. The remaining period is the forward projection for determining yield. The constant annual yield taken in this projection is 2 815 tonnes.

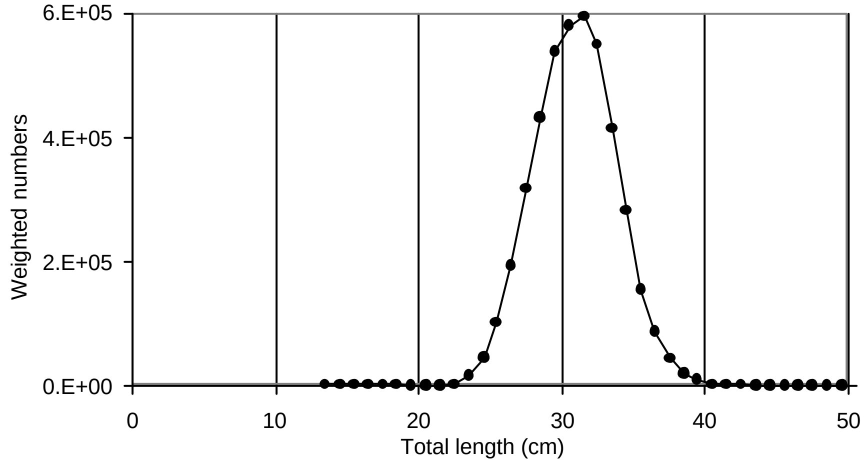


Figure 24: Catch-weighted length distribution for *Champsocephalus gunnari* from commercial fishing in Subarea 48.3 in the 2000/01 season.

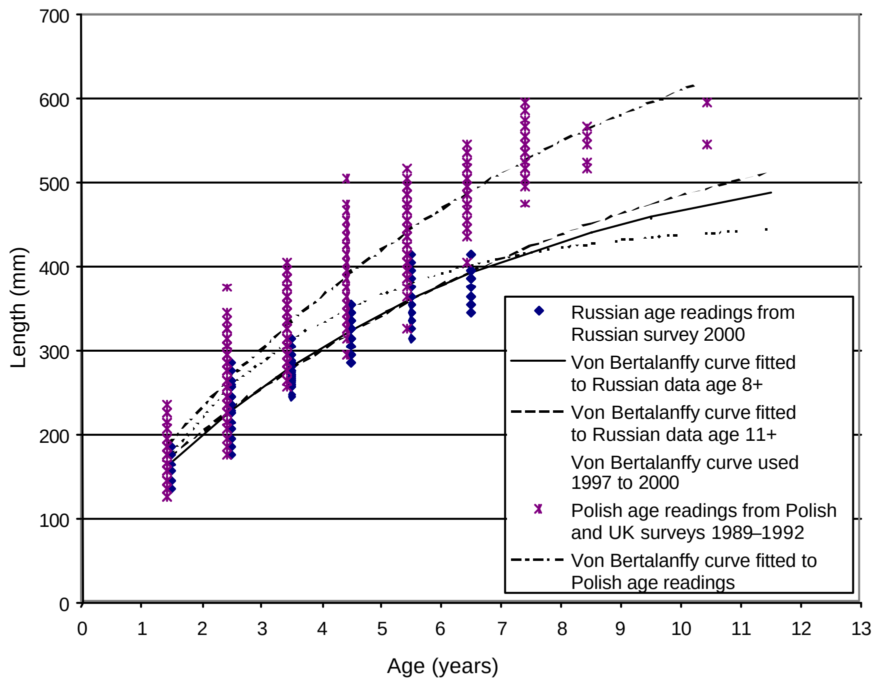


Figure 25: Growth curves for *Champsocephalus gunnari* fitted to age–length data derived from otolith readings by Russian and Polish scientists (data sources: WG-FSA-00/51 and WAMI-01/7 for Russian data; Parkes, 1993 for Polish data).

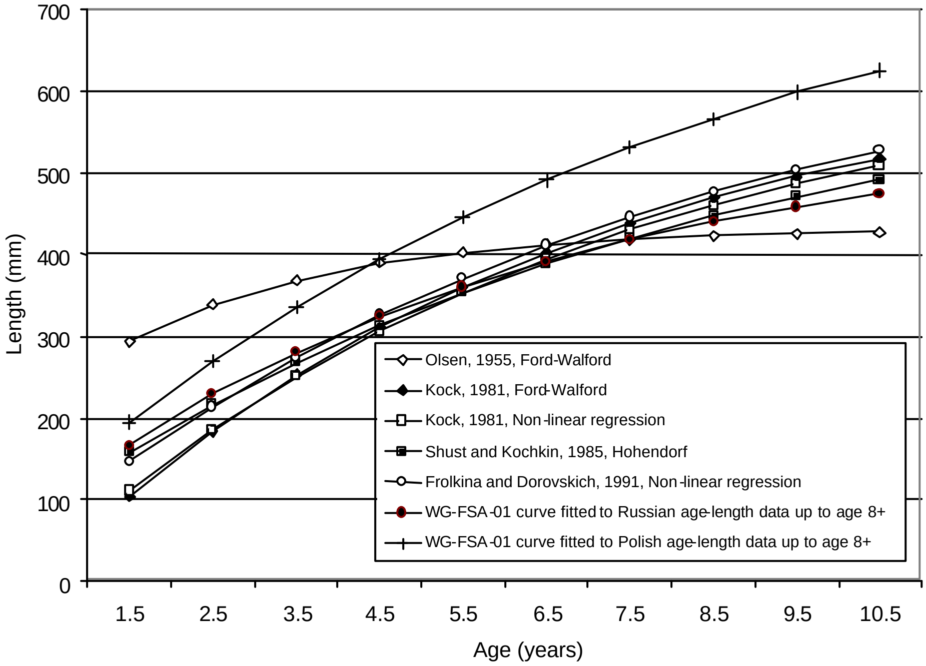


Figure 26: Comparison of growth curves for *Champsocephalus gunnari* estimated at this year's meeting with those estimated previously.

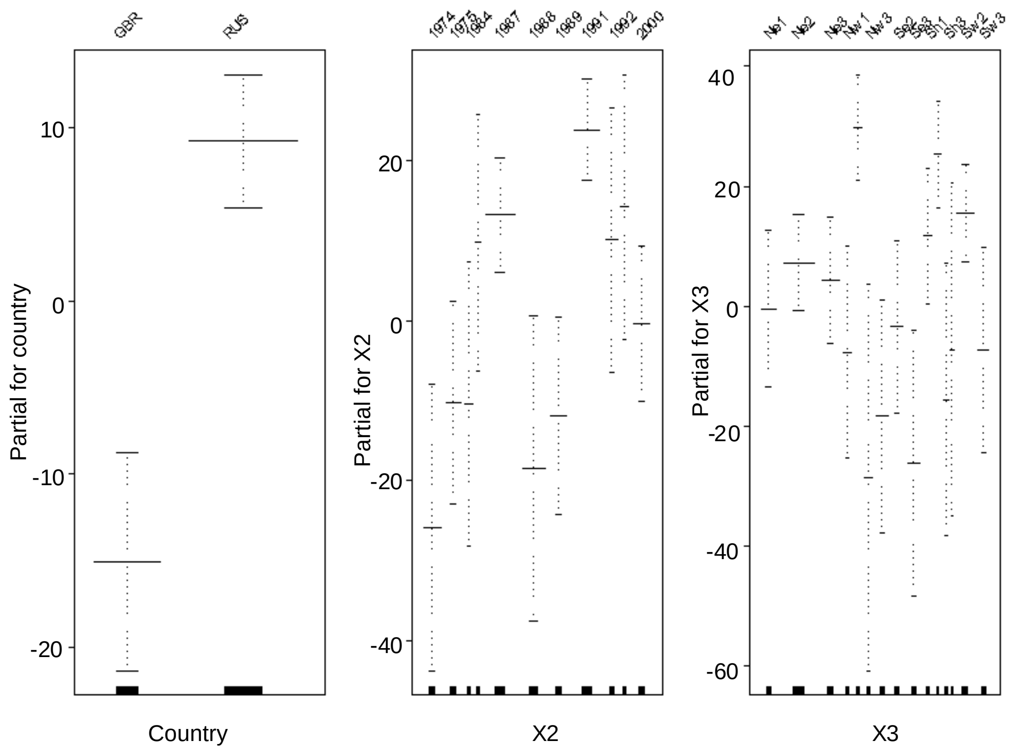


Figure 27: Diagnostic diagrams of GLM standardisation for UK and Russian (including former Soviet Union) survey indices of *Champsocephalus gunnari* in Subarea 48.3. Variable X2 is split-year, X3 is stratum.

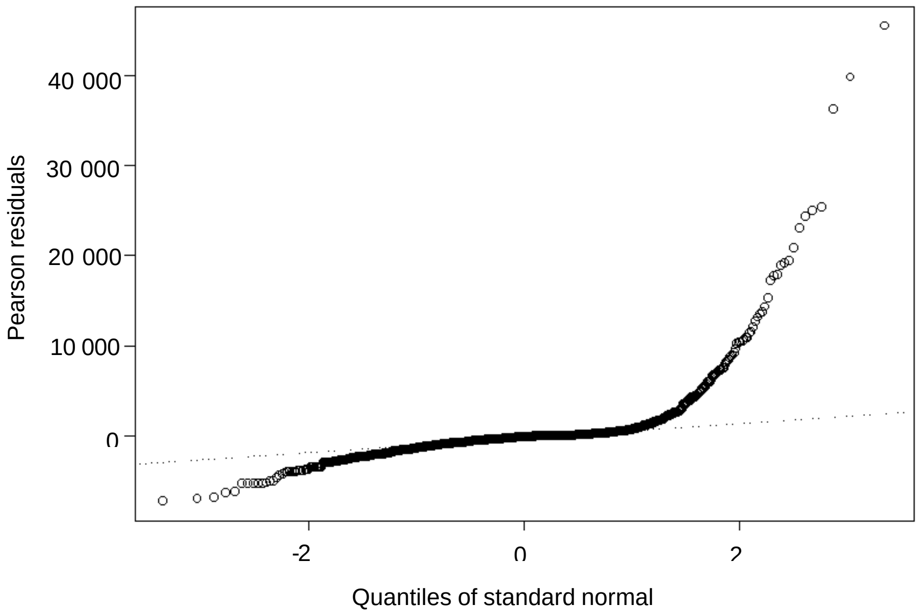


Figure 28: QQ plot of GLM standardisation for UK and Russian (including former Soviet Union) survey indices of *Champsocephalus gunnari* in Subarea 48.3.

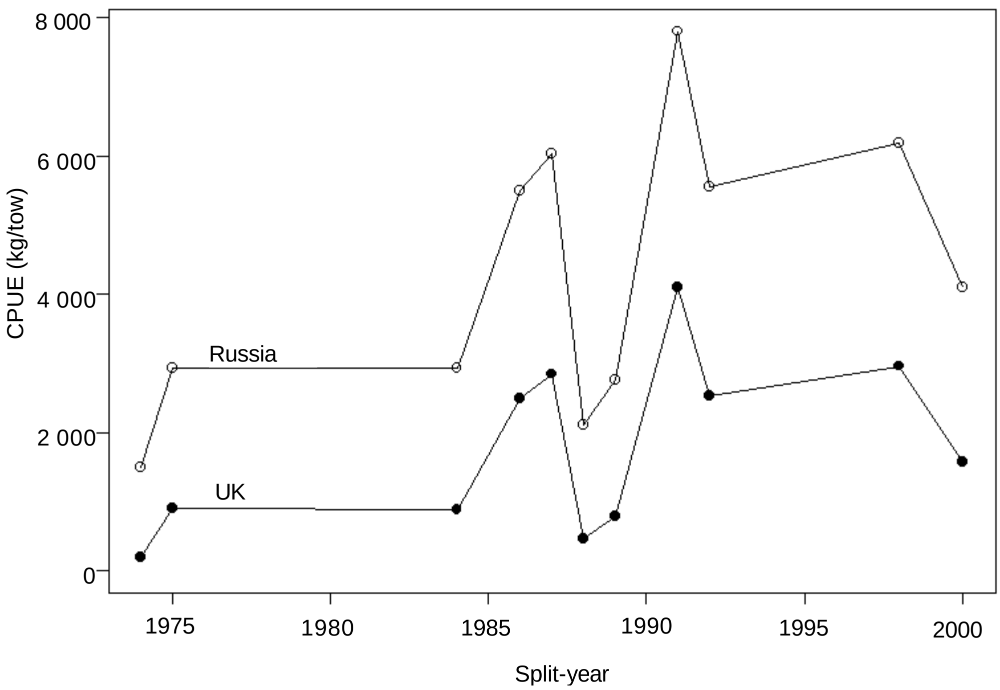


Figure 29: Time series of standardised abundance index for *Champsocephalus gunnari* in Subarea 48.3 from GLM.

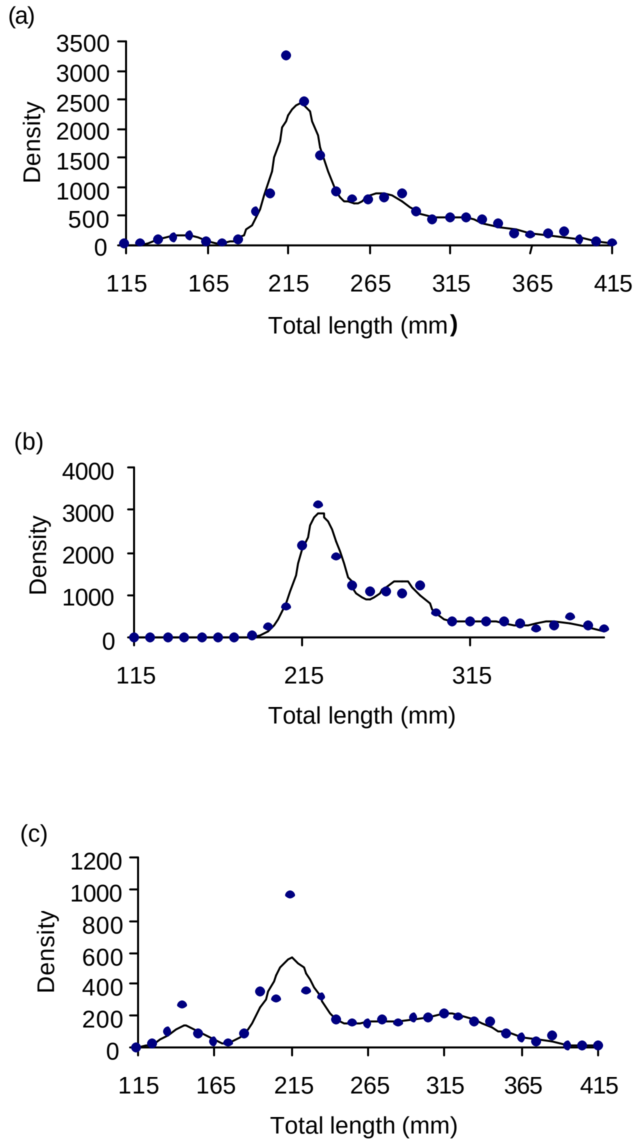


Figure 30: Outputs from the mixture analysis of *Champsocephalus gunnari* length at age in 2000: (a) combined dataset, (b) Russian survey, and (c) UK survey.

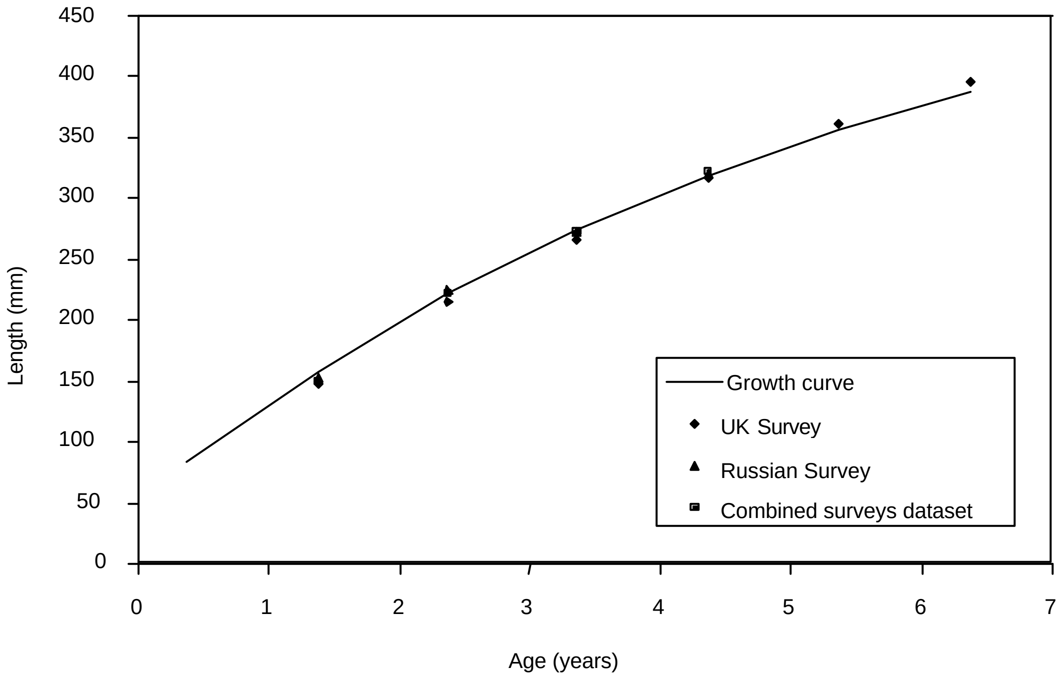


Figure 31: Comparison of the growth curve used in the short-tem assessment of *Champsocephalus gunnari* in Subarea 48.3 with the mean lengths of the mixture components from the mixture analysis of 2000 survey data.

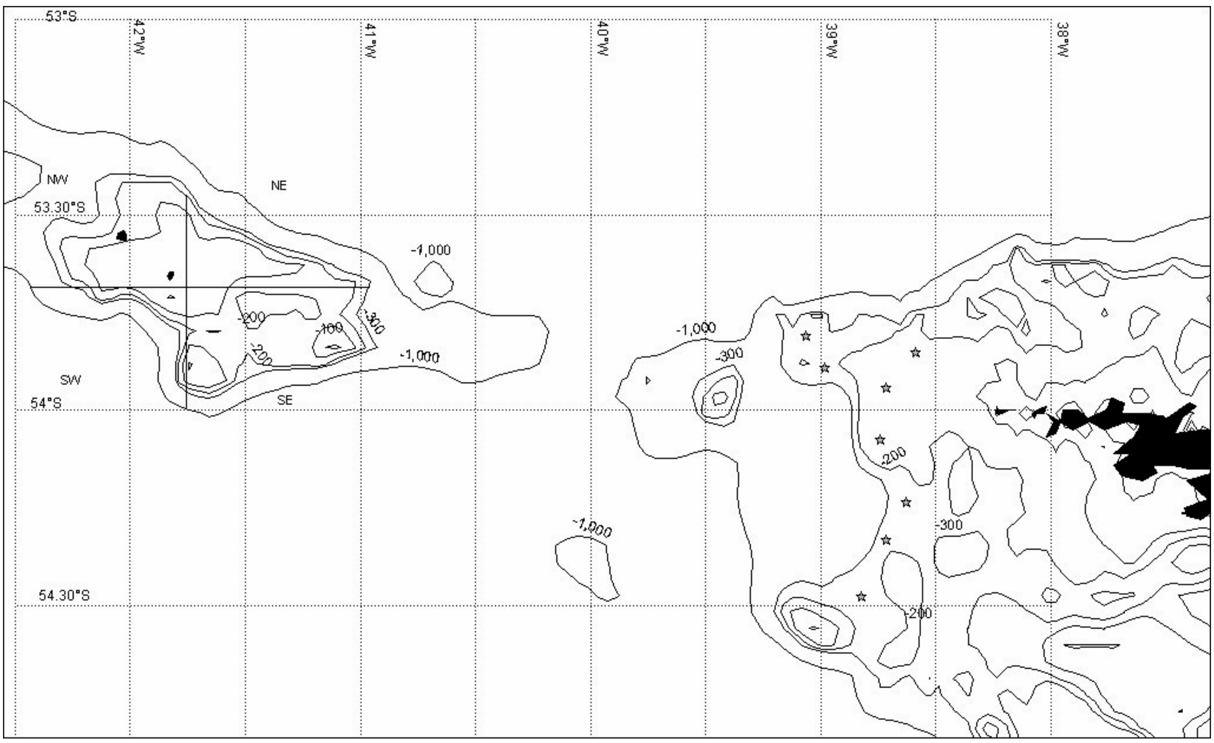


Figure 32: Distribution of 20 exploratory fishing hauls on *Champsocephalus gunnari* at Shag Rocks (12) and South Georgia (8) from 1 March to 31 May 2002.

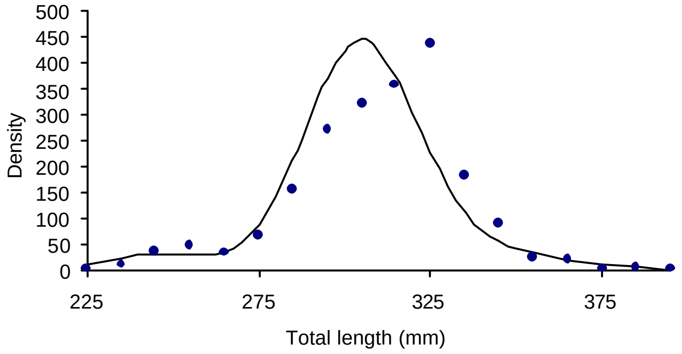
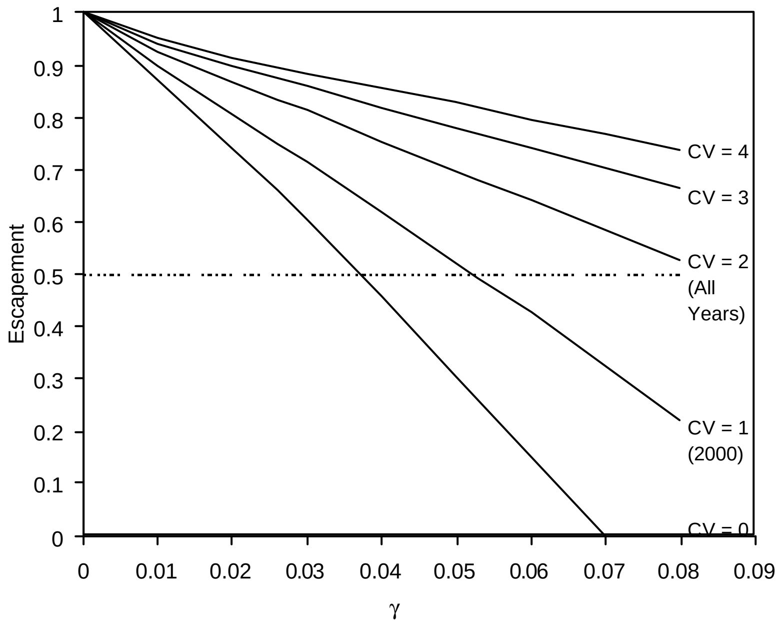


Figure 33: Observed densities at length and fitted mixtures of distributions for the Australian survey in Division 58.5.2 in May 2001.

(a)



(b)

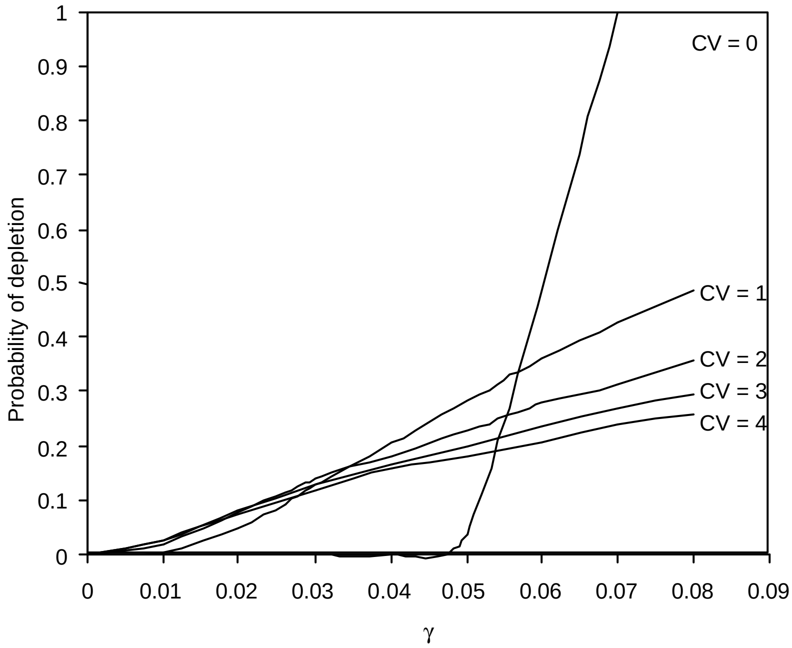


Figure 34: Response of (a) escapement and (b) depletion as a function of precautionary pre-exploitation harvest level (γ) under various levels of coefficient of variation of B_0 for skates and rays around South Georgia. Dashed line represents the level of γ under the established decision rule.

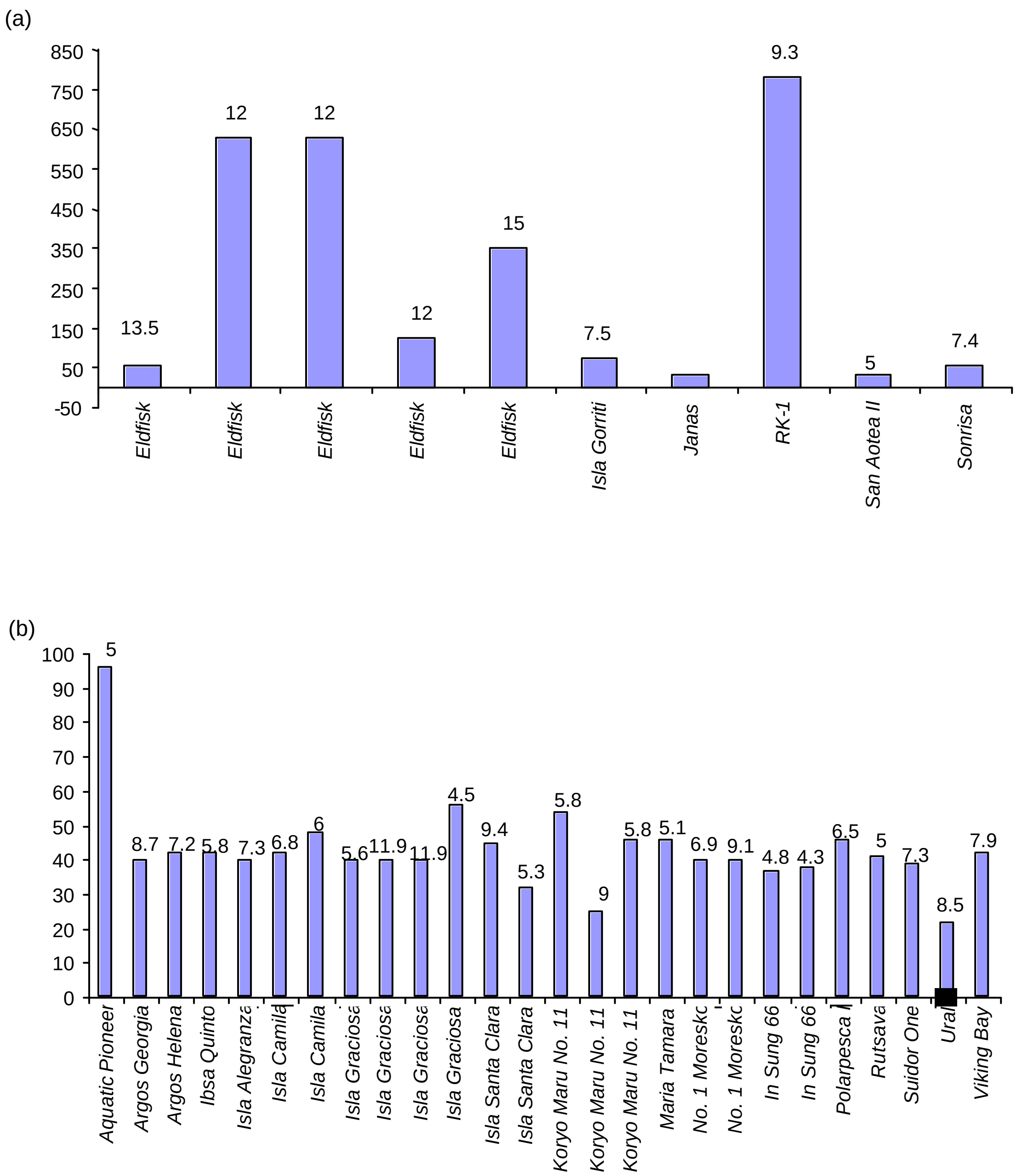


Figure 35: Longline weight spacing (y-axis in metres) and weights used (kilograms) by (a) autoline and (b) Spanish systems during the 2001 season.

APPENDIX A

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2001)

1. Opening of the Meeting

2. Organisation of the Meeting and Adoption of the Agenda

3. Review of Available Information

    3.1 Data Requirements specified in 2000

        3.1.1 Development of the CCAMLR Database
        3.1.2 Data Processing
        3.1.3 Other

    3.2 Fisheries Information

        3.2.1 Catch, Effort, Length and Age Data Reported to CCAMLR

        3.2.2 Estimates of Catch and Effort from IUU Fishing (Subgroup Report)

        3.2.3 Catch and Effort Data for Toothfish Fisheries in Waters adjacent to the Convention Area
            3.2.3a Potential for Toothfish Fisheries

        3.2.4 Scientific Observer Information (Subgroup Report)
            3.2.4a Structure of Scientific Observer Reports

        3.2.5 Research Surveys

        3.2.6 Mesh/Hook Selectivity and related Experiments Affecting Catchability

        3.2.7 Conversion Factors

    3.3 Fish and Squid Biology/Demography/Ecology (Subgroup Report)

        3.3.1 Workshop on Estimating Age in Patagonian Toothfish
        3.3.2 Results of WAMI relating to Biology, Demography and Ecology

    3.4 Developments in Assessment Methods (Subgroup Report)

4. Assessments and Management Advice

4.1 New and Exploratory Fisheries

4.1.1 New Fisheries in 2000/01
4.1.2 Exploratory Fisheries in 2000/01
4.1.3 New Fisheries notified for 2001/02
4.1.4 Exploratory Fisheries notified for 2001/02
4.1.5 Progress towards Assessments in New and Exploratory Fisheries
4.1.6 Apportioning Catch Limits between Trawl and Longline Fisheries

4.2 Assessed Fisheries

4.2.1 *Dissostichus eleginoides* South Georgia (Subarea 48.3)
4.2.2 *Dissostichus eleginoides* Kerguelen Islands (Division 58.5.1)
4.2.3 *Dissostichus eleginoides* Heard Island (Division 58.5.2)
4.2.4 *Dissostichus eleginoides* Prince Edward and Marion Islands (Subarea 58.7)
4.2.5 Results of WAMI relating to the Assessment and Management of *Champsocephalus gunnari*
4.2.6 *Champsocephalus gunnari* South Georgia (Subarea 48.3)
4.2.7 *Champsocephalus gunnari* Heard Island (Division 58.5.2)

4.3 Other Fisheries

4.3.1 Other Finfish Fisheries
4.3.2 Crabs
4.3.3 Squid

4.4 By-catch (Subgroup Report)

4.5 Regulatory Framework

5. Considerations of Ecosystem Management

5.1 Interactions with WG-EMM
5.2 Ecological Interactions (e.g. multi-species, benthos etc.)

6. Research Surveys

6.1 Simulation Studies
6.2 Recent and Proposed Surveys

7. Incidental Mortality Arising from Longline Fishing (ad hoc WG-IMALF Report)

7.1 Intersessional Work of ad hoc WG-IMALF

7.2 Research into the Status of Seabirds

7.3 Incidental Mortality of Seabirds during Regulated Longline Fishing in the Convention Area

7.3.1 Data Submitted for the 2000/01 and the beginning of the 2001/02 Seasons
7.3.2 Evaluation of Levels of Incidental Mortality
7.3.3 Compliance with Conservation Measure 29/XIX

7.4 Incidental Mortality of Seabirds during Unregulated Longline Fishing in the Convention Area

7.5 Incidental Mortality of Seabirds in relation to New and Exploratory Fisheries

7.5.1 Assessments of Risk in CCAMLR Subareas and Divisions
7.5.2 New and Exploratory Fisheries Operational in 2000/01
7.5.3 New and Exploratory Fisheries Proposed for 2001/02

7.6 Incidental Mortality of Seabirds during Longline Fishing Outside the Convention Area

7.7 Research into and Experience with Mitigating Measures

7.8 International and National Initiatives relating to Incidental Mortality of Seabirds in relation to Longline Fishing

7.9 Advice to the Scientific Committee

8. Other Incidental Mortality

8.1 Interactions involving Marine Mammals with Longline Fishing Operations
8.2 Trawl or Pot Fishing

9. CCAMLR Website

10. Future Work

10.1 Data Requirements
10.2 Software and Analyses to be Prepared or Developed Prior to the Next Meeting

11. Other Business

    11.1 Options for Re-organising the Work of WG-FSA
    11.2 IUCN List of Globally Threatened Species
    11.3 Publication Matters

12. Adoption of the Report

13. Close of the Meeting.

APPENDIX B

LIST OF PARTICIPANTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2001)

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APPENDIX C

LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2001)

WG-FSA-01/1	Provisional and Annotated Provisional Agenda for the 2001 Meeting of the Working Group on Fish Stock Assessment (WG-FSA)
WG-FSA-01/2	List of participants
WG-FSA-01/3	List of documents
WG-FSA-01/4	Vacant
WG-FSA-01/5	Vacant
WG-FSA-01/6	Fishery information for WG-FSA-01 Secretariat
WG-FSA-01/7 Rev. 1	Workshop on Estimating Age in Patagonian Toothfish (23 to 27 July 2001)
WG-FSA-01/8	Seabird mortality in the Patagonian toothfish longline fishery around the Prince Edward Islands, 1996–2000 D.C. Nel, P.G. Ryan and B.P. Watkins (South Africa) (*Antarctic Science*, submitted)
WG-FSA-01/9	Albatross and Petrel Mortality from Longline Fishing International Workshop (Honolulu, Hawaii, USA, 11–12 May 2000)
WG-FSA-01/10	Foraging interactions of wandering albatrosses *Diomedea exulans* breeding on Marion Island with longline fisheries in the southern Indian Ocean D.C. Nel, P.G. Ryan, J.L. Nel, N.T.W. Klages (South Africa), R.P. Wilson (Germany) and G. Robertson (Australia) (*Ibis*, submitted)

WG-FSA-01/11	Population trends of albatrosses and petrels at sub-Antarctic Marion Island D.C. Nel, P.G. Ryan, R.J.M. Crawford, J. Cooper and O. Huyser (South Africa) (*Polar Biology*, in press (2001). Published online – http://dx.doi.org/10.1007/s003000100315)
WG-FSA-01/12	Exploitation of mesoscale oceanographic features by grey-headed albatross *Thalassarche chrysostoma* in the southern Indian Ocean D.C. Nel, J.R.E. Lutjeharms, E.A. Pakhomov, I.J. Ansorge, P.G. Ryan and N.T.W. Klages (South Africa) (*Marine Ecology Progress Series*, 217: 15–26 (2001))
WG-FSA-01/13	Report on a BirdLife South Africa workshop to design a medium-sized grant application to the Global Environment Facility (GEF) to address the problem of seabird mortality by longline fishing in developing countries (Cape Town, 2–6 April 2001) D.C. Nel and J. Cooper (South Africa)
WG-FSA-01/14	Population status, breeding biology and conservation of the Tristan albatross *Diomedea [exulans] dabbenena* P.G. Ryan, J. Cooper and J.P. Glass (South Africa) (*Bird Conservation International*, 11: 35–48 (2001))
WG-FSA-01/15	Longline fishing at Tristan da Cunha: impacts on seabirds N. Glass, I. Lavarello, J.P. Glass and P.G. Ryan (South Africa) (*Atlantic Seabirds*, 2 (2):49–56 (2000))
WG-FSA-01/16	Length-at-age juvenile Patagonian toothfish *Dissostichus eleginoides* J. Ashford (USA), I. Everson (UK), C. Jones and S. Bobko (USA) (*CCAMLR Science*, submitted)
WG-FSA-01/17	Problems in estimating population length at age from commercial catches, the Patagonian toothfish as an example I. Everson (United Kingdom) (*CCAMLR Science*, submitted)
WG-FSA-01/18	Modelling the impact of fishery by-catches on albatross populations G. Tuck, T. Polacheck (Australia), J.P. Croxall (UK) and H. Weimerskirch (France) (*Journal of Applied Ecology*, 38: in press (2001))
WG-FSA-01/19	Global relationships amongst black-browed albatrosses: analysis of population structure using mtDNA and microsatellites T.M. Burg and J.P. Croxall (United Kingdom) (*Molecular Ecology*, 10: in press (2001))

WG-FSA-01/20	Summary of observations aboard trawlers operating in the Convention Area in 2000/01 Secretariat
WG-FSA-01/21	Summary of observations aboard longliners operating in the Convention Area in 2000/01 Secretariat
WG-FSA-01/22	Summary of scientific observations related to Conservation Measures 29/XIX and 63/XV Secretariat
WG-FSA-01/23	Withdrawn
WG-FSA-01/24	The impact of longline fishing on seabirds in the north-east Atlantic: recommendations for reducing mortality United Kingdom E. Dunn, and C. Steel (*NOF Rapportserie Report*, 5 (2001))
WG-FSA-01/25	Foraging location and range of white-chinned petrels *Procellaria aequinoctialis* breeding in the south Atlantic S.D. Berrow, A.G. Wood and P.A. Prince (United Kingdom) (*J. Avian Biol.*, 31: 303–311 (2000))
WG-FSA-01/26 Rev. 1	Status of white-chinned petrels *Procellaria aequinoctialis* Linnaeus 1758, at Bird Island, South Georgia S.D. Berrow, J.P. Croxall and S.D. Grant (United Kingdom) (*Antarctic Science*, 12 (4): 399–405 (2000))
WG-FSA-01/27	IV Marine Science Congress, Puerto Madryn, Argentina (11–15 September 2000)
WG-FSA-01/28	Seabird by-catch by tuna longline fisheries off southern Africa, 1998–2000 P.G. Ryan, D.G. Keith and M. Kroese (South Africa) (*S. Afr. J. Mar. Sci.*, 24: in press (2001))
WG-FSA-01/29	Seabird mortality and the double-line system of longline fishing G. Robertson (Australia), C. Carboneras (Spain), M. Favero, P. Gandini (Argentina), C. Moreno (Chile) and A. Stagi (Uruguay)
WG-FSA-01/30	Preliminary analysis of seabird by-catch in the South Georgia icefish fishery D.J. Agnew, N. Ansell and J.P. Croxall (United Kingdom)

WG-FSA-01/31	Exploratory jig fishery for squid in Subarea 48.3 – June 2001 Joint submission by the United Kingdom and the Republic of Korea
WG-FSA-01/32	Distribution, demography and discard mortality of crabs caught as by-catch in an experimental pot fishery for toothfish in the South Atlantic M.G. Purves (South Africa), D.J. Agnew, G. Moreno, C. Yau and G. Pilling (United Kingdom)
WG-FSA-01/33 Rev. 1	Results and standing stock biomass estimates of finfish from the 2001 US AMLR bottom trawl survey of the South Shetland Islands (Subarea 48.1) C.D. Jones, K.-H. Kock, D. Ramm, J. Ashford, S. Wilhelms, T. Near, N. Gong and H. Flores
WG-FSA-01/34	On some fishes of by-catch from Kerguelen Islands (Division 58.5.1) L.K. Pshenichnov (Ukraine)
WG-FSA-01/35	Solutions to seabird by-catch in Alaska's demersal longline fisheries E.F. Melvin, J.K. Parrish, K.S. Dietrich and O.S. Hamel (USA)
WG-FSA-01/36	United States research under way on seabirds vulnerable to fisheries interactions K.S. Rivera (USA)
WG-FSA-01/37	Abnormal distribution of South Georgia ray, *Raja georgianus*, in February 2000 F.F. Litvinov, V.N. Shnar, V.A. Khvichia and O.A. Berezhinskiy (Russia)
WG-FSA-01/38	Population structure of the Patagonian toothfish (*Dissostichus eleginoides*) in Australian waters S.A. Appleyard, R.D. Ward and R. Williams (Australia)
WG-FSA-01/39	Otolith and body size relationships in the bigeye grenadier (*Macrourus holotrachys*) in CCAMLR Subarea 48.3 S. Morley and M. Belchier (United Kingdom) (*CCAMLR Science*, in press)
WG-FSA-01/40	A simple investigation of the effects of % observer coverage on estimated bird catch rates D.J. Agnew (United Kingdom)
WG-FSA-01/41	France research under way on Southern Ocean seabirds vulnerable to fisheries interactions – 2001 H. Weimerskirch (France)

WG-FSA-01/42	Summary of observations aboard pot and squid jig vessels operating in the Convention Area during the 2000/01 season Secretariat
WG-FSA-01/43	Preliminary age and growth estimates for the ridge-scaled rattail *Macrourus whitsoni* P. Marriott and P.L. Horn (New Zealand)
WG-FSA-01/44	Longline sink rates of an autoline vessel, and notes on seabird interactions N.W.McL. Smith (New Zealand) (*Science for Conservation*, 183)
WG-FSA-01/45	Fishes collected during the Ross Sea exploratory fishery (Subarea 88.1) in 1999/2000 and 2000/01, and registered in the National Fish Collection at the Museum of New Zealand Te Papa Tongarewa A.L. Stewart and C.D. Roberts (New Zealand)
WG-FSA-01/46	A simple new method for monitoring longline sink rate to selected depths J.M. Fenaughty and N.W.McL. Smith (New Zealand)
WG-FSA-01/47	Australian research under way on Southern Ocean seabirds vulnerable to fisheries interactions – 2001 R. Gales (Australia)
WG-FSA-01/48	Trends in mean lengths and selectivities for *Dissostichus eleginoides* taken by longliners in Subarea 48.3 G.P. Kirkwood and D.J. Agnew (United Kingdom)
WG-FSA-01/49	Spatio–temporal trends in longline fisheries of the Southern Ocean and implications for seabird by-catch G.N. Tuck and C. Bulman (Australia)
WG-FSA-01/50	Report of the WG-FSA Intersessional Subgroup on Sampling Catches from Longlines
WG-FSA-01/51	Information on the spawning season and size of maturity of *Dissostichus mawsoni* from Subarea 88.1 in the 2000/2001 season G. Patchell (New Zealand)
WG-FSA-01/52	Age and growth of the Antarctic skates, *Bathyraja eatonii* and *Amblyraja georgiana* M.P. Francis and C.Ó. Maolagáin (New Zealand)
WG-FSA-01/53	Withdrawn

WG-FSA-01/54	A first attempt at an assessment of the Patagonian toothfish (*Dissostichus eleginoides*) resource in the Prince Edward Islands EEZ A. Brandão, B.P. Watkins, D.S. Butterworth and D.G.M. Miller (South Africa) (*CCAMLR Science*, submitted)
WG-FSA-01/55	Global status of albatrosses and Macronectes and Procellaria petrels (Source: BirdLife International, 2000. *Threatened Birds of the World*)
WG-FSA-01/56	Preliminary review of the sink rate of longline fishing gear in the toothfish fishery, 1997–98 to 2000–01 R.G. Blackwell, S.M. Hanchet and N.W.McL. Smith (New Zealand)
WG-FSA-01/57	An update on developments toward video monitoring of seabird incidental mortality N.W. McL. Smith (New Zealand)
WG-FSA-01/58	Withdrawn
WG-FSA-01/59	Incidental capture of seabird species in commercial fisheries in New Zealand waters, 1999–00 S. Baird (New Zealand)
WG-FSA-01/60	A discussion of some aspects and factors involved in the use of seabird mortality mitigation devices currently used by New Zealand longline fishing vessels J.M. Fenaughty (New Zealand)
WG-FSA-01/61	Seabird by-catch in the Patagonian toothfish longline fishery at the Prince Edward Islands: 2000–2001 P.G. Ryan and B.P. Watkins (South Africa)
WG-FSA-01/62	FAO's NPOA–Seabirds: a progress report by BirdLife International J. Cooper (Coordinator, BirdLife International Seabird Conservation Programme)
WG-FSA-01/63	The New Zealand toothfish fishery in Subarea 88.1 from 1997/98 to 2000/01 S.M. Hanchet, P.L. Horn and M.L. Stevenson (New Zealand)
WG-FSA-01/64	A short note on the tagging of Antarctic toothfish (*Dissostichus mawsoni*) in Subarea 88.1 N.W.McL. Smith (New Zealand)

WG-FSA-01/65	A short note on the tagging of skates in Subarea 88.1 N.W.McL. Smith (New Zealand)
WG-FSA-01/66	A short note on conversion factors for toothfish in Subarea 88.1 N.W.McL. Smith (New Zealand)
WG-FSA-01/67	National research programs into the status and foraging ecology of albatrosses, giant petrels and white-chinned petrels United Kingdom
WG-FSA-01/68	Using hierarchical methods for sub-sampling hauls taken by trawl during fisheries surveys J.R. Ashford and C.D. Jones (USA)
WG-FSA-01/69	Genetic variation among populations of the Antarctic toothfish: evolutionary insights and implications for conservation R.W. Parker, K.N. Paige and A.L. DeVries (USA)
WG-FSA-01/70	In support of a rationally managed fishery: age and growth in Patagonian toothfish (*Dissostichus eleginoides*) – dissertation summary J.R. Ashford (USA)
WG-FSA-01/71	Report of the Workshop on Approaches to the Management of Icefish (Hobart, Australia, 3 to 5 October 2001)
WG-FSA-01/72	Trawl survey of the Patagonian toothfish (*Dissostichus eleginoides*) resource off the Prince Edward Islands R.W. Leslie and B.P. Watkins (South Africa)
WG-FSA-01/73	Reassessment of important population parameters for *Dissostichus eleginoides* on the Heard Island Plateau (Division 58.5.2) based on time series of surveys and fishery data A.J. Constable, R. Williams, T. Lamb, I.R. Ball and E. van Wijk (Australia) (*CCAMLR Science*, submitted)
WG-FSA-01/74	Modifications to the Generalised Yield Model: updated input of recruitment time series data and annual fishing selectivity functions A.J. Constable (Australia)
WG-FSA-01/75	Ideal survey patterns: an example of using a simulated world I.R. Ball and A.J. Constable (Australia)
WG-FSA-01/76	Toothfish tagging at Heard Island: a summary of principal results R. Williams, T. Lamb and A. Constable (Australia) (*CCAMLR Science*, submitted)

WG-FSA-01/77 — Summary of research on New Zealand seabirds vulnerable to fisheries interactions
New Zealand

WG-FSA-01/78 — Seabird and longline interactions: effects of a bird-scaring streamer line and line shooter on the incidental capture of northern fulmars *Fulmarus glacialis*
S. Løkkeborg (Norway) and G. Robertson (Australia)

WG-FSA-01/79 — Quantifying and mitigating seabird by-catch in the Falkland Islands
United Kingdom

WG-FSA-01/80 — AFMA Research Fund – Final Report.
Performance assessment and peformans improvement of two underwater line setting devices for avoidance of seabird interactions in pelagic longline fisheries
N. Brothers, D. Chaffey and T. Reid (Australia)
(*Nature Conservation Report* 01/4, Appendix 2 (2001))

WG-FSA-01/81 — The effect of line weighting on the sink rate of pelagic tuna longline hooks, and its potential for minimising seabird mortalities
N. Brothers, R. Gales and T. Reid (Australia)
(*Nature Conservation Report* 01/4, Appendix 1 (2001))

WG-FSA-01/82 — Seabird interactions with longline fishing in the AFZ: seabird mortality estimates and 1988–1999 trends
T. Reid, N. Brothers and R. Gales (Australia)
(*Nature Conservation Report* 01/4 (2001))

Other Documents

WAMI-01/15 Rev. 1 — Icefish fishery information
Secretariat

CCAMLR-XX/5 — Notification of Australia's intention to continue an exploratory trawl fishery in Division 58.4.2 for *Chaenodraco wilsoni*, *Lepidonotothen kempi*, *Trematomus eulepidotus* and *Pleuragramma antarcticum*
Delegation of Australia

CCAMLR-XX/6 — Notification of Australia's intention to continue an exploratory trawl fishery in Division 58.4.2 for *Dissotichus* spp.
Delegation of Australia

CCAMLR-XX/7 — Notification of Australia's intention to initiate a new trawl fishery in Division 58.4.2 for *Macrourus* spp.
Delegation of Australia

CCAMLR-XX/8	Notification of Chile's intention to initiate an exploratory longline fishery in Subarea 58.6 for *D. eleginoides* Delegation of Chile
CCAMLR-XX/9	Notification of France's intention to initiate an exploratory longline fishery in Subarea 58.6 and Divisions 58.4.3 and 58.4.4 Delegation of France
CCAMLR-XX/10	Notification of exploratory fisheries for *Dissostichus* spp. in the 2001/02 season Delegation of Japan
CCAMLR-XX/11	Notification by New Zealand of its intention to continue an exploratory fishery for *Dissostichus* spp. in CCAMLR Subareas 88.1 and 88.2 for the 2001/2002 season Delegation of New Zealand
CCAMLR-XX/12	Notification of New Zealand's intention to undertake exploratory fishing in Subareas 48.6 and 88.3 and Division 58.4.4 Delegation of New Zealand
CCAMLR-XX/13	Notification of Russia's intention to conduct an exploratory longline fishery in 2001/2002 in Subarea 88.1 Delegation of Russia
CCAMLR-XX/14	Notification by Russia of its intention to initiate a new or exploratory fishery for *Dissostichus* spp. in Subarea 48.2 Delegation of Russia
CCAMLR-XX/15	Notification of exploratory fisheries for *Dissostichus* spp. in the 2001/2002 season Delegation of South Africa
CCAMLR-XX/16	Notification of Uruguay's intention to conduct an exploratory fishery in Subarea 48.6 Delegation of Uruguay
CCAMLR-XX/17	Notification of Uruguay's intention to conduct an exploratory fishery in Division 58.4.4 Delegation of Uruguay
CCAMLR-XX/20 Rev. 1	CCAMLR conservation measures: alternative approaches for fishery measures Secretariat
CCAMLR-XX/BG/4	CCAMLR conservation measures: a review Secretariat

CCAMLR-XX/BG/7	Implementation of conservation measures in 2000/2001 Secretariat
SC-CAMLR-XX/5	A proposal to modify the boundaries of Statistical Division 58.4.3 and neighbouring divisions to define Elan and BANZARE Banks Delegation of Australia
SC-CAMLR-XX/BG/10	Summary of Notifications for New and Exploratory Fisheries in 2001/2002 Secretariat
SC-CAMLR-XX/BG/11	IMALF assessment of new and exploratory fisheries by statistical area (Working Group on Fish Stock Assessment)
SC-CAMLR-XX/BG/17	Report to the Scientific Committee on the final drafting meeting for the Agreement on the Conservation of Albatrosses and Petrels (Cape Town, 27 January to 2 February 2001) Delegation of South Africa
SC-CAMLR-XX/BG/19	Summary report of the International Fishers' Forum – Solving the Incidental Capture of Seabirds in Longline Fisheries CCAMLR Observer (New Zealand)
SC-CAMLR-XX/BG/20	Progress toward an agreement on the conservation of albatrosses and petrels Delegation of Australia

APPENDIX D

REPORT OF THE WORKSHOP ON APPROACHES TO THE MANAGEMENT OF ICEFISH
(Hobart, Australia, 3 to 5 October 2001)

CONTENTS

REPORT OF THE WORKSHOP ON APPROACHES TO THE MANAGEMENT OF ICEFISH

(Hobart, Australia, 3 to 5 October 2001)

INTRODUCTION

1.1 The Workshop on Approaches to the Management of Icefish (WAMI) was held at CCAMLR Headquarters, Hobart, Australia, from 3 to 5 October 2001. The Co-conveners of the workshop, Drs K.-H. Kock (Germany) and G. Parkes (UK), chaired the meeting. A List of Participants is included in this report as Attachment A.

1.2 The report was prepared by Dr A. Constable (Australia), Dr D. Ramm (Secretariat), Dr S. Hanchet (New Zealand), Mr C. Jones (USA), Dr Kock, Dr Parkes, Dr K. Sullivan (New Zealand) and Ms E. van Wijk (Australia).

1.3 Terms of reference had been developed by WG-FSA over the period from 1997 to 2000. A composite list was compiled by the Co-conveners to serve as guidelines for the discussion. These are provided as Attachment B.

1.4 A Provisional Agenda was circulated in advance of the workshop. The following subitems were added:

- Subitem 4.1.5 'Minimum mesh size and fish size'; and
- Subitem 6.5 'Effects of fishing gear'.

With these amendments, the Agenda was adopted. The Agenda is given as Attachment C.

PRESENTATION OF PAPERS

2.1 Sixteen papers were presented at the meeting, 10 of which were available on the CCAMLR website in advance of the workshop. These papers were presented and discussed under the appropriate agenda items. A list of papers is provided as Attachment D. In addition, workshop participants compiled a bibliography on *Champsocephalus gunnari* (mackerel icefish) (Attachment E).

REVIEW AND CHARACTERISATION OF FISHERIES

3.1 Annual catches of *C. gunnari* in the CCAMLR Convention Area, as reported in STATLANT data, were presented in WAMI-01/15 Rev.1, and are summarised in Table 1. These data include catches of *C. gunnari* taken during surveys, or as by-catch in other fisheries. Fishing effort is reported in various formats in the STATLANT data (e.g. fishing hours, vessel.days), and it was not possible to obtain a consistent time series for fisheries targeting *C. gunnari*. However, the workshop noted that a time series of CPUE could be derived from fine-scale catch and effort data; the fine-scale data are a subset of the STATLANT data.

3.2 Records of fishing for *C. gunnari* in Area 48 are available dating back to the split-year 1970/71. Catches have been reported in Subarea 48.1 from 1978/79 to 1988/89, Subarea 48.2 from 1977/78 to 1990/91 and Subarea 48.3 from 1970/71 to the present. *C. gunnari* was fished extensively during the late 1970s and in the 1980s. Annual catches of *C. gunnari* peaked at 35 930 tonnes in Subarea 48.1 in 1978/79 (the first year of reported fishing in that subarea), 138 895 tonnes in Subarea 48.2 in 1977/78 (the first year of reported fishing in that subarea), and 128 194 tonnes in Subarea 48.3 in 1982/83.

3.3 Records of fishing for *C. gunnari* in Area 58 are available dating back to the 1969/70 split-year. Catches have been reported in Division 58.5.1 from 1969/70 to 1996/97 and in Division 58.5.2 from 1971/72 to the present. Catches of *C. gunnari* reported from Subarea 58.5 between 1979/80 and 1987/88 (Table 1) are believed to have been taken in Division 58.5.1. Australia declared a 200 n mile Fishing Zone (AFZ) in Division 58.5.2 in 1979. There were no reports of commercial fishing for *C. gunnari* from that area until the start of the Australian fishery in 1996/97. Annual catches of *C. gunnari* peaked at 35 568 tonnes in Division 58.5.1 in 1971/72 and 16 166 tonnes in Division 58.5.2 in 1977/78.

3.4 The recent history of the fishery for *C. gunnari* in Division 58.5.2 was described in WAMI-01/4.

3.5 Trawl fisheries for *C. gunnari* in the 2000/01 season have been conducted in Subarea 48.3 (Conservation Measure 194/XIX) and Division 58.5.2 (Conservation Measure 195/XIX). The current catch limit in Subarea 48.3 is 6 760 tonnes, and a total of 1 427 tonnes of *C. gunnari* has been reported to date. Five trawlers have fished (France 1, Chile 1, UK 2, Russia 1), and the fishery will remain open until 30 November 2001, or until the catch limit is reached, whichever is sooner. The current catch limit in Division 58.5.2 is 1 150 tonnes, and a total of 938 tonnes of *C. gunnari* has been reported to date. Two Australian-flagged trawlers have fished, and the fishery will remain open until 30 November 2001, or until the catch limit is reached, whichever is sooner.

3.6 The information available at the workshop indicated that fisheries for *C. gunnari* in Subarea 48.3 and Divisions 58.5.1 and 58.5.2 share many characteristics. These fisheries may be characterised by:

- large fluctuations in catch;
- periods of low or zero commercial catches;
- a recent resurgence in interest in the fishery in the mid- to late 1990s with modest levels of fishing effort and catches in Subarea 48.3 and Division 58.5.2;
- reliance of the commercial fishery on a few age classes – mainly ages 3 and 4; and
- age 5+ fish are poorly represented in survey and commercial catches, suggesting an age-specific increase in natural mortality (M).

3.7 Dr Ramm presented a draft Fishery Plan for the *C. gunnari* fishery in Subarea 48.3 that had been prepared at the request of the Scientific Committee. The plan was reviewed by the workshop. It was proposed that the data reporting requirements be formalised into a 'Data Collection Plan' and that the meaning of this term, originally defined for exploratory fisheries, be generalised for all fisheries under the revised framework. The revised plan is set out in WAMI-01/15 Rev. 1. The workshop recommended that WG-FSA look at how data collection plans for new and exploratory fisheries be distinguished from data requirements for assessments.

3.8 A time series of catch-weighted length frequencies for *C. gunnari* was presented for Subarea 48.3 and Division 58.5.2 (WAMI-01/15 Rev. 1). These data are the only length data presently available for this species in the CCAMLR database. The time series in Subarea 48.3 and Division 58.5.2 begin in the split-years 1986/87 and 1996/97 respectively. Data for Division 58.5.1 have been presented earlier in Duhamel (1987, 1991).

3.9 The workshop recognised the value of these data, and the need to extend these time series so as to include the periods of high catches from the fisheries during the 1970s and 1980s. It was understood that data from this early period of fishing in Subarea 58.5 were collected and that the raw data are now held by Dr V. Herasymchuk, State Committee for Fisheries of Ukraine. The workshop discussed how these important data may be processed and made available to CCAMLR. This matter was referred to WG-FSA and the Scientific Committee for further consideration.

MANAGEMENT NEEDS

Management Objectives

4.1 The workshop identified that the main objective of the management of *C. gunnari* in the Convention Area was to provide rational and sustainable use of the *C. gunnari* resource with the following three requirements, in accordance with Article II of the Convention:

(i) maintenance of spawning stock at a size that recruitment is not impeded;

(ii) maintenance of the ecological relationships between harvested, dependent and related species; and

(iii) prevention of changes in the ecosystem that are not reversible over 20–30 years.

These objectives have been implemented using measures available to the Commission under Article IX. These measures include catch limits, by-catch limits, closed seasons, closed areas, gear regulations (mesh size limits and a ban on bottom trawling) and minimum fish sizes.

Catch Limits

4.2 Historically, the various *C. gunnari* fisheries were assessed and managed as single-species fisheries. The focus was initially on the use of catch limits to restrict fishing mortality, in order to maintain the spawning stock. Assessments at South Georgia were carried out using VPA approaches, based mainly on catch-at-age data from the commercial fishery, and tuned using surveys and CPUE indices of abundance derived from the fishery.

4.3 During the mid-1990s an equilibrium yield model was developed as an assessment tool for krill (KYM). In 1997 this was generalised into the GYM for finfish species. A key aspect of the model was the explicit use of decision rules within the model itself, which allowed for both the maintenance of the spawning stock above a certain level, as well as specifying escapement levels so that dependent stocks were unlikely to suffer from fisheries. During this period two problems with the existing stock assessments at South Georgia were identified. Firstly, in some years there was a large mismatch between model projections of biomass and estimates of biomass from trawl surveys in the following year. Secondly, there was a growing awareness of the potential ecosystem dynamics between fur seals, icefish and krill which go well beyond single-species approaches.

4.4 In 1997 possible methods for assessing and managing *C. gunnari* were re-examined in the light of the GYM. Because of the high recruitment variability, precautionary catch limits using a constant yield strategy would have been very low. The alternative was to consider estimates of cohort strength from trawl surveys. Under this approach, estimates of cohort biomass from the trawl surveys were considered as absolute, and were projected forward under certain assumptions of growth and M to provide short-term yield estimates. This management approach aims to maximise yield when the abundance is high and minimise risk when abundance is low. This approach does, however, rely on regular surveys so that yields can be regularly updated, particularly in short-lived species, such as *C. gunnari*, in parts of their range.

4.5 The management approach had therefore changed from the management of the population as a whole (with associated biological reference points) to the management of individual cohorts. The second important aspect of the approach was that this yield estimate was still conditional on the maintenance of the spawning biomass and on the escapement of a certain percentage of the population. In line with the management of krill, an escapement level of 75% was used which was deemed appropriate to provide for predators in years when krill was abundant. As for krill, the requirements of this species by predators need to be reviewed as data become available in order to determine the appropriate level of escapement that takes account of ecosystem interactions (paragraph 8.6).

4.6 Management advice on appropriate catch limits since 1997 has been based on this approach for Subarea 48.3 and Division 58.5.2.

Other Management Measures

4.7 In addition to the catch limits, a number of other conservation measures have been introduced over time to deal with various other perceived problems.

4.8 Concern over levels of by-catch of other finfish species in bottom trawls resulted in a ban on bottom trawling for *C. gunnari* in Subarea 48.3 starting in the 1989 season. Similarly, in Subareas 48.1 and 48.2, *C. gunnari* were depleted in the late 1970s, and the fishery continued at a low level. The fishery has been closed since 1990 to avoid the high by-catch of other species (Conservation Measure 27/IX). This closure was meant to allow both *C. gunnari* and other stocks (e.g. *Notothenia rossii* at the South Shetland Islands) to recover. Bottom trawling is still permitted at Heard and McDonald Islands.

4.9 Conservation measures aimed at reducing by-catch in the targeted *C. gunnari* fisheries were introduced in 1989 at South Georgia and in 1997 at Heard and McDonald Islands, and have remained in force since then. By-catch measures have included both 'trawl-by-trawl' by-catch limits which encourage trawlers to move away from areas where the catch of another species exceeds certain limits and 'overall area' by-catch limits which would lead to closure of the fishery.

4.10 Season closures for either whole or part of the season have been used as management measures in the South Georgia fishery since 1988/89 (Table 2). Partial season closures were usually related to the catch limit being reached, or to the protection of spawning. No season closures have been in place since catch limits were first introduced for Heard and McDonald Islands in 1996.

4.11 A mesh-size restriction of 90 mm has been in place in all directed *C. gunnari* fisheries (except for waters adjacent to the Kerguelen and Crozet Islands) since 1992 (Conservation Measure 19/IX). In addition, a conservation measure aimed at avoiding catches of small *C. gunnari* (<240 mm) has been in place at South Georgia and Heard Island since 1997.

REVIEW OF DATA

Biology and Demography

Age and Growth

5.1 It is presently feasible to reliably age *C. gunnari* from South Georgia, Kerguelen and Heard Islands. Fish from South Georgia have been aged by Russian scientists by means of otoliths. Ageing in the Indian Ocean sector and at South Georgia is currently accomplished using modes of length-frequency distributions collected during trawl surveys. Aspects of methodologies for age determination of *C. gunnari* were presented in Kock (1980, 1981) and Frolkina (1989).

5.2 Problems in age determination from length-frequency samples start at age 4. After age 3 the modes in length compositions substantially overlap. In addition, there appear to be few fish in the catch older than age 4, with almost all fish having disappeared in the catches after age 6 at South Georgia and in the Indian Ocean.

5.3 WAMI-01/4 presented von Bertalanffy growth curves fitted to modal length-frequency data from the Kerguelen Islands, Heard Island and Shell Bank. The workshop recommended that this approach could usefully be extended to data from South Georgia. Previous attempts to obtain modal length data from fish at South Georgia have been provided by Kock (1980).

5.4 Otolith readings are so far only reliable at South Georgia (Shust and Kochkin, 1985; Frolkina, 1989). New estimates of von Bertalanffy growth parameters can be found in WAMI-01/7. Age determinations from fishing grounds further to the south were found to be still unreliable.

5.5 There are differences in age structure in different areas of the Scotia Arc. In the southern Scotia Sea (South Shetland Islands, South Orkney Islands), large fish of 40–50 cm, which are at least age 7–10, have been observed. Fish of this age are typically found only in low numbers at South Georgia and further to the north. These older fish from the southern Scotia Sea cannot be successfully aged using length-frequency techniques, and thus must rely on otolith ageing techniques which are poorly developed at present.

5.6 Tagging studies on *C. gunnari* that may be useful to validate ageing have not been successful, mainly due to the substantial mortality of fish in the course of sampling. Fish are usually already moribund when they come on board and die soon after. Some tagging experiments of *C. gunnari* will be attempted at South Georgia in the forthcoming season.

5.7 The age and growth findings presented in WAMI-01/4 suggest that growth rates for *C. gunnari* (during the first two years) may be different between Heard Plateau and Shell Bank although L_8 is remarkably similar. The workshop recommended that potential differences in growth between fish around South Georgia and Shag Rocks should be examined.

Mortality

5.8 There have been several studies attempting to estimate M in *C. gunnari*. A review of mortality estimation methodologies was presented in WAMI-01/7. Other investigations were presented in Everson (1998), Sparre (1989), and Frolkina and Dorovskikh (1990). There appear to be large differences between estimates using different methods. Nevertheless, it is not known how reliable these estimates are. The methodologies considered to be most reliable by the authors of WAMI-01/7 resulted in a range of estimates of M from 0.7 to 0.87, with a mean value of 0.76.

5.9 The workshop agreed that the value of M for *C. gunnari* is considerably higher than in other Antarctic fish species. However, the value of M is likely to be dynamic and not constant and may vary in areas, such as South Georgia, between years. At South Georgia, annual variation in M may change as influenced by 'good' and 'poor' krill years. The availability of krill may influence the position of *C. gunnari* in the water column, and would lead to higher predation rates in years of poor krill availability if fish move up and down in the water column more frequently, and Antarctic fur seals dive deeper in those years and encounter *C. gunnari* more often. Lower than average condition indices in years of poor krill availability may be an indication of a higher M rate (Everson et al., 1997).

5.10 The workshop agreed that M is likely to be age specific. Young fish are more likely to have a higher M rate. This probably decreases during age 2–3 and then increases again at older ages when post-spawning mortality contributes to M. The workshop therefore recommended that WG-FSA explore whether it is possible to include a range of M values for each age class in the models.

5.11 The importance of ecosystem-related mechanisms on dispersal and M remains poorly understood, and requires considerably more research in the near future. The impact of the increasing population of fur seals at South Georgia may be having a profound effect on the mortality of *C. gunnari*, particularly in poor krill years. Following initial research by Everson et al. (1999), the workshop recommended that a time series of the abundance of fur seal populations and krill be examined, along with the available data on abundance indices for *C. gunnari*, to better understand the role of predator–prey dynamics on annual survival rates and stock size of *C. gunnari*.

Reproduction

5.12 Spawning patterns, seasonality and reproduction for *C. gunnari* have been studied in almost all areas where the species occurs. Information was provided in Permitin (1973), Kock (1979), Lisovenko and Silyanova (1980), Kock (1989), Kock and Kellermann (1991), Everson et al. (1991, 1996, 1999, 2001) and Duhamel (1987, 1995).

5.13 Differences in spawning seasonality for the Heard Plateau and Shell Bank were described in WAMI-01/4. The spawning season at Shell Bank appears to take place in April and May, whereas spawning at Heard Plateau and Gunnari Ridge occurs in August and September.

5.14 A meridional trend is apparent in fecundity estimates. Fecundity is highest in populations in the Indian Ocean sector and decreases over South Georgia towards the southern Scotia Arc. Fish in Subareas 48.1 and 48.2 become sexually mature one year older than those further to the north in Subarea 48.3. Egg size was smaller in the Indian Ocean sector (3.2 mm) compared to the Atlantic Ocean sector (3.7 mm).

5.15 The workshop acknowledged that problems remain in distinguishing between spent and immature (or resting) females. The determination between these two reproductive states is less problematic immediately after spawning. The workshop recommended that ovaries of fish from spawning grounds be obtained and examined over the length of the spawning season in order to better understand the processes of ovary maturation, spawning and resorption.

Diet

5.16 The diet of *C. gunnari* in most parts of the Southern Ocean has been examined by several authors. Around South Georgia dietary composition has been examined by Barrera-Oro et al. (1998), Kock (1981), Kock et al. (1991, 1994), Kompowski (1980), Kozlov et al. (1988), Permitin and Tarverdiyeva (1972), around Elephant Island by Kock (1981) and Gröhsler (1992), in the South Shetland Islands by Tarverdiyeva and Pinskaya (1980) and Takahashi and Iwami (1997), in the South Orkney Islands by Permitin and Tarverdiyeva (1978), and in the Indian Ocean by Chechun (1984). In addition, WAMI-01/10 presents preliminary information on dietary composition of *C. gunnari* from recent surveys in the South Shetland and South Orkney Islands.

5.17 The composition of dietary components vary in different regions of the Southern Ocean. In the Atlantic sector the preferred food item is *Euphausia superba*. The availability of *E. superba* appears to be more consistent in the southern Scotia Arc, whereas its presence in the diet around South Georgia is more susceptible to interannual changes in krill biomass. When abundant, krill constitutes a substantially higher proportion of the diet of *C. gunnari* than in years of poor krill availability. At Kerguelen and Heard Islands there is no *E. superba* found in the diet of *C. gunnari*, instead other species of euphausiids and hyperiids tend to dominate.

5.18 WAMI-01/6 and 01/10 analyse the relationship between the spatial distribution of *E. superba* and the distribution of *C. gunnari*. Both studies concluded that the spatial distribution of krill is highly influential in the distribution of *C. gunnari*. WAMI-01/10 modelled the relationship between the spatial distribution of prey density with the distributions of *C. gunnari* abundance, mean size, and average stomach fullness, and found significantly positive relationships between these factors and krill density. The workshop recommended that krill surveys should be conducted in real time with finfish trawl surveys, as this can provide important insight into a potentially important mechanism that influences spatial distribution of *C. gunnari*.

Stock Identity and Structure

Large-scale Stock Identity and Movements

5.19 The geographic delineation of *C. gunnari* stocks has been based on several techniques, including the use of morphometrics and meristics (Kock, 1981; Sosinski, 1985), parasites (Siegel, 1980) and genetic approaches (Carvalho and Lloyd-Evans, 1990; Carvalho and Warren, 1991; Duhamel et al., 1995; Williams et al., 1994). Separate stocks of fish are currently defined in the Atlantic Ocean sector around South Georgia, and the South Shetland and South Orkney Islands. Some evidence has been presented that there may be separate stocks around South Georgia and at Shag Rocks.

5.20 WAMI-01/4 presents evidence that there are two separate stocks around Heard Island. More stocks may have existed on other banks, such as Pike or Discovery Bank, which now appear to be absent. Around Kerguelen there appear to be two stocks (Kerguelen Shelf, Skif Bank) as well. Spawning times between stocks may differ by five months, such as on the Kerguelen Shelf and Skif Bank and Heard Island and Shell Bank. Results from recent DNA studies indicate that all populations in the Indian Ocean sector may be genetically homogeneous. This suggests that separation into the various populations could have occurred only recently or that there is a limited exchange of individuals between the populations. The workshop recommended that additional DNA samples should be collected from as many areas as possible to further elucidate stock identity and structure in *C. gunnari*.

5.21 The workshop discussed the potential consequences of treating two separate stocks erroneously as one single unit when setting catch limits. The workshop agreed that it is preferable to treat these stocks as separate units even if the evidence for stock separation is weak in order to minimise the risk of reducing one stock to very low levels while the overall stock still appears to be relatively healthy.

Shelf Distribution and Movements

5.22 WAMI-01/8 describes vertical and horizontal patterns of distribution of *C. gunnari* around South Georgia. There are strong seasonal effects on the distribution, with winter season yielding no fishable concentrations (see additional details in paragraph 7.6). The seasonal changes in temperature appear to be one of the important factors that influence the formation of concentrations. The workshop recommended that it would be useful to collect CTD data on as many trawl stations as possible in order to help understand the role of the physical environment in the formation of aggregations.

5.23 Diurnal changes in the vertical distribution of *C. gunnari* around Heard Island were investigated in WAMI-01/5 using a bottom trawl in conjunction with acoustic methods. The results indicate that vertical distribution is linked to the diel light signal (dusk, dawn). The study suggests that bias in abundance estimates of *C. gunnari* from bottom trawl surveys is negligible if hauls are conducted only during daylight hours between sunrise and sunset. *C. gunnari* tend to leave the bottom layers at sunset. The workshop recommended, where possible, the use of acoustic devices in conjunction with bottom trawls in obtaining information on the proportion of fish off the bottom.

5.24 Factors that influence the horizontal distribution of *C. gunnari* in the South Shetland Islands were presented in WAMI-01/10. In this analysis a relationship was drawn between the depth, krill availability and bathymetry. There is likely to be a confluence of events in the northwestern sector of the shelf area along the 200 m isobath that creates optimal conditions for concentrations of krill and *C. gunnari*. The steep bathymetric gradient and hydrography in this area tends to concentrate krill, and since this region is positioned around 200 to 250 m, this overlaps with the preferred depth range of *C. gunnari*, thus making conditions favourable for higher abundances in this particular region. The lower South Shetland Islands, however, do not have an equivalently steep bathymetric gradient in any specific area along the preferred depth strata of *C. gunnari*, thus the relationship is not as clearly defined in this region.

5.25 There appear to be segregations of size and age classes around South Georgia Island, and there is evidence that in certain regions, fishing may be occurring on only one age class spanning over a limited length range. This is likely having an important effect on the assessment of the stock. WAMI-01/16 examined the depth distribution of *C. gunnari* from nine bottom trawl surveys. Results indicate that the depth of maximum abundance increased as fish size increased. The workshop recommended that future surveys should be designed to provide a uniform sampling intensity over the depth range from 100 to 300 m. WAMI-01/4 provided similar results for the Heard Island region.

Recruitment and Year-class Strength

5.26 The difference between ‘strong’ and ‘weak’ year classes of *C. gunnari* can differ by a factor of 20. There is presently no clear relationship between recruitment and parent stock size in the Atlantic sector. Around Kerguelen, strong year classes were observed every three years over the course of 20 years. It is possible that this was attributable to a stock recruitment effect.

ECOSYSTEM CONSIDERATIONS

Predator–Prey Relationships

6.1 Predator–prey relationships and the importance of *C. gunnari* in the diets of land-based marine predators were briefly reviewed for the southern Scotia Arc, South Georgia and Heard Island.

6.2 At South Georgia studies have shown that fur seals and penguins can switch their feeding preferences, feeding on krill in years of high krill abundance, and increasing the proportion of *C. gunnari* in years of low krill abundance. *C. gunnari* feed primarily on krill in years of high krill abundance while they increase the proportion of *Themisto* in their diet in years of low krill abundance. It is obvious that there is a strong relationship between krill, *C. gunnari* and some of the land-based predators.

6.3 The workshop recognised that there are likely to be differences between South Georgia and the southern Scotia Arc in terms of the importance of *C. gunnari* in the food web.

6.4 Dietary studies of Antarctic fur seals and king penguins at Heard Island indicate that both these species feed on *C. gunnari* at certain times of the year, such as August in king penguins. However, fur seals at Heard Island, and also in the Kerguelen Islands, feed mainly on myctophids.

6.5 The workshop agreed that increases in the populations of fur seals (5–10% per annum) at South Georgia over the past 50 years may be exerting increasing predation pressure on *C. gunnari*, particularly in years of poor krill abundance. A similar situation may be occurring in other areas where predator populations have been increasing, such as at Heard Island where breeding numbers of king penguins have increased from none observed in 1963, to 30 000 pairs at present.

6.6 The workshop concluded that:

(i) there was a strong relationship between krill, *C. gunnari* and land-based predators at South Georgia;

(ii) the importance of *C. gunnari* in the diet of land-based predators may be high in years of low krill abundance at South Georgia; and

(iii) *C. gunnari* may be an important prey item during critical phases of the life history of some predators, particularly in the Indian Ocean sector.

6.7 It was recommended that studies be undertaken to:

(i) further quantify the relationship between krill, *C. gunnari* and land-based predators; and

(ii) examine possible interactions between the *C. gunnari* fishery, *C. gunnari* and its predators, and quantify any overlap which may occur (as is done by WG-EMM in the case of krill).

Ecosystem Changes since the Early 1970s

6.8 Evidence for long-term, large-scale changes in populations of predators and the environment in Areas 48 (South Atlantic) and 58 (Indian Ocean) was reviewed. Major trends include:

(i) increases in populations of fur seals and some species of penguin at South Georgia;

(ii) increases in populations of fur seals and king penguins in the Indian Ocean;

(iii) increases in mean annual air temperature at the Antarctic Peninsula; and

(iv) decreases in the mean annual extent of sea-ice in the southern Scotia Arc.

6.9 In the context of Article II it is possible that a change has occurred in the ecosystem which may not be reversible over two or three decades. However, the workshop recognised the high variability in the size of *C. gunnari* stocks and the potential for recovery following an event of high recruitment.

6.10 The workshop agreed that further work was needed to compile information on long-term, large-scale, changes in populations and the environment in Areas 48 (Atlantic Ocean) and 58 (Indian Ocean). Simulation studies were also needed to examine plausible scenarios which could lead to observations on the abundance of *C. gunnari*, krill and the predators. The workshop requested assistance from WG-EMM in addressing these issues.

By-catch

By-catch in Fisheries targeting *C. gunnari*

6.11 Ms van Wijk presented a summary of by-catch data for the Australian trawl fishery for *C. gunnari* in Division 58.5.2. Data have been collected by scientific observers (two observers/trip) for every fishing trip undertaken since 1996/97. Over the past five years:

(i) 94% of the hauls were observed, covering 93% of the total catch of *C. gunnari*;

(ii) by-catch typically comprised 1–6.5%, by weight (1–11 tonnes), of the total observed catch (63–915 tonnes) in each split-year;

(iii) there was one anomalous year (1998/99) when the by-catch comprised 34% (13 tonnes) of the total observed catch (37 tonnes) – that year, the catch of *C. gunnari* was below average;

(iv) the main components of the by-catch are *Dissostichus eleginoides*, skates and jellyfish, and these species are common to both fishing grounds (Plateau Shallow and Shell Bank); and

(v) *Channichthys rhinoceratus*, sponges and soft corals are important components of the by-catch on Plateau Shallow, whereas porbeagle sharks and *Lepidonotothen squamifrons* are important on Shell Bank.

6.12 By-catch in the trawl fishery for *C. gunnari* in Subarea 48.3 in the 1999/2000 and 2000/01 seasons was reported in WAMI-01/15 Rev. 1. The dominant component of the by-catch in 1999/2000 was myctophids (67 tonnes or 1.6% of the total catch by weight). So far in the 2000/01 season, the total by-catch is <10 tonnes, and the dominant species was *Pseudochaenichthys georgianus* (7 tonnes or 0.5% of the total catch by weight). These estimates were derived from the five-day catch and effort reports.

By-catch of *C. gunnari* in Other Fisheries

6.13 The abundance of *C. gunnari* in the by-catch from the krill fishery in Subarea 48.2 was reported in WAMI-01/11. The information covered a single trip. The catch of *C. gunnari* consisted mostly of 0+ and 1+ aged fish, and their abundance ranged from 12 individuals observed in a haul of 3 tonnes of krill, to 3 500 individuals observed in a haul of 17 tonnes of krill.

6.14 The workshop agreed that this information was valuable and that scientific observers should be further encouraged to collect data on by-catch in krill fisheries. The attention of WG-EMM was drawn to the high number (1 000s) of Antarctic fur seals seen in the area (near 60°40’S and 46°20’W) at the time of fishing (May–July 1999).

6.15 The workshop agreed that information on the by-catch of *C. gunnari* in other fisheries was an important component of developing our understanding of the fishery–icefish interactions. However, it was noted that the current short-term projections are independent of levels of mortality of early age classes of *C. gunnari*.

Incidental Mortality

6.16 The workshop reviewed the information on the incidental catches, and associated mortality, of seabirds taken in the fishery for *C. gunnari* in Subarea 48.3 in the 1998/99 and 2000/01 seasons (WG-FSA-01/30). The following points were noted:

(i) Detailed analysis of the data contained in observer reports for fishing between December 2000 and February 2001 identified month and vessel as two possible factors influencing the probability that a haul would catch birds, with most (93%) of all seabird mortality occurring in the first three weeks of February – there were no significant factors that could explain the numbers of birds that would be caught in non-zero hauls.

(ii) Differences between the three recent years (numbers of birds by season were 1998/99 = 4, 1999/2000 = 19, 2000/01 = 92) also suggest that there may be year effects, but these differences could also have been caused by month or vessel effects.

(iii) More detailed research on the *C. gunnari* fishery is required to identify what factors are important in explaining bird by-catch and how to mitigate the problem.

6.17 The workshop agreed that in order to facilitate future scientific observer investigation of this potential problem, detailed protocols and recording formats need to be developed. This matter was referred to WG-FSA and ad hoc WG-IMALF for further consideration.

Effects of Fishing Gear

6.18 The workshop recalled discussions in the late 1980s on the effect of trawl gear on the seafloor within the Convention Area. Concern about this impact and the potential taking of species of depleted stocks, such as *N. rossii*, in the by-catch of trawl fisheries in Area 48, lead to the prohibition of bottom trawling in this region. As a result, commercial fisheries for *C. gunnari* in Subarea 48.3 operate midwater trawls.

6.19 In contrast, the use of bottom trawls in commercial fishing is permitted in other parts of the Indian Ocean, including Divisions 58.5.1 and 58.5.2. Vessels targeting *C. gunnari* in Division 58.5.2 currently use trawls towed on or close to the bottom. The workshop noted that the composition of the fish fauna and the potential for by-catch taken by trawl in Division 58.5.2 was different to those in Subarea 48.3.

6.20 The US AMLR Program is mapping the distribution of benthic by-catch and investigating the effects of bottom trawls on the seafloor and benthos in Subareas 48.1 and 48.2 (e.g. WAMI-01/10). Data from by-catch in research trawls, video-photography, acoustic data and benthic samples are being used.

ASSESSMENT METHODS

Previous/Current CCAMLR Assessments

7.1 The workshop briefly summarised the history of *C. gunnari* assessments performed by WG-FSA (see Tables 3 and 4). In 1986 CCAMLR agreed in principle to set catch limits regulating fishing activity in Subarea 48.3 (South Georgia and Shag Rocks). From 1989 to 1991 assessments were performed annually during WG-FSA using VPA tuned using indices of abundance from either: (i) CPUE data from the commercial fishery; or (ii) research trawl surveys to estimate size and age of the population. Population size and estimated catches were projected from the terminal year of the VPA using the catch equation with a stochastic recruitment function derived from the VPA results and a target fishing mortality $F_{0.1}$ derived from a yield-per-recruit analysis. In 1993 the VPA was tuned using the ADAPT method (Gavaris, 1988). WG-FSA was concerned about incompatibility between projected abundance of age and that observed during research surveys. Periodic reductions in biomass in the absence of fishing were evident in the surveys but these were not reflected in the projections. Concern was raised by WG-FSA that the VPA analysis was not providing a reliable assessment of stock status. With the lack of a commercial catch since the 1990/91 season, in 1994, the Working Group ceased using VPA to assess *C. gunnari* in Subarea 48.3. With no fishery, the catch-at-age matrix could not be extended. Research surveys were then the only source of information on current abundance, however there was no way of converting these from relative to absolute indices. In the absence of reliable information on catchability, which is generally assumed to be less than 1, WG-FSA adopted a conservative approach to the assessment, assuming that the surveys provided estimates of absolute abundance.

7.2 In 1997 two possible approaches for deriving catch limits were identified: long-term precautionary catch limits and short-term catch projections from estimates of current abundance derived from surveys. Precautionary catch limits were based on the GYM, applied in a similar way to the assessment of *D. eleginoides* in Subarea 48.3, but with a target escapement of 75%. Given that the stock size is highly variable even without fishing, WG-FSA deemed short-term projections to be more appropriate.

7.3 Short-term projections require a number of inputs: a biomass estimate, distribution of numbers at age, an estimate of M, a selection function, von Bertalanffy growth parameters, a weight–length relationship and known catches since the time of the biomass estimate. They can be updated each year if new information on biomass and age structure of the population becomes available.

7.4 The workshop endorsed the current use of short-term projections to provide catch limits for *C. gunnari* and noted the lack of alternative methods. It also noted that with the fishery based on two age classes, the currency of assessments is two years. If there is no survey information from the most recent two seasons, the advice on catch limits becomes unreliable. The workshop recommended that WG-FSA consider the currency of these assessments in the absence of surveys.

7.5 Dr Parkes noted that research surveys need to be as representative as possible of the true status of the stock as they are now the primary means of measuring the current status of the stock and form the starting point for the subsequent calculation of catch limits. He also stated that even though there were limitations to the bottom trawl method, it was important to continue these surveys as they provide a continuous time series conducted using similar techniques. Further work in developing survey methods that augment the bottom trawl approach would be useful. This was discussed further by the workshop (paragraphs 7.17 to 7.29).

7.6 The workshop discussed the potential importance of dispersal and the effect this may have on estimation of stock size. At South Georgia fish may be more likely to concentrate during the late spring–summer–autumn period than in winter. Evidence presented in WAMI-01/8 suggests that *C. gunnari* feed poorly and do not appear to form large aggregations during winter. During spring *C. gunnari* begin to form aggregation near the bottom and to migrate vertically in order to feed more intensively. In summer fish appear to perform extensive vertical and horizontal migrations and are intensively feeding, densely aggregating in some years. Finally, in autumn, fish are in more near-bottom areas and feeding intensity decreases significantly when fish approach spawning. Thus, seasonality can bias the indices of abundance and potentially also affect the estimates of mortality.

New Methods and Modifications to Previous/Current Methods

7.7 Dr P. Gasiukov (Russia) presented a summary of the results of WAMI-01/13. This paper provided biological reference points (RPs) for *C. gunnari* based on a stock assessment using Extended Survivors Analysis (XSA). In the early 1990s stock assessments were carried out using the ADAPT method. These assessments were revised by analysing the original catch-at-age and survey data using XSA, as complemented in the software used by ICES. XSA is a more flexible approach and provides various options for weighting, catchability models, and shrinkage procedures. The analyses show that abundance and total and spawning biomass estimates were significantly higher than values obtained by ADAPT. At the same time, there appears to be a total lack of a stock-recruitment relationship, indicating a random pattern of recruitment. Diagnostic statistics indicated that the input data are noisy and of poor quality.

7.8 Dr Kock noted that this was a useful approach but emphasised that the results in this model, as those of other models, would be driven by the high value of M. Furthermore, the high value of residuals in some years, was of concern. He suggested that it may be useful to gather information on other techniques or analyses used in other fisheries, on species with a similar life history.

7.9 Dr Constable added that the decoupling of recruitment and stock, apparent in the analyses of historical fishery data and research data, means that recruitment is not a reliable indicator of stock status. It may be that there are no methods for checking the status of the system and it is important to incorporate this into management strategies, ensuring that they are robust against uncertainty (see Agenda Item 8).

7.10 The workshop thanked Dr Gasiukov for his work noting that this technique is very useful in giving an overview of stock dynamics. In particular, these techniques can be used to derive recruitment time series and estimates of catchability, although it was noted that the diagnostics suggested that many of the problems encountered by WG-FSA in its last attempts to perform VPA using ADAPT remained with the XSA approach.

7.11 Dr Gasiukov presented the results of WAMI-01/12. This paper addressed the problem of using data from multiple surveys carried out over a number of years by different countries using different vessels.

7.12 At last year's meeting WG-FSA combined trawl data from different vessels to obtain a single ranked dataset used to derive abundance and biomass estimates. The assumption in this approach was that the survey vessels fished with equal efficiency. This is unlikely to be valid as vessels will differ in many aspects, including size, gear, experience of crew etc. Using a GLM approach, the paper noted significant differences between the catchability of different surveys in Subarea 48.3 undertaken by Argentina, Russia and the UK. This analysis provides a method whereby values of one vessel can be standardised to those of another. Data from 1989/90 were excluded from the analysis due to abnormally high catches that precluded computation. The average catchability of vessels used in Russian surveys was 4.14 times the average catchability of vessels used by the UK.

7.13 The workshop again thanked Dr Gasiukov for his valuable work, noting that it is very important to provide methods that can reconcile data from different surveys, and adding that it was encouraging to see that this type of work is being explored. Several members noted that their concern that the multiplier of 4.14 was very large and thought it important to determine why the differences between the two survey series might be so great. During the discussion, several possible factors were identified, including: variance caused by factors not included in the analysis, such as sampling/survey design, fishing gear or seasonal influences. It was also noted that whilst the nations undertaking the surveys were used as a proxy for vessel, each country had used several different vessels.

7.14 Drs Constable and Kock suggested that an experiment comparing the results of two vessels fishing in a small area at the same time could provide useful information to solve this problem.

7.15 Dr Parkes suggested that it may be informative to look at results of this analysis done elsewhere to place the magnitude of the multiplier value determined here into context. Dr Gasiukov replied that studies in the Baltic Sea comparing eight different vessels from eight different countries had provided relative values that were comparable. Similarly, Dr Hanchet noted that studies in New Zealand yielded multipliers of 2 to 1 or 3 to 1, but that 4.14 seemed high.

7.16 The workshop noted that it was important to consider the above issues at WG-FSA and to encourage further work in this area intersessionally. Dr Gasiukov indicated that he would be developing this work further in the future.

Future Monitoring

Surveys

7.17 Traditionally, surveys used to derive abundance estimates for *C. gunnari* are conducted by bottom trawl. The assumption implicit in the use of those estimates as values of absolute abundance is that *C. gunnari* are distributed very closely to the bottom during the day and that therefore the bottom trawl samples all the fish in the water column. Recent observations have suggested that there is a significant pelagic component to the stock (Frolkina and Gasiukov, 2000; Kasatkina, 2000). This has raised the question in recent years of whether current bottom trawl surveys are the most appropriate method to assess the absolute abundance of *C. gunnari*.

7.18 Two papers were presented to the workshop which addressed this issue: WAMI-01/5 and 01/9.

7.19 Ms van Wijk presented the results of WAMI-01/5. This paper investigated whether a research trawl survey targeting *C. gunnari* in the Heard Island region showed bias due to the vertical migration of *C. gunnari*. The design of research surveys in this region has been based on anecdotal evidence from the fishing skippers that *C. gunnari* do not start moving up into the water column until three hours post-sunset. Thus trawls were considered acceptable if conducted between sunrise and three hours after sunset. Analysis of acoustic data in this paper showed that this assumption is incorrect and that vertical migration of *C. gunnari* is tightly tuned to the diel light signal. *C. gunnari* move down/up in the water column within an hour of sunrise/sunset. The analysis showed that during the day pelagic aggregations of fish were only rarely present above the level sampled by the trawl. The paper concluded that providing bottom trawls were conducted between the times of sunrise and sunset, bias should not be a problem.

7.20 Dr Parkes raised the question of whether it was possible to provide quantitative acoustic abundance estimates from a similar survey in future. Ms van Wijk replied that while this was certainly possible, there were a number of issues that would need to be addressed first, notably, accurate range of target strength values for *C. gunnari*, calibration of the echosounder (logistically difficult as surveys in Division 58.5.2 are conducted by commercial vessels) as well as issues of bias. Dr Parkes also commented that while pelagic aggregations in this study were only rarely noted, it was unknown whether they comprised *C. gunnari* as they were not successfully trawled. Thus even though no bias was evident in this survey, in future surveys where pelagic aggregations occur it will be important to trawl these marks to be able to determine the extent of possible bias.

7.21 WAMI-01/9 proposed the design of a trawling/acoustic survey planned for *C. gunnari* in Subarea 48.3. This survey is planned by Russia for January–February 2002. It is designed to improve quantitative assessments for *C. gunnari* by combining an acoustic and bottom trawl survey to resolve the pelagic and benthic components of the stock respectively. The original bottom trawl survey design used in previous years will be repeated to maintain continuity of the time series. In addition, an acoustic survey will be conducted after the trawl survey to determine the pelagic component of the stock. The temporal separation of the two surveys will be kept as low as possible. Target strength values for *C. gunnari* will be measured during the survey to provide a basis for determining quantitative estimates of abundance from the acoustic data. Abundance estimates from the acoustic survey will be combined with those from the trawl survey to provide total estimates of abundance that include both the pelagic and benthic components.

7.22 Dr Gasiukov noted that discussion would be necessary at next year's WG-FSA meeting to determine ways in which these two abundance estimates might be combined.

7.23 Several members of the workshop noted that there were many issues that would need to be resolved before quantitative estimates could be derived from acoustic data. These included: determination of target strength values for *C. gunnari* and their validity; influence of fish behaviour on target strength, detectability of *C. gunnari* in acoustic data; characterisation of vessel avoidance; and possible diving responses. Dr Hanchet noted anecdotal evidence from the New Zealand fishery that some fish reacted to net approach by diving 30 or 40 m towards the seafloor. If *C. gunnari* exhibit a similar behaviour and both trawl and acoustic data were used to derive abundance estimates, then there could be a possibility of 'double counting'. This would be extremely difficult to characterise.

7.24 Dr Constable noted that the issue of bias is a different question than the efficiencies of different survey methods. The potential underestimation of abundance by trawls needs to be assessed by monitoring what is caught versus not caught in a trawl. Comparisons of results between trawl and acoustic surveys is a question of efficiency. Deployment of video gear on the trawl net may be able to provide information on fish avoidance and therefore aspects of the bias problem. If this and target strength issues can be overcome then acoustic surveys may be more efficient than trawl surveys as they can provide greater spatial coverage in a shorter time span. It is important to quantify bias in both trawl and acoustic surveys.

7.25 Dr R. Holt (USA) mentioned that putting video gear on the trawl net may introduce other problems such as fish avoidance/attraction to light. Dr Parkes mentioned that using an upward-looking sounder mounted on the net may give additional useful information.

7.26 Dr Parkes questioned how the various species would be discriminated during the acoustic survey. Dr Gasiukov replied that multifrequency techniques would be used and that for species that were difficult to separate, such as *C. gunnari* and myctophids, target trawls would be used for verification.

7.27 Dr M. Belchier (UK) noted that the UK would also carry out a bottom trawl survey in Subarea 48.3 in January 2002. The survey design will be the same as that used previously to maintain continuity of the data series, but will also collect acoustic information using a hull-mounted EK500.

7.28 Similarly, Mr Jones noted that a US AMLR acoustic survey for krill will take place at the same time as the German groundfish survey at the South Shetland Islands in January 2002. A comparison between the acoustic data and trawl data will be useful in examining vertical distribution of *C. gunnari*.

7.29 The workshop recognised the value of combined acoustic and trawl surveys. It encouraged discussion between the UK and Russia to explore options to coordinate the two surveys in Subarea 48.3. A two-vessel collaborative survey collecting concurrent acoustic and trawl data would yield a very valuable dataset that may address issues such as bias and the most appropriate survey techniques for *C. gunnari*. The workshop recommended that, where possible, continuous acoustic recording should be undertaken during bottom trawl surveys to allow potential bias to be determined in survey catch rates.

MANAGEMENT PROCEDURES

8.1 The workshop discussed management procedures for *C. gunnari* and noted that a number of papers have addressed these issues in the recent past following the development of a precautionary approach for krill, including de la Mare et al. (1998) and Agnew et al. (1998). A number of general issues surrounding the development of a management procedure were briefly discussed, including the need to specify operational objectives (such as those adopted for krill), decision rules that would use information, and assessment methods to make decisions in order to achieve the operational objectives. Many of these issues have been presented to CCAMLR previously in the Working Group on Developing Approaches to Conservation (WG-DAC) in the mid-1980s (see, for example, the paper by de la Mare, 1988).

8.2 The workshop noted that a management procedure comprises both decision rules and operational objectives. The objectives are based on attributes of the system that can be measured (paragraph 4.1) and for which provision is made for conservation and rational use. The performance of the management procedure would be judged against the status of those attributes. Differences between the desired states of those attributes and the observed state of the system provide measures of performance. Such differences may not be able to be measured in reality but can be used in performance evaluations based on simulated environments.

8.3 In that context, the workshop agreed that the types of assessment methods and decision rules that could be used for *C. gunnari* should be evaluated in a simulation framework to test the performance of the procedures before suggesting modifications to the current management system.

8.4 The evaluation framework requires the elaboration of plausible models of the ecological and fishery system on which the performance of the management procedure will be evaluated. To that end, the workshop requested that members develop the following:

(i) quantitative simulation models that encompass the biological features of *C. gunnari* populations, including predator and prey requirements, noting the potential differences between the southern Scotia Arc, South Georgia and the Kerguelen Plateau;

(ii) understanding of the historical interactions of the fishery with the fish stocks, following the work described in WAMI-01/13;

(iii) understanding of the importance of *C. gunnari* as a prey species and the life history consequences to predators of a fluctuating stock of *C. gunnari*;

(iv) scenarios concerning long-term changes in the ecosystem, including oceanographic changes along with recovery of formerly depleted species such as fur seals; and

(v) appropriate ecological reference points for *C. gunnari*, taking into account the relative importance of this species to predators and the highly variable nature of the stock.

8.5 The workshop noted that the development of management procedures required consideration of the combination of decision rules, assessment methods and information requirements. WG-FSA has considered three approaches for assessing yield of *C. gunnari*. The approach used in the 1980s and early 1990s was based on using VPAs tuned with surveys and a target F ($F_{0.1}$) to estimate yield. Since 1997 WG-FSA has used the objectives developed for prey species, such as krill. A method based on the approach for toothfish and krill is inappropriate for *C. gunnari* because they naturally fall to low abundances. For that reason, the short-term assessment method was adopted.

8.6 The workshop considered alternative approaches to management that could be evaluated, including:

(i) the development of decision rules that take account of changes in the relative status of the stock in order that assessments of long-term annual yield can be made;

(ii) the development of short-term methods that take account of uncertainty in parameters such as M;

(iii) consideration of the components of the existing decision rule for the short-term assessments, such as the confidence bound on the biomass estimate and the escapement of the cohorts following fishing, to identify whether any part of the decision rule could be made less stringent while still ensuring a high probability of maintaining productivity of the stock and its predators;

(iv) consideration of medium-term assessment methods such as those used in ICES that endeavour to account for the probability of recruitment success in subsequent years;

(v) consideration of closed seasons to safeguard predators and therefore not require a specific provision for predators in the decision rule; and

(vi) consideration of how to ensure the conservation of the stock if the fishery pursues the catch limit after the assessed cohorts have disappeared. (The workshop noted the risk of exploiting unassessed cohorts if they enter the fishery at this time.)

8.7 The workshop requested that WG-EMM be asked to consider the importance of *C. gunnari* to predators in the Antarctic ecosystem in order to evaluate the escapement of *C. gunnari* required from the fishery to provide for predators. It also requested that the Commission be asked for guidance concerning the definition of operational objectives for this species.

RECOMMENDATIONS TO WG-FSA

9.1 The workshop made the following recommendations under each agenda item:

(i) Review and characterisation of fisheries:

(a) The recently compiled bibliography on *C. gunnari* should be developed as an electronic database (paragraph 2.1).

(ii) Management needs:

(a) The Fishery Plan for each area needs to list the information (research) requirements for the management approach adopted. The currency of the assessment should also be stated (paragraph 3.7).

(b) Reporting requirements must be met to enable catch limits to be monitored (paragraphs 4.2 to 4.6).

(c) Where possible, WG-FSA should update the short-term projections annually (paragraphs 4.4 and 4.5).

(d) Where stock structure is uncertain, stocks should be managed as smaller units (paragraph 5.21).

(iii) Review of data:

(a) Growth should be studied at South Georgia and Shag Rocks to reveal possible differences (paragraph 5.7).

(b) WG-FSA should explore whether it is possible to include a range of M values (paragraph 5.10).

(c) Ovary sampling should be carried out throughout the season to determine staging criteria for *C. gunnari* (paragraph 5.15).

(d) Sampling should continue in each area for stock separation work (paragraph 5.18).

(e) Sampling should be uniform over a 100 to 300 m depth range (paragraph 5.25).

(iv) Ecosystem considerations:

(a) A comparison over time should be made of the population abundance of predators–icefish–krill in each area (paragraph 5.11).

(b) Predator dependence studies are required to determine how important *C. gunnari* are to predators (seals, penguins etc.). WG-EMM has previously determined an overlap index for krill. Foraging ranges of predators should be provided (paragraphs 5.11 and 6.7).

(c) A simulation study of the impact of seal predation may help determine what future work is required (empirical studies) (paragraph 6.7).

(d) WG-FSA should seek advice from WG-EMM on the likely effects on the ecosystem of the observed increase in temperature and other ecological ranges over the last 20 years (paragraph 6.10).

(e) WG-FSA should review commercial by-catch rates in each fishery and review survey by-catch rates in each area (analyse trends) (paragraph 6.12).

(f) A consistent approach to by-catch issues should be taken across the various fisheries (following paragraphs 6.12 to 6.15).

(g) Further information is required from the krill fishery on by-catch rates of juvenile *C. gunnari* (paragraph 6.15).

(h) ad hoc WG-IMALF should consider development of a protocol for observers concerning seabird by-catch in trawl fisheries. The relative vulnerability of each species to trawl fisheries should be determined (paragraph 6.17).

(v) Assessment methods:

(a) Review levels of M used in the assessment (paragraph 5.10).

(b) Additional tissue samples should be collected for DNA microsatellite analysis to further elucidate stock identity (paragraph 5.20).

(c) CTD data should be collected on as many stations as possible (paragraph 5.22).

(d) The workshop endorsed the current use of short-term projections to provide catch limits for *C. gunnari* (paragraph 7.4).

(e) WG-FSA should look at the different vessel catchabilities in the trawl survey series within Subarea 48.3 (paragraph 7.16).

(f) Where possible, target strength work should be completed as part of acoustic surveys (paragraph 7.23).

(g) Continuous acoustic recording should be undertaken during bottom trawl surveys to allow potential bias to be determined in survey catch rates (paragraph 7.29).

(h) The workshop supported the proposal to carry out joint acoustic and trawl surveys in 2002 and encouraged discussion between the UK and Russia to explore options to coordinate the two surveys planned for Subarea 48.3 in January–February 2002 (paragraph 7.29).

(vi) Management procedures:

(a) The types of assessment methods and decision rules that could be used for *C. gunnari* should be evaluated in a simulation framework to test the performance of the procedures before suggesting modifications to the current management system (paragraph 8.3).

(b) Members should elaborate plausible models of the ecological and fishery systems on which the performance of the management procedure will be evaluated (paragraph 8.4).

(c) The workshop requested WG-EMM be asked to consider the importance of *C. gunnari* to predators in the Antarctic ecosystem (paragraph 8.7).

(d) The workshop requested that the Commission be asked for guidance concerning the definition of operational objectives for *C. gunnari* (paragraph 8.7).

ADOPTION OF THE REPORT

10.1 The report of the workshop was adopted.

CLOSE OF THE WORKSHOP

11.1 Dr Holt congratulated the Co-conveners for bringing the workshop together, and for guiding the discussion and work to a successful outcome. Dr Holt also thanked Ms G. Tanner and Dr Ramm for their contribution to the workshop. The hard work of the Co-conveners and the Secretariat had been appreciated by all participants.

11.2 Drs Parkes and Kock thanked all participants for their contribution to the workshop. WAMI had been a long time in the planning and it was gratifying to have co-convened the workshop. The outcome would be useful to WG-FSA and there was a bright future for further work on *C. gunnari*.

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Table 1: Annual catches (tonnes, live weight) of *Champsocephalus gunnari* in the CCAMLR Convention Area, as reported in STATLANT data. Split-years start on 1 July and end on 30 June of the following.

Split year	Area/Subarea/Division							
	48	48.1	48.2	48.3	58	58.5	58.5.1	58.5.2
1969/70							5	
1970/71				10 701			380	
1971/72				551			35 568	5 860
1972/73				1 830			45	
1973/74				254			25	
1974/75				746			1 764	14 572
1975/76				12 290			11 577	2 663
1976/77				93 400		264	33 112	4 201
1977/78			138 895	7 557		296	16 581	16 166
1978/79		35 930	21 439	641	101			
1979/80		1 087	5 231	7 592			[a]1 631	
1980/81		1 700	1 861	29 384			[a]1 122	
1981/82		0	557	46 311			[a]16 083	
1982/83		2 604	5 948	128 194			[a]25 852	
1983/84			4 499	79 997			[a]7 127	
1984/85		17	2 361	14 148			[a]8 253	
1985/86	32		2 682	11 107			[a]17 137	
1986/87		75	29	71 151			[a]2 625	
1987/88		1	1 336	34 619			[a]159	
1988/89		141	532	21 359			23 628	
1989/90			2 528	8 087			226	1
1990/91			14	92			13 283	
1991/92				5			57	2
1993/94			0	13			12	3
1994/95				10			3 936	
1995/96							5	
1996/97							0	217
1997/98				6				67
1998/99			1	265				73
1999/00				[b]4110				81
2000/01[c]		1		573				930

[a] Reported from Subarea 58.5 – assumed to be caught in Division 58.5.1
[b] From monthly catch and effort reports
[c] Incomplete

Table 2: Catch limits and fishing season for *Champsocephalus gunnari*.

Area	Conservation Measure	Season			Catch Limit (tonnes)
		Start	Closure	End	
Subarea 48.3	8/VI	1987	-	1988	35 000
			1988/89		0
	13/VIII	1989	-	1990	8 000
	20/IX	1990	-	1991	26 000
			1991/92		0
	49/XI	6 Nov 1992	1 Apr 1993 +	31 Mar 1993	9 200
	66/XII	1 Jan 1994	1 Apr 1994 +	31 Mar 1994	9 200
			1994/95		0
	97/XIV	1995	1 Apr 1996 +	31 Mar 1996	1 000
	107/XV	1996	1 May 1997 +	30 Apr 1997	1 300
	123/XVI	1997	1 Apr 1998 +	31 Mar 1998	4 520
	153/XVII	1998	1 Apr–30 Nov 1999	31 Mar 1999	4 840
	175/XVIII	1 Dec 1999	1 Mar–31 May 2000	30 Nov 2000	4 036
	194/XIX	1 Dec 2000	1 Mar–31 May 2001	30 Nov 2001	6 760
Division 58.5.2	110/XV	1996	-	1997	311
	130/XVI	1997	-	1998	900
	159/XVII	1998	-	1999	1 160
	177/XVIII	1 Dec 1999	-	30 Nov 2000	916
	195/XIX	1 Dec 2000	-	30 Nov 2001	1 150

\+ Until the end of the CCAMLR meeting that year

Table 3: Review of Assessment methods for *Champsocephalus gunnari* in Subarea 48.3.

Year	Assessment Method	Reference
2000	Short-term yield calculation based on surveys in January and February 2000.	SC-CAMLR-XIX, Annex 5, paragraphs 4.193 to 4.213
1999	Short-term yield calculation based on UK survey in September 1997.	SC-CAMLR-XVIII, Annex 5, paragraphs 4.166 to 4.173
1998	Short-term yield calculation based on UK survey in September 1997.	SC-CAMLR-XVII, Annex 5, paragraphs 4.162 to 4.163
1997	Survey biomass and age structure used as the basis for short term projections.	SC-CAMLR-XVI, Annex 5, paragraphs 4.179 to 4.182 and 4.199 to 4.208
1996	No new assessment was performed.	SC-CAMLR-XV, Annex 5, paragraphs 4.135
1995	No new assessment was performed.	SC-CAMLR-XIV, Annex 5, paragraphs 5.106 to 5.109
1994	Surveys in 1993/94 indicated significantly lower biomass than predicted by projections made at the 1993 Working Group meeting. Decline in biomass in the absence of fishing may be linked to the low availability of krill in Subarea 48.3 during the 1993/94 season.	SC-CAMLR-XIII, Annex 5, paragraphs 4.78 to 4.83
1993	Extensive re-analysis of VPA and survey estimates of biomass produced a more consistent past series of *C. gunnari* biomass. However for stock projections the 1992 survey was used to estimate 1993/94 biomass between 51 and 396 000 tonnes.	SC-CAMLR-XII, Annex 5, paragraphs 6.30 to 6.54
1992	VPA assessment tuned to survey abundance and CPUE indices in WG-FSA-92/27 and at the meeting gave poor results for most recent years, current abundance estimate provided by 1992 trawl survey.	SC-CAMLR-XI, Annex 5, paragraphs 6.46 to 6.88
1991	VPA assessments tuned to commercial effort and survey abundance indices in WG-FSA-91/27 and 91/15.	SC-CAMLR-X, Annex 6, paragraphs 7.37 to 7.78
1990	VPA assessment tuned to standardised effort was presented in WG-FSA-90/26. Population projections based on biomass estimates from trawl surveys were carried out .	SC-CAMLR-IX, Annex 5, paragraphs 44 to 47
1989	Two VPA assessments were considered, one tuned to the UK/Polish survey estimate of biomass, the other tuned to effort data (see WG-FSA-89/27 and 89/22 Rev 1.).	SC-CAMLR-VIII, Annex 6, paragraphs 90 to 99

Table 4: Review of Assessment methods for *Champsocephalus gunnari* in Division 58.5.2.

Year	Assessment Method	Reference
2000	Short-term yield calculation based on a survey in May 2000.	SC-CAMLR-XIX, Annex 5, paragraphs 4.222 to 4.227
1999	Short-term yield calculation based on Australian survey in April 1998.	SC-CAMLR-XVIII, Annex 5, paragraphs 4.196 to 4.197
1998	Survey in June 1998 and short term yield calculation.	SC-CAMLR-XVII, Annex 5, paragraphs 4.175 to 4.177
1997	WG-FSA-97/29 – short-term projections based on the results from a recent trawl survey in August 1997.	SC-CAMLR-XVI, Annex 5, paragraphs 4.179 to 4.182 and 4.199 to 4.208
1996	No new data or assessment.	SC-CAMLR-XV, Annex 5, paragraphs 4.241 to 4.242
1995	No new data or assessment.	SC-CAMLR-XIV, Annex 5, paragraphs 5.183 to 5.184
1994	Biomass surveys by Australia according to random stratified design and calculated by MVUE. Precautionary catch limits calculated by estimating ? from modified krill yield program.	SC-CAMLR-XIII, Annex 5, paragraphs 4.147 to 4.159

ATTACHMENT A

LIST OF PARTICIPANTS

Workshop on Approaches to the Management of Icefish
(Hobart, Australia, 3 to 5 October 2001)

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ATTACHMENT B

TERMS OF REFERENCE

Workshop on Approaches to the Management of Icefish
(Hobart, Australia, 3 to 5 October 2001)

1. To review the fisheries targeting *Champsocephalus gunnari* in various subareas and divisions, including trends in catches and changes in stock composition in terms of length and age (SC-CAMLR-XVI, paragraph 5.62).

2. To review information on the biology and demography of the species, including age, growth, and reproduction and diet (SC-CAMLR-XVI, paragraph 5.62).

3. To review information on stock identity, distribution and large scale movements (SC-CAMLR-XVI, paragraph 5.62).

4. To review information on smaller-scale (shelf) distribution, movements (horizontal and vertical), segregation by age and size (SC-CAMLR-XIX, Annex 5, paragraph 10.2(iii)).

5. To review estimates of absolute and relative abundance and year-class strength (SC-CAMLR-XVI, Annex 5, paragraph 4.209).

6. To review the historical assessment methods, including short- and long-term methods, and highlight their shortcomings (SC-CAMLR-XVI, Annex 5, paragraph 4.209).

7. To evaluate interactions of *Champsocephalus gunnari* with other components of the ecosystem, including krill and fur seals, to investigate past fluctuations in natural mortality and explore the potential to predict changes in M (SC-CAMLR-XVI, paragraph 4.178).

8. To develop long-term management strategies for the fisheries on *Champsocephalus gunnari* including management under conditions of periodic changes in M (SC-CAMLR-XVI, paragraph 5.62; SC-CAMLR-XIX, Annex 5, paragraph 10.3).

9. To address the question of whether the ecosystem in Subarea 48.3 could support, in the future, a *Champsocephalus gunnari* fishery at the scale experienced at the beginning of the fishery (SC-CAMLR-XIX, Annex 5, paragraph 10.3).

ATTACHMENT C

AGENDA

Workshop on Approaches to the Management of Icefish
(Hobart, Australia, 3 to 5 October 2001)

1. Introduction
   - 1.1 Appointment of Convener
   - 1.2 Appointment of Rapporteurs
   - 1.3 Review of Terms of Reference
   - 1.4 Adoption of the Agenda

2. Presentation of papers

3. Review and characterisation of fisheries
   - 3.1 Brief review and comparison of catch and effort history of the main fisheries

4. Management needs (top-down approach)
   - 4.1 Current management measures
     - 4.1.1 Catch limits
     - 4.1.2 Season length
     - 4.1.3 Closed areas
     - 4.1.4 Fishing methods
     - 4.1.5 Minimum mesh size and fish size
   - 4.2 Information needs for management

5. Review of data
   - 5.1 Biology and demography
     - 5.1.1 Age
     - 5.1.2 Growth
     - 5.1.3 Mortality
     - 5.1.4 Reproduction
     - 5.1.5 Diet
   - 5.2 Stock identity and structure
     - 5.2.1 Large-scale stock identity and movements
     - 5.2.2 Shelf distribution and movements (horizontal and vertical migration, segregation by age and size)
     - 5.2.3 Recruitment and year class strength

6. Ecosystem considerations
   - 6.1 Predator/prey relationships
   - 6.2 Ecosystem changes since the start of the fishery (early 1970s)
   - 6.3 By-catch
   - 6.4 Incidental mortality
   - 6.5 Effects of fishing gear

7. Assessment Methods
   - 7.1 Previous/current CCAMLR assessments
   - 7.2 New methods and modifications to previous/current methods
   - 7.3 Future monitoring
     - 7.3.1 Surveys (frequency, timing, bias)
     - 7.3.2 Experimental fishing

8. Management Procedures
   - 8.1 Management procedures
     - 8.1.1 Short-term versus long-term management
     - 8.1.2 The need for harmonising management across fisheries
   - 8.2 Performance of management procedures under various scenarios
     - 8.2.1 Fluctuations and/or high uncertainty in M
     - 8.2.2 Ecological regime (carrying capacity)
     - 8.2.3 Currency of information
     - 8.2.4 Others?

9. Recommendations of WG-FSA
   - 9.1 Future assessment
   - 9.2 Future management

10. Adoption of the report

11. Close of the workshop.

ATTACHMENT D

LIST OF DOCUMENTS

Workshop on Approaches to the Management of Icefish
(Hobart, Australia, 3 to 5 October 2001)

WAMI-01/1	Provisional Annotated Agenda for the CCAMLR Workshop on Approaches to the Management of Icefish
WAMI-01/2	List of participants
WAMI-01/3	List of documents
WAMI-01/4	The fishery for *Champsocephalus gunnari* and its biology at Heard Island (Division 58.5.2) R. Williams, E. van Wijk, A. Constable and T. Lamb (Australia)
WAMI-01/5	Acoustic assessment of potential bias in abundance estimates of mackerel icefish from trawl surveys E. van Wijk, T. Pauly, A. Constable and R. Williams (Australia)
WAMI-01/6	Some thoughts of mackerel icefish distribution in connection with krill distribution S.M. Kasatkina, Zh.A. Frolkina, A.P. Malyshko and V.A. Senioukov (Russia) (*CCAMLR Science*, submitted)
WAMI-01/7	On assessment of instantaneous natural mortality rate of mackerel icefish (*Champsocephalus gunnari*) from South Georgia subarea Zh.A. Frolkina, R.S. Dorovskikh (Russia)
WAMI-01/8	Possible causes of variation of *Champsocephalus gunnari* vertical and horizontal distribution Zh.A. Frolkina and S.M. Kasatkina (Russia) (*CCAMLR Science*, submitted)
WAMI-01/9	Proposals for improvement of census surveys for mackerel icefish quantitative assessment – design of acoustic trawling survey in Subarea 48.3 S.M. Kasatkina, Zh.A. Frolkina and P.S. Gasyukov (Russia)
WAMI-01/10 Rev. 1	Notes on *Champsocephalus gunnari* biology, availability, diet and spatial distribution in the South Shetland and South Orkney Islands (Subareas 48.1 and 48.2) C.D. Jones and J. Emery (USA)

WAMI-01/11	Occurrence by-catch juvenile *Champsocephalus gunnari* under krill fishing in Subarea 48.2 in May to July 1999 V.A. Bibik and L.K. Pshenichnov (Ukraine)
WAMI-01/12	Estimation of relative fishing power of vessels carried out bottom trawl survey off South Georgia P.S. Gasyukov (Russia)
WAMI-01/13	Biological reference points for *C. gunnari* based on the stock assessment with integrated statistic methods (XSA) P.S. Gasyukov and R.S. Dorovskikh (Russia)
WAMI-01/14	Assessments of mackerel icefish I. Everson (United Kingdom), S. Kasatkina (Russia), C. Goss and M. Belchier (United Kingdom)
WAMI-01/15 Rev. 1	Icefish fishery information Secretariat
WAMI-01/16	Distribution of mackerel icefish by size-group at South Georgia A.W. North and I. Everson (United Kingdom)

Other Documents

WG-FSA-01/30	Preliminary analysis of seabird by-catch in the South Georgia icefish fishery D.J. Agnew, N. Ansell and J.P. Croxall (United Kingdom)

ATTACHMENT E

BIBLIOGRAPHY ON *CHAMPSOCEPHALUS GUNNARI*

BIBLIOGRAPHY ON *CHAMPSOCEPHALUS GUNNARI*

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APPENDIX E

REVISED DRAFT FISHERY PLAN FOR THE ICEFISH FISHERY IN SUBAREA 48.3

REVISED DRAFT FISHERY PLAN FOR THE ICEFISH FISHERY IN SUBAREA 48.3

CCAMLR Fishery Plan – Draft			Closed Fisheries
Fishery details — Species:	**Icefish (*Champsocephalus gunnari*)**		
Area, subarea or division, or subdivision:	**Subarea 48.3**		
Gear types:	**Midwater trawl**		
	CCAMLR Season		
	1999/2000	2000/2001 (expectations)	
Conservation measure adopted?	175/XVIII	194/XIX	
1. Harvest Controls			na
Closed areas	None	None	
Open and/or closed seasons	Mid-season closure 1 Mar–31 May 00	Mid-season closure 1 Mar–31 May 01	
Total allowable catch	4 036 t	6 760 t	
Effort limitation (no. of vessels, Member States etc.)	None	None	
Fish size limits	None	None	
By-catch limits:			
Target species	Yes – see CM 175	Yes – see CM 194	
Other finfish species	Yes – see CM 95	Yes – see CM 95	
2. Data Reporting Requirements (as requested in conservation measures)			
Catch and Effort Reporting System			
5-day reporting period (CM 51/XIX)	Yes	Yes	
10-day reporting period (CM 61/XII)	No	No	
Monthly reporting period (CM 40/X)	No	No	
Fine-scale Data			
Catch and effort data (CM 122/XIX)	Yes	Yes	
Biological data (CM 121/XIX)	Yes	Yes	
Other data			
STATLANT data	Yes	Yes	
Scientific observer data	Yes	Yes	
Data collection plan	CM 51, 121, 122 and observers	CM 51, 121, 122 and observers	
Research plan	None	None	
Fishery operations plan	None	None	
Other Data	None	None	
2a. Scientific Observer Requirements			
International CCAMLR scientific observer requirements	Yes	Yes	
Other observer requirements	None	None	
Any other provisions (specify)	None	None	
3. Notification Requirements			
Notification required?	None	None	
Notification deadline	None	None	
Notifications received by CCAMLR	None	None	
Notification preferences			
(i) Research and fishery operations plan The nature of the proposed fishery including target species, methods of fishing, proposed region.	None	None	

Any minimum level of catches that would be required to develop a viable fishery. Biological information from comprehensive research/survey cruises, such as distribution, abundance, demographic data and information on stock identity. Details of dependent and associated species and the likelihood of them being affected by the proposed fishery. Information from other fisheries in the region or similar fisheries elsewhere that may assist in the valuation of potential yield. Other requirements (specify)? (ii) Limits on fishing capacity and effort. (iii) The name, type, size, registration number and radio call sign of each vessel participating. (iv) Other notification preferences (specify)?	None Required None	None Required None	
4. Data Collection Plan (in addition to standard CCAMLR reporting requirements) Data collection plan required/prepared? Data collection plan contents A description of the catch, effort and related biological, ecological and environmental data required to undertake an evaluation of the status and potential of the fishery, in accordance with Article II. A plan for directing fishing effort during the exploratory phase. An evaluation of the time scales involved in determining the responses of harvested, dependent and related populations to fishing activities.	None None	None None	
5. Fishing Activity Total allowable catch Total reported catch No. of vessels Days fished Period of season Major by-catch species	4 036 t (Catch and effort reports) 4 110 t (STATLANT data) 2 70 vessel.days 1 Dec 99–1 Feb 00 Myctophidae 67 t	6 760 t (Catch and effort reports to 2 Oct) 1 427 t (STATLANT data) 5 113 vessel.days 1 Dec 00–28 Feb 01, 1 Jun 00+ *Pseudochaenichthys georgianus* 7 t	
6. Data Reported to CCAMLR 5-day catch and effort reports Catch data by fine-scale rectangle or smaller rectangle Effort data by fine-scale rectangle or smaller rectangle Haul-by-haul catch and effort data Biological data by fine-scale rectangle or smaller rectangle Observer data STATLANT data	• Reported by all Contracting Parties • Haul-by-haul (see below) • Haul-by-haul (see below) • Reported by all Contracting Parties • Usually reported by observers • All fishing trips • Yes		
7. Assessment Research need for assessment Most recent assessment performed? Method of discounting for lapse since last assessment	Pre-recruit survey (conducted in 1999) WG-FSA-99 None	Pre-recruit survey (conducted in 2000) WG-FSA-2000 None	

APPENDIX F

INTERSESSIONAL WORK PLAN FOR
AD HOC WG-IMALF FOR 2001/02

INTERSESSIONAL WORK PLAN FOR AD HOC WG-IMALF FOR 2001/02

The Secretariat will coordinate the intersessional work of the IMALF group. An interim review of work will be conducted in June 2002 and advised to ad hoc WG-IMALF at the time of WG-EMM (July 2002). The outcome of the intersessional work will be reviewed in August/September 2002 and reported to WG-FSA in October 2002.

[1] In addition to Science Officer

	Task/Topic	Paragraphs of WG-FSA Report	Action[1]	Start/ Completion Deadlines	Action
1.	**Planning and coordination of work:**				
1.1	Circulate materials on IMALF matters as contained in reports of current meetings of CCAMLR.	Standing request		Dec 2001	Circulate all relevant sections of CCAMLR-XX to IMALF group members, and technical coordinators and (via them) to scientific observers.
1.2	Circulate papers submitted to WG-FSA on IMALF matters.	Standing request		Dec 2001	Circulate the list of papers submitted to WG-FSA on IMALF matters and advise that copies of papers may be provided on request. Circulate the papers requested.
1.3	Acknowledge work of technical coordinators and scientific observers.	Standing request		Dec 2001	Commend technical coordinators and all observers for their efforts in the 2000/01 fishing season.
1.4	Review new and exploratory fishery notifications.	Standing request	B. Baker (Australia)	At submission deadline	Transmit hard copies of notifications to Mr Baker to prepare initial draft of IMALF table.
1.5	Membership of WG-IMALF.	7.7	Members	Nov 2001/ as required	Request nomination of new members to IMALF as required. Request all Members to send their representatives to the next IMALF meeting.
1.6	Educate and train fishing companies and fishers on issues of incidental mortality of seabirds.	Standing request (see also 7.194)	Technical coordinators	Dec 2001/ Aug 2002	Urge Members to improve education and training of fishers on issues of incidental mortality of seabirds via technical coordinators; report to IMALF-2002.
1.7	Protect observers on board vessels against adverse weather conditions.	Standing request	Technical coordinators	Dec 2001	Request technical coordinators to ask vessel owners and captains to provide as much protection as possible for observers against adverse weather conditions.
1.8	Awareness of CCAMLR conservation measures in force.	Standing request	Technical coordinators	Dec 2001/ Aug 2002	Request feedback information from technical coordinators.
1.9	Feedback from scientific observers on the book *Identification of Seabirds of the Southern Ocean*.	Standing request	Technical coordinators	Dec 2001/ Sep 2002	Request feedback, incorporate questions into revised observer reports, collate responses for IMALF-2002.

	Task/Topic	Paragraphs of WG-FSA Report	Action[1]	Start/ Completion Deadlines	Action
1.10	Submission of scientific observers data from the 2001/02 fisheries.	Standing request	Technical coordinators	Dec 2001/ as required	Liaise with technical coordinators, as necessary, on data submission for the 2001/02 season.
2.	**Members' research and development activities:**				
2.1	Update information on national research programs into status and foraging ecology of albatrosses, giant petrels and white-chinned petrels.	7.9	Members, IMALF members, Dr Fanta (Brazil)	Jul–Sep 2002	Use existing standard format for this submission.
2.2	Produce detailed data on albatross and petrel population and foraging range studies.	7.11, 7.14	Members, IMALF members	Nov 2001/ Sep 2002	Use format developed in 2001. Dr Gales/Science Officer to coordinate and report to IMALF-2002.
2.3	Report research on genetic profiles of albatrosses, giant petrels and white-chinned petrels.	7.23	Members, IMALF members	Nov 2001/ Sep 2002	Request IMALF members in Australia, New Zealand, South Africa, France, UK to assist in provision of information. Request information from SCAR members via the SCAR EVOLANTA website.
2.4	Number and nature of by-catch specimens and samples.	7.26	Technical coordinators, nominated scientists	Nov 2001/ Sep 2002	Science Officer/SODA/Dr Gales to specify details of request and collate responses.
2.5	Risk assessment of seabird by-catch in the Convention Area. (Undertake full assessment for Subarea 48.5.)	Standing request	IMALF members	Nov 2001/ Sep 2002	Further work as appropriate to update SC-CAMLR-XX/BG/11 for the Scientific Committee. Circulate any new tabled papers relating to seabird at-sea distributions to Mr Baker, Prof. Croxall and Dr Gales – and to other WG-IMALF members as requested.

	Task/Topic	Paragraphs of WG-FSA Report	Action[1]	Start/ Completion Deadlines	Action
2.6	Information on the development and use of fisheries-related methods of the avoidance of incidental mortality of seabirds. In particular, information is sought on the following: • seabird capture rates in relation to artificial bait, snoodline and mainline colour, bait depth and sink rates; • optimum configuration of line-weighting regimes and equipment; • automated methods for adding and removing weights to and from the line; • line-setting devices for autoline vessels; and • underwater longline setting devices.	Standing request (see 7.180)	Members, IMALF members, Technical coordinators	Nov 2001/ Sep 2002	Request information, collate responses for IMALF-2002.
2.7	Feasibility of using video recording of line hauling operations for observations on seabird incidental catch.	Standing request (see 7.100–7.103)	Technical coordinators	Nov 2001/ Sep 2002	Request reports, collate responses for IMALF-2002.
2.8	Tests of/experiences with paired streamer lines and boom-and-bridle arrangements.	7.163, 7.164	USA; New Zealand; Members	Sep 2002	Report to IMALF-2002
2.9	Investigate light-level definition devices.		Members	Sep 2002	Report to IMALF-2002.
2.10	Line-weighting experiments on autoliners.	7.180	South Africa; New Zealand; other Members as appropriate	Sep 2002	Report to IMALF-2002.
2.11	Line-weighting requirements for autoliners.	SC-XX 4.45	IMALF members	Oct 2002	Consider incorporation into Conservation Measure 29/XIX at IMALF-2002.
2.12	Experiences with revised requirements for line weighting for Spanish system vessels.		Members	Sep 2002	Report to IMALF-2002.
2.13	Experimental research to test effectiveness of mitigation measures in Spanish system vessels.	7.187, 7.188, SC-XX 4.63, CC-XX 6.26	Appropriate IMALF scientists, Members	By Oct 2002, if possible	Report to IMALF-2002
2.14	Experiences with the bottle test method of monitoring line sink rate.	7.182, 7.183	Technical coordinators	Sep 2002	Request information, collate responses for IMALF-2002.

	Task/Topic	Paragraphs of WG-FSA Report	Action[1]	Start/ Completion Deadlines	Action
2.15	Information on measures for mitigating incidental seabird mortality in trawl fisheries, especially for icefish in Subarea 48.3.	8.17, 8.21, 8.26	New Zealand; other Members as appropriate	Nov 2001/ Sep 2002	Report to IMALF-2002 Obtain current information from New Zealand, circulate to technical coordinators. Collate responses for IMALF-2002.
3.	**Information from outside the Convention Area:**				
3.1	Information on longline fishing effort in the Southern Ocean to the north of the Convention Area.	Standing request (see also 7.153, 7.158, 7.214–7.216)	Members, non-Contracting Parties, international organisations	Sep 2002	Request information intersessionally from those Members known to be licensing fishing vessels in areas adjacent to CCAMLR (e.g. Argentina, Brazil, Chile, UK [in respect of Falkland/Malvinas Islands and Tristan da Cunha], South Africa, Uruguay, New Zealand, Australia); review situation at IMALF-2002. Request information from other parties (Members and non-Contracting Parties (e.g. Republic of Korea, Taiwan, Japan, China); international organisations (e.g. CCSBT, ICCAT, IOTC)) known to be fishing, or collecting data on fishing in areas adjacent to the Convention Area.
3.2	Summarise existing information already circulated to the working group.	7.159	IMALF members	Sep 2002	Science Officer to prepare and circulate list of previously tabled papers. IMALF members to discuss how to progress.
3.3	Information on incidental mortality outside the Convention Area of seabirds breeding within the area.	Standing request (see also 7.169)	IMALF members	Sep 2002	Repeat request to all IMALF members, especially to those mentioned under item 3.1 above; review at IMALF 2002.
3.4	Reports on use and effectiveness of mitigating measures outside the Convention Area.	Standing request (see also 7.158)	Members, non-Contracting Parties, int. organisations	Sep 2002	Request information on use/implementation of mitigating measures, especially provisions in Conservation Measure 29/XIX, as under item 3.1 above; review responses at IMALF-2002.
3.5	Reports on nature of observer programs, including observer coverage.	7.158	Members, non-Contracting Parties, international organisations	Sep 2002	Request information intersessionally from those Members known to be licensing fishing vessels in areas adjacent to CCAMLR (e.g. Argentina, Brazil, Chile, UK [in respect of Falkland/Malvinas Islands and Tristan da Cunha], South Africa, Uruguay, New Zealand, Australia); review situation at IMALF-2002. Request information from other parties (Members and non-Contracting Parties (e.g. Republic of Korea, Taiwan, Japan, China); international organisations (e.g. CCSBT, ICCAT, IOTC)) known to be fishing, or collecting data on fishing in areas adjacent to the Convention Area.

	Task/Topic	Paragraphs of WG-FSA Report	Action[1]	Start/ Completion Deadlines	Action
3.6	Request information on the current requirements for the use of measures to mitigate by-catch of seabirds on Japanese longline fishing vessels.	7.157, 7.213, SC-XIX 4.35		Sep 2002	Request again specific information from Japan.
4.	**Cooperation with international organisations:**				
4.1	Participation at the 2002 meeting of CCSBT-ERSWG; invite CCSBT to attend WG-FSA.	Standing request	CCSBT Secretariat	As required	Invite and nominate observers as decided by the Scientific Committee.
4.2	Cooperation with ICCAT and IOTC on specific issues regarding incidental mortality of seabirds.	Standing request	CCAMLR observers	Nov 2001/ Sep 2002	Brief CCAMLR observers on desired feedback on IMALF matters (seabird by-catch levels and mitigating measures).
4.3	Input to ICCAT agenda.	New request 7.215, CC-XX 6.31	IMALF members, EC	Nov 2001/ May 2002	Prepare background document for ICCAT.
4.4	Collaboration and interaction with all tuna commissions and regional fishery management organisations with responsibility for fisheries in areas where Convention Area seabirds are killed.	7.214–7.216 SC-XX 4.74, CC-XX 6.30, 6.33	Members, CCAMLR observers	Nov 2001 and at specific meetings	Request information on: (i) existing data on levels of seabird by-catch; (ii) mitigating measures currently in use and whether voluntary or mandatory; and (iii) nature and coverage of observer program. Support regulations for use of mitigating measures at least as effective as Conservation Measure 29/XIX.
4.5	Progress with National Plans of Action in respect of FAO IPOA–Seabirds.	7.206, SC-XX 4.65, CC-XX 6.27	Relevant members, IMALF members	By Oct 2002	Solicit reports to CCAMLR on progress for information and make review.
4.6	Assist Japan in improving its NPOA and use of mitigating measures.	SC-XX 4.58, 4.66, CC-XX 6.29	Members, IMALF	As soon as possible	Discuss progress at IMALF-2002.
4.7	International Fishers' Forum	7.194	Members	As feasible	Disseminate information on forum to fishers.
4.8	IUCN Red List: Seabirds		Secretariat	Jan 2002 onwards	Obtain from BirdLife International, circulate to IMALF members and table for SC-CAMLR-XXI, any proposals for revision to the conservation status of albatross, *Macronectes* and *Procellaria* species.
4.9	South American Regional Workshop	7.200		Dec 2001/ Sep 2002	Request report of meeting from BirdLife International and circulate to IMALF.

	Task/Topic	Paragraphs of WG-FSA Report	Action[1]	Start/ Completion Deadlines	Action
4.10	BirdLife International	7.202		Nov 2001/ Sep 2002	Request information from BirdLife International about its activities, in particular its 'Save the Albatross Campaign'.
5.	**Data acquisition and analysis:**				
5.1	Preliminary analyses of data from the current fishing season.	Standing request	Technical coordinators	Sep–Oct 2002	Standing request: summarise and analyse current year data at a level adequate to undertake a preliminary assessment at IMALF-2002.
5.2	Acquisition from EEZs and elsewhere as appropriate, of seabird incidental mortality data for trawl fisheries.	Standing request (see 8.23)	Members (France)	Nov 2001/ Sep 2002	Request Members for appropriate data.
5.3	Acquisition of original data on seabird incidental mortality for French EEZs in Subarea 58.6 and Division 58.5.1 for 1999, 2000, 2001 and 2002.	7.65	France	Sep 2002	Request France to submit reports and data logbooks prepared by national observers for the current and past fishing seasons.
5.4	Analysis of seabird incidental mortality data for EEZ in Subareas 58.6/58.7.	Standing request	South Africa	Nov 2001/ Sep 2002	Request South Africa to undertake analysis and report to IMALF-2002.
6.	**Scientific observer issues:**				
6.1	Preliminary analysis of data from 2001/02 fisheries.	Standing request	SODA	IMALF meeting	Produce draft tables equivalent to Tables 51 to 59 and 64 of the FSA-2001 report.
6.2	Review codes for seabird species.	?	IMALF members	Apr 2002	Secretariat to provide revised list, using updated FAO codes and indicate any anomalies and/or species requiring codes.
6.3	Review and revise instructions in manual and address identified issues.	7.93–7.96, 8.20		Nov 2001	Report, as necessary, to IMALF-2002.
7.	**Revision of Conservation Measure 29/XIX**	SC-XX 4.60	IMALF		Review at IMALF-2002

APPENDIX G

LINE SINK RATE MONITORING

LINE SINK RATE MONITORING

This protocol, which is intended to replace or supplement that in Annex A to Conservation Measure 210/XIX, relates to the use of line weighting to achieve a sink rate of at least 0.3 m/s.

2. Paragraph 3 of Conservation Measure 29/XIX shall not apply only where a vessel can each year demonstrate prior to participating in the fishery its ability to comply fully with the following protocol, observed by a scientific observer:

(i) set a minimum of five longlines of the maximum length to be used in the Convention Area with a minimum of four bottle tests on the middle one-third of the longline;

(ii) randomise bottle test placement on the longline within and between sets, noting that all tests should be applied half way between weights;

(iii) calculate an individual sink rate for each bottle test, where the sink rate shall be measured as the time taken for the longline to sink from the surface (0 m) to 15 m;

(iv) this sink rate shall be at a minimum rate of 0.3 m/s;

(v) if the minimum sink rate is not achieved at all 20 sample points (four tests on five lines), continue testing until such time as a total of 20 tests with a minimum sink rate of 0.3 m/s are recorded; and

(vi) all equipment and fishing gear used in the tests is to be to the same specifications as that to be used in the Convention Area.

3. During fishing, for a vessel to maintain the exemption to paragraph 3 of Conservation Measure 29/XIX, regular line sink rate monitoring shall be undertaken by the CCAMLR scientific observer. The vessel shall cooperate with the CCAMLR observer who shall:

(i) aim to conduct a bottle test on every longline set during the observer’s shift, noting that the test should be undertaken on the middle one-third of the line;

(ii) every seven days place at least four bottle tests on a single longline to determine any sink rate variation along the line;

(iii) randomise bottle test placement on the longline within and between sets, noting that all tests should be applied half way between weights;

(iv) calculate an individual sink rate for each bottle test; and

(v) measure the line sink rate as the time taken for the line to sink from the surface (0 m) to 15 m.

4. The vessel shall whilst operating under this exemption:

(i) ensure that their longline is weighted to achieve a minimum line sink rate of 0.3 m/s at all times;

(ii) report daily to their national agency on their achievement of this target; and

(iii) ensure that data collected from line sink rate monitoring are recorded in the approved format and submitted to the relevant national agency at the conclusion of the season.

5. A bottle test is to be conducted as described below.

Bottle Set Up

6. 15 metres of 2 mm multifilament nylon snood twine, or equivalent, is securely attached to the neck of a 750 ml plastic bottle[1] (buoyancy about 0.7 kg) with a longline clip attached to the other end (see WG-FSA-01/46, Figure 1). The length measurement is taken from the attachment point (terminal end of the clip) to the neck of the bottle, and should be checked by the observer every few days.

7. Reflective tape should be wrapped around the bottle to allow it to be observed at night. A piece of waterproof paper with a unique identifying number large enough to be read from a few metres away should be placed inside the bottle.

Test

8. The bottle is emptied of water, the stopper is left open and the twine is wrapped around the body of the bottle for setting. The bottle with the encircled twine is attached to the longline[2], midway between weights.

9. The observer records the time at which the bottle enters the water as t_1 in seconds. The time at which the bottle is observed to be pulled completely under is recorded as t_2 in seconds[3]. The result of the test is calculated as follows:

Line sink rate = $15 / (t_2 - t_1)$

10. The result should be equal to or greater than 0.3 m/s. These data are to be recorded in the space provided in the electronic observer logbook.

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[1] A plastic water bottle that has a hard plastic screw-on 'stopper' is needed. The stopper of the bottle is left open so that the bottle will fill with water after being pulled under water. This allows the plastic bottle to be re-used rather than being crushed by water pressure.

[2] On autolines attach to the backbone; on the Spanish longline system attach to the hookline.

[3] Binoculars will make this process easier to view, especially in foul weather.

APPENDIX H

REPORT OF THE WORKSHOP ON ESTIMATING AGE IN PATAGONIAN TOOTHFISH

(Center for Quantitative Fisheries Ecology, Old Dominion University, Norfolk, Va., USA, 23 to 27 July 2001)

CONTENTS

REPORT OF THE WORKSHOP ON ESTIMATING AGE IN PATAGONIAN TOOTHFISH

(Center for Quantitative Fisheries Ecology, Old Dominion University, Norfolk, Va., USA, 23 to 27 July 2001)

INTRODUCTION

1.1 The Workshop on Estimating Age in Patagonian Toothfish was held at the Center for Quantitative Fisheries Ecology (CQFE), Old Dominion University, Norfolk, Va., USA, from 23 to 27 July 2001. The workshop was chaired by Dr I. Everson (UK) and attended by 17 participants. The list of participants is given in Attachment 1. Local arrangements for the meeting had been made by Dr J. Ashford (USA).

1.2 Dr Cynthia Jones (CQFE) welcomed participants to the workshop. She noted that, unlike in other branches of ecology, it was possible to determine the age of individual fish over time scales of days to years. This ability had influenced the development of fisheries models such that accurate and precise age determinations were now normal requirements for population assessments. The importance and value of Patagonian toothfish (*Dissostichus eleginoides)* internationally placed a high priority on achieving consensus on the best methods for age determination and she looked forward to a successful meeting.

1.3 The requirement for the meeting had been foreshadowed during the 2000 meeting of the Working Group on Fish Stock Assessment (WG-FSA-2000) when it was noted that some differences were present in the growth parameters being used for assessments of *D. eleginoides*. Dr Everson had been invited to contact all those undertaking age determination of *D. eleginoides* in order to determine whether these differences were real or else due to methods of otolith preparation and reading. Through SC CIRC 00/21 he had contacted colleagues interested in this research and they had agreed to participate in an otolith exchange project. They had also agreed to come together at a workshop whose primary aim would be to seek conformity in estimating the age of *D. eleginoides*, if such a meeting could be arranged. Although there is growing interest in age determination of other species, in particular *D. mawsoni*, it had been agreed by those who had responded to SC CIRC 00/21 that the primary aim should be to concentrate on the one species *D. eleginoides*.

1.4 In summary form, the main objectives for the workshop had been to consider and advise WG-FSA on:

(i) otolith collection protocols;
(ii) otolith preparation protocols;
(iii) agreed definitions of otolith structures used for age determination;
(iv) quality control and quality assurance; and
(v) validation.

1.5 In recent years there has been coordination of work on fish otoliths through the European Fish Ageing Network (EFAN) that had resulted in a series of reports. These reports were accessed through the EFAN website (www.efan.no) to provide background guidance in setting up the workshop and this was gratefully acknowledged.

1.6 Drs Ashford and Everson had developed an agenda and work plan that had been circulated just prior to the meeting and these were discussed by the workshop. In addition to topics directly concerned with the use of otoliths for age determination, it was agreed that it would be appropriate to include time for discussion on information from otoliths which might be used to improve knowledge of toothfish ecology. With this modification the agenda was adopted (Attachment 2).

1.7 The report of the meeting was prepared by all participants and collated by Dr Everson.

BACKGROUND INFORMATION ON *D. ELEGINOIDES*

2.1 High-quality age and growth information is critical to the accurate assessment of *D. eleginoides* stocks in the Southern Ocean. The techniques of estimating age and growth patterns for *D. eleginoides* from otoliths are influenced by a number of factors, including sampling regimes, preparation techniques, reader experience and analytical approaches. Thus, the age determination methodologies are heavily dependent on the specific laboratory and principal investigator. The goal of this workshop was to bring together scientists and provide a forum for exchange of ideas and insight into various techniques and methodologies related to age determination of *D. eleginoides* from otoliths. In addition, this workshop was structured to demonstrate age estimation methodologies for individuals who are considering using these techniques in different institutes, and to encourage collaborative efforts between interested scientists.

2.2 Currently used assessment techniques of *D. eleginoides* stocks rely heavily on age and growth information. For example, in recent assessments length-frequency data from trawl surveys have been analysed using mixture analysis in order to generate estimates of recruitment to the population of *D. eleginoides*. Length-at-age relationships are used as a guide for setting the initial conditions necessary to identify the number of cohorts present, as well as their mean lengths. During the 2000 meeting of WG-FSA, von Bertalanffy growth parameters (L_8, k and t_0) for the mixture analysis and general yield model (GYM) were based on several sources of age and growth information from several laboratories. For example, growth parameters for stocks around South Georgia were based on values estimated by combining the lengths at age from two sources: otoliths collected in the UK survey around South Georgia in January and February 1991; and an age–length key from readings of scales taken from the commercial longline fishery during February to May 1991. Other estimates of growth parameters were available, though the values were sometimes quite different depending on the study. WG-FSA was very concerned by the variability and uncertainties within and between these sets of growth parameters, and stressed that work to refine and validate age determination methods was a high priority. Further, WG-FSA had encouraged introduction, progress, and testing of alternative age-structured models for future assessments of *D. eleginoides*. Thus it is critical that age estimation techniques be refined to improve the quality of these assessments.

2.3 It was noted that the preparation and reading of otoliths was only one part of a continuum in the process of providing information on the age of individuals for stock assessments. In the first instance it was essential to decide on the purpose for which age determination was required. This should be used to indicate the number of otoliths which would need to be read, as well as optimal sampling protocols. Information from previous work would provide an indication of the likely precision associated with a given sample size. This and other information should be used in a 'feedback' system in order to determine the most cost-effective sampling and analysis program consistent with the aims of the study.

RESULTS OF THE OTOLITH EXCHANGE PROJECT

3.1 The three main laboratories engaged in age determination *D. eleginoides* had participated in the study. These were: National Institute of Water and Atmospheric Research, Nelson, New Zealand (NIWA), local coordinator Mr P. Horn; Central Ageing Facility, Victoria, Australia (CAF), local coordinator Dr K. Krusic-Golub; and CQFE, local coordinator Dr Ashford.

3.2 It is the practice at each of these centres for otolith readers to be given no more information than the date and location of capture of individual fish. No information is given to the reader of the size of the fish.

3.3 Otoliths for the study had been sent initially to Dr Everson and he, in conjunction with Dr M. Belchier (UK) had arranged for the circulation of samples and collation of results. Samples had been received and read twice, independently and separated in time by one week, by Mr Horn, Drs Krusic-Golub, Ashford, S. Wischniowski (CQFE) and E. Larson (CQFE). The CAF and NIWA otolith preparations were brought to the workshop.

3.4 Results from the independent age estimation were discussed. Whilst there was reasonably good agreement between readings on some otolith preparations, for others there was a significant disparity. The workshop noted that it is important to recall the differences in otolith preparation methods, discussed latter, that are in use at the different institutes. The otolith preparations were being read and interpreted by researchers closely familiar with their own laboratory's methods, but largely unfamiliar with those used elsewhere.

3.5 The results from the otolith exchange were used for two main purposes: firstly to indicate the level of precision present in independent estimates of age and secondly to highlight individual specimens that might be used to indicate both good and unclear examples of annuli. These topics were considered more fully under latter agenda items.

READING AGES FROM SAMPLES

4.1 The workshop received descriptions of the techniques in use at CQFE (from Dr Ashford), NIWA (from Mr Horn) and CAF (from Dr Krusic-Golub). In all of these it was emphasised that reading otoliths utilises skills in pattern recognition that had been developed over a significant period of time. Whilst for some fish, such as black drum (*Pogonias cromis*), examples of which were shown to participants, the pattern of otolith growth follows a regular pattern which can be understood with reasonable ease, this is not the case with *D. eleginoides* otoliths. Growth in whole *D. eleginoides* otoliths follows complex patterns that include many crenulations and spikes as shown in Figure 1. Arising from this, it is extremely difficult to prepare a section in one plane that displayed all annuli, in a clear manner but without artefacts. This means that the reader must have in mind the three-dimensional structure of the otolith in order to take account of annuli and be able to distinguish these from false checks.

4.2 Mr Horn described the otolith reading technique in use at NIWA for *D. eleginoides* otoliths collected from the southern New Zealand Exclusive Economic Zone and Subarea 88.1. He noted that some aspects of the interpretation may not apply to otoliths collected from other areas.

4.3 An example otolith preparation is shown in Figure 2. The number of complete translucent zones is counted. Zone counts are generally made on the ventral part of the section, either on the proximal surface adjacent to the sulcus or else along the dorso-ventral axis. However, all areas of the section are examined to find the area where the zonation pattern is clearest. Sometimes the count is started near to the sulcus, but finished in some other area of the proximal surface; counts in the two areas are linked by tracing a clear and continuous zone across the section.

4.4 The clarity of the zonation pattern varied considerably between otoliths. Examination of a number of otoliths in which the zonation was relatively clear indicated that many had an exceptionally dark fourth zone. Sometimes this darker zone occurred at the third or fifth zone. Measurements from the primordium to the longest axis of the first and third zones (on the ventral part of the section) were approximately 1.2 and 1.9 mm respectively. Interpretation of the first three to five growth zones was often complicated because of an abundance of what were considered to be false rings. However, the dark zone was also generally apparent in these otoliths and this band could be used as a boundary inside which the false rings could usually be subjectively, but logically, grouped into three (but sometimes two or four) multi-banded zones. The approximate measurements made on clear otoliths to the first and third zones were also used to help to indicate the likely position of these zones in otoliths with apparent multi-banding. Zones outside the dark growth zone were generally narrow and regular in width, but sometimes a region of transition was apparent outside the darkest zone where consecutive annuli became increasingly narrow before becoming regular in width. Also split zones were sometimes apparent in the area outside the dark zone. A zone was considered to be split if two opaque bands merged to form a single clear zone in any part of the section between the sulcus and ventral margin on the proximal side of the otolith.

4.5 Dr Krusic-Golub described the otolith reading technique in use at CAF for *D. eleginoides* otoliths. An example otolith preparation is shown in Figure 3. All sections of each row of otoliths are inspected and the section showing the clearest annuli is used for age estimation. This is generally, but not always, the section closest to the primordium. Estimation of age is made using the area of the otolith section in which annuli can be counted most clearly and consistently. Generally the sector from the primordium to the proximal edge of the section, on the ventral side of the sulcus is used. However for some preparations, increments formed on the dorsal side are at least as clear as those on the ventral side.

4.6 Under transmitted light, otolith sections are predominantly opaque especially near the nucleus. The first two to seven increments are generally broader and more opaque than the later increments. A transition period has been observed between the ages of 3 to 9. This transition period is recognised as a point of sudden change in increment width, however in some sections the transition from wide to narrow is gradual rather than sudden. Interpretation of the first three to five annuli is often difficult due to the presence of fine checks that are considered to be subannual. Generally these checks are irregularly spaced and are not continuous throughout the section. Zones after this period become far more regular in width and appearance and the annuli are easier to interpret.

4.7 Dr Ashford described the otolith reading technique in use at CQFE for *D. eleginoides*. An example otolith preparation is shown in Figure 4. The count path followed the large annuli along the dorsal axis, moving to the regular annuli along the proximal dorsal axis as the dorsal axis became compressed. Structures occurred at different scales in all regions: in the regular region, the narrowest annuli were considered annual as long as they persisted clearly either side of the count path. Marks or structures that did not persist far to either side of the count path or occurred irregularly at a lower scale were considered false checks. In the region of large annuli, it was more difficult to distinguish between annuli and checks: annuli are considered to be larger, have stronger contrast between opaque and translucent zones, and to persist either side of the count path notably into the compressed medial region. Checks tend to be confined to one region, particularly the proximo-ventral, or vary considerably in clarity between regions. Evidence of splitting was particularly clear in the distal dorsal area, a single translucent zone running along the distal side in contrast to a translucent zone with associated check running along the proximal side. In the nucleus, a discontinuity was observed running diagonally between the core and the dorsal protrusion. The edge of the nucleus was defined as the inner border of the first translucent zone, which was typically clearer than the succeeding translucent zones. As the hatch date of *D. eleginoides* is not known, the nucleus may not represent a full year's growth, so the outer edge of the nucleus was considered as time 0. The birthday of all fish was taken to be 1 July, so that the annulus was counted if the fish was taken after 1 July but not if taken before.

4.8 The workshop thanked Mr Horn, Dr Krusic-Golub and Dr Ashford for their presentations.

4.9 It was noted that otolith preparations had been examined under reflected light (CQFE and NIWA) and transmitted light (CAF). This difference was due to the current practice in the respective laboratories. The workshop agreed that such a difference would be very unlikely to introduce bias into the results. Since the appearance of the translucent and opaque zones of the otolith to the reader is strongly dependent on the form of illumination and to avoid confusion in the interpretation of results, the workshop agreed the definitions of the zones as set out in Table 1.

4.10 The occurrence of split zones or checks had been noted by the three primary readers. This characteristic is illustrated in Figure 5. Otoliths believed to contain split zones were examined and each reader described which zones they considered to be split and why. There was a general agreement on what constitutes a split zone. Any pattern of split zones was generally consistent between the dorsal and ventral sides of the section. It was concluded that the three readers interpreted split zones similarly.

4.11 It was acknowledged that, on occasions, it will be difficult to determine whether an area of predominantly translucent material constitutes a single split annulus or two distinct annuli. In such a situation it was resolved that if the problem area occurred in the first eight years of life, then it should be considered a split annulus, and if it occurred after eight years, then two annuli should be assumed. This criterion is based on two themes, i.e. the relatively high abundance of split zones in the early years of growth, and a desire to age conservatively (from a resource management point of view).

4.12 Arising from the presentations and the subsequent discussion it was apparent that there were minor differences in the definitions being used for nucleus and annuli. Arising from plenary discussion a series of definitions were agreed; these are listed below and shown diagrammatically in Figures 6 and 7 and on actual preparations in Figures 2 to 5.

Primordium: The point from which all growth in the otolith originates.

Nucleus: includes the primordium and extends outwards to the inside edge of the first translucent zone.

Annulus: working from the nucleus, this comprises one opaque and the next adjacent translucent zone. Thus:

Year 1: that part of the otolith from the nucleus extending out to the outer edge of the first translucent zone; and

Year 2: that part of the otolith that extends from the inner edge of the first opaque zone after the nucleus to the outer edge of the second translucent zone.

Checks: translucent growth zones, denoting a slowing of growth that forms within the opaque zone; do not form annually but reflect various environmental or physiological changes.

Distal surface: the external surface of the whole otolith, opposite the sulcus.

Proximal surface: the internal surface/sulcus-side of the whole otolith

Plus growth: opaque zone forming on the edge of the otolith; not counted in the age class designation.

Sulcus: the groove on the proximal surface through which the auditory nerve passes.

Transition zone: a region of change in the form (e.g. width or contrast) of the increments. The change can be abrupt or gradual. Transition changes are often formed in otoliths during significant habitat or lifestyle changes, such as movement from a pelagic to demersal habitat or the onset of first sexual maturity.

4.13 The Workshop agreed that 1 July was the most appropriate birthday to be used for *D. eleginoides*. This date was chosen because it:

- conforms with the best knowledge of the timing of spawning (Kock and Kellermann, 1991); and

- is also congruent with the best available knowledge of the time of formation of the translucent zone (Horn, 1999, 2001).

4.14 An illustration of the model of otolith growth adopted by the workshop is presented in Figure 7a. Because formation of the translucent zone coincides with spawning, the use of a 1 July birth date allows for correct year-class assignment (e.g. fish spawned in 1998 are always assigned to the 1998–1999 year class).

4.15 As a comparison to the otolith growth model adopted for *D. eleginoides*, a model is illustrated for a hypothetical fish which spawns or hatches in September and with annulus formation in May. This is shown in Figure 7b. In this example, the use of a 1 January birth date allows for correct year-class assignment (e.g. fish spawned in 1998 are always assigned to the 1998 year class). However, the use of a 1 September birth date, while being the correct biological birth date, causes the incorrect year-class assignment (i.e. fish harvested from January through August and belonging to the 1998 year class are mistakenly assigned to the 1999 year class).

OTOLITH SAMPLE PREPARATION

5.1 Mr Horn described the technique in use at NIWA to prepare otoliths for reading. The sequence of activities in use is as follows:

- clean dry otoliths are marked transversely through the primordia with a pencil;
- the otoliths are baked whole in an oven at 275°C for about 12 minutes, until amber in colour;
- the otoliths are embedded in rows in epoxy resin, and sectioned along the pencil lines (NB: all preparation and use of epoxy resin must be conducted in a fume cupboard by a technician using protective gloves);
- the sectioned surfaces are coated with paraffin oil prior to examination; and
- sections are viewed using reflected light under a binocular microscope at a magnification of x40.

5.2 Dr Krusic-Golub described the technique in use at CAF to prepare otoliths for reading. The sequence of activities is as follows:

- clean dry sagittal otoliths are embedded in rows of five in blocks of clear casting polyester resin ensuring that the primordium of each of the otoliths is in line. (NB: a well ventilated room and the use of organic gas masks is recommended);
- a minimum of four transverse sections (approximately 300–400 μm thick) are cut from the centres of the otoliths using a modified Gemmasta™ lapidary saw fitted with a 0.25 mm wide diamond impregnated blade;
- the sections are cleaned in water, rinsed with alcohol and dried;
- sections are mounted on microscope slides under glass cover slips with further polyester resin; and
- sections are viewed under transmitted light at x25 and x40 magnification.

Generally the otoliths are not baked in this process although this can be undertaken if so desired.

5.3 Dr Ashford described the technique in use at CQFE to prepare otoliths for reading. The sequence of activities is as follows:

- one of each pair of otoliths is selected randomly and baked at 400°C for approximately three minutes;

- otoliths are ground by holding the anterior side against the grinding wheel of a Hillquist Thin Section Machine until an internal mark is revealed which has been found to lie consistently just anterior to the nucleus;

- the ground face is then mounted on a glass slide using Krazy-Glu, left to dry, and ground from the posterior side to form a thick transverse section incorporating the nucleus and avoiding crenellations;

- the section is finally polished using Mark V Laboratory 3M aluminium oxide polishing paper, covered with Flo-Texx; and

- sections are viewed using reflected light under a binocular microscope at a magnification of x25.

5.4 The workshop concluded that the methods for preparation and reading of otoliths in use at CAF, CQFE and NIWA gave essentially similar estimates of age. Accordingly the workshop recommended to WG-FSA that these methods are the best currently available for the estimation of age in *D. eleginoides*.

5.5 It was noted that although these protocols provide satisfactory estimates of age, they are not necessarily the only ones that might be appropriate. Whilst favouring the current protocols the workshop accepted that new or revised protocols might be equally effective.

SAMPLING AND EXPERIMENTAL DESIGN

Assessment of Precision

6.1 Preliminary analyses of the data obtained from the otolith exchange project were undertaken using the 'Age-comparisons' spreadsheet (Eltink, in Eltink et al., 2000) available from the EFAN website. Only data from those experienced readers who routinely analyse *D. eleginoides* otoliths were included in the analysis. A total of 149 otoliths were analysed. Some technical difficulties were encountered whilst using the 'Age-comparisons' spreadsheet as it had been designed for age reading comparisons for fish less than 15 years old. Since it was not possible to rectify the problem during the course of the workshop, a small proportion of the results, 15%, were not included in the analysis. In spite of this difficulty, the spreadsheet enabled a quick and easy analysis of the precision of otolith age estimates of *D. eleginoides*.

6.2 Overall there was reasonable agreement in age estimations between all three readers. The close agreement in overall CV (Table 2) obtained from the three sets of otoliths strongly suggests that the method of sample preparation does not affect the precision of estimated age. There is little evidence that the variability of age estimates increases when readers are presented with material prepared by methods with which they are unfamiliar. Although there is no evidence that preparation method has an effect on precision, an analysis of bias plots (Figure 8) for each reader shows that the age estimates made by one reader (reader 3) were consistently lower than those of the other two readers. This trend is in broad agreement with the results of a previous otolith exchange exercise undertaken between readers 2 and 3. It is suggested that differences in the interpretation of the first few annuli are probably the main cause of these differences.

6.3 The results obtained from the preliminary otolith exchange project have highlighted the value of continued otolith exchanges between those laboratories which routinely use otoliths to estimate the age of *D. eleginoides*. The workshop recommended that exchanges should occur annually and should include any new laboratories that wish to start reading *D. eleginoides* otoliths.

6.4 The workshop suggested the following scheme for a future routine otolith exchange program:

- Each participating laboratory should select pairs of otoliths from 40 fish (80 otoliths total).
- One otolith of each pair should be prepared and read using the routine methods of the 'originating' laboratory.
- In order to assess the effects of differences in preparation methods between laboratories the remaining otoliths of each pair should be divided between the other two laboratories, designated 'receiving laboratories', (20 otoliths each) for preparation and reading.
- The preparations to be archived and the results collated into a single annual report by the receiving laboratory.
- Organisation for such an exchange and the eventual central archiving of samples could be undertaken through the CCAMLR Otolith Network.
- The same archived otolith preparations should be made available for all new laboratories wishing to read *D. eleginoides* otoliths thus providing a source of reference material for all methods of otolith preparation.

Reference Otolith Sets and Validation Tests

6.5 The three main laboratories estimating age in *D. eleginoides* already use reference otolith sets in internal protocols as standards to prevent drift in the reader's estimates of age over time. Dr Ashford indicated that CQFE had data documenting this type of error in age estimation of *D. eleginoides* during training of a reader.

6.6 The workshop participants considered that the use of sample collections with standard ages were essential in preventing drift, and should be recommended. It was suggested that the proposed central archive of otoliths from the CCAMLR Otolith Network (see paragraph 6.4) might be used as a CCAMLR-wide standard set which could be passed around laboratories. The quality control (QC) methodology could then be used to see if significant biases occurred between estimated and standard ages.

6.7 Although standardised reference sets would allow the quality of age data to be monitored and corrections made when bias is found, the relationship between true and estimated age would be left unknown. The workshop considered that validation tests of the standard ageing methodology were of the highest priority.

6.8 Marginal increment analysis would allow the timing of zone formation in the otoliths to be ascertained. Although important, this would not however allow direct estimations of accuracy. These would be best achieved by tag–recapture studies with otoliths chemically marked by bomb-carbon analysis or by rearing experiments. These would allow a quantitative treatment comparing true ages and ages estimated by reading otoliths in an ANOVA design. However, the null hypothesis would be that there was no significant difference, and to test if this was true, a high statistical power would be needed. As a result, the group agreed that it was necessary to estimate the sample size needed for the correct level of power, using estimates of precision in repeat readings. It was observed that enough data now existed on precision for this to be possible.

6.9 Dr Krusic-Golub reported on a collaborative study with Mr R. Williams (Australian Antarctic Division). Sagittal otoliths collected from tagged and recaptured *D. eleginoides* were examined to determine if Strontium Chloride marks can be detected and secondly, the relationship between annulus formation and the period at liberty.

6.10 A strong mark had been detected on 66 of the 68 otoliths examined. This high rate of detection indicates that the technique is an effective method for marking *D. eleginoides* otoliths and provides a tool by which validation may be undertaken. For each year at liberty positive growth occurred and a single annulus was formed. Results from this preliminary study support the view that each annulus in the otolith, as defined by the current criteria, represents a year's growth.

Quality Control and Quality Assurance

6.11 Dr Ashford made a presentation showing that for *D. eleginoides* repeat readings within and between readers can be treated in a statistically rigorous manner. Thus, variance of repeat age estimates from the 1:1 relationship does not increase with age after the first three or four years. As a result, the residuals are normally distributed, usually show reasonably homogeneous variances between readings, and show no trends, fulfilling the assumptions of ANOVA. Using a design blocked on individual fish (Ashford, 2001), bias between readings and between readers can therefore be estimated using the difference between the estimated general mean and estimated treatment mean ($y_{..}$-$y_{i.}$), and reader variability can be estimated by the variance of the residuals. This allows data to be corrected for bias, and monitored for levels of variability to assure quality control. Corrections can then be made for any biases from true age in estimated ages that subsequently become evident through validation studies.

6.12 He also pointed out that estimates of reader variability using CV usually did not correct for bias beforehand, and were inflated as a result when bias was present. The distribution of residuals also meant that CV decreased with age, confounding comparisons between samples with different ages.

6.13 The workshop agreed that the method of estimating precision and variability in readings allowed a more sophisticated treatment of age data, and provided a rigorous framework for quality control of data.

6.14 In further discussion, the representatives of the three main laboratories estimating age in *D. eleginoides* agreed that they should exchange otoliths on a regular basis, and use the QC methodology to ensure that their readings were in agreement. Each laboratory would provide a sample of otoliths, processing and reading one randomly chosen otolith from each pair. Half of the remaining otoliths would be sent to each of the other laboratories to process and read.

Sampling for Age Data

6.15 Dr Ashford presented some results from a field trial of a sampling methodology designed with members of WG-FSA (Ashford et al., 1998; Ashford, 2001). The methodology used a multi-stage sampling design: essentially, a line is divided into 10 sections and two of these sections are randomly chosen. All fish caught on these sections are then sampled. The method allowed different observer tasks required to be integrated into a single random sampling design. Information from the trial indicated that most variability occurred within each section, but significant variability occurred at broader scales which needed to be accounted for. The trial also indicated that observers could sample fewer lines, thereby improving efficiency and freeing up time that could be allocated to other tasks.

6.16 The workshop agreed that this appeared a reasonable solution to the problem of obtaining representative samples from the *D. eleginoides* catch, and a subgroup was formed to consider the methodology further. The subgroup consisted of four participants who had acted as observers, with experience of a wide variety of longliner designs (Mr J. Selling, Germany), Mr P. Brickle (UK), Dr Belchier and Dr Ashford), and several others with experience in designing protocols for obtaining age data through observer programs, or for fisheries surveys (Dr C. Jones (USA), Mr Horn, Dr A. Arkhipkin (UK)).

6.17 Dr Jones pointed out that the CCAMLR *Scientific Observers Manual* did not include sampling for age data among the observer's highest priority tasks, even though this had been recommended by WG-FSA. He further observed that although the use of a randomised sampling design was recommended in the manual, none was provided to observers. The subgroup agreed that it was important that both these omissions should be corrected.

6.18 Dr Jones suggested that an important facet of sampling was the purpose for which the sampling was undertaken. The questions to be addressed should be defined beforehand. The subgroup then considered the methodology of Ashford et al. (1998). The members with observer experience agreed that the design was realistic, and easy to implement. The workshop agreed that, for obtaining population length data, this represented a considerable improvement over present ad hoc methods and should be incorporated in the *Scientific Observers Manual*.

6.19 For sampling for an age–length key, as it would be impossible to sample all fish within each line section, the workshop agreed subsamples should be taken instead. Various ways of achieving this were considered; eventually it was agreed that the first five fish of every selected line section should be subsampled for age. While recognising other methods would provide more statistical rigour, it was felt that this provided a practical solution in the interim until a methodology combining practicality and rigour could be developed. Meanwhile, sampling the beginning of the line section was a great improvement on the ad hoc method presently used.

6.20 For obtaining age data for von Bertalanffy growth function estimates, the design should be stratified by 5 cm total length increments: thus, observers should use the methodology of Ashford et al. (1998), sampling for each 5 cm stratum until that cell is filled. This was considered a practical solution, although the workshop recognised that, because of the numbers-at-length, cells for increments between 80–100 cm would be filled quickly, while those for large and small fish would be filled more slowly. Thus the sampling frames for different cells would be somewhat different.

6.21 The workshop also discussed the numbers of samples requested by CCAMLR from each observer. It was felt that enough information was now available on precision levels in age estimations to calculate the sample numbers necessary for each purpose defined. The group asked Dr Ashford to undertake these calculations and present a report at the next meeting of WG-FSA.

OTOLITH STUDIES LINKED TO OTHER ASPECTS OF SOUTHERN OCEAN ECOLOGY

7.1 During discussions on future work, the workshop was given three small presentations on oceanography, some aspects of which may prove useful in the elucidation of *D. eleginoides* distribution and migration.

7.2 Dr Cynthia Jones (CQFE) told the workshop of her work on the trace elemental components that are incorporated into fish otoliths from the water column. CQFE uses a technique called laser ablation Inductively Coupled Plasma Mass Spectrometry (ICPMS) to measure the concentrations of trace elements from a small sample taken from the otolith. Trace element accumulation into fish otoliths varies among samples collected at different areas and reflects the characteristics of different waters. The concentrations of trace elements such as strontium and dO^{18} and dO^{16} isotope ratios have a relationship with salinity and temperature respectively. This technique is useful for looking at the spatial distribution of fish. It may also have implications in the study of fish movements and migration by investigating the trace elements in samples taken from earlier growth rings and the outer growth rings of otoliths.

7.3 Dr E. Hofmann (USA) talked to the workshop on Southern Ocean oceanography and how the structure of the environment affects ecosystems. She gave examples of where large and small-scale variability in the environment results in changes of the nature of biological interactions. She presented examples of new conceptual models that affect the nature of ecosystems. These included the Circumpolar Wave, a meteorological phenomenon, that has an effect on the extent of the sea-ice with a 4~5 year periodicity. Other examples included the interannual variations in the extent of the sea-ice, the distribution of upper Circumpolar Deep Water and the southern boundary of the Antarctic Circumpolar Current. The latter seems to have most effect on ecosystems in its boundary currents and a number of species are affected by this, examples given included krill and *Pleuragramma* spp. Dr Hofmann also presented a model for the oceanography of Drake Passage Scotia Sea area.

7.4 Dr Arkhipkin spoke of a project proposal to study the demography and migrations of the *D. eleginoides* in the Southwest Atlantic. He presented fishery data on *D. eleginoides* around the Falkland/Malvinas Islands. Dr Arkhipkin also described the distribution of juvenile *D. eleginoides* in the trawl fishery on the shelf and in the longline fishery in waters greater than 600 m. He described three areas, one in the north (50°S), one in the southeast (54°S) and one of lesser importance to the east where the fishery is concentrated. It is unclear as to whether these concentrations represent a single stock or several stocks originating from different regions in the Southwest Atlantic. Dr Arkhipkin presented a scheme of currents around the Falkland/Malvinas Islands and a hypothesis of the ontogenetic migrations of the *D. eleginoides* from the slope waters to the three major areas off the shelf in deeper waters associated with these currents. The aims of the project will include genetic screening of mitochondrial and microsatellite DNA, ICPMS for trace elemental analysis and parasitological studies to identify stocks and trace migrations of *D. eleginoides*.

FUTURE WORK ON *D. ELEGINOIDES* OTOLITHS AND ADVICE TO WG-FSA

Advice to WG-FSA

8.1 (i) the workshop agreed that although age determination of *D. eleginoides* was difficult, it could be achieved using otolith sections (paragraph 4.1);

(ii) key features to be taken into account in reading otoliths are set out in paragraphs 4.9 to 4.15;

(iii) three otolith preparation protocols were discussed, all of which were considered suitable for age determination of *D. eleginoides* (paragraphs 5.1 to 5.5);

(iv) the workshop recommended that a routine program to exchange otoliths for age determination between laboratories be established (paragraphs 6.4. and 6.14.);

(v) the workshop recommended that all protocols for age determination be subject to quality assurance and quality control as described in paragraphs 6.4, 6.5 to 6.8 and 6.14;

(vi) the workshop recommended that reference sets of otoliths be prepared in order to monitor the precision of experienced and new readers (paragraph 6.6); and

(vii) the workshop recommended that the CCAMLR *Scientific Observers Manual* should be revised to incorporate the randomised sampling methodology of Ashford et al. (1998), and reflect the priorities laid down by WG-FSA (paragraphs 6.17 to 6.21).

Future Work

8.2 The workshop agreed that further research is needed on the following topics:

(i) determine more precisely the time interval between the formation of the primordium and the formation of the distal edge of the first translucent zone or the edge of the nucleus (paragraph 4.13);

(ii) validation of the timing of annulus deposition through Marginal Increment Analysis (MIA) (paragraph 4.13);

(iii) develop other validation methods specifically to estimate accuracy (paragraph 6.7); and

(iv) follow modal progression of length density of pre-recruits from a single area with otolith ground-truthing, with the aim of better defining their growth (paragraph 6.7).

Coordination of Otolith Research

8.3 The workshop had provided a valuable opportunity for participants to discuss their work and to develop new ideas and collaborations. It was agreed that there would be considerable merit if this activity could continue and agreed to form its own CCAMLR Otolith Network (CON) to which all participants along with anyone interested in studies on otoliths of Southern Ocean fish could join. Initially CON would meet by correspondence through email although meetings might be arranged in the margins of symposia or CCAMLR meetings.

CLOSE OF THE MEETING

9.1 The Convener noted that the workshop could not have taken place without a great deal of hard work by many individuals. He thanked Drs Ashford and Krusic-Golub and Mr Horn for providing samples and leading the way with the otolith exchange exercise. He thanked all the participants at the workshop for their hard work throughout the meeting. Support for the workshop had come from CQFE and also from the US AMLR Program and this was gratefully acknowledged. Finally he thanked all the CQFE team for keeping the meeting running smoothly and efficiently. The CQFE team in turn thanked the Convener for his considerable efforts in initiating and chairing the workshop.

9.2 The Convener wished all participants a safe journey home and closed the workshop.

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Table. 1: Descriptions of translucent and opaque zones as seen in otoliths when viewed under reflected and transmitted light

Definition	Light Source	
	Reflected Light	Transmitted Light
Translucent Zone – Zone that allows greater passage of light than opaque zone. Has been referred to by some authors as the hyaline zone.	Appears as darker bands on otolith surface when light is reflected.	Appears as lighter bands when light is transmitted.
Opaque Zones – Zone where passage of light is restricted.	Appears as lighter bands on otolith surface when light is reflected.	Appears as darker bands when light is transmitted.

Table 2: Coefficient of variation (CV) in total age estimations from otoliths prepared at different institutions.

Otolith Preparation (institution)	CV all Readers (%)
CQFE	14
MAFRI	19
NIWA	16

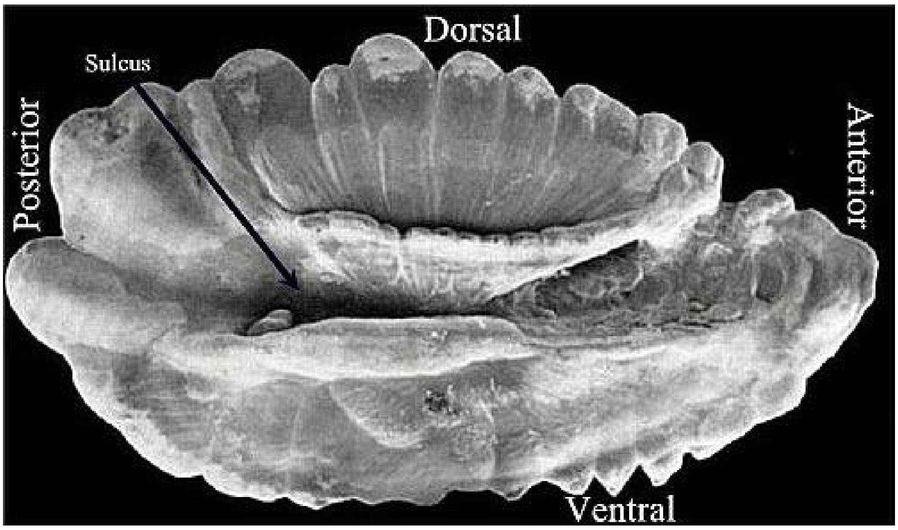


Figure 1: Proximal surface view of whole *Dissostichus eleginoides* otolith. Otolith SEM image © Australian Antarctic Division.

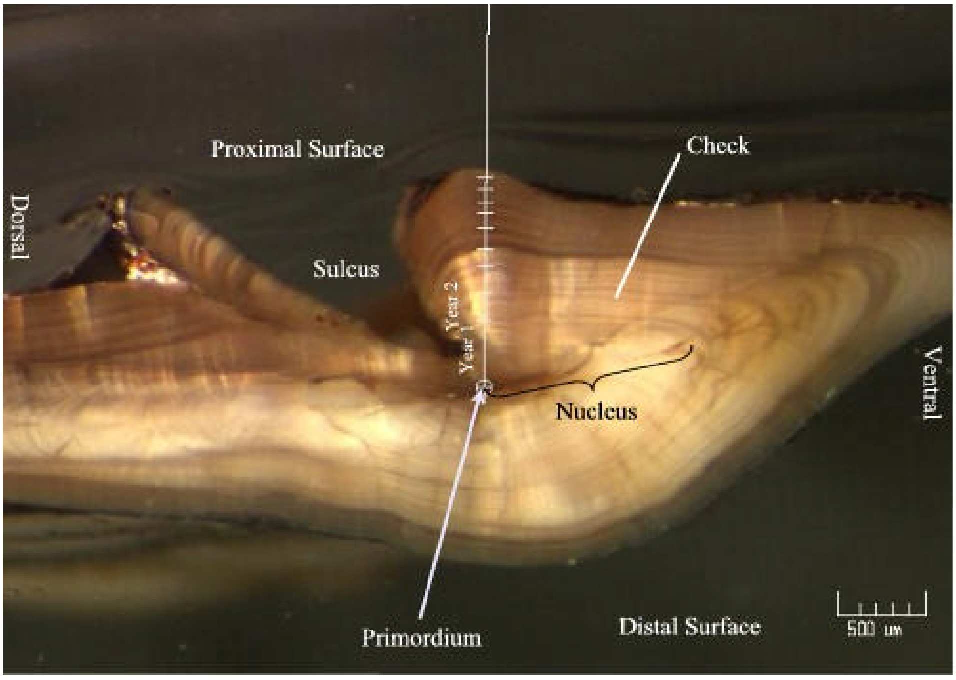


Figure 2: Features associated with sectioned *Dissostichus eleginoides* otolith prepared according to NIWA methodology and viewed under reflected light.

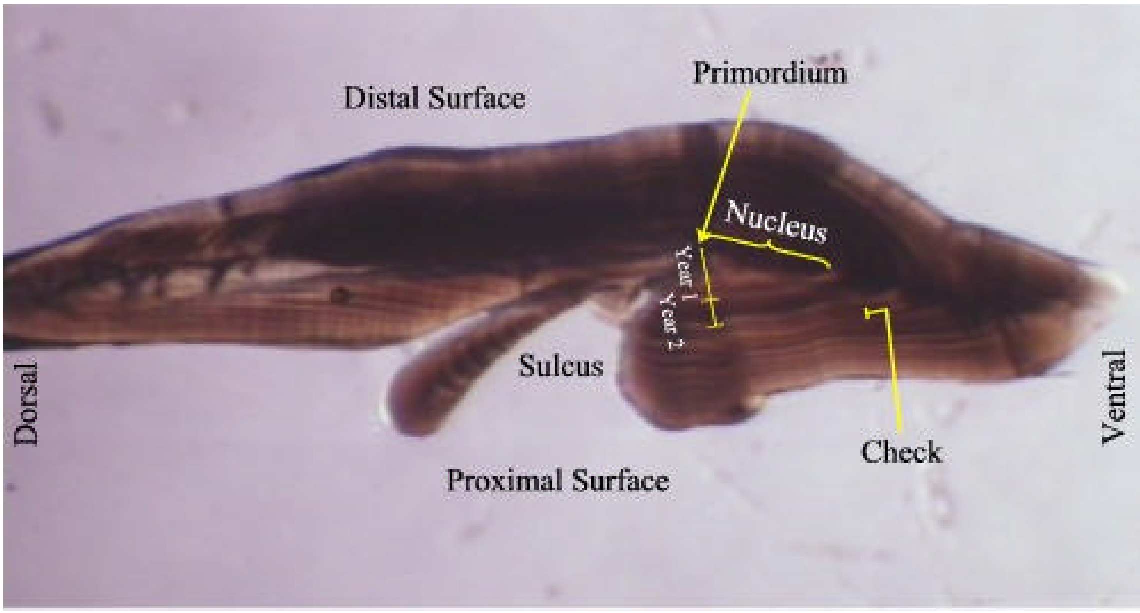


Figure 3: Features associated with sectioned *Dissostichus eleginoides* otolith prepared according to CAF methodology and viewed under transmitted light.

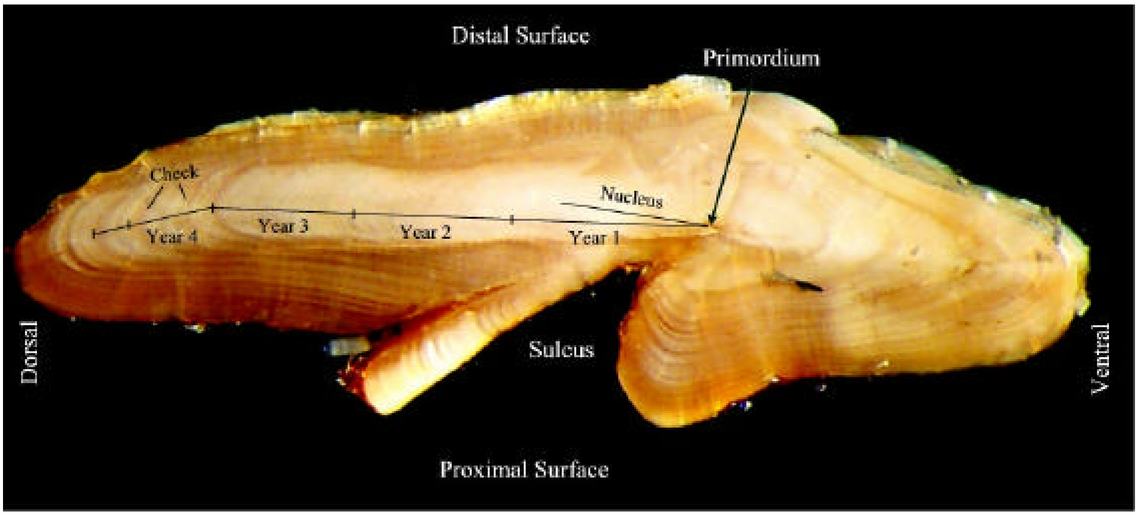


Figure 4: Features associated with sectioned *Dissostichus eleginoides* otolith prepared according to CQFE methodology and viewed under reflected light.

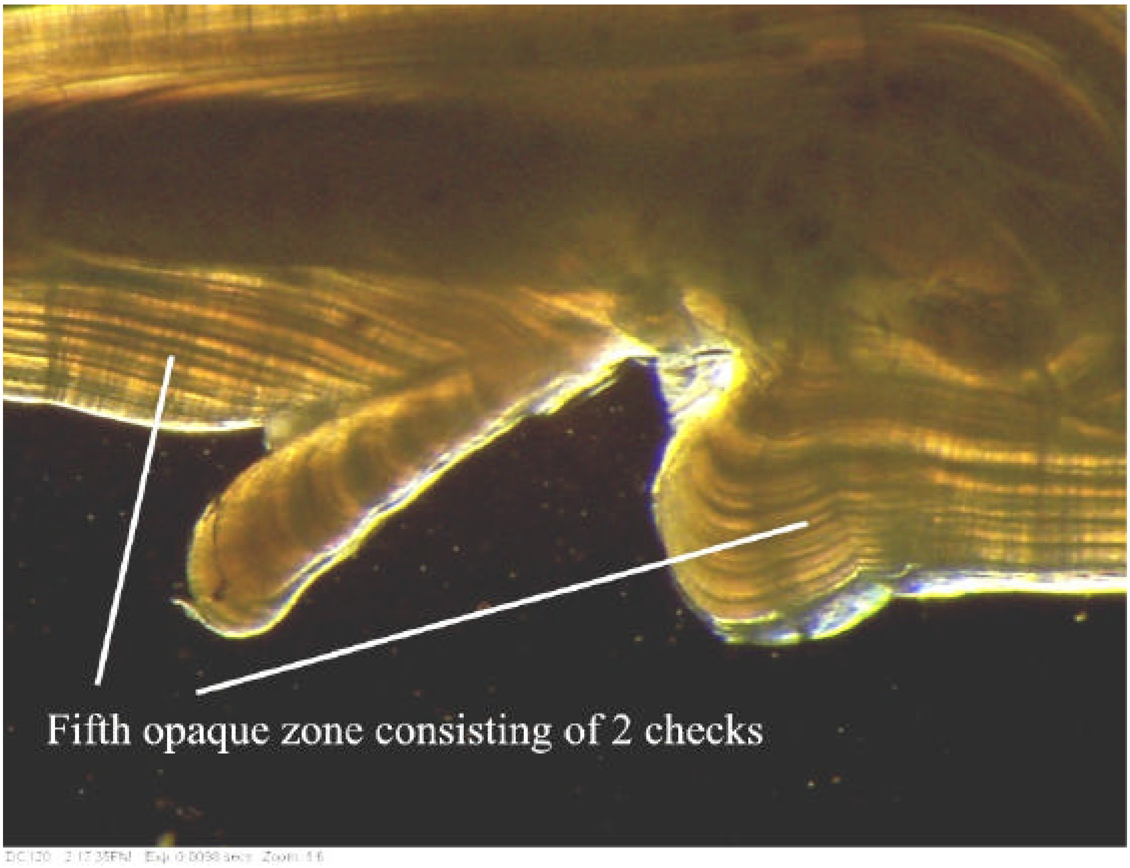


Figure 5: Checks associated with sectioned *Dissostichus eleginoides* otolith prepared according to CAF methodology and viewed under transmitted light.

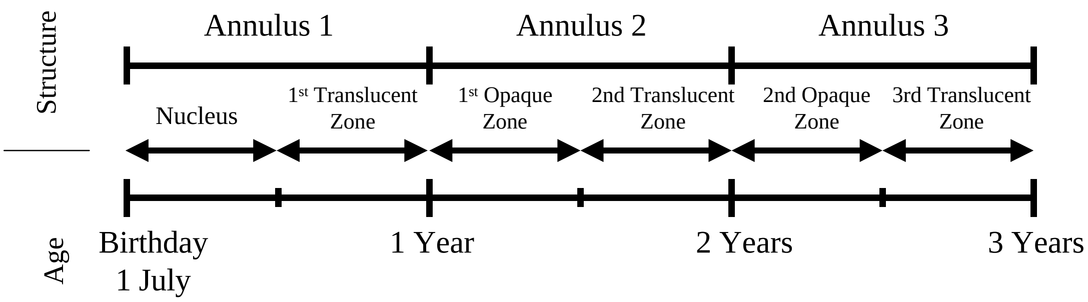
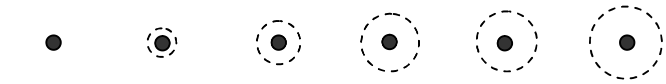
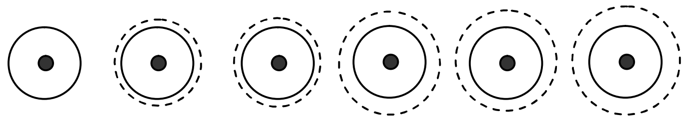


Figure 6: Defined timeline of otolith age and growth structures for *Dissostichus eleginoides*.

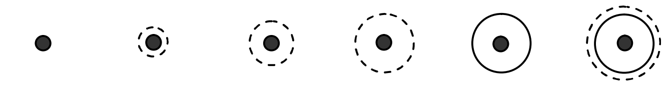


	Jul. 1998	Sept. 1998	Nov. 1998	Jan. 1999	Mar. 1999	May 1999
True Age	0	0.167	0.333	0.5	0.667	0.833
Assigned Age	0	0(0+)	0(0+)	0(0+)	0(0+)	0(0+)
True Year-Class	98-99	98-99	98-99	98-99	98-99	98-99
Assigned Year-Class	98-99	98-99	98-99	98-99	98-99	98-99

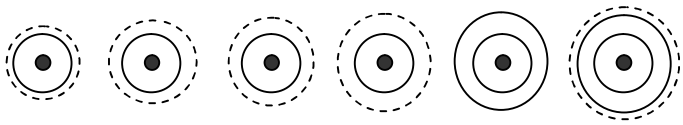


	Jul. 1999	Sept. 1999	Nov. 1999	Jan. 2000	Mar. 2000	May 2000
True Age	1	1.167	1.333	1.5	1.667	1.833
Assigned Age	1(1)	1(1+)	1(1+)	1(1+)	1(1+)	1(1+)
True Year-Class	98-99	98-99	98-99	98-99	98-99	98-99
Assigned Year-Class	98-99	98-99	98-99	98-99	98-99	98-99

Figure 7a: Model of otolith growth and annulus formation for *Dissostichus eleginoides*. Solid circles represent annuli and dashed circles represent plus growth.



	Sept. 1998	Nov. 1998	Jan. 1999	Mar. 1999	May 1999	Jul. 1999
True Age	0	0.167	0.333	0.5	0.667	0.833
Assigned Age	0	0(0+)	1(0+)	1(0+)	1(1)	1(1+)
True Year-Class	1998	1998	1998	1998	1998	1998
Assigned Year-Class	1998	1998	1998	1998	1998	1998



	Sept. 1999	Nov. 1999	Jan. 2000	Mar. 2000	May 2000	Jul. 2000
True Age	1	1.167	1.333	1.5	1.667	1.833
Assigned Age	1(1+)	1(1+)	2(1+)	2(1+)	2(2)	2(2+)
True Year-Class	1998	1998	1998	1998	1998	1998
Assigned Year-Class	1998	1998	1998	1998	1998	1998

Figure 7b: Model showing otolith growth and annulus formation for a fish which spawns in September and with annulus formation in May. Solid circles represent annuli and dashed circles represent plus growth. (a) Use of a 1 January birth date allows for correct year-class assignment. The age-class designation, or age, is written first followed by the actual number of annuli visible listed within brackets (e.g. 1(1+)). The presence of a '+' after the number in the brackets indicates new growth, or 'plus growth' visible on the structure's margin. Using this method, a fish sacrificed in January before annulus formation with one visible annuli would be assigned the same age, 2(1), as a fish with two visible annuli sacrificed in August after annulus formation, 2(2). (b) Use of a 1 September birth date, while the correct biological birth date, causes the incorrect year-class assignment.

ATTACHMENT 1

LIST OF PARTICIPANTS

Workshop on Estimating Age in Patagonian Toothfish
(Center for Quantitative Fisheries Ecology, Old Dominion University,
Norfolk, Va., USA, 23 to 27 July 2001)

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ATTACHMENT 2

AGENDA

Workshop on Estimating Age in Patagonian Toothfish
(Center for Quantitative Fisheries Ecology, Old Dominion University,
Norfolk, Va., USA, 23 to 27 July 2001)

1. Introduction and Welcome

2. Adoption of Agenda and Arrangements for the Meeting

3. Aims of the Project

4. Results of Otolith Exchange

5. Estimation Methodology
   - 5.1 NIWA
   - 5.2 CAF
   - 5.3 CQFE

6. Definitions of Nucleus and Annuli

7. Reading Ages from Samples

8. Sample Preparation

9. Sampling and Experimental Design

10. Reference Otolith Sets

11. Methods Report
    - 11.1 Otolith Preparation
    - 11.2 Otolith Reading

12. Further Work
    - 12.1 Validation
    - 12.2 Otolith Studies Linked to Other Aspects of Southern Ocean Ecology

13. Adoption of Report

14. Any Other Business

15. Close of Meeting.